Oxytetracycline Detection Analysis on Age-0 Walleye in Bell and North Steeprock Lake(s), Western Region, Manitoba (2013-2016)

Final Report for Fisheries & Wildlife Enhancement Fund (FWEF) Project

Project 15-036 Integrated Fisheries Assessment, Maintenance & Monitoring

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1.0 Introduction

Determining natural recruitment success and stocking efficiency on high pressure walleye fisheries has become a high priority for SVSFE and Manitoba Sustainable Development. Through recruitment surveys, partners can (1) work together in determining appropriate and more effective fry stocking rates, (2) allocate the limited annual fry supply more effectively and efficiently and (3) help determine success of natural recruitment. In 2013, SVSFE initiated the first Oxytetracycline (OTC) Detection Analysis in the Western Region on Bell and North Steeprock Lake(s). The program was in partnership with the Eastern Region's Multi-Year OTC Study (FEF project 10-004) with the primary funding acquired through annual Fisheries Enhancement Fund (FEF) or the latter, Fisheries and Wildlife Enhancement Fund (FWEF) projects managed by SVSFE (12-042, 13-063, 15-004, 15-036). FWEF promotes and funds projects that enhance and conserve Manitoba's recreational fisheries resource. Please refer to the projects mentioned above for more information. Final reports can be found on the SVSFE website. www.swanvalleysportfishing.com

During the late 90's studies both Bell and North Steeprock Lake were identified as established walleye fisheries and have been intermittently stocked with fry since 1959. In efforts to sustain these walleye populations a protected slot size regulation was imposed on both North Steeprock and Bell lake in 2009. Following several surveys conducted by both fisheries branch and SVSFE over the years it was agreed the extent on stocking success compared to natural recruitment remained unknown. Therefore in 2013, an three year OTC detection study was initiated on both Bell and North Steeprock Lake(s).

In order to measure the success of a stocking program, there must be a goal in which the program is striving to achieve, and only once that has been defined, can one measure the relative success of the program as a function of the ability to meet that goal (Waples 1999). Many researchers have considered stocking programs which contributed to walleye year-class abundance to represent a successful stocking program (Johnson 1971, McWilliams and Larsceid 1992, Parsons 1994, and Kampa and Jennings 1998). Ultimately, the majority of stocking programs, including those in place in Manitoba, do not have clearly outlined goals and therefore seem to work towards the goal of providing walleye for future harvest (Brooks et al. 2002). SVSFE perceives goals in a successful walleye stocking program include;

- sustaining a healthy and diverse walleye population.
- Provides good angling quality (ie. angling opportunities for both "eater" sized and larger fish).
- Where/when possible develops/supports long-term natural sustainability.
- The stocking program is economically viable (cost effective)

2.0 Background Information

2.1 Bell Lake: As mentioned, Bell Lake has been intermittently stocked with walleye since 1959. The rate and frequency has varied depending on fry availability and changing management objectives but most recently stocking rates have been slightly above 1000 fry/littoral hectare with 200,000 fry on supplemental (annual) stocking years.

Over the years, multiple studies have been conducted on Bell Lake. Following the 1992 index netting managers suggested Bell Lake was a "reasonably good walleye fishery that has been maintained mostly by natural recruitment" (Yakes, 1992). The study also suggested "recruitment does not appear to be a problem" as they "observed numerous rocky shoals in the lake that appeared to be adequate for walleye spawning" (Yakes, 1992).

A 2009 Creel Survey indicated minimal fishing pressure at 1.96 anglers/day and fishing quality of 2.1 walleye/hour. In addition angling pressure expressed through barrel counts, complimented survey feedback with moderate harvests throughout the open water season with an average of 346 fish being harvested/year. Peak fishing was noted during the month of July.

The 2012 & 2013 trap netting (FEF Projects 11-035 & 12-024) carried out by SVSFE indicated "walleye populations are characterized to have a fair density (3.9 walleye/hectare) with frequencies of mature fish increasing" (Urban 2013). It also stated receiving age results (pending at that time) would help further understand the walleye population dynamics. The subsample of walleye aged found some of the largest fish (540-570mm) to be between the ages of 8 – 12. Seining results during that time found low densities and diversity of forage fish with no signs of walleye recruitment. It was also stated, fluctuating water levels during walleye spawning periods may be influencing the success of spawning/recruitment. Interestingly enough, the 1992 survey also noted slow growth to be associated with forage availability and consideration could be given to the introduction of a yellow perch, shiners or fathead minnows. Following the recent surveys, SVSFE put Bell Lake on the radar to further investigate forage availability, stocking success, and better understand natural recruitment.

Bell Lake Foggy Morning - June 3rd, 2013

2.2 North Steeprock Lake: North Steeprock Lake has been intermittently stocked with walleye since the late 50s. The rate and frequency has varied depending on fry availability and changing management objectives but most recently was stocked slightly below 1000 fry/littoral hectare at a rate of 400,000 fry/year on years where supplemental stocking existed. Over the last 30+ years, multiple studies have been conducted on North Steeprock Lake, but similar to Bell Lake, the extent of natural reproduction was not fully understood.

One of the quinquennial surveys conducted in 1992 suggested "recruitment of walleye as a problem which may be due to; poor spawning habitat and/poor fry survival after spawning "(Yake, 1992). Subsequently, a telemetry study was conducted in 1998 to identify potential walleye spawning habitat. It was determined the majority of fish (5/8) visited the inflowing river inlet during critical periods suggesting spawning may be occurring here. Improvements were made to the crossing of this inflow and interestingly in 2009, SVSFE technicians observed a 100% visual on walleye spawning in this inlet significantly upstream (Urban 2009).

Through the 2009 angler survey, fishing pressure was a slightly higher then Bell lake at 4.8 anglers/day but the angling quality was similar with 2.1 walleye caught/hour. Annual barrel counts of the three species present an average 1383 fish per year harvested since 2004. Walleye has usually fell below the maximum sustainable yields with the exception of 2015 where the estimated harvest was slightly above 1,000 kg of walleye removed. Peak fishing included the months of June and July for walleye and pike, while August was best for lake whitefish.

Further studies, including walleye tagging in 2009 and trap netting in 2012 & 2013, found walleye populations were fair to moderate (3.7 walleye/hectare) with mature walleye being the average sized fish. Walleye ages found some of the oldest fish to be well into the high teens and low twenties. In was stated "Lower numbers of smaller walleye could indicate recent challenges with recruitment success " (Urban, 2013). It was apparent through seining results, forage was highly available with high densities of spottail shiners. These studies have concluded recent walleye recruitment was potentially occurring as age 0+ walleye were found in seine catches during both years of the trap netting program. However, it is important to state, the amount of natural success was an unknown variable because supplemental fry stocking occurred during those years.

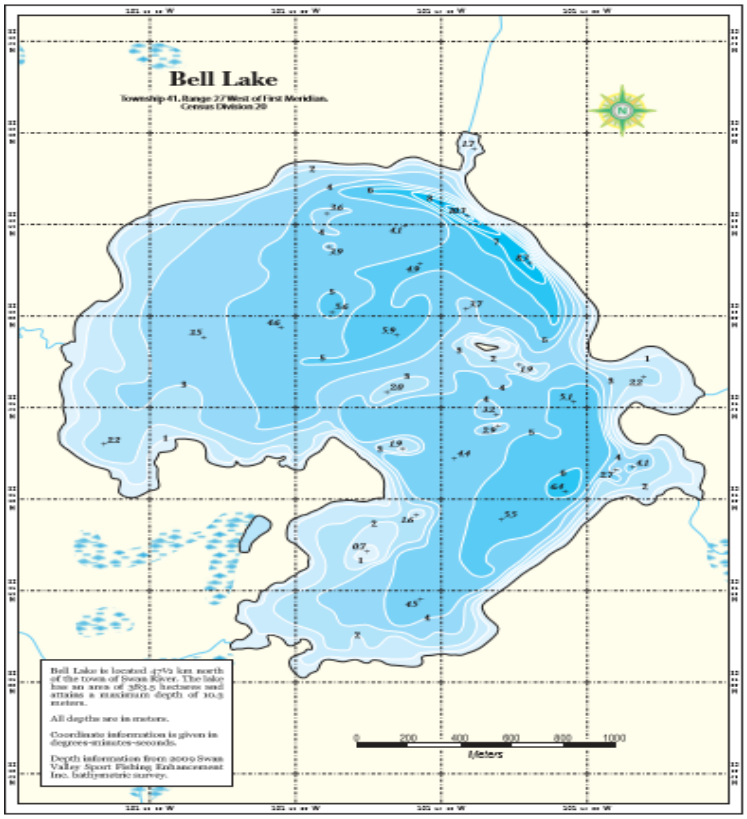
North Steeprock Sunset –August 6th, 2013

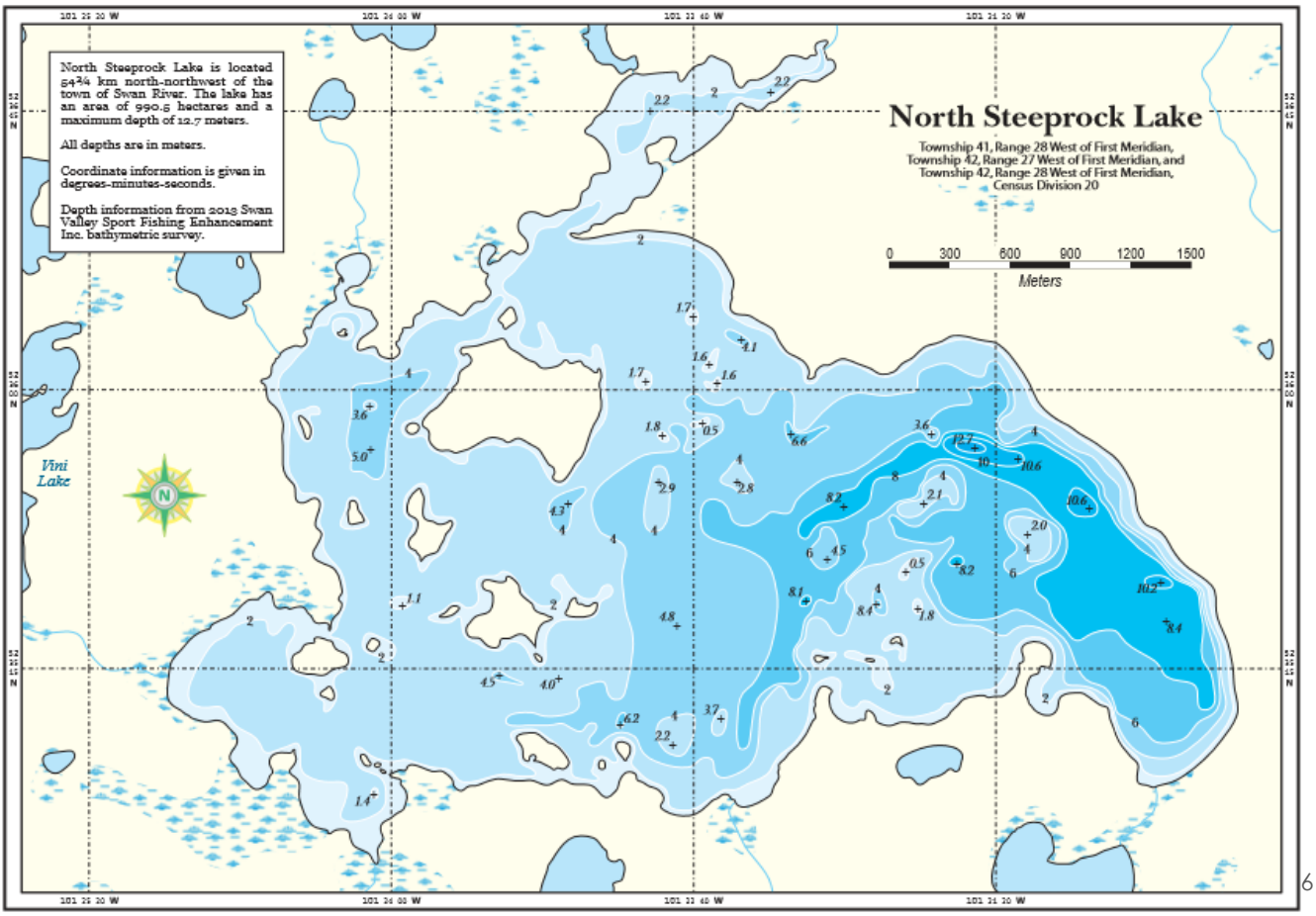
3.0 Study Area

Both lakes included in the OTC detection program are located in the Porcupine Provincial Forest north of Swan River Manitoba.

Bell Lake is located 47½ km north of the town of Swan River. The lake has an area of 383.5 hectares, 127.8 hectares which are littoral areas and attains a maximum depth of 10.3 meters and mean depth of 3.45 meters.

North Steeprock Lake is located 54¾ km north-northwest of the town of Swan River. The lake has an area of 990.5 hectares, 445.3 hectares which are littoral areas (<3m) and a maximum depth of 12.7 meters and a mean depth of 3.59 meters.

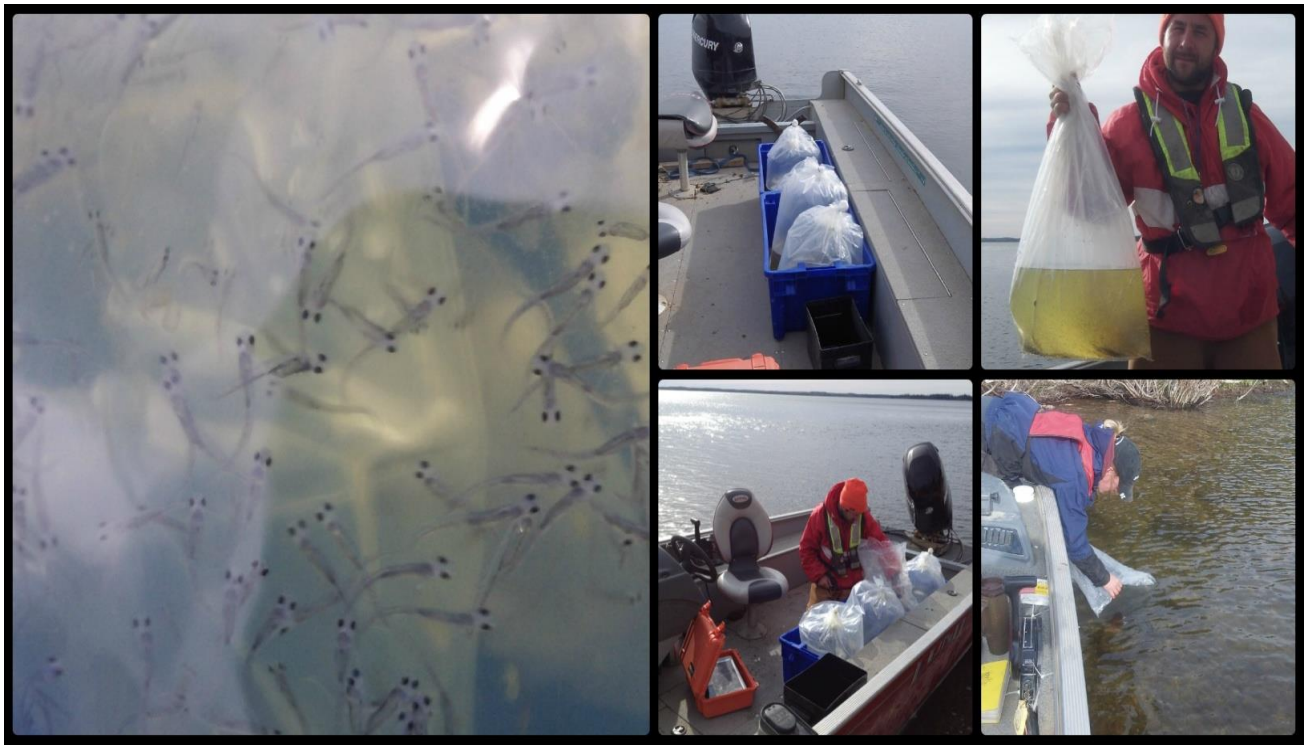




4.0 Methods

The first step to the OTC detection program begins at the hatchery. Since 2003, the Whiteshell and the Swan Creek hatcheries (the two major walleye hatcheries in Manitoba) have been marking walleye fry using Oxytetracycline (OTC). OTC is a non-lethal, non-toxic internal dying agent that imprints a mark on boney structures of fish (i.e. Otoliths). Prior to stocking, recently hatched walleye fry are immersed in an OTC solution for 6-7 hours; thus dying their bony structures. Efficacy trials (for the Whiteshell Hatchery) at this time have reached the 95+% mark (Kansas, 2013). Efficacy trials have never been conducted on Swan Creek OTC fry.

Fry stocked during the three year OTC detection program was consistently supplied by the Whiteshell Fish Hatchery. Stocking rates remained constant at 400,000 and 200,000 fry for North Steeprock and Bell Lake, respectively. Stocking dates were dependant on the spawn/egg collection in the Eastern Region and commenced on; May 30th in 2013, June 3rd in 2014, May 20th in 2015. In all years fry were scatter stocked in different areas of each lake to ensure dispersal and to plant fry in areas where zooplankton would be most available. In addition to the OTC detection program, in 2016 it was decided by managers and SVSFE stocking committee to reserve walleye fry stocking in either lake with the objective to evaluate natural recruitment success on a year which excluded supplemental stocking.



4.0 Methods:

Each fall of the program (2013, 2014, 2015 and 2016), SVSFE technicians along with various provincial fisheries staff re-visited these two candidate lakes in order to capture young-of-year walleye for analysis. Work was continuous during the month of September with North Steeprock surveys falling on September 9th (2013), 8th (2014), 7th (2015) and 26th (2016). Bell Lake surveys fell on September 10th (2013), 9th (2014), 7th (2015) and 26th(2016).

Electrofishing utilized the Smith-Root SR20 electrofishing boat to target YOY walleye. Electro-fishing is essentially a catchment method that has to ability to electrify the water and temporarily stun fish within the immediate area. In 2013, sample transects were predetermined and chosen based on a variety of substrates where young of the year were expected to be (sandy beaches with interspersed gravel, cobble, rock) but included various habitat compositions and fish cover found within each lake. All sites were marked and a route was created to simplify navigation during the process. Sampling was conducted at night (9pm-2am) during peak yoy walleye activity. In 2014, 2015 and 2016 sites were determined based on successful CPUE sites from 2013 as collecting the target sample size was priority (Figures).

4.0 Methods:

Conductivity was measured prior to electrofishing to predetermine settings for surveys. Conductivity at North Steeprock during the time of sampling was between 160$_u$s and 180$_u$s determining a setting ranged at 60 pulse/sec, DC 500 volts at 60 – 80% power for each of the four years. Output amperes ranged from 4.5 – 8.0. Conductivity at Bell Lake was found to be between 140$_u$s to 154$_u$s and transects were shocked with 60 pulses/sec, DC 500 volts at 75-90% power over the four years. Output amperes ranged from 5.8 – 7.5. Shocking settings were replicated/very similar from year to year, as relevant parameters (i.e. conductivity) remained the comparable.

While fishing along transects, two dip netters would be located on the fishing platform with one along the shore side of the boat. Following the completion of each transect all walleye were counted, recorded, bagged (labelled with transect number) and placed on ice for later sampling. Effort, habitat and settings were also documented for each transect.

All walleye were later sampled for fork length(mm) and weight(to a tenth of a gram using a digital Ohaus - Scout Pro SP2001 scale). Otoliths were placed in 1.5 ml micro-tubes or plastic bags to protect them from being damaged during shipping and the number of otoliths extracted and stomachs contents were recorded.

4.0 Methods:

Analysis of structures was in part of the Multi-Year OTC Study conducted by Ken Kansas within the Eastern Region Fisheries Branch. Otolith samples were sent to Dr. Daniel Isermann, assistant professor of fisheries and co-director of the Fisheries Analysis Center and the University of Wisconsin-Stevens Point in 2013. Do to unanticipated circumstances, Isermann was unable to conduct analysis on 2014 and 2015 samples, and these samples were sent to AAE Tech Services out of Winnipeg, Manitoba. AAE Tech Services (Mark Lowden), is known for their quality of work in all aspects of fisheries research and meet the aging standards set our by the Department of Fisheries and Oceans.

5.0 Results/Discussion

5.1 Bell Lake

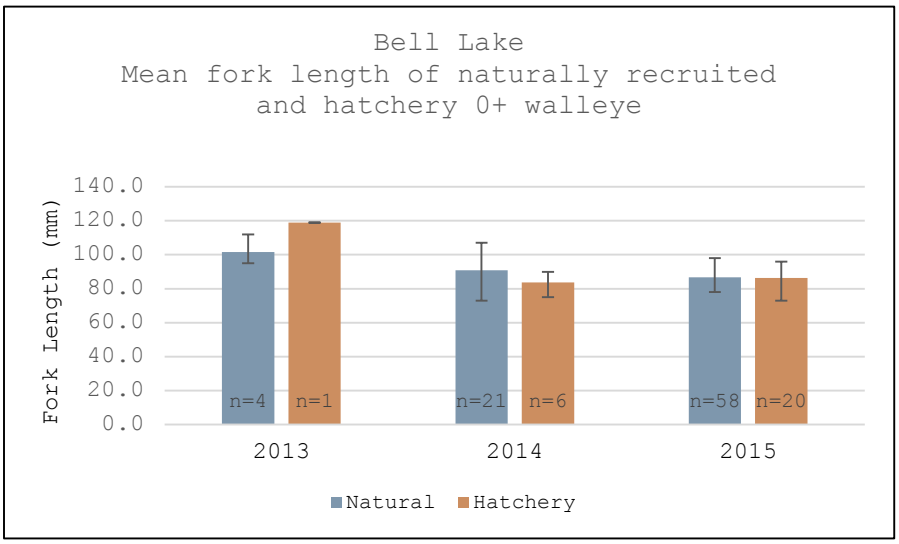
5.1.1 OTC Mark: Over the three year study a total of 110 0+ walleye were collected and sampled for OTC mark on Bell Lake. Of this sample, 83 yoys exhibited no OTC mark suggesting, on average, 77% of the total sample was naturally recruited (Table below).

Bell Lake Walleye Recruitement Success (Stocked vs. Natural)										
									Stocking	
Year	Sample Size	# of 0+ Walleye	% of 0+ Walleye	# 0+ with marked (OTC)	no mark (OTC)	% of stocked walleye	% of natural recruitment	Electrofishing Effort (hours)	Date	Annual Rate
2013	38	5	13%	1	4	20%	80%	1.45	30-May-13	200,000 fry or 1564 fry/ littoral hectare
2014	45	27	60%	6	21	22%	78%	1.96	02-Jun-14	
2015	81	78	96%	20	58	26%	74%	1.46	20-May-15	
Total	**164**	**110**	**56%**	**27**	**83**	**23%**	**77%**			

Important to state that one should not draw too many conclusions from the 2013 sample. The sample size is far from ideal to depict any theories/assumptions. Although, even as the sample size increased in the 2014 & 2015 surveys, the results are reasonably consistent with 74-80% of the 0+ being of natural origin.

5.1.2 Growth: In terms of walleye growth in the four month period, fingerlings are slightly smaller (Figure below) compared to North Steeprock 0+ growth, which is later discussed. Average size of 0+ walleye was 86.9 mm with an average condition factor of 0.95 (Table). Fulton's condition factor, (K) is another measure of an individual fish's health. It assumes that the standard weight of a fish is proportional to the cube of its length (Nash, 2006). Condition factors assume heavier fish of a given length are in better condition.

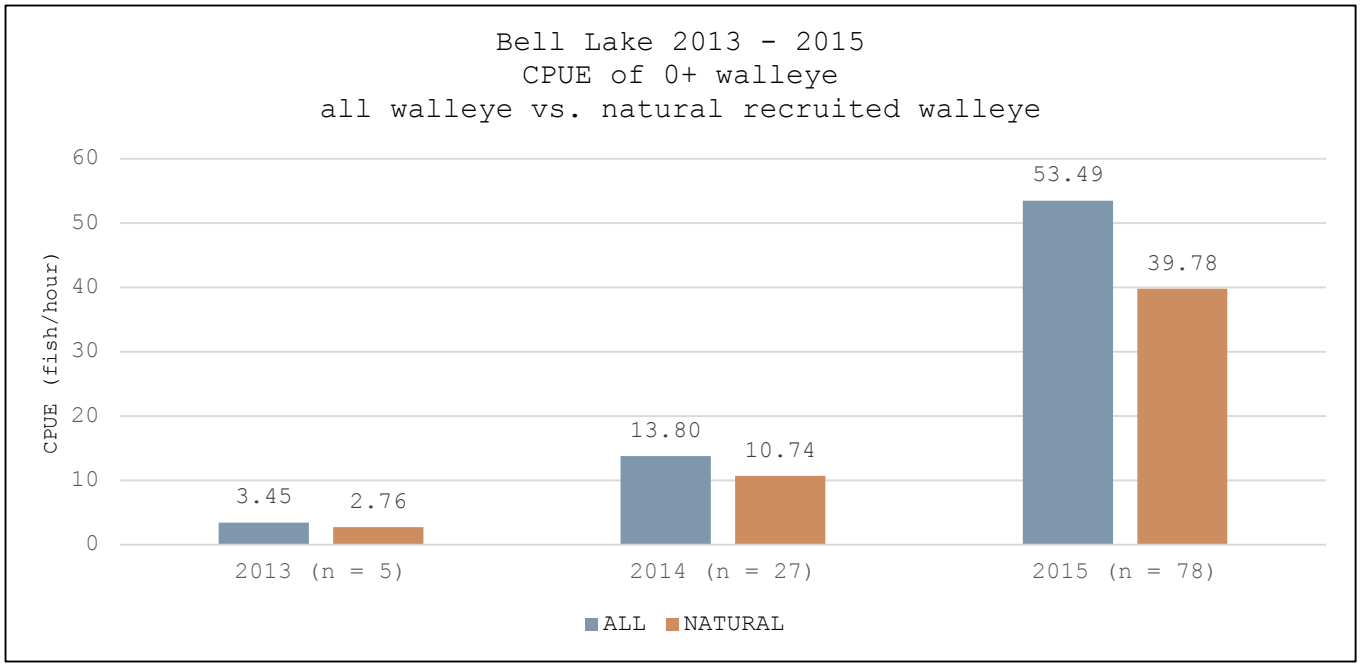
Year	Origin	n	Mean K
2013	Natural	4	0.96
	Hatchery	1	0.96
2014	Natural	21	0.93
	Hatchery	6	0.94
2015	Natural	58	0.99
	Hatchery	20	0.93
All Years	**Natural**	**83**	**0.96**
	Hatchery	**27**	**0.94**



The size of naturally recruited walleye seem comparable to the stocked walleye but on average grew slightly bigger. In a review of over 1700 walleye stocking records from Minnesota, Li et al. (1996a) found stocking fry into lakes with natural reproduction decreased the mean weight of fish in that year class.

Interestingly enough, with this concept in mind, during the 2016 recruitment survey where no supplemental stocking occurred, walleye growth was much greater then years where stocking commenced. The average size of 0+ walleye in 2016 was 102.3 mm.

5.1.3 Catch Per Unit Effort: In terms of catch per unit effort (CPUE), 2015 displayed the highest recruitment compared to others. Low catches in 2013 compared to the remaining two years could be simply related to more sites selected in low catch areas, habitat types which may not have been preferred locations for walleye fingerlings. In terms of the 2014 & 2015 surveys, efforts were concentrated on collecting a sufficient sample size and targeted only ideal yoy habitats.



2016 CPUE, not shown on the chart, found a catch of 16.25 fish per hour. Efforts in 2016 replicated the 2015 transects and as stated previously, the lake was not stocked during this year. Assessment conditions were not favourable in regards to visibility. High winds on days previous to the survey caused increased turbidity which was still present during electrofishing. This could partially contribute to lower catches compared to 2015. The fact that CPUE of 2016 walleye is higher then both 2013 & 2014, provides some awareness to the ability/degree of walleye to recruit naturally.

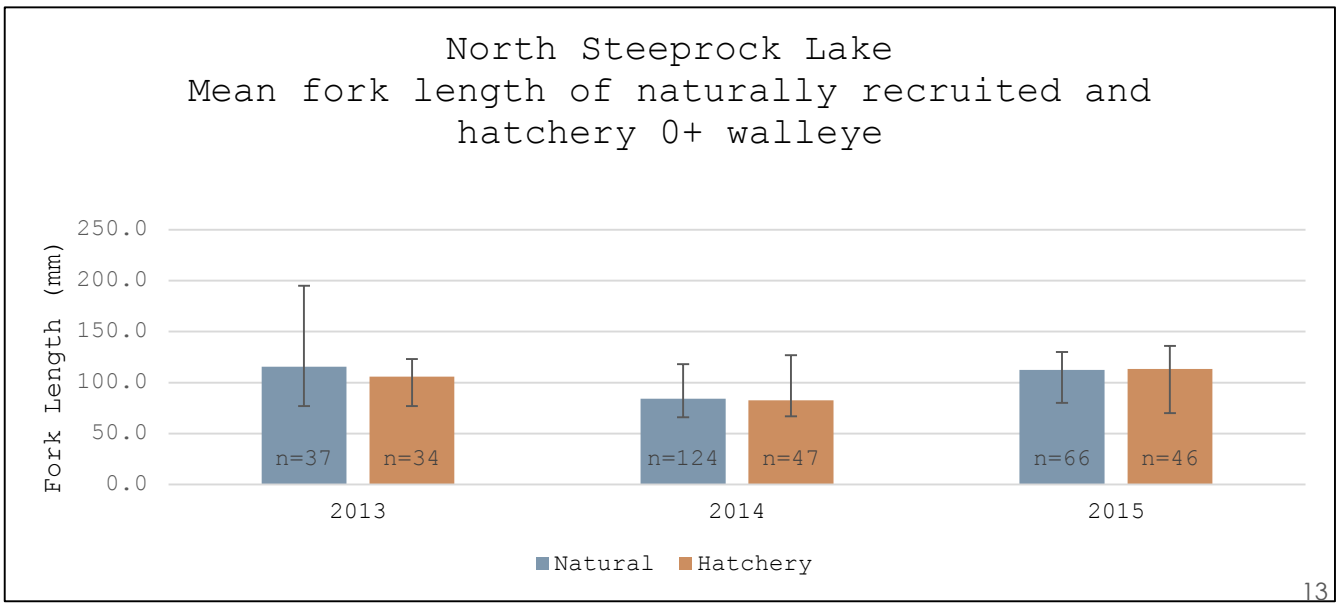
5.2 North Steeprock Lake

5.2.1 OTC Mark: Over the three year study a total of 354 0+ walleye were collected and sampled for OTC mark on North Steeprock Lake. Of this sample, 227 yoys exhibited no OTC mark suggesting on average 61% of the total sample was naturally recruited (Table below).

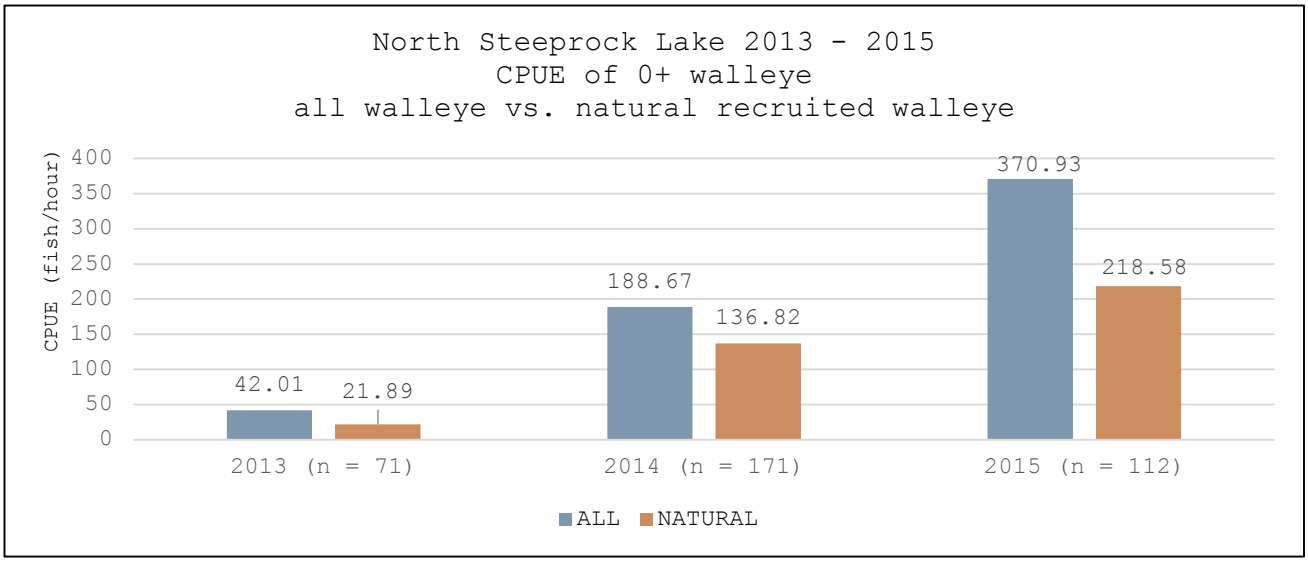
North Steeprock Lake Walleye Recruitement Success (Stocked vs. Natural)										
									Stocking	
Year	Sample Size	# of 0+ Walleye	% of 0+ Walleye	# marked (OTC)	# no mark (OTC)	% of stocked walleye	% of natural recruitment	Electrofishing Effort (hours)	Date	Annual Rate
2013	115	71	62%	34	37	48%	52%	1.69	30-May-13	400,000 fry or 898 fry/ littoral hectare
2014	181	171	94%	47	124	27%	73%	0.91	02-Jun-14	
2015	112	112	100%	46	66	41%	59%	0.30	20-May-15	
Total	**408**	**354**	**85%**	**127**	**227**	**39%**	**61%**			

5.2.2 Growth: Fingerling growth appeared to remain fairly consistent, with the exception of 2014 displaying growth more similar to the "norm" (83 mm) of Bell Lake walleye. The average size of a 0+ walleye at the end of the four month period was 102 mm (Figure below). Interestingly enough, walleye seemed to fair the best condition and average growth in 2015 which may simply be a reflection of an earlier spawn (stocking date May 20th). Size and condition factor between hatchery and natural origin walleye were comparable (Table right). During the 2016 recruitment survey where no supplemental stocking occurred, walleye growth was slightly greater than the average but comparable to both 2013 and 2015 growth. The average size of 0+ walleye in 2016 was 112.7 mm.

Condition Factor (k) of Natural and Hatchery Walleye			
Year	Origin	n	Mean k
2013	Natural	37	0.95
	Hatchery	34	0.93
2014	Natural	124	0.89
	Hatchery	47	0.89
2015	Natural	66	0.95
	Hatchery	46	0.97
All Years	**Natural**	**227**	**0.93**
	Hatchery	**127**	**0.93**



5.2.3 Catch Per Unit Effort: When reviewing CPUE, 2015 also indicate higher recruitment for that specific year compared to others. Low catches in 2013 compared to the remaining two years could be simply more sites selection and efforts exhibited were dispersed amongst a variety of habitat types, types which may not be preferred locations for walleye fingerlings. While again, 2014 & 2015 efforts were concentrated on collecting a sufficient sample size and targeted ideal habitat (ie. firm sandy beaches).



Catches in 2016, with effort replicating the 2015 survey, found a CPUE of 53.65 fish per hour. Again, results could partially related to low visibility. It is important to note, North Steeprock was also not stocked in the spring of 2016 and the survey was an evaluation on only natural recruited walleye. Findings do draw some interests to the effects supplemental stocking has on recruitment success in North Steeprock Lake.

6.0 Discussion/Recommendations:

With OTC detection results from three consecutive years, SVSFE and provincial fisheries staff now have the ability to re-evaluate the current management practices in place and adapt them to efficiently manage fry distribution in the these two popular walleye fisheries. To interpret results, guidelines for future management support developed through the multi-year OTC study (Prj 10-004) provided by fisheries biologist, Ken Kansas was utilized.

Guidelines for future management are as follows (Kansas, 2014):

- Lakes that showed 10-20% natural recruitment should be stocked annually, with 0+ assessments done after 4/5 years to confirm stocking success.
- Lakes that showed 25-75% should be stocked every second year with follow up 0+ assessments
- Lakes that showed 75%+ should not be stocked with walleye fry and left to natural recruitment with subsequent regulations to assist (ie. slot limits)
- Lakes that show a low catch of walleye in general likely have some kind of environmental and/or, species composition and/or, forage at life stage problem.
    - In this case, fingerling stocking should be a serious consideration with follow up non-lethal survey protocols (NSLP) after 2-3 years of such.

6.1 Walleye Stocking Literary Review: Upon literature review on walleye stocking practices and successes, findings do differ but pose valuable insight. Despite the fact that walleye have been stocked in North America for over one hundred years, walleye stocking success often continues to be unpredictable (Kerr, 2008).

Laarman (1978), stated supplemental stocking of walleye into waterbodies with naturally reproductive populations was deemed successful only five percent of the time. Another review of walleye stocking, Ellison and Franzin (1992) similarly found that 32 % (11 of 34 studies in question) reported success in stocking walleye fry, the majority of which would be classified as maintenance stockings. This is valuable to note as the majority of walleye stocking in Manitoba for recreational purposes would be defined by as supplemental/maintenance stocking (Groening 2015).

In contrary, some studies for example, Li et al. (1996b) found that although stocking walleye fry did increase the strength of the stocked year-class in lakes with existing natural reproduction, the surrounding year classes were significantly decreased. They suggested that the higher densities of walleye in the stocked year class could increase density dependent effects, thus negatively impacting the strength of surrounding year classes (Li et al. 1996b). Stocking often occurs with the assumption that the population can simply be increased by adding more fish, despite the understanding of density dependent effects, which ultimately maintain a population within the carrying capacity of the current environment (Groening, 2015). Identifying density dependent reactions would involve further investigations but should always be a consideration during developing stocking programs, especially in smaller waterbodies. Laarman and Schneider (1986) concluded that returns from stocked walleye could be optimized by stocking every second or third year instead of annually.

6.2 Bell Lake Proposed Stocking Program:
Bell Lake OTC marks suggest the walleye fishery borderlines on the 75% threshold of natural recruitment ratios. Due to the possibility to waver in either direction, SVSFE recommends to stock fry every second year with follow up 0+ assessments. In years of supplemental stocking, Bell Lake should be stocked with the traditional stocking rate of 200,000 walleye fry (~1,000 fish per littoral hectare) marked with OTC supplied by the Whiteshell Fish Hatchery.

6.3 North Steeprock Lake Proposed Stocking Program:
Results from North Steeprock suggest the natural recruitment of walleye is between 25-75%. This suggests that North Steeprock should be stocked every second year with follow up 0+ assessments. It is recommended the lake be stocked with the traditional stocking rate of 400,000 ((~1,000 fish per littoral hectare)OTC marked walleye fry supplied by the Whiteshell Fish Hatchery.

6.4 Stocking Program Considerations:

- Monitor harvests; The recommended stocking program is facilitating an angling fishery, therefore communications between neighboring first nations and metis communities on the extent of subsistence harvest taking place should be considered. In addition, reinitiating partnerships with Parks Branch to conduct barrel counts is essential to monitoring angling mortality/harvests.

- Follow up assessments for both waterbodies should be completed (at minimum) four years after implementing the suggested stocking program. Success of the program should be evaluated through "Non-Lethal Sampling Protocols" which would include replicating 0+ recruitment surveys and trap netting protocols. The combination of methods will aid in monitoring the immediate contribution (0+ recruitment) of alternate year stocking practices and its contribution to other walleye year classes. Lucchesi (2002) admits that large year classes of fall age-0 walleye do not necessarily translate into large adult walleye populations.

- Methods to stocking practices; It is strongly advised to scatter stock. Prior to the OTC detection program, stocking methods were limited to spot stocking fry at campground/launch shorelines. It order to increase the success of fry stocking it is recommended, in addition to tempering fry, that they be stocked in locations where zooplankton is readily available. Post yolk sac absorption, presence of zooplankton is vital to walleye survival.

- Fingerlings stocking (ie. North Lake transfer). The degree of success for fingerling stocking in both Bell and Steeprock Lake appears to be very limited. Yake (2003) suggested to continue stocking walleye fry versus using North Lake to rear walleye as; the results didn't appear to provide much better success than fry stocking and noted the rearing project was very labour intensive and expensive. In addition, a preliminary action plan implemented in the fall of 2014, as a result of low catchment of juvenile walleye. . . Bell Lake was "super-stocked" with 10,890 walleye fingerlings (SVSFE, 2014). To date, there has been no evidence of this stocking practice contributing to this fishery.

6.5 Bell Lake Specific Considerations:

There are a few factors specific to Bell Lake worth mentioning. These concerns pertain to low catchment of juvenile walleye and forage. The guidelines (Kansas 2014) suggest for "Lakes that show a low catch of walleye in general likely have some kind of environmental and/or, species composition and/or, forage at life stage problem" (Kansas 2014). 0+ walleye catches are significantly lower in comparison to North Steeprock but interestingly enough, past trap netting (2012/13) and index netting (92/07) results indicated a fair to good walleye population. It is critical to state forage base diversity and abundance have been of a concern for the last 20+ years. Yake (1992) stated "slow growth and type of forage suggests that there is considerable intra-specific competition for available food as well as inter-specific competition". Today, longnose dace and darters are the primary small-bodied fish species found. What is contributing to low forage diversity and whether this is affecting recruitment still remains unknown. A variety of factors, factors beyond manager's control could be contributing to both low recruitment & forage base; water quality, fluctuating water levels during critical spawning periods, lake productivity, cannibalism, etc. Forage introductions have been suggested (Yake 1992 & SVSFE 2014) but if issues are caused from something related to early life history of walleye/forage, introducing a new forage species make have more negative effects then beneficial. If further need to introduce a forage species is warranted, it is recommended to conduct a comprehensive study (ie. investigate lower food chain interactions, evaluate potential impacts, conduct a stomach analysis study, and evaluate spawning habitat of the particular species) prior to any introductions.

7.0 Conclusion:

In summary, SVSFE and managers are optimistic that implementing a stocking program of ~1,000 fry/littoral hectare on alternate years for both Bell and North Steeprock Lake will help reach goals of stocking success. With the data collected to date and long term monitoring, valuable walleye fry will continue to be effectively managed and walleye fisheries will be managed to their highest potential.

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