White Bass Assessment in Regards to Changes in Water Level on Lake Traverse

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Until recently the white bass *Morone chrysops* has been somewhat ignored by anglers, more so in Minnesota than other states; most likely due to their limited distribution throughout the state. However, with more anglers becoming aware of the sporting and culinary potentials of white bass, interests have risen. With this rise in angler interest, there should be a rise in white bass assessments. Knowing what factors may be influencing white bass population dynamics will allow fisheries professionals to better manage and protect white bass fisheries. White bass are often found in rivers and impoundments were dams are present and water levels often fluctuate. The objective of this study was to determine if water level was influencing growth of white bass. It was determined there was a trend of increased length of age-0 fish with increased water levels up to a threshold limit resulting in the relationship to be non-linear.

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Introduction

Lake Traverse is a somewhat popular recreational destination on the border of west central Minnesota and northeast South Dakota. Compared to other angling destinations in these states, Lake Traverse receives lower angling pressure. This is likely due to the isolated location in regards to major cities and the lack of resorts located near the lake. Another possible reason for low pressure is the lack of knowledge on navigating the lake. With a significant number of unpredictable submerged hazards caused by fluctuating water levels unfamiliar anglers shy away from fishing the lake.

At the top of the list for important game fishes in Lake Traverse is walleye *Sander vitreus*, with fry stocking occurring on odd number years for the decade. Other important game fishes are northern pike *Esox lucius*, bluegill *Lepomis macrochirus*, both white *Pomoxis annularis* and black *Pomoxis nigromaculatus* crappies, channel catfish *Ictalurus punctatus*, and white bass *Morone chrysops*.

Lake Traverse is primarily managed for walleye and channel catfish, with those two species being the only species present with lake specific regulations or slot size limits. White bass are considered an unprotected fish species and have no closed season or possession limit. In the Missouri River reservoirs and few natural lakes in eastern South Dakota that contain white bass they are amongst the top species harvested by anglers (Willis et al., 1996). In Lake Traverse, anglers still seem to release the white bass they catch. This may be due to anglers misidentifying the fish due to limited distribution or to their sometimes unappetizing taste if not prepared correctly. Listing it as an unprotected species along with traditional non harvested species like the common carp *Cyprinus carpio* may also negatively influence anglers.

The white bass has been a somewhat ignored species by fisheries professionals, but with a growing interest by anglers, more attention has been put forth by fisheries managers (Willis et al., 2002). There are many factors that may influence a fishery, many of which managers have little control over, but one factor that can be controlled on reservoirs like Lake Traverse is water level.

Studies conducted on Lake Texoma, a reservoir in Oklahoma and Texas has shown with an extended high water season there is acceleration in growth white bass (Bonn, 1953). This acceleration is a result of the fish feeding on fish (piscivory) earlier in their life cycle, resulting in higher growth rates and possible a healthier fish (Bettoli, 1992). Increased water depth may also influence spawning; with elevated water, fish may have greater access to areas of preferred spawning habitat (Wallis et al., 2002). Even though the seasonal water depth changes are primarily based on flood control, not fish management, water level effects still need to be incorporated into fish management.

The purpose of this study is to assess the current condition of the white bass in Lake Traverse and determine if there is a relationship between water level and white bass growth, weigh, condition, and health. Recommendations for future management strategies will be made.

Methods

Sampling area

Lake Traverse is a 4,665 hectare, eutrophic, dimictic reservoir located in the Northern Glaciated Plains ecoregion. The lake forms the boundaries of Traverse County in Minnesota and Roberts County in South Dakota. The lake was formed by the construction of the Reservation Dam in 1941, located on the out flowing Bois de Sioux River at the north end of the lake. There is also an earth dike at the south end of the lake. The purpose for the dam was to control flooding along the Bois de Sioux River and the Red River Valley. Lake Traverse is the southernmost body of water in the Hudson Bay watershed. The main inflow to the lake is the Mustinka River, which flows in at the north end of the lake. Lake Traverse is approximately 25 km long with a width ranging from approximately 0.8 - 3.0 km. The lake has a maximum depth of 3.7 m and an average depth of 3.2 m. The historic water clarity ranges from 0.93 - 1.54 m. Because Lake Traverse is used for flood control of the Red River Valley it is subjected to seasonal water level changes, primarily in the spring after snow melt.

Field sampling

White bass were collected by angling on Lake Traverse during July, August, and September 2012. Fish were taken from widely scattered areas of the southern half of the lake from shore and from boat. A variety of pan-fish style hooks and jigs with both live and artificial bait, along with artificial crankbaits were used as tackle to catch the white bass.

White bass length, weight, sex, and age was also provided by the Minnesota Department of Natural Resources office in Ortonville for years 2007, 2008, 2009, 2010, and 2011. Water level data was collected from the Army Corp of Engineers.

Harvest rates

To provide an estimate of harvest rate catch per unit effort (CPUE) (catch per angling hour) was calculated for based on the angling effort in 2012.

Age and growth

Total length (mm), weight (kg), and sex were recorded. All fish were aged by counting rings on whole otoliths (sagittae) in a drop of glycerin under a dissecting microscope. Assigned ages were the number of annuli due to midyear sampling. The von Bertalanffy growth equation was calculated to attain growth parameters (L_∞ (asymptotic length), K (growth coefficient) and t_0 (age at which length is zero)). Length at age-0 was calculated for all sample years. Regressions were run to determine significance in lengths and weights between year classes for all sample years.

Water level

Water level was plotted against von Bertalanffy calculated lengths at age-0 and mean length at age 0 from each sample year. Regressions were run to determine if there was a significant relationship between water level and age-0 lengths.

Condition

Length-weight regressions were calculated for males, females, and both sexes combined. Relative weights (W_r) were calculated using the procedures in Wege and Anderson (1978). Analysis of covariance was used to compare males and females for the length-weight regression, and relative weight compared to fish length. Regression analysis was used to determine if there was a relationship between water level and yearly mean W_r.

Length frequency

Size structure was assessed using traditional and incremental proportional size distribution (PSD). Standard values of 150 mm for stock, 300 mm for quality, 320 mm for preferred, 380 mm for memorable, and 460 mm for trophy sized fish were used to calculate PSD (Gabelhouse, 1984).

Mortality

Total instantaneous mortality (Z) was obtained using the descending portion of the catch curve (Van Den Avyle, 1999) with both sexes combined for each sample year. Annual mortality was obtained using the equation $A = 1\text{-}e^{-Z}$ (Van Den Avyle, 1999). Survival (S) was calculated from instantaneous mortality using the equation $Z = -\ln S$. Annual mortality (A) was calculated according to the equation $A = 1 – S$.

Fish health

The fish health index (FHI) is a necropsy based process that quantitatively accesses fish health. Mean fish health was calculated using methods described by (Adam et al., 1993). FHI versus total length was plotted for males, females, and both sexes combined to determine if there is a sex based relationship between FHI and length.

Results

Harvest rates

If CPUE is calculated off of total catch (187) per angling hours (45) the resulting CPUE is 4.16 fish/angling hr. CPUE for individual outings ranged from 0 fish per angling hour to 30 fish per angling hour.

Age and growth

Mean total length for each year class and sample year is presented in (Table 1). After running a single factor Anova, it was determined that there was a significant difference in age-0 lengths between at least two of the sample years (P = 0.0035). There was also a significant difference between at least two of the sample years for age-1 lengths (P = <0.001). Age-2 (P = 0.21), 3 (P = 0.35), 4 (P = 0.43), and 5 (P = 0.17) showed no significant differences in lengths among sample years. Age-6, 7, 8, 9, and 10 fish were captured in some years but were not analyzed due to missing or small sample sizes. Age-10 was the oldest age group collected. von Bertalanffy calculated lengths at age-0 were 146 mm (2007), 158 mm (2008), 154 mm (2009), 147 mm (2010), 180 mm (2011), and 170 mm (2012).

Table 1. Mean length of each age class from 2007-2012 for white bass captured in Lake Traverse.

Year	2007		2008		2009		2010		2011		2012	
Age	(mm)	N	(mm)	N	(mm)	N	(mm)	N	(mm)	N	(mm)	N
0	161	12	150	6	137	26	150	24	157	8	146	95
1	271	25	264	26	260	44	277	3	265	23	247	18
2	327	20	323	16	323	15	324	16		0	320	57
3	359	5	351	12	349	11	354	9	360	4	364	2
4	376	7	358	3	372	9	373	7	372	5	380	5
5	398	11		0	396	9	379	5	381	3	389	3
6	414	3	408	2	405	4	394	3	394	9	406	4
7	416	1	387	4		0	390	2		0	411	2
8		0		0		0	406	1		0	427	1
9		0	416	0		0		0		0		0
10		0	430	1		0		0		0		0

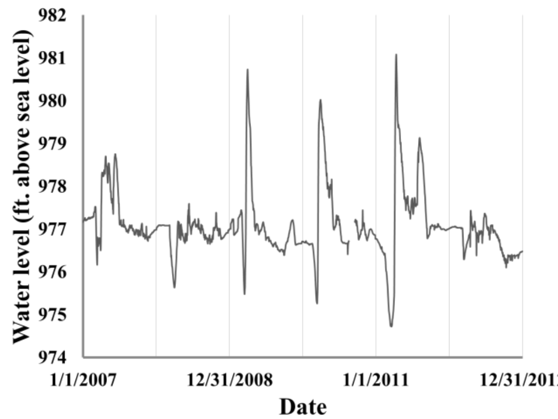

Figure 1. Water levels from 1 January 2007- 31 December 2012 in Lake Traverse.

Water level

Yearly water levels are plotted in (Figure 1). In analyzing the influence of water level to growth, two length variables were used. First, the length at age-0 calculated from the von Bertalanffy equation was plotted on the secondary y-axis, yearly water level was plotted on the primary y-axis, and date was on the x-axis. It was decided to have a fixed time period for water level, June 1 – 31 August, this time period being the approximated growth period of age-0 white bass before capture in September (Figure 2).

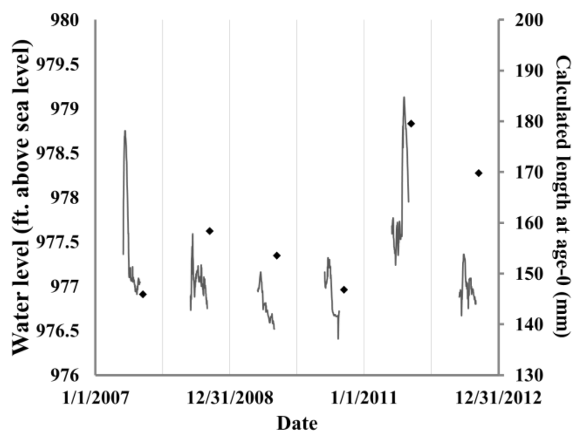

Figure 2. Calculated length at age-0 (from von Bertalanffy equation) in relation to water level 1 June - 31 August in Lake Traverse for each year from 2007-2012.

White bass length appears to be higher in years with higher water levels and lower in years with lower water levels. However, based on regression analysis of median water level verses von Bertalanffy calculated length at age-0, the resulting p-value was (P = 0.11) indicating the relationship was not significant.

The second length variable that was used was mean length of sampled age-0 fish. This length was plotted on the secondary y-axis and 1 June - 31 August water levels on the primary y-axis (Figure 3). This graph shows an even clearer trend of higher lengths in years with higher water levels and lower lengths in years with lower water levels. However, again based on regression analysis of median water level verses mean length of sampled age-0 fish, the resulting p-value was ($P = 0.16$) indicating the relationship was not significant.

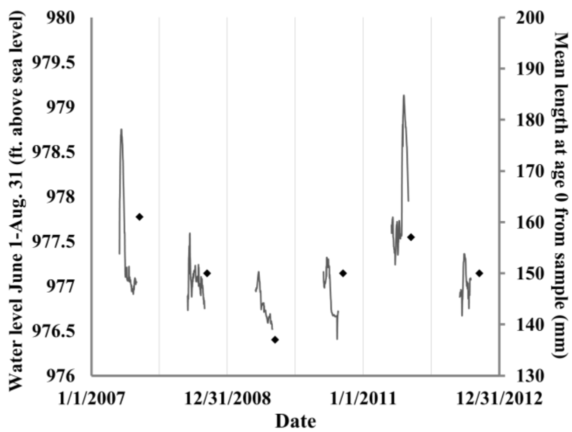

Figure 3. Mean length at age-0 from sampled white bass and water level 1 June – 31 August in Lake Traverse for each year from 2007-2012.

A closer look at the data indicated that increases in length of age-0 fish may flatten out at a point with increased water level resulting in a non-linear trend ($R^2 = 0.78$; Figure 4).

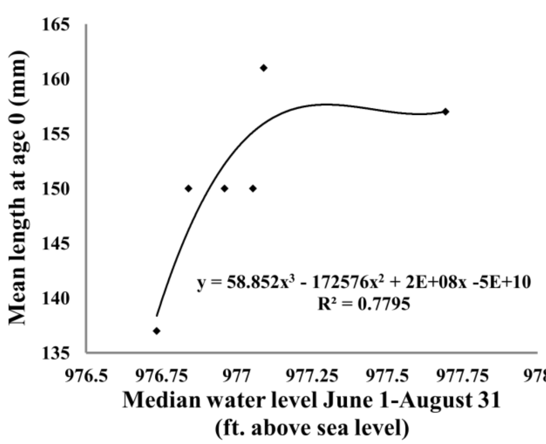

Figure 4. Mean length from sampled white bass verses median water levels 1 June – 31 August in Lake Traverse for each year from 2007-2012.

Condition

Analysis of the length weight regression showed no significant differences between males and females for all sample years. The slope parameters for all sample years was >3 indicating allometric growth. A total length-weight regression was calculated to be $W = 5E\text{-}06L^{3.16}$, where W equals wet weight (g) and L total length (mm).

A single factor Anova indicated that there were significant differences among W_r of at least two sample years for age-0 ($P = <0.001$), age-1 ($P = 0.01$), and age-2 ($P = 0.01$); after age-2 no significant difference between sample years were calculated. Mean W_r values for sample years were $93.4^{\%}$ (2007), $94.7^{\%}$ (2008), $95.4^{\%}$ (2009), $93.0^{\%}$ (2010), $95.3^{\%}$ (2011), and $89.6^{\%}$ (2012). There was no relationship between W_r and median water level ($P = 0.46$).

Length frequency

Traditional PSD values for each sample year were calculated (Table 2). There were no trophy (≥460 mm) sized fish captured, but all sample years had good numbers of memorable (≥380 mm) and preferred (≥300 mm) sized white bass. In all sample years but one, 50 percent of total harvest was quality sized white bass or larger.

Table 2. Traditional PSD values for white bass sampled from Lake Traverse 2007-2012.

Traditional	size class	length (mm)	2007	2008	2009	2010	2011	2012
PSD	quality	≥230	71	65	92	46	44	87
PSDp	preferred	≥300	47	39	48	43	21	74
PSDm	memorable	≥380	15	8	13	11	11	11
PSDt	trophy	≥460	0	0	0	0	0	0

Mortality

Based on catch curves, both instantaneous and annual mortality were calculated for each sample year (Table 3). The highest instantaneous and annual mortality occurred in 2012 with ($Z = 0.50$) and (A $39.1^{\%}$). The lowest instantaneous and annual mortality rates occurred in 2011 with ($Z = 0.23$) and ($A = 20.6^{\%}$). More analysis is needed to determine if there is any correlation between water level and mortality.

Table 3. Instantaneous mortality (Z) and annual mortality (A) for white bass in Lake Traverse 2007-2012.

sample year	2007	2008	2009	2010	2011	2012
Z	0.345	0.384	0.392	0.298	0.231	0.495
A	29.14%	31.90%	32.44%	25.75%	20.60%	39.06%

Fish health

The mean FHI for white bass sampled during the summer of 2012 from Lake Traverse was 36.76. There was a slight increase in FHI scores as length increased but the relationship was not significant (P=0.23).

Discussion

It was determined that the only ages that had a significant difference in length between sample years was age-0 and 1. Those age classes were the only two that showed significances between W_r. Based on the evidence presented in Figure 4 I suggest the change in water level is the presumed factor causing these differences. Bonn (1953) reported that with an increase in water levels there is an increase in white bass growth rates. The primary belief for this is a change in their diet to a higher quality food source, like fish (Bettoli, 1992). This may also be the cause of differences in W_r between sample years but a long term study of dietary changes would be required to verify.

In assessing water level from 1 January 2007- 31 December 2012, it is easy to see that there is significant fluctuation from not only year to year but seasonally. Originally, length was compared to seasonal water levels, predominantly spring flooding that resulted from high snow amounts and rapid melt. This water level change from increased run off from snow melt took place during the month of April.

Water levels during the approximated growth period of age-0 white bass sampled in September (June 1- August 31) were compared to age-0 von Bertalanffy calculated length, mean length of sampled age-0 white bass and W_r of age-0 white bass. When comparing the calculated length at age-0 to median water level from the stated time period, it was determined to be insignificant; but when water level and length were both plotted on the y-axis, there was a visual trend of increased length with increased water level and decreased length with decreased water level (Figure 2). Mean length verse median water level also resulted in no significant correlation but likely because the relationship is not linear. There appears to be a limit to increased length with increased water level (Figure 4.), which may be important for the future management of this game species.

Several reasons to why there was a visual trend with no significant correlation as seen in (Figure 4), is most likely due to the correlation being non-linear, a small sample size, and the additional factors influencing growth.

CPUE for white bass from July-September 2012 was 4.16 fish per hour. For anglers looking for increased catch rates, targeting white bass is an option; compared with walleye, which has a state wide mean catch rate of less than 1 fish per hour in Minnesota. Lake Traverse offers a high likelihood of catching a preferred size white bass (≥300 mm), what most would consider a keeper. There is also a fairly good chance of catching a memorable size fish (≥380 mm). When the age of white bass was determined, it showed they exhibit a fairly quick growth rate in their first two years, reaching preferred size as a two year old fish.

In summary, it was determined that water levels during the primary growth period (1 June-31 August) has more of an impact on white bass growth than the increased water levels due to spring time flooding due to snow melt. The water levels from the time a fish hatches to the end of the year may impact the growth rate. Knowing this can help fisheries managers improve that year's white bass population if there are a few down years. This is also beneficial since it only takes two years to get a harvestable size white bass. Purposefully increasing water level during the primary growth period of white bass will increase growth rates and shorten the period of time it takes to produce a harvestable size fish for anglers. If managers wanted to increase the amount of forage sized white bass available to other predatory species, the opposite could be done to suppress growth rates.

Ultimately, the trends presented in this study should continue to be monitored in future years to confirm my conclusions about the effects of water level on white bass. Other factors that are suggested to impact white bass recruitment are air temperature and precipitation (Willis et al., 2002); these could also be assessed to see if they affect white bass growth along with water temperatures, time of spawn, and time of ice off.

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