Thompson Lake Dam Operations and New Fish Screen Assessment, 2021

Water: Thompson Lake (3444), Casco, Otisfield, Oxford, Poland..

Acres: 4,419

Watershed: 47.21 square miles.

Background: Thompson Lake is a very popular water for recreational angling with exceptional fisheries for Landlocked Salmon, Lake Trout, and Smallmouth Bass. Angler estimates from 2014 indicate 2,068 and 6,690 ice and open water angling trips per year, respectively. The salmon fishery at Thompson Lake is typically very consistent and regularly produces quality-sized salmon in the 3-5-pound range. In fact, it certainly ranks within the top three salmon lakes within the entire Sebago Lakes Region.

It is believed Robinson Manufacturing installed the original fish screen in front of the outlet dam (circa 1960-70's), and they may have been required to do so by the Maine Department of Inland Fisheries and Wildlife (MDIFW) to retain stocked salmon in the lake. The Town of Oxford took over ownership of the mill building and dam in 2009, and the fish screens were removed by the Town in 2011 due to deterioration and maintenance requirements. This act was unknowingly a violation of Maine State Law Title 12, Subsection 12753, Item 2. Since the screens were removed, MDIFW has received numerous angler reports of salmon in the Little Androscoggin River system and has documented the loss of large numbers of adult salmon down the outlet. Around 2015, MDIFW began receiving angler complaints regarding the abundance of salmon in the lake and a review of limited open water creel survey data indicates as much as a 40% decline in angler catch rates for legal-sized salmon.

In the absence of fish screens, spawning salmon attracted to the outlet flow during the fall drawdown period are exiting the lake system. These quality-sized, lake-grown salmon cannot return to the lake and provide only limited fishing opportunity in the river, where they face inadequate food resources and disappear from the system in a relatively short period of time. Additionally, changes in lake level management in association with Town ownership and/or Thompson Lake Environmental Association's (TLEA) 2012 request to institute a revised water level management plan may be impacting the lake fishery.

Francis Brautigam of MDIFW first contacted the Town in 2016 inquiring about changes to dam operations and fish screen conditions, but personnel changes at the Town and MDIFW left that correspondence unanswered. In early 2019, James Pellerin of MDIFW reinitiated those conversations and later that same year recognized them as an area of concern in our review of the Town's NRPA permit for their proposed 2020 dam rehabilitation project. Pellerin addressed Town officials regarding the importance of the fish screens and MDIFW's observations on the salmon fishery in relation to screen removal.

The Town of Oxford, TLEA, and many of the local fish and game clubs have been very supportive of the fish screen project. The Town asked their engineer to include a set of plans for fish screens and to consult with MDIFW as needed. MDIFW expressed significant concerns about the new screen designs as they were not simply a replacement of the original single, large screen system that had worked effectively for many decades, but rather a set of three smaller screens in front of each sluice opening. The Town's engineer cited the cost of replacing the old screen as being prohibitive, while MDIFW expressed several concerns with the three smaller screens including: fish impingement; excessive maintenance (i.e., debris cleaning); ability to manage water levels; and safety of the dam structure. The Town manager, Butch Asselin, and the Town's engineer made the decision to move forward with the engineer's screen design.

In the fall/winter of 2020, the Town of Oxford initiated the project to rehabilitate the upstream side of the dam and to restore/improve gate functions. The cost of this project was a significant burden to the Town of Oxford, which is a noncommercial entity that derives no income from the dam. The unanticipated need for fish screens added to that burden and they were only able to install a single screen. The east sluice screen was fabricated and installed in the winter of 2020/2021 as part of the Town's dam rehabilitation project. Slight modifications to the screen were required (horizontal bars welded to back side) to fix warped slats related to the galvanizing process. Funding was not available to fabricate and install the remaining two screens; the Town and MDIFW worked together to secure additional funding for the fabrication costs of the remaining two screens including an Outdoor Heritage Grant for ~ $24,000 and an MDIFW grant from a dedicated funding source for $8,000. The west sluice screen was fabricated and installed by MDIFW/Town staff in late August/early September of 2021. A few minor modifications were made to this screen (i.e., lifting lug for screen removal, full corners). The center sluice screen was fabricated and is on-site but has yet to be installed due to funding limitations and timing. Based on MDIFW's urging, the new Town manager, Adam Garland, allowed the fabricator to modify the center sluice screen into three sections, so that two sections could be removed without divers and a crane in the event of a flood event. The central sluice should be able to prevent salmon loss via operational procedures until full funding for installation can be secured. In addition to the above changes the Town recently lost their long-time dam operations person, so there will be a learning curve for the current Town staff.

After a partial year of operation including the leaf drop season it has become very clear to the Town, MDIFW, and TLEA that we will need to address and explore opportunities to fine tune dam and screen maintenance operations. MDIFW has developed the following assessment as a discussion starting point to move us all forward in the best interest of the parties involved, the lake ecosystem, and its fisheries.

Purpose: (1) examine historical dam operations data to gain knowledge and insight for the Town's staff on how to best manage and operate the dam; (2) compare the new fish screens to the historical situation, explore observations from 2021 fall operations with new screens installed, and determine if the new fish screens can meet operational needs, as well as, potential improvements; and (3) review available fisheries data to determine if dam operations may have impacted the lake's fish populations, particularly lake trout.

Findings:

<u>Lake Levels – A Review of Historical Operations</u>

MDIFW requested historical dam operations data from the Town and TLEA, to date the TLEA sent records for 1960-1986 and 2010-2013. We reviewed the lake level history from 1970-1985 and the more recent 2010-2013 data. The older data set (1970-1985) was largely complete, whereas the 2010-2013 data only covered a portion of the entire year. Figure 1 represents the mean monthly water level by year for 1970-1985. The graph illustrates that although there was a general lake level pattern, water level management was relatively erratic from year to year and a further review of the raw data even suggests water levels within a given month and year were also quite variable. Variable water levels within a given month are obviously influenced by specific weather events (i.e., rain, snowmelt), but correspondence from Robinson Manufacturing also suggest they often manipulated water levels for processing water when they were operating. The same graph indicates that the water level during the earlier period went from a low of 53.5 inches from the top of the dam in October 1973 to a high of 12.0 inches in July of the same year.

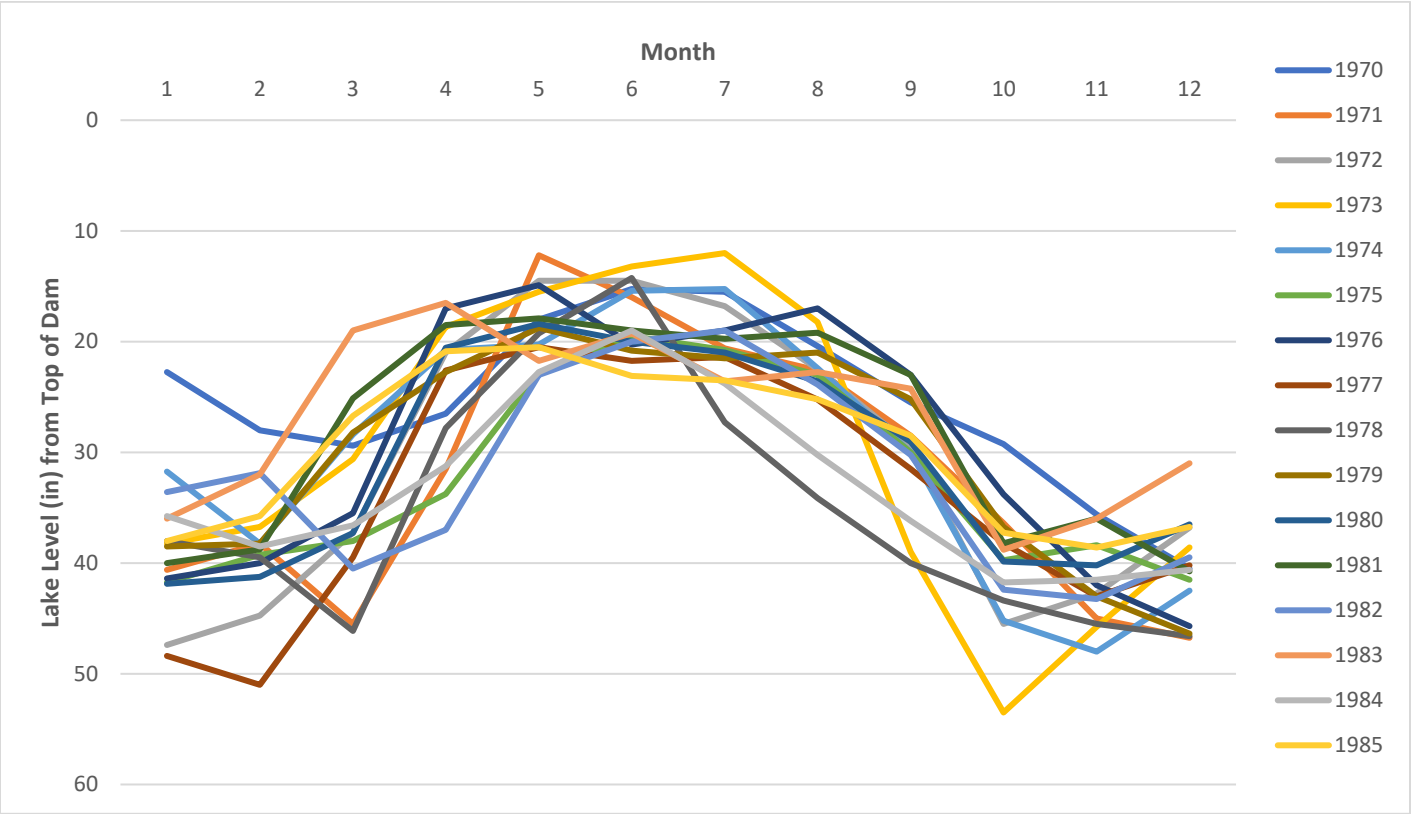


Figure 1. Thompson Lake Mean Water Level by Month, 1970-1985.

Figure 2 shows the mean, minimum, and maximum water levels by month for the same period across all years to reveal the general water level pattern. In general, the lake was at its higher levels from May – July at around 18-20 inches from the top of the dam. Water levels began to recede around August and general reached a low for the winter (Nov-January) in the 38-42-inch range. Sometime in February water levels typically increased gradually back to the high point. The minimum and maximum illustrate the monthly variability across all years, which was usually plus or minus 8-12 inches from the mean monthly value. Figures 1 and 2 show the low point was generally reached sometime between October and November, which could be important for lake trout spawning.

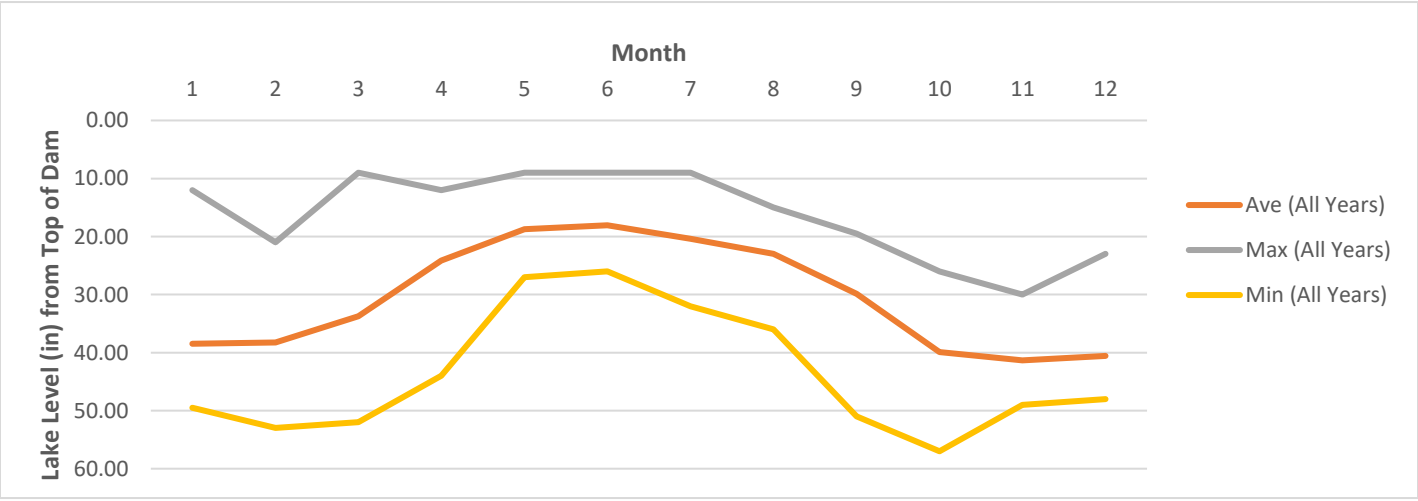


Figure 2. Thompson Lake Mean, Minimum, and Maximum Water Level by Month Across All Years, 1970-1985.

In the early 1990's there was a lot of discussion between Robinson Manufacturing, TLEA, and the resource agencies regarding water level management for Thompson Lake (See Appendices A and B). In summary there are several main points to be conveyed:

(1) In 1992 TLEA suggested the following water levels (from top of dam) to Robinson Manufacturing:

Month	Lower Limit	Upper Limit
January	35	39
February	27	39
March	30	38
April	20	34
May	15	25
June	15	21
July	17	23
August	18	26
September	21	31
October	32	40
November	37	43
December	35	41

(2) State Resource agencies convey the following:
MDIFW, Stu DeRoche – To protect spawning lake trout, the lowest lake level should not exceed 38 inches below the top of the dam, and the level of the lake should not be lowered after October 15th.

MDEP, Jeff Dennis – Maintaining water levels with the least amount of seasonal and year to year variation generally has the least impact on the ecology of the lake and its inhabitants.

(3) Robinson Manufacturing – Indicated TLEA's proposal conflicted with MDIFW concerns and that they wanted to reserve the right to refill the lake to full level (14 inches) whenever conditions allowed, presumably to store/use extra water for their mill processing needs. They then presented a water level management plan termed the "rule curve" by Acheron Engineering (Figure 3).

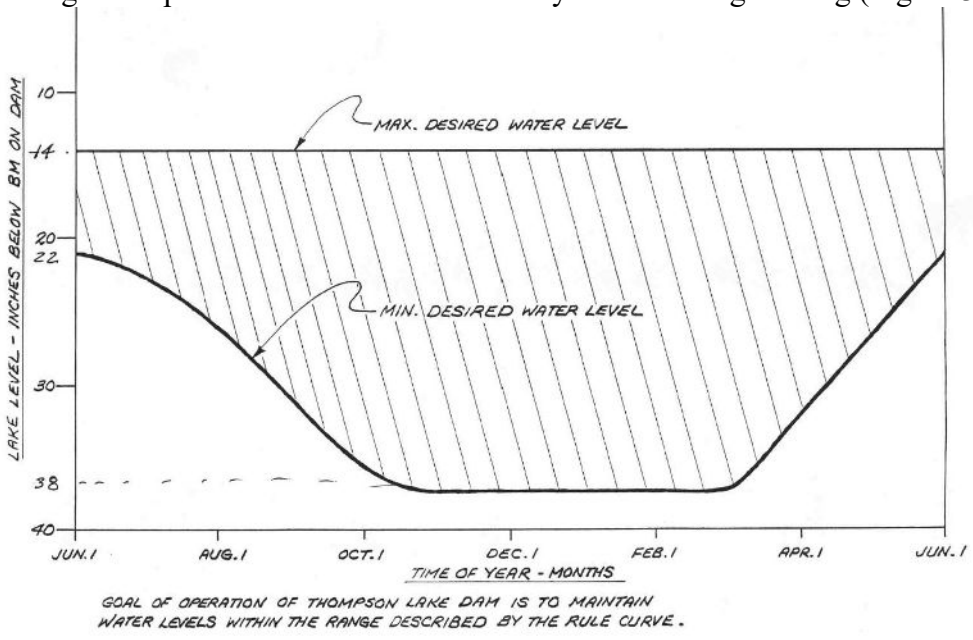


Figure 3. Thompson Lake Rule Curve by Acheron Engineering, 1993.

Based on a lack of additional correspondence in the file, it is assumed the "rule curve" went into effect circa 1993. Interestingly, the rule curve gave Robinson the ability to manage the lake levels much higher in the October 1- April 1 time period if they wanted, which they had rarely done according to 1970-1985 data. Correspondence in the file suggests it was very important that Robinson be able to draw the lake down very low in the fall-winter to accommodate spring flooding and they advocated to MDIFW for at least 48 inches; managing at higher levels in the fall/wintertime period would certainly have put the lake at risk to flooding and shoreline erosion. There seems to be a lack of dam operational data from 1986-2009 to confirm or explore how the lake was managed post 1993.

After the Town took over dam ownership, TLEA entered discussions to modify and/or develop a revised water level management plan for Thompson Lake. Appendix C documents TLEA's recommendations; a summary of the proposed target water levels follow: Summer Level - 16" (14" maximum); Winter Level: 32" with fall drawdown to begin around 10/1 and be completed by 10/20. According to Jim Skinner, TLEA President 2021, these recommendations were presented to the Town and "adopted" in 2012.

A review of the limited data from 2010-2013 (Figure 4), TLEA complaints, and information from the Town's engineer all suggest the Town has not entirely operated the dam as recommended by TLEA in 2012. While the Town has strived to obtain and maintain the high and low points of that agreement the timing of the fall drawdown has been significantly off. This is a concern for MDIFW as it may be impacting the lake's salmon and trout resources, which is discussed in more detail later in this document. According to the Town's engineer and based on correspondence with the Town's former dam operator, Craig Delano, Thompson Lake water levels have been managed as follows:

- 32" below top of the dam (low stage) from Jan to Apr
- 24" in May
- 16" in Jun-Oct (high stage),
- 24" in Nov
- 32'' in Dec

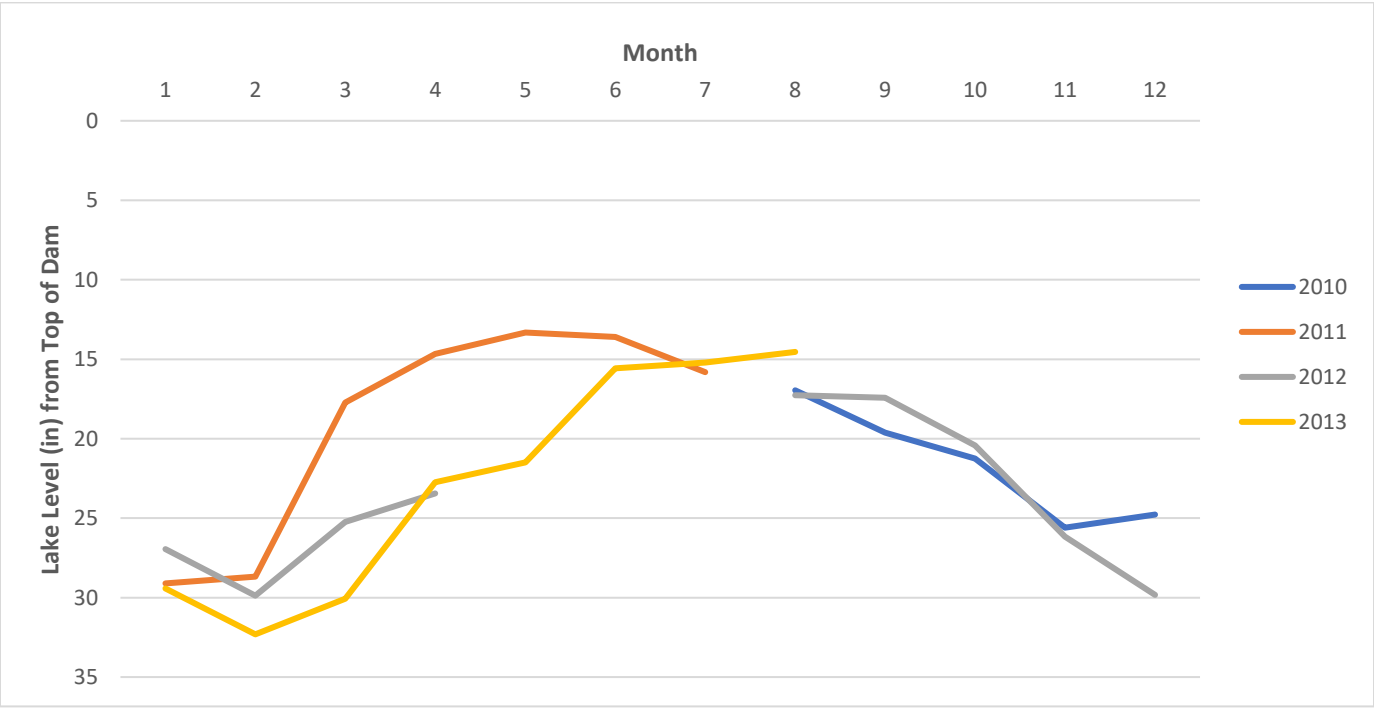


Figure 4. Thompson Lake Water Levels, 2010-2013.

Thompson Lake Outlet Stream (TLOS)

For operational purposes it would be good for the Town to know what various gate openings equate to for outlet flow, which could then be used to predict lake drawdown rates to assist with lake level management. MDIFW called the Town Engineer to see if he had calculated flow relationships for each sluice opening for operational purposes; he indicated he had not. During our investigation, MDIFW noted the Town had a water level gage on the outlet and were recording the value for their routine monitoring. Unfortunately, the current Town staff had no knowledge of how the gage level equated to flows. MDIFW conducted field measurements for two different flow rates and recorded the gage height. In addition, a review of the historical data (2010) showed some flow values for several gage heights. Interestingly, we also noted on the gage cover that Town staff had been adjusting the gage reading by +3.83ft for some unknown reason. It is assumed something changed (i.e., King St. bridge, gage cover, gage tape length) that required the adjustment. MDIFW later determined the gage was a USGS gaging station (01058005) that had been operated from 6/19/1975-9/12/1982, and historical flow data is available on-line at Water Resources of the United States—National Water Information System (NWIS) Mapper (usgs.gov). The original chart showing gage height and discharge was acquired from USGS; however, USGS indicated it may no longer be valid.

Figure 5 is a plot of the gage height and discharge relationships for MDIFW-2010 Town data and adjusted USGS data. It was determined adding 3.98 to the original USGS gage height chart data (close to the Town's 3.83) resulted in an almost perfect alignment with the MDIFW-2010 Town discharge data. The MDIFW-Town data relationship is likely reasonably accurate in the 4.5-5.5 gage range and could be used by Town staff to help with lake level management. More data points could be acquired to further develop and validate the curve if deemed necessary. Table 1 provides extrapolated gage heights and discharges in cubic feet per second (cfs) for TLOS, which is a valuable tool for dam operations and water level management. Town staff should continue to monitor gage height and include outlet flow using this table.

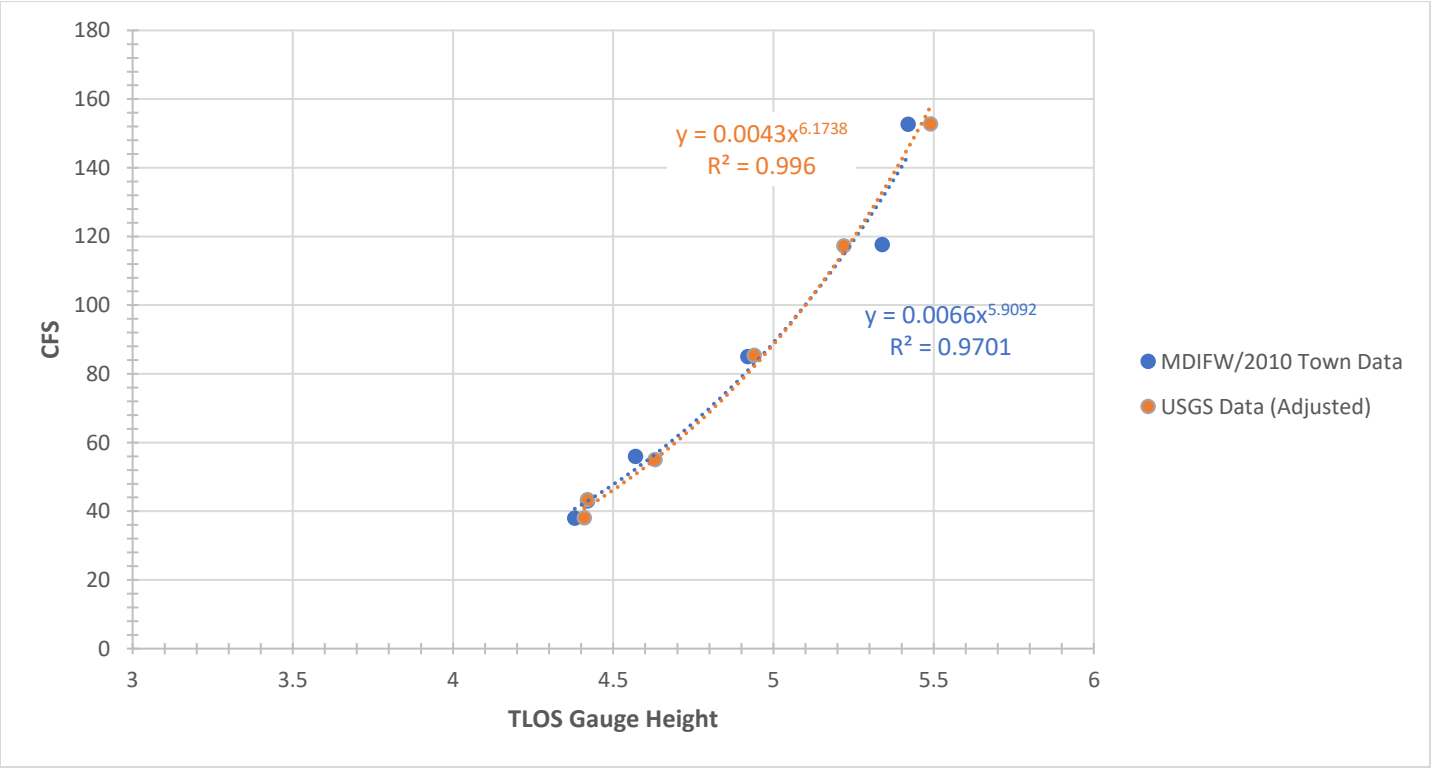


Figure 5. Thompson Lake Outlet Stream (TLOS) Gage Height-Discharge Relationships.

Table 1. TLOS gage height and estimated discharge (cfs), based on MDIFW/Town data.

Gage Height (ft)	Estimated Flow (cfs)									
	Guge Height (100ths of a ft)									
	0.00	**0.01**	**0.02**	**0.03**	**0.04**	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**
3.0	3.8	3.9	4.0	4.0	4.1	4.2	4.3	4.4	4.5	4.6
3.1	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5
3.2	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.5	6.6	6.7
3.3	6.8	7.0	7.1	7.2	7.4	7.5	7.6	7.8	7.9	8.1
3.4	8.2	8.4	8.5	8.7	8.8	9.0	9.2	9.3	9.5	9.7
3.5	9.8	10.0	10.2	10.4	10.5	10.7	10.9	11.1	11.3	11.5
3.6	11.7	11.9	12.1	12.3	12.5	12.7	13.0	13.2	13.4	13.6
3.7	13.8	14.1	14.3	14.6	14.8	15.0	15.3	15.5	15.8	16.1
3.8	16.3	16.6	16.9	17.1	17.4	17.7	18.0	18.3	18.6	18.9
3.9	19.2	19.5	19.8	20.1	20.4	20.7	21.1	21.4	21.7	22.1
4.0	22.4	22.8	23.1	23.5	23.8	24.2	24.6	24.9	25.3	25.7
4.1	26.1	26.5	26.9	27.3	27.7	28.1	28.6	29.0	29.4	29.8
4.2	30.3	30.7	31.2	31.6	32.1	32.6	33.1	33.5	34.0	34.5
4.3	35.0	35.5	36.0	36.6	37.1	37.6	38.2	38.7	39.2	39.8
4.4	40.4	40.9	41.5	42.1	42.7	43.3	43.9	44.5	45.1	45.7
4.5	46.4	47.0	47.7	48.3	49.0	49.6	50.3	51.0	51.7	52.4
4.6	53.1	53.8	54.6	55.3	56.0	56.8	57.5	58.3	59.1	59.9
4.7	60.7	61.5	62.3	63.1	63.9	64.7	65.6	66.5	67.3	68.2
4.8	69.1	70.0	70.9	71.8	72.7	73.6	74.6	75.5	76.5	77.5
4.9	78.5	79.4	80.4	81.5	82.5	83.5	84.6	85.6	86.7	87.8
5.0	88.9	90.0	91.1	92.2	93.4	94.5	95.7	96.8	98.0	99.2
5.1	100.4	101.7	102.9	104.1	105.4	106.7	108.0	109.2	110.6	111.9
5.2	113.2	114.6	115.9	117.3	118.7	120.1	121.5	123.0	124.4	125.9
5.3	127.4	128.8	130.3	131.9	133.4	135.0	136.5	138.1	139.7	141.3
5.4	142.9	144.6	146.2	147.9	149.6	151.3	153.0	154.8	156.5	158.3
5.5	160.1	161.9	163.7	165.5	167.4	169.3	171.2	173.1	175.0	176.9
5.6	178.9	180.9	182.9	184.9	186.9	189.0	191.1	193.2	195.3	197.4
5.7	199.6	201.7	203.9	206.1	208.4	210.6	212.9	215.2	217.5	219.8
5.8	222.2	224.6	227.0	229.4	231.8	234.3	236.8	239.3	241.8	244.3
5.9	246.9	249.5	252.1	254.8	257.4	260.1	262.8	265.6	268.3	271.1
6.0	273.9	276.7	279.6	282.5	285.4	288.3	291.3	294.3	297.3	300.3
6.1	303.3	306.4	309.5	312.7	315.8	319.0	322.2	325.5	328.8	332.1
6.2	335.4	338.7	342.1	345.5	349.0	352.4	355.9	359.5	363.0	366.6
6.3	370.2	373.8	377.5	381.2	385.0	388.7	392.5	396.3	400.2	404.1
6.4	408.0	412.0	415.9	420.0	424.0	428.1	432.2	436.3	440.5	444.7
6.5	449.0	453.3	457.6	461.9	466.3	470.7	475.2	479.7	484.2	488.8
6.6	493.4	498.0	502.7	507.4	512.1	516.9	521.7	526.6	531.5	536.4
6.7	541.4	546.4	551.4	556.5	561.6	566.8	572.0	577.2	582.5	587.8
6.8	593.2	598.6	604.1	609.6	615.1	620.7	626.3	631.9	637.6	643.4
6.9	649.2	655.0	660.9	666.8	672.7	678.8	684.8	690.9	697.0	703.2

Note: Gage Height – Vertical column used to determine gage height up to 10ths of foot, use vertical and horizontal column in combination to determine gage heights to 100ths of a foot.

Lake Drawdown Rate

It has been suggested by the TLEA (Appendix 3) and the Town's Engineer that the lake's water level could be managed using only the East and West Sluices. In addition, TLEA indicated rapid drawdowns as much as 2.5 inches per day could be conducted with only the East and West sluices even when the lake's watershed was still contributing water to the lake. However, in the fall of 2021 the Town was struggling to achieve ¾ of an inch drawdown per day with East gate fully open 36 inches and West sluice fully open (fish screens installed). Note: TLEA's comments were based on the old sluice opening, which was much larger than the new gate opening installed in 2020; the Town Engineer's comments should have been cognizant of the new gate size, fish screens, and operational restrictions to prevent fish impingement (East Gate only open a maximum of 8 inches). Consequently, the lake drawdown rate needs to be more fully explored and understood by all parties to discuss reasonable and achievable operations regarding water level management of the lake.

A review of the historical data (Table 2) indicates the maximum daily drawdown rate achieved in the two time periods examined was only 1.9 inches with a mean of 0.4 inches. Furthermore, daily drawdowns rarely exceeded a rate of more than 1 inch per day. Records on sluice management were typically missing or unclear, so it was not possible to relate these drawdown rates to any specific operational schemes. However, it is believed, particularly in the later period, that the lake was largely managed with just the historical east and west sluice openings.

Table 2. Historical Drawdown Rates (inches) for Thompson Lake.

Time Period	Mean	Minimum	Maximum
1970-1986	0.4	0.10	1.9
Drawdown rate => 1.0 inch/day 19 of 340 weeks (5.6%) Drawdown rate => 1.5 inches/day 3 of 340 weeks (0.8%)			
2010-2013	0.47	0.25	1.5
Drawdown rate => 1.0 inch/day 9 of 409 days (2.2%) Drawdown rate => 1.5 inches/day 7 of 409 days (1.7%)			

On 10/21/2021 MDIFW measured the outlet flow with both the East and West sluices fully open and relatively clean fish screens with the following results: lake level was ~ 23" from the top of dam; measured flow was 152.7 cfs = 13,193,280 cf/day = 1.2 days to drop lake 1"; and no significant rain events prior/post measurement. Observed lake level decline during this time was ~ ¾ inch per day. Table 3 shows theoretical calculations based on lake acreage and the amount of flow out of TLOS that would be necessary to achieve various daily drawdown amounts in ½ inch increments. Our measurement of 152.7 cfs and the observed ¾ inch daily lake level drop corresponds reasonably well with the theoretical data.

Table 3. Theoretical Drawdown Rates for Thompson Lake.

Daily Drawdown (in)	Acre-Ft	CuFt	TLOS CFS Required (No inflow/no rain)
2.5	920.6	40,101,336	464
2	736.5	32,081,940	371
1.5	552.4	24,062,544	279
1	368.3	16,043,148	186
0.5	184.1	8,019,396	93

The above table in conjunction with the TLOS discharge table are expected to be valuable tools for managing lake water levels. For example, the Town could predict the amount of time and/or discharge required for a

particular target drawdown level or preemptively to accommodate impending storm events. It should be noted that the above theoretical values only account for lake water volume and does not include watershed additions or losses via evaporation. USGS StreamStats data (Table 4) shows estimated mean watershed discharge by month, which may need to be accounted for in addition to a desired drawdown. Additional modifications would likely be required for significant rain events. This is general guidance only and will need to be modified/adjusted based on observed field conditions.

Table 4. USGS StreamStats – Estimated Mean Stream Flow by Month

Month	Flow (cfs)
Jan	81.4
Feb	64.3
Mar	45.4
Apr	110
May	343
Jun	82.1
Jul	33.6
Aug	21.8
Sep	21.6
Oct	72.7
Nov	121
Dec	121

This fall's observations and the above information suggests that use of the East and West sluices fully open with clean screens, and no rainfall only equated to a ¾ inch daily drawdown. However, based on the engineer's calculations the sluices would need to be operated much more conservatively to address fish impingement issues:

- East Sluice Open 8" (22% of fully open) = 34 cfs = 1 fps screen velocity = 2,937,600 cf/day = 5.5 days to drop lake 1".
- Center Sluice Open 17" (35% of fully open) = 102 cfs = 1 fps screen velocity = 8,812,800 cf/day = 2.6 days to drop lake 1".
- West Sluice – not determined.

If the gates were operated with screens as designed and recommended by engineer to address impingement issues, then that would equate to 136 cfs plus whatever could be accommodated by the west sluice (assumed to be around 38 cfs fully opened based on visual observation but that does not account for impingement velocities). Best case scenario, using all three sluices the Town might be able to achieve a 3/4-inch daily drawdown under ideal circumstances. Additional rainfall and leaf drop clogging issues will be discussed in later sections.

Rainfall and Lake Level Rise

Knowing how large rainfall events impact the lake level is also an important component of lake level management. TLEA (Appendix C) analyses indicated "one inch of rainfall equated to roughly 2 inches of lake level rise." MDIFW reviewed the 2010-2013 data set to re-examine this parameter. A quick plot of the rainfall-lake level rise relationship by month indicated some similarities in line slope within seasons, which makes sense given different seasonable variables including snowmelt/thaw events, changes in runoff coefficients, evaporation, and water uptake by vegetation. The same data were then replotted by season based

on similar sloped monthly lines (Figure 6). Estimated lake level rise per inch of rainfall by season are as follows:

- All Seasons Formula (no winter): 1" rain ~ 1.7" lake level increase
- Spring Formula: 1" rain ~ 3.1" lake level increase
- Summer-Fall Formula: 1" rain ~ 0.97" lake level increase

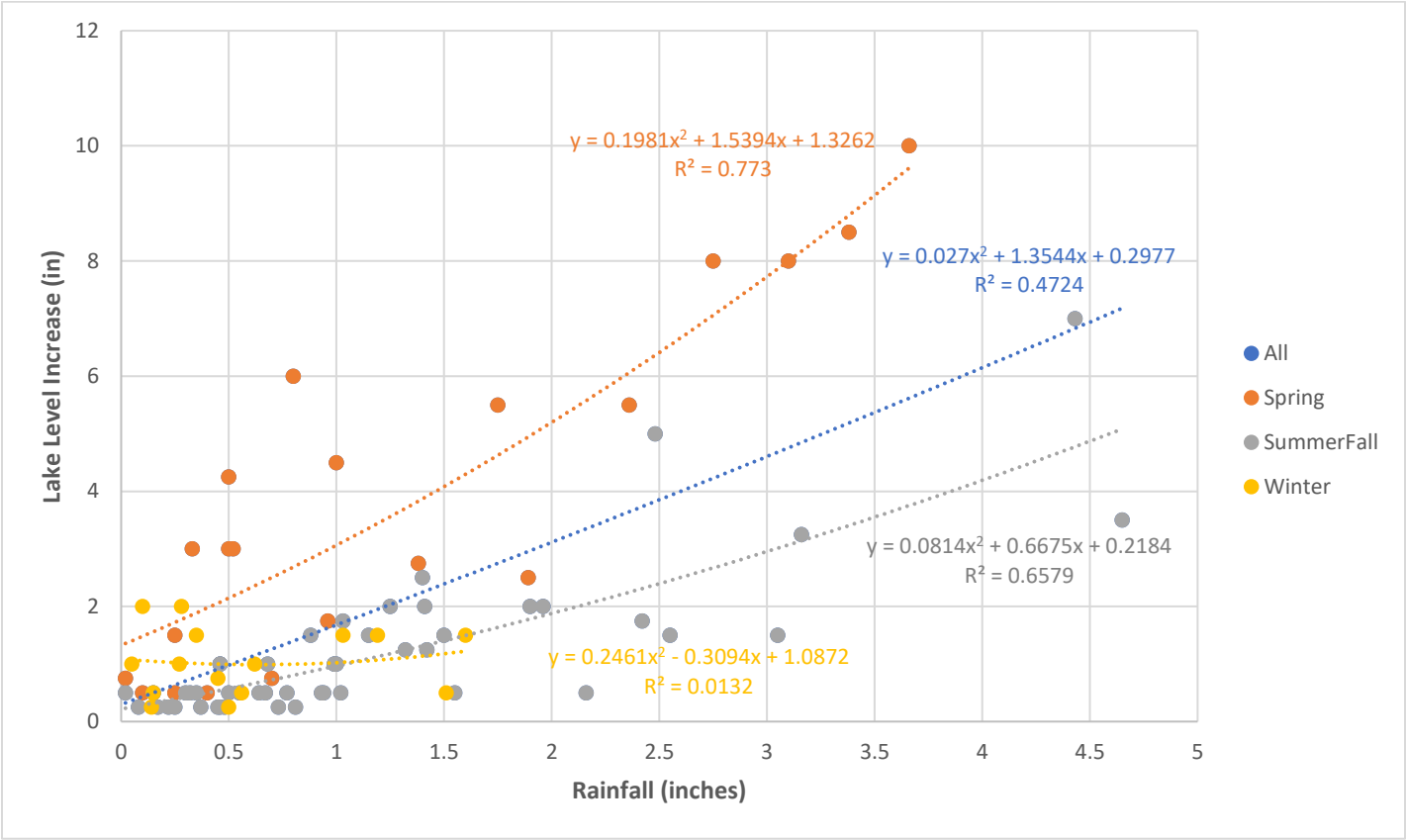


Figure 6. Thompson Lake - Seasonal Rainfall and Lake Level Relationship, 2010-2013.

The All-Seasons Formula, in which 1 inch of rainfall equates to ~ 1.7 inches of lake level rise, is similar to results reported by TLEA and provides a very general rule of thumb. The seasonal formulas are a bit more informative, particularly the Spring Formula. This period shows lake level rise can be much more unpredictable and volatile for small or large rain events, presumably due to the presence or absence of snowmelt and thawing situations related to temperature. For example: a single ¾ inch rainfall equated to a 6-inch lake level rise, while the largest reported event, a 3.6-inch rainfall, resulted in a dramatic 10-inch increase in lake level. While the Summer-Fall Formula shows a 1:1 relationship, it is suspected that the 1:1 relationship is more representative of summertime when vegetation is actively growing and taking up more water in the watershed, and evaporation is higher. It is likely that the fall relationship is closer to a 1:2 ratio, rainfall to lake level. The winter curve shows a relatively flat relationship, which is expected given typically light rainfall events, and the absorption of those events by the snowpack. The dataset analyzed was limited, which may partially explain some of the weaker R^2 values and the inability to separately define the Summer and Fall periods. Nonetheless, this exercise provides some valuable insight and could be revisited with a larger dataset to strengthen and better define the seasonal relationships between rainfall and lake level rise.

Fish Screens:

During the design of the fish screens, MDIFW engaged the Town and their engineer on multiple occasions. We initially advocated for replacing/repairing the original screening structure or a new structure of similar size as it had a long history of being effective, manageable, and safe. Ultimately, a different approach with much smaller screens were pursued by the Town due to anticipated costs. MDIFW expressed several concerns related to the smaller sizing including: increased debris maintenance issues, dam safety issues if debris not cleaned regularly, inability to remove screens in case of emergency flooding, fish impingement, as well as the ability to meet water level management goals. The Town's engineer addressed or dismissed MDIFW's concerns, but the Town felt they needed to rely on their engineer's expertise.

Table 5 compares various estimated sizes of the three sluice openings, the new screens, the old screen, as well as the fish screen sizing being employed by SAPPI at the Sebago Lake dam (~250% of the maximum gate opening). While individual sluice opening comparisons can be made, a look at the total for all screens shows that the new screening falls well below the suggested 250% sizing at all lake levels and is substantially smaller than the original screening structure.

Table 5. Sizing Comparison of original screen, new screen, and gate structures.

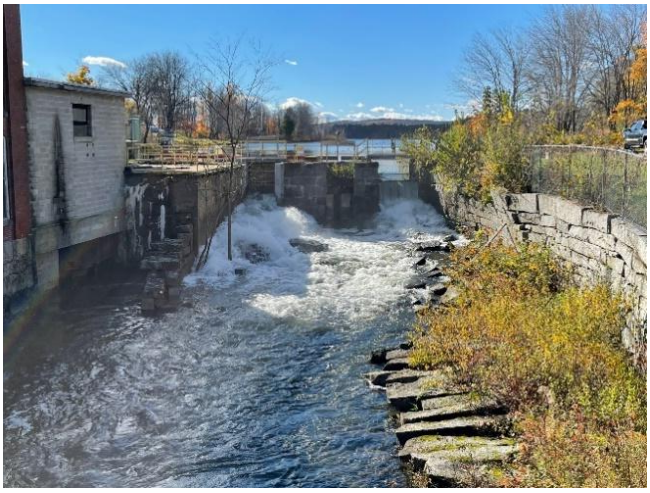
Item Description	**~Area (sq ft)**	**Notes**
East Sluice		
Original Sluice Opening	56.3	7.5'x7.5'
New Gate Opening	17.5	5'10"x5'10" (max of 36" open)
250% of 17.5	61.25	
Full Screen Open Space (SOS)	32.7	6'4"x7'2" 1/4" bars 1" OC
SOS at 16" & 32" lake level	26.6 & 20.5	
Center Sluice		
Gate Opening	20	5'x6' (max of 48" open - assumed)
250% of 20	70	
Full Screen Open Space	88.7	13'1"x9' 1/4" bars 1" OC
SOS at 16" & 32" lake level	76.1 & 67.5	
West Sluice		
Original Sluice Opening	25.4	7'1"x3'7"
250% of 25.4	88.9	
Full Screen Open Space	17.9	7'6"x4'
SOS at 16" & 32" lake level	14.4 & 7.2	
All Screens		
SOS	139.3	
SOS at 16" & 32" lake level	117.1 & 95.2	
250% of All Gate Openings	220.2	250% - suggested minimum based on Sebago Lake screens
Old Screen Area (SOS)	520 (364)	Assuming ~65'x8'; SOS assumed ~70%

The original screens being larger were more forgiving, the new screens clog rapidly with debris particularly during the fall. Debris clogging equates to the need for much higher maintenance, far less ability to manage lake levels, increased velocities risking fish impingement, and a greater potential for overtopping the dam during flooding conditions. If it occurred, overtopping could jeopardize the dam structure and public safety.

Despite the relatively dry fall and cleaning the screens 3 times/day, Town staff struggled to make headway on the fall drawdown in the latter half of October due to leaf drop and several moderate rain events (10/16-17/2021 – 1.63 inches; 10/25-26/2021 – 1.26 inches; 10/30-31/2021 – 2.39 inches). Our observations during this time period were that the lake was typically dropping ½ to ¾ inches per day during dry weather but rain events and the lack of debris cleaning over the weekends setback or even reduced any previous gains in lowering the lake level. Additionally, it should be noted that MDIFW gave the go ahead for the Town to fully open the East Sluice gate (36"), well beyond the 8-inch maximum limit recommended by the engineer to prevent fish impingement. Clearly, operating only the East Sluice with an 8" limit and the West Sluice would not be adequate for water level management issues requiring rapid and/or large drawdowns of the lake. All three sluices will likely be required for managing these types of events, particularly at times when debris loads are heavy.

An example of how quickly the dam screens can clog under the right conditions was observed on 10/21/2021 when outlet flows were being measured by MDIFW, flows went from 152.7 to 117.6 cfs in 3.3 hours due to debris clogging. The photos (below) taken on 11/1/2021 illustrate the differences in flow from the East Sluice (gate fully open) when the Town had not cleaned the screen over the weekend versus just after cleaning. Note: West Sluice screen had been lifted out of the way to address clogging issues and the immediate need to reduce the lake level. Fall clogging associated with leaf drop appears to occur over about a four-week period, while debris clogging is expected to be manageable during the winter/summer. Historically, spring clogging was reportedly an issue that will need to be explored and assessed in more detail this year.





In addition, the single piece design of the east sluice screen and the fact that there is no infrastructure in place for rapid removal or lifting of the three screens in case of an emergency flooding event is concerning.

Operational Impacts on Thompson Lake Fisheries:

As noted earlier, MDIFW has historically advocated that the lake level should not be lower than 38 inches below the top of the dam, and the level of the lake should not be lowered after October 15th. These measures were designed to insure adequate spawning habitat for lake trout at the lowest lake level and that lake trout spawn are not exposed to dry, frozen, or ice scour conditions resulting in lost recruitment. In 2012, TLEA advocated for 32 inches as a maximum drawdown and that the drawdown be completed by 10/20. Going from 38 to 32 inches likely leaves more lake trout habitat wetted/unfrozen but gives less freeboard to mitigate high spring-time levels and heavy rain/thaw events. DeRoche (circa 1960) reported that lake trout in Maine first appear on the spawning grounds from October 9th to the 20th when water temperatures are in the mid-fifties. It is uncertain if the slightly later drawdown date proposed by TLEA would be a significant impact.

On the other hand, it appears since Town ownership the lake has been drawn down well after lake trout spawning occurs (see Lake Levels section). Figure 7 depicts recent lake trout frequency by age and birth year, which suggests a precipitous decline in lake trout recruitment beginning around 2011. Normally this type of graph would be heavily skewed to the left as younger aged fish are typically most abundant except for fish that are not fully recruited to the gear. All fish in this sampling exceeded 300mm in length, which is the cutoff for population estimation with this methodology. In other words, based on size most of the fish should been vulnerable to the sampling gear and well represented.

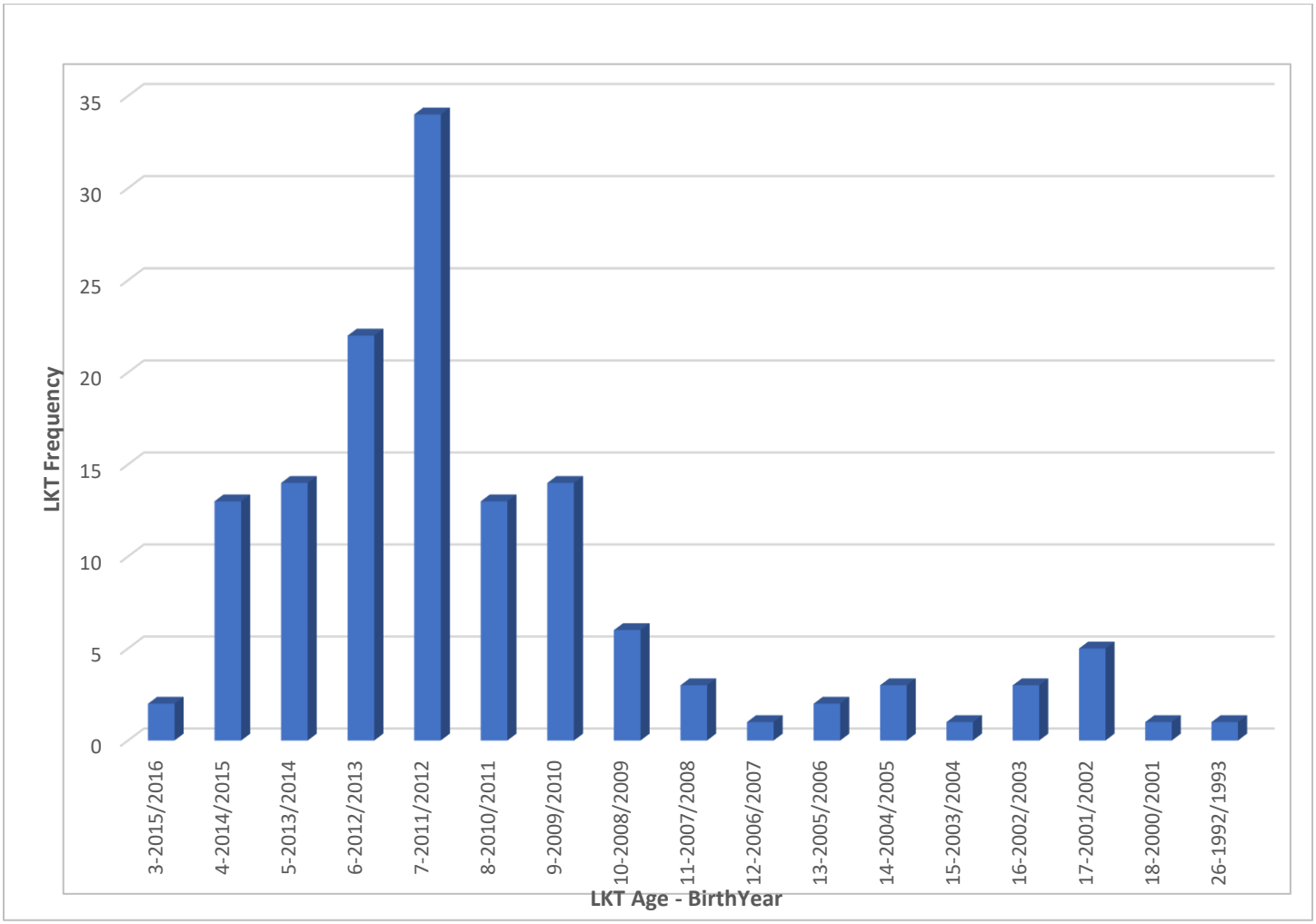


Figure 7. Lake trout age frequency plot from Thompson Lake SPIN data, 2018 and 2019.

As noted earlier, escapement of adult Landlocked Salmon from Thompson Lake after the original fish screens were removed became an issue that was certainly impacting the quality and quantity of salmon. Salmon typically spawn in the 1st or 2nd week of November and are highly attracted to flowing water areas prior to that time. In a system like Thompson Lake they roam throughout most of October, but peak "flow" searching behavior likely occurs in the last two weeks of October. Hence, fall drawdowns that occur after mid-October probably contribute to additional salmon losses from the lake in the absence of fish screens.

A few salmon were periodically noted in front of the dam in early-mid October; however, a large pod was observed several days after the East Sluice was fully opened and were likely attracted to the additional flow. Due to the lack of progress in lowering the lake, heavy leaf drop, and several moderate storm events MDIFW authorized the Town to lift the West Sluice screen, it was lifted on 10/25. It was hoped that salmon would be

less attracted to the West Sluice due to the smaller flow attraction and its higher proximity in the water column. For the entire week salmon seemed to remain in the lake even with the West Sluice unobstructed; however, after a large rain event the following weekend a large group of salmon (30-50) exited the lake. High flows and the plugged screen on the East Sluice likely contributed to a greater attraction to the West Sluice.

Impingement was a screening issue that was to be addressed and has been partially discussed earlier in this document. Despite the East and West Sluices being fully open with flow velocities certainly exceeding 1 fps, impingement was rare. The Town reported: 3 – Burbot (12-18”); 3 – American Eel (24+”); and 5 – Smallmouth Bass (< 8”). In addition, MDIFW staff observed 1 – Fallfish and 1- Burbot. It is unknown if these mortalities were all due to impingement or had some simply died from other causes and drifted towards the outlet dam.

Miscellaneous Notes:

- Fall leaf drop appeared to last about 4 weeks from mid-October to mid-November.
- MDIFW authorized the Town on 10/26 that they could open the center sluice 1” to assist with lowering lake levels while minimize salmon losses, which they eventually did.
- Lake reached the desired wintertime level of 32” on 11/24 and that level was maintained (until at least 12/10) with East and Center sluices fully closed and 3 planks in the West Sluice.

Conclusions:

- Lake levels – Lake water levels are currently not being managed under the former rule curve or as requested by TLEA in 2012. These former lake level operations and management schemes may no longer be entirely possible or beneficial.
- TLOS - Rediscovered outlet discharge to water level gage relationship will be a helpful tool in future lake water level management.
- Drawdown Rate - Historical lake drawdown data suggests the lake levels were generally maintained with relatively modest drawdowns rates of about ½” per day. Lake drawdown data and observations from this year indicate that rapid drawdowns or large lake drawdowns in short time periods (i.e. fall) are not reasonably achievable from the dam as currently built and designed due to reduced sluice sizing and screening.
- Rainfall and Lake Level Rise – These relationships should also help with water level management by allowing the Town to predict and proactively manage for larger storm events. The springtime is the most volatile period and experiences very rapid and large increases in water levels due to small or large rains events coupled with snowmelt. While providing some guidance, the relationships were built on relatively limited data and could be further refined with more historical data.
- Fish Screens – In our opinion, the fish screens were poorly designed and sized. The screens should have covered the entire forebay expanse as they did historically; however, the new screens might be salvageable with some modifications, and a commitment from the Town that the dam and screens need more attention and maintenance.
- Fishery Impacts - Current lake level management appears to be impacting the lake trout population and may be attracting more salmon to the outlet than historical practices. The impacts on lake trout could be used as a fishery management tool to favor salmon; however, MDIFW would need to explore that option with various stakeholders as it deviates from historical and current management goals. The fish screens did appear to retain salmon this fall until the West Sluice screen was lifted to deal with high lake levels, fall debris loading, and several moderate rain events. Impingement seems to be minimal even at much higher flows than designed by engineer; the Town may need to explore eel impingement/escapement in more detail.

Recommendations:

- Meet with the Town to discuss these findings and determine what direction they want to go with the screening issue.
- If the Town decides to move forward with the existing screen design, then the following should be considered:
  - Screen lifting removal structures are a must to deal with emergency flooding and this should be implemented before the center screen is installed.
  - Split East Sluice screen into two pieces for partial removal if it cannot be lifted high enough with preceding recommended structure. Splitting into 2 pieces and lifting only the top portion may better protect the gate from jamming with sticks/logs.
  - Could modify screens to maximum lake level (16" below dam), so they can be overtopped during flood events without reaching the top of dam. May not be necessary if lifting mechanisms installed for all three screens.

    Or in lieu of the above 3 items: Could split top 32-38" of screens into manageable sized pieces (like stop logs) and remove/add them as the lake level drops/rises.
- Remove top lip of West and Center Sluice screens (like East Sluice screen) to facilitate cleaning.
- Fabricate better tools for cleaning screens. Tools need to catch leaves falling off backside as they drop, and they need to be lighter.
- Debris and leaves need to be cleaned multiple times/day and seven days a week during heavy debris loading (i.e. fall leaf drop).
- In 2022, determine if spring debris loading is an issue, how long it lasts, and how much effort is required to keep screens clean.
- Town has expressed concerns regarding labor required for debris cleaning, particularly weekend work. If liability is a nonissue then volunteers might be an option.
- Floating silt boom may be able to direct leaves to congregate in an area where they could be removed to minimize screen clogging/maintenance.
- Install new lake water level gage that can be observed from the fence and that allows for a direct reading without having to do mental math to read it correctly.
- Town should add status of all three sluice positions to their datasheet.
- Consider starting fall drawdown earlier, prior to heavy leaf drop.
- Consider periodic pre-drawdowns prior to predictions of significant rain/thaw events to buffer lake level rise.
- Given the above information and changes to the dam infrastructure, lake level management should be revisited, and a stakeholder group should be involved in the development of the new plan.
- Encourage the Town to develop a Dam Operations Manual that clearly defines the lake level schedule, relationships between TLOS gage and discharge, and standard operating procedures.
- In the future, MDIFW will continue to monitor Thompson Lake's fisheries and work with the Town to ensure the screening project is successful. It is likely the Town, MDIFW, and other entities may need to work together on a successful outcome.
- Town should consider other future dam infrastructure improvements as recommended by an engineer including: shoring up West wall below the dam; fortifying voids in the West/Central sluices and the back of the dam; removal of downstream slabs that obstruct flow; and consider additional sluice openings/spillways on East or West sides of the dam.

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Appendices

Appendix A. Robinson Dam and Negotiations with TLEA re Water Levels 1992-1993, complied by Marcia Pottle, June 15, 2009



1992 lake level document with Rob

Appendix B. April 23, 1993 Letter from Robinson Manufacturing to Mark Gray (TLEA).



IFW recommended water levels for fish

Appendix C. TLEA Recommended Water Level Management for Thompson Lake, circa 2012.



Lake level recommendations.p

Literature Cited

DeRoche, Stuart. Circa 1960. A study of Lake Trout in Thompson Lake. Final Report: Federal Aid Project F-13-R. Maine Department of Inland Fisheries and Wildlife, Augusta, Maine, pp. 32.