SEBAGO LAKE MANAGEMENT UPDATE
SEPTEMBER, 2014

The purpose of this summary is to update various tables and charts used to monitor changes in the Sebago Lake fishery and assess attainment of management objectives established in the Sebago Lake Landlocked Atlantic Salmon Plan (July 2008, revised 2011/2014). Updates reflect data collection since plan development. The update focuses on landlocked salmon, lake trout, and angler use.

Landlocked Atlantic Salmon

Salmon Stocking History:

Currently, 2,500 spring yearling salmon are stocked annually (Table 1) in three different

Table 1. Sebago Lake Salmon Stocking History

Year	*Actual Number of Fall Fingerlings Stocked	*Effective Number of Fingerling Stocked to Reflect Spring Yearling Survival	No. SY Stocked	Absolute No. LLS Stocked (Yearlings + Fingerlings)	Adjusted Annual Stocking Rate to Reflect Fingerling Survival
1988	20,000	2859	3,278	23,278	6,137
1989	18,000	2571	0	18,000	2,571
1990	18,000	2571	7,200	25,200	9,771
1991	18,000	2571	7,200	25,200	9,771
1992	0	0	9,000	9,000	9,000
1993	0	0	9,000	9,000	9,000
1994	0	0	3,000	3,000	3,000
1995	0	0	4,000	4,000	4,000
1996	0	0	4,000	4,000	4,000
1997	0	0	4,100	4,100	4,100
1998	0	0	6,250	6,250	6,250
1999	0	0	7,000	7,000	7,000
2000	0	0	4,000	4,000	4,000
2001	0	0	4,000	4,000	4,000
2002	0	0	1,000	1,000	1,000
2003	0	0	1,000	1,000	1,000
2004	0	0	1,000	1,000	1,000
2005	0	0	1,000	1,000	1,000
2006	0	0	2,000	2,000	2,000
2007	0	0	2,500	2,500	2,500
2008	0	0	3,500	3,500	3,500
2009	0	0	3,000	3,000	3,000
2010	0	0	2,500	2,500	2,500
2011	0	0	2,500	2,500	2,500
2012	0	0	2,500	2,500	2,500
2013	0	0	2,500	2,500	2,500
2014	0	0	2,500	2,500	2,500

* Post stocking fall fingerling survival was very low; 7 fall fingerlings to equal the survival to legal size of 1 spring yearling (personal communication, former Regional Biologist Sony Pierce).

areas of the lake. The presence of a robust and competing wild lake trout population, significant recruitment from wild salmon production in the Crooked River, and expectations under the "plan" to enhance salmon size quality collectively justify current conservative stocking levels. Hatchery salmon are stocked to supplement wild salmon recruitment and to provide a future source of brood salmon that annually migrate to the Jordan River Fish Trap. More recently the proportion of salmon stocked in "Jordan Bay" has increased to encourage higher returns of future brood to the fish trap. Fertilized eggs obtained at the Jordan River Fish Trap, in conjunction with captive brood maintained at the Casco Hatchery provide the entire source of hatchery salmon stocked in waters located in southern and central Maine.

Salmon Size Quality:

Salmon size quality (length, weight, and overall condition (Fulton K) objectives (Table 2) defined in the plan are monitored annually based on data collected at the Jordan River Fish Trap. Returning adults are virtually all of hatchery origin, as few wild salmon stray into the trap and little if any natural production occurs within the Jordan River. Data collected from post spawn males provide a basis to assess attainment of salmon size quality objectives under the plan. Male weight is relatively unaffected by the milt stripping process, unlike female weight which is significantly reduced by egg stripping. Therefore, only males are used to index size quality.

Table 2. Salmon Size Quality Objectives

Age	*Length (inches)	*Weight (lbs)	**Fulton K
II+ (male hatchery)	18 - 20	2.2 – 2.7	> 0.90
III+ (male hatchery)	20 - 23	2.8 – 4.3	> 0.90

In 1988 (when most anglers consider the fishery to have peaked as reported at the time of plan development) age II+ stocked male salmon averaged 18.8" and 2.2 lbs. Age III+ male salmon at that time averaged 21.8" and 3.5 lbs. The length and weight objective ranges developed in the plan were developed independently and reflect demonstrated growth during the best growth years on Sebago. **The Fulton K objective was also developed independent from listed length and weight objectives. For example, an age III+ salmon that is 20" long and weighs 2.8 pounds would actually have a calculated Fulton K of 0.96.

2013 Age II+ male salmon averaged 17.5 inches and 1.8 pounds (Charts 1 & 2), which is on par with the long term lake average (17.6 inches / 1.8 pounds) and just short of the plan objectives (Table 2). An average condition factor of 0.94 meets the plan objective.

Age III+ and older salmon are most desired by the angling public. Age III+ male salmon averaged 20.5 inches and 2.9 pounds in 2013 (Charts 3 & 4), exceeding the long term lake average (19.7 inches / 2.6 pounds) and meeting plan objectives (Table 2). An average condition factor of 0.93 also meets the plan objective. Furthermore, while salmon growth has declined since a "record high" in 2006, the decline is not of a magnitude observed during past dips in growth (most apparent in Chart 4). Since 2006 growth has been either exceptional or close to the long term lake average. This more stable growth pattern is at least partially attributed to conservative and consistent hatchery stocking levels (Table 1) initiated in the early 2000's to reduce fluctuations in growth and create more sustainable and consistent size quality.

Chart 1. Age II+ Male Salmon Length by Year

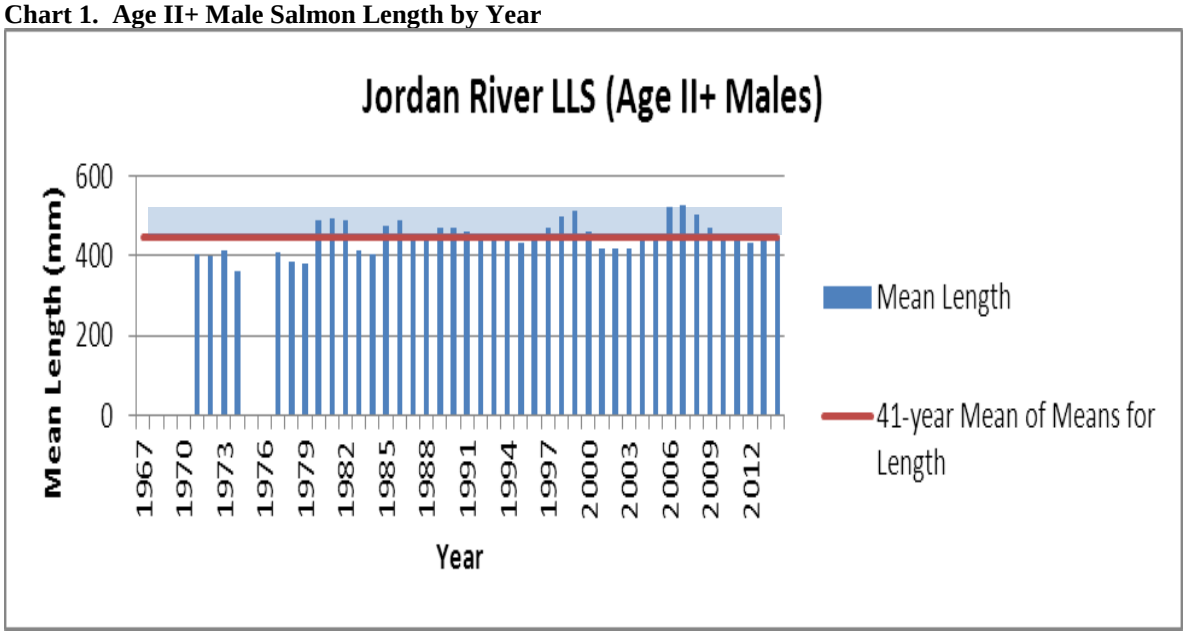


Chart 2. Age II+ Male Salmon Weight by Year

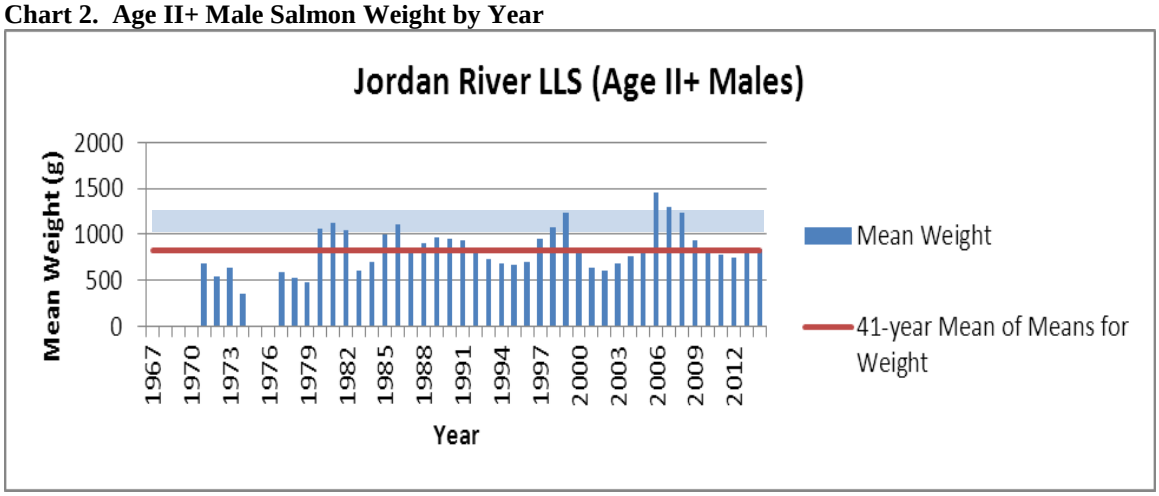


Chart 3. Age III+ Male Salmon Length by Year

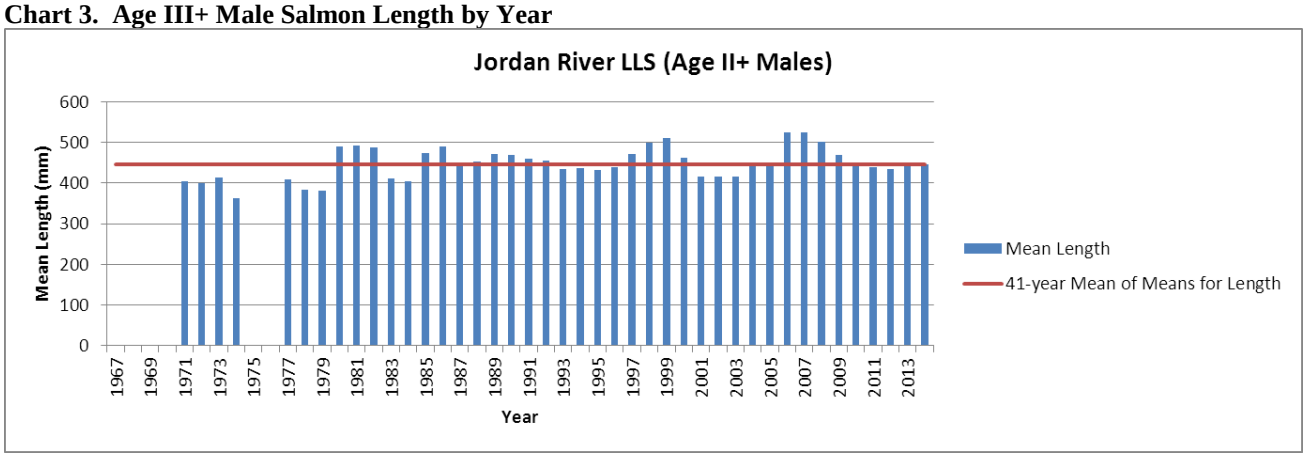
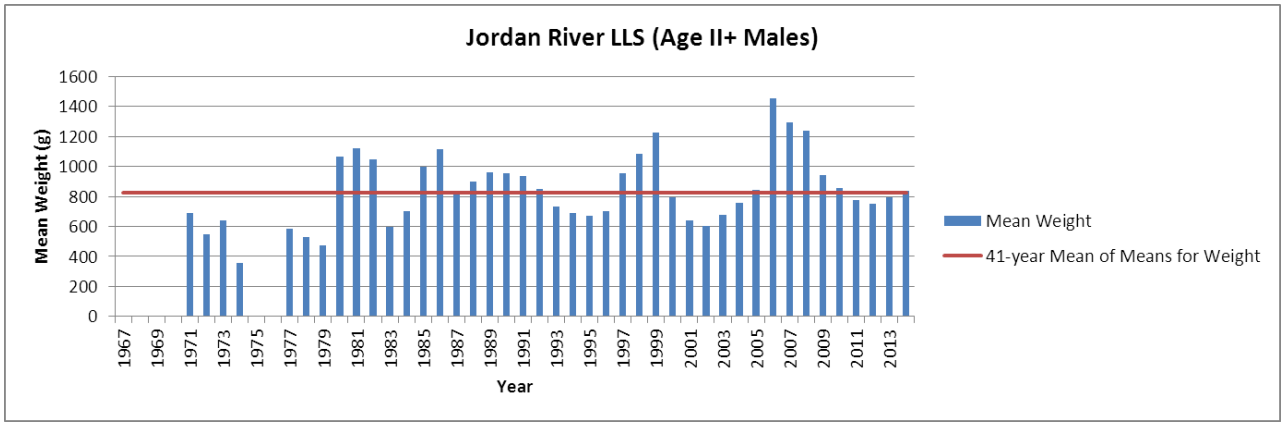


Chart 4. Age III+ Male Salmon Weight by Year



Salmon Catch Rates:

During plan development anglers identified catch rates experienced during 1988 as the "standard" to meet and based on angler survey data collected for that year a season long average catch rate of 0.035 legal salmon/hour was estimated and serves as the benchmark used to assess attainment of angler catch rate expectations in the plan. It is important to note that the calculated catch rate of 0.035 does not reflect the actual catch rate experienced by anglers exclusively targeting salmon and grossly overestimates the actual time required (calculated at 28.6 hours/legal salmon) to catch a legal salmon. This is in part attributed to current and past clerk survey interviews not differentiating salmon and lake trout anglers, and the common practice of anglers fishing for both species during a trip. In reality, experienced anglers exclusively targeting salmon realize a markedly higher season long catch rate. In addition, the numerical standard also reflects the need to maintain catch rates that are socially acceptable while striving to achieve higher size quality objectives. Maintaining acceptable catch rates while enhancing size quality can be challenging since salmon growth and size are density dependent (e.g., lower density of salmon (lower catch rate) produces faster growing/bigger salmon).

Recent salmon catch rates (legals) have been high and appear to be increasing since 2008 (Chart 5). Estimated legal salmon catch rates since 2008 are the highest reported, averaging 0.10 legal salmon per hour (10 hours/legal salmon). This is a relatively high salmon catch rate particularly considering that the calculated rate reflects fishing over the entire open water fishing season and also lake trout anglers not targeting salmon. This recent average catch rate exceeds the 0.035 legal salmon per hour minimum plan objective by 3-fold.

Interestingly, catch rates for all size salmon (legal + sublegal) have also been relatively high and stable since 2008 (Chart 6), in spite of conservative hatchery stocking rates initiated in 2002 (Table 1). Available information indicates wild salmon production and/ or survival has increased and benefited from reduced intraspecific competition from stocked hatchery salmon. Available information indicates salmon catch rates (all sizes) are not only relatively high, but also reflect a higher catch of legal salmon. Salmon fishing regulations which can influnce angler catch have remained fairly constant over

the last several decades, with a 16" minimum length limit that has been in effect since 1980, and a 1 salmon daily bag limit imposed in 1990.

Chart 5. Legal Salmon Caught by Anglers per Hour by Year

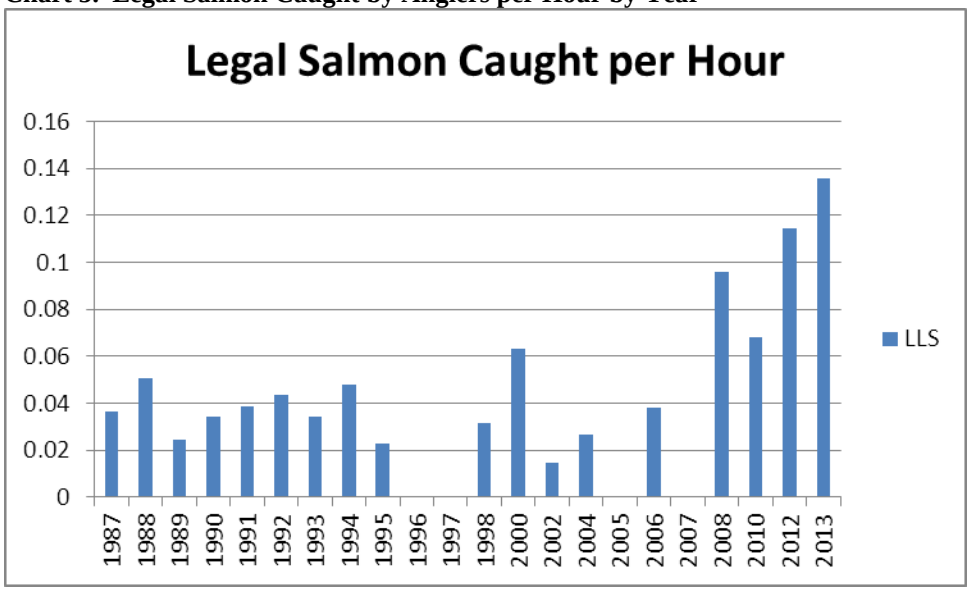
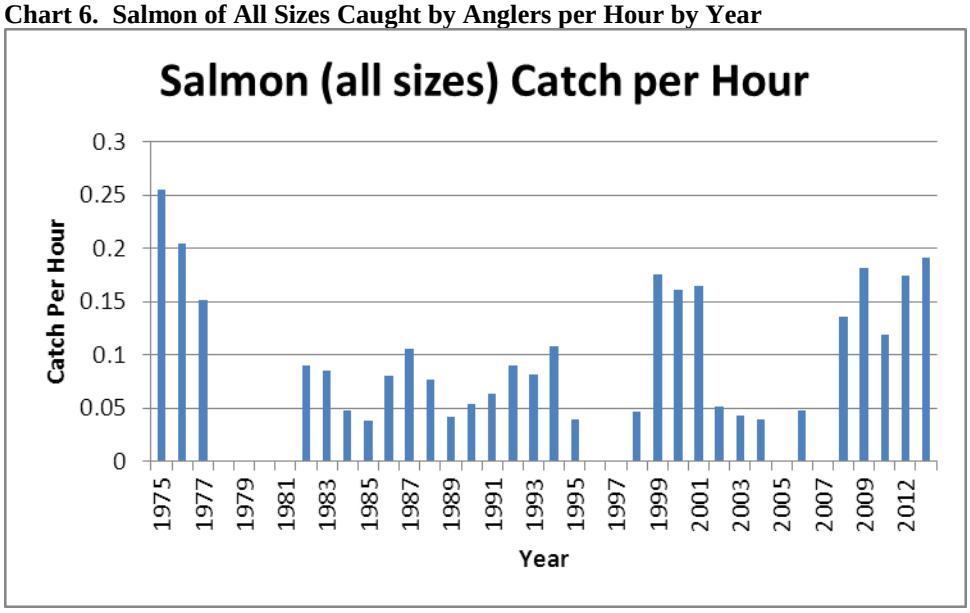


Chart 6. Salmon of All Sizes Caught by Anglers per Hour by Year



Contribution of Wild Salmon:

Since 2008, clerk surveys have included an assessment of origin for all angler harvested salmon. Successful anglers were asked to hold up their catch of salmon for the clerk to assess hatchery or wild origin based on [1]presence/absence of fin clips. Since 2008 wild salmon comprised between 54 and 62% of the salmon harvest. A review of personal

[1] Fin/fins are removed from hatchery salmon prior to their release. Fin/fins clipped are specific to a given year and based on rotating marking schedule.

fishing log data collected from three ardent Sebago Lake Angler Association salmon anglers in 2006 suggested a slightly higher contribution (69%) from wild salmon (included salmon kept and released), but inability by anglers to consistently distinguish the presence of regenerated fins may have increased the number of salmon identified as "wild". In 1981 less than 1% of the legal salmon harvested were wild. The contribution of wild salmon increased to [2]39.5% by 1987. Increasing the contribution of wild salmon to the lake fishery is consistent with plan objectives.

Lake Trout

Lake Trout Stocking History:

Between 1972 and 1982 over a 300,000 lake trout were stocked into Sebago Lake to develop a new fishery. This introduction established a fishery that is currently well established and entirely self-sustaining.

Lake Trout Size Quality:

Prior to 2002, lake trout size quality in the fishery was assessed by collecting length and weight data from fish harvested by ice anglers that was collected by a census clerk. Tentative ice conditions in recent years and related safety concerns on such a large lake prompted an alternative data collection strategy. The Windham Rotary hosts an annual ice fishing derby on Sebago Lake that is structured (at MDIFW's request) to encourage registration of all legal lake trout caught. Registration provides an opportunity for harvested lake trout to be measured and weighed. This registartion process results in a robust lake trout data set, unmatched by past creel surveys.

Angler harvest data collected prior to 2002 were less influnced (biased) by fishing regulations in effect (Table 4) and more representative of the lake trout population size structure at that time. This is because the regulation framework was based on minimum length and bag limits that only restricted harvest of smaller lake trout that were not typically caught, nor targeted by Sebago Lake anglers. However, fishing regulations in effect after 2002 limited the harvest of lake trout over 23 inches and therefore, directly influenced the size of the larger lake trout that anglers harvested and registered in the Sebago Lake Ice Fishing Derby durng any given year. Between 2002 and 2011 anglers could harvest as many as 6 lake trout, but only one could be over 23 inches long. Therefore, lake trout over 23 inches long were not necessarily represented in the harvest data in the same proportion they existed in the popultion and potentially bias conclusions regarding mean size and presence/absence of larger fish in the population. However, in spite of these limitations the derby data offers a low cost opportunity to collect biological data from a large sample to assess overall condition and health of lake trout under 23 inches. In the future the dataset should be reanalyzed to include only fish under 23" after 2001 to reduce the influence of regulation changes. Since derby data was not available for 2012/2013 this adjustment is unecessary at this time.

[2] Urban D. Pierce. 1988. A Characterization of the Landlocked Salmon and Lake Trout Fisheries and Populations at Sebago Lake from 1980 to 1987. Maine Department of Inland Fisheries and Wildlife. 11pp.

Table 4. Lake Trout Regulations in Effect on Sebago Lake Between 1990 and 2012.

YEAR	LAKE TROUT BAG LIMIT	LAKE TROUT LENGTH LIMIT	OTHER
2012	Unlimited: < 23” (+) 1 over 33”	No minimum length, No harvest: 23 – 33”	Artificial lure Only: Oct 1 – Dec 31
2011			
2010			LKT harvest extended: Oct 1 – Dec 31 (year round harvest) (+) increased winter lines from 2 to 5
2009			
2008			
2007			
2006			
2005			
2004			
2003			
2002	6	minimum 14”, only 1>23”	
2001			
2000			
1999			
1998	5	minimum 16”	
1997			
1996			Closed to taking of smelt
1995			
1994	3	minimum 18”	
1993			
1992			
1991			
1990	2	minimum 18”	

Between 1994 and 2012 mean size of angler-harvested lake trout has ranged from 19.8 to 23.2 inches long, and from 2.6 to 4.11 pounds. Although mean annual size of angler harvested lake trout has declined after 1996, it has remained fairly stable since then (Table 3). Some annual variation in weight and overall condition since 1996 is attributed to changing smelt/forage availability.

Table 3. Lake Trout Length, Weight, and Condition by Year

Year	Length (in)	n	Weight (lbs.)	n	Condition	n	*Collection Method
1992	21.3	48	3.66	37	0.917	37	clerk
1993	23.2	84	4.11	51	0.828	51	clerk
1994	23.2	410	3.67	341	0.780	341	clerk
1995	23.0	116	3.45	104	0.783	104	clerk
1996	22.5	129	3.14	108	0.770	108	clerk
1997	21.5	97	3.0	88	0.831	88	clerk
1998	19.8	66	2.71	60	0.965	60	clerk
1999	20.6	45	3.15	44	0.917	44	clerk
2000	21.6	281	3.02	267	0.809	267	clerk
2001	21.7	78	2.91	76	0.769	76	clerk
2002	NA		NA		NA		NA
2003	20.3	930	2.52	930	0.798	930	derby
2004	20.2	1222	2.67	1222	0.863	1222	derby
2005	21.5	*100 (453)	3.39	*100 (453)	0.92	*100 (453)	derby
2006	NA		NA		NA		NA
2007	21.1	297	3.19	297	0.88	297	derby
2008	20.8	371	3.1	371	0.89	371	derby
2009	20.7	1092	2.8	1092	0.82	1092	derby
2010	NA		NA		NA		NA
2011	20.9	1497	2.9	1497	0.84	1497	derby
2012	NA		NA		NA		NA
2013	NA		NA		NA		NA

* "Clerk": winter creel survey / "Derby": catch registered during a weekend derby. Poor ice conditions precluded fishing on Sebago some years.

Lake Trout Catch Rates:

To account for the influence of numerous changes in lake trout regulations (differential size and bag limits) over time and their influence on the size of harvested togue, lake trout catch rate information is reported for all lake trout caught, without regard to size, as a means to normalize the data for comparison. Since the initial introduction of lake trout in the early 1970's angler lake trout catch rates have increased and appear to have peaked in 2009 (Chart 7). Currently it is uncertain if the recent apparent decline in angler catch of lake trout since 2009 constitutes a declining trend in population growth. Caution should be exercised in drawing a definitive conclusion regarding declining lake trout catch rate in regards to population size, as other changes in the lake fishery may have had a direct or indirect effect on anglers and their ability to catch lake trout, including a relatively recent illegal introduction of landlocked alewives. Anecdotal reports from winter anglers indicate successful fishing much deeper to catch lake trout feeding on alewives. Changes in fishing technique have also been reported on other lakes where alewives have become established, including East Grand Lake. Increasing open water angler preference for salmon could also influence calculated lake trout catch rates, which

is based on a survey methodology that pools salmon and lake trout anglers. A decline in population growth would be consistent with plan objectives.

Prior to 2012 the liberal lake trout harvest regulations (6 fish bag, only one over 23") in effect resulted in high angler release rates of legal size lake trout, creating uncertainty whether anglers could harvest sufficient numbers of lake trout to curb population growth (Chart 8). Since 2008 anglers released 59% of their lake trout catch that could have been legally harvested. Rules adopted in 2012 (no minimum length and bag limit under 23", no harvest between 23 and 33", and only 1 fish harvest over 33") were developed to restructure the lake trout population to biologically suppress population growth. An advantage of the new experimental regulatory approach is it places less reliance upon angler harvest to suppress population growth and offers more promise given the prevailing catch and release ethic (Chart 8).

Chart 7. Lake Trout of All Sizes Caught by Anglers per Hour by Year

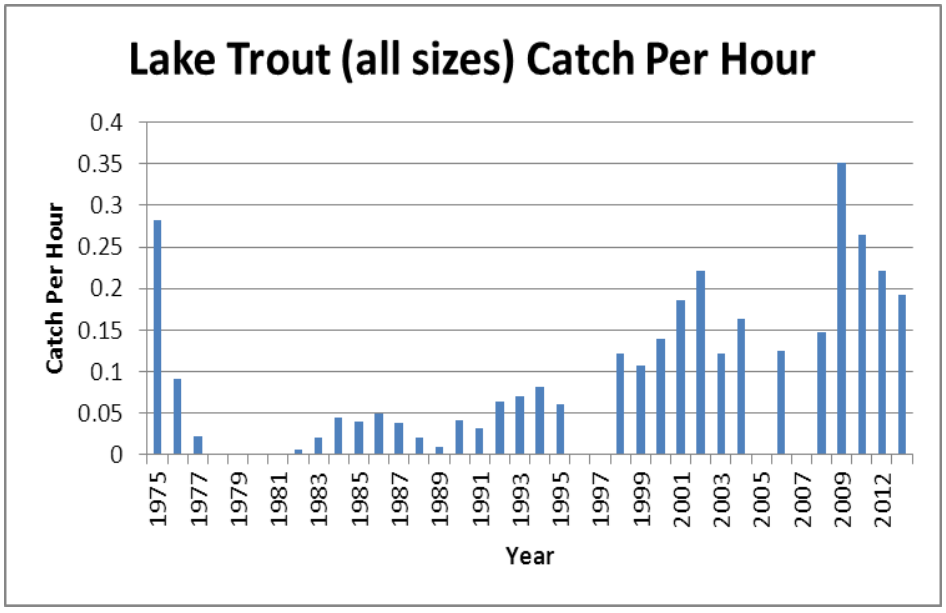
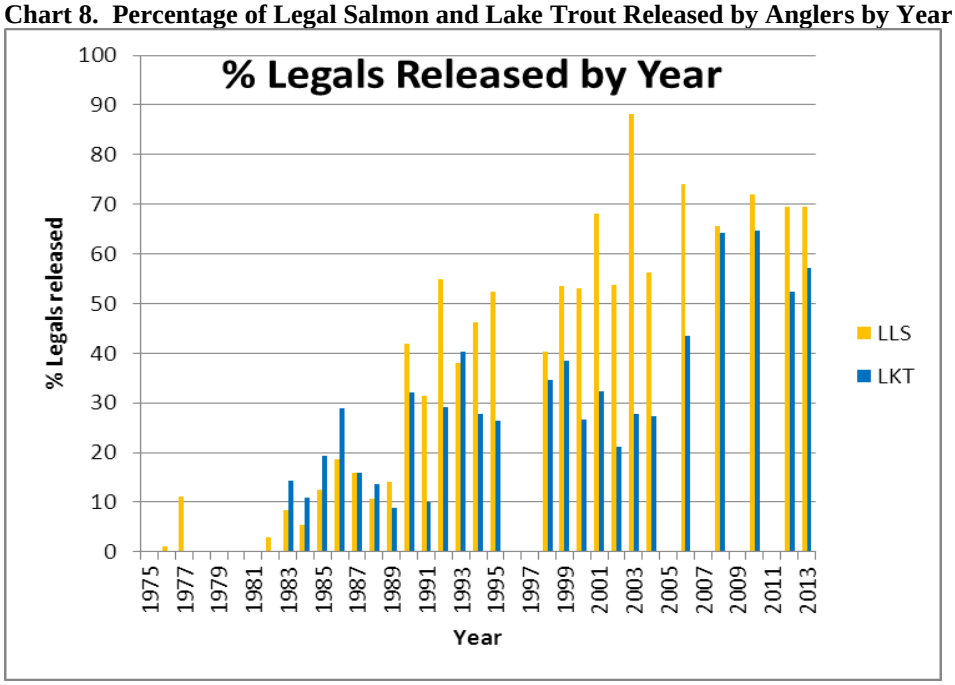


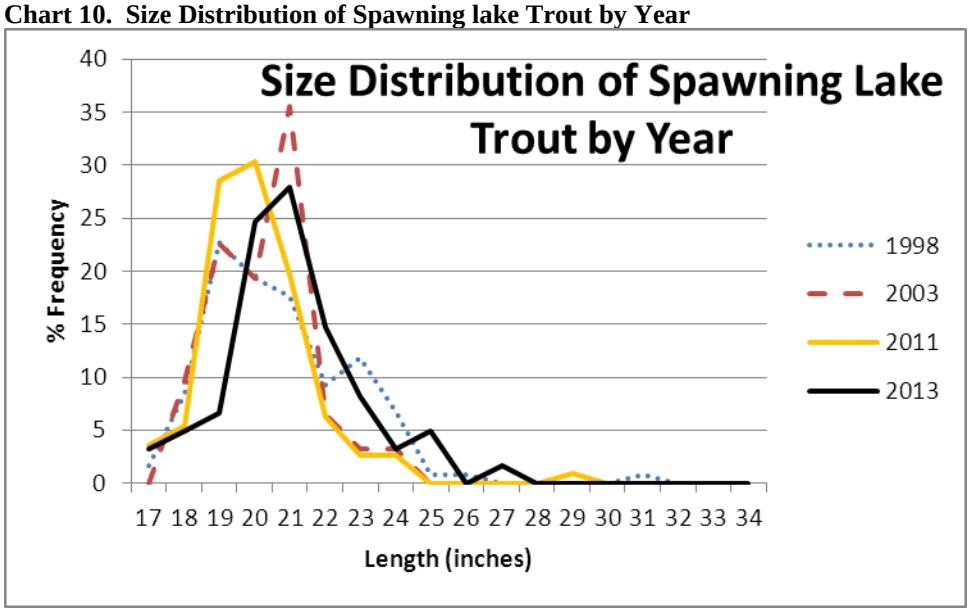
Chart 8. Percentage of Legal Salmon and Lake Trout Released by Anglers by Year



Spawning Lake Trout:

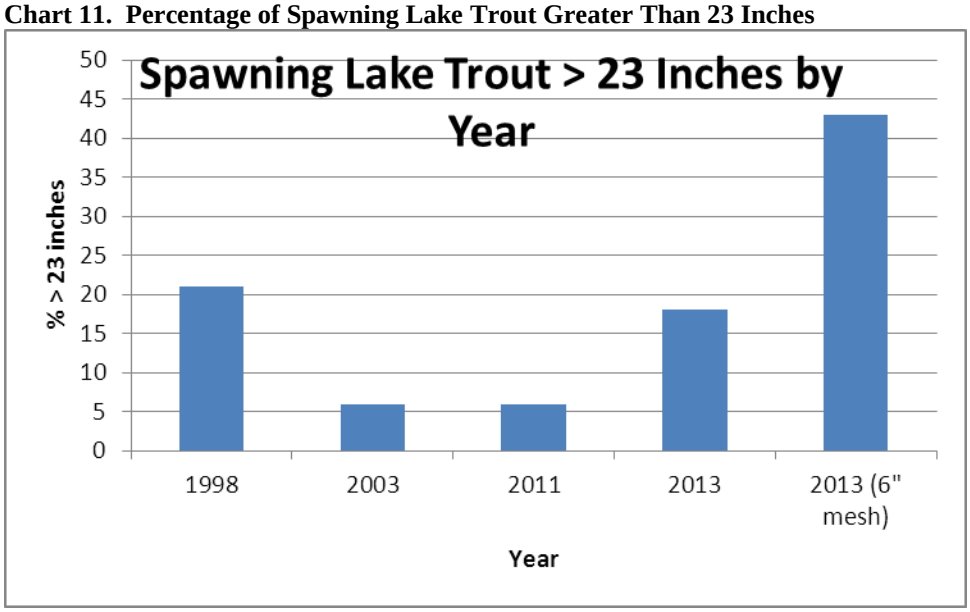
Spawning lake trout have been monitored on four occassions using a variety of sampling gear (eboat, trap nets, gill nets). Past sampling relied primarily upon 2 – 4 inch experimental gill nets which provided a basis to assess size distribution of spawning lake trout between 1998 and 2013. Mean length of spawning lake trout has varied very little over the years, ranging from between 20.7 to 21.5 inches long. Furthermore, plotting length frequency data by year does not reveal any obvious changes in overall size quality from 1998 to 2013 (Chart 10).

Chart 10. Size Distribution of Spawning lake Trout by Year



A closer examination of adult lake trout larger than 23 inches (the 23" reference size is rooted in the last 2 regulation changes) suggests a decline in the availability of lake trout over 23 inches between 2003 and 2011 (Chart 11). Angler reports of catching fewer large lake trout during that period are consistent with this finding. However, an increase in lake trout larger than 23 inches was observed in 2013, and may be attributed to the 23 to 33 inch no harvest slot adopted in 2012. In addition to deploying 2 – 4 inch experimental gill nets in 2013, a straight 6 inch mesh net was set to assess capture efficiency on larger fish and as expected appeared to be more effective at capturing larger lake trout (Chart 11). Capture results in the 6 inch mesh net cannot be compared to earlier sampling since 6 inch mesh nets were not previously used. 2013 netting results indicate an increasing number of larger fish in the lake trout spawning population and this population shift is consistent with plan objectives. Interestingly, the apparent increase in lake trout over 23 inches long did not influence mean size of spawning adults, suggesting any increase realized to date is small, as would be expected so soon after the new rule change.

Chart 11. Percentage of Spawning Lake Trout Greater Than 23 Inches



Lake Trout Harvest:

Previously, season-long estimates of open water catch and harvest were developed, but data collection methods create uncertainty regarding the accuracy and precision of some prior estimates. In 2013 a comprehensive open water creel survey and full season flight count was completed, supporting a reliable estimate of total catch and harvest. It should be noted that surveys by air and on water were generally conducted on "fair weather" days, so estimates may bias actual values on the high side. In 2013 13,373 (+/- 2433) legal lake trout were caught, of which 5,471 (+/- 995) legal lake trout were harvested. By comparison 14,043 (+/-2555) legal salmon were caught, of which 4,165 (+/- 758) legal salmon were harvested.

The Department's statewide Lake Trout Management Plan states:

- *"…the best lake trout habitat often supports no more than one lake trout 18 inches and larger per surface acre of water".*
- *"…the abundance of fish of this size typically ranges between 0.4 and 0.8 lake trout per acre"*
- *"…annual yields in excess of 0.45 pounds per acre from wild populations cannot be sustained"*

The 2013 angler harvest reflects a yield of 0.57 lbs/acre (0.64 kg/ha) for lake trout and 0.3 lbs/acre (0.34 kg/ha) for salmon and, for a combined salmon-lake trout biomass removal of 0.87 lbs/acre (0.98 kg/ha). Yield estimates above are based on the following data sources and assumptions:

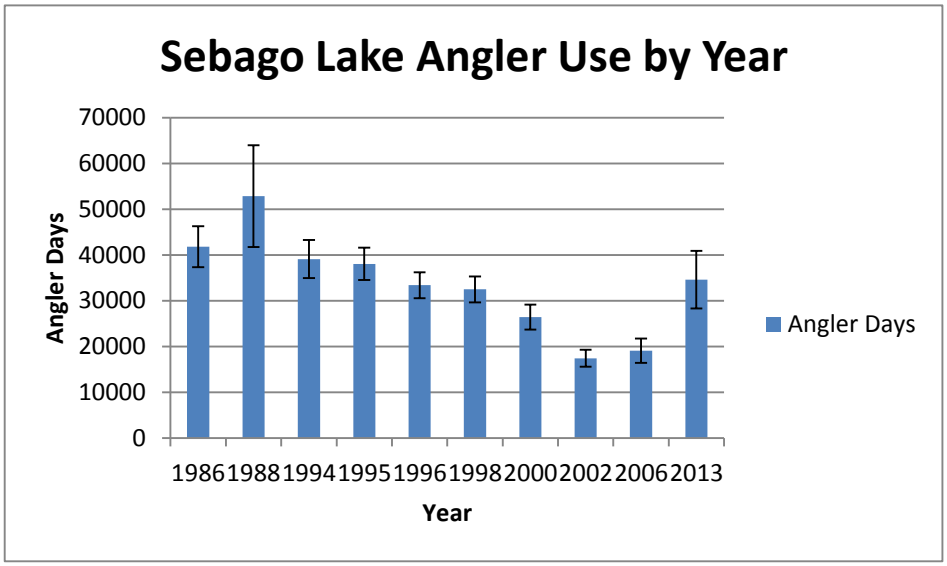
- 2012 personal fishing logbooks provided a source of salmon and lake trout length data for fish "kept" (2013 data set was incomplete at time of estimate).
- Sebago derby lake trout length and weight data pooled over 1999, 2008, 2011 (moderate "K" years) to estimate mean weight for mean lake trout length "kept" as reported in 2012 personal fishing logbooks.
- Jordan River fish trap male salmon data provided information to estimate mean weight for mean salmon length "kept" as reported in 2012 personal fishing logbooks.

The current rate of lake trout harvest exceeds sustainable levels identified in the statewide lake trout plan. Prior harvest estimates have also exceeded this plan recommendation, yet the level of harvest has not yet suppressed the togue trout population. Management guidelines developed in the statewide lake trout plan do not appear to apply to Maine's second largest lake.

Angler Use

Overall use by salmon and lake trout anglers declined from over 52,000 angler trips in the late 80's to a low of 17,000 in 2002 (Chart 12). A low salmon catch in the early 2000's appeared to heavily influence use, even though the lake trout fishing was good and catch rates were increasing. Angler count data collected and analyzed in 2013 indicates angler use is again on the rise, approaching 35,000 angler trips in 2013 (Chart 12). This significant increase in angler participation is likely in response to the improved salmon fishing. Even though angler use increased markedly, 2013 salmon catch rates (legals) remained the highest on record (Chart 5). As use increases average angler salmon catch may decline, but that has not occurred. A restrictive 1 fish bag limit and very high salmon release rates (69% average since 2008) encourage "recycling" and maintenance of high catch rates. Increased angler participation is also expected to increase lake trout harvest opportunity, consistent with plan objectives.

Chart 12. Estimated Angler Use by Year



Conclusions:

1) Season-long catch rates for legal salmon are excellent on Sebago, exceeding plan objectives and providing the highest returns to anglers on record. During the popular spring fishery skilled anglers have reported catching 12 to 18 salmon in a morning of fishing in recent years.
2) Conservative hatchery salmon stocking rates have not adversely affected salmon catch rates and have likely enhanced survival and recruitment of wild salmon by reducing intraspecific competition.
3) Stable and conservative hatchery salmon stocking rates have reduced the magnitude of annual fluctuations in salmon size and condition, thereby providing fish of higher and more consistent size quality.
4) Salmon size quality is good. Age 3+ salmon are meeting size quality objectives, but Age II's are slightly short. Condition (K) of both age classes is very good and consistent with the plan. Recent angler reports suggest general satisfaction with salmon size quality and the presence of some salmon between 4 and 6 pounds.
5) Wild salmon are a significant component of the lake fishery and comprise 54 – 62% of the salmon harvest. In the future the lake fishery may be entirely sustained by wild salmon production.
6) The recent decline in mean lake trout catch rate since 2009 may represent a decline in lake trout abundance. However, caution should be exercised in drawing a definitive conclusion regarding lake trout population status as other changes in the lake fishery may have had a direct or indirect effect on anglers and their ability to catch lake trout, including changes in fish behavior in response to a relatively recent illegal introduction of landlocked alewives, as well as angler fish preferences. A decline in population growth would be consistent with plan objectives.
7) The percentage of larger lake trout (>23") appears to be increasing to a small extent in the adult spawning lake trout population, which is anticipated in

response to the 23 – 33 inch protected slot recently adopted in 2012. This change is consistent with efforts to restructure the age/size structure to increase the percentage of older larger lake trout and to "naturally" suppress population growth.

8) Open water angler use has markedly increased since 2006, which is likely in response to the very good and improving salmon fishing, and to a lesser extent the excellent fishing for lake trout. Higher angler use may increase lake trout harvest opportunity, consistent with plan objectives to reduce the lake trout population.

Recommendations:

1) Conduct annual or biannual (as resources allow) open water clerk surveys to assess angler catch, catch rates, contribution of wild salmon, and relative occurrence of lake trout by size class (<23", 23 – 33 slot, over 33")
2) Conduct another flight survey to obtain angler count data by 2019 to evaluate changes in angler use, harvest, and catch.
3) Future analysis of derby caught lake trout should focus on lake trout less than 23" in years following 2002 to best reflect regulations in effect. Should the regulation framework change in the future this recommnendation should be reevaluated.
4) Annually collect length and weight data from male salmon captured at the Jordan River fish trap.
5) Every 2 to 5 years resample spawning lake trout using multipanel 2-4" experimental gill nets to assess shifts in size structure under the new protective slot regulation. Six-inch mesh gillnet(s) used for the 1st time in 2013 should also be fished since they are more selective for larger fish. Netting results by year should be presented for each mesh size fished.
6) Further reductions in salmon stocking would likley improve salmon size quality and possibly wild salmon recruitment, but are not recommended until such time the Jordan River fish trap operation is no longer needed to meet hatchery production needs. The current low stocking rate marginally maintains the brood program. As wild production increases in the Crooked River and if an alternative salmon brood program is developed future salmon stocking on Sebago may eventually be suspended.
7) Install a portable weir on the lower reach of the Crooked River to provide a means to directly access and monitor the wild adult salmon spawning population. A variety of information, including timing and duration of the run, population abundance, fish health, size, age, and growth, and access to gravid wild salmon to enhance hatchery brood stock are some of the anticipated data collection benefits. However, there are some challenges to install and maintain a successful weir on the lower Crooked River and initial efforts will focus on trouble shooting and developing an SOP for the installation, operation, and maintenance of the weir.

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