



**Myomere/Fillet Study: Investigating
Two Simple Indicators of Total
Length for Walleye, Pike, and
Trout in the Northwest Region**

NWST Technical Report TR-122

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by
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Introduction

New regulations for size limits and slot sizes in the Northwest Region make it desirable for enforcement officers to determine if fish fillets are from trophy game species. The objective of this study is to find a method for the officer in the field to determine if the total length of the fish is greater than the size restriction by examining simple indicators on the fillet. Two indicators were investigated in detail: 1) the myomere width and 2) the fillet length in relation to the total length of the fish. The species studied in this project were walleye, northern pike and lake trout.

In a preliminary review of the problem, outside agencies were contacted and asked about their solutions to size restriction in their state or province.

The Department of the Natural Resources in Michigan has used fillet length in some instances as a regulatory mechanism to enforce size limits. In this case the regulation states a total length of the fish and/or a minimum fillet length. This was started in the 1930s primarily in the perch and walleye fisheries. While it did have some merit, it may have made law enforcement more difficult (Asa T. Wright, Fisheries Biologist, Fisheries Division, Michigan Department of Natural Resources, pers. comm. 1989).

The Nebraska Game and Parks Commission is currently studying the problem of fish identification using the fillet. Normally the fish would be identified in the lab by some form of electrophoresis, but it is very time consuming. A student from Doane College, with the cooperation of the Nebraska Fishery Division, has so far examined 180 fish including 26 species. Several physical features are being examined and used to determine the size of the fish (David Oates, Forensic and Analytical Specialist, Nebraska Game and Parks Commission, Lincoln, Nebraska, pers. comm. 1989). This information is now compiled in the *Field Manual for the Identification of Selected North American Freshwater Fish by Fillets and Scales*.

The Department of Natural Resources in Manitoba in 1984 used a fillet/total length conversion system based on body proportions given by Scott and Crossman (1973). In order to give the angler the benefit of the doubt the minimum head length percent was used and the caudal fin was included in the calculation of body or fillet length. (See Appendix A).

Methods

Each district in the Northwest Region of the Ontario Ministry of Natural Resources (OMNR) was asked to donate fish for this study from their 1989 summer programs if the program involved the termination of fish. Sioux Lookout, Kenora and Fort Frances had programs that supplied this study with large amounts of the target species. Depending on the weather, distance and transportation availability, the fish were delivered to the Regional Ageing Laboratory in Dryden within a few days of the catch. If whole fish could not be delivered easily, the district were asked to fillet the fish (carefully). The fillet should have been cut from immediately behind the cleithrum of the fish to the base of the tail. The skin and bones were not to be removed. The fillet was then inserted into a plastic bag with the vital information of the fish (i.e. fork and total length, date of catch, weight, sex, etc.) included.

When the samples arrived at the laboratory, one of two procedures occurred. If there were no other samples being measured, the samples were stored in the lab refrigerator and the measuring was begun at once. If however, there was a sample of fish already under way, the incoming fillets were measured for weight and length and then frozen flat in plastic bags in the deep freeze.

Two persons were involved in the measuring. The author did all the measuring for the entire program (for consistency) and the other person recorded all the information on the form designed for the project (Appendix B).

The following instruments were used in the study: plywood cutting board, fillet knife, teasing needles, ruler marked in millimetres and centimetres, proportional dividers, electronic Sartorius scale (6 kg max.), lighted magnifying glass, and a permanent marker.

As the project progressed, some new measurements were added. Samples done at the beginning of the project may have fewer measurements taken than those at the end of the project.

The author filleted the fish that came in the round. This ensured all of the flesh was taken from the cleithrum to the base of the tail. The fillet was weighed on the scale with the skin and bones on (fillet weight — raw). Then it was measured with the ruler with the skin on (fillet skin on) along the horizontal skeletogenous septum.

The skin was then removed and the length measured again (fillet skin off). This measurement was done to test whether or not the length varied with the removal of the skin.

The skinless fillet was placed stomach cavity down with the horizontal skeletogenous septum in a straight line (Appendix C). All effort was made to not unduly stretch or compress the fillet. The length of the horizontal skeletogenous septum was measured with the ruler from the anterior end of the fillet to the posterior end (total fillet length). The measurement included all the myomeres of the main trunk and any of the caudal tail muscles taken when filleting the fish.

The anal opening of the fish was used as the main reference point where all of the myomere measurements started. The anal opening was located from the underside of the fillet. A straight edge was used to sight a line straight up from the anus to the myomere above the horizontal skeletogenous septum. This imaginary line was used to divide the fillet into the anterior and posterior sections. The first myomere of the anterior section (intersected by the anal opening reference line) was marked with a permanent marker. This marked myomere was called the first myomere of the anterior side or Ant1-01. The myomere that was behind the anal opening reference line (or posterior to the marked myomere) was referred to as Pos1-01. Marking the myomere made it easier to find when it was frozen and thawed.

Individual myomeres were then measured using the proportional dividers and a ruler. The points of the divider were laid above the first and second myoseptum on the horizontal skeletogenous septum. The horizontal skeletogenous septum was used as the guide for all the myomere measurements for all fish in the study. The points of the divider were then laid on the ruler and a measurement read and recorded. Readings were taken to the nearest whole or 0.5 millimetres. The second myomere measurement was taken from the second and third myoseptum, etc. The anterior section of the fish was done first, followed by the posterior section of the fillet.

Measurements of the anterior section progressed from the first myomere (Ant1-01) to the anterior end of the fillet (i.e. Ant1-22). Incomplete myomeres (those cut by the fillet knife) were denoted by an asterisk. This indicated that a myomere was present, but that a measurement could not be taken. Measurements of posterior myomeres started at the myomere immediately behind the first myomere of the anterior section (Pos1-01) and progressed to the posterior end of the fillet (i.e. Pos1-20). The asterisk was also used when myomeres were present but not complete.

Later on in the study, two groups of ten myomeres (before and after the anus reference point) were also measured. These measurements were used to compare the accuracy of measuring the ten individually measured myomeres. All complete myomeres in the fillet were also measured as a group to compare to all the individually measured myomeres.

All the myomeres in each fillet were counted and recorded.

Lake of the Woods samples were measured in the fresh state, frozen flat in a plastic bag, thawed and then measured for a second time. This procedure was used to determine if there was a difference in lengths and weights in the fresh and thawed states.

Results

Table 1 is a summary of the samples collected for this study. Data analysis was performed by using a combination of computer software programs: Microsoft Excel and StatSoft Statistica.

Table 1. Summary of the samples collected for this study.

Lake	District	Species	Sample Size	State of Flesh
Obikoba	Fort Frances	Walleye	39	Fresh
		Pike	35	Fresh
Mainville	Fort Frances	Walleye	28	Fresh
Weller	Fort Frances	Walleye	61	Thawed
		Pike	68	Thawed
Entwine	Fort Frances	Lake Trout	36	Fresh & Thawed
Lac Seul	Sioux Lookout	Walleye	60	Fresh & Thawed
		Pike	24	Fresh & Thawed
Lake of the Woods	Kenora	Walleye	59	Fresh & Thawed
		Pike	2	Fresh & Thawed

Comparisons were done by combining data of individual lakes involving total lengths of the fish, the number of myomeres, the length of the fillet, the average myomere width and the physical state in which the fillet was measured.

All samples except Lake of the Woods walleye were filleted by district field staff and submitted for this study. Mainville Lake walleye fillets had on average 34.2 +/- 4.5 myomeres contrasting with Lake of the Woods walleye fillets which had on average 44.3 +/- 2.4 myomeres. The average number of myomeres for pike samples did not differ as much as it did for walleye. Obikoba Lake had on average 54.8 +/- 3.6 myomeres where as Weller samples had 55.7 +/- 2.7 and Lac Seul had 55.6 +/- 2.4 myomeres. Unfortunately there was only one lake trout lake sampled for this study. The average number of myomeres for those samples were 57.6 +/- 1.6 (Table 2).

Fish fillets were measured fresh and then thawed depending upon the circumstances of the arrival of the samples to the lab from the other districts. It

Table 2. Average number of myomeres found for walleye, northern pike and lake trout from all of the study lakes.

Species	Lake	n	Mean	Variance	St. Dev.	Max.	Min.
Walleye	Obikoba	42	38.1	8.37	2.89	43	31
	Lac Seul	60	42	1.64	1.28	45	39
	Lake of the Woods	56	44.3	2.11	1.45	48	39
	Mainville	29	34.2	7.15	2.67	41	30
	Weller	64	41.2	1.92	1.39	44	36
N. Pike	Obikoba	35	54.8	3.59	1.9	58	49
	Lac Seul	24	55.6	2.43	1.56	59	52
	Lake of the Woods	2	60	2	1.41	61	59
	Weller	68	55.7	2.65	1.63	59	51
L. Trout	Entwine	36	57.6	1.63	1.27	60	55

was found that there was no significant difference between measurements (either fillet length or myomere width) for fillets that were fresh, frozen and then measured thawed using the Student t test (at 0.05 level).

Differences in length were examined for fillets with and without the skin on. A *t test for paired comparisons* was performed on fresh samples (n=60) and indicated that there was no significant differences between each other. This comparison is important because the skin of the fillet needs to be removed for the myomere width measurements.

Figures 1a, 1b and 1c illustrate the positive linear regression between fillet length and total length in walleye, trout and pike. These were based on fresh samples except for 24 pike from Lac Seul where the thawed measurements were included to increase the sample sizes. Table 3 gives the linear regression equations for fillet length for the three fish species.

Table 3. Predictive regression equations for estimating total length from fillet lengths.

Species	Regression equation
Walleye	$Y = 96.2349 + 1.4175 * X$
N. Pike	$Y = 60.9431 + 1.5290 * X$
Lake Trout	$Y = 27.1790 + 1.7280 * X$

Two sets of measurements were made on the first ten myomeres anterior to the anal opening. The first set of measurements were the individual myomere widths and the second set of measurements were the same ten myomeres inclusive. Statistical analysis revealed (t test paired comparison) that there was no significant difference (at the 0.05 level) between the two methods.

The first ten myomeres of the anterior section of the fillet (in front of the anal opening) were used as the representative sample for the fillet, averaged and then used as an indicator of the total length. The myomeres in this portion of the fillet appeared and then later confirmed with measurements, to be homogenous in width along the septum. Predictive linear regressions equations were calculated (Table 4).

Table 4. Predictive regression equations for estimating total length from average myomere widths.

Species	Regression equation
Walleye	$Y = 34.200 + 64.332 * X$
Northern Pike	$Y = 110.93 + 73.267 * X$
Lake Trout	$Y = -8.258 + 108.724 * X$

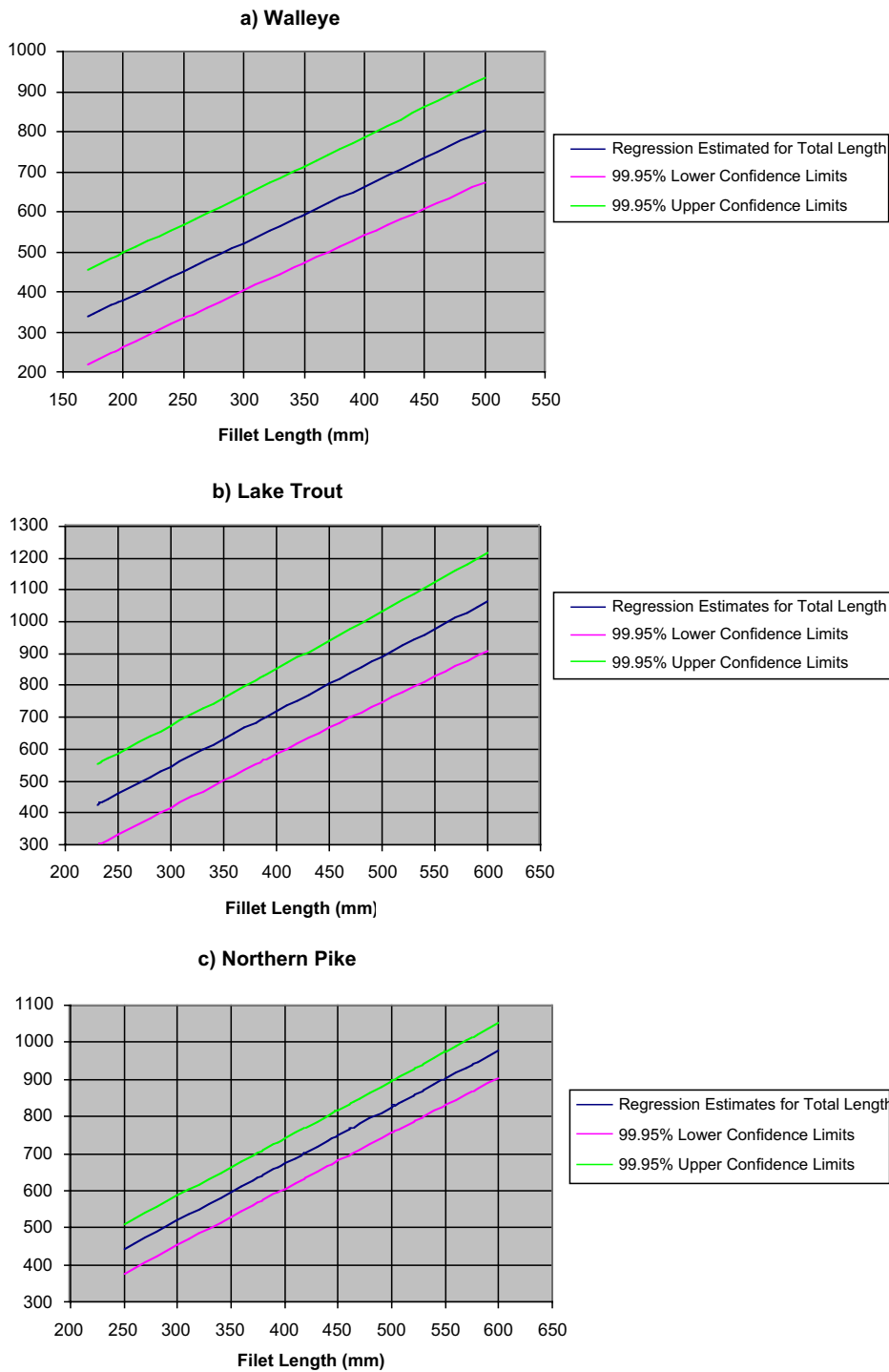
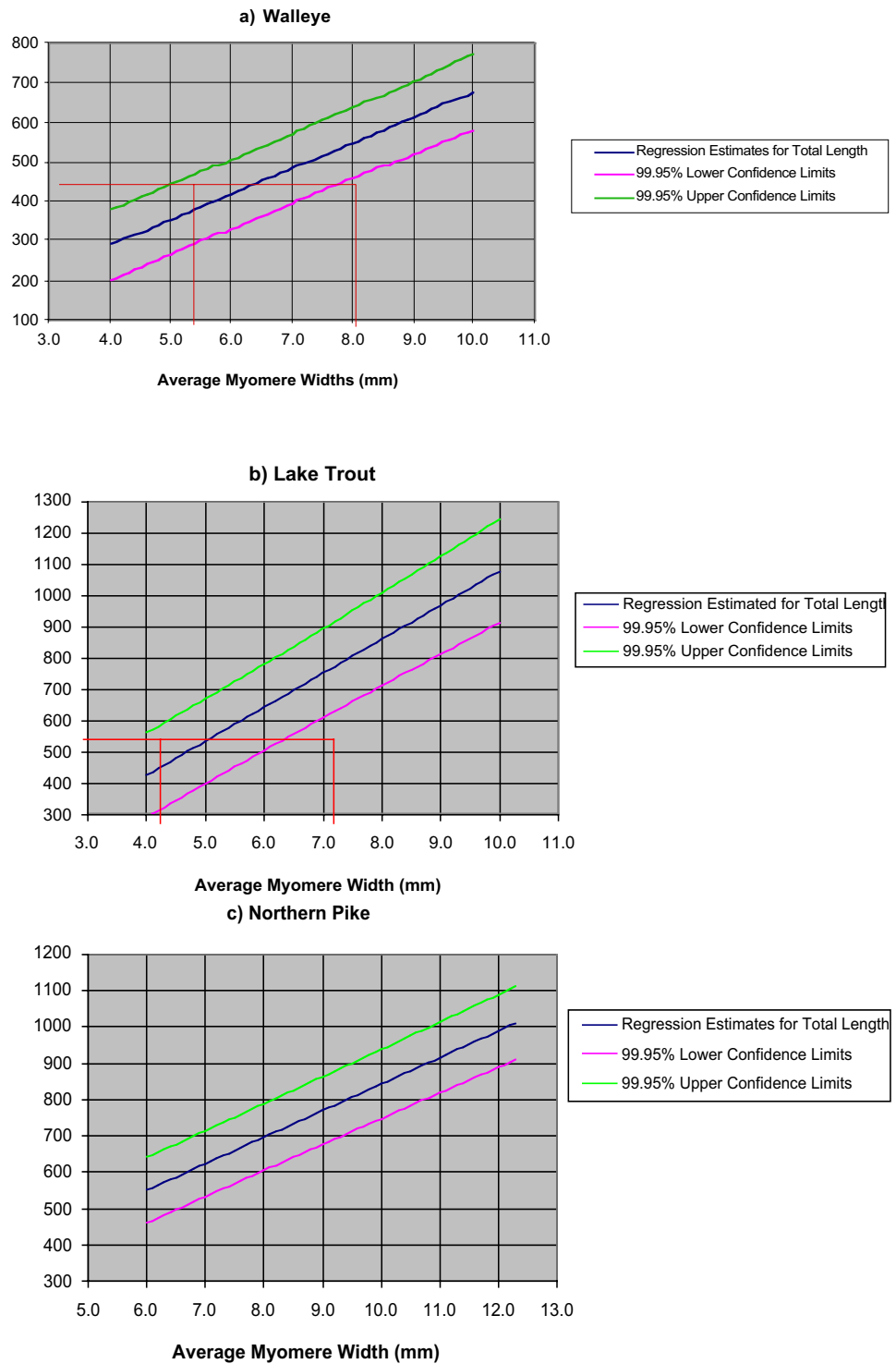


Figure 1. Estimation of total length from fillet length (99.95% confidence limits).

Figures 2a, 2b, and 2c demonstrates the positive linear relationship between total length and mean myomere width for walleye, lake trout and northern pike.

There were several problems noted during the study. 1) Different filleting techniques between various persons in the field and the author produced different linear regression equations. Because the field staff more closely resembled how the public would fillet, the measurements from field cut fillets were used in the calculations. 2) Once the skin was taken off the fillet, it was possible to stretch the fillet. 3) Fillet samples were purposely frozen flat to be measured. Fillets from fisherman may not be so carefully packaged and frozen.

Figure 2. Estimation of total length from myomere width (99.95% confidence limits).



Discussion

The purpose for making separate measurements on fresh and thawed fillets was to discover if there would be any significant differences between the states. After statistical comparisons, it was found there was no significant difference. With this fact, measurements can be made on thawed fillets and considered to be the same as they would have been on fresh. This is convenient for enforcement officers that examine frozen fish and suspect that they might be oversized.

According to Scott and Crossman (1973), walleye have 44 to 48 vertebrae, pike 57 to 65 vertebrae and lake trout 61 to 69 vertebrae. Throughout the length of the trunk, the bodies of the vertebrae have lateral processes that bear ventral and dorsal ribs. The ventral ribs develop within the connective tissue partitions (myosepta) of the lateral muscle bundles (myomeres) at the peritoneum. The dorsal ribs lie in the horizontal skeletogenous septum at junctions of the septum with the myoseptum, often called “intermuscular bones” (Laglar *et al.* 1977). In short, for each vertebrae and rib, there is an associated myomere. The number of myomeres in the study northern pike and lake trout versus the number of vertebrae probably differed because of poor filleting technique on the part of the field collectors.

There was an obvious difference in the average fillet length for walleye and pike between each lake in this study. This can be attributed to filleting technique of each field staff in the sample districts. This is also true for the number of myomere in each fillet. The Lake of the Woods fish filleted by the author had more myomeres than any of the others. This would indicate that even the OMNR field staff does not utilize all of the flesh on the fish. This is also true of the number of fisherman who, for one reason or another, do not know the best filleting technique for a particular species and may not have the time or the patience for it. The closer the myomere count was to the species number of vertebrae, the truer the fillet length became. One thing can be said for a fillet with almost all of its myomeres: if it is almost as large as the species size restriction itself, the total length of that fish must have been very large.

By counting the number of myomeres anterior and posterior to the anal opening, and comparing that to Table 5, it is possible to determine where the myomeres were taken from on the fillet. If a fillet has less than the average number of myomeres for a particular species, it would indicate that the fillet was removed carelessly (or fraudulently).

Species	Myomere Numbers		
	Anterior Portion	Posterior Portion	Total
Walleye	21	21	42
Northern Pike	33	18	51
Lake Trout	36	19	55

Table 5. A guide for the minimum number of myomere an average fillet would have, including myomere numbers on the anterior and posterior portions

Species	Size Restriction (mm)	Upper Limit (mm)	Estimated Fillet Length (mm)	Lower Limit (mm)
Walleye n=133@T.0005	46	175	257	342
Northern Pike n=59@T.0005	90	503	549	600
Lake Trout n=36@T.0005	56	560	309	385

Table 6. The estimated maximum fillet size (in bold) for enforcement purposes (for 99.95% confidence limits).

The size restriction for walleye is 46 cm; lake trout is 56 cm; and northern pike is 90 cm in the Northwest Region. By using the regression analysis equations for fillet length from Table 3, the following guide in Table 6 indicates the estimated fillet length for each species size restriction at the 99.95% confidence level as well as the upper and lower confidence limits. For enforcement purposes, any fillet greater than the guide lines indicates a fish greater than the trophy size. The lower confidence limits for each species was used to give the fisherman the benefit of the doubt as to the estimated size of the fish.

While an angler can reduce the size of a fillet by cutting away flesh to give a false impression of the total length, he cannot change the mean myomere width, short of mangling the flesh itself. Mean myomere widths also have a positive linear relationship to the total length of the fish.

To determine the mean myomere width for a fillet, a measurement of the first ten myomeres in the anterior section as a group should be taken. Measuring those ten myomeres separately is not required since the means of the two methods were not significantly different.

The larger the fish, the larger the myomeres grow to accommodate movement appropriate for a larger fish. Table 7 lists the estimated mean myomere width for the species size restrictions. The lower limit of the average myomere width was used when assessing the fish fillet to give the fisherman the benefit of the doubt.

Finding a total length from the mean myomere width is difficult for lakes with a slot size. The linear regression model for pike was calculated to be $111.0 + 73.2 * X$. The slot size is 70 to 90 cm. The mean myomere width for 70 cm would be 8.1 mm with the upper and lower limits (99.95% C.I.) as 9.4 to 6.8 mm. The mean myomere width for 90 cm would be 10.8 mm with upper and lower limits of 12.2 and 9.5 mm. Notice the upper limit of 70 cm is 0.1 mm away from the lower limit of the 90 cm size restriction. With such a range as this it would be difficult to say, with any degree of certainty, if the total length would be from the low or high end of the slot size.

Table 7. Estimated average myomere widths (in bold) for enforcement purposes (for 99.95% confidence limits).

Species	Size Restriction (cm)	Upper Mean Width (mm)	Mean Myomere Width (mm)	Lower Mean Width (mm)
Walleye n=81@T _{.0005}	46	5.3	6.7	8.1
Northern Pike n=61@T _{.0005}	90	9.5	8.1	12.2
Lake Trout N=34@T _{.0005}	56	4	5.3	6.6

Summary

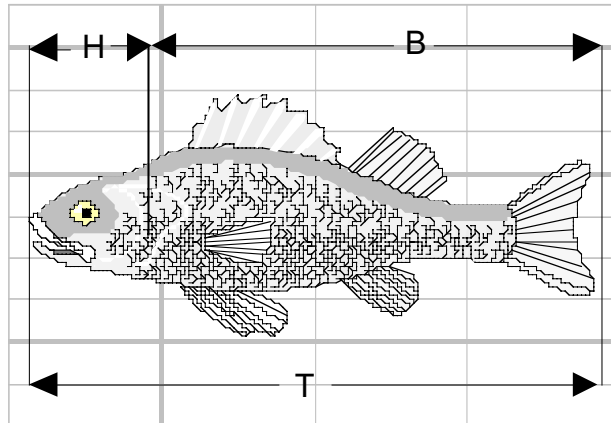
1. There was no significant difference in measurements between fresh and thawed fillets.
2. There was no significant difference in length for a fillet with or without its skin on.
3. The number of myomeres in a fish is directly related to the number of vertebrae and ribs.
4. The more myomeres a fillet has left on it after filleting, the truer the estimated total length of the fish is.
5. By knowing the number of myomeres anterior and posterior of the anal opening, and comparing those numbers that are actually on the fillet, one can determine where the flesh was left off or cut away from the fillet.
6. The mean myomere width of a fillet is a reliable indicator of the estimated total length of the fish. However it is not an accurate tool for slot size enforcement because of its overlapping variance.
7. Together the fillet length, myomere number and mean myomere width is useful to identify whether a fish is over the trophy size or not.

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Appendix A - Fillet/Total Length Conversion

The fillet/total length conversion is based on body proportions given by Scott and Crossman (1973). In order to give the angler the benefit of the doubt, the minimum head length percent was used and the caudal fin was included in the calculation of body or fillet length.



T = total length (100%)
 H = minimum head length (% of total length)
 B = rest of body or fillet (% of total length)
 and $B = T - H$

Therefore conversion factor = $T/B = 100\%/B$

Conversion Factors

Species	Minimum Head Length (H%)	Rest of Body (B%)	Conversion Factor
Walleye (Sauger)	23.8	76.2	1.31
Northern Pike	25.2	74.8	1.34
Lake Trout	21	79	1.27
Arctic Grayling	16	84	1.19

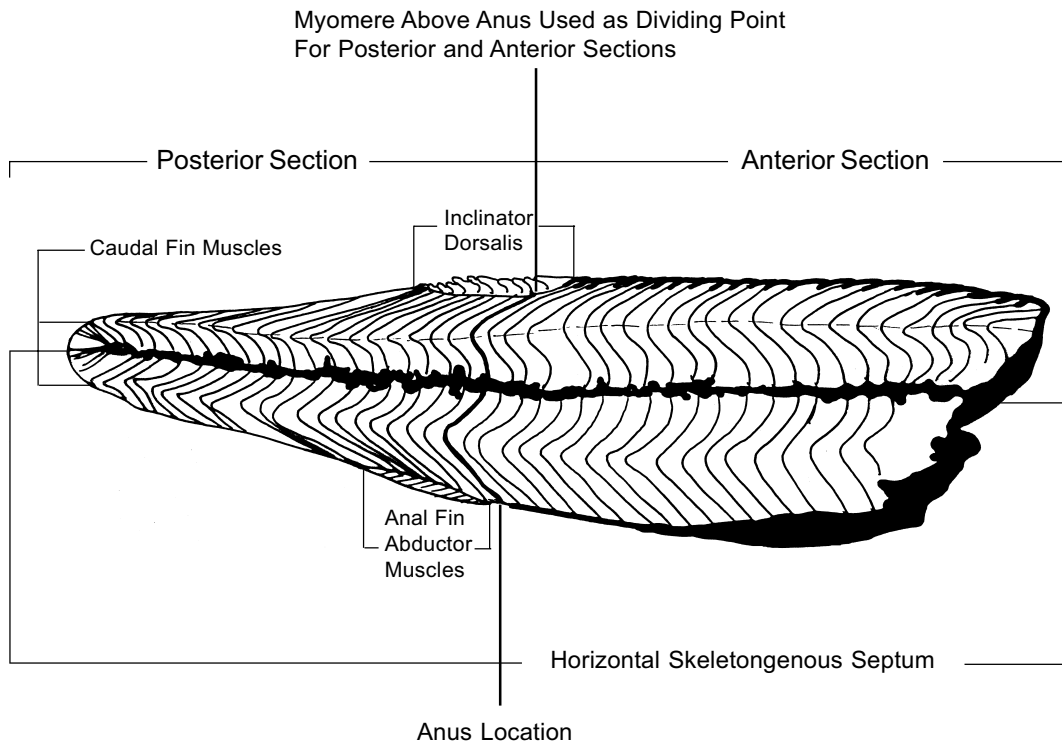
To convert from fillet length to total length, multiply the fillet length by the conversion factor.

- e.g. 1 – a 46 cm walleye fillet came from a $46 \times 1.31 = 60$ cm walleye (total length)
- e.g. 2 – a 67 cm pike fillet came from a $67 \times 1.34 = 90$ cm pike (total length)
- e.g. 3 – a 59 cm lake trout fillet came from a $59 \times 1.27 = 75$ cm lake trout (total length)
- e.g. 4 – a 34 cm grayling fillet came from a $34 \times 1.19 = 40$ cm grayling (total length)

Appendix B - Raw Data Form

LAKE:						DISTRICT:						PROGRAM:						SPECIES:																
WHOLE FISH INFORMATION						FILLET INFORMATION																												
FISH ID	SAMPLE DATE	FORK LENGTH (mm)	TOTAL LENGTH (mm)	WEIGHT (gr)	SEX	STATE	FILLET LENGTH	MEAS. AREA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20						
<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">Anterior Myomeres(1-10)=</div>						FRESH		Anterior																										
						Skin on	MEAS. AREA	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40							
							Anterior																											
							MEAS. AREA																											
<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">Anterior Myomeres(1-10)=</div>						THAWED		MEAS. AREA																										
						Skin off	Anterior																											
							MEAS. AREA																											
							Posterior																											

Appendix C - Parts of Reference for a Walleye Fillet



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