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Condition (Fatness)  
of Herring**

**by Judith H. Stoddard**

FISHERIES RESEARCH BOARD OF CANADA

**TECHNICAL REPORT NO. 5**

**1967**



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STUDIES OF THE CONDITION (FATNESS)  
OF HERRING

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Judith H. Stoddard

This is the third FRB Technical Report from the  
Fisheries Research Board of Canada  
Biological Station, St. Andrews, N. B.

## Studies of the Condition (Fatness) of Herring

### INTRODUCTION

A knowledge of the condition of the Atlantic herring, Clupea harengus L., is of prime importance to the herring industry. This is especially true in cases where the herring are to be reduced to fish meal and oil. Because such information is required, chemical analyses of the fat content of herring were carried out from May to August 1966 at the Fisheries Research Board's Biological Station at St. Andrews, N.B.

Information on the fatness of herring is available, although the literature is not extensive. Battle, et. al. (1936), reported that in the Passamaquoddy region, the fattest herring occur in the passage between Campobello Island and the Maine coast and that fatness diminished in every direction from this passage.

Leim (1943) substantiated the findings of Battle, et. al. (1936) and found that within samples the larger fish were slightly fatter than the smaller ones as long as they were sexually immature. Investigations carried out from March 1942 to August 1943 on herring purse seined on the New Brunswick side of the Bay of Fundy revealed a seasonal variation in the fatness of herring. The condition (fatness) of the fish was poorest in

the months of April to August inclusive.

As a result of investigations from 1944-49 on herring from various areas in the Gulf of St. Lawrence and Atlantic coast of Nova Scotia, Leim (1957) reported that maximum fatness occurred in July and August, with minima in April and June and again in October. Therefore, variations in fat content occur within areas and years. That this was true was later shown again, but more pointedly by significant variation in the fatness of Passamaquoddy herring with respect to size, season, year, locality, and disease (Leim, 1958).

Various methods have been devised and employed for the extraction of fat from fish tissues. Battle, et al. (1936) estimated the fat content of herring by calculating a condition factor. Johnson (1942) used a modified Gerber reagent method. Leim (1957), in the majority of his fat extractions, used ethyl ether in a Soxhlet apparatus, but also used the modified Gerber method described by Johnson. Leim (op. cit.) found that the results obtained by the Gerber method usually gave a fat value that was 70-90% of the ether extracted Soxhlet method.

Damberg's (1956) devised a procedure in which acetone with various (0-50 ml) amounts of water was the fat extractant. Bligh and Dyer (1959), noting that Damberg's method was too time-consuming for routine investigation, reported a new procedure whereby lipids could be extracted and purified in a single operation. They used a strictly proportioned mixture of chloroform, methanol, and water for the fat extractant. This



method yielded higher fat values than those obtained by Dambergs' method.

#### MATERIALS

Herring for fat analyses were obtained from weir and purse seine catches in various parts of the Gulf of St. Lawrence, along the Nova Scotia coast, and in the Passamaquoddy region.

Samples from the Gulf of St. Lawrence and Nova Scotia regions were placed in plastic bags and frozen immediately for shipment to St. Andrews. Each sample usually consisted of six fish of approximately the same size. If the herring were sexually mature, the sexes were analyzed separately. Although it was desirable to have the herring measured prior to freezing, this was not always possible under field conditions and in such cases the sizes were estimated.

Weekly samples from inside Passamaquoddy Bay were alternated with weekly collections just outside Passamaquoddy Bay. These herring were not taken at random, but were chosen for a particular size. When the size distribution of the catch allowed, several samples of different sizes were collected. Again, each sample usually consisted of six fish and it was handled in the same manner as previously described. Altogether there were 25 samples (153 fish) from Nova Scotia (Table II); 30 samples (221 fish) from the Passamaquoddy region (Table III); and 24 samples (146 fish) from the Gulf of St. Lawrence (Table IV).

## METHODS

Generally, the procedure utilized in this study was that followed by Leim (1957). The method of Bligh and Dyer (1959) was attempted unsuccessfully on one occasion. On two occasions, in samples from Souris, P.E.I., and Bliss Harbour, N.B., the condition factor used by Battle, et. al. (1936) was calculated. This factor was compared with the actual percentage fat content obtained by ether extraction of the same fish.

## RESULTS

The results comparing the method of Battle et. al. (1936) and that of Leim (1957) are shown in Table I. There does not appear to be any correlation between the condition factor and the fat content, which suggests that the condition factor is an inadequate measure of fatness.

The other results are tabulated in chronological order for each area in Tables II, III, and IV (Nova Scotia, Passamaquoddy region and Gulf of St. Lawrence, respectively). Graphs have also been drawn for the three areas examined (Figures 3, 4, 5). Time (in days) is plotted against per cent fat content for each day concerned. All values obtained for a particular area on any one day were averaged and the means plotted.

## DISCUSSION

In general, the fat content varied from sample to sample within an area, but no particular orders or trends were

apparent. The highest fat value obtained was 16.38% (St. Annes Point, N.S., July 9, 1966). The lowest value was 3.39% (Birch Cove, Bocabec Bay, Aug. 4, 1966). The herring from Nova Scotia had a higher average fat content (10.31%) than those from either the Passamaquoddy region (8.17%) or the Gulf of St. Lawrence (9.48%).

Analysis of the changes in the fat content with respect to time in each area shows no recognizable trends in the Nova Scotia and Passamaquoddy areas (Figures 3, 4). However, the herring of the Gulf of St. Lawrence (Figure 5) show a rapid increase in late May and early June, but little change thereafter. It is suggested that the herring concerned are spring spawners. The rapid increase in fat follows spawning, after which there is a levelling off as the herring reach maximum fatness.

Leim (1958) generalized that the fat content of "sardines" increased with size. In this current work on larger herring, such an increase was seen on only one occasion -- in samples of four different sizes from Trinity Ledge, N.S., on August 18. The values are given in Table II.

In other similar size comparisons (Northwest Harbour, Deer Island, N.B., June 20; St. Andrews Pt., N.B., June 29; Bliss Harbour, N.B., July 7; Schooner Cove, Campobello Island, N.B., July 28; and Trinity Ledge, N.S., Aug. 12), there was no consistent relationship between size and fat content.

Sex did not influence the fat content in any consistent manner. The males were fatter in 9 out of 14 comparisons. The



difference in fat content of males and females was from .09 to 1.82% in nine cases and from 2.60 to 3.12% in three. A difference of more than 5% was found in only two cases. These were samples taken from Shippigan Island on May 18, where the males had a fat content 5.59% higher than the females and at St. Anns Bay, N.S., on May 25, where the difference between males and females was 5.54%.

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Table I. Condition Factor =  $K = \frac{100w}{L^3}$

Souris, P.E.I. - May 24, 1966

<u>Sex</u>	<u>Weight (g)</u>	<u>Length (cm)</u>	<u>K</u>	<u>% Fat</u> (by extraction)
♂	157.64	31.2	.52	
♂	157.50	31.2	.52	
♂	154.58	31.4	.50	
♀	206.64	30.4	.74	
♀	217.38	30.5	.77	
♀	214.80	30.2	.78	
Means ♂	156.57	31.3	.51	11.03
Means ♀	212.94	30.4	.76	9.97

Bliss Harbour - July 7, 1966

	17.02	13.6	.68	
	23.08	15.2	.66	
	22.78	15.0	.67	
	27.69	15.7	.72	
	32.66	17.2	.64	
	28.20	16.8	.59	
<u>Mean</u>	25.24	15.6	.66	5.81
	58.49	20.5	.68	
	71.68	21.2	.75	
	57.38	20.6	.66	
	55.70	20.1	.69	
	46.18	19.2	.65	
	52.20	19.8	.67	
<u>Mean</u>	57.11	20.2	.68	10.03
	125.68	26.7	.66	
	94.46	23.2	.76	
	103.08	24.2	.73	
	97.30	24.5	.66	
	115.05	24.9	.75	
	83.12	21.9	.79	
<u>Mean</u>	103.12	24.2	.73	9.95
	245.10	31.5	.78	
	239.51	31.0	.80	
	230.60	31.1	.77	
	234.40	26.2	1.30	
<u>Mean</u>	237.40	29.95	.91	10.08

Table II. Fat contents of herring from Nova Scotia 1966

Date	Locality	No. of Fish	Sex	Mean length (mm)	Fat content %	
					Range	Mean
May 17	L. West Pubnico	6	-	-	11.24-11.66	11.45
May 25	St. Anns Bay	6	♂	302	10.45-11.02	10.74
			♀	321	4.70- 5.54	5.20
May 27	W. Pubnico	6	-	299	12.96-13.63	13.24
May 28	Griffin Cove	6	-	288	10.77-11.80	11.24
May 31	St. Anns Bay	6	-	321	7.95- 8.75	8.34
June 6	Petit de Grat	6	-	263	8.38-10.02	9.27
June 16	Petit de Grat	6	-	349	13.34-15.15	14.28
June 18	Cape St. Mary	6	-	250	9.37-12.64	10.89
June 29	Cape Forchu	6	-	-	11.43-11.87	11.64
July 6	St. John's I.	6	-	-	10.58-11.37	10.91
July 7	Shag Harbour	6	-	-	14.84-15.23	15.00
July 9	St. Annes Pt.	6	-	-	16.12-16.38	16.27
July 15	Tucket I.	6	-	-	12.45-13.94	13.31
July 21	Digby Neck	6	-	297	11.61-12.38	11.93
July 27	Trinity Ledge	6	-	317	8.37- 8.41	8.39
Aug. 5	Trinity Ledge	6	-	329	9.20-10.73	9.90
Aug. 9	Cape St. Mary	11	-	200	5.24- 5.73	5.52
Aug. 10	Long I.	8	-	-	6.27- 6.55	6.39
Aug. 12	Trinity Ledge	6	-	297	9.05-10.01	9.53
Aug. 12	Trinity Ledge	6	-	314	10.19-11.63	11.07
Aug. 12	Trinity Ledge	6	-	359	8.95-10.66	9.89
Aug. 18	Trinity Ledge	4	-	230	5.55- 7.78	6.65
Aug. 18	Trinity Ledge	4	-	284	8.74- 9.12	9.27
Aug. 18	Trinity Ledge	6	-	323	9.45- 9.59	9.51
Aug. 18	Trinity Ledge	6	-	342	10.12-11.27	10.56

Table III. Fat contents of herring from the Passamaquoddy

Region 1966

Date	Locality	No. of Fish	Sex	Mean length (mm)	Fat content %	
					Range	Mean
May 16	Dipper Harbour	6	-	165	5.35- 5.92	5.57
May 25	Bocabec	20	-	147	7.00- 7.27	7.10-
May 27	Passamaquoddy Bay	6	-	191	6.79- 7.23	6.98
May 31	Passamaquoddy Bay	6	-	-	9.09- 9.53	9.29
June 7	Bocabec	12	-	184	7.17- 7.38	7.36
June 13	Passamaquoddy Bay	6	-	176	6.47- 7.80	7.16
June 20	North West Harbour	6	-	181	7.11- 8.46	7.79
June 20	North West Harbour	6	-	216	10.11-10.50	10.25
June 20	North West Harbour	6	-	262	7.57- 8.45	7.88
June 21	Moose I., Me.	8	-	175	6.06- 8.17	7.42
June 21	Pleasant Pt., Me.	8	-	200	7.61- 8.56	8.21
June 28	Mill Cove	6	-	200	7.93- 8.34	8.10
June 29	St. Andrews Pt.	6	-	136	5.52- 6.14	5.76-
June 29	St. Andrews Pt.	6	-	189	8.03- 9.16	8.49
June 29	St. Andrews Pt.	6	-	225	5.57- 6.13	5.91
July 7	Bliss Harbour	6	-	156	5.54- 6.02	5.81
July 7	Bliss Harbour	6	-	202	9.48-10.50	10.03
July 7	Bliss Harbour	6	-	242	9.84-10.14	9.95
July 7	Bliss Harbour	4	-	300	9.45-10.90	10.08
July 21	Bocabec	5	-	205	5.20- 5.71	5.52
July 21	Bocabec	6	-	204	6.51- 7.69	7.00
July 28	Schooner Cove	6	-	158	10.16-11.53	10.93
July 28	Schooner Cove	6	-	198	10.77-11.39	11.11
July 28	Schooner Cove	6	-	231	10.53-11.59	11.09
July 28	Schooner Cove	5	-	285	9.63-10.78	10.16
Aug. 4	Birch Cove	12	-	145	3.39- 3.63	3.49-
Aug. 4	Birch Cove	11	-	187	4.68- 7.09	6.19
Aug. 10	Mill Cove	14	-	200	11.85-12.31	12.14
Aug. 11	Mill Cove	8	-	200	10.83-13.12	12.17
Aug. 11	East Wolf I.	6	-	213	5.16- 5.71	5.51



Table IV. Fat contents of herring from Gulf of St. Lawrence 1966

Date	Locality	No. of Fish	Sex	Mean length (mm)	Fat content %	
					Range	Mean
May 16	Escuminac, N.B.	4	-	300	6.45- 7.64	7.20
May 16	Caraquet, N.B.	6	♂	321	7.28- 7.39	7.35
			♀	328	8.57- 9.01	8.79
May 17	Egmont Bay, P.E.I.	6	♂	309	8.21- 9.51	8.88
			♀	298	7.51- 7.97	7.81
May 17	Grand Anse, N.B.	6	♂	323	6.62- 6.83	6.72
			♀	327	4.57- 5.51	5.05
May 18	Shippigan I., N.B.	6	♂	312	9.41- 9.99	9.67
			♀	335	6.95- 7.30	4.08
May 18	Magdalen Is., P.Q.	6	♂	292 <sup>x</sup>	7.95- 8.21	8.05
			♀	292 <sup>x</sup>	7.84- 8.53	8.14
May 19	Pt. Sapin, N.B.	6	♂	309	8.35- 8.48	8.40
			♀	308	5.14- 5.41	5.29
May 21	Shippigan, N.B.	6	-	300	7.58- 7.96	7.77
May 21	Shippigan I., N.B.	6	-	323	4.79- 7.77	6.43
May 23	N. Rustico, P.E.I.	6	♂	275	5.30- 7.14	6.49
			♀	-	9.29- 9.91	9.61
May 23	Egmont Bay, P.E.I.	6	-	293	6.24- 7.55	7.03
May 24	Magdalen Is., P.Q.	6	-	299	8.95- 9.98	9.50
May 24	Souris, P.E.I.	6	♂	313	10.82-11.20	11.02
			♀	304	9.57-10.54	9.97
May 27	Caraquet, N.B.	6	-	300	7.05- 7.50	7.26
May 28	Shippigan I., N.B.	6	-	317	11.64-12.03	11.79
May 30	Egmont Bay, P.E.I.	7	-	301	11.07-11.70	11.40
June 4	Shippigan I., N.B.	6	-	300	11.89-12.41	12.07
June 8	Shippigan I., N.B.	9	-	254	11.18-11.62	11.33
July 29	Caraquet, N.B.	6	♂	330	12.60-12.98	12.79
			♀	334	10.28-11.88	10.97

<sup>x</sup>average length of 400 fish taken from this area

Table IV. (continued)

<u>Date</u>	<u>Locality</u>	<u>No. of fish</u>	<u>Sex</u>	<u>Mean length (mm)</u>	<u>Fat contents%</u>	
					<u>Range</u>	<u>Mean</u>
Aug. 1	Paspebiac, P.Q.	6	♂	325	9.57-10.76	10.11
			♀	332	11.82-13.31	12.71
Aug. 2	Caraquet, N.B.	6	♂	347	11.40-14.28	12.87
			♀	336	11.11-12.21	11.84
Aug. 3	Bonaventure I., P.Q.	6	♂	351	11.26-11.37	11.30
			♀	334	11.84-12.30	12.06
Aug. 3	Bonaventure I., P.Q.	6	-	300	12.29-13.25	12.76
Aug. 3	Port Daniel, P.Q.	6	♂	343	10.52-13.39	11.97
			♀	336	13.56-13.96	13.74

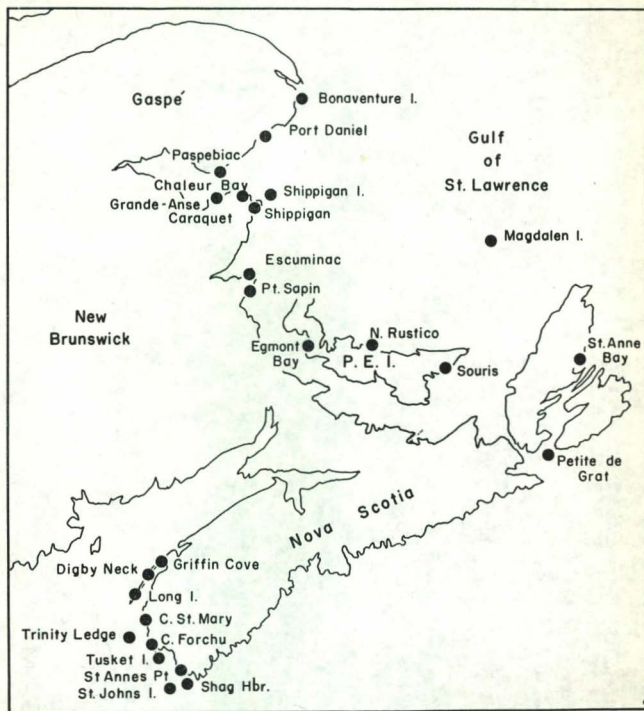


Fig. 1. Sampling Areas of the Gulf of St. Lawrence and Nova Scotia.

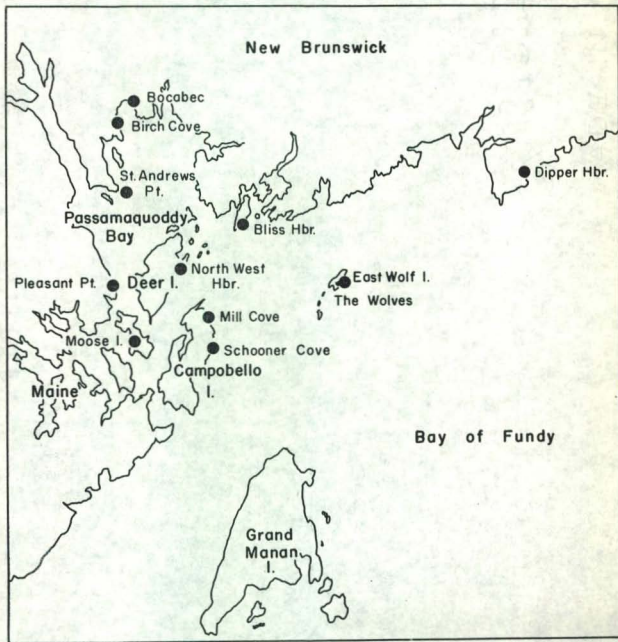


Fig. 2. Sampling Areas of the Passamaquoddy Region.

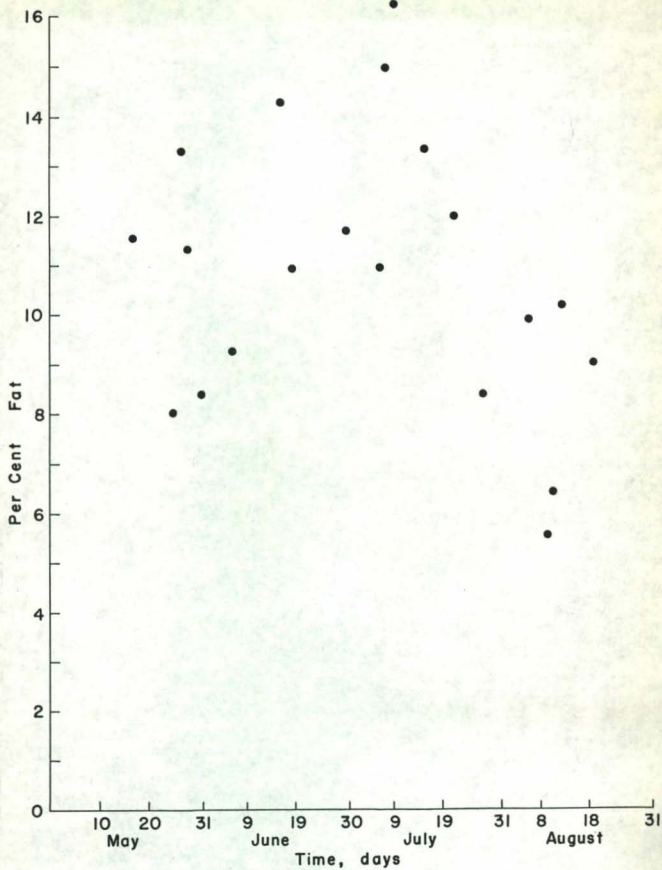


Fig. 3. Seasonal variations in the fat content of herring from Nova Scotia.



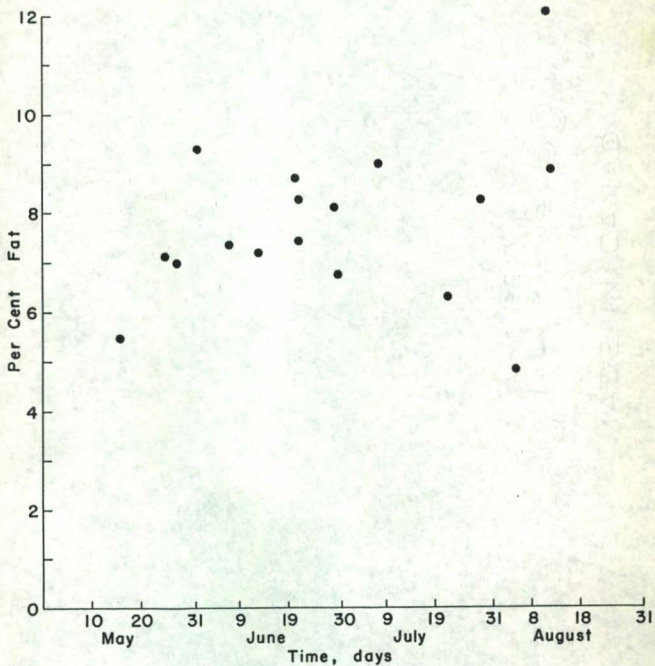


Fig. 4. Seasonal variations in the fat content of herring from the Passamaquoddy Region.

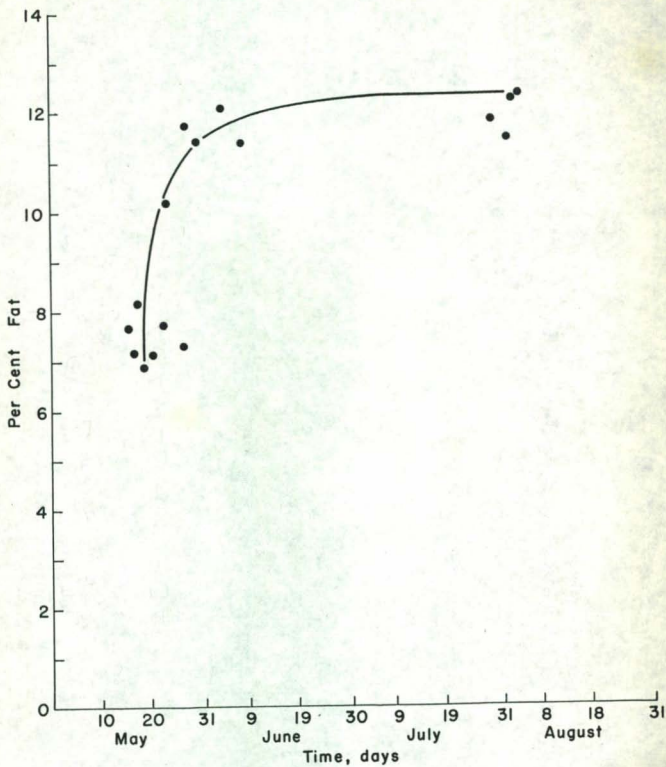


Fig. 5. Seasonal variations in the fat content of herring from the Gulf of St. Lawrence.