PROGRESS REPORT

OTTER TRAWL INVESTIGATIONS

November 1953 through April 1954

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INTRODUCTION

During the "winter" period (Nov.-April) little field work was undertaken. The markets for all otter trawl fish remained good throughout this period and inclement weather was apparently the only limiting factor to the fleet's activities.

A new Dover sole grounds was discovered in early March, and was intensively exploited until the middle of April when the Dover sole moved out of the area. These grounds are located off Willapa Bay in 200-300 fathoms (Block Areas 1321 & 1327). During March approximately 500,000 pounds of Dover sole were landed in Astoria, and the great bulk of this came from the aforementioned area. Many of the boats, however, did not have sufficient cable on their winches to fish in such deep water, so that most of the landings were made by a few boats. The average catch per trip was approximately 30,000 pounds.

Two unsuccessful Pacific Ocean Perch mesh experiments were undertaken during April. The first trip was halted at the end of one day due to engine trouble. The second trip lasted eight days, but the prospects of a successful Dover sole catch (more valuable fish) caused the fishermen to forsake "perch" fishing early in the trip. A broken boom and three torn nets precluded any "perch" fishing after the Dover sole had been caught.

Following is a brief resume, by month, of the activities and projects which were undertaken during the "winter" period. The monthly trips to the Portland office to code landings have not been included, nor has the time spent interviewing fishermen to obtain information concerning areas and drags which had not been reported on the landing records. These two projects are considered routine procedures. Considerable aid is now obtained from the Otter Trawlers Benevolent Society checkers who record the landing weights for member boats. These checkers collect the areas and drags from many landings which would otherwise go unreported as to fishing area.

November

1. Preparation of brief to be presented to the U.S. Tariff Commission. This report indicated an inverse correlation between the volume of fillet imports and the volume of Oregon otter trawl landings, particularly after 1951.

2. Preliminary analysis of 1952 otter trawl landings from IBM sheets received in October.

December

1. Compilation of 1952 Dover Sole landing records from IBM sheets.

2. Pacific Ocean Perch -- age and growth analysis.

3. Preparation for, and attendance at, PMFC meeting in San Francisco.

January

1. Dover Sole -- landings by area, 1951-53.
-- length-frequency analysis, 1948-53.

2. Preparation for, and attendance at:

   a. Staff meeting in Portland.

   b. Convention of Oregon State Fur Breeders Association in Portland.

   c. PMFC biologist meeting in Portland.

March

1. Pacific Ocean Perch -- age and growth analysis.

2. Dover Sole -- catch records, by area, 1951-53.

3. Mink Food -- 1953, production by species.

April

1. Pacific Ocean Perch -- age and growth analysis.

2. English and Petrale Soles -- catch analysis, 1952.

3. Calculation of "first wholesale" value of Oregon otter trawl fishery. (c. $2,000,000)

This report will deal with the results obtained to date from the following projects:

1. Mink Food Landings -- 1953.

2. Dover Sole -- Catch Records, 1942-53.

3. Pacific Ocean Perch -- age and growth.

The Results of the 1953 Mink Food Study

The study of whole fish landed for mink food by the otter trawl fishery was conducted to determine the numbers of pounds of each species of fish landed for mink food and the numbers of pounds of fillet size dover, english, and petrale soles that were sold for mink food.

Samples of the fish landed for mink food were taken at Astoria, Newport, and Coos Bay throughout the summer of 1953 as described in the May through October 1953 Otter Trawl Investigations, Marine Fisheries Progress Report.

The total pounds of each of the major species of fish in the mink food landings for the year were determined from two sources: (1) the pounds per species landed May through September at Astoria, and July through September at Newport as computed from data derived from the sampling program; (2) the pounds per species landed during the months of the year not covered by the sampling program which were obtained from the monthly reports submitted by the Oregon Fur Producers' Association plants at Astoria and Newport.

Since the species composition of the mink food landings varies with the season of the year, the percent composition by weight of the fish species as computed from the sampling program could not be projected to cover the entire year. A comparison of the percent composition by weight of the major species as reported by the plants and as computed from the samples for the same period of time, Table 1, indicated that the pounds per species as reported by the plants compare reasonably well, with a few exceptions, with the pounds

per species as computed from the samples. Therefore, the plant reports were used for the months of the year not covered by the sampling program.

Table 1. Percent Composition by Weight of the Major Fish Species in the Mink Food Samples and as reported in the Mink Food Landings at the O.F.P.A. Plants, May through September at Astoria, and July through September at Newport.

Species	Astoria		Newport	
	Pounds in samples (percent)	Pounds reported (percent)	Pounds in samples (percent)	Pounds reported (percent)
Dover sole	8	16	19	5
English sole	11	19	16	16
Petrale sole	1	1	2	-
Rex sole	18	18	18	23
Bellingham sole	8	12	6	5
Turbot	36	28	14	13
Sand Dab	1	-	5	9
Flounder	10	2	1	-
Misc. Rockfish	1	3	7	26
Misc. Fish	6	1	12	3
	100	100	100	100

A total of 4,975,861 pounds of fish were reported landed for mink food in Astoria, Newport, and Coos Bay in 1953. Almost every boat in the Oregon otter trawl fleet made some landings of mink food during the year. Most of the mink food landings at Astoria were incidental to the fillet market landings of bottom fish. However, with few exceptions, the mink food landings at Newport and Coos Bay were from boats that fished mainly for mink food.

Thirty-two boats landed 2,086,270 pounds of fish for mink food at Astoria during the past year. Seven boats landed 2,813,464

pounds of fish for mink food at Newport over a five-month period, while one boat landed 76,127 pounds of mink food April through November in the Coos Bay area. The fish landed for mink food in the Coos Bay area amounted to only one percent of the total mink food landed in the state, and is not included in the following statistics.

Table 2 shows the total pounds of each major fish species in the mink food landings at Astoria and Newport for 1953. Turbot and rex sole composed 38 percent by weight of the mink food landings; while dover, english, and petrale sole composed 26 percent by weight of the mink food landings. A little more than twice as much dover, english, and petrale soles were landed for mink food at Newport than at Astoria.

A total of 1,240,390 pounds of dover, english and petrale soles were computed to have been landed for mink food during 1953. Of this amount 570,031 pounds, or 46 percent by weight, were large enough for the fillet market. A species breakdown shows that 64 percent of the dover sole, 30 percent of the english sole, and 36 percent of the petrale sole were large enough for the fillet market. The minimum size of fillet market fish is determined by the fillet processing plants and are as follows: dover sole, 36 centimeters; english and petrale soles, 33 centimeters.

The percent composition by weight of the food soles in the mink food landed in 1953 that were large enough for the fillet market, as given in the previous paragraph, was a projection of the percent composition of the fillet size food soles found in the mink food samples. To make such a projection required the assumption that the ratio of fillet size food soles to non-fillet size food soles in the

Table 2. Pounds by Species of Whole Fish Landed for Mink Food at the O.F.P.A. Plants at Astoria and Newport, 1953.

	Astoria		Newport		Total landings Astoria and Newport	
	Pounds landed	Percent of total	Pounds landed	Percent of total	Pounds landed	Percent of total
Turbot	604,889	29	422,801	15	1,027,690	21
Rex sole	376,492	18	445,591	16	822,083	17
*Misc.Rockfish	166,322	8	481,375	17	647,697	13
English sole	249,370	12	364,718	13	614,088	13
Dover sole	119,457	6	423,727	15	543,184	11
Bellingham	204,605	10	138,730	5	343,335	7
Flounder	219,938	11	11,701	Tr.	231,639	5
Sand Dab	8,470	Tr.	156,898	6	165,368	3
Petrale sole	43,314	2	39,804	1	83,118	2
**Misc. fish	87,412	4	328,112	12	415,524	8
Total	2,086,270	100	2,813,464	100	4,903,726	100

* Misc. Rockfish includes:

Sebastodes alutus
S. brevispinis
S. crameri
S. elongatus
S. flavidus
S. goodei
S. melanops
S. paucispinis
S. pinniger
S. saxicola

Sebastolobus alascanus

** Misc. fish includes:

Flathead sole
Rock sole
Sand sole
Slender sole
Cancer magister
Dogfish
Eel pout
Jack mackerel
Ratfish
Sea sculpin
Sea poacher
Shad
Black cod
Hake
Ling cod
True cod
Tom cod
Skates

Table 3. Percent of the total pounds of dover, english, and petrale soles in the 1953 mink food landings which were landed at O.F.P.A. plants, Astoria and Newport, during the respective sampling periods.

	Astoria (May-Sept)	Newport (July - Sept.)
Dover	73%	84%
English	42%	82%
Petrale	12%	81%

mink food landings is relatively constant throughout the year, or that most of the dover, english, and petrale soles landed for mink food were landed during the sampling period. The first assumption is probably true for the most part, although there are no data to substantiate the assumption. The second assumption is generally true, as can be noted from Table 3.

More whole fish was used for mink food in 1953 when the fillet market conditions were poor, than in 1952 when the fillet market conditions were good (Table 4). More fillet scrap was available for mink food in 1952, and thus not so much whole fish was needed for mink food.

Table 4. The pounds of whole fish landed for the fillet market and for mink food, and the number of pounds of fillet scrap sold for mink food in Oregon, 1952 and 1953.

	*Pounds whole fish Fillet market	Pounds whole fish Mink food	Pounds fillet scrap Mink food
1952	20,500,000	1,300,000	12,000,000
1953	8,000,000	5,000,000	5,000,000

*Preliminary figures.

A summary of the 1953 mink food study was presented to the Oregon mink ranchers at the annual meeting of the Oregon State Fur Breeders Association in Portland, Oregon, February 1954.

DOVER SOLE -- Catch Record Analysis

The analysis of the dover sole catch records is incomplete as yet, but the preliminary results are of sufficient interest that they have been included. Since April, 1951, we have been able to segregate most of the otter trawl landings by fishing area. The LOCAL grounds for dover sole have been defined as the area bounded on the north by the mouth of Willapa Bay and on the south by Cape Falcon (south of Tillamook Rock). The east and west boundaries are of little importance, since virtually all the dover sole are caught between the depths of 40 and 100 fathoms at the present time. Prior to 1951 practically the entire catch of dover sole landed in Astoria was taken from this region.

The Astoria dover sole landings in pounds, average pounds per landing, and calculated numbers of landings, by year, 1942-53, are included in Table 5 together with the allocation of the catches for 1951-53 by area of capture.

The total landings of Dover sole in Astoria, regardless of area of capture, reached an initial peak of 6.6 million pounds in 1943, and a secondary peak of 5.8 million pounds in 1952. The low levels of production between 1943 and 1950 are due principally to two factors: (1) 1944-47: competition for the fleet's activities by other species, viz., albacore and rockfish; and (2) 1948-49: a "depression" of the frozen fillet market. The low production (1.5 million pounds) in 1953 was again caused by economic conditions, i.e., poor demand for fillets.

Table 5. Dover sole, Astoria, 1942-53: Total pounds landed, calculated number of landings, and pounds per significant landing, by year, by area (1951-53 only).

YEAR	TOTAL POUNDS LANDED		CALCULATED NUMBERS OF LANDINGS 2/	POUNDS PER SIGNIFICANT LANDING 3/
	All areas	By area 1/		
1942	2,189,287	2,189,287-(L)	140	15,604
1943	6,587,312	6,587,312-(L)	376	17,442
1944	1,318,179	1,318,179-(L)	102	12,899
1945	2,570,845	2,570,845-(L)	164	15,722
1946	2,979,687	2,979,687-(L)	245	12,157
1947	1,606,587	1,606,587-(L)	139	11,526
1948	2,943,453	2,943,453-(L)	281	10,469
1949	2,457,719	2,457,719-(L)	191	12,848
1950	4,763,173	4,763,173-(L)	346	13,767
1951	4,688,405	(788,781)-(N) 3,800,194-(L) (99,430)-(S)	(71) 326 (8)	(11,141) 11,659 (12,368)
1952	5,801,715	(733,489)-(N) 3,193,497-(L) (1,874,729)-(S)	(70) 374 (140)	(10,497) 8,540 (13,435)
1953 4/	1,529,974	(258,046)-(N) 835,636-(L) (436,292)-(S)	(21) 91 (42)	(12,288) 9,183 (10,388)

1/ Areas: (N) = North of the mouth of Willapa Bay.
(L) = LOCAL AREA = Cape Falcon to mouth of Willapa Bay.
(S) = South of Cape Falcon.

2/ Calculated numbers of landings = $\frac{\text{Total pounds landed}}{\text{Pounds per significant landing}}$

3/ Significant landing = Landing in which dover sole constitutes more than 29 percent of the total landing.

4/ Incomplete and unofficial figures.

The production records for the LOCAL AREA present a somewhat different picture. The initial peak of 6.6 million pounds occurred in 1943, of course, but the secondary peak occurred at 4.8 million pounds in 1950. Subsequent to 1950 the total production from the LOCAL AREA declined to 3.8 million pounds in 1951 and 3.2 million pounds in 1952, the year in which the total dover sole production for Astoria hit its secondary peak. These data appear to indicate that the demand for dover sole during the period 1950-52 exceeded the supply available in the LOCAL AREA and the fleet was forced to move to other areas in search of dover sole. The catch-per-trip for the local area declined from 13,767 pounds in 1950 to 8,540 pounds in 1952. During the same period the catch-per-trip for other areas (north and south) remained more or less stable at approximately 11-12,000 pounds per trip.

This preliminary, and superficial, analysis suggests that the stock of dover sole in the LOCAL AREA has been reduced to a level of near marginal economic value.

PACIFIC OCEAN PERCH -- Age Determination

The analysis, such as it is, is now nearly complete for the determination of age of the Pacific Ocean Perch (Sebastodes alutus). For brevity's sake, the results will be discussed rather briefly at this time.

Methods

All samples of fish were taken from the fillet plants at Newport and Astoria during the period April 1951 through November 1952.

Scales were selected as the least undesirable structure from which to obtain age readings. Dry mounts proved to be satisfactory for use with the Rayoscope projector. Three scales from the same fish were mounted on each glass slide and each slide was serially numbered for identification.

The scales were "read" as projected images from a Rayoscope projector at 44 diameters magnification. A white strip of paper, 1/2" x 8-1/2", was laid on the projected image so that one corner of the strip lay on the right or left anterior corner of the scale image and the corresponding edge passed through the focus of the scale image. A plus-mark was made on the edge of the strip where the edge passed through the focus and a mark perpendicular to the edge of the strip was made where each annulus intersected the edge of the strip. At the bottom of the strip the slide number, scale number (1-3), scale axis (R or L), and date of reading were recorded.

After selection of the most readable scale and its most readable axis at the first reading, the subsequent readings were made on the same axis of the same scale.

Each scale selected was read three times without reference to previous readings or size and sex of the fish from which the scale was taken. The readings were usually at intervals of 2-5 days. The three readings were then compared and the paper strips were checked for coincidence in location of the annuli. If any two of the three readings were identical, the coincident reading was accepted and the reading was recorded as an "agreement". In cases of disagreement a fourth reading was taken with reference to the previous three, and a decision rendered.

The purpose of the three, rather than the conventional two, readings was the reduction of the number of "decisions". The anticipated growth studies could then be based upon "agreement" readings only and no alterations of the marks on the paper strips would be necessary. That is, all "decision" readings were to be excluded from the material to be used for growth analysis.

Results

Readability for these scales was only fair. For the 533 scales examined, "agreements" were reached for 373 scales (70 percent). These data were examined to determine, if possible, the cause of the low readability. Tabulation by age and sex (Table 6) indicated that the scales from male fish were somewhat more readable, i.e., 76% readability as compared with 66% for females. For both sexes, however, readability was generally below 70 percent for scales with more than 12 rings. For both male and female fish, 100% agreement was obtained for scales with less than 7 rings and greater than 80% for scales with less than 11 rings. The overall difference in

readability between sexes appears to be largely due to the greater numbers of females with more than 10 rings on their scales.

Table 6. Numbers of Pacific Ocean Perch scales read and percentage "agreement", by "age", by sex.

"AGE"	MALES		FEMALES		TOTALS	
	T	%A	T	%A	T	%A
2	1	100	-	-	1	100
3	0	-	0	-	0	-
4	1	100	0	-	1	-
5	1	100	0	-	1	100
6	6	100	2	100	8	100
7	10	100	10	80	20	90
8	19	89	19	95	38	92
9	39	69	23	83	62	74
10	41	83	31	84	72	83
11	34	76	52	73	86	74
12	24	67	43	77	67	73
13	24	50	28	57	52	54
14	12	67	17	41	29	52
15	9	89	16	56	25	68
16	4	75	23	61	27	63
17	3	67	9	33	12	42
18	0	-	11	18	11	18
19	1	100	6	33	7	43
20	0	-	6	17	6	17
Greater than 20	0	-	8	25	8	25
Totals	229	76	304	66	533	70

Reliability was tested indirectly by the following methods.

1. Relationship of body-length to number of rings on the scale.

2. Relationship between back-calculated sizes of fish at earlier ages and observed lengths at same age.

3. Time of formation of the ring.

A correlation (apparently curvilinear) appears to exist between body length and number of rings on the scale, for both males and females (Tables 7 and 8).

Table 7. "Age"-Length Relationship for 229 Male Pacific Ocean Perch.

LENGTH*	"AGE"																		TOTALS
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
18	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
8	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	2
9	-	-	-	-	-	-	-	1	0	-	-	-	-	-	-	-	-	-	1
30	-	-	-	1	2	1	-	0	0	-	-	-	-	-	-	-	-	-	4
1	-	-	-	-	2	2	2	3	1	-	-	-	-	-	-	-	-	-	10
2	-	-	-	-	1	3	3	2	0	-	-	-	-	-	-	-	-	-	9
3	-	-	-	-	1	2	5	5	4	1	-	-	-	-	-	-	-	-	18
4	-	-	-	-	-	1	2	7	11	2	-	-	-	-	-	-	-	-	23
5	-	-	-	-	-	0	2	5	5	6	2	-	-	-	-	-	-	-	20
6	-	-	-	-	-	0	1	6	6	9	6	1	1	-	1	-	-	-	31
7	-	-	-	-	-	0	2	5	5	9	7	8	3	1	1	-	-	-	41
8	-	-	-	-	-	0	0	2	6	2	6	8	2	2	2	1	-	-	31
9	-	-	-	-	-	0	2	1	0	3	1	4	2	6	-	0	-	-	19
40	-	-	-	-	-	1	-	2	2	1	1	2	2	-	-	1	-	-	12
1	-	-	-	-	-	-	-	-	-	1	0	0	1	-	-	1	-	-	3
2	-	-	-	-	-	-	-	-	-	-	1	1	0	-	-	-	-	1	3
3	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	0
44	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Totals	1	0	1	1	6	10	19	39	41	34	24	24	12	9	4	3	0	1	229

* Grouped to nearest lower centimeter.

Table 8. "Age"-Length Relationship for 304 Female Pacific Ocean Perch

Length*	"AGE" 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	>20**	Totals
27	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
8	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
9	-	0	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
30	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	0
1	1	0	2	0	1	-	-	-	-	-	-	-	-	-	-	-	4
2	0	1	2	1	1	-	-	-	-	-	-	-	-	-	-	-	5
3	0	3	0	3	0	2	-	-	-	-	-	-	-	-	-	-	8
4	1	2	5	3	1	3	1	-	-	-	-	-	-	-	-	-	16
5	-	2	4	3	4	1	1	1	-	-	-	-	-	-	-	-	16
6	-	1	2	5	5	4	4	0	-	-	1	-	-	-	-	-	22
7	-	-	2	3	6	12	5	1	1	1	1	-	-	-	-	-	32
8	-	-	2	4	6	9	11	8	3	2	1	1	-	-	-	-	47
9	-	-	-	-	3	10	10	5	3	2	1	0	-	-	-	-	34
40	-	-	-	-	3	7	3	8	2	4	3	2	-	1	-	-	33
1	-	-	-	-	1	2	6	4	2	3	3	2	3	1	-	-	27
2	-	-	-	-	-	1	0	1	3	0	4	1	2	1	1	2	16
3	-	-	-	-	-	1	1	-	3	2	1	2	1	1	2	3	17
4	-	-	-	-	-	-	1	-	-	0	4	0	3	2	0	1	11
5	-	-	-	-	-	-	-	-	-	2	2	1	2	-	2	0	9
6	-	-	-	-	-	-	-	-	-	-	2	-	-	-	0	1	3
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	1	1
48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Totals	2	10	19	23	31	52	43	28	17	16	23	9	11	6	6	8	304

**Breakdown:

Age	Length*
22	43
22	44
22	42
22	43
24	46
24	43
25	42
27	47

* Grouped to nearest lower centimeter.

Back-calculated lengths at earlier ages were determined by means of the assumed relationship of proportional growth of the fish, in fork length, and the scales, in measured distance from focus to each annulus. The general formula is:

$$\frac{\text{Radius of Scale to } i^{th} \text{ Ring}}{\text{Total Radius of Scale}} = \frac{\text{Length of Fish at } i^{th} \text{ Age}}{\text{Fork Length of Fish}}$$

The results are included in Table 9, and indicate, in general, negligible differences between observed (OL) and calculated (CL) lengths at the i^{th} age. It is of some interest to note that virtually all the observed differences ($\overline{CL} - \overline{OL}$) are negative. This appears to be another manifestation of Lee's phenomenon. However, the differences are generally only a few millimeters.

The time of ring-formation during the year is indicated when the percentage of scales having marginal increments (beyond the last annulus) are calculated by month (Table 10). Here we have a selected group of data from 10-12 ring fish only. It was found that the near linear (negatively correlated) relationship held for magnitude of the observed marginal increment in standard units and the number of rings on the scale. The relationship was such that beyond the 12th ring the expected marginal increment, in standard units, was 2 mm or less. This small an increment could not be detected consistently. The scales with less than 10 rings were omitted due to too few examples for forming a consistent pattern.

Table 9. Mean calculated lengths (CL), mean observed lengths (OL), and deviations of calculated lengths from observed lengths (CL - OL), in millimeters, for Pacific Ocean Perch, by "age", by sex.

"AGE"	MALES			FEMALES		
	CL*	OL**	CL-OL	CL*	OL**	CL-OL
2	182	181	+ 1	-	-	-
3	-	-	-	-	-	-
4	252	280	-28	-	-	-
5	277	300	-13	-	-	-
6	300	314	-14	307	332	-25
7	318	333	-15	327	337	-10
8	333	345	-12	343	351	- 8
9	345	353	- 8	357	358	- 1
10	355	357	- 2	368	374	- 6
11	366	369	- 3	378	383	- 5
12	373	376	- 3	387	390	- 3
13	381	386	- 5	395	396	- 1
14	385	393	- 8	404	407	- 3
15	388	392	- 4	415	411	+ 4
16	388	378	+10	420	421	- 1

* Mean Calculated Length in Millimeters.

** Mean Observed Length in Millimeters.

Table 10. Numbers of Selected Scales (10-12 rings only) from Pacific Ocean Perch, and Numbers and Percent Exhibiting Marginal Growth Zones Beyond the Last Annulus, by Month, by Year, 1951-52.

TIME	NUMBERS EXAMINED	WITH MARGINAL INCREMENTS	
		Nos.	Percent
1951:			
Apr	24	0	0
May	33	1	3
Jun	22	3	14
Jul	11	7	64
Aug	0	-	-
Sep	28	9	32
Oct	0	-	-
Nov	0	-	-
Dec	14	1	7
1952:			
Jan	0	-	-
Feb	20	3	15
Mar	9	1	11
Apr	27	8	30
May	0	-	-
Jun	18	9	50
Jul	6	1	17
Aug	0	-	-
Sep	10	1	10
Oct	0	-	-
Nov	3	0	0
Totals	225		

The selected data indicate the appearance of the growth zone during the summer months, and conversely the formation of a ring during the winter months. The relatively low percentage during the peak months of growth zone formation, i.e., 64% in July 1951, and 50% in June 1952, may indicate that the growth zone formation is not uniform in time for all Pacific Ocean Perch. However, the paucity of data certainly contributes to the general confusion.

Summarizing briefly, a positive correlation appears to exist between the number of rings on the scale and the length of the fish from which the scale was taken. Furthermore, the percentage of scales exhibiting marginal growth increments beyond the last annulus rises and falls throughout the year in such a manner that a single maximum is reached during the summer months and a single minimum during the winter months. Although this can only be demonstrated for scales with 10-12 rings, it has been shown that the calculated length of fish closely approximates observed lengths, regardless of the number of rings on the scale from which the calculations were made.

The circumstantial evidence presented indicates that the observed rings on the scales of Pacific Ocean Perch may be annular. However, there is no direct evidence available to substantiate such a claim.

Table 11. Mean Observed Length (OL), Mean Calculated Length (CL), Mean Calculated Weights (CW), Annual Increment of Calculated Length (ΔCL), and Annual Increment of Calculated Weight (ΔCW), for Pacific Ocean Perch, by Age, by Sex.

AGE	MALES					FEMALES				
	OL*	CL*	ΔCL*	CW**	ΔCW**	OL*	CL*	ΔCL*	CW**	ΔCW**
1	--	129		0.06		--	130		0.06	
			53		0.11			55		0.12
2	181	182		0.17		--	185		0.18	
			40		0.15			41		0.16
3	--	222		0.32		--	226		0.34	
			30		0.16			31		0.16
4	280	252		0.48		--	257		0.50	
			25		0.16			26		0.18
5	300	277		0.64		--	283		0.68	
			23		0.19			24		0.20
6	314	300		0.83		332	307		0.88	
			18		0.17			20		0.19
7	333	318		1.00		337	327		1.07	
			15		0.16			16		0.17
8	345	333		1.16		351	343		1.24	
			12		0.13			14		0.16
9	353	345		1.29		358	357		1.40	
			10		0.12			11		0.14
10	357	355		1.41		374	368		1.54	
			11		0.14			10		0.14
11	369	366		1.55		383	378		1.68	
			7		0.10			9		0.13
12	376	373		1.65		390	387		1.81	
			8		0.11			8		0.11
13	386	381		1.76		396	395		1.92	
			4		0.06			9		0.14
14	393	385		1.82		407	404		2.06	
			3		0.05			11		0.18
15	392	388		1.87		411	415		2.24	

* Lengths in millimeters.

** Weights in pounds.

PACIFIC OCEAN PERCH -- Growth

Since few Pacific Ocean Perch younger than 7 years are available for study (see Table 6), the only alternative method available for determination of growth of these fish is indirect, viz., the measurements from the scales.

The aforementioned paper strips provided a record of each scale's growth, and hence, a potential measure of the growth of the fish from which the scale was taken. If the fish increases in length proportionally to the increase in the radius, or other measurement, of the scale, these scale measurements may be used to calculate the length of the fish at its earlier ages.

Age-length

For these calculations, only the "agreement" scales (373) were used. Figure 1 presents the calculated age-length (CL) relationship for 173 male and 200 female Pacific Ocean Perch, together with the observed age-length (OL) and the calculated annual growth increments (ΔCL). The disparity between observed and calculated mean lengths at age 7 and less are probably due to selectivity of gear or differential availability by size and/or age of the fish. That is, the Pacific Ocean Perch less than 8 years of age in the sample may be the larger members of their respective age classes.

The ΔCL curve indicates that the greatest annual increment in length occurs during the first year and the subsequent annual increments decrease at a near logarithmic rate.

Age-Weight

The age-weight relationship was obtained by converting mean lengths at each age to mean weight by means of the calculated length-weight relationship for these fish. The results of this transformation, by sex, are presented in Figure 2. The annual increments of weight (ΔCW) are included and the curve indicates a maximum increment during the 6th year for both sexes. The age-weight curves appear to be slightly sigmoid in shape. However, the aberrations in the ΔCW curves for both sexes suggest that perhaps an underestimation of the ages of these older fish has occurred.

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Figure 1. "PERCH"

A·L

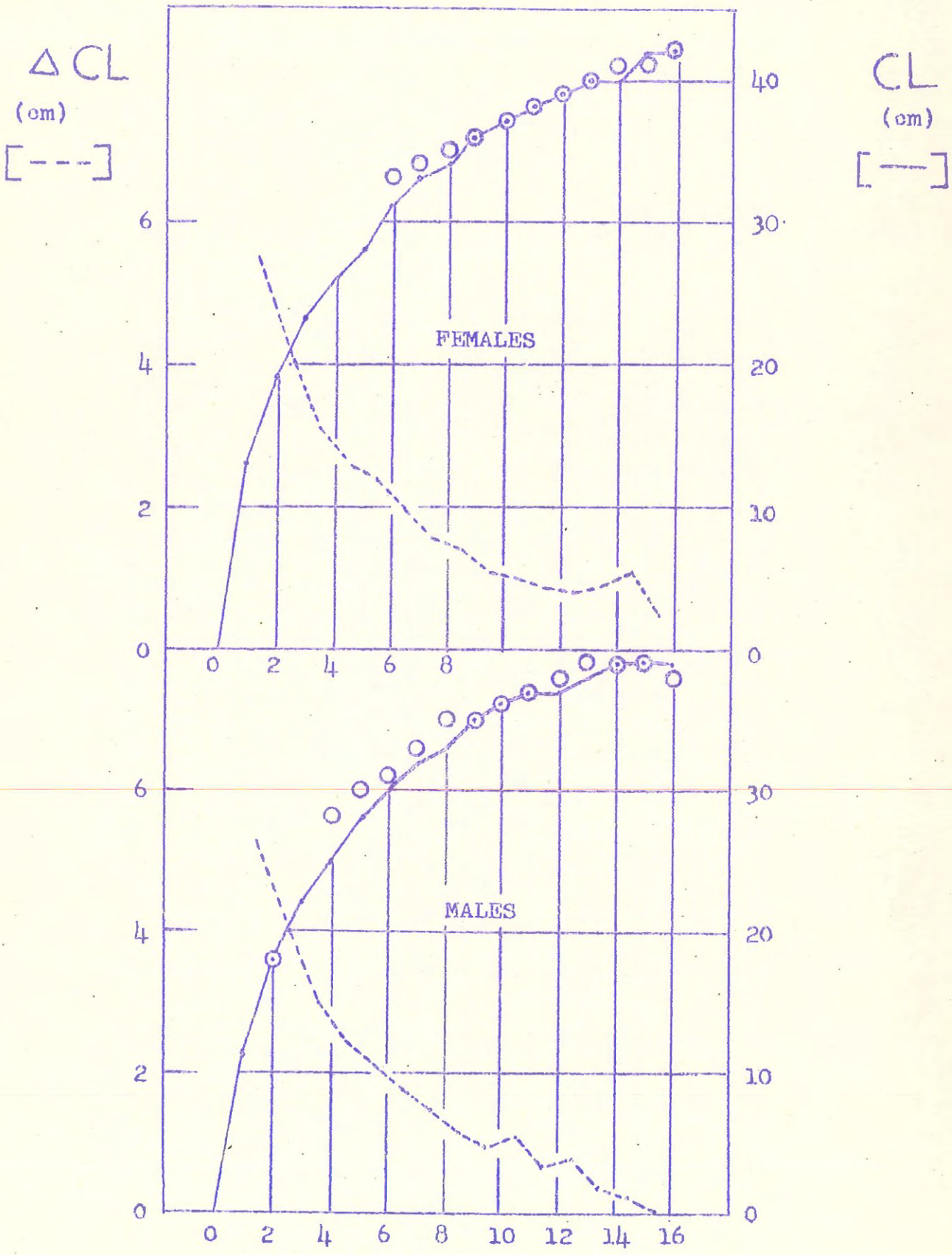

Figure 2. "PERCH"