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PACIFIC FISHERIES EXPERIMENTAL
STATION

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These progress reports are issued from time to time to acquaint the fishing industry with some aspects of investigations undertaken by the Fisheries Research Board of Canada through its Pacific Coast Stations.

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Hon. H. Francis G. Bridges

The unexpected passing of the Honourable H. Francis G. Bridges, Minister of Fisheries, on August 10, 1947, came as a sudden shock to his friends and associates in the Department of Fisheries and the Fisheries Research Board of Canada.

His sincere interest in the work of the Department and Board had been evidenced continually from his appointment in 1945. Although administrative duties made great demands on his time, he nevertheless always provided occasion to acquaint himself with the scientific details of the Fisheries Research Board's work.

During his visits to the Board's Stations on both coasts and in Winnipeg, he showed genuine interest in their work, and his genial personality evidenced in all associations with the Board results in his loss being considered as that of a personal friend.

THE RATE OF GROWTH IN LEMON SOLE IN THE STRAIT OF GEORGIA

The recovery of tagged fish provides an excellent source of data on the determination of growth rates. The information presented in this report is derived from the returns of lemon soles (*Parophrys vetulus*) tagged in the Boat harbour and Baynes sound spawning grounds in January and February, 1946, and recovered in these regions from November, 1946, to March, 1947, inclusive. Tag recoveries indicate that no appreciable interchange between the two populations occurs.

Recovery measurements made by Pacific Biological Station representatives or fishermen who measured fish to within one eighth of an inch were considered reliable and only these returns were used in calculating the growth rates.

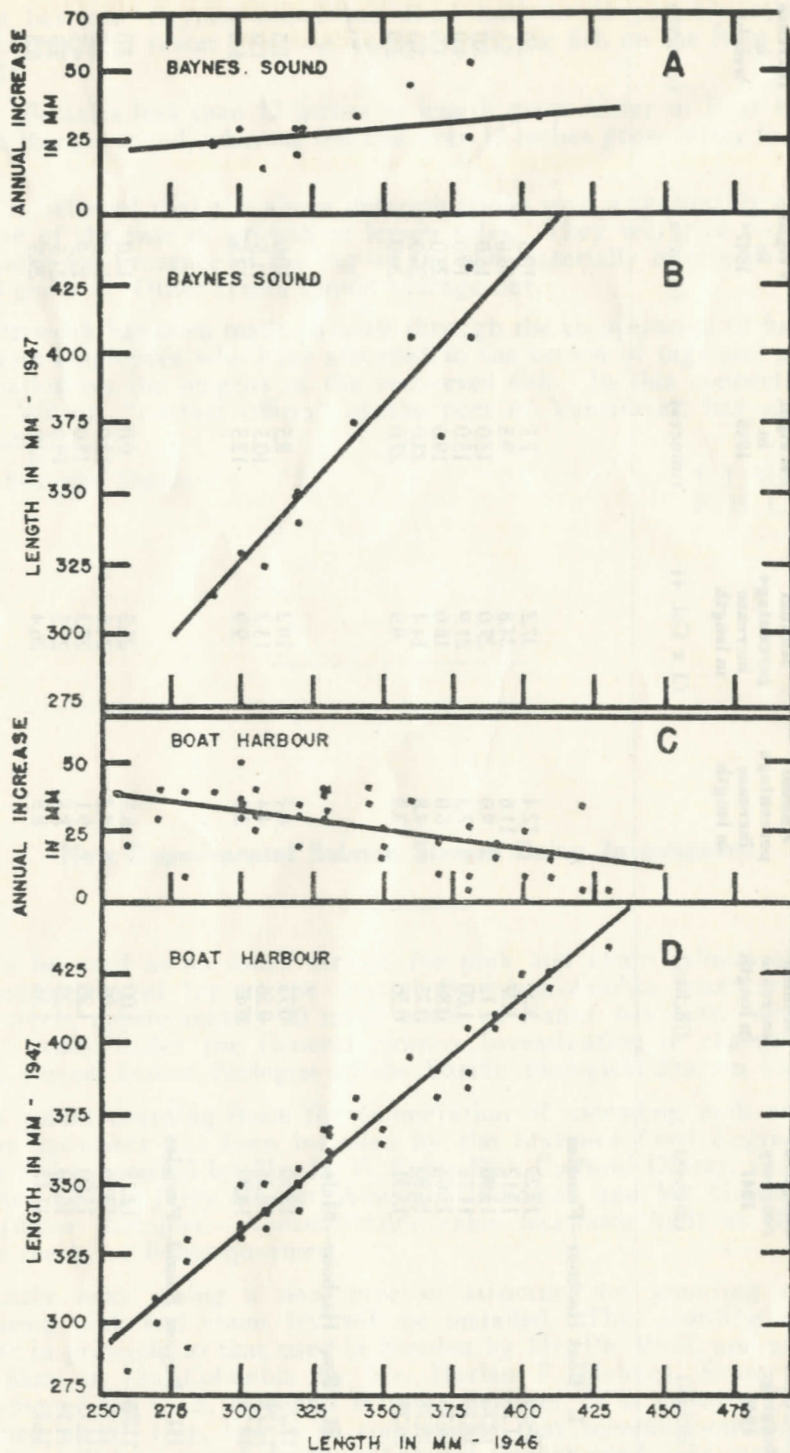
In each area the growths of male and female fish were considered separately. In the Baynes sound region the returns of males were not sufficient in number to warrant consideration.

All of the data obtained from the examination of the fish were first plotted in the form of graphs. Some of these used in this report are shown in the accompanying figure. From these graphs and other similar ones the data given in the table were obtained. In the table the metric measurements have been transformed into inches.

In sections B and D of the accompanying figure the lengths of fish in 1946 were plotted against the corresponding length in 1947, for Baynes sound (B) and Boat harbour (D), respectively. From these graphs, knowing the length of a fish in either 1946 or 1947, it is possible to determine its length in the other year and, hence, to calculate the amount of growth made in a year. In sections A and C of the figure are given the lengths in 1946 plotted against the annual increases in length, as indicated by the length reached in 1947, for Boat harbour and Baynes sound, respectively. It will be observed that in Baynes sound the annual increase in length for females is greater for the larger fish than for the smaller ones, whereas in Boat harbour the annual increase in length for females is less for the larger fish.

The table shows:

1. In Boat harbour the growth of females is about twice that of males (Column 3, Section I and II).
2. The extent to which small male and female lemon soles in Boat harbour grow faster than larger ones. For example, small males add $\frac{3}{4}$ inch per year while large males increase by only $\frac{1}{2}$ inch per year; small females show an increase of $1\frac{1}{2}$ inches per year, large females only $\frac{5}{8}$ inch per year.
3. In Baynes sound large female lemon soles grow somewhat faster than smaller ones— $1\frac{3}{8}$ inches per year as compared with 1 inch for the smaller ones (Column 3, Section III, and Section A of the figure). The annual *percentage* increase in length remains approximately constant for all lengths considered (Column 4, Section III). The difference in growth



Rate of Growth in Lemon Sole Tagged in the Strait of Georgia

Length at tagging, 1946	Length at recovery, 1947	Annual increase in length	Annual percentage increase in length	Annual percentage increase in length	Weight in 1946	Weight in 1947	Increase in weight
(inches)	(inches)	(inches)		(3 x Col. 4)	(ounces)	(ounces)	(ounces)
I. Boat Harbour—Females							
10.90	12.25	1.35	12.4	37.2	7.5	10.5	3.0
11.75	13.12	1.37	11.6	34.8	9.5	13.0	3.5
12.75	13.90	1.15	9.0	27.0	12.0	15.0	3.0
13.75	14.75	1.00	7.3	21.9	15.0	19.0	4.0
14.75	15.63	0.88	6.0	18.0	19.0	23.0	4.0
15.75	16.50	0.75	4.8	14.4	23.0	26.0	3.0
16.75	17.31	0.56	3.3	9.9	27.0	29.0	2.0
II. Boat Harbour—Males							
11.75	12.50	0.75	6.4	19.2	8.5	10.0	1.5
12.75	13.31	0.56	4.4	13.2	10.5	11.5	1.0
13.75	14.20	0.45	3.3	9.9	12.5	13.5	1.0
III. Baynes Sound—Females							
11.75	12.75	1.00	8.5	25.5	9.0	12.0	3.0
12.75	13.80	1.05	8.2	24.6	12.0	15.0	3.0
13.75	15.00	1.25	9.1	27.3	15.0	19.5	4.5
14.75	16.00	1.25	8.5	25.5	19.0	24.5	5.5
15.75	17.13	1.38	8.8	26.4	23.0	29.5	6.5

Approximate conversions: 10 inches = 255 mm.; 15 inches = 380 mm.

pattern between Baynes sound and Boat harbour is possibly related to the occurrence of faster growing, earlier maturing fish on the Boat harbour grounds.

4. Females less than 13 inches in length grow faster in Boat Harbour than in Baynes sound, whereas females over 13 inches grow faster in Baynes sound.

It is believed that the above determinations give a reasonably accurate estimate of the rate of growth of lemon soles. They will give too low an estimate if the presence of the tag on the fish materially interferes with its rate of growth. Other errors should average out.

The work has been made possible through the co-operation of fishermen and shore employees who have attended to the return of tags and provided information on the lengths of the recovered fish. In this connection Mr. R. M. Wilson, "contact officer" at the port of Vancouver, has also been invaluable.

Pacific Biological Station

J. I. Manzer
F. H. C. Taylor

New Experimental Salmon Stream Being Investigated

To be used as an index stream for pink and chum salmon spawning and production of fry in the central British Columbia coast area, Port John creek, approximately 20 miles north of Namu, has been selected for special study under the General Salmon Investigation in charge of Mr. Ferris Neave, Senior Biologist of the Pacific Biological Station staff.

A picket counting-fence for enumeration of ascending pink and chum salmon spawners has been installed by the Station's Civil Engineer, Mr. Grant Starr, assisted by Mr. E. V. Epps, Fish Cultural Officer, and will be operated by Mr. Jerry Hunter, Assistant Biologist, and Mr. Grant Robertson, Junior Biologist. A comfortable cabin has been built at the outlet of the creek for living quarters.

Early next spring a new type of structure for counting seaward-migrating pink and chum fry will be installed. This counting device is similar in principle to that used in Sweden by Mr. Ph. Wolf, and at Bonneville dam on the Columbia by Mr. Harlan F. Holmes, Senior Aquatic Biologist of the U. S. Fish and Wildlife Service. It is called a "Wolf" or "inclined plane" trap, and is so constructed that screening-out of fry for counting will be assured despite whatever freshet conditions may occur.

LAKES OF THE SKEENA RIVER DRAINAGE

VI. THE LAKES OF THE UPPER SUSTUT RIVER*

Location and General Description

On the headwaters of the Sustut river (figure 1), in the area enclosed by latitudes $56^{\circ} 30'$ and $56^{\circ} 40'$ N. and longitudes $126^{\circ} 00'$ and $126^{\circ} 30'$ W. at an altitude of 4,250 to 5,000 feet, lies a group of lakes which are annually visited by numbers of salmon. These bodies of water are adjacent to high snow-covered and glaciated peaks whose lower slopes are clothed by open coniferous forests. The valley floors vary from marshy grassland through willow and alder swamps to close stands of tall trees. Caribou, wolves and grizzly bears constitute the bulk of the larger members of the fauna; marmots, squirrels and lemmings dominate the smaller forms. Though the Ingenika trail which passes through this region has fallen into disuse, the recent discovery of gold in the area promises a renewal of local traffic.

Sustut lake (figure 2), the most westerly of the group, is the best known insofar as the production of salmon is concerned. At an altitude of 4,250 feet, $3\frac{1}{2}$ miles long by $\frac{1}{2}$ mile wide, it is drained by the Sustut river which flows north from the lake before turning to follow a narrow valley south-westerly through the mountains to the Bear river. The lake is characterized by depths up to 30 feet in the southern portion, an area of deeper water in the central part with a maximum depth of 61 feet, and extensive shallows with some extruding rocks at the northern end.

The tributary streams are small. Only upper Sustut river and Transparent creek, are of sufficient size to be considered in connection with salmon spawning. The others enter the lake either broken up into very small streamlets or as seepage. This seepage appears to create suitable conditions for "beach" spawning in the lake.

Asitka lake (figure 1) at the head of Asitka river is located 2 miles east of the southern end of Sustut lake at almost the same altitude. Approximately $\frac{1}{2}$ mile wide by $\frac{3}{5}$ mile long, it has a maximum depth of 26 feet. The shore line is irregular, being broken by several bays, none of which is over 18 inches in depth.

All its tributaries are small and none offers any suitable areas for salmon spawning. In Ova bay is a considerable seepage area which provides the main spawning locality for sockeye.

Johanson lake (figure 2), about 10 miles east of Sustut lake and situated at an altitude of 4,730 feet, is narrow, 3 miles long with a maximum width of $\frac{1}{2}$ mile. It is characterized by a lack of shallows, the shore in most areas dropping off rapidly to moderately deep water. There is a small portion over 150 feet in depth, the maximum sounding made being 162 feet. There are several small islands.

Only two tributaries occur, the main one being Darb creek on which is situated Darb lake.

* The sixth in a series presenting general information on the lakes of the Skeena river drainage particularly insofar as it affects salmon production.

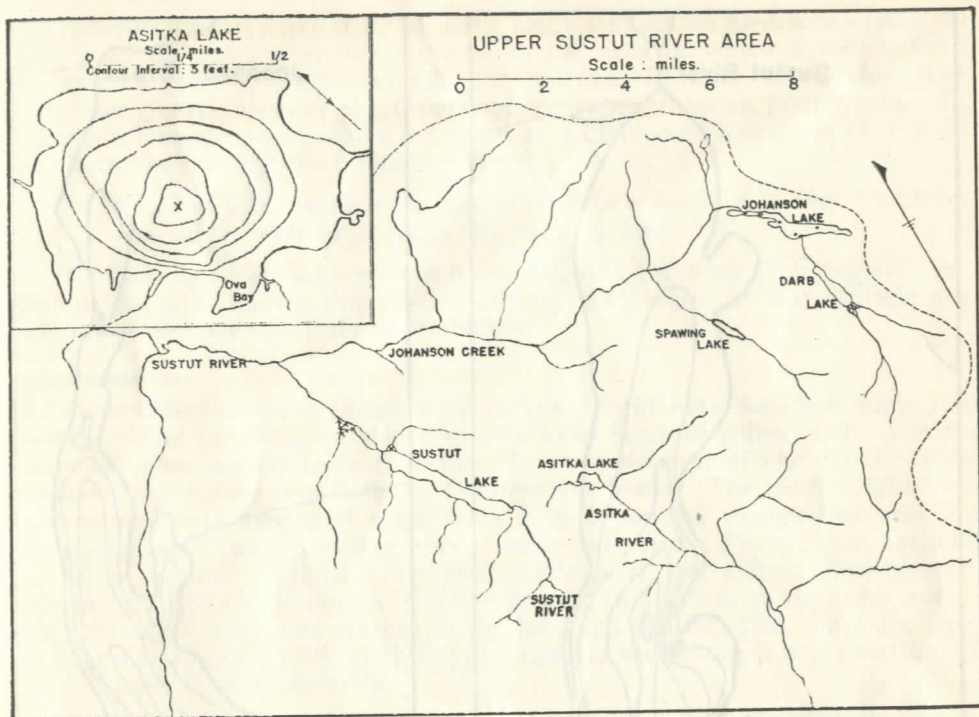


Figure 1

Darb lake, $\frac{1}{2}$ mile south of Johanson lake and approximately 30 feet higher, is about $1\frac{1}{2}$ miles long by $\frac{1}{3}$ mile wide and the water is very silty. No soundings were made on this lake but the slope of the beaches seems to indicate that it is generally shallow.

Spawning lake, at the same altitude or slightly higher than Johanson lake, is located 3 miles southwest of it on an unnamed creek tributary to Johanson creek. It is somewhat smaller than Darb lake, but is also silted.

Limnological Conditions

Sustut lake temperature records taken on August 22, 1945, and September 9, 1946, show close correspondence, the surface temperatures being respectively 58.1°F . and 58.6°F . with a fairly uniform upper layer or epilimnion to 30 feet and a rapid decrease below that to minima of 49.1°F and 48.7°F . at the bottom.

Secchi's disc could be seen to a depth of 30 feet, indicating moderate transparency. Plankton was relatively scarce.

Asitka lake had a surface temperature of 57.3°F . which decreased to 53.8°F . at the bottom on September 10, 1946.

Secchi's disc was visible to a depth of 18 feet in this lake. The greater relative abundance of plankton in Asitka lake appears to account for much of the decrease in visibility as compared with Sustut lake. In this respect it more nearly resembles Bear lake (Progress Reports No. 70).

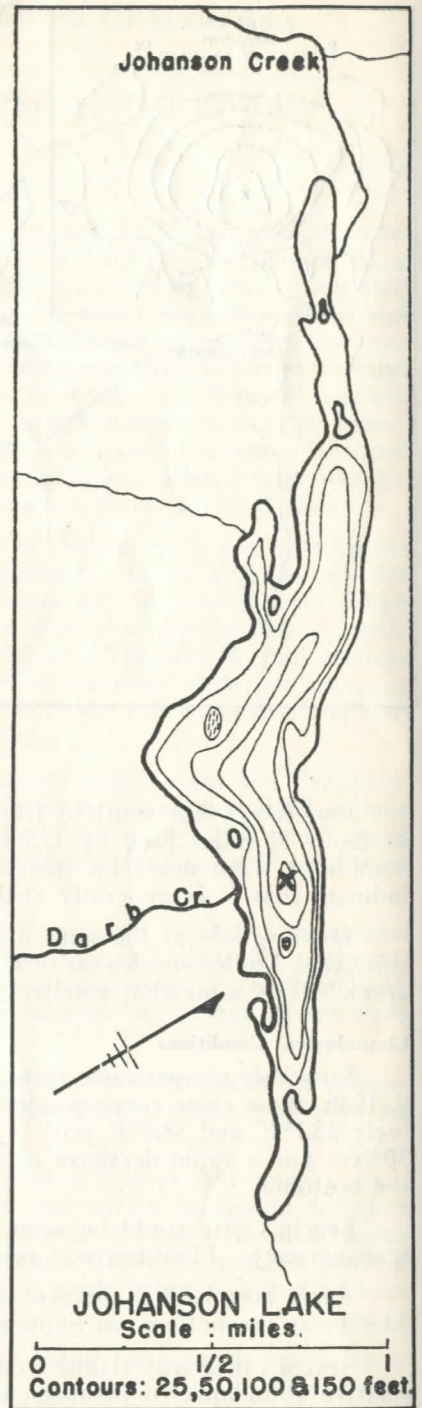
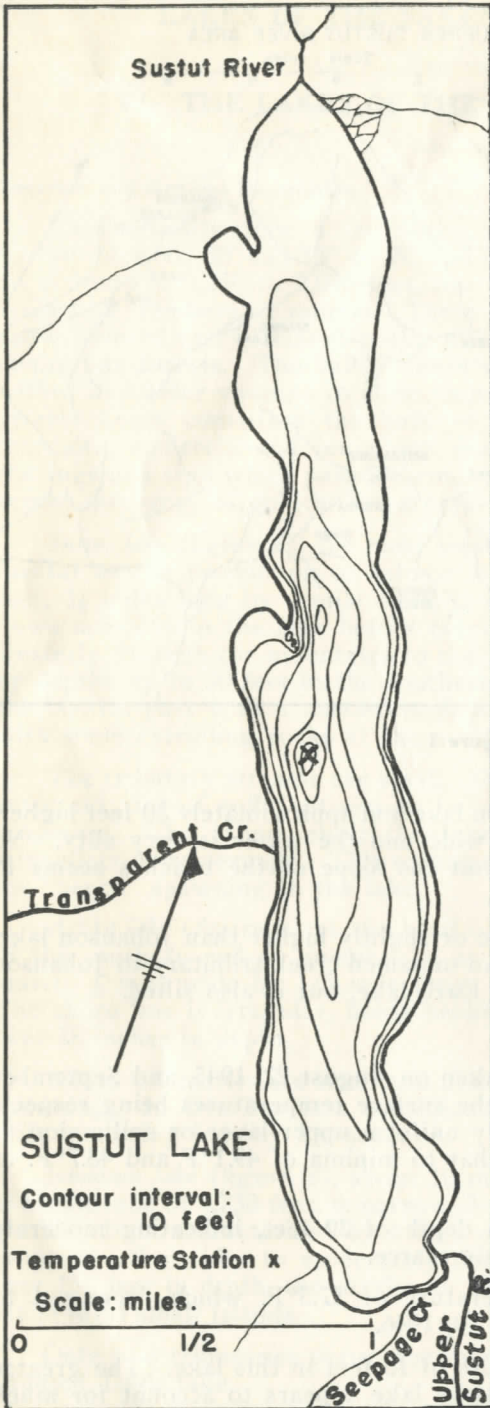


Figure 2

Johanson lake on September 16, 1946, had a surface temperature of 41.7°F. This body of water was the only one in the area in which a well defined thermocline was present though the bottom 20 feet in Sustut lake had a temperature gradient of thermocline proportions in both years. In Johanson lake the thermocline consisted of a change of 8 degrees (F.) in 10 feet between the depths of 35 and 45 feet.

Secchi's disc was visible, as in Sustut lake, to a depth of 30 feet. Plankton was of the same relative scarcity as in that lake.

Darb and Spawning lakes were not investigated for their limnological conditions, but it is known that bodies of very silty water at this altitude are generally cold and relatively unproductive.

Fish Populations

Sustut lake fish were sampled by means of gill nets, beach seining and trolling. The following predator species have been identified: dolly varden char, *Salvelinus malma*; burbot or ling, *Lota maculosa*; steelhead trout, *Salmo gairdnerii*, and young coho salmon, *Oncorhynchus kisutch*. The char weighed up to 6 pounds and steelhead were from 7 to 8 pounds, though one seen in Johanson creek was probably three times this size. Forage fish include Rocky mountain whitefish, *Prosopium williamsoni*; the shiner, *Richardsonius balteatus*, and the chub minnow, *Couesius greeni*. In addition to the coho, sockeye salmon, *O. nerka*, are present in the lake and the fact that there are two distinct size ranges in fry of this type suggests that there is a population of the kokanee, *O. nerka kennerlyi*.

Johanson lake was fished by gill nets only, so it is likely that there are species present other than those sampled. The following were recorded: dolly varden char, Rocky mountain whitefish, sockeye and coho salmon. Steelhead trout were seen in the lake but none was caught. Of extreme interest was the fact that while all the char between 6 and 8 inches in length were apparently ready to spawn, none of the larger specimens showed any indications of ripening gonads.

Darb, Spawning and Asitka lakes were not fished. However, sockeye and coho salmon were seen in the last-mentioned. No fish were seen in *Darb lake*. A prospector reported that there were many dead salmon on the shores of *Spawning lake* in early September, 1946. As sockeye are the only salmon known to spawn in the lakes in this region, it is probable that these were sockeye.

Salmon Spawning

The only salmon known to spawn in the area are the sockeye and coho. The sockeye spawn only in the lakes and, it is believed, only where seepage occurs. Coho, however, apparently do not spawn in the lakes.

At *Sustut lake*, a thorough check of both Upper Sustut river and Transparent creeks was made. No sockeye were seen in these creeks or in Sustut river below the lake. A similar check of Johanson and *Darb creeks* revealed no sockeye. The recognized sockeye spawning area in this lake is confined to the upper (southern) third. Here shallow water spawning occurs along the eastern edge and at the southern end where Seepage creek enters the lake through the gravel. Spawning has also been observed in the waters below 15 feet in this region. Coho are said to spawn in late September and early October in the main and upper Sustut river.

In *Asitka lake* the main sockeye spawning area is Ova bay (figure 1). A few sockeye were also seen just above Asitka river. According to the Indians, beaver dams sometimes obstruct the passage of salmon. Large numbers of salmon are reported to spawn 10 miles below the lake but no reliable information has been received as to the species involved. From a prospector's report that "The pools were black with salmon," it is assumed that the majority were coho.

In the *Johanson lake* area no sockeye redds were located, but the condition of the salmon caught in the gill net and reports from Indians acquainted with the district indicate that spawning takes place in the lake. A careful check of all the shallows indicated that spawning must take place below the normal limit of visibility.

Dark lake is said by the Indians to receive no salmon, but they state that steelhead spawn in Darb creek and also enter the lake in February and March. As was mentioned before, reports indicate a sockeye population in Spawning lake. Though the water is very silty it is probable that spawning would occur only where clear seepage enters the lake.

Indian Fishing

Indian fishing in this district is at present confined to coho and steelhead in the creek just below Johanson lake. Here a family of ten takes chiefly steelhead and coho with both spears and gill nets. Formerly sockeye were fished with spears in Asitka lake and steelhead with nets in the winter in Sustut river just below Sustut lake. Shifting traplines and a decrease in the sockeye runs to Asitka lake largely account for the abandonment of fishing in this area.

Acknowledgments

The writer wishes to take this opportunity to thank Mr. Carl Hanawald of Bear lake for his many courtesies and information in connection with trips to the area, also Messrs. Bert Goodrich and Len Belleveau for information and kindnesses during the stay at Johanson lake. Thanks are due to Captains Russ Baker and Pat Carey of Central B. C. Airways for services rendered, often under adverse circumstances. To my friend and co-worker, Mr. Peter Abear, special thanks are extended for his helpful service and companionship. Dr. A. L. Pritchard, in charge of the Skeena river salmon investigation, again assumed the responsibility of assuring the delivery of supplies and equipment.

Pacific Biological Station

D. R. Foscett

HERRING PRODUCTS

Investigations conducted at this Station into the development of variety in herring products have resulted in several products worthy of note. The average annual catch of herring is large and there is the possibility of an extended future market provided the demand for a variety of products is created. The most pronounced objection to herring has been the number of bones the fish contains; in the products described below this objection has been minimized. Articles in previous issues of these Reports describe marinated herring (No. 58, pp. 20-22), bloater paste (No. 63, pp. 38-40) and kippers (No. 66, pp. 9-11).

Fishettes

The name "fishettes" was selected for sausage-like delicatessen. After testing numerous methods of preparation a satisfactory product was obtained using herring flesh with its bones. Methods in which the bones were removed proved tedious, costly and time-consuming. The fins, heads and tails were removed and the cleaned fresh herring were cooked on steel racks under pressure (10.3 lb. per sq. inch gauge pressure) at 240° F. for 90 minutes. The cooked flesh was ground in a meat grinder using a coarse plate ($\frac{1}{4}$ -inch holes); the "silent cutter," a commercial machine designed primarily for the cutting of meat, was found unsatisfactory for this product, though it has been used to advantage with other fish flesh. The ground, cooked flesh was mixed with 1.5% salt and stuffed into casings, using a commercial machine known as a "stuffer" for pushing the forcemeat into the casing. Tests included the use of both animal and artificial casings.

The fishettes were smoked at 120° F. for 30 minutes in the air-conditioned smoke tunnel described in issue No. 56, pp. 4-5, of these Reports. The fishettes were served as hors d'oeuvres, in sandwiches without further cooking, and as a hot entrée, to tasting panels. The flavour was distinct and appetizing, but in every instance the cold products were preferred. The fishettes were cooked by sautéing in a frying pan and by boiling. Since artificial casings are not edible the casings were removed before sautéing and the product showed a tendency to break. For this reason it was felt that animal casings were more satisfactory in the making of herring fishettes.

One parcel of herring fishettes was frozen following the smoking period. This batch has been sampled by tasting panels periodically over several months. The flavour and quality of the product was not affected by storage at -16° F. to -20° F.

The fishettes made from the straight herring and salt mixture were liked better than those to which a commercial spice blend or trial groups of spices had been added.

One batch of fishettes was prepared and smoked for 4½ hours, at 90° F. The product of this processing was divided into three lots. The first lot was packed in cans and the air replaced by nitrogen. To the second lot mustard sauce was added before canning. The third lot was canned without treatment. A fourth lot was prepared by smoking another batch of fishettes for 2½ hours at 90° F. and canning them. After 6 months in storage at -16° F. to -20° F. peroxide values were determined on each lot with the following results.

Lot	Storage time	Peroxide value
1	6 months	3.1
2	"	7.0
3	"	29.0
4	"	39.4

The peroxide value is a measure of the unpalatable change that takes place in fat of fatty fish products that have been stored. These values were determined by Dr H. L. A. Tarr using a modified Lea test.

Little difference could be detected in flavour of the above lots by a tasting panel.

Herring Niblets

"Niblets" was the name selected for a "bite"-size portion of canned herring fillets developed at this Station during 1946. Herring fillets were prepared by hand, brined for 5 minutes in a saturated salt solution, drained and smoked in the Station air-conditioned smoke tunnel at 120° F. for 30 minutes. The fillets were cut crosswise and the "bite"-size pieces were fitted upright into round cans ($\frac{1}{4}$ -lb. flats). Half the cans prepared were precooked in an upright position under atmospheric pressure at 212° F. for 12 minutes then processed 40 minutes at 240° F. (gauge pressure 10.3 lb. per square inch). The remaining cans were inverted during the precooking period but otherwise the procedure was the same.

A skinless canned herring niblet was obtained by drying niblet-size herring fillets at 170° F. for 30 minutes then smoking at 170° F. for 15 minutes in the air-conditioned smoke tunnel. In this processing it was found that the product held its shape better when the fillets were cut to canning size before placing on the trays of the smoke tunnel. The skin remained on the trays and the skinless niblets were easily lifted from the trays by hand and packed on end in the cans. Without precooking, the cans were processed under pressure for 40 minutes at 240° F.

A sample from each of the above processings was opened. The contents were allowed to drain on screens for 3 minutes. The weights of flesh and volumes of oil and water in these $\frac{1}{4}$ -lb. cans were measured with the following results:

	Solids	Oil	Water
	(ounces)	(cubic inches)	(cubic inches)
Precooked in upright position	3.2	0.3	0.67
Precooked in inverted position	3.2	0.3	0.55
Not precooked	3.1	0.3	0.25

A tasting panel found the products excellent. Several tasters preferred the skinless niblets, but none could detect any difference between the products precooked in inverted or upright position.

Spiced Herring Niblets

This product is the result of efforts to obtain a product similar in colour, texture and flavour to a sample imported from Sweden. The herring were dressed but heads and tails were left on. They were then split along the backbone and placed for 48 hours in salt brine (80° Baumé) containing 200 parts per million of sodium nitrite. The sodium nitrite acts upon the blood remaining in the fish flesh to form nitrosohaemoglobin; the colour produced

by this chemical reaction, which is also used in the curing of some meats, adds to the attractiveness of the product. The fish were next leached for 10 to 15 minutes in fresh water, drained, and slit along the backbone to the tail. By working the thumbs from the tail towards the head on either side of the backbone the flesh was parted and the tail, backbone and rib bones were removed intact with the head. The fish sides were lifted with the dorsal fin upward and held in the left hand and the thumb of the right hand was forced under the skin at the dorsal fin area. In this way the skin peeled off readily leaving the fillet clean. The fillets thus prepared were cut crosswise into niblet portions and packed upright in cans ($\frac{1}{4}$ -lb. flats). A pickle of the following composition in parts by weight was added and the cans were sealed.

Vinegar	600	Mustard	2	Bay leaves	1
Water	300	Black pepper	2	Dehydrated onion	1
Sugar	30	Cardamom	1	Chopped pimento	
Cloves	4	Ginger	1		

After 1 month of storage at 40° F. the niblets had an appealing flavour and the texture of fresh fish. After 6 months storage at 40° F. the niblets still had retained their flavour and texture.

As a further test to obtain a "clear" pickle, the herring were cleaned as above and after the fresh-water leaching were packed in a tub containing the above pickle. After 2 weeks storage at 40° F. the product was removed, drained, deboned by the above method, cut to niblet size and packed in $\frac{1}{4}$ -lb. cans. Fresh pickle was added and the cans were sealed. After 6 months storage at 40° F. texture was satisfactory, flavour was excellent and the pickle was without sediment.

Thin slices of pimento and bay leaf placed on the exposed surface of the fish before canning added to the attractiveness of the product.

Smoked Spiced Niblets

Herring were treated as in the preceding section, with the exception that the fish were smoked for 5 to 15 minutes in the air-conditioned smoke tunnel at 70° F. following the leaching treatment.

A portion of the fish was cut, packed in $\frac{1}{4}$ -lb. cans, fresh pickle was added, and the cans were sealed. The remainder was packed in a tub containing standard pickle and stored at 40° F. for 2 weeks. The fish were then removed from the pickle, drained and prepared as in the other processes reported herein, and canned with fresh pickle added.

After 1 month in storage at 40° F. the products were examined. They were meaty, of pleasing flavour and preferred to the unsmoked niblets by the majority of the tasters. After 6 months in storage at 40° F. they still had a fine flavour, had retained their meatiness and were still preferred to the unsmoked products. The niblets which were treated to pickle for 2 weeks before canning were excellent and the pickle was clear and attractive in appearance.

Note: All cans used in these experiments were sterilized in an autoclave at 240° F. for 15 minutes. This was considered necessary because some of the products were not processed. Both enameled and plain cans were used. The enamel was unaffected by any of the products, and the interior of the plain cans showed only a slight etching after 8 months storage.

THE HARBOUR SEALS (*Phoca vitulina richardii*) ON THE SKEENA RIVER, B.C.

THE PROBLEM

During the summers of 1945 and 1946 as part of the Skeena River Investigation, a study of the harbour seals (*Phoca vitulina richardii*) in the Skeena river was carried out with the following objectives in view:

- (1) To determine the effect of the harbour seals on the gill-net fishery in causing damage to nets and to the salmon in the catches.
- (2) To gain information on the food habits of the species and the relation of salmon to these habits to indicate the effect of harbour seal predation on the run generally and the escapement in particular.
- (3) To study the life history of the seals in the area, their numbers, distribution and movements.
- (4) To investigate possible methods of control, paying particular attention to the effect of the "Bounty Method" now practised.

The present paper summarizes briefly the observations made and conclusions reached.

RESULTS

(1) Effects of Harbour Seals on the Skeena River Gill-net Fishery

A. Damage to Nets

As a result of close observation and analysis of reports from fishermen, damage to nets from seal action must be considered as small. At times an animal may become entangled and cause wide tears, but in the over-all picture the result is not of serious proportions. The usual extent of damage amounts to a few broken strands where the seal has attacked a salmon caught in the net.

B. Damage to Salmon in Nets

To discover the amount of damage to the salmon catch, mimeographed forms were distributed to selected fishermen asking them to record for each set made the number of salmon caught, the number of these bitten by seals, the percentage of the body destroyed, the original weight, the weight of the remains, and the actual monetary loss suffered. Co-operation in completing these forms was not as good as would have been expected from the many and serious complaints against the harbour seal. The few which were returned are, however, considered to be reliable and representative for the season covered.

The nature of the damage usually consists of a few mouthfuls of meat torn from the throat region of the fish. In some cases the entire head may be eaten and at the same time strips of skin may be torn from the body. In other instances, only the head is left hanging in the net, or the lower jaw is torn away.

Most of the spring salmon (*Oncorhynchus tshawytscha*) caught on the Skeena during the season for the species in May, June and July are of the red-fleshed variety which in 1946 brought the fishermen 20 cents per pound.

For individuals partly damaged, e.g., with a mouthful of meat torn from the body, the price dropped to 10 and 6 cents per pound depending on the extent of mutilation. If mutilation was excessive, no credit was given. For the sockeye salmon (*O. nerka*), taken mainly during July and August, the reduction for slight damage is not so serious since the species is used mainly for canning and not often for mild curing where perfect appearance is demanded. The coho salmon (*O. kisutch*), caught later in the autumn, are used both for canning and fresh fish markets. The losses recorded in table I are calculated on the basis of the above regulations which are definitely set down and maintained by the buyers for each variety.

TABLE I—Summary of Monetary Loss by Months in Spring Salmon Catches in the Skeena River in 1946 due to Harbour Seal Damage.

Date	Records examined	Salmon caught	No.	Damaged per cent.	Total value	Loss	Per cent. loss
May 20-31	5	65	12	18.4	\$ 193.76	22.95	12
June	5	657	71	10.8	1935.16	255.20	13
July	5	672	8	1.3	1994.52	29.68	1.5

Although the figures for 1946 indicating seal depredation are similar for May and June, many fairly well authenticated reports indicate that in many years it is worst in April and May when few boats are in the river. With the great increase in gear which occurs from the last Sunday in June when the sockeye salmon fishing season opens, the activity of the seals on the fishing grounds appears to diminish and damage to the commercial fishery becomes almost negligible.

The time at which the fishermen's demands for control of seals in the Skeena river appears to have most justification is during the early part of the year when spring salmon are being taken. If the run is large, the money made in spite of seal damage may still be considerable. If the run is small, the monetary loss becomes a matter of grave concern because many fishermen depend on these earnings to support them for an entire year. To add to the difficulty, seals appear to be more active when fishing is poor.

Verbal reports, well substantiated, indicate that seal damage increases again during the coho salmon fishing season in the late summer and autumn when the number of boats becomes reduced.

(2) Effect of Harbour Seals on the Salmon Escapement

The main essential in reaching a decision on the effect of seal predation on the natural run of salmon to any area is to examine a representative series of stomachs collected in the district throughout the year to gain a definite idea of the importance of salmon in the diet and the seasonal variation.

Unfortunately, due to the difficulty in collection of the animals, only 50 stomachs were obtained in the present study. Many of these were empty and many were from pups and thus contained only milk. There was sufficient material, however, from this investigation and from others, to reach the undoubted conclusion that the harbour seal is a "chance predator;" i.e., it preys upon anything available with no preference for any item. Local fluctuations in numbers of harbour seals may be due to variations

in abundance of certain food organisms; *e.g.*, seals concentrate off Metlakatla during the herring (*Clupea pallasii*) spawning run, off Point Lambert in the Skeena during the eulachon (*Thaleichthys pacificus*) run, or in up-river areas during the salmon run. In most instances, however, fluctuations in abundance of food organisms appear to result merely in a change of food habits.

In spite of the limited data concerning predation pressure on the Skeena river salmon run, those available, coupled with field observations, suggest that *the most serious depredations in numbers of salmon by hair seals take place up river above the fishing boundaries*. A group of 45 individuals observed at the mouth of the Lakelse river in September, 1946, was undoubtedly taking salmon as demonstrated by the stomach analysis. In many other cases, the animals were observed with fish in their mouths as they tossed their heads in eating them.

There are no accurate assessments of the amount of fish eaten by harbour seals in a natural environment, but in captivity they will take 8 to 15 pounds per individual daily. If one assumed that each adult seal in the Skeena destroyed 10 pounds of salmon daily, a fairly serious problem would present itself in view of the fact that the number of individuals recorded later is about 450. Nothing is, however, known of the extent to which seals make use of other freshwater fish in the river.

(3) Life History of Harbour Seals in the Skeena River—Distribution, Numbers and Movements

A. Distribution

Table II shows a list of the bars on which the harbour seals haul out in the lower Skeena and at its mouth, together with pertinent comments and estimates of numbers thereon.

B. Numbers

An estimate of the population is difficult because one could not cover all hauling-out sites at one time or be sure on any visit that all seals were out of the water. From assessments made on repeated visits, 450 harbour seals is a conservative figure for the population from the area about the mouth of the Skeena river to and including the Ecstall and Lamb island. There must at the same time be several hundred distributed along the Skeena at least up to and perhaps slightly above Hazelton.

C. Movements

General movements—As far as can be discovered, the seals in the Skeena river are generally local in distribution. As proof that the population remains in the area and does not move up and down the coast for long distances, is the fact that certain peculiarly marked individuals are recognizable from year to year usually in the same definite locality.

Seasonal up-river movements—A seasonal up-river movement coinciding with the salmon run and changes in fishing intensity is definitely recognizable. This is not a mass migration, but takes place gradually as the number of salmon rises. The exact time at which it occurs is not known, but they apparently appear up river as soon as the ice breaks in February or March. It is reported that they first become numerous when the eulachons

TABLE II—List of Hauling-out Bars used by Harbour Seals in the Lower Skeena River and off its Mouth.

Location	Numbers	Remarks
Sand bar—N.W. corner of Kennedy island	Few	Small numbers in summer apparently augmented by up-river population in winter
Genn island, South rocks	12 to 24	Usually when salmon are not running
Bar between Croasdaile and De Horsey islands	40 to 60	
Rocky area—S.E. coast of De Horsey island	Variable	During half-tide periods. At low tide must go to bar described just above
Raspberry island — Mouth of Ecstall river	25	Spring and late autumn when fishing boats are scarce
Sand bar—2 miles below Big Falls creek, Ecstall river	20 to 50	Only hauling-out area in Ecstall except rocks opposite Big Falls creek, where 2 to 6 appear
Sandbars—4 miles above Kwinitsa, Skeena river	150 to 200;	At extreme low tide these go to grassy island up river
(a) Bar in middle of river	usual 60 to 100	
(b) Bar 1 mile downstream	25	Scattered groups
Mouth of Lakelse river	45	On gravel bank of island directly opposite river groups
Miscellaneous		Maze of sandbars and islands to Terrace and above

begin to spawn. One has been observed in Lakelse lake as early as April 14. From April on, the numbers rise; a maximum occurs in September. The early phase of the movement coincides with the onset of the pupping season in late May and early June.

The extent of up-river distribution appears to be dependent on the available salmon supply. In a heavy run many seals appear at and above Terrace while in light runs few reach that point. Reliable Indians report that only within the last 40 to 50 years have seals become numerous above the mouth of Lakelse river. Before that time the tribes hunted them heavily for food. The cessation of this hunting, coupled with increased hunting pressure at the coast resulting from the development of the fishing industry and the installation of the bounty system of control, may be the cause of the present up-river spread which is apparently gradually increasing in extent.

Daily local movements—In the area of tidewater influence, the rise and fall of the tide is the determining factor in the daily movements. While the animals are gregarious when hauled out, they are solitary in their foraging habits. Dispersal for feeding is exceedingly rapid and a group of seals will, on a flood tide, become widely scattered in the locality of the hauling grounds. The ranges of movement are not definitely known, but from observations are estimated at from a few hundred yards to several miles.

In up-river areas, while some individuals stay in the general areas of the bars while these are under water at high tide, many allow themselves to drift up with the flood and back with the ebb apparently feeding as they go.

D. Breeding Habits

Mating activity, though not observed during the study, is reliably reported to be at a maximum in September, when much squalling and fighting takes place on the hauling-out bars.

It was definitely established that the birth season in the Skeena area begins during the last part of May and ends during the latter half of June, being at its peak early in June. The young are born on sand bars near the mouth of the river regularly used throughout the year as hauling-out sites. Pups are scarce in the De Horsey island area compared to their number further up river in the vicinity of the Skeena and Ecstall sand bars, where it appears that the majority of births in this area take place.

(4) Methods of Control

The bounty method of control, in which a reward is paid for the return of noses from seals destroyed, has its limitations in areas such as the lower Skeena river. During the fishing season the fishermen are too busy to hunt seriously. Due to the heavy tides and current many animals cannot be recovered after shooting. In addition great danger would accrue to human lives when five hundred or more fishermen are operating in a small area.

It was found possible to secure pups fairly easily using a shotgun from a skiff. These young are very vulnerable just after birth since they are curious and have to come to the surface more often than older animals. The females also remain close to watch the young at that time. A .30-'06 rifle fitted with a telescopic sight worked well on adults at long range since in most areas it was found possible to approach with care a group hauled-out to within 300 yards. In such cases machine guns might be effective, but soft pointed or other mushrooming ammunition should be used since military ammunition frequently does not kill.

Dynamiting of hauling-out bars has been tried on the Fraser river and appears to work well although one cannot count on reclaiming the carcasses for biological examination.

Employment of one or more crews of trained hunters with suitable firearms, boats and materials for experimentation, should produce best results. Such crews should be fully aware of the biological aspects of the problem and be prepared to take advantage of such vulnerable periods in the life history as pupping, as well as to try other methods of elimination experimentally.

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Pacific Biological Station

H. D. Fisher

VITAMIN A IN LONG-JAW FLOUNDER LIVERS

The variation over a year's time in the vitamin A potency of the livers from a number of species of flatfish was reported by Betty H. McKercher in Progress Reports No. 68. Samples of some of the species were frequently obtained, and enabled a good picture of seasonal variations to be drawn. Samples of other flatfish livers were obtained less frequently, either through scarcity or through commercial disinterest in the species.

One of the latter species, the long-jaw flounder (*Atheresthes stomias*) yielded a sample caught in August off the west coast of Vancouver island from which the livers analyzed over 2,000,000 USP units of vitamin A per lb. and contained 21% oil. The presence of a large number of these fish off the mouth of the Fraser river in May of this year prompted Dr. Hart of the Pacific Biological Station to suggest another examination at this time in hope that it might lead to utilization of this fish which is at present considered useless.

If the fish were of value it was necessary to demonstrate this quickly, so that they might be still available for capture. A sample of 37 fish, selected to give maximum variation in size, was collected by the "Investigator No. 1" of the Biological Station on May 16. Their lengths, weights and sex were recorded, their otoliths removed for age determinations, and their livers removed and frozen for vitamin A analysis on the day of capture. The vitamin A and oil analyses were carried out as described in Progress Reports No. 69, p. 74, excepting that, to save time, only one sample of each liver was analyzed.

The results were disappointing. Although the quantity of vitamin A in the liver from the biggest fish approached that in the liver from the longer brill (see page 13 of Issue No. 71), in general it was much less in fish of the same size of the two species. Thirty-three of the 37 fish varied between 1,300 and 26,000 USP units per liver, with length of fish ranging from 11 to 18 in. The four largest fish of the sample (19 to 25 in.) displayed a rapid increase of vitamin content from 70,000 to 285,000 units per liver.

Vitamin A potency of the livers from the 33 smaller fish fluctuated between 163,000 and 680,000 units per pound; the livers from the four largest fish had potencies from 1,300,000 to 3,500,000 units per pound.

The potency of the liver oils from the smaller fish fell between 1,700 and 7,200 units per gram of oil, only five being over 5,000; those from the four largest fish ran 7,100, 13,500, 9,200 and 61,700 units per gram. The livers were comparatively oily, averaging 32.8% oil, which explains the low potency of the oils obtained from them.

These figures suggest that long-jaw flounders caught in Strait of Georgia waters in May do not contain sufficient vitamin A in their livers to make their fishery a profitable business for vitamin A oil production. They do not obviate the possibility that in other areas and at other times of the year more profitable fishing may result. Although this sample was selected from a commercial catch by size of fish and contained *all* the longer ones with only a proportion of the shorter ones, the August sample mentioned

above consisted only of large fish averaging 3.7 lb., which were representative of a commercial catch. The liver and oil potencies of the August sample (2,100,000 per lb. and 22,100 per g. respectively) were comparable with those found in the separate livers of the four large fish of this April's sample (which averaged 3.8 lb. in weight), and therefore suggest that better fishing is possible than the present data imply.

Although these results indicate little commercial value in long-jaw flounder livers, they are of some theoretical interest because of the abruptness with which the vitamin A content increased. They might be a clue leading to an explanation of the sudden rise in vitamin A content with increasing size noted in several species of fish.

Grateful thanks are due to Miss E. Taylor and to Miss P. Boyce for their assistance in vitamin A and oil analyses of these livers.

Pacific Fisheries Experimental Station
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The Second 1947 Railway Refrigeration Car Experiment

As reported in a News Item on page 20 of the previous issue of these Reports (No. 71, June, 1947), a test of a new refrigerating mixture for overhead-bunkered railway refrigeration cars used for transporting frozen fish and other frozen commodities was made in June over the Canadian Pacific Railway Company lines.

During August a second experimental shipment took place over the Canadian National Railways lines from Prince Rupert to Montreal. The new refrigerant being tested was a mixture of ammonium nitrate, ordinary salt, and crushed ice. Three carloads of frozen halibut and salmon, averaging 30,000 lb. apiece, were used. One car contained the test mixture in the latest improved overhead bunkers; a second car contained the standard ice-and-salt mixture in similar overhead bunkers, while the third car contained an ice-and-salt mixture in the older type of overhead bunkers.

Personnel accompanying the shipment were Messrs. O. C. Young, Principal Research Engineer, and D. H. Taylor, Assistant Research Engineer, of the Fisheries Research Board's Fisheries Experimental Station, Vancouver; Messrs. J. L. Townshend, D. C. McVeigh and Norman Walton, Perishable Traffic and Research Bureau of the Canadian National Railways; Messrs. J. M. Carbert, and E. A. Rooke of the Canadian National Research Council, Ottawa; and Messrs. P. L. Brougham, G. F. Morrison, Howard Fowler and James Griffiths, Perishable Traffic Division of the Canadian Pacific Railway Company.

Results of the experiment have not yet been tabulated, but will be reported later.

As in the June experiment, the Fishermen's Co-Operative Federation kindly gave its consent to use commercial consignments of frozen fish for experimental purposes. The latter shipment was from the plant of the Prince Rupert Fishermen's Co-Operative Association, which is a member of the Federation.

NEWS ITEMS

Distribution of Marine Forms in Inter-Tidal Zones

During July and early August the facilities of the Pacific Biological Station, Nanaimo, were extended to Doctor and Mrs. T. A. Stephenson of the University of Wales who are visiting strategic areas of the Atlantic and Pacific coasts of North America in order to obtain material for a monograph on plant and animal life between tide marks throughout the world. Already studies have been made in England, South Africa and Australia, and during the present expedition observations have been made at Beauport, N.C., Charleston, S.C., and Miami and Marineland, Florida. They go next to Hopkins Marine Station, Monterey, California.

Tagging of Pink Salmon in the Central Area

During the present season tagging of pink salmon in Fitzhugh sound, Fisher and Seaforth Channels is being conducted by Messrs. Ralph Wilson and Grant Robertson of the Pacific Biological Station, with the M.V. "*Siliqua*."

Pink salmon are being purchased directly from seiners, tagged with coloured celluloid disks and released. The purpose is to determine migration routes of the pinks in these areas and spawning streams to which they are proceeding. Some data on fishing intensity may also be obtained. The study is another phase of the General Salmon Investigation.

Atlantic Lobsters Successfully Propagating

Early in July it was observed that lobsters, part of the shipment planted in Lasqueti Island lagoon in June, 1946, but subsequently placed in a floating cage for observation purposes, were laying eggs. Six females were found to be carrying eggs. Subsequently a female with eggs was caught in the lagoon, thus signifying that the planted stock was behaving similarly to the caged individuals.

During June it was found that the lobsters were moulting normally and it is thus evident that the transplants are taking well to their new Pacific habitat despite the fact that the salinities of the lagoon water have been appreciably lower than the minimum reported for lobster grounds of the Atlantic coast.

The lobster introduction, initially financed by the British Columbia Packers Limited, is now being followed through by the Fisheries Research Board of Canada through the Pacific Biological Station, Nanaimo.

Scientist from India Visits West Coast Stations of Board

In line with the policy of the Government of India to send scientists and administrators to America for the purpose of acquainting themselves with western ideas of fisheries industry and research, Rao Sahib V. John, Deputy Director of Fisheries, Madras, India, spent a month during July and August observing the Canadian West Coast fisheries industries using the Pacific Fisheries Experimental Station in Vancouver as a base.

Mr. John had already spent six weeks in both California and Washington before arriving in Vancouver.

While in British Columbia he visited many local fishing companies and their plants, and made trips to the Pacific Biological Station at Nanaimo and to the fisheries industries at Prince Rupert. He departed on August 27th for the Canadian and American East Coast, where he expects to spend an additional four months before returning to India.

Department's Director of Publicity Visits West Coast Stations

Mr. H. F. S. Paisley, Director of Publicity for the Department of Fisheries, Ottawa, paid a brief visit to the Vancouver and Nanaimo Stations of the Fisheries Research Board of Canada during July. Mr. Paisley's interest in the scientific work of the Board has been reflected for many years in the Department's "*Fisheries News Bulletin*" and his recent visit was much appreciated.