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DAILY SEAWATER OBSERVATIONS

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Pacific Oceanographic Group

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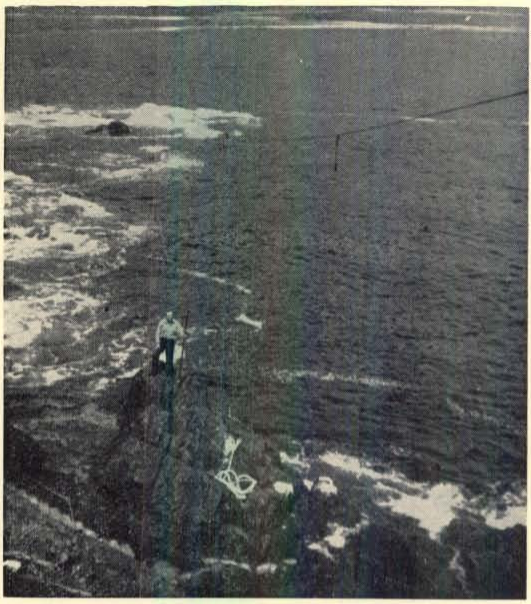
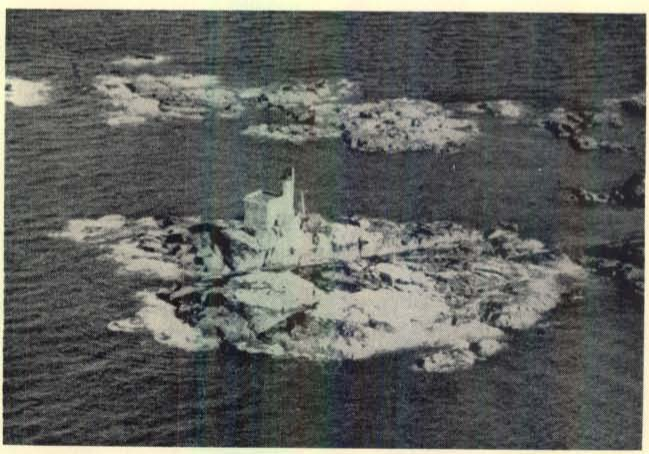
(File N 7-25 November 15, 1952)

Table of Contents



A view of the boat landing at Kains Island. Mr. Rendell is about to take the daily water sample.



An aerial view of Triple Island lightstation. This is one of the few calm days. —Photo courtesy R.C.A.F.

FOREWORD

At the meeting of the Joint Committee on Oceanography in Canada on January 5, 1952, "It was noted that some progress has been made in the analysis of data (from the Daily Seawater Observation Program) but as yet the number of points of observations and the amount of routine data handled remains high. It was agreed that the project should be reviewed a year hence".

I. SUMMARY

This review was undertaken to show the plan for, and examples of, the relations of the Daily Seawater Observations to Pacific Coast Oceanography, to Fisheries Research, and to Naval Research and Operations.

The value and cost of the program, and the necessary modifications are discussed.

TABLE I

The principal oceanographic regions along the British Columbia coast with dates of oceanographic surveys, daily seawater observing stations and dates of their operation.

Principal Oceanographic Regions - (Dates of Surveys)	Chart Index	Observing Stations	Dates of Operation
Inland Seas			
Dixon Entrance (1937,1938)	1	Langara	Sept. 1940-
Chatham Sound (1948)	5	Green Id.	Jan. 1935-Sept. 1936
	4	*Triple Id.	Oct. 1939-
Hecate Strait (Proposed)	21	Banks Id.	Proposed
Northern B.C. Inlets and Passages (1951)	-	-	- -
Queen Charlotte Sound (Proposed)	8	*Ivory Id.	July 1937-
Queen Charlotte Strait (Proposed)	9	*Pine Id.	Jan. 1936-
Johnstone Strait & envirous (1948-1952)	12	*C. Mudge	Nov. 1936-
Northern Georgia Strait (1928-32, 1949-51)	24	Texada Id.	Proposed
Southern Georgia Strait (1928-32, 1949-51)	16	*Entrance Id.	May 1936-
Fraser River (Temp. only)	18	New Westminster	Feb. 1927-
Gulf Islands (1928-1930)	25	Stuart Chan'l.	Proposed
San Juan Archipelago (1930-1950)	26	U. of Wash.	1932-
Juan de Fuca Strait (1952)	20	William Head	Jan. 1921-Mar. 1941
	19	*Race Rocks	Apr. 1941-
Approaches to Juan de Fuca Strait (1936-1939)	22	Swiftsure	Proposed
Ocean Coast			
Southern Vancouver Island Coast (1933-1938,1951)	13	*Amphitrite Pt.	Aug. 1934-
Northern Vancouver Island Coast (1951)	10	*Kains Id.	Jan. 1935-
Southern Q.C. Island Coast (1934)	7	*C. St. James	July 1934-
Northern Q.C. Island Coast	1	*Langara	Sept. 1940-
Oceanic			
Offshore (1950-51-52)	23	"Peter"	July 1952

* Department of Transport lighthouses where observers are paid $108 per annum.

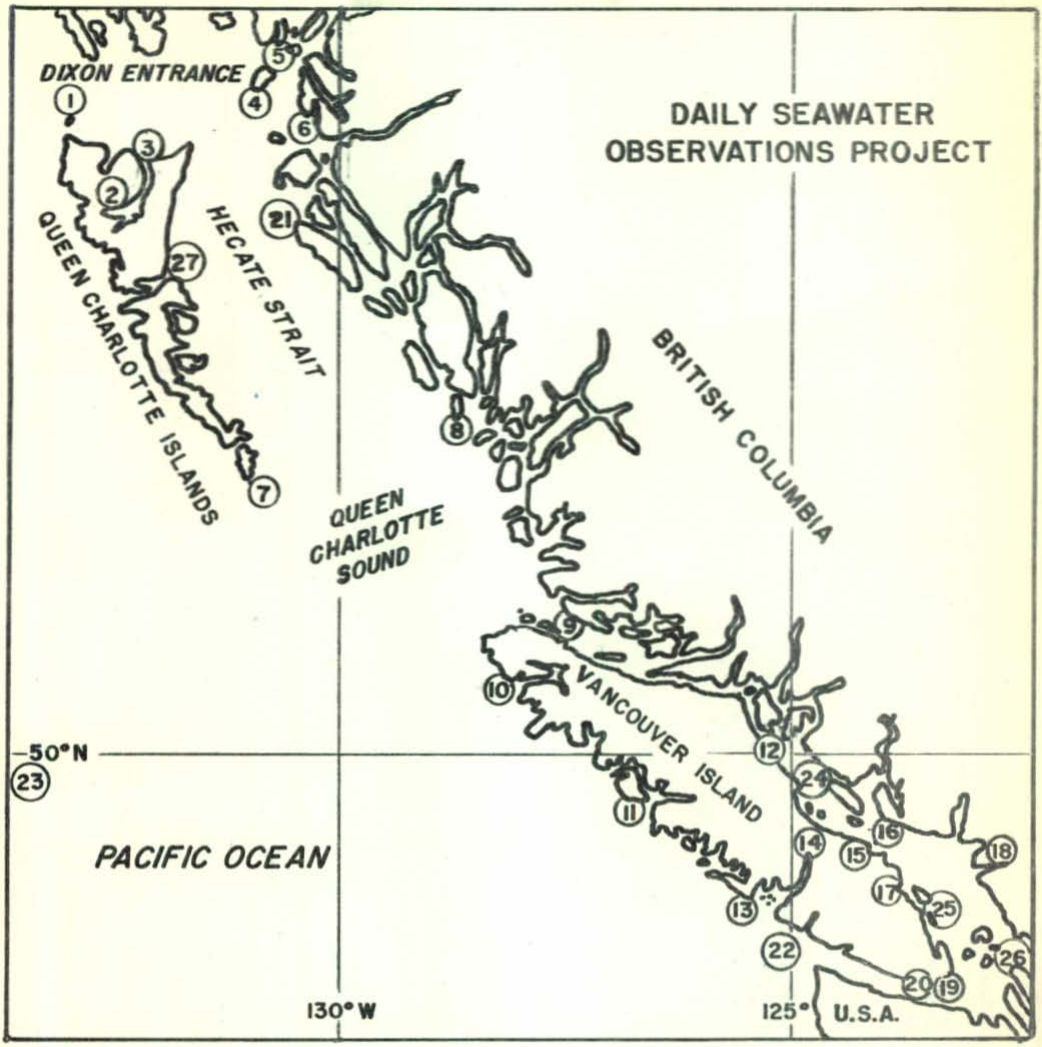


Chart Index	Local Stations - Special Purposes	Dates of Operation
15	Departure Bay	Jan. 1914-
11	*Nootka (1933)	Aug. 1934-
2	Shannon Bay, Q.C. (1938)	Dec. 1939-Sept. 1942
3	Massett (1938)	Nov. 1939-Sept. 1942
27	Skidegate (1938, 1951)	June-Sept. 1952
6	Prince Rupert (1948)	Jan. 1940-Oct. 1942
14	Port Alberni (1940-42)	Apr. 1940-Sept. 1942
17	Ladysmith Hbr. (1937)	June 1937-

II. CONCLUSIONS

1. The present program of Daily Seawater Observations is based on the requirements of Fisheries Research, and is maintained at the request of the Pacific Biological Station.

2. The requirements of an adequate program are:-

   (a) That the details of the procedure be consistently and rigidly maintained so that all data are comparable.

   (b) That there be at least one station in each distinct oceanographic region of interest.

   (c) That returns should be made at monthly or lesser intervals to facilitate prediction of fisheries and oceanographic states.

3. The present program is justified because:-

   (a) It provides a continuous climatological record in representative regions.

   (b) It defines the climatological similarities and differences between regions.

   (c) The data are unique since there are no other series of observations which continuously indicate the properties of the water or oceanographic state.

   (d) Each station represents a region which is distinct for a fisheries and/or an oceanographical reason.

   (e) It provides a readily observable index which can be related to the annual cycle of oceanographic conditions as observed by the series of surveys in each region.

   (f) The data offer reasonable prospects for the prediction of fisheries, and the oceanographic states within the limits of a season.

   (g) Some correlations with fisheries have been established, and more are indicated.

   (h) The increasing use of the data by fisheries, shipping, and industry in British Columbia and United States indicates that there is an expanding market for the information.

   (i) The present and indicated returns on the program are well worth the annual expenditure.

4. The program should be continued indefinitely because:-

   (a) It is the cheapest means of recording oceanographic conditions.

   (b) Without these data it would be necessary to maintain tedious and costly oceanographic surveys indefinitely.

   (c) Correlations with the fisheries are still being developed, and continuing data are required for comparison with continuing fisheries research.

   (d) There is no point in establishing correlations by which the data can be used to predict the oceanographic conditions or the fisheries if the bases for the predictions are to be removed.

5. Because of their similarity of purpose the projects associated with

   Weathership at Station Peter
   Fisherman's BT observations

   are included with the Daily Seawater Observation program.

III. RECOMMENDATIONS

1. Observations at Nootka lightstation should be discontinued since there is no apparent demand for the data.

2. The remaining (13) stations in the current program should be retained.

3. The program should be expanded to include

   Hecate Strait
   Swiftsure Light vessel
   Northern Georgia Strait
   Gulf Islands region, Georgia Strait

   because these are distinct regions, not represented in the existing program, and for which data are required for fisheries and oceanographic reference.

4. Studies of the data should be undertaken to determine:-

   (a) The history of oceanographic climate along the coast particularly to note any evidence of epochal changes.

   (b) The types of seasons, their characteristics and occurrence.

(c) The similarities and differences in the individual data between stations in similar climatic regions.

(d) Further correlations with oceanographic survey results, and fisheries.

IV. PROCEDURE

Cases containing a hundred specially prepared 2 ounce bottles are sent to each observing station, where the sea water is observed daily at a depth of 3 feet, using a simple apparatus which obtains the sample and records the temperature simultaneously. The observer records the date and temperature on the label of the sample bottle and on a log sheet. The observation is made during the latter half of the rising tide (within one hour of high water) occurring during the daytime. The case of bottles is filled in about three months and returned to the Pacific Biological Station where the salinities of the samples are determined. The temperature and salinity are presented in tabular form, including the monthly mean values, and a ten year moving monthly mean value, in the manuscript report series entitled: "Observations of Seawater Temperature and Salinity on the Pacific Coast of Canada" (17 to 27).

This procedure was modeled on a similar program that has been in effect along the coast of Norway since the beginning of the century. That program, along the only other coast similar to British Columbia, has been found profitable and the data have been used successfully to monitor the oceanographic conditions, and the fishery, and provide a basis for their prediction.

Purpose

This program was initiated by the Fisheries Research Board of Canada to provide a continuous index of oceanographic conditions along the British Columbia coast which could be correlated to fisheries data such as catch, spawning, and escapement records, or any other regular observations which might be made. When this Group was absorbed into the Joint Committee on Oceanography in Canada it was understood at the Pacific Biological Station that the project would be continued and the service provided as long as required.

The program is also a fundamental requirement of physical oceanography because it provides a record of oceanographic climate, an index of the oceanographic state, and some bases for prediction of oceanographic conditions in several regions along the British Columbia coast. In addition it serves a number of purposes of interest to other members of the Joint Committee.

History

Observations are currently being made at 14 stations (Table I)

of which 11 are lighthouses. Most of these were initiated between 1933 and 1938 but several commenced earlier. The oldest series is at Departure Bay dating from 1914. The first publications in 1947 included all prior data, and since then each year's data has been published annually.

The circulation of these published data records has increased steadily from 90 copies in 1947 to 130 in 1952. This increase is due entirely to requests, and includes fishery and oceanographic research groups, meteorologists, coastwise shipping, fishing industry, public utilities, and others in Canada and the United States. There is a growing demand for the information as it becomes known, and the use of the sea increases.

V. FUNCTION OF DAILY SEAWATER OBSERVATIONS IN PACIFIC COAST OCEANOGRAPHY

Oceanography is the description of the sea around us, its form, physical properties, composition, and behaviour. All the work of the Pacific Oceanographic Group is directed towards providing an accurate description of the oceanographic conditions in the coastal waters and means of predicting these conditions in terms suitable for fisheries, naval, social, and industrial use.

Conditions in the sea are dynamic. It is a fluid medium where there are tidal and seasonal cycles of change, each cycle being to some degree similar and some degree different (6, 11). It must also be recognized that there are distinct climatological regions in the many entrances, estuaries, inlets, bays, sounds, straits, narrows, and coastal seas. In all these the water is saline, the tides rise and flow, and the seasons follow the same annual cycle, but here the similarity stops. The range and cycle of salinity, the range of the tide, the nature of the currents, and the seasonal variations of temperature and other properties of the water are as distinct as the geography and climate of British Columbia's mountains and valleys.

Before the War (1930 to 1940) exploratory oceanographic surveys were made in most coastal regions to define their general character and limits. Since the War (1948) the principal task has been to define the tidal and seasonal cycles of physical oceanographic events and the effects of runoff and weather in each broadly defined region, by intensive oceanographic surveys at intervals throughout a year or more, and this effort is shifted from one region to another in successive years (4). Each survey involves the observation and resolution in length, breadth, and depth of temperature, salinity, density, and the currents. The resolution in time is made by comparing successive surveys.

Surveys have been carried out in Chatham Sound, Georgia Strait, Juan de Fuca Strait, some inlets, and are continuing in the coastal and offshore ocean. The principal unsurveyed waters are in

the northern British Columbia regions such as Queen Charlotte Sound, Hecate Strait and Dixon Entrance.

These surveys are necessary to define the oceanographic states, the mechanism of circulation in a region, and the effects of tide, runoff, and weather, but they are very tedious and costly and the results are not available until some time after the observed conditions have passed. However it is usually possible to relate the oceanographic conditions to daily observations of sea water (7, 8) temperature and salinity at one or more positions in the region. These daily observations provide an easily observed index which records the sequence of oceanographic events, their extent and continuity, and similarities and differences, (5) and from which the oceanographic state can be quickly identified, and which can be continued indefinitely at small cost. Without these indices it would be necessary to repeat the onerous and lengthy surveys every time oceanographic information is required, there would be no continuity in the information, and the condition would always have passed by the time the information was available.

Daily Seawater Observations are Unique

The tidal rise has been recorded and is predicted at more than 150 points along the coast, and the same service is provided for tidal currents at 37 points by the Hydrographic Service. The weather is observed at least twice daily at 52 coastal stations, and weather predictions are given for 7 regions by the Meteorological Service. The discharge of 21 coastal rivers is observed daily by the Dominion Water Power Bureau.

All these provide data which may be used to assess the magnitude of the boundary conditions affecting the oceanographic state, however they give no indication of the temperature and salinity of the waters which must be observed directly.

The number of Daily Seawater Observing stations is small compared to the number of coastal weather observatories and tidal observation points. However those services are much further developed than the Daily Seawater Observations which only recognize the major oceanographic areas, and some few of the minor areas at the present time.

Daily Seawater Observations are Necessary

It has been proposed that the conditions in the sea could be directly related to those in the atmosphere, since insolation and consequent phenomena are common to both (2). If this were so the Daily Seawater Observations would not be necessary.

However the properties of the atmosphere are very different from the sea where the effects of heating and runoff are cumulative over a considerable distance and time. The general seasonal cycles

are similar but as shown by Pickard and McLeod (28) and Tully (6) the maximum and minimum temperatures occur about a month later in the sea than in the atmosphere.

Each major change of weather is marked by a change in the properties of sea water (4,7). A short time after a north-west wind starts to blow in the summer, the coastal seawater temperatures fall and salinities rise, and the converse effects are associated with southeasterly winds. The Daily Seawater Observations record the time and degree of the change of conditions and their duration in the sea. Study of these data show that these relations are only qualitative. Sometimes large effects follow light winds, and vice versa, and the effects of variable winds are completely unpredictable. (7).

Carruthers, in England, has announced a correspondence between certain fisheries and the barometric pressure distribution, but has not been able to explain it, or repeat it in any other region. The possibility of utilizing this principle on the Pacific Coast is remote because the weather data are known only on the lee side of this very much larger ocean.

It is possible that some means of directly relating the properties of sea water to the state of the atmosphere and the tides may eventually be found, but it is apparent from past researches that the relation will be neither simple nor exact.

Direct observation is the only satisfactory method of determining the properties of sea water since these data represent the net effect of the many complex situations through which the water has passed.

The Daily Seawater Observations provide the index to the occurrence and continuity of the conditions observed by oceanographic surveys (8). The past observations show the number and sequence of oceanographic conditions, their duration, the nature and degree of the changes, and the probability of repetition. Observations during a survey identify the type situation being surveyed, its degree and duration. In a series of surveys they indicate the number of type situations that have been observed and draw attention to types that have been omitted. Future observations serve to monitor the state and provide an index to identify the current situation with types that have been surveyed.

No other observations provide this information which is essential to assessment of the oceanography of any region, and in this sense they provide the basis for the whole oceanographic program on the Pacific Coast.

Daily Seawater Observations are Indices of the Oceanographic Conditions

The amount of Fraser River water present in Georgia Strait at any time is related to the salinity at Entrance Island, and the temperature at this station is an index of the temperature in the whole area. Similarly the salinity at Triple Island is a measure of influence of the Skeena River in Chatham Sound, and the temperature is a record of the insolation.

The recent study by Pickard and McLeod (28) has shown that the rise of salinity along the ocean coast in the summer is due to lack of rainfall, and to upwelling caused by prevailing westerly winds. The effect and relative importance of the two causes are recognizable in the daily salinity observations, but have defied repeated analyses of the atmospheric data.

The correspondence of the Daily Seawater Observations to the offshore oceanographic conditions has recently been demonstrated by Tully and Bennett (16). During the summers of 1949 and 1950, three great clouds of warm water lay in a band off the British Columbia coast. As a result the temperature increased to seaward to a maximum about 120 miles offshore, and then decreased further to westward. Alternate maxima and minima of temperature occurred in the band of warm water clouds along the line parallel to the coast. This condition of "irregular temperature distribution" was associated with an irregular sequence of temperatures from Amphitrite, through Kains and St. James to Langara, during June, July, and August.

During 1951 the summer oceanographic conditions were significantly different. The surface seawater temperature increased regularly to seaward, and decreased regularly northward parallel to the coast. This condition was associated with a regular decrease of the average monthly temperatures at the four stations from Amphitrite to Langara. Evidently the sequence of the coastal temperatures provided an index to the distribution of oceanic temperatures.

Examination of Daily Seawater Observations prior to 1950 shows that the irregular and regular conditions have occurred before, but there are also definite indications of other type conditions which cannot be explained for lack of corresponding oceanographic surveys. In this case the Daily Seawater Observations indicate the number of possible type situations that may exist, and the amount of survey that will be necessary to define them.

The deep waters near Entrance Island in Georgia Strait maintain a nearly constant temperature and salinity throughout the year, while the surface waters fluctuate daily but tends to follow a seasonal cycle, which is recorded by the Daily Seawater Observations (6). Finally recent investigations are revealing the forms of the temperature and salinity-depth gradient. Knowing these factors it appears possible to relate the seawater structure in this region to the Daily Seawater Observations.

These examples are sufficient to show that the Daily Seawater Observations are indices of the oceanographic state.

Such correlations are limited to situations where the Daily Seawater Station and the surveys are in the same oceanographic region. Pickard and McLeod (28) classified Entrance Island in Georgia Strait as being climatologically similar with Triple Island, 500 miles to the North in Chatham Sound because the temperature and salinity cycles are similar in form. However the level and duration of the temperature minima and maxima are of different orders and the salinity of one is dependent on the Fraser River runoff, while the other depends on the Skeena River. Therefore these are distinct oceanographic regions and the data from one cannot be regarded as an index for the other any more than the weather at Vancouver can be regarded as an index of the weather at Prince Rupert.

Daily Seawater Observations Define Oceanographic Climate

Climate is generally understood to be the average seasonal cycle of meteorological conditions prevailing in a region, and a similar interpretation may be made in the sea where the temperature and salinity are the defining properties, corresponding to temperature and precipitation in the atmosphere.

Pickard and McLeod (28) have studied the 13 year averages of the monthly averages of temperature and salinity data at 11 stations. The maximum air temperatures occur in late July, but the maximum seawater temperatures occur a month or more later in August. The highest and lowest temperatures occur in harbours and bays without regard to latitude, while those in rapid flowing straits and narrows vary the least. The greatest precipitation occurs in November, and along the ocean coast is indicated within two weeks by a lowering of salinity, as the rivers on Vancouver and the Queen Charlotte Islands rise to flood levels. However, along the mainland coast the precipitation is held as snow in the mountains until May when the rivers rise in flood and dilute the sea water along the adjacent coast.

They recognized three types of oceanographic region associated with the mainland runoff cycle, the coastal island cycle, and the open sea, and three types of location, harbours, and bays, open seaways, and straits. The type of oceanographic cycle in each region is similar but the causitive factors and the individual variations are properties of the particular region. There is no suggestion that stations in one group may be used as an index of the other.

Tully (2) recognized the significance of weather in the sea and showed that there are considerable differences from place to place along the ocean coast (5). The temperatures may be rising at one place, falling at the adjacent station and at the same time be steady at others.

There is reason to believe that there are epochal changes,

because some fisheries such as the pilchard and tuna appeared on the coast for no known reason and have vanished just as mysteriously. Conditions observed in 1936 do not compare with those observed in 1950. Evidently we cannot observe the oceanographic conditions in one year and assume that this cycle of events will be repeated indefinitely, we must be on the lookout for changes in the whole order or character of conditions, and be prepared to re-survey the areas and recognize new cycles and events.

Daily Seawater Observations Form a Basis for the Prediction of Oceanographic Conditions

This principle has been illustrated in the study of the offshore data by Tully and Bennett (16). The surface temperature distribution offshore in August 1951 differed markedly from those in August of 1949 and 1950, and was associated with the relations between the average August temperatures at four seawater observing stations along the ocean coast. It was also noted that the critical relation in the daily observations occurred in the preceeding two months in every case, whence the oceanographic state in August may be forecast from the June and July data.

It is obvious that if the data are to be used for forecasting it will be necessary to have the temperatures and seawater samples returned to the laboratory daily, weekly, or at least at monthly intervals, rather than quarterly as at present. Weekly returns of seawater temperature were obtained by radio from Triple Island during January, February, and March of this year (1952) for the forecast of lemon sole fishery. Similar arrangements can be made with nearly all stations if and when the need arises. In the meantime it is proposed to have the data and samples returned monthly after January 1953.

VI. FUNCTION OF DAILY SEAWATER OBSERVATIONS IN PACIFIC COAST FISHERIES

Fisheries biologists are finding correlations between the fisheries and these daily seawater data which allow, or promise, prediction of the fishery. These studies have only been instituted here in the last two years, because there were not adequate fisheries data previously to establish the correlations, and those established have not yet been published. Obviously there will be a period of testing the validity of predictions before their use becomes general. Cancellation of the critical observing stations would of course cancel the whole of this promising research.

Fisheries researchers have found that every one of the existing seawater observation stations represents a distinct region, associated with particular fisheries, and they are most emphatic that none of these should be abandoned. They also find that certain regions, such as Hecate Strait, the approaches to Juan de Fuca Strait and Georgia Strait require additional monitoring.

Tully and Bennett (16) observed that the tuna fishery was successful in 1949 and 1950 when the series of coastal temperatures from Amphitrite to Langara were irregular, and that the fish did not appear in the area under the regular conditions of 1951. Confirmation of the correlation will be required, but it appears possible that the conditions suitable for tuna fishing may be identified and predicted from the Daily Seawater Observations at these stations.

Mr. K.S. Ketchen has found a correlation between the daily seawater data during January, February and March and the occurrence of groundfish in April and May. He States:-

> Despite the encouraging results shown by Carruthers on the relation of fish "events" to weather (barometric pressure) "events" in the North Sea, we have no assurance that such superficial treatments will apply here. As Dr. Tully points out, the North Sea is monitored on all sides whereas our coast is poorly monitored. It is evident that no simple relationship exists between weather events and ocean events in Hecate Strait. If the seawater observations are terminated then we may be losing our only clue clue (faint as it may be) to the ocean "events".
>
> "I am confident that before the Groundfish Investigation has completed its first ten years of existence, we shall have established firm relationships between lighthouse oceanographic records and fish events which will be potent weapons for prediction."

Mr. J.C. Stevenson, in charge of herring investigations, writes:-

> "Prediction of fisheries demand oceanographic data from year to year. A full-scale oceanographic survey can elucidate the oceanographic conditions in great detail for the period over which it is conducted, but it is largely useless for prediction purposes."
>
> "I endorse the proposal of increasing the number of stations. I particularly like the prospect of having new stations, Hecate, Swiftsure, and Peter. If, perchance, there should be sharp curtailment of existing stations, I see little value in maintaining any of them, insofar as application to fisheries is concerned. It will be specific oceanographic differences that we will require, not broad general differences."
>
> "I question the suggestion that lack of data (either biological or daily seawater) has been the most important factor in delaying use of Daily Seawater information. In many cases it has been lack of time,

and lack of awareness of the vast amount of pertinent data available in the Daily Seawater records. F.H.C. Taylor was becoming steeped in relating herring data to these records when his progress was halted by his diversion to seals."

Previous to the recently discovered possibility of predicting suitable conditions for tuna (albacore), from coastal seawater observations (16). J.M. Partlo discussed the desirability of oceanic data which is now being supplied by the weathership on station Peter.

"with regard to the oceanic albacore fishery, it has been very evident that oceanographic data, particularly water temperatures, are an absolute necessity in order to interpret the occurrence and distribution of the exploitable populations in British Columbia waters. In this regard I would welcome the inclusion of the weather station "Peter" as station 23 of the Daily Seawater Observation program."

The migratory salmon fishery has been one of the principal programs of the Pacific Biological Station since 1930. During the past year a relation has been found between the cohoe catch in the vicinity of Kains Island and the salinity history. It appears that along the west coast of Vancouver Island the inshore (Canadian) fishery is good when the salinities are higher than average, while the offshore (American) fishing is best when the salinities are low. This may offer some clue as to the behaviour of the salmon.

Dr. Ferris Neave remarks:-

"From the point of view of salmon investigations, the Daily Seawater Observation program supplements and to some extent resembles the program of gauging stations and key stream observations which we have found it necessary to set up in dealing with freshwater phases of salmon biology."

"Use of the Daily Seawater data has already been made by salmon investigators. I am hopeful that further correlations, leading to prediction or to increased knowledge of salmon movements, can be established in the future."

"As a salmon investigator I would certainly be in favour of increasing the number of stations and would regard any reduction as a retrograde step."

Dr. D.J. Milne adds:-

"From the point of view of attempting to understand and eventually to predict the variations in seasonal occurrence and migratory movements of salmon in ocean I strongly recommend continuance and extension of these records. We are just starting to shift our work in this direction and if the Daily Seawater Observations are stopped we will have no continuous series of data to use. These records are the envy of the Americans. In a recent paper on silver salmon in Oregon they had to use salinities recorded at Cape St. James for ocean conditions. With the first accurate catch figures (1951) just now available for the whole B.C. Coast (30 areas) it will be a few years before reasonable correlations between catch and ocean data can be made except in local areas. Thus it would be too bad if the Daily Seawater Observations were dropped before any correlations could be attempted."

"Weather records do not give similar information"

It is of some interest to note that statistical analyses have shown that 27 districts are required in the assessment of the fisheries. Although these are arbitrary divisions, they represent approximately the number of natural units of habitat of the commercial fishes, and it may be inferred that the properties of the environment should be considered in each one. By this standard the present list of 15 stations falls far short of the required number.

It is evident that the Daily Seawater Observations are considered necessary in Pacific Coast Fisheries Research, and that the emphasis is on expansion rather than reduction of the program.

Recently, Van Cleve, who has been concerned with the researches of the International Fisheries Commission, and is now Director of the Washington State School of Fisheries, proposed there had been a major climate change in these coastal seas during recent years. This coincides with other evidence in the pilchard fishery, and comparison of early and recent oceanographic surveys. The Daily Seawater Observations are the only data in which such a change could be sought, and he proposes a major research in these to evaluate the climatological history. This study alone would justify the whole program.

VII. REQUIREMENTS OF THE PROGRAM

The Number of Stations

It is fundamental that correlations of the Daily Seawater

Observations with oceanographic states or the fisheries depends on the data being unmistakably applicable to the region and time of study.

As the program stands there is no more than one observing station in any major oceanographic region, and each of these are associated with major oceanographic or fisheries researches, or are obvious regions of such studies in the near future. In none of these can the conditions be defined from observations in other regions. These eleven are the principal stations to which oceanographic events in the contiguous minor regions may be referred.

In addition, observations have been, and are being made at a number (3) of local stations (Table I) to accompany particular fisheries or oceanographic studies. Usually these are discontinued when they have served their purpose, or a correlation with some major station is established. This procedure is similar to the tidal observations at reference positions.

With the exception of Nootka all existing observing stations are necessary for the purposes of the oceanographic and fisheries program. The number is high because of the extreme variability of the oceanographic conditions along the British Columbia coast. However there are several regions of obvious importance where no observations are being made at present, and for which the data are required. It appears evident that as oceanographic knowledge increases, more distinct regions will be recognized as in the case of meteorological, tidal, and fisheries studies. Therefore it is anticipated that the number of major stations will in general increase. Every effort is being made to recognize these major areas and locate the Seawater Observation station at the most strategic position.

Station "Peter": After three years negotiation with the meteorological Service bathythermograph observations have been instituted on the Weathership on Station "Peter" (Latitude 50°N. Longitude 145°W.) this year (1952). Observations are made every two hours during the run-out and run-in, and twice daily while the ship is on position (36 days). These provide an effective monitor of the oceanic temperatures as well as a section through the "Offshore" area every 5 weeks. This fulfills the agreement under the International Civil Aviation Organization and is required not only for fisheries, but for meteorological and naval, as well as oceanographic reasons. Copies of the data are provided for the World Atlas at Scripps Institution of Oceanography at La Jolla, California. It is unfortunate that this was not operative during the offshore surveys, so that the data might be correlated with conditions in the whole area, however it is hoped that some interpretation can be made, and future surveys will enable the correlation.

Fishermen's BT Program: Instruments are now on hand to provide six to ten fishermen with Bathythermographs, and these will be issued and instructions provided during the coming winter. The

fishermen have agreed to make regular observations during their tuna and salmon fishing operations and return the slides with the fishing records to this station. This program is based on the need for large amount of data in the coastal approaches for relation to fisheries and oceanographic records.

These programs could be regarded as special projects although they are grouped with the Daily Seawater Observations because of their similarity of purpose.

Duration of the Program

The reason for correlating the Daily Seawater Observations with the oceanographic surveys and the fisheries is to make use of this cheap and efficient means of providing an index of past and present conditions, and a basis for prediction. The correlations are of no value if the basis for their application is removed. Consequently the program should be continued indefinitely.

Study of the Data

The basic plan of oceanographic research on the Pacific Coast envisioned concurrent surveys and Daily Seawater Observations in each region. Then the survey data would be analysed to evaluate the oceanographic states in the region, and their occurrence would be correlated with the Daily Seawater Observations.

Such studies require that there be a series of Daily Seawater Observations, corresponding to series of oceanographic surveys in each region and that the data from both have been analysed and compared. This is no light task and of necessity lags considerably behind the observational program which is the principal concern of the Group at present. Some analyses of oceanographic surveys have been made in Alberni Inlet, Chatham Sound, Georgia Strait and Offshore, and only a few correlations have been sought in the last two. The plan is still being developed with more emphasis to be placed on the study of the data in the future. The little work that has been done has been most productive, as shown by the list of 16 publications in the bibliography. These, the use of the data in fisheries research, and the evident promise of further correlations are ample justification of the plan, and indicate a high priority should be placed on the study of the data.

There are probably no more promising or profitable observations in oceanographic research.

Proposed Modifications

(a) Deletions

The observations at Nootka lightstation may be eliminated. This station concerns only the conditions in Nootka sound and has not

been of major importance recently. It is suspected that it may be of some interest to the local salmon fishery but this has not been demonstrated. It is the only station representative of the west coast sounds.

(b) Additions

Hecate Strait: There is no representative station in this region, which is becoming the most important sea fishing area in British Columbia. Ketchen and Butler have shown that data from an exposed position such as Banks Island (Figure 1, number 21) are required for the groundfish and crab studies. This station is also required in anticipation of the proposed oceanographic survey program in this region.

Northern Georgia Strait: Recent studies of the oceanographic data have shown that this region is distinct from the southern part, and cannot be related to Entrance Island. Since this is a major fishing area for groundfish, salmon, and herring, a record is required for fisheries as well as for physical oceanography. Observations from Northern Texada Island (Figure 1, number 24) would appear to be the most suitable.

Gulf Islands: This region among the islands along the south western side of Georgia Strait is oceanographically and climatologically distinct from the open Strait represented by Entrance Island. It is a considerable salmon, herring and shellfish area for which data have been requested, particularly in the region of Stuart Channel (Figure 1, number 25, 26).

Swiftsure Lightship: This station is in the approaches to Juan de Fuca Strait and is in a key position with respect to herring and to the migrating salmon approaching the Fraser and Columbia Rivers. It has been shown that the approach to Juan de Fuca Strait in the vicinity of Swiftsure Lightship is a distinct oceanographic region (8) which is not monitored at present. Milne and Stevenson (section V) have remarked on its importance to salmon and herring fisheries and the necessity for monitoring. Its commercial and strategic importance is obvious.

Costs

The total cost of the 14 stations in 1951 was $1950 for which the detail is shown in Table II. Lightkeepers at 11 stations were paid $108 per annum for taking the samples and the remaining costs are $56 for each of the 14 stations. The average total cost of each observation is about 38 cents.

The routine processing has been reduced considerably in the last year, by the improved efficiency of the sea water analysis laboratory which has reduced the time required for salinity determination to about one half of that required formerly; and by eliminating

TABLE II

Cost of Daily Seawater Observation Program
January 1 to December 31, 1951

Triple*, Ivory*, Pine*, Mudge*, Entrance*, Fraser R., Race Rocks*, Amphitrite*, Nootka*, Kains*, St. James*, Langara*, Departure Bay*, Ladysmith. - 14 Stations.

*Lighthouse Keepers wages	$ 1166.00
Shipping Charges	136.40
Laboratory Reagents	50.00
Laboratory Equipment	30.00
Labour for Titration	288.00
Labour for Calculations	72.00
Labour for Washing, Labelling & Packing	48.00
Typing Manuscript	30.00
Stencils and Paper (for 175 copies)	10.00
Labour for Mimeographing and sorting	20.00
Supervision	100.00
Total Cost	$ 1950.40

These figures approximate within +5% or -10%.

TABLE III

Estimated cost of the expanded
Daily Seawater Observation Program

April 1, 1953 to March 31, 1954.

Current program (14 stations)	$ 1957
Georgia Strait, Gulf Islands	330
Hecate Strait	300
Swiftsure Lightship	400
Station Peter	770
Fishermen's BT	1200
Total	$ 4957

the density calculation from the bulletin. This was a time-consuming chore which was originally included for the use of shipping interests, however these require only average values in particular areas and can be satisfied from the existing records. These savings have been offset by cost increases in the past year so that there is no change in overall expense.

The cost of the expanded program is shown in Table III. The Georgia Strait stations should be a simple extension of the Lighthouse arrangements. A private observer will be required in Hecate Strait and will probably be more expensive. Observations at Swiftsure Lightship will probably cost a dollar per day for a surface and bottom sample.

Station Peter and Fishermen's BT programs which are already committed, are included here.

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