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**MANUSCRIPT REPORT SERIES  
(OCEANOGRAPHIC and LIMNOLOGICAL)**

**No. 108**

**Data Record of Oceanographic Observations  
Made in Pacific Naval Laboratory  
Underwater Sound Studies  
1961**

by  
**R. H. Herlinveaux**

**Pacific Oceanographic Group  
Nanaimo, B.C.**

**December 28, 1961**

**Programmed  
by  
THE CANADIAN COMMITTEE ON OCEANOGRAPHY**

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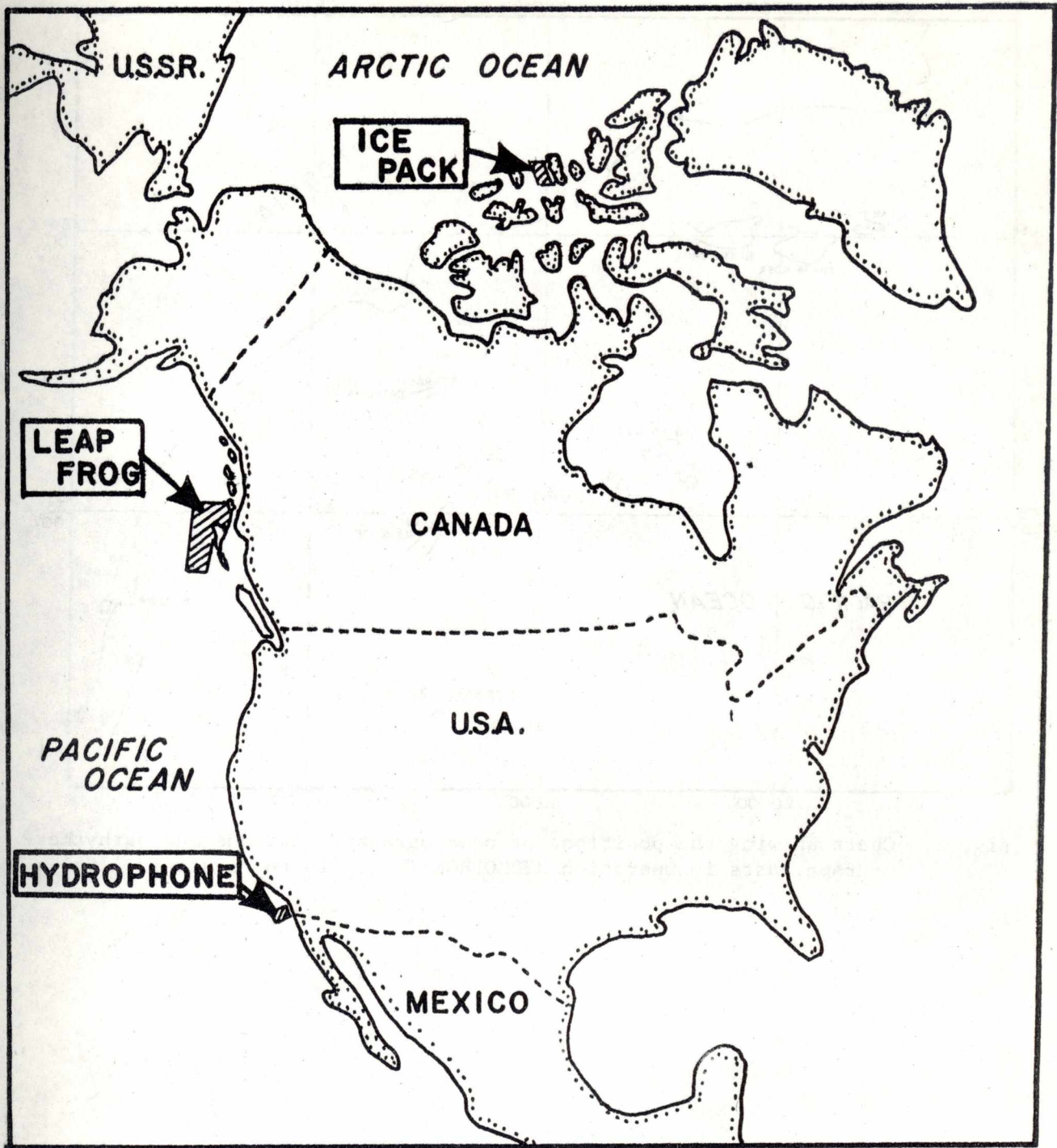


Fig. 1. Chart showing the location of the survey areas presented in this report.

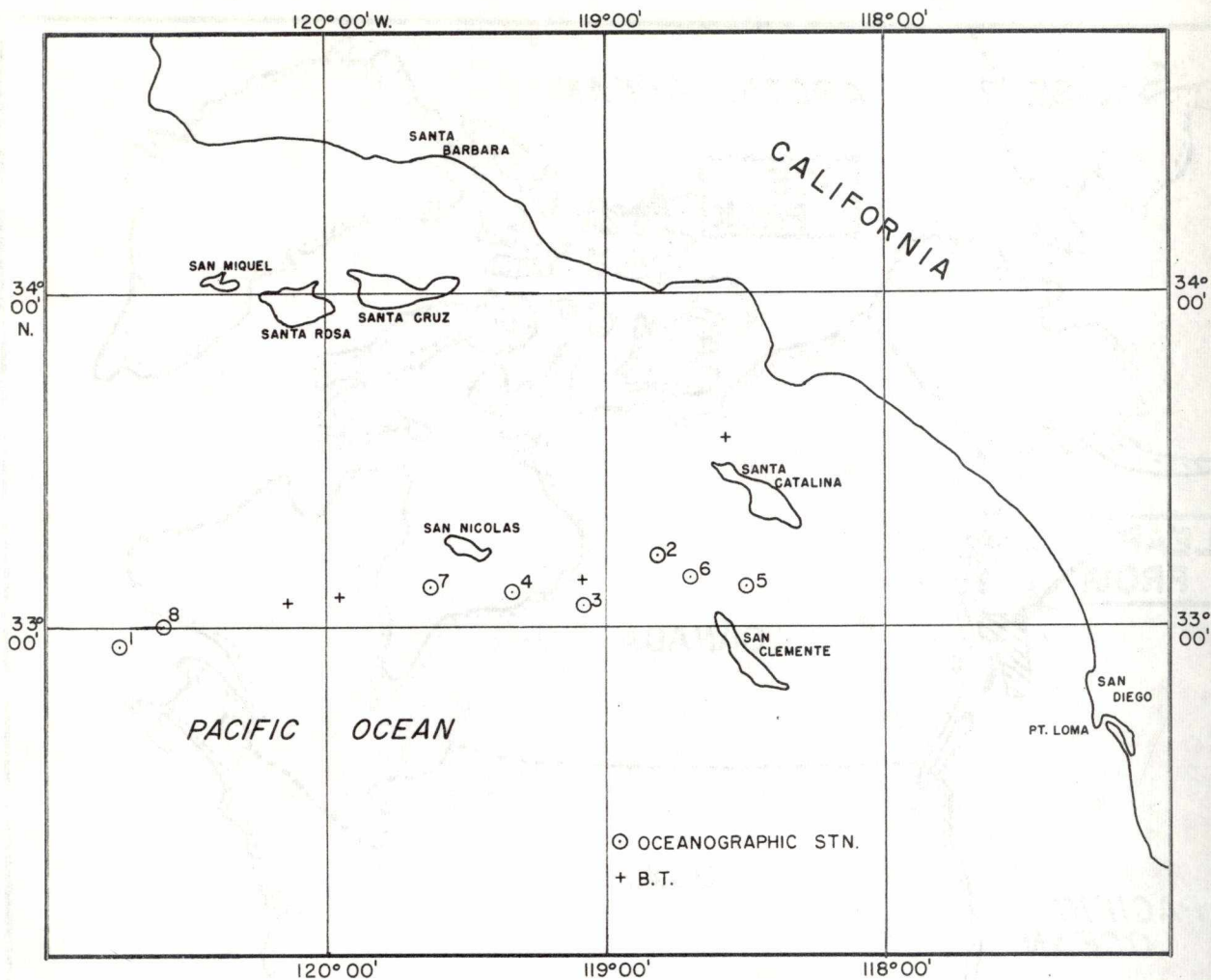


Fig. 2. Chart showing the positions of oceanographic stations and bathythermograph casts in Operation HYDROPHONE, July 26 to August 13, 1961.

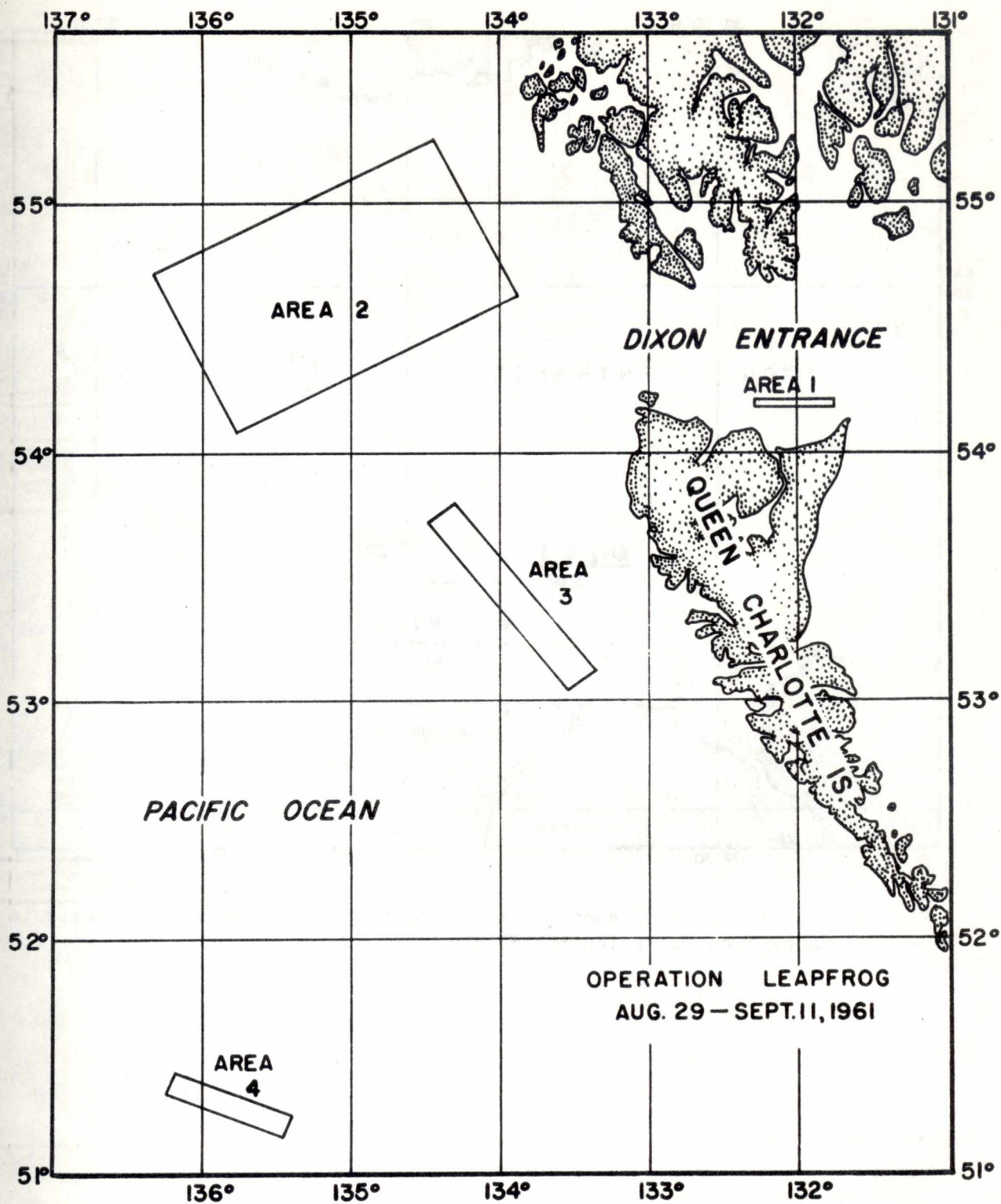


Fig. 3. Chart showing the areas surveyed in Operation LEAPFROG, August 29 to September 11, 1961.

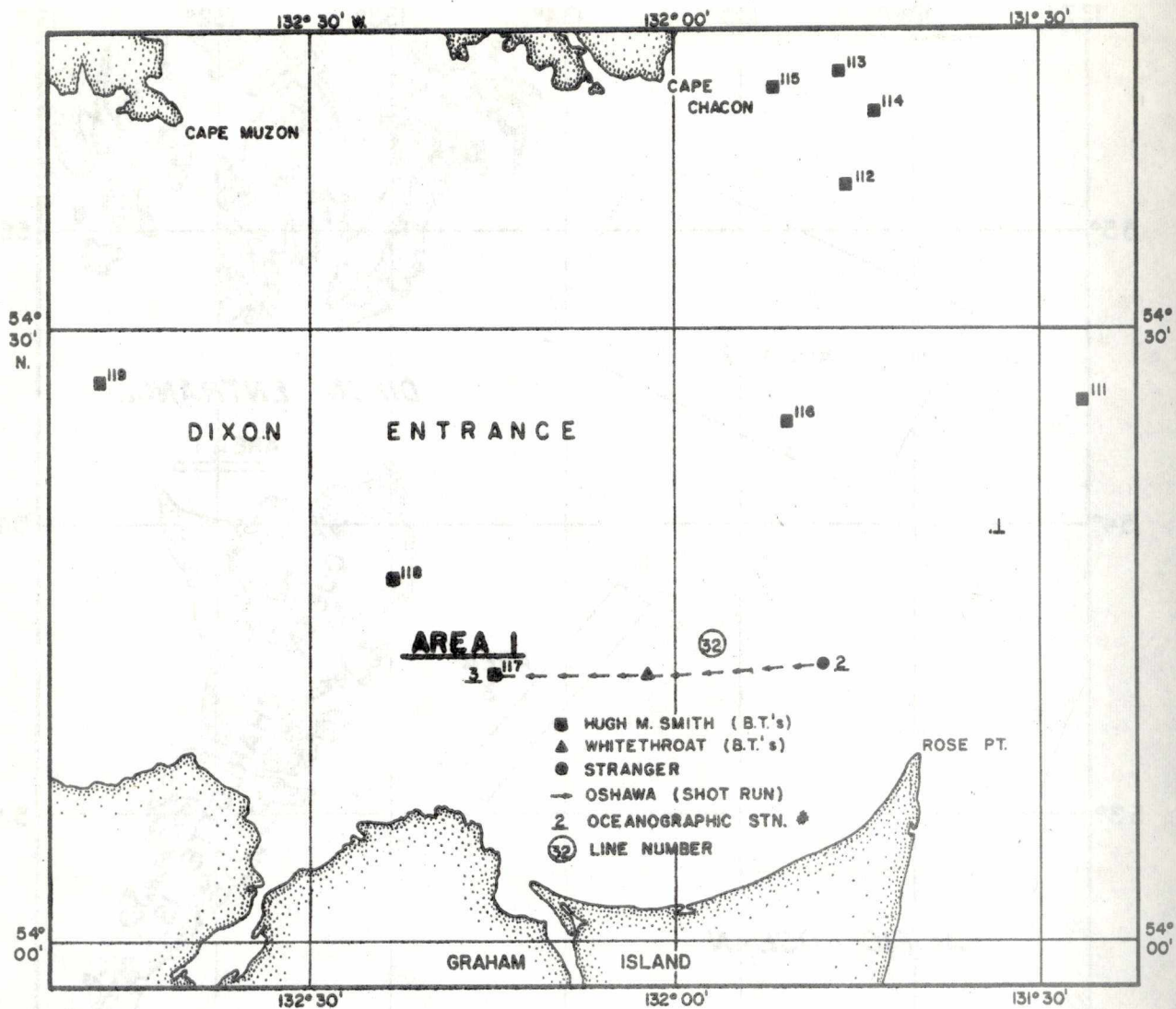


Fig. 4. Positions of oceanographic stations and bathythermograph casts in Area 1 of Operation LEAPFROG.

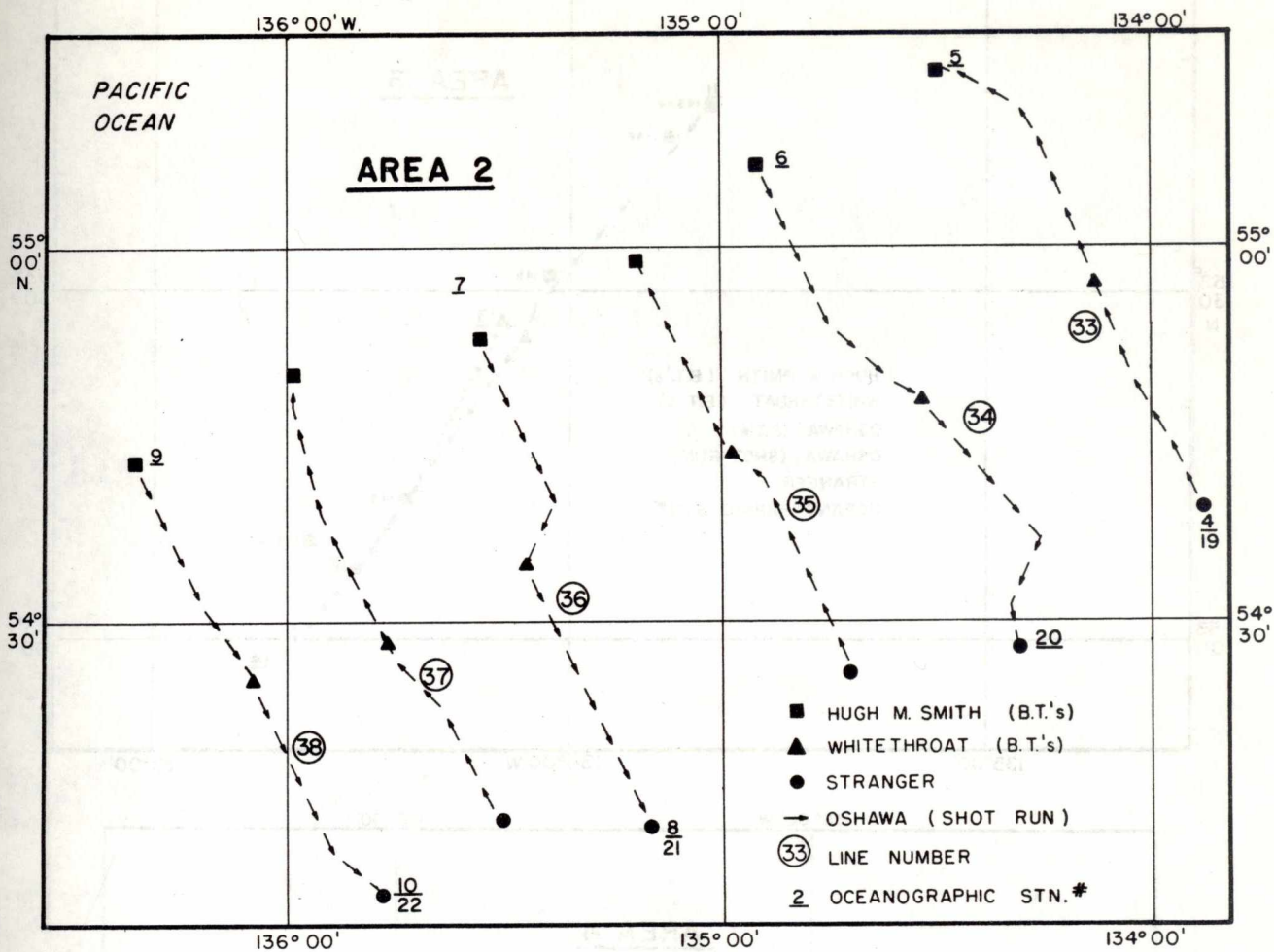


Fig. 5. Positions of oceanographic stations and bathythermograph casts in Area 2 of Operation LEAPFROG.

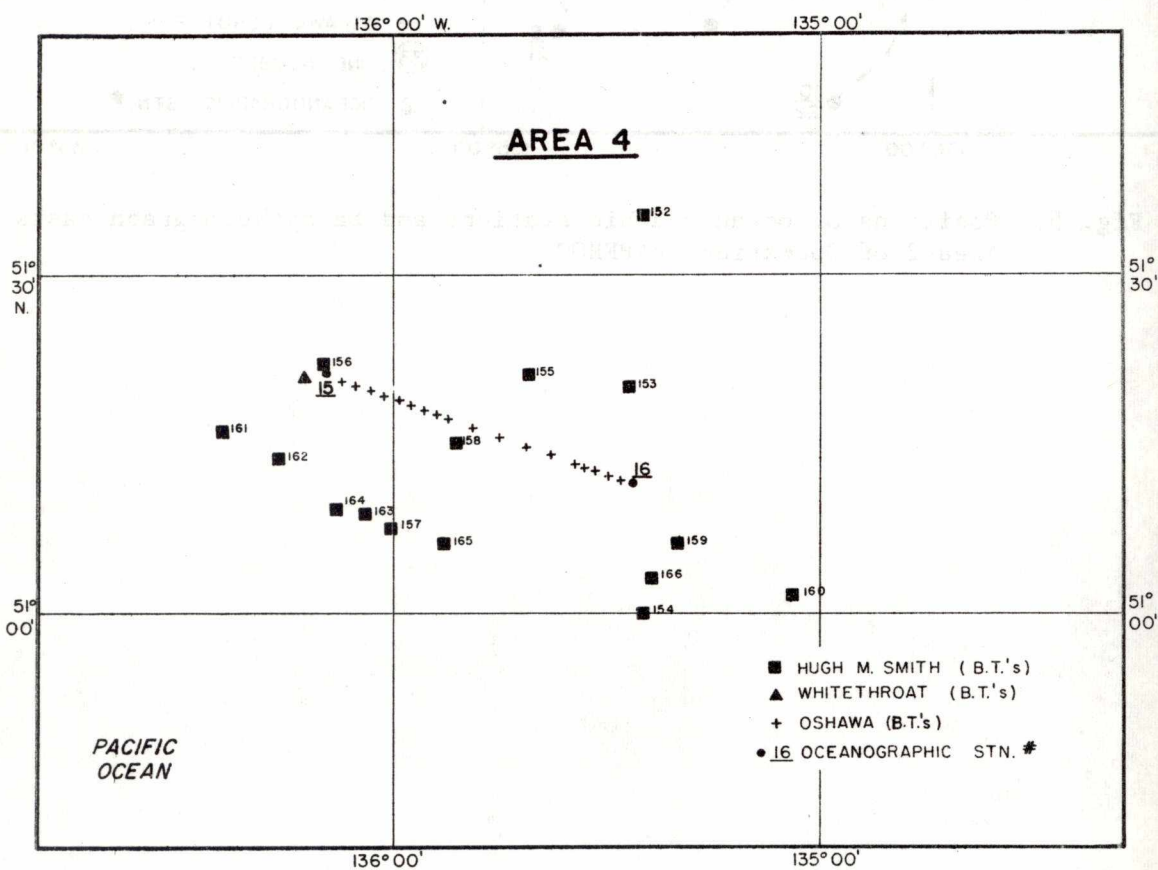
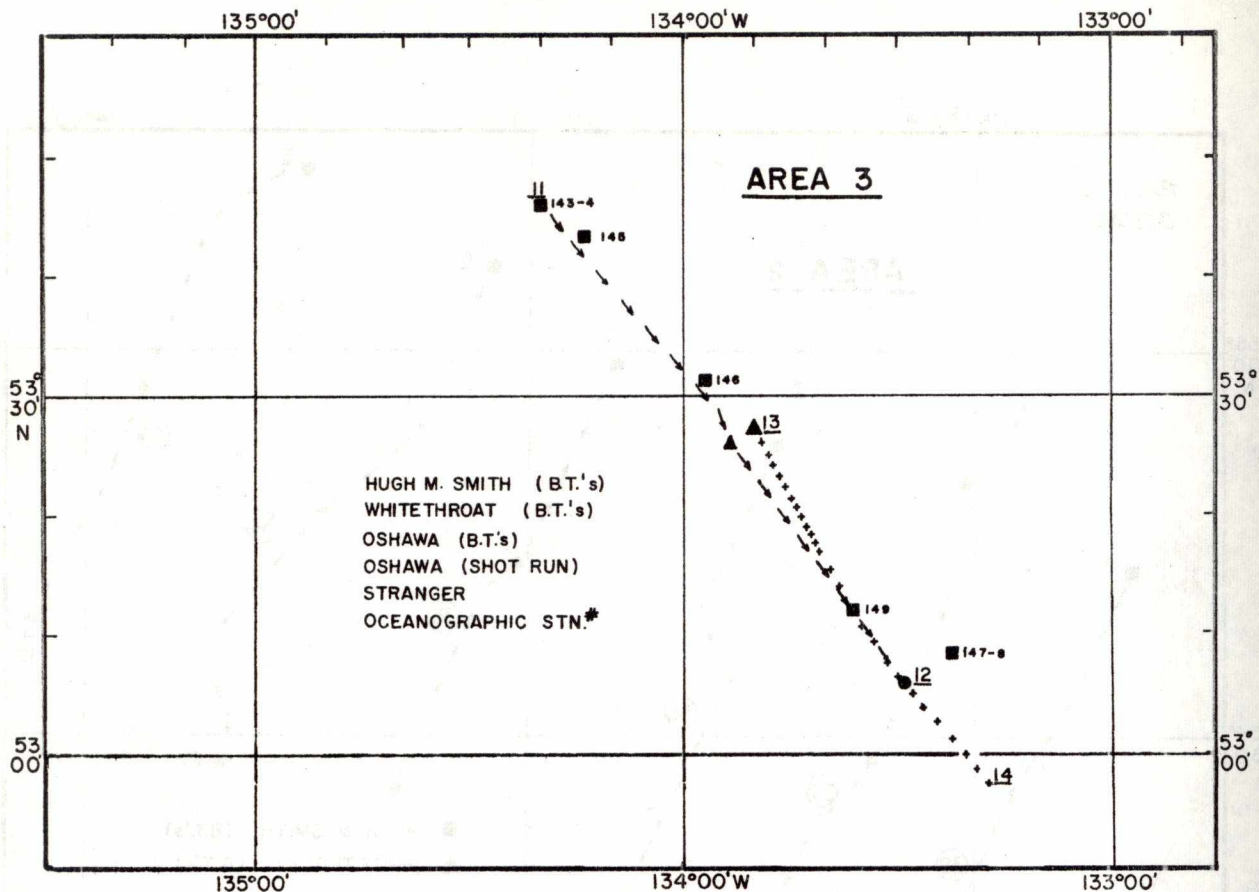


Fig. 6. Positions of oceanographic stations and bathythermograph casts in Areas 3 and 4 of Operation LEAPFROG.

Data record of oceanographic observations made in  
Pacific Naval Laboratory underwater sound studies, 1961

by

R.H. Herlinveaux

Introduction

The data in this report were obtained in conjunction with various specific studies carried out by the Pacific Naval Laboratory of the Defence Research Board. Two of these studies were joint operations with the U.S. Naval Electronics Laboratory and Scripps Institution of Oceanography, La Jolla. Three separate groups of data are presented, as listed in the table below, and the operation areas are shown in Fig. 1.

Operation Identification	Area	Survey Vessel	Survey Dates, 1961
Ice Pack	Canadian Arctic Archipelago (west of Ellef Rignes Island)	On the ice	Mar 27-May 12
Hydrophone	California Coast (east of San Clements Island)	C.N.A.V. "Oshawa"	July 26-Aug 13
Leapfrog	West coast of British Columbia and Alaska	C.N.A.V. "Oshawa" C.N.A.V. "Whitethroat" M.V. "Hugh M. Smith" R.V. "Stranger"	Aug 29-Sept 11

Program of observations and procedures

The program varied with each survey and was dependent on the extent of oceanographic data required. Oceanographic stations were observed to determine the general oceanographic conditions in the region being used for the studies. A large number of bathythermograph observations were made also. When a number of vessels were used in the studies (LEAPFROG), several maintained a position on a grid while one vessel steamed past the stationary vessels.

Observations of temperature, salinity and oxygen were made at the oceanographic stations. Bathythermograph casts to 275 metres were made from all vessels. A more detailed description of the program for each survey is presented in the introductory pages to the survey data record section.

## OPERATION ICE PACK

The survey team travelled over the ice to the observation locations, using special tractors and "wannigans". Holes were made in the ice using a boring auger and dynamite. The equipment was lowered and raised through the ice by a gasoline-powered winch. Four oceanographic stations were observed through the ice along a line extending 18 miles in the Prince Gustaf Adolf Sea. Stations 1 and 4 are at the same location.

### Oceanographic station procedure:

1. Serial observations were made at 0, 5, 10, 20, 30, 50, 75, 100, 125, 150, 175, 200, 250, 300 and 450 metres, depending on the depth of water. Three casts were made at each station, using 5 Fjarlie sampling bottles (Fjarlie, 1953) in each cast.

2. Temperatures were measured with one protected deep-sea reversing thermometer on each bottle. One unprotected thermometer was used on the two deepest bottles.

3. Salinity samples were drawn into 8-oz citrate bottles, and were returned to the Pacific Oceanographic Group for analysis.

4. Dissolved oxygen samples were analysed on the site with a specially designed analysis kit.

5. Three vertical plankton hauls were made at Station 1.

6. Current meter observations at 100 feet depth were made during a 24-hour period at the same dates as the plankton observations. The meter was an induced current type designed and built by H. Derricks of the Pacific Naval Laboratory.

Soundings of the bottom were taken every 1/3 mile along the 18 mile line, using a sounding line and lead.

### Methods of analyses:

The salinity analyses were made using a conductivity salinometer (Strickland, MS, 1958). The dissolved oxygen analyses were done by a modified Winkler method using a 60 ml aliquot (Strickland and Parsons, 1960).

### Bathythermograph observations:

A BT cast to 275 m was made at each serial station (except at Station 3) and in between stations when time permitted.

Plankton collections:

Vertical zooplankton hauls were made from 400 feet depth to the surface with a 6-inch diameter net of nylon mesh size 173 to the inch. The haul was made with a hand-operated winch.

Personnel

The field operations were directed by Mr. A.R. Milne, Pacific Naval Laboratory. Other personnel engaged in the survey operations were:

T. Hughes, J. O'Malia, C. Kelly (Pacific Naval Laboratory)  
R.H. Herlinveaux (Pacific Oceanographic Group)  
P. Langlebin (McGill University, Physics Department).

OPERATION HYDROPHONE

Eight oceanographic stations were observed along a line based on latitude  $33^{\circ} 05'N$ , between longitudes  $118^{\circ} 45'W$  and  $120^{\circ} 45'W$  (Fig. 2), for a period of 8 days (August 1-9, 1961).

Oceanographic station procedures:

1. Serial observations were made at intervals of 10, 20, 30, 50, 75, 100, 150, 200, 250, 300, 400, 500, 800, 1000 and 1500 metres in one cast, depending on the depth of water.

2. Surface samples (0 metres) for salinity analyses were obtained with a one-gallon metal bucket. The surface temperature was measured in this bucket sample with an armoured thermometer graduated in  $0.5^{\circ} C$  intervals.

3. Samples at depth were obtained with Nansen reversing water samplers. Samples for salinity analyses were drawn into 8-oz medicine bottles which were sealed with a wax-impregnated cork. This was further sealed by pouring melted paraffin wax over the top. The samples were returned to the base laboratory at the Pacific Oceanographic Group for analysis.

4. Temperatures at depth were measured by protected deep-sea reversing thermometers. Generally, one thermometer was used on each sampler except the three deepest samplers on which a pair of protected thermometers was used. The two deepest bottles were also equipped with one unprotected thermometer each.

Methods of analyses:

The salinity determinations were made, using a conductivity salinometer, according to the methods described by Strickland (MS, 1958). The dissolved oxygen analyses were done by a modified Winkler method (Strickland and Parsons, 1960).

### Bathythermograph observations:

A BT cast to 275 m was made soon after the completion of the oceanographic station observations, and occasionally between stations.

### Personnel

The scientist in charge of the sea operations was Dr. J. Scrimger, Pacific Naval Laboratory. Other personnel engaged in the work were:

J. Borsa, T. Culling, D. Street (Pacific Naval Laboratory)  
R.H. Herlinveaux (Pacific Oceanographic Group)

The survey ship was the C.N.A.V. "Oshawa" under the command of Mr. H. Rhodes. Members of the crew assisted in the oceanographic station procedures. Station positions were determined by the officers of the watch.

### OPERATION LEAPFROG

This was a joint operation by research groups from the United States (University of California, School of Science and Engineering, Scripps Institution of Oceanography and U.S. Naval Electronics Laboratory) and Canada (Pacific Naval Laboratory, Pacific Oceanographic Group).

A total of twenty-two oceanographic stations were observed in the four areas shown in Fig. 3. Numerous bathythermograph observations were taken from two American and two Canadian research vessels.

### Oceanographic station procedures:

1. Serial observations were made at intervals of 10, 20, 30, 50, 75, 100, 125, 150, 175, 200, 225, 300, 400, 500, 600, 800, 1000, 1200, 1500, 2000, 2500 and 3000 metres. In stations over 500 m depth, there were two casts, the first to 300 m.

2. Surface samples (0 metres) for salinity and dissolved oxygen analyses were obtained with a one-gallon bucket. The surface temperature was measured in this bucket sample with an armoured thermometer graduated in 0.5 C° intervals.

3. Samples at depth were obtained with Nansen reversing water samplers. From each sampler, the first aliquot was drawn into a 300 ml B.O.D. bottle for dissolved oxygen analyses. Then, a sample for salinity analysis was drawn into an 8-oz glass medicine bottle, sealed with a plastic-lined screw cap. Both analyses were done in the shipboard laboratory soon after the completion of the oceanographic cast.

4. Temperatures at depth were measured by protected deep-sea reversing thermometers. Generally, one thermometer was used on each sampler, but five pairs of protected thermometers were used at randomly spaced intervals on the deep stations. Six unprotected thermometers were used on the deep casts,

one on the 500 m sampler, and the others on the five deepest bottles.

5. Weather observations were made by the officers of the watch.

#### Methods of analyses:

The salinity determinations were made, using a conductivity salinometer, according to the methods described by Strickland (MS, 1958). The dissolved oxygen analyses were done by a modified Winkler method (Strickland and Parsons, 1960).

#### Bathythermograph observations:

A BT cast to 275 m was made soon after the completion of each oceanographic station. During acoustic ranging operations in all 4 areas (Figs. 4, 5, 6), BT observations were made by two ships which maintained a fixed position along a line, whilst the other ship (C.N.A.V. "Oshawa") steamed along the line taking BT casts at 15 or 30 minute intervals.

#### Personnel

In the American Group, Dr. G. Shor was the senior scientist in charge aboard the M.V. "Hugh M. Smith, a U.S. Fish and Wildlife Service vessel, and Mr. A. Jones was the scientist in charge on board the R.V. "Stranger", a Scripps Institution of Oceanography vessel. Dr. C. Maunsell (Pacific Naval Laboratory) was the senior scientist in charge of the Canadian group aboard C.N.A.V. "Whitethroat". Pacific Oceanographic Group personnel engaged in the oceanographic program on board the C.N.A.V. "Oshawa" were: R.H. Herlinveaux, J.H. Meikle and J. Lazier. The ship was under the command of Mr. H. Rhodes. C.N.A.V. "Whitethroat" was under the command of Mr. R. Hooper. Mr. K. Bottom of Scripps Institution of Oceanography was responsible for the oceanographic program on the R.V. "Stranger".

#### Description of the data record

This report presents tabulations of observed and interpolated data and resultant computations, and reproductions of bathythermograms. Computations based on the observed depth, temperature, and salinity were done by the ALWAC III-E digital computer at the Computing Centre of the University of British Columbia. Methods of computation used are described by Froese (MS, 1960). Interpolated values are obtained by means of a two-point logarithmic interpolation of the form:

$$X_s = X_1 + (X_2 - X_1) \left[ \log \left( \frac{z_s + 10}{z_1 + 10} \right) / \log \left( \frac{z_2 + 10}{z_1 + 10} \right) \right]$$

where:  $X_s$  is the interpolated value at standard depth  $Z_s$ , and  $X_1$ ,  $X_2$  are observed values at depths  $Z_1$ ,  $Z_2$  respectively. The observed depths are selected so that  $Z_2 > Z_s > Z_1$ .

The data for each of the three operations are presented as separate sections in the report. In each section the oceanographic station data appears first, the stations being arranged in a chronological order, and are numbered in a consecutive order, according to the positions shown on the track charts. The pages of bathythermograph data follow the station data pages.

#### Temperature data:

There was considerable variation between the procedures used in the three operations to record the readings from the deep-sea reversing thermometers. A classification system for temperature data has been designed to indicate the precision of the records. It is described as follows:

Class a: In a pair of thermometers,  $T_1$  (the mean of two readings of one of the thermometers) differs from  $T_2$  (the mean of two readings from the other thermometer) by less than or equal to  $0.035\text{ C}^\circ$ :

$$T_1 - T_2 \leq 0.035\text{ C}^\circ$$

Class b: In a pair of thermometers,  $T_1$  differs from  $T_2$  by more than  $0.035\text{ C}^\circ$  but less than or equal to  $0.065\text{ C}^\circ$ :

$$0.035\text{ C}^\circ < (T_1 - T_2) \leq 0.065\text{ C}^\circ$$

Class c: In a pair of thermometers,  $T_1$  differs from  $T_2$  by more than  $0.065\text{ C}^\circ$ :

$$T_1 - T_2 > 0.065\text{ C}^\circ$$

or the readings from one of the pair are rejected because of obvious malfunction; or only one protected reversing thermometer was used at that depth.

The classification indices are noted in the data record immediately following the depth tabulations. Where no indices are reported, the data are class c.

Surface (0m) temperatures are read to  $0.1\text{ C}^\circ$  but are reported to two decimal places to facilitate machine computation.

#### Salinity data:

Salinities are the mean of duplicate determinations. The correct value lies in the range of  $\pm 0.004\text{ ‰}$  at the 95% probability level (Strickland, MS, 1958). The salinity samples from the stations taken by the R.V. "Stranger" were analysed at the Pacific Oceanographic Group.

Dissolved oxygen data:

These are from a single determination. The correct value lies in the range of  $\pm 0.003$  mg-at/l (Strickland and Parsons, 1960).

Bathythermograms:

The BT traces have been drawn on standard pre-printed graphs resembling a BT calibration grid. The slides were positioned on the appropriate calibration grid in an adjustable holder, and displayed in a reflecting-type projector.

Different methods of aligning the traces on the grids were used for the observations from each operation. The BT slides obtained at oceanographic stations in Operations ICE PACK and HYDROPHONE were aligned on the grid to give the best possible fit with associated reversing thermometer temperatures at several depths. Traces from BT casts taken between oceanographic stations were positioned on the grid using a locked adjustment determined by the previous oceanographic station BT set-up. BT observations in Operation LEAPFROG were made from four ships. The BT slides taken by C.N.A.V. "Oshawa", the oceanographic survey vessel, were aligned in a manner identical to that for the previous mentioned operations. Those taken from the C.N.A.V. "Whitethroat" and the M.V. "Hugh M. Smith" were aligned on the calibration grids using observed surface temperatures. When a BT observation was made near an oceanographic station, the alignment of this trace was compared with the station temperature data to check for reliability. The BT slides taken by the R.V. "Stranger" were aligned on the grid using temperature data obtained from associated oceanographic stations. All the BT traces were aligned on the grids with the top of the trace on the zero depth grid line.

The bathythermograms are arranged in each operation's section in a chronological order. The observing ship is listed on the first page of each group. In the bathythermogram section for Operation LEAPFROG, the areas of operation are also recorded. The time/date group and oceanographic station number or position co-ordinates are noted below each bathythermogram. Time zones are the same as those for the oceanographic stations.

Plankton collection, Operation "ICE PACK":

The analysis of the samples was done by Mr. T.H. Butler, Biological Station, Nanaimo, B.C. The results are presented in the following table.

Station	Time/date	Species	No. in sample
1	1730T/4-v-61	copepod - <u>Calanus</u>	6
		postlarval gastropod	1
		detritus	
1	2400T/4-v-61	copepod - <u>Calanus</u>	3
		amphipod - <u>Gammarid</u>	2
		postlarval gastropod	1
		detritus	
1	0245/5-v-61	copepod - <u>Calanus</u>	17
		detritus	

Current meter observations, Operation ICE PACK:

The observations at Station 1, May 4 and 5, recorded no measurable current movement, and direction measurements were quite erratic because of the lack of water movement.

The following persons were engaged in the analysis of the data and preparation of the data record:

- R.H. Herlinveaux: summarizing data for computations.  
H.J. Hollister: supervision of computation work, and preparation and editing of data record.  
M.C. Cairns (Miss): preparation of data for computer, typing.  
J.H. Meikle: drawing bathythermograms, analysis of Operation LEAPFROG salinity samples.  
R.B. Tripp: analysis of Operation HYDROPHONE salinity samples.

This report was printed by the Queen's Printer, Esquimalt Unit, Department of Public Printing and Stationery.

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- MS, 1960. Programs for oceanographic computations and data processing on the electronic digital computer ALWAC III-E. DP-3, oceanographic station data program. Fish. Res. Bd. Canada, MS Rept., Oceanog. and Limnol. Series, No. 73, 38 pp.
- Strickland, J.D.H. MS, 1958. Standard methods of seawater analyses. Volume II. Fish. Res. Bd. Canada, MS Rept. Oceanogr. and Limnol., No. 19, 78 pp.
- Strickland, J.D.H., and T.R. Parsons. 1960. A manual of seawater analysis. Bull. Fish. Res. Bd. Canada, No. 125, 185 pp.

TABLE I NUMERICAL WEATHER CODES—PRESENT WEATHER

<b>00</b> Cloud development NOT observed or NOT observable during past hour.	<b>01</b> Clouds generally dissolving or becoming less developed during past hour.	<b>02</b> State of sky on the whole unchanged during past hour.	<b>03</b> Clouds generally forming or developing during past hour.	<b>04</b> Visibility reduced by smoke.	<b>05</b> Haze.	<b>06</b> Widespread dust in suspension in the air, NOT raised by wind, at time of observation.	<b>07</b> Dust or sand raised by wind, at time of observation.	<b>08</b> Well developed dust devil(s) within past hour.	<b>09</b> Duststorm or sandstorm within sight of or at station during past hour.
<b>10</b> Light fog.	<b>11</b> Patches of shallow fog at station, NOT deeper than 6 feet on land.	<b>12</b> More or less continuous shallow fog at station, NOT deeper than 6 feet on land.	<b>13</b> Lightning visible, no thunder heard.	<b>14</b> Precipitation within sight, but NOT reaching the ground.	<b>15</b> Precipitation within sight, reaching the ground, but distant from station.	<b>16</b> Precipitation within sight, reaching the ground, near to but NOT at station.	<b>17</b> Thunder heard, but no precipitation at the station.	<b>18</b> Squall(s) within sight during past hour.	<b>19</b> Funnel cloud(s) within sight during past hour.
<b>20</b> Drizzle (NOT freezing and NOT falling as showers) during past hour, but NOT at time of ob.	<b>21</b> Rain (NOT freezing and NOT falling as showers) during past hour, but NOT at time of ob.	<b>22</b> Snow (NOT falling as showers) during past hour, but NOT at time of observation.	<b>23</b> Rain and snow (NOT falling as showers) during past hour, but NOT at time of observation.	<b>24</b> Freezing drizzle or freezing rain (NOT falling as showers) during past hour, but NOT at time of observation.	<b>25</b> Showers of rain during past hour, but NOT at time of observation.	<b>26</b> Showers of snow, or of rain and snow, during past hour, but NOT at time of observation.	<b>27</b> Showers of hail, or of hail and rain, during past hour, but NOT at time of observation.	<b>28</b> Fog during past hour, but NOT at time of observation.	<b>29</b> Thunderstorm (with or without precipitation) during past hour, but NOT at time of observation.
<b>30</b> Slight or moderate duststorm or sandstorm has decreased during past hour.	<b>31</b> Slight or moderate duststorm or sandstorm no appreciable change during past hour.	<b>32</b> Slight or moderate duststorm or sandstorm has increased during past hour.	<b>33</b> Severe duststorm or sandstorm, has decreased during past hour.	<b>34</b> Severe duststorm or sandstorm, no appreciable change during past hour.	<b>35</b> Severe duststorm or sandstorm, has increased during past hour.	<b>36</b> Slight or moderate drifting snow, generally low.	<b>37</b> Heavy drifting snow, generally low.	<b>38</b> Slight or moderate drifting snow, generally high.	<b>39</b> Heavy drifting snow, generally high.
<b>40</b> Fog at distance at time of observation, but NOT at station during past hour.	<b>41</b> Fog in patches.	<b>42</b> Fog, sky discernible, has become thinner during past hour.	<b>43</b> Fog, sky NOT discernible, has become thinner during past hour.	<b>44</b> Fog, sky discernible, no appreciable change during past hour.	<b>45</b> Fog, sky NOT discernible, no appreciable change during past hour.	<b>46</b> Fog, sky discernible, has begun or become thicker during past hour.	<b>47</b> Fog, sky NOT discernible, has begun or become thicker during past hour.	<b>48</b> Fog, depositing rime, sky discernible.	<b>49</b> Fog, depositing rime, sky not discernible.
<b>50</b> Intermittent drizzle (NOT freezing) slight at time of observation.	<b>51</b> Continuous drizzle (NOT freezing) slight at time of observation.	<b>52</b> Intermittent drizzle (NOT freezing) moderate at time of ob.	<b>53</b> Continuous drizzle (NOT freezing), moderate at time of ob.	<b>54</b> Intermittent drizzle (NOT freezing), thick at time of observation.	<b>55</b> Continuous drizzle (NOT freezing), thick at time of observation.	<b>56</b> Slight freezing drizzle.	<b>57</b> Moderate or thick freezing drizzle.	<b>58</b> Drizzle and rain, slight.	<b>59</b> Drizzle and rain, moderate or heavy.
<b>60</b> Intermittent rain (NOT freezing), slight at time of observation.	<b>61</b> Continuous rain (NOT freezing), slight at time of observation.	<b>62</b> Intermittent rain (NOT freezing), moderate at time of ob.	<b>63</b> Continuous rain (NOT freezing), moderate at time of observation.	<b>64</b> Intermittent rain (NOT freezing), heavy at time of observation.	<b>65</b> Continuous rain (NOT freezing), heavy at time of observation.	<b>66</b> Slight freezing rain.	<b>67</b> Moderate or heavy freezing rain.	<b>68</b> Rain or drizzle and snow, slight.	<b>69</b> Rain or drizzle and snow, moderate or heavy.
<b>70</b> Intermittent fall of snowflakes, slight at time of observation.	<b>71</b> Continuous fall of snowflakes, slight at time of observation.	<b>72</b> Intermittent fall of snowflakes, moderate at time of observation.	<b>73</b> Continuous fall of snowflakes, moderate at time of observation.	<b>74</b> Intermittent fall of snowflakes, heavy at time of observation.	<b>75</b> Continuous fall of snowflakes, heavy at time of observation.	<b>76</b> Ice needles (with or without fog).	<b>77</b> Granular snow (with or without fog).	<b>78</b> Isolated starlike snow crystals (with or without fog).	<b>79</b> Ice pellets (sleet, U. S. definition).
<b>80</b> Slight rain shower(s).	<b>81</b> Moderate or heavy rain shower(s).	<b>82</b> Violent rain shower(s).	<b>83</b> Slight shower(s) of rain and snow mixed.	<b>84</b> Moderate or heavy shower(s) of rain and snow mixed.	<b>85</b> Slight snow shower(s).	<b>86</b> Moderate or heavy snow shower(s).	<b>87</b> Slight shower(s) of soft or small hail with or without rain or rain and snow mixed.	<b>88</b> Moderate or heavy shower(s) of soft or small hail with or without rain or rain and snow mixed.	<b>89</b> Slight shower(s) of hail, with or without rain or rain and snow mixed, not associated with thunder.
<b>90</b> Moderate or heavy shower(s) of hail, with or without rain or rain and snow mixed, not associated with thunder.	<b>91</b> Slight rain at time of ob.; thunderstorm during past hour, but NOT at time of observation.	<b>92</b> Moderate or heavy rain at time of ob.; thunderstorm during past hour, but NOT at time of observation.	<b>93</b> Slight snow or rain and snow mixed or hail at time of observation.; thunderstorm during past hour, but not at time of observations.	<b>94</b> Mod. or heavy snow, or rain and snow mixed or hail at time of ob.; thunderstorm during past hour, but NOT at time of observation.	<b>95</b> Slight or mod. thunderstorm without hail, but with rain and/or snow at time of observation.	<b>96</b> Slight or moderate thunderstorm, with hail at time of observation.	<b>97</b> Heavy thunderstorm, without hail, but with rain and/or snow at time of observation.	<b>98</b> Thunderstorm combined with duststorm or sandstorm at time of observation.	<b>99</b> Heavy thunderstorm with hail at time of observation.

Table I, cont'd

Meteorological Codes used in Data Record

HEIGHT OF SEA

Code	Mean Max. Height	Code	Mean Max. Height
0	< 1 foot	51	17.5 feet
1	1.5 feet	52	19 feet
2	3 feet	53	21 feet
3	5 feet	54	22.5 feet
4	6.5 feet	55	24 feet
5	8 feet	56	25.5 feet
6	9.5 feet	57	27 feet
7	11 feet	58	29 feet
8	13 feet	59	30.5 feet
9	14 feet	x	Height impossible to determine
50	16 feet		

SWELL CONDITIONS

Code	Approx. Height in feet	Description	Approx. Length in feet
0	0	No swell	0
1	1 - 6	Low swell Short or av'ge	0 - 600
2		Long	Above 600
3	6 - 12	Moderate Short	0 - 300
4		Average	300 - 600
5		Long	Above 600
6	Greater than 12	High Short	0 - 300
7		Average	300 - 600
8		Long	Above 600
9		Confused	

CLOUD TYPES

CLOUD COVER

Name	Code	Code	Fraction of sky covered	Code	Fraction of sky covered
Stratocumulus	Sc	0	Cloudless	6	3/4
Stratus	St	1	1/8 or less but not zero	7	7/8 or more, but not 8/8
Fractostratus	Fs	2	1/4	8	Completely overcast
Nimbostratus	Ns	3	3/8	9	Sky obscured by fog or other phenomenon
Cumulus	Cu	4	1/2		
Cumulonimbus	Cb	5	5/8		
Fractocumulus	Fc				
Altostratus	As				
Alto cumulus	Ac				
Cirrus	Ci				
Cirrocumulus	Cc				
Cirrostratus	Cs				

EXPLANATION OF DATA RECORD HEADINGS

Observed Data:

- Station: Indicates the chronological order in which the stations were observed.
- Time: The time when the messenger was released to trip the first cast. The time zone for ICE PACK records is G.M.T.; for HYDROPHONE and LEAPFROG it is P.D.T. (+7).
- Date: Day, month, year.
- Lat: Position of the ship during the period of observation, reported to the closest whole minute.
- Long:
- Sounding: Depth in fathoms obtained from EDO echo sounder (HYDROPHONE and LEAPFROG), and by wire in ICE PACK.
- Weather: Reported in code as described in Table I.
- Wind: Estimated true direction and speed in knots. The wind speed records from "Oshawa" are measured by an anemometer 60 feet above the sea surface.
- Air Temp: Temperatures (°F) obtained from instruments in an unventilated psychrometer mounted on the ship's bridge for Operations  
Dry, Wet: HYDROPHONE and LEAPFROG.
- Baro: Corrected reading of ship's barometer.
- Cloud: Type of predominating clouds reported in code described in  
Type, Amt. Table I, and sky coverage in eighths (Table I).
- Sea: Estimated true direction from which the sea and swell were  
Swell: coming, and height as described in Table I. (Wave height code is an adaption of Table XIX in Canadian ship code card, form 2361-1/1-55).
- Secchi Disc: Depth in metres at which a white metal disc 30 cm in diameter just disappears from sight.
- Depth: Depth in metres of the sampling bottle at the time of re-  
m. versal calculated from thermometric and wire angle information. The a, b, c postscripts are temperature classification indices, as described in the Procedures section.

<u>Temp:</u> °C	Temperatures from reversing thermometers read to 0.01°C. Values marked with an asterisk have been interpolated using two-point logarithmic interpolation on the ALWAC III-E computer. Values marked with a plus (+) sign have been interpolated graphically or read from the BT trace. Surface temperatures are reported to two decimal places to facilitate machine computations.
$\frac{S}{\text{‰}}$	Salinity as defined by $S = 0.03 + 1.805 Cl \text{ ‰}$ . Values marked with an asterisk have been interpolated on the ALWAC III-E computer, using two-point logarithmic interpolation.
$\sigma_t$	"Sigma-T". The specific gravity anomaly as defined by: (Specific gravity - 1) x 1000.
$\frac{S}{V}$ : ft/sec	Sound velocity calculated using Del Grosso's formula at atmospheric pressure with pressure terms based on Kuwahara's tables for sound velocity (Froese, MS, 1958; MS, 1960).
<u>D.O.:</u> mg.at/l	Dissolved oxygen content expressed as milligram-atoms per litre (000 filler indicates no determinations made). The data for Operation ICE PACK are recorded as ml/l x 10 <sup>-1</sup> .

Interpolated Data at Standard Depths:

<u>Depth:</u> m.	Standard depth in metres.
<u>Temp:</u> °C	Interpolated value.
$\frac{S}{\text{‰}}$	Interpolated value.
$\sigma_t$	Computed value of "Sigma-T", calculated from the interpolated values of temperature and salinity.
$\frac{S}{V}$ : ft/sec	Computed value from interpolated values of temperature and salinity.
<u>D.O.:</u> mg.at/l	Interpolated value (000 filler indicates no determinations made).
<u><math>\Delta D</math>:</u>	Anomaly of dynamic height, in dynamic metres, of the sea surface relative to the pressure surface at the indicated depth. The integration is carried out with respect to pressure rather than depth according to the formula $\Delta D = \int_0^p \delta dp, \text{ where } \delta \text{ is the specific volume anomaly and } p \text{ is pressure.}$

P.E.:

Potential energy anomaly in units of  $10^8$  ergs/cm<sup>2</sup>. The potential energy anomaly  $X$  is defined by  $1/g \int_0^p \delta dp$ , where  $g$  is gravity,  $\delta$  specific volume anomaly, and  $p$  pressure. The geostrophic transport, in millions of metric tons per second, between two stations, relative to a pressure surface  $p_0$ , is given by  $(X_2(p_0) - X_1(p_0)) / 10^4 f$ , where  $f$  is the Coriolis parameter in radians per second.

Pot. Temp:  
°C

Potential temperature at standard depths calculated from the interpolated values of temperature and salinity and the pressure at the indicated standard depth (Froese, MS, 1960).



Pacific Naval Laboratory Surveys

OPERATION ICE PACK

April 9 to May 6, 1961

Oceanographic Station Data

and

Bathythermograms



## STATION 1

TIME: 2210 DATE: 13-iv-61 LAT: 78° 28' N. LONG: 105° 16' W. SOUNDING: 261 fms.  
 WEATHER: 00 WIND: Dir. 180° Speed 1 AIR TEMP: Dry-9 °C Wet ° BARO: . mb.  
 LOUD: Type Amt. SEA: °- SWELL: °- SECHI DISC: m.

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O.
0000	-01.64*	31.891*	25.67	4714.5	.826*
0005	-01.72	31.829	25.63	4713.2	.822
0010	-01.78	31.785	25.59	4712.4	.819
0020	-01.78	31.787	25.59	4713.0	.837
0030	-01.75	31.833	25.63	4714.2	.818
0050	-01.45	32.499	26.16	4722.9	.675
0075	-01.41	32.591	26.24	4725.4	.632*
0100	-01.33	33.137	26.68	4730.4	.601
0125	-01.00	33.694	27.12	4739.4	.601
0150	-00.70	34.157	27.48	4747.4	.590
0175	-00.42	34.518	27.76	4754.7	.617
0206	-00.27	34.640	27.85	4759.3	.650
0256	00.02	34.787	27.95	4767.3	.607
0306	00.14	34.803	27.96	4772.2	.595
0456	00.20	34.337	27.58	4780.1	.649

N.B. Dissolved oxygen data are recorded as ml/l x 10<sup>-1</sup>.

## INTERPOLATED DATA

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O.	$\Delta D$	P.E.	Pot.Temp. °C
0000	-01.64	31.891	25.67	4714.5	.826	00.000	000.00	-01.63
0010	-01.78	31.785	25.59	4712.4	.819	00.024	000.01	-01.78
0020	-01.78	31.787	25.59	4713.0	.837	00.048	000.05	-01.78
0030	-01.75	31.833	25.63	4714.2	.818	00.072	000.11	-01.75
0050	-01.45	32.499	26.16	4722.9	.675	00.115	000.28	-01.45
0075	-01.41	32.591	26.24	4725.4	.632	00.160	000.57	-01.41
0100	-01.33	33.137	26.68	4730.4	.601	00.200	000.92	-01.33
0125	-01.00	33.694	27.12	4739.4	.601	00.229	001.25	-01.00
0150	-00.70	34.157	27.48	4747.4	.590	00.249	001.53	-00.70
0175	-00.42	34.518	27.76	4754.7	.617	00.261	001.72	-00.43
0200	-00.30	34.618	27.83	4758.5	.644	00.269	001.87	-00.30
0250	-00.01	34.771	27.94	4766.4	.612	00.280	002.13	-00.02
0300	00.13	34.801	27.96	4771.6	.596	00.288	002.36	00.12
0400	00.18	34.491	27.71	4777.1	.631	00.316	003.43	00.16

## STATION 2

TIME: 2043 DATE: 25-iv-61 LAT: 78° 47' N. LONG: 105° 31' W. SOUNDING: 163 fms.  
 WEATHER: 00 WIND: Dir. 180° Speed 3 AIR TEMP: Dry 3 °C Wet ° BARO: . mb.  
 CLOUD: Type Amt. SEA: ° SWELL: ° SECCHI DISC: m.

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O.
0000	-01.68*	31.891*	25.68	4713.8	.990
0005	-01.75	31.883	25.67	4713.0	.990
0010	-01.80	31.877	25.67	4712.5	.865
0020	-01.78	31.877	25.67	4713.4	.825
0030	-01.75	31.877	25.66	4714.4	.841
0050	-01.57	32.227	25.94	4719.9	.745
0075	-01.34	32.757	26.37	4727.2	.657
0100	-01.20	33.259	26.77	4733.0	.613
0125	-00.94	33.821	27.22	4740.8	.595
0150	-00.59	34.230	27.53	4749.4	.606
0175	-00.43	34.403	27.67	4754.1	.622*
0200	-00.20	34.540	27.77	4759.6	.636
0250	00.04	34.750	27.92	4767.1	.618
0300	00.09	34.800 +	27.96	4771.1	.603*

## INTERPOLATED DATA

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O.	$\Delta D$	P.E.	Pot. Temp. °C
0000	-01.68	31.891	25.68	4713.8	.990	00.000	000.00	-01.68
0010	-01.80	31.877	25.67	4712.5	.865	00.023	000.01	-01.80
0020	-01.78	31.877	25.67	4713.4	.825	00.047	000.05	-01.78
0030	-01.75	31.877	25.66	4714.4	.841	00.070	000.11	-01.75
0050	-01.57	32.227	25.94	4719.9	.745	00.115	000.29	-01.57
0075	-01.34	32.757	26.37	4727.2	.657	00.162	000.58	-01.34
0100	-01.20	33.259	26.77	4733.0	.613	00.199	000.91	-01.20
0125	-00.94	33.821	27.22	4740.8	.595	00.226	001.21	-00.94
0150	-00.59	34.230	27.53	4749.4	.606	00.243	001.46	-00.59
0175	-00.43	34.403	27.67	4754.1	.622	00.256	001.66	-00.44
0200	-00.20	34.540	27.77	4759.6	.636	00.265	001.85	-00.21
0250	00.04	34.750	27.92	4767.1	.618	00.279	002.15	00.03
0300	00.09	34.800	27.96	4771.1	.603	00.288	002.40	00.08

## STATION 3

TIME: 0239 DATE: 30-iv-61 LAT: 78° 35' N. LONG: 105° 28' W. SOUNDING: 220 fms.  
 WEATHER: 00 WIND: Dir. 000° Speed 3 AIR TEMP: Dry-18°C Wet ° BARO: . mb.  
 CLOUD: Type Amt. SEA: ° SWELL: ° SECCHI DISC: m.

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O.
0000	-01.63*	31.712*	25.53	4713.9	.876*
0005	-01.71	31.709	25.53	4712.9	.852
0010	-01.77	31.707	25.53	4712.2	.835
0020	-01.77	31.712	25.53	4712.8	.844
0030	-01.75	31.715	25.53	4713.8	.829
0050	-01.57	32.203	25.93	4719.8	.755
0075	-01.38	32.876	26.47	4727.1	.625
0100	-01.32	33.359	26.86	4731.5	.590
0125	-01.02	33.915	27.30	4740.0	.632
0150	-00.63	34.230	27.53	4748.8	.639
0175	-00.37	34.400	27.66	4755.0	.605
0204	-00.35	34.544	27.78	4757.6	.620
0261	00.08	34.713	27.89	4768.2	.630
0318	00.12	34.792	27.95	4772.5	.632
0425	00.17	34.909*	28.04	4780.1	.635*

## INTERPOLATED DATA

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O.	$\Delta D$	P.E.	Pot. Temp. °C
0000	-01.63	31.712	25.53	4713.9	.876	00.000	000.00	-01.62
0010	-01.77	31.707	25.53	4712.2	.835	00.025	000.01	-01.77
0020	-01.77	31.712	25.53	4712.8	.844	00.050	000.05	-01.77
0030	-01.75	31.715	25.53	4713.8	.829	00.074	000.11	-01.75
0050	-01.57	32.203	25.93	4719.8	.755	00.120	000.30	-01.57
0075	-01.38	32.876	26.47	4727.1	.625	00.166	000.59	-01.38
0100	-01.32	33.359	26.86	4731.5	.590	00.201	000.89	-01.32
0125	-01.02	33.915	27.30	4740.0	.632	00.226	001.17	-01.02
0150	-00.63	34.230	27.53	4748.8	.639	00.243	001.41	-00.63
0175	-00.37	34.400	27.66	4755.0	.605	00.255	001.61	-00.38
0200	-00.35	34.525	27.76	4757.3	.618	00.265	001.80	-00.36
0250	00.00	34.683	27.87	4766.3	.628	00.280	002.13	-00.00
0300	00.11	34.769	27.93	4771.2	.631	00.290	002.43	00.10
0400	00.16	34.884	28.02	4778.4	.634	00.304	002.92	00.14

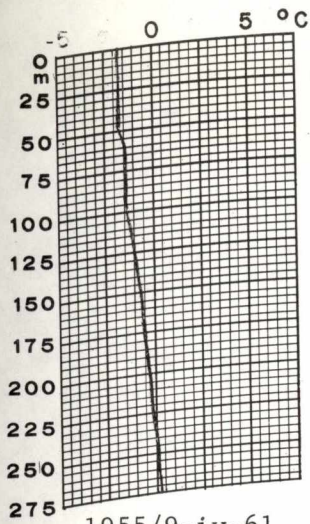
## STATION 4

TIME: 2112 DATE: 3-v-61 LAT: 78° 28' N. LONG: 105° 16' W. SOUNDING: 261 fms.  
 WEATHER: 01 WIND: Dir. 045° Speed 4 AIR TEMP: Dry 2°C Wet ° BARO: . mb.  
 CLOUD: Type Cs Amt. 7 SEA: °- SWELL: °- SECCHI DISC: m.

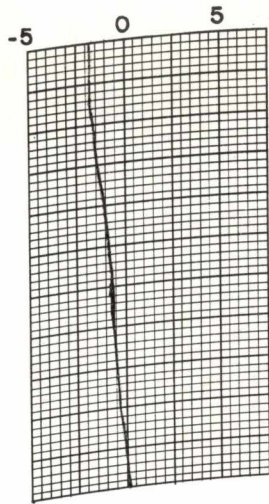
Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O.
0000	-01.60	32.121	25.86	4716.1	.827
0005	-01.72	31.789	25.59	4713.1	.826
0010	-01.75	31.788	25.59	4712.9	.844
0020	-01.75 +	31.788	25.59	4713.5	.827
0030	-01.76	31.947	25.72	4714.6	.810
0050	-01.57	32.287	25.99	4720.2	.756
0075	-01.32	32.731	26.35	4727.4	.678*
0100	-01.13	33.247	26.76	4734.0	.621*
0125	-00.90	33.768	27.17	4741.2	.575
0150	-00.71	34.144	27.47	4747.2	.575
0175	-00.51	34.343	27.62	4752.6	.591
0206	-00.25	34.510	27.74	4759.1	.619
0258	00.09	34.715	27.89	4768.2	.602
0310	00.27	34.831	27.98	4774.5	.621
0462	00.30	34.926	28.05	4784.4	.614

## INTERPOLATED DATA

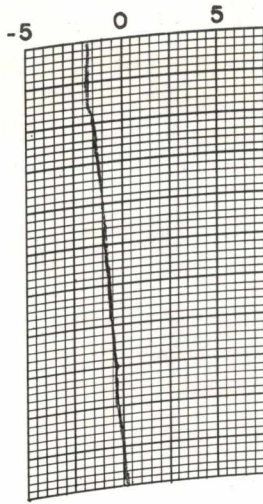
Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O.	$\Delta D$	P.E.	Pot. Temp. °C
0000	-01.60	32.121	25.86	4716.1	.827	00.000	000.00	-01.60
0010	-01.75	31.788	25.59	4712.9	.844	00.023	000.01	-01.75
0020	-01.75	31.788	25.59	4713.5	.827	00.047	000.05	-01.75
0030	-01.76	31.947	25.72	4714.6	.810	00.071	000.11	-01.76
0050	-01.57	32.287	25.99	4720.2	.756	00.114	000.28	-01.57
0075	-01.32	32.731	26.35	4727.4	.678	00.161	000.58	-01.32
0100	-01.13	33.247	26.76	4734.0	.621	00.198	000.91	-01.13
0125	-00.90	33.768	27.17	4741.2	.575	00.225	001.22	-00.90
0150	-00.71	34.144	27.47	4747.2	.575	00.245	001.49	-00.71
0175	-00.51	34.343	27.62	4752.6	.591	00.258	001.71	-00.51
0200	-00.30	34.480	27.72	4757.9	.614	00.269	001.92	-00.30
0250	00.04	34.686	27.87	4766.9	.604	00.285	002.27	00.03
0300	00.24	34.810	27.96	4773.3	.618	00.295	002.55	00.23
0400	00.29	34.892	28.02	4780.4	.617	00.308	003.00	00.27



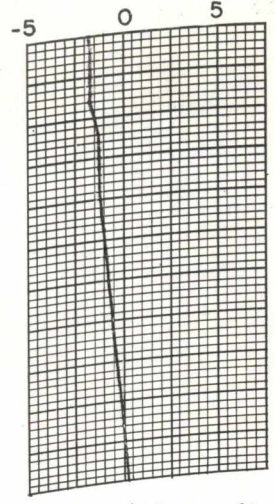
1955/9-iv-61  
Station 1



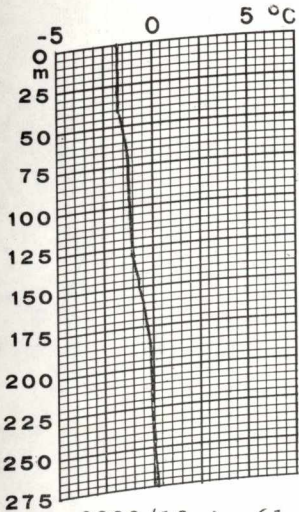
0112/14-iv-61  
Station 2



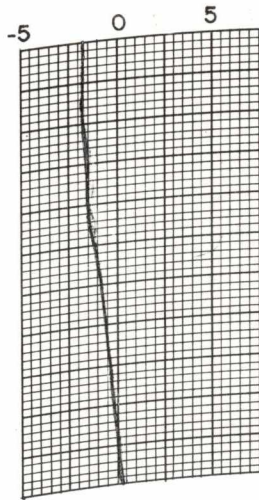
1830/17-iv-61  
78° 30'n  
105° 26'w



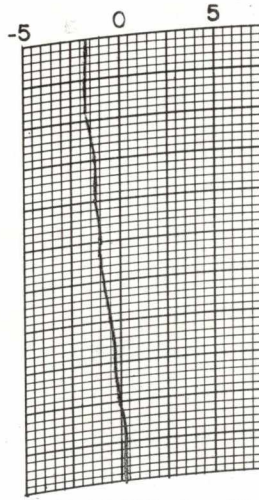
2200/18-iv-61  
78° 32'n  
105° 30'w



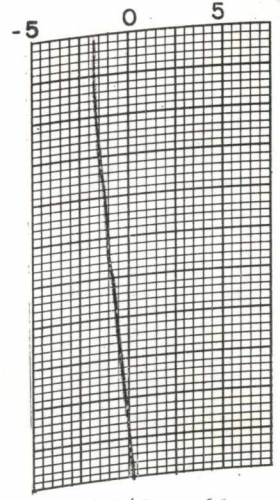
2200/19-iv-61  
78° 34'n  
105° 25'w



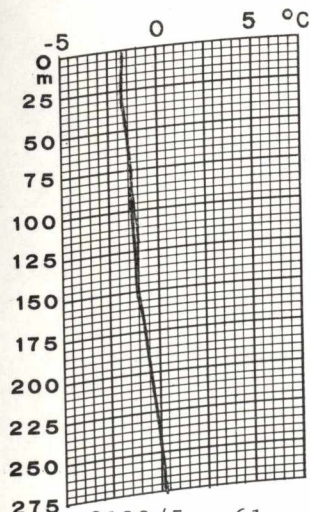
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Station 2



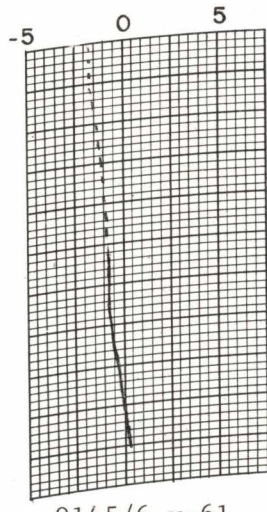
2015/28-iv-61  
78° 42'n  
105° 26'w



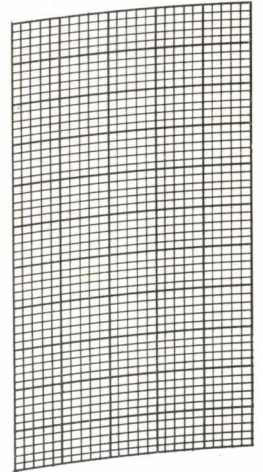
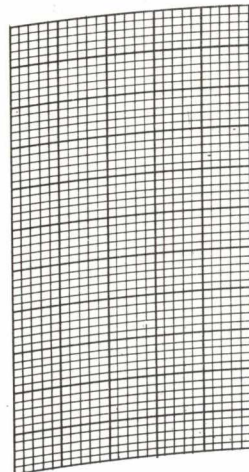
2245/3-v-61  
Station 4



2100/5-v-61  
Station 4



0145/6-v-61  
Station 4





Pacific Naval Laboratory Surveys

OPERATION HYDROPHONE

August 1 to 9, 1961

Oceanographic Station Data

and

Bathythermograms



STATION 1

TIME: 1938 DATE: 1-viii-61 LAT: 32° 56' N. LONG: 120° 44' W. SOUNDING: 2029 fms.  
 WEATHER: 03 WIND: Dir. 330° Speed 18 AIR TEMP: Dry ° Wet ° BARO: , mb.  
 CLOUD: Type Sc Amt. 8 SEA: °-0 SWELL: °-0 SECCHI DISC: m.

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/1
0000	16.80	33.709	24.59	4957.9	.525
0010	16.70	33.699	24.61	4957.4	.523
0020	16.50	33.699	24.65	4956.0	.525
0030	15.39	33.796	24.98	4945.5	.530
0050	12.08	33.811	25.67	4910.6	.382
0075	10.86	33.719	25.82	4897.7	.459
0100	09.49	33.929	26.22	4883.6	.232
0150	08.85	34.028	26.40	4879.1	.188
0200	07.71	34.028	26.57	4867.8	.202
0250	07.61	34.128	26.67	4869.9	.242
0300	06.82	34.115	26.77	4862.7	.185
0400	06.80	34.275	26.90	4869.0	.122
0500	06.18	34.416	27.09	4867.4	.076

## INTERPOLATED DATA

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/1	$\Delta D$	P.E.	Pot. Temp. °C
0000	16.80	33.709	24.59	4957.9	.525	00.000	000.00	16.80
0010	16.70	33.699	24.61	4957.4	.523	00.034	000.02	16.70
0020	16.50	33.699	24.65	4956.0	.525	00.067	000.07	16.50
0030	15.39	33.796	24.98	4945.5	.530	00.099	000.15	15.39
0050	12.08	33.811	25.67	4910.6	.382	00.153	000.36	12.07
0075	10.86	33.719	25.82	4897.7	.459	00.210	000.73	10.85
0100	09.49	33.929	26.22	4883.6	.232	00.261	001.18	09.48
0125	09.14	33.983	26.32	4881.0	.208	00.305	001.69	09.13
0150	08.85	34.028	26.40	4879.1	.188	00.348	002.30	08.83
0175	08.24	34.028	26.50	4873.0	.195	00.389	002.98	08.22
0200	07.71	34.028	26.57	4867.8	.202	00.428	003.72	07.69
0250	07.61	34.128	26.67	4869.9	.242	00.502	005.42	07.59
0300	06.82	34.115	26.77	4862.7	.185	00.571	007.38	06.79
0400	06.80	34.275	26.90	4869.0	.122	00.700	011.99	06.76
0500	06.18	34.416	27.09	4867.4	.076	00.815	017.26	06.13

## STATION 2

TIME: 0205 DATE: 5-viii-61 LAT: 33° 11' N. LONG: 118° 47' W. SOUNDING: 447 fms.  
 WEATHER: 02 WIND: Dir. 270° Speed 2 AIR TEMP: Dry 64° Wet 63° BARO: 1018. mb.  
 CLOUD: Type Sc Amt. 8 SEA: °-0 SWELL: °-0 SECCHI DISC: m.

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/l
0000	18.90	33.576	23.98	4978.0	.000
0010	17.51	33.550	24.30	4965.0	.000
0020	15.63	33.486	24.69	4946.3	.000
0030	13.83	33.456	25.05	4927.6	.000
0050	11.63	33.537	25.54	4904.5	.000
0100	10.19	33.805	26.01	4891.5	.000
0150	09.26	33.962	26.28	4883.9	.000
0200	08.73	34.075	26.46	4880.8	.000
0250	08.20	34.153	26.60	4877.4	.000
0300	08.10	34.279	26.71	4879.6	.000
0400	07.18	34.292	26.86	4873.9	.000
0600	05.82	34.359	27.09	4868.3	.000

## INTERPOLATED DATA

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/l	$\Delta D$	P.E.	Pot. Temp. °C
0000	18.90	33.576	23.98	4978.0	.000	00.000	000.00	18.90
0010	17.51	33.550	24.30	4965.0	.000	00.038	000.02	17.51
0020	15.63	33.486	24.69	4946.3	.000	00.073	000.07	15.63
0030	13.83	33.456	25.05	4927.6	.000	00.104	000.15	13.83
0050	11.63	33.537	25.54	4904.5	.000	00.158	000.37	11.62
0075	10.80	33.691	25.81	4896.9	.000	00.217	000.74	10.79
0100	10.19	33.805	26.01	4891.5	.000	00.271	001.22	10.18
0125	09.68	33.891	26.16	4887.3	.000	00.320	001.79	09.67
0150	09.26	33.962	26.28	4883.9	.000	00.366	002.44	09.24
0175	08.98	34.022	26.38	4882.1	.000	00.410	003.16	08.96
0200	08.73	34.075	26.46	4880.8	.000	00.452	003.97	08.71
0250	08.20	34.153	26.60	4877.4	.000	00.530	005.77	08.17
0300	08.10	34.279	26.71	4879.6	.000	00.603	007.82	08.07
0400	07.18	34.292	26.86	4873.9	.000	00.737	012.60	07.14
0500	06.43	34.329	26.99	4870.3	.000	00.858	018.21	06.39
0600	05.82	34.359	27.09	4868.3	.000	00.970	024.50	05.77

## STATION 3

TIME: 0535 DATE: 5-viii-61 LAT: 33° 05' N. LONG: 119° 04' W. SOUNDING: fms.  
 WEATHER: 00 WIND: Dir. 270° Speed 2 AIR TEMP: Dry 64° Wet 63° BARO: 1017.5 mb.  
 CLOUD: Type Amt. SEA: °-0 SWELL: °-0 SECCHI DISC: m.

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/l
0000	18.20	33.555	24.14	4971.2	.000
0010	17.93	33.541	24.19	4969.1	.000
0020	17.55	33.534	24.28	4965.9	.000
0029	14.15	33.409	24.95	4930.9	.000
0049	11.84	33.510	25.48	4906.7	.000
0073	10.54	33.614	25.80	4893.4	.000
0098	09.81	33.740	26.02	4886.6	.000
0147	08.60	33.934	26.37	4875.5	.000
0195	08.54	34.091	26.50	4878.2	.000
0244	08.04	34.164	26.63	4875.1	.000
0283	07.64	34.199	26.72	4872.5	.000
0488	06.63	34.315	26.95	4872.1	.000
0782	05.01	34.415	27.23	4868.5	.000
0979	04.26	34.468	27.36	4870.2	.000
1468	03.75	34.511	27.44	4892.3	.000
1500	03.72*	34.513*	27.45	4893.8	.000

## INTERPOLATED DATA

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/l	$\Delta D$	P.E.	Pot. Temp. °C
0000	18.20	33.555	24.14	4971.2	.000	00.000	000.00	18.20
0010	17.93	33.541	24.19	4969.1	.000	00.038	000.02	17.93
0020	17.55	33.534	24.28	4965.9	.000	00.075	000.08	17.55
0030	14.01	33.415	24.98	4929.4	.000	00.109	000.16	14.00
0050	11.78	33.515	25.50	4906.1	.000	00.164	000.38	11.77
0075	10.47	33.625	25.82	4892.8	.000	00.223	000.76	10.47
0100	09.75	33.750	26.04	4886.1	.000	00.276	001.23	09.74
0125	09.09	33.856	26.23	4879.9	.000	00.324	001.78	09.08
0150	08.60	33.945	26.38	4875.6	.000	00.369	002.41	08.58
0175	08.56	34.031	26.45	4877.0	.000	00.410	003.10	08.54
0200	08.48	34.099	26.51	4877.8	.000	00.450	003.87	08.46
0250	07.97	34.170	26.65	4874.7	.000	00.526	005.62	07.95
0300	07.53	34.211	26.74	4872.2	.000	00.597	007.61	07.50
0400	07.00	34.272	26.87	4871.6	.000	00.729	012.33	06.96
0500	06.55	34.320	26.97	4871.8	.000	00.851	017.97	06.50
0600	05.92	34.359	27.08	4869.7	.000	00.965	024.35	05.87
0700	05.39	34.391	27.17	4868.7	.000	01.069	031.30	05.33
0800	04.93	34.420	27.25	4868.6	.000	01.166	038.75	04.87
1000	04.23	34.470	27.36	4871.1	.000	01.342	054.97	04.15
1200	04.00	34.490	27.40	4879.9	.000	01.505	073.45	03.91
1500	03.72	34.513	27.45	4893.8	.000	01.743	106.40	03.60

STATION 4

TIME: 1634 DATE: 5-viii-61 LAT: 33° 06' N. LONG: 119° 20' W. SOUNDING: 800 fms.  
 WEATHER: 00 WIND: Dir. 270° Speed 7 AIR TEMP: Dry ° Wet ° BARO: 1017. mb.  
 CLOUD: Type Sc Amt. 3 SEA: °-0 SWELL: 270°-1 SECCHI DISC: m.

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/1
0000	18.80	33.868	24.23	4978.0	.000
0010	16.99	33.807	24.62	4960.7	.000
0020	15.44	33.816	24.98	4945.5	.000
0030	13.65	33.797	25.35	4926.9	.000
0050	10.48	33.825	25.97	4892.1	.000
0100	09.21	33.955	26.29	4880.3	.000
0150	08.64	34.057	26.46	4876.6	.000
0200	08.26	34.137	26.58	4875.2	.000
0250	07.89	34.198	26.68	4873.7	.000
0300	07.77	34.283	26.77	4875.5	.000
0500	06.47	34.358	27.01	4870.9	.000
0700	05.39	34.388	27.17	4868.7	.000
1000	04.19	34.476	27.37	4870.5	.000

## INTERPOLATED DATA

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/1	$\Delta D$	P.E.	Pot. Temp. °C
0000	18.80	33.868	24.23	4978.0	.000	00.000	000.00	18.80
0010	16.99	33.807	24.62	4960.7	.000	00.035	000.02	16.99
0020	15.44	33.816	24.98	4945.5	.000	00.067	000.07	15.44
0030	13.65	33.797	25.35	4926.9	.000	00.096	000.14	13.65
0050	10.48	33.825	25.97	4892.1	.000	00.143	000.33	10.47
0075	09.75	33.900	26.16	4885.1	.000	00.192	000.64	09.74
0100	09.21	33.955	26.29	4880.3	.000	00.238	001.05	09.20
0125	08.90	34.011	26.38	4878.2	.000	00.282	001.55	08.89
0150	08.64	34.057	26.46	4876.6	.000	00.323	002.13	08.62
0175	08.44	34.100	26.52	4875.7	.000	00.363	002.80	08.42
0200	08.26	34.137	26.58	4875.2	.000	00.401	003.54	08.24
0250	07.89	34.198	26.68	4873.7	.000	00.475	005.23	07.86
0300	07.77	34.283	26.77	4875.5	.000	00.544	007.19	07.74
0400	07.04	34.325	26.90	4872.3	.000	00.673	011.80	07.00
0500	06.47	34.358	27.01	4870.9	.000	00.792	017.28	06.42
0600	05.89	34.374	27.09	4869.3	.000	00.903	023.51	05.83
0700	05.39	34.388	27.17	4868.7	.000	01.006	030.42	05.33
0800	04.94	34.421	27.24	4868.7	.000	01.103	037.88	04.87
1000	04.19	34.476	27.37	4870.5	.000	01.279	054.00	04.11

## STATION 5

TIME: 2305 DATE: 5-viii-61 LAT: 33° 05' N. LONG: 118° 29' W. SOUNDING: 661 fms.  
 WEATHER: 01 WIND: Dir. 270° Speed 10 AIR TEMP: Dry 67° Wet 65° BARO: 1017. mb.  
 CLOUD: Type Amt. SEA: °- SWELL: °- SECCHI DISC: m.

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/1
0000	20.30	33.739	23.74	4991.6	.000
0010	20.26	33.720	23.74	4991.8	.000
0020	17.14	33.675	24.49	4962.4	.000
0030	13.93	33.578	25.12	4929.2	.000
0050	12.23	33.597	25.48	4911.6	.000
0100	09.89	33.805	26.06	4888.0	.000
0150	09.09	33.998	26.34	4881.9	.000
0200	08.86	34.165	26.51	4882.7	.000
0250	08.66	34.340	26.68	4883.9	.000
0300	08.08	34.281	26.72	4879.4	.000
0500	06.55	34.333	26.98	4871.9	.000
0700	05.34	34.393	27.18	4868.0	.000
1000	04.26	34.491	27.38	4871.5	.000

## INTERPOLATED DATA

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/1	$\Delta D$	P.E.	Pot.Temp. °C
0000	20.30	33.739	23.74	4991.6	.000	00.000	000.00	20.30
0010	20.26	33.720	23.74	4991.8	.000	00.042	000.02	20.26
0020	17.14	33.675	24.49	4962.4	.000	00.080	000.08	17.14
0030	13.93	33.578	25.12	4929.2	.000	00.112	000.16	13.93
0050	12.23	33.597	25.48	4911.6	.000	00.166	000.38	12.22
0075	10.89	33.717	25.82	4898.0	.000	00.226	000.76	10.88
0100	09.89	33.805	26.06	4888.0	.000	00.279	001.23	09.88
0125	09.45	33.910	26.21	4884.6	.000	00.327	001.78	09.44
0150	09.09	33.998	26.34	4881.9	.000	00.372	002.41	09.07
0175	08.97	34.087	26.43	4882.3	.000	00.414	003.12	08.95
0200	08.86	34.165	26.51	4882.7	.000	00.455	003.90	08.84
0250	08.66	34.340	26.68	4883.9	.000	00.530	005.63	08.63
0300	08.08	34.281	26.72	4879.4	.000	00.601	007.63	08.05
0400	07.22	34.310	26.87	4874.5	.000	00.734	012.39	07.18
0500	06.55	34.333	26.98	4871.9	.000	00.856	018.02	06.50
0600	05.90	34.365	27.09	4869.4	.000	00.969	024.35	05.84
0700	05.34	34.393	27.18	4868.0	.000	01.072	031.25	05.28
0800	04.94	34.430	27.25	4868.6	.000	01.168	038.64	04.87
1000	04.26	34.491	27.38	4871.5	.000	01.343	054.68	04.18

## STATION 6

TIME: 2320 DATE: 8-viii-61 LAT: 33° 08' N. LONG: 118° 42' W. SOUNDING: 320 fms.  
 WEATHER: 05 WIND: Dir. 295° Speed 8 AIR TEMP: Dry 63° Wet 62° BARO: 1013. mb.  
 CLOUD: Type Amt. SEA: 295°-1 SWELL: 295°-2 SECCHI DISC: m.

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/l
0000	20.00	33.747	23.83	4988.9	.000
0010	19.75	33.735	23.88	4987.1	.000
0020	15.73	33.511	24.68	4947.4	.000
0030	14.05	33.460	25.01	4930.0	.000
0050	12.68	33.480	25.30	4916.2	.000
0075	11.23	33.578	25.65	4901.5	.000
0100	10.03	33.700	25.95	4889.2	.000
0150	09.12	33.938	26.29	4882.1	.000
0200	08.54	34.092	26.50	4878.5	.000
0250	08.23	34.163	26.60	4877.8	.000
0300	08.11	34.244	26.68	4879.6	.000
0400	07.16	34.305	26.87	4873.7	.000
0500	06.38	34.322	26.99	4869.6	.000

## INTERPOLATED DATA

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/l	$\Delta D$	P.E.	Pot.Temp. °C
0000	20.00	33.747	23.83	4988.9	.000	00.000	000.00	20.00
0010	19.75	33.735	23.88	4987.1	.000	00.041	000.02	19.75
0020	15.73	33.511	24.68	4947.4	.000	00.078	000.08	15.73
0030	14.05	33.460	25.01	4930.0	.000	00.109	000.16	14.05
0050	12.68	33.480	25.30	4916.2	.000	00.166	000.39	12.67
0075	11.23	33.578	25.65	4901.5	.000	00.230	000.79	11.22
0100	10.03	33.700	25.95	4889.2	.000	00.286	001.29	10.02
0125	09.53	33.830	26.14	4885.2	.000	00.336	001.87	09.52
0150	09.12	33.938	26.29	4882.1	.000	00.383	002.52	09.10
0175	08.81	34.020	26.40	4880.1	.000	00.426	003.24	08.79
0200	08.54	34.092	26.50	4878.5	.000	00.467	004.03	08.52
0250	08.23	34.163	26.60	4877.8	.000	00.544	005.81	08.20
0300	08.11	34.244	26.68	4879.6	.000	00.617	007.87	08.08
0400	07.16	34.305	26.87	4873.7	.000	00.752	012.68	07.12
0500	06.38	34.322	26.99	4869.6	.000	00.873	018.25	06.33

## STATION 7

TIME: 0353 DATE: 9-viii-61 LAT: 33° 08' N. LONG: 119° 39' W. SOUNDING: 265 fms.  
 WEATHER: 05 WIND: Dir. 275° Speed 12 AIR TEMP: Dry ° Wet ° BARO: 1011. mb.  
 CLOUD: Type Amt. SEA: 295°-1 SWELL: 295°-2 SECCHI DISC: m.

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/l
0000	18.10	33.674	24.25	4970.6	.000
0010	18.30	33.657	24.19	4973.1	.000
0020	17.89	33.708	24.33	4969.9	.000
0030	13.55	33.775	25.35	4925.7	.000
0050	10.68	33.831	25.94	4894.5	.000
0075	09.74	33.887	26.15	4885.0	.000
0099	09.21	33.944	26.28	4880.2	.000
0149	08.65	34.070	26.47	4876.7	.000
0188	08.25	34.134	26.58	4874.3	.000
0248	07.88	34.190	26.68	4873.4	.000
0297	07.70	34.237	26.74	4874.2	.000
0396	06.80	34.317	26.93	4868.9	.000
0400	06.77*	34.320*	26.94	4868.7	.000

## INTERPOLATED DATA

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/l	$\Delta D$	P.E.	Pot.Temp. °C
0000	18.10	33.674	24.25	4970.6	.000	00.000	000.00	18.10
0010	18.30	33.657	24.19	4973.1	.000	00.037	000.02	18.30
0020	17.89	33.708	24.33	4969.9	.000	00.074	000.08	17.89
0030	13.55	33.775	25.35	4925.7	.000	00.106	000.15	13.55
0050	10.68	33.831	25.94	4894.5	.000	00.153	000.34	10.67
0075	09.74	33.887	26.15	4885.0	.000	00.203	000.66	09.73
0100	09.20	33.947	26.28	4880.1	.000	00.249	001.07	09.19
0125	08.89	34.015	26.39	4878.1	.000	00.293	001.57	08.88
0150	08.64	34.072	26.47	4876.7	.000	00.334	002.15	08.62
0175	08.37	34.114	26.54	4875.0	.000	00.373	002.81	08.36
0200	08.17	34.146	26.60	4874.0	.000	00.411	003.54	08.15
0250	07.87	34.192	26.68	4873.5	.000	00.484	005.22	07.85
0300	07.67	34.240	26.75	4874.0	.000	00.554	007.19	07.64
0400	06.77	34.320	26.94	4868.7	.000	00.683	011.77	06.73

## STATION 8

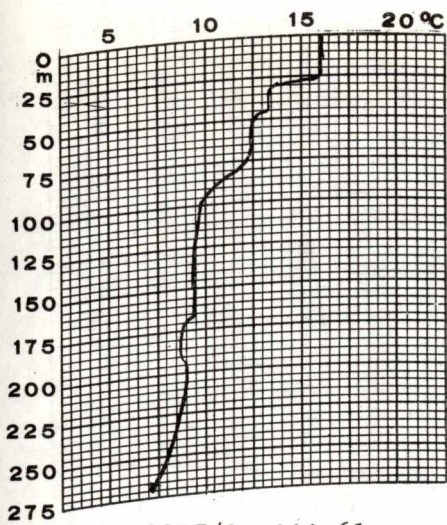
TIME: 1532 DATE: 9-viii-61 LAT: 33° 00' N. LONG: 120° 35' W. SOUNDING: 2014 fms.  
 WEATHER: 02 WIND: Dir. 280° Speed 5 AIR TEMP: Dry 61° Wet 61° BARO: 1016. mb.  
 CLOUD: Type Sc Amt. 8 SEA: 270°-1 SWELL: 270°-1 SECCHI DISC: m.

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/l
0000	17.20	33.686	24.48	4961.8	.000
0010	16.97	33.671	24.52	4960.0	.000
0020	16.81	33.664	24.55	4959.0	.000
0030	16.44	33.749	24.71	4956.2	.000
0049	14.26	33.768	25.20	4934.5	.000
0074	10.83	33.723	25.83	4897.3	.000
0078	09.79	33.875	26.13	4885.7	.000
0148	08.69	34.033	26.43	4877.0	.000
0197	08.22	34.115	26.57	4874.4	.000
0246	07.60	34.135	26.67	4869.6	.000
0295	06.65	34.085	26.77	4860.1	.000
0493	06.16	34.321	27.02	4866.3	.000
0784	04.65	34.407	27.27	4863.7	.000
0800	04.58*	34.411*	27.28	4863.8	.000

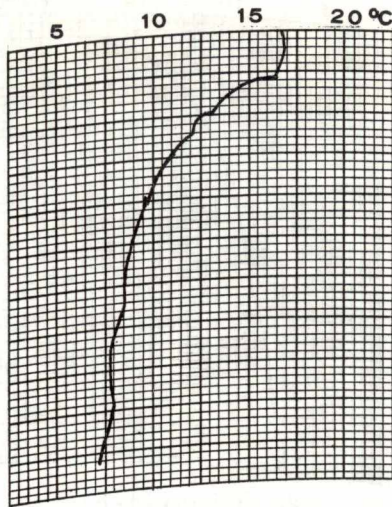
## INTERPOLATED DATA

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/l	$\Delta D$	P.E.	Pot.Temp. °C
0000	17.20	33.686	24.48	4961.8	.000	00.000	000.00	17.20
0010	16.97	33.671	24.52	4960.0	.000	00.035	000.02	16.97
0020	16.81	33.664	24.55	4959.0	.000	00.069	000.07	16.81
0030	16.44	33.749	24.71	4956.2	.000	00.103	000.16	16.44
0050	14.10	33.766	25.23	4932.8	.000	00.163	000.40	14.09
0075	10.57	33.762	25.91	4894.4	.000	00.225	000.78	10.56
0100	09.37	33.935	26.25	4882.2	.000	00.274	001.22	09.36
0125	08.99	33.991	26.35	4879.1	.000	00.318	001.73	08.97
0150	08.67	34.037	26.44	4876.9	.000	00.360	002.32	08.65
0175	08.42	34.081	26.51	4875.4	.000	00.400	002.99	08.40
0200	08.18	34.116	26.57	4874.1	.000	00.439	003.74	08.16
0250	07.52	34.131	26.68	4868.7	.000	00.512	005.43	07.49
0300	06.63	34.093	26.78	4860.2	.000	00.581	007.37	06.61
0400	06.36	34.225	26.92	4863.1	.000	00.709	011.92	06.32
0500	06.11	34.324	27.03	4866.1	.000	00.826	017.30	06.07
0600	05.52	34.357	27.13	4864.4	.000	00.933	023.37	05.47
0700	05.02	34.386	27.21	4863.7	.000	01.033	030.00	04.96
0800	04.58	34.411	27.28	4863.8	.000	01.126	037.15	04.52

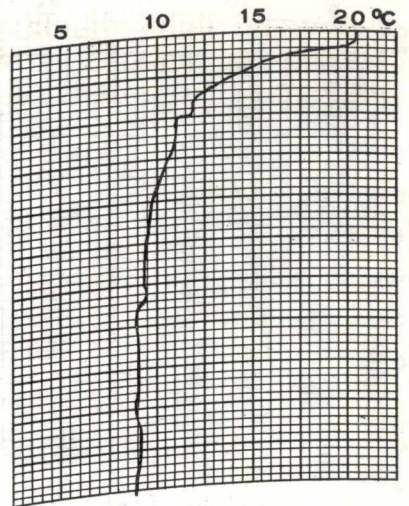
C.N.A.V. "Oshawa"



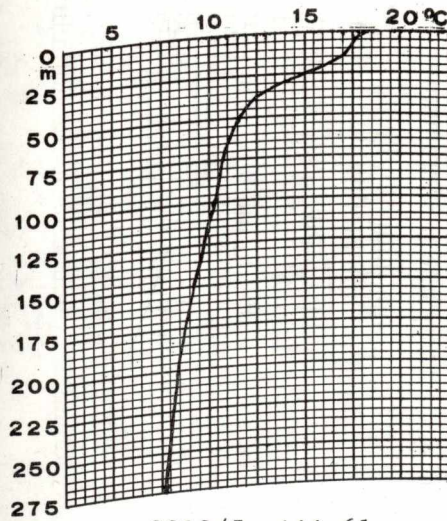
0815/1-viii-61  
Station 1



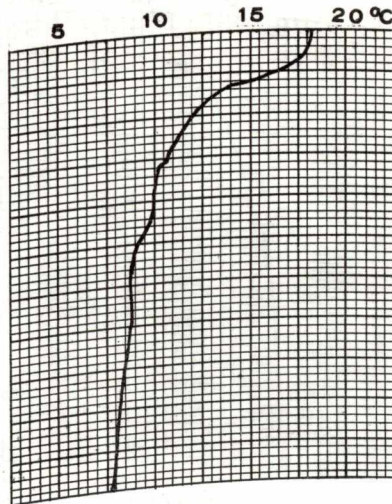
2000/1-viii-61  
Station 1



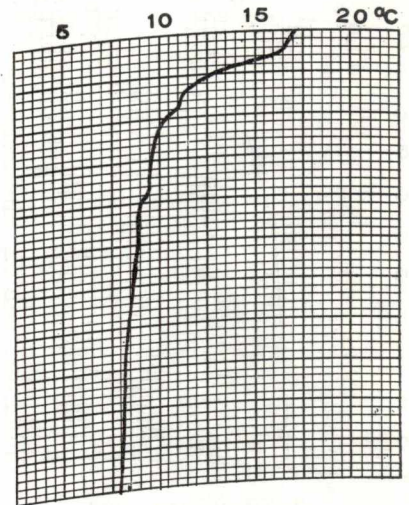
1035/3-viii-61  
33° 33'n  
118° 34'w



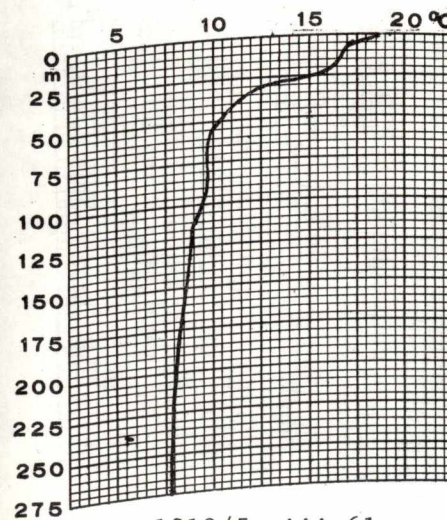
0212/5-viii-61  
Station 2



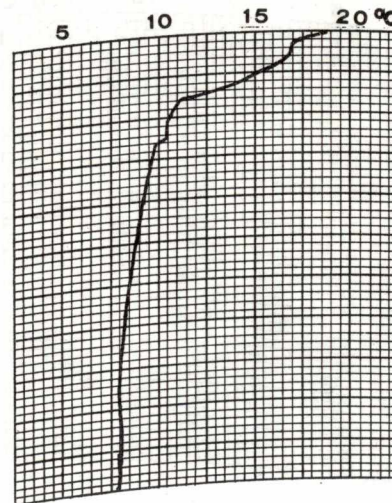
0615/5-viii-61  
Station 3



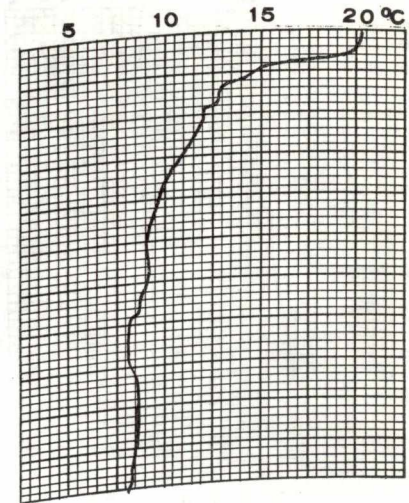
1100/5-viii-61  
33° 05'n  
119° 17'w



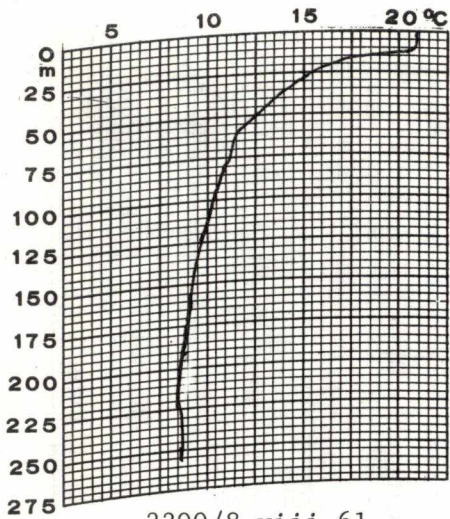
1312/5-viii-61  
33° 05'n  
119° 17'w



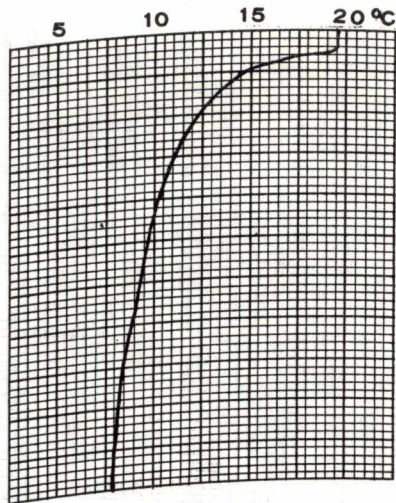
1605/5-viii-61  
Station 4



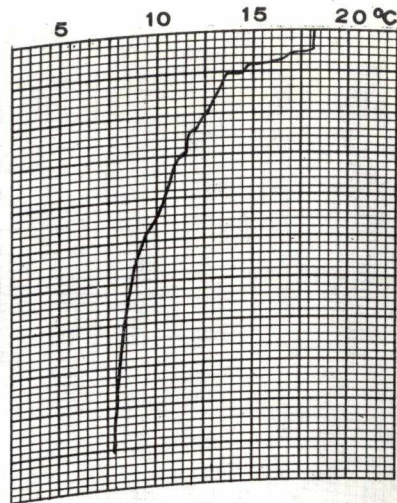
2345/5-viii-61  
Station 5



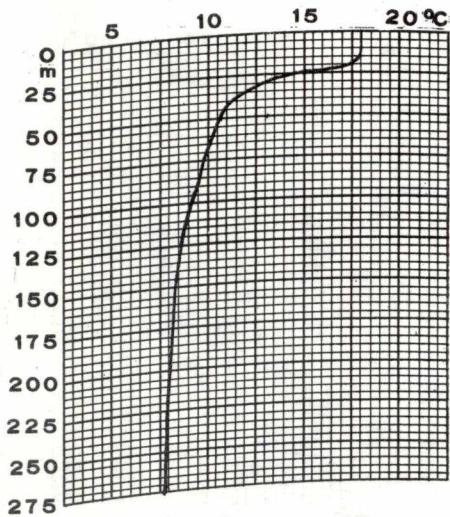
2200/8-viii-61  
33° 06'n  
118° 29'w



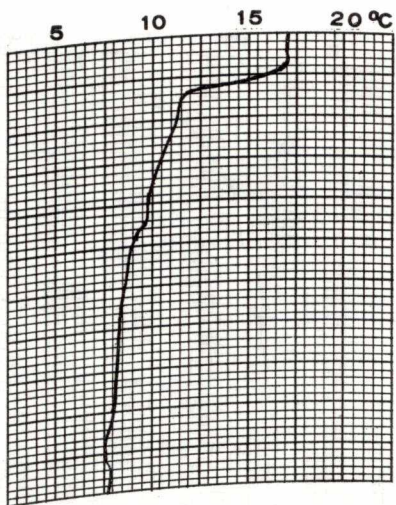
2345/8-viii-61  
Station 6



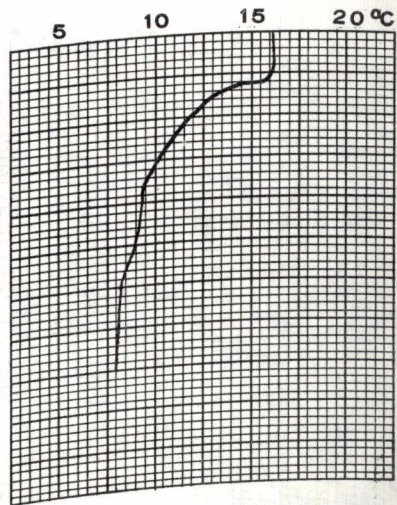
0117/8-viii-61  
33° 08'n  
119° 06'w



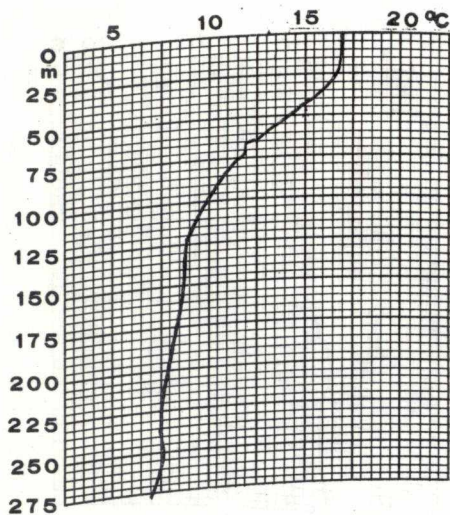
0410/9-viii-61  
Station 7



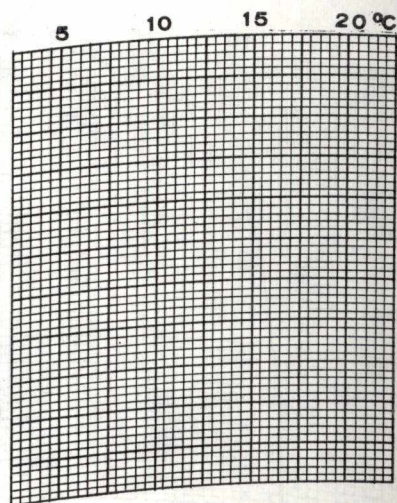
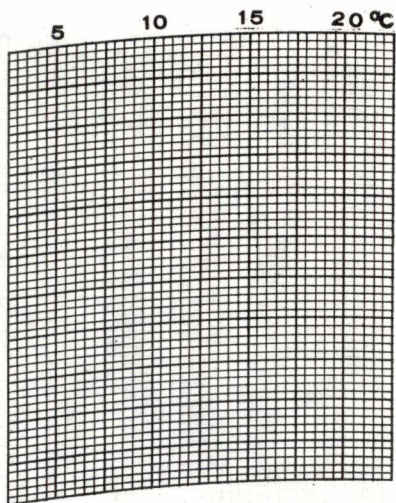
0530/9-viii-61  
33° 05'n  
120° 00'w



0630/9-viii-61  
33° 02'n  
120° 05'w



1553/9-viii-61  
Station 8



Pacific Naval Laboratory Surveys

OPERATION LEAPFROG

August 29 to September 12, 1961

Oceanographic Station Data

and

Bathythermograms



## STATION 1

TIME: 1312 DATE: 2-ix-61 LAT: 54° 20' N. LONG: 131° 34' W. SOUNDING: 96 fms.  
 WEATHER: 63 WIND: Dir. 160° Speed 20 AIR TEMP: Dry 55° Wet 54° BARO: 1017. mb.  
 CLOUD: Type Amt. 8 SEA: 280°-1 SWELL: 280°-2 SECCHI DISC: m.

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/l
0000	11.30	31.041	23.67	4888.5	.518
0010	11.03	31.048	23.72	4885.9	.521
0020	10.84	31.222	23.89	4884.9	.498
0030	10.61	31.631	24.25	4884.3	.507
0050	09.96	32.082	24.71	4879.4	.458
0075	07.52	32.264	25.22	4851.2	.323
0100	06.64	32.818	25.77	4843.5	.271
0125	06.21	33.054	26.01	4840.2	.243
0160	05.89	33.291	26.24	4839.0	.226

## INTERPOLATED DATA

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/l	$\Delta D$	P.E.	Pot.Temp. °C
0000	11.30	31.041	23.67	4888.5	.518	00.000	000.00	11.30
0010	11.03	31.048	23.72	4885.9	.521	00.042	000.02	11.03
0020	10.84	31.222	23.89	4884.9	.498	00.084	000.08	10.84
0030	10.61	31.631	24.25	4884.3	.507	00.123	000.18	10.61
0050	09.96	32.082	24.71	4879.4	.458	00.193	000.47	09.95
0075	07.52	32.264	25.22	4851.2	.323	00.269	000.95	07.51
0100	06.64	32.818	25.77	4843.5	.271	00.332	001.51	06.63
0125	06.21	33.054	26.01	4840.2	.243	00.385	002.12	06.20
0150	05.97	33.229	26.18	4839.3	.230	00.434	002.81	05.96

## STATION 2

TIME: 1550 DATE: 3-ix-61 LAT: 54° 13' N. LONG: 131° 48' W. SOUNDING: 73 fms.  
 WEATHER: 02 WIND: Dir. 250° Speed 2 AIR TEMP: Dry 57° Wet 56° BARO: 1017. mb.  
 CLOUD: Type Sc Amt. 7 SEA: °-0 SWELL: 270°-2 SECCHI DISC: m.

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/l
0000	12.30	31.196	23.61	4900.6	.539
0010	11.47	31.570	24.05	4893.0	.431
0020	11.14	31.746	24.24	4890.4	.461
0030	10.85	31.924	24.43	4888.2	.501
0050	09.88	32.171	24.79	4878.7	.459
0075	09.16	32.291	25.00	4871.9	.408
0100	08.65	32.318	25.10	4867.2	.392
0124	07.20	32.719	25.62	4851.8	.308
0125	07.15*	32.734*	25.64	4851.2	.305*

## INTERPOLATED DATA

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/l	$\Delta D$	P.E.	Pot.Temp. °C
0000	12.30	31.196	23.61	4900.6	.539	00.000	000.00	12.30
0010	11.47	31.570	24.05	4893.0	.431	00.041	000.02	11.47
0020	11.14	31.746	24.24	4890.4	.461	00.079	000.08	11.14
0030	10.85	31.924	24.43	4888.2	.501	00.116	000.17	10.85
0050	09.88	32.171	24.79	4878.7	.459	00.183	000.44	09.87
0075	09.16	32.291	25.00	4871.9	.408	00.261	000.94	09.15
0100	08.65	32.318	25.10	4867.2	.392	00.335	001.60	08.64
0125	07.15	32.734	25.64	4851.2	.305	00.401	002.36	07.13

## STATION 3

TIME: 1900 DATE: 3-ix-61 LAT: 54° 13' N. LONG: 132° 15' W. SOUNDING: 82 fms.  
 WEATHER: 02 WIND: Dir. 250° Speed 10 AIR TEMP: Dry 57° Wet 56° BARO: 1017. mb.  
 CLOUD: Type Amt. 8 SEA: °-0 SWELL: 270°-2 SECCHI DISC: m.

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/1
0000	13.50	31.179	23.36	4914.0	.543
0010	12.42	31.808	24.06	4904.8	.546
0019	10.00	31.671	24.38	4876.5	.483
0029	09.68	31.700	24.45	4873.3	.425
0048	09.99	32.208	24.80	4880.1	.453
0072	08.82	32.385	25.12	4867.9	.400
0097	07.55	32.676	25.54	4854.5	.344
0121	06.23	33.141	26.08	4840.6	.262
0125	06.03*	33.210*	26.16	4838.5	.250*

## INTERPOLATED DATA

Depth m.	Temp. °C	S ‰	$\sigma_t$	S/V ft/sec	D.O. mg.at/1	$\Delta D$	P.E.	Pot. Temp. °C
0000	13.50	31.179	23.36	4914.0	.543	00.000	000.00	13.50
0010	12.42	31.808	24.06	4904.8	.546	00.042	000.02	12.42
0020	09.96	31.674	24.39	4876.1	.476	00.080	000.08	09.96
0030	09.70	31.732	24.48	4873.7	.427	00.115	000.17	09.70
0050	09.88	32.225	24.83	4878.9	.448	00.182	000.44	09.87
0075	08.65	32.424	25.18	4866.1	.392	00.256	000.91	08.64
0100	07.37	32.740	25.61	4852.6	.333	00.322	001.50	07.36
0125	06.03	33.210	26.16	4838.5	.250	00.376	002.11	06.02