THE ECOLOGY OF SOME TIDEPOOLS OF THE AVALON PENINSULA, NEWFOUNDLAND

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THE ECOLOGY OF SOME TIDEPOOLS OF THE AVALON PENINSULA, NEWFOUNDLAND

by

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ABSTRACT

The relationships between plants, animals and physical factors of the tidepool environment were examined. Seasonal and diurnal observations were made in six tidepools, three of which were located on an extremely exposed coast and three on a moderately exposed coast.

Pools located on moderately exposed coasts were subject to less extreme wave exposure. The decrease in wave exposure was positively correlated with the number of species found in pools. However, larger numbers of fewer species were often found in pools on highly exposed coasts.

Elevation of pools above sea level was also correlated with a reduction in the number of species and stratification in pools. Temperature, salinity and oxygen stratification were frequently found in pools of high elevation.

Variations in tidepool physical factors were found. Over a 12 hour period the tidal cycle caused variations in temperature pH and Oxygen content of the pool water.

Faunal and floral species were subject to extreme pool conditions resulting in seasonal and daily fluctuations in number or coverage in a tidepool. Plants of spring flora and animals whose population increased due to breeding cycles were observed in the tidepools.

Biomass of tidepools was found to be highest in pools of the mid-littoral. Thus, pools which can provide moderated conditions of exposure and submergence are most likely to produce greatest biomass.

ACKNOWLEDGEMENTS

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INTRODUCTION

General introduction to littoral zone, tidepools and tidal cycles.

Tidepools are littoral bodies of water which are under the influence of tidal cycles. Tidepools may be exposed to the force of ocean waves or may be influenced by seaspray or saltwater runoff. The tidepools studied here are under the influence of marine semi-diurnal tidal fluctuations and are also rockpools, since their substrate is rock.

This thesis will quantitatively describe the flora and fauna of tidepools and relate these findings to physical and chemical observations.

Recent research on tidepools has been centered in the United Kingdom where Round (1959), Pyefinch (1943), and Naylor (1958) have quantitatively analyzed the biological aspects of tidepools and Scandinavian countries where similar research has been published by Wulff (1971), and Ganning (1966, '69, '70, '71). Ganning's research has been the most comprehensive to date and has dealt with the physical and biological aspects of tidepools quantitatively. Studies have also been completed in Japan, Russia and Canada by Utinomi (1950), Zhyubrikas (1968) and Green (1971) respectively.

Specific tidepool studies have not previously been carried out in Newfoundland although the intertidal biota has been studied by South (1970), Evans (1970), and others.

Lewis (1964) has distinguished between the littoral and intertidal zones. The littoral zone represents the biological entity and the intertidal zone represents the physical entity.

The intertidal zone can be described as that part of the coastline which is under the influence of submersion and emersion from the marine environment due to tidal fluctuations. Zones within the intertidal area are defined by the fluctuations of tides. Depending on the tidal cycle of an area the number of zones can vary greatly. Many authors have defined only a low, mean and high tide level while others such as Doty (1946) in his discussion of the California and Oregon coast has defined three groups of low, mean and high tide levels.

The littoral zone can be described as that part of the coastline which is affedted by the ocean. Within the littoral zone organisms which are under the influence of the sea are found. In the zone, above which submersion and emersion affect the organisms, are found those organisms whose only contact with the sea is by spray or runoff. These organisms live in the supra-littoral zone. The lowest part of the littoral zone is the infra-littoral zone where organisms are submerged except for rare occasions. The flora and fauna are situated within the littoral according to their individual critical tide levels. The critical tide level of a species can be defined as that level above or below which the species could not survive.

Tidal Cycles and their Effects on Pools

The tidepools discussed in this thesis are under the influence of the semi-diurnal tidal cycles of the North Atlantic, which bring spring and neap tides to the coast bimonthly. The influence of spring and neap tides affects physical factors such as O_2, salinity, and temperature of the tidepool water depending upon pool height. Tidepools in Newfoundland are restricted to a narrow belt within the littoral, due to the relatively small mean tidal range (84.33 cms - Can. Tide and Current Tables 1971, 1972) and the steep cliffs of which much of the coastline consists.

General Characteristics of Tidepool Flora and Fauna

Tidepools which are found in a particular area may vary in their biotic content due to their particular characteristics. Wave exposed and sheltered shores also vary in their biotic content. Differences also occur in rockpools of different size as large pools are able to support more permanent ecosystems and therefore tend to contain resident species forms, at the expense of other less permanent species. Small pools which frequently become hypersaline or dry out, or in other words are subject to relatively greater extremes, tend to contain smaller numbers of species (Unpublished observations). Another factor which must be considered is the elevation of the pools, as this also has an effect on physical conditions and biotic content.

As has been shown by Ganning and Wulff (1970), the primary production of Swedish rockpools during the summer is equal to that of high productivity tropical environments. Ganning (1971) has also shown two basic types of food webs that are to be found in Swedish rockpools. A food web can be dependent on suspended organic matter in the pool water or on detrital material which collects on the bottom of some pools. Pools of low elevation will tend to be the former type while pools of the latter type will be found higher in the intertidal zone.

Animals which live in rockpools must be able to withstand changing conditions. Special adaptations include the ability to withstand extended periods of dessication and the ability to move from one pool to another if conditons should change or become adverse. Rockpool organisms such as Littorina spp. can withstand extended periods of exposure and Gammarus duebeni often move along cracks in rock surfaces up and out of rockpools into other pools as the water is drained. Similar observations of Gammarus duebeni have also been reported by Forsman (1948,1951) in his studies of Swedish rockpools. The ability to attach oneself securely to the intertidal rock surface is also an important adaptation found in some plants and animals found in tidepools.

Physical Characteristics of Tidepools

The composition of the flora and fauna of a tidepool is often affected by the topography of the surrounding area as this affects the type of contact that an intertidal body of water has with the sea.

Sea water contact with the intertidal pools can be summarized in the following way:

Catergory (i) Wave contact - a. Water runs into pools from surrounding area.

b. Water from wave runs directly into pool.

c. Splash water enters pool.

Catergory (ii) Spray contact.

Purpose of Thesis and Study Areas

This thesis will present a discussion of the differences that exist between tidepools on highly exposed and moderately exposed coasts. Logy Bay (Figs. 1 and 2) being open to the Atlantic is highly exposed, whereas Portugal Cove in Conception Bay (Figs. 1 and 3) is sheltered, by Bell Island 3 miles offshore, except to the northeast.

Other physical factors which will be discussed are salinity, temperature, oxygen content, pH, and meterological conditions.

Figure 1. Map of Northeast Avalon Peninsula.
Arrows indicate study areas.

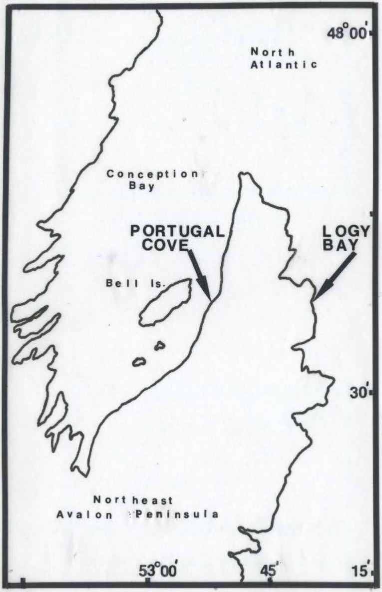

48°00'
North
Atlantic
Conception
Bay
PORTUGAL
COVE
LOGY
BAY
Bell Is.
30'
Northeast
Avalon Peninsula
53°00'
45'
15'

Fig. 1

Figure 2. Map of Logy Bay Study Area.
Arrow indicates position of pools.

Figure 3. Map of Portugal Cove Study Area.
Arrow indicates position of pools.

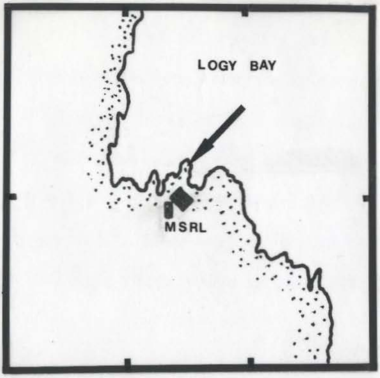


Fig. 2 - Logy Bay

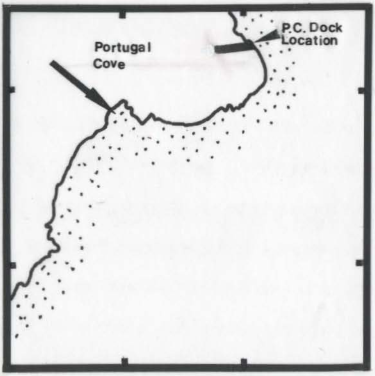


Fig. 3 - Portugal Cove

SCALE

GENERAL METHODS

Pools were selected at Logy Bay and Portugal Cove in order to examine the difference between tidepool ecosystems on exposed and moderately exposed coasts. Pools in both sampling areas were chosen at different levels to show the effect of tidal fluctuations and so that they would be little affected by fresh water land runoff. Ten pools were numbered in each area. When pool elevation and fresh water runoff observations had been made three pools in each area were selected for study.

The lower pool was just above the low water of neap tides, the upper, well above high water of spring tides and the third in between.

Having selected the pools temperature, pH, salinity and mg O_2/1 were measured in each pool at specified periods during the year. These measurements were also recorded for diurnal cycles.

Floral and faunal quantitative studies were completed for the pools during the year survey and at the end of the survey when organisms were cleared from the pools.

Mapping

Mapping was performed with the use of a $1m^2$ grid which was subdivided into 2500, 4 cm^2 divisions. This grid was then superimposed over the pools and the pool outline as well as pool contours were measured from this grid and recorded on a representative m^2 grid on graph paper, which had also been divided into 4 cm^2 divisions. Thus, squares on which diagrams of tide pools are presented are representative $1m^2$. This grid was applied to the surface as many times as required to map the pool. All maps of pools with the exception of pool 3 at Portugal Cove are drawn to scale of 6 cms. = 1 m. Contour lines, as previously plotted, were constructed with a 5 cm contour interval as this was found to be most representative of pool shape.

Pool Volume

Volume was read by measuring the amount of water in each pool. The pools were emptied using a hand operated pump. The amount of water which was taken from the pools was measured and the pool depth was also noted before the pools were emptied.

Pool Elevation

Elevation above the mean tide level was calculated at both Portugal Cove and Logy Bay. Pools were surveyed using a level and rod. In Portugal Cove the pools were surveyed from a bench mark while the Logy Bay survey began from the ground floor of the Memorial University Marine Sciences Research Laboratory, the elevation of which had been obtained from the architect of the building. (Appendix A)

Pool Depth

The pool surfaces were normally calm enough to allow an accurate estimate of pool depth. The meter stick was placed on the same mark in the deepest part of the pool at each sampling. Thus depth as recorded is maximum depth. (Appendix B)

Tidal Fluctuations

The Canadian Current Tide Tables (1971, 1972) provided tide level information. Time and date of sampling periods was noted and this was later used to determine tide height during the sampling period.

Water Temperature

Temperature of water was measured using a precision mercury thermometer. This thermometer was inserted to the top, mid-depth, and bottom of each pool during each sampling period. Ocean temperatures at Logy Bay were obtained from the daily recordings of temperature made at the Marine Sciences Research Laboratory. These recordings were made as sea water entered the first deck of the building.

pH and Salinity

Water samples for pH and salinity were collected from three depths, top, middle, and bottom in each pool throughout the year. The water was run into the 10 dram vials and returned to the lab for analysis. The water samples were obtained from the pools by using a 250 cc pipet which was rinsed with water from the level for which it was to be used before the water sample was obtained.

pH was determined using the ORION SPECIFIC ION METER - MODEL NO. 401.

Salinity was determined from the conductivity of the sea water. The conductivity of the sea water was measured with the Bach-Simpson Conductivity Meter in millimohs/cm - Type CDM 2d No. 102112. The conductivity was then located on a graph which plotted Specific Conductance in millimohs/cm against salinity (p.p.t.) at temperatures ranging from 0° - 30°C. This graph "Electrical Conductivity of Sea Water" was published by MARTEK INSTRUMENTS INC.

Dissolved Oxygen

The method of collecting dissolved oxygen samples was similar to that of the pH and salinity except that 250 ml. B.O.D. bottles were used and in the diurnal surveys the mid-depth was not sampled. A 250 ml. pipet was filled at the appropriate depth and the sample was run into the bottles with little turbulence or agitation. The B.O.D.

Bottles were allowed to overflow before they were stoppered. Samples were preserved by the addition of manganous sulphate and alkaline iodide solution in the field and analyzed using a modification of the Winkler Titration Procedure (Strickland and Parsons - 1960).

After preservation samples obtained during 12 hr. surveys were analyzed within 24 hours, while those obtained during the seasonal observations were analyzed within 2 hours.

Method 1 - Procedures used specifically for seasonal observations.

This section involved analysis of the physical and biological characteristics of pools and the changes that occured during a one year period. Dissolved oxygen content, salinity, temperature and pH were measured as previously described. Observations were made monthly, however during periods when biotic and physical factors changed more rapidly more observations were made. Pools were observed and/or sampled on eighteen occasions from June 1971 to August 1972. (Appendix B)

Sampling Flora and Fauna

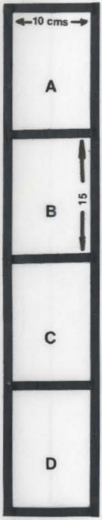
Great difficulty was experienced in quantifying the flora and fauna in the pools. Irregularity of the substrate can be considered a factor contributing to error in measurement that may have occurred. However, the substrate areas were chosen so as to conform as closely as possible to two conditions. The substrate chosen must be characteristic of the rest of the tidepool substrate and the degree of irregularity of the substrate be kept as constant as possible within the sample areas. A sampling grid was constructed for the quantitative sampling of tide pool flora and fauna.

The sampling grid (Fig. 4) is subdivided into four 150 cm^2 sections. This grid was used for the annual sample group in all pools. Certain pools, due to their size, were only able to accommodate two sections of this grid. Thus, in some pools where only two sections were used (sections C & D in Fig. 4) sections A and B will be used to designate these sections in Records of Observation. The bottom of the grid was always placed in the deepest section of the pool perpendicular to the pool contour lines.

At the beginning of the study each pool was surveyed and the most advantageous position in the pool was chosen according to previously mentioned criteria. This position was marked with a nail or its postion recorded, and the grid was placed in the same position during each sampling period. All estimates of flora in these grids were done by coverage estimates in %. In order to prevent flattening of species such as *Fucus*, the grid was held over the sampling area to obtain these coverage estimates.

Because of this method of sampling in the pools any section of the grid that was used represented the substratum of the pool at a specified depth - the depth being dependent on the water level in each pool which did vary slightly in five pools and greatly in one pool from one sampling period to another.

FIGURE 4. - DIAGRAM OF SAMPLING GRID.



Length (total) - 62.5 cm
Width (total) - 11.0 cm
Length (of each section) - 15 cm
Width (of each section) - 10 cm
Area (of each section) - 150 cm^2

Scale: 2.5 cm = 10 cm

Fig. 4

Method 11 - Pool Clearout

Procedures outlined in this section will be those that were used to obtain data when pools were emptied of water and cleared of flora and fauna. In smaller pools or pools which appeared to have relatively small numbers of individuals, the total populations were sampled. In larger pools or those with relatively large numbers of individuals a 150 cm^2 section of each contour interval was sampled. An estimate of the area of each contour interval was determined and an estimate of biomass was made by determination of pool surface area from pool maps.

Sampling for fauna involved two procedures due to the two main types of animals that were present, attached and non-attached. Attached animals were removed as each 5 cm contour interval was uncovered. Non attached, free swimming and floating animals were sampled by straining all water through a net of mesh size 1 mm^2. All pool water was run through the net and not replaced into the pool. Animals were then later sorted and counted.

The procedure used for flora involved the collection of plants from each 5 cm contour interval in each pool. Species which were collected were later sorted. The wet and dry weights for each species in a particular contour interval were measured. Not all species were collected due to the difficulty of adequately collecting certain species, such as the coralline algae.

Method 111 - 12 Hour Survey

Observations of tidepools over a period of 12 hours were made on four occasions. Each location was visited on two occasions. Readings and samples were taken every hour for a twelve hour period.

Water samples for mg O_2/l, pH and salinity, were collected and preserved as described in general methods. In addition the frequency of small or large scale entries of sea water into the pool, was recorded in fifteen minutes of each hour . (Appendix F' & G')

RESULTS

Description of Tidepools

Pools studied were located on the Avalon Peninsula of Newfoundland (Fig. 1 Page 7). The pools were not under the influence of any fresh water runoff from higher areas other than in the immediate vicinity (0.5 - 1m.) of the pool.

Tidepools which will be discussed have been described below.

TABLE 1 - PORTUGAL COVE
DESCRIPTION OF POOLS

POOL No.	LOCATION	SURFACE AREA (m^2.)	ELEVATION M.L.W. (m.)	VOLUME (l.)	MAPS	PHOTOGRAPHS
1	Fig. 1&3	1	1.2	81.8	Fig. 12	Fig. 16&17
3	Fig. 1&3	6.14	1.9	395.5	Fig. 13	Fig. 18
4	Fig. 1&3	.86	3.4	32.9	Fig. 14	Fig. 19

The sampling area at Portugal Cove was located in an area as shown in Fig. 3. These pools were sheltered due to the structure of the rock formations in the area which protected the pools from direct wave action. Fig. 15 shows the position of the pools in relation to one another and Figs. 16,17,18 and 19 show the individual pools as photographed. Accurate measurements of pools and contours are diagrammed in Figs. 12,13 and 14.

TABLE 2 - LOGY BAY
DESCRIPTION OF POOLS

POOL No.	LOCATION	SURFACE AREA (m^2.)	ELEVATION M.L.W. (m.)	VOLUME (l.)	MAPS	PHOTOGRAPHS
1A	Fig. 1&2	1.38	1.9	117.1	Fig. 5	Fig. 9
1B	Fig. 1&2	1.54	2.8	304.6	Fig. 6	Fig. 10
4	Fig. 1&2	1.91	5.4	360.9	Fig. 7	Fig. 11

These pools were located on a rocky point to the seaward side of the Memorial University Marine Sciences Research Laboratory at Logy Bay.

The position of the pools at Logy Bay with respect to one another is shown in Fig. 2, Figs 9,10 and 11 show the topography with more detailed information on pool shape and contours provided in Figs 5, 6 and 7.

Figure 5-7

Pools maps - Logy Bay

All depths recorded in cms.

☐ Stations at which seasonal observations of flora and fauna were made.

(1), (2) Station number

N North

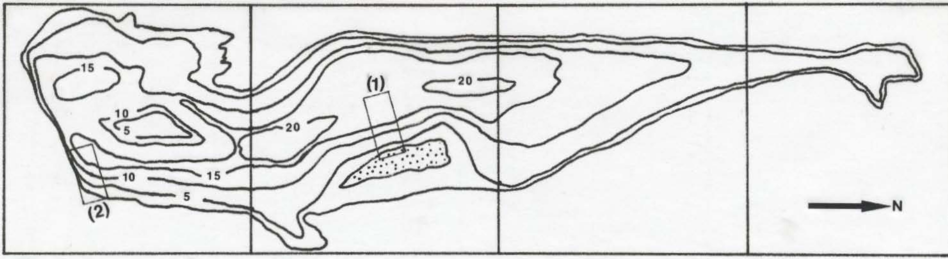


Fig. 5 - Pool 1A - L.B.

Figure 5 - Map of pool 1A - Logy Bay

Scale: 6 cms = 1m

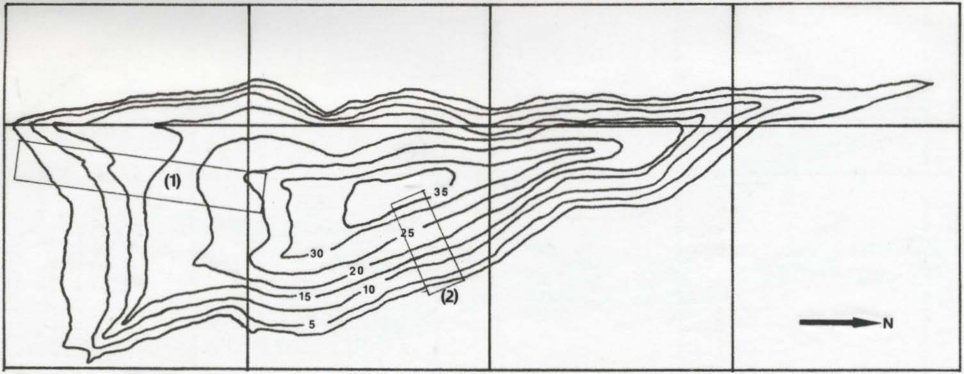


Fig. 6 - Pool 1B-L.B.

Figure 6 - Map of pool 1B - Logy Bay

Scale: 6 cms = 1m

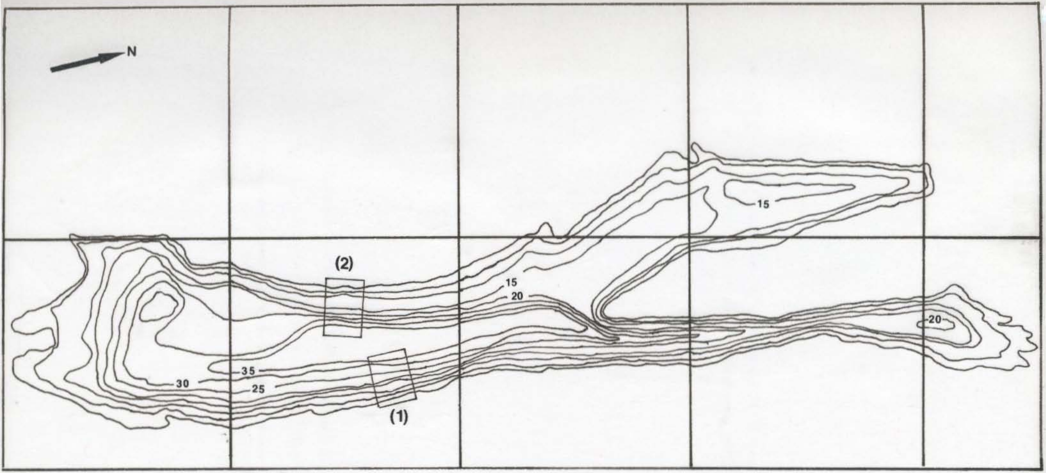


Fig. 7–Pool 4–L.B.

Figure 7 - Map of pool 4 - Logy Bay

Scale: 6 cms = 1M

Figure 8.- Arrows indicate the positions of pools sampled at Logy Bay. The effect of ice on pools can also be observed, particularly in pool 1B.

Figure 9.- Pool 1A at Logy Bay with characteristic alga Fucus distichus distichus located in rock crevices in the pool. This alga covered more of the substrate as the summer progressed.

Logy Bay
Feb. 12, 1972
Scale: 1m = .4 cm

N

Fig. 8

Logy Bay
Pool 1A
April 21, 1972
Scale: 1m = 6.9 cm

N

Fig. 9

Figure 10 - In pool 1B the growth of Verrucaria and Cyanophytes can be observed on the pool substrate. The band of rock around the top of the pool indicates an area unsuitable for the growth of these algae.

Figure 11 - In pool 4 lack of macroscopic algal growth is evident. Verrucaria later became well established in this pool, which also contained a large Gammarus duebeni population throughout the study.

Logy Bay
Pool 1B
April 21, 1972
Scale: 1m = 5.4 cm

Fig. 10

Logy Bay
Pool 4
April 21, 1972
Scale: 1m = 8 cm

Fig. 11

Figures 12-14

Pool maps - Portugal Cove

All depths recorded in cms.

Stations at which seasonal observations of flora and fauna were made.

(1), (2) Station number

N North

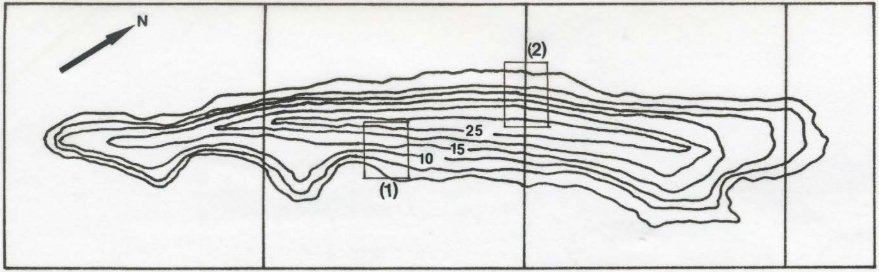


Fig. 12 - Pool 1 - P. C.

Figure 12 - Map of Pool 1 - Portugal Cove.

Scale: 6 cms = 1m

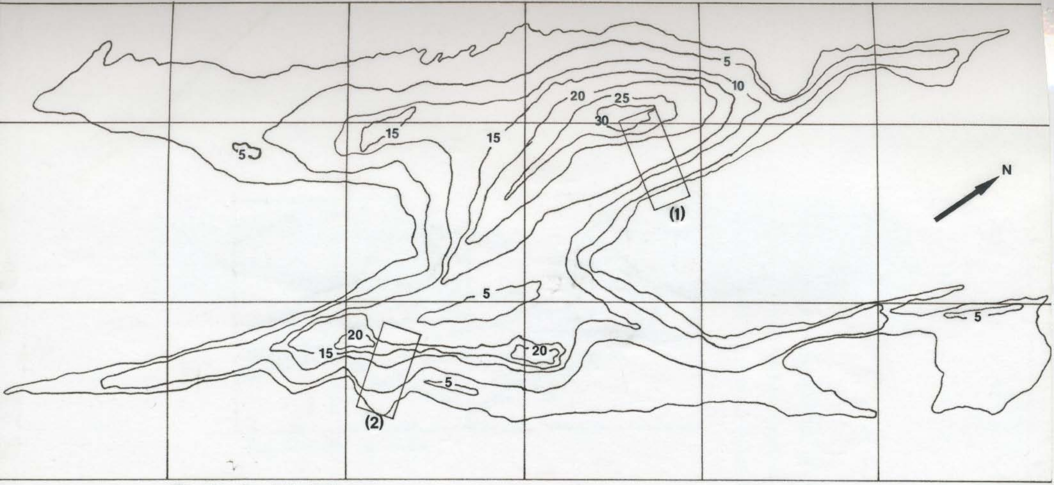


Fig. 13 – Pool 3 – P.C.

Scale: 4.5 cms. =1m.

Figure 13 - Map of Pool 3 - Portugal Cove.

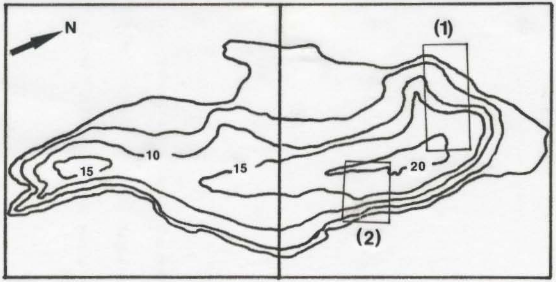


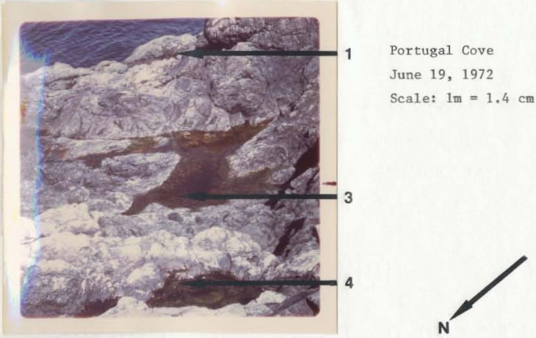
Fig. 14 - Pool 4 - P.C.

Figure 14 - Map of Pool 4 - Portugal Cove.

Scale: 6 cms = 1m

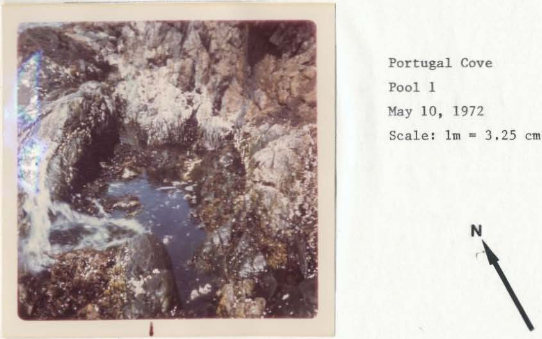
Figure 15 - Sampling area at Portugal Cove and the position of the pools. Structure and topography of surrounding rock which reduces fresh water runoff can also be observed.

Figure 16 - In pool 1 at Portugal Cove splash water from waves can be observed entering by contact with a large rock outcrop sheltering the pool from direct contact with sea waves.



Portugal Cove
June 19, 1972
Scale: 1m = 1.4 cm

Fig. 15



Portugal Cove
Pool 1
May 10, 1972
Scale: 1m = 3.25 cm

Fig. 16

Figure 17 - Characteristic flora of pool 1 at Portugal Cove including Clathromorphum circumscriptum and Acrosiphonia arcta can be observed.

Figure 18 - The various flora of pool 3 at Portugal Cove can be observed. Comparison of the lower part of the pool with the higher section indicates the presence of two algal communties. However the dominant found in both areas was Fucus distichus distichus, with maximum coverage at mid-depth.

Fig. 17

Portugal Cove

Pool 1

June 19, 1972

Scale: 1m = 5.5 cm

Fig. 18

Portugal Cove

Pool 3

June 19, 1972

Scale: 1m = 1.5 cm

Figure 19 - The lack of abundant algal growth and the position with respect to surrounding area can be observed in pool 4. This photograph shows that pool 4 is isolated from any runoff as most surrounding area is lower in elevation. Verrucaria and Cyanophytes were common in this pool throughout the study.

Fig. 19

Portugal Cove

Pool 4

May 10, 1972

Scale: 1m = 4.5 cm

RESULTS I

SEASONAL OBSERVATIONS

PHYSICAL FACTORS

Temperature

The range of temperature at Portugal Cove (-1.8°C - 28.5°C) (Fig. 20 - App. C) was similar to that at Logy Bay (-1.8°C - 28.1°C) (Fig. 21-App. D). In both areas the greatest temperature ranges were found in middle pools.

Temperature of surface layers of pools (Figs. 20 and 21) tend to approximate air temperatures more closely as distance from the sea and pool elevation above sea level increase. Pools 1A (Logy Bay) and 1 (Portugal Cove) are not affected by air temperatures as much as are the highest pools on each area.

No consistent temperature gradients were found within the pools. However 76% of the observations made showed that the temperature of the top layer in the pool was equal to or less than the temperature of the bottom layer.

Sea temperatures were found to be lower than that of surface water in all pools on 24 occasions. During December the temperature of pool water was 4-6°C colder than that of the sea. (Logy Bay)

Salinity

Salinity varied from .6 to 42.9‰. The ranges of salinity to which pools were subjected increased as pool height increased. On rare occasions pool salinities were extremely high due to evaporation or very low due to precipitation.

Figure 20 Air and Water Temperature of Pools at Portugal Cove. This graph shows the effect of air temperature on the temperature of surface water in the pools.

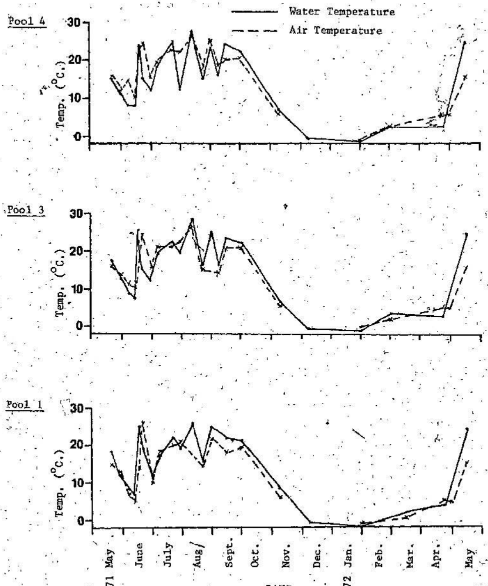

Pool 4
Water Temperature
Air Temperature
Temp. (°C.)
30
20
10
0
Pool 3
Pool 1
'71 May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
'72 Jan.
Feb.
Mar.
Apr.
May
DATE

FIG. 20

Figure 21 Air and Water Temperature Of Pools At Logy Bay. This graph shows the correlation between air and ocean temperature, and temperature of surface water in pools.

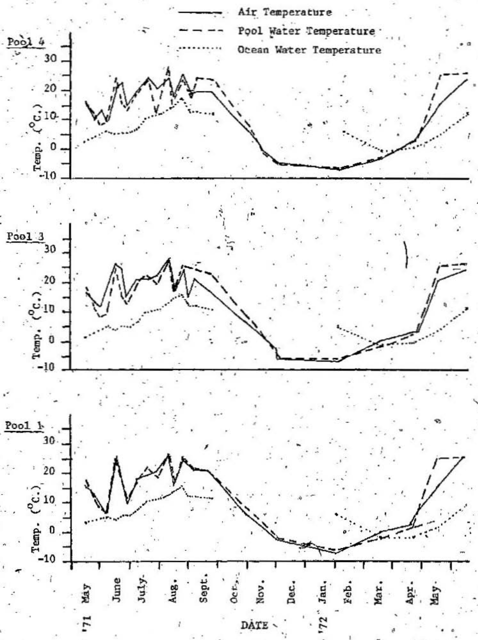

Air Temperature
Pool Water Temperature
Ocean Water Temperature
Pool 4
Temp. (°C.)
30
20
10
0
-10
Pool 3
Temp. (°C.)
30
20
10
0
-10
Pool 1
Temp. (°C.)
30
20
10
0
-10
May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
Apr.
May
'71
DATE
'72

FIG. 21

In the lowest pools at Portugal Cove and Logy Bay the ranges of salinity were 19.9-37 and 6.2-42.9‰. These relatively smaller ranges of salinity are due to more frequent contact with the sea. Ranges of salinity of middle pools were 10.3-43.9‰ (Pool 3-P.C.) and 6.1-33‰ (Pool 1B-L.B.). The highest pools studied showed salinity ranges of .8-30‰ (Pool 4-P.C.) and .6-31.8‰ (Pool 4-L.B.) (App. E & F).

The effect of evaporation on pool salinity was particularly noticeable in pools 1B, and 4 At L.B. and 3 and 4 at Portugal Cove (Fig. 22 App. G). Appendix G shows salinity values for high and low tides at Portugal Cove and Logy Bay. High and low tide salinity values were grouped and averaged to obtain results expressed in Fig. 22. Evaporation in pool 3 at Portugal Cove raised the salinity to 31.7‰ at top and 33.4‰ at Bottom. As the pool became filled with water, pool salinity tended to drop to 10.3‰ at the top. Similarly, pool 1B at Logy Bay showed, on several occasions, that evaporation tended to raise salinity.

There is also a further connection between pool salinity and elevation. Due to isloation from the sea, high pools tend to show gradients of increasing salinity from top to bottom. At Portugal Cove this gradient was observed on 6,7, and 11 occasions in pools 1, 3 and 4 respectively. This gradient occurred most frequently in pool 1B at Logy Bay.

In pool 1A and pool 1, salinity varies slightly from the top to the bottom of the pool. (Fig. 22). This is due to the lack of complete mixing during high tide periods. Averages have been used since daily meterological variations produce variations in the data. Greater variations in salinity from top to bottom of the pools occur during low tide when the pool is less under the influence of mixing due to sea water.

Figure 22: Salinity versus tide height.

Variations in salinity from top to bottom during high and low tide periods at Logy Bay and Portugal Cove.

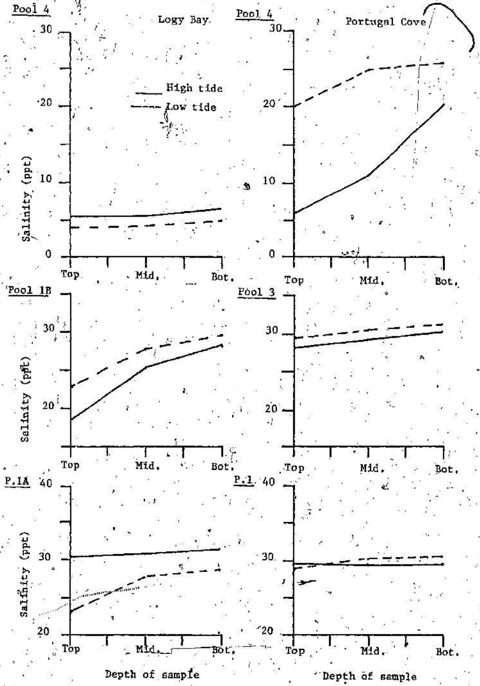

Pool 4
Logy Bay
Pool 4
Portugal Cove
High tide
Low tide
Salinity (ppt)
30
20
10
0
Top
Mid.
Bot.
Pool 1B
Pool 3
P.1A
P.1
40
Depth of sample

FIG. 22

Salinity values for pool 1B and pool 3 show that tidal fluctuations have affected salinity stratification to a lesser degree. During both high and low tide periods stratification occurs. Since pool 1B is 2.8 m. above sea level, as opposed to pool 1A which is 1.9 m. above sea level, it is affected by mixing caused by sea water entry into the pool.

Similarly, Fig. 22 shows that pool 4 in both areas is influenced to a lesser degree by tidal cycles. Pool 4 at Logy Bay which is 5.4 m. above sea level is only reached by sea water during periods of storm when very heavy seas push water over the point into the pool.

In summary, variations in salinity in high pools are much more pronounced than in lower pools. This fact is reflected in floral and faunal analysis as will be discussed later.

pH

Graphs on page 48 show the number of observations made in any one pool at that level and the frequency of pH's observed. These graphs were constructed using nineteen sampling periods in which a complete set of pH values were recorded.

Portugal Cove - pH values in all pools varied little from the top to the bottom of the pools. (Fig. 23 - App.H). However, in pool 1 when observations from the top, middle and bottom were totalled there were forty-six pH values within the range from 7 to 7.9, while in pools 3 and 4 there were only 3 observations within this range. Also, in pool 1 there were only 9 pH values in the range from 8 to 10 while in pools 3 and 4, there were 37 and 32 respectively. Thus, there was a

Figure 23 pH at Logy Bay and Portugal Cove. This graph shows the number of water samples taken within the pH groups specified.

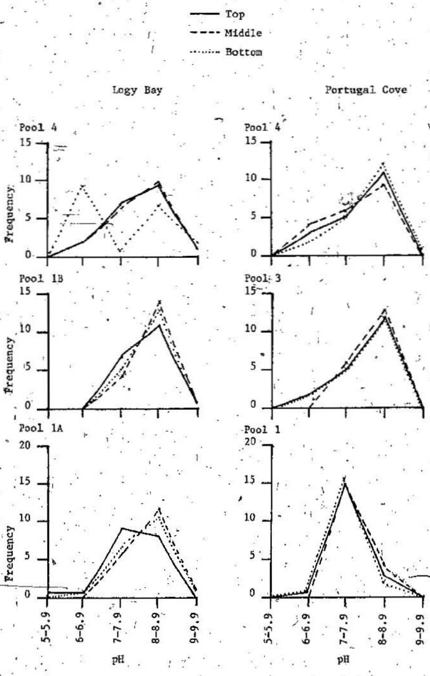

Top
Middle
Bottom
Logy Bay
Portugal Cove
Pool 4
Pool 1B
Pool 1A
Pool 4
Pool 3
Pool 1
Frequency
0
5
10
15
20
5-5.9
6-6.9
7-7.9
8-8.9
9-9.9
pH

FIG. 23

tendency towards higher pH values in pools with a higher elevation (1.9 m. and 3.4 m. above sea level). pH values at Lovy Bay (Fig. 23 - App. 1) showed that variation in pH was greatest in pool 4. In all pools the greatest number of observations were made within the range of 8 to 10 pH.

Oxygen

In both sampling areas mg $O_2/1$ (Dissolved Oxygen Content) results were reported by grouping values found in each pool during each sampling period. These values were plotted against observation periods from February 12, 1972 to June 13, 1972. These results were correlated with temperature, salinity pool volume and the tide level during the sampling periods which were carried out at approximately 1500 hours.

The lowest value of mg $O_2/1$ recorded in pool 1B at Logy Bay was on April 15, 1971, where the top layer contained 6.40 mg $O_2/1$. The highest value recoded was 28.6 in pool 4 at Portugal Cove on April 23, 1971. Highest mg $O_2/1$ values in the pools were recorded in April and May 1971 followed by a gradual decline to April 15, 1972 when sampling ended.

Dissolved Oxygen Content ranges in all pools varied between 9.92 mg $O_2/1$ and 17.2 mg $O_2/1$. Differences between the highest and lowest mg $O_2/1$ values in high pools were 17.2 mg $O_2/1$ (Logy Bay) and 16.6 mg $O_2/1$ (Portugal Cove). Similar values for low pools were 9.92 mg $O_2/1$ (Logy Bay) and 11.82 mg $O_2/1$ (Portugal Cove).

% Oxygen Saturation

Oxygen saturation in pools at Logy Bay ranged from 95 to 228%. On May 15, a maximum salinity of 209% occurred with an O_2 saturation of 228% at 12.8°C, while on March 17, minimum salinity of 1.6% and temperature of 2.2°C occured with a saturation of 95%.

BIOTIC FACTORS

General Results of Seasonal Observations for Flora and Fauna

Plant and animal species were sampled for a twelve month period. (App. K-V). Species observed were usually found at both Logy Bay and Portugal Cove, although the coverage and numbers often varied.

Species which occurred most frequently at Portugal Cove were Fucus distichus distichus, Clathromorphum circumscriptum, Corallina officinalis, Littorina saxatilis, Littorina obtusata, Jaera ischeosetosa, Hyale nilssoni, and Lepidonatus squamatus. Dominant species at Logy Bay were Fucus distichus distichus, Verrucaria and Cyanophyta, Littorina sp., Jaera ischeosetosa, Mytilus edulis, and Gamarellus angulosus. In both study areas certain species were restricted not only to a particular intertidal level but also were found at specific depths in the tidepools.

In the following results faunal and floral sampling have been reported from two stations in pools 1 and 3 at Portugal Cove and 1A, 1B and 4 at Logy Bay. Pool 4 at Portugal Cove has been reported with one station. The following is a summary of the flora and fauna found at Logy Bay and Portugal Cove. In both areas the number of species in pools declined as pool elevation increased (Table - 4).

TABLE 3 - %OXYGEN SATURATION AT LOGY BAY AND PORTUGAL COVE

LOGY BAY

POOL	DATE	SATURATION (O_2)
1A	Feb. 12-72	161 %
	Mar. 18	198
	Apr. 21	116
	Apr. 27	162
	May	228
1B	Feb. 12-72	152
	Apr. 21	106
	Apr. 27	150
	May 15	183
4	Mar. 17-72	95
	Apr. 21	
	Apr. 27	215
	May 15	177

PORTUGAL COVE

POOL	DATE	SATURATION (O_2)
1	Feb. 12-72	126 %
	Feb. 19	148
	Mar. 18	185
	Apr. 22	134
	May 10	119
	May 23	109
	June 13	231
3	Feb. 19-72	158
	Mar. 18	241
	Apr. 22	201
	May 10	118
	May 23	190
	June 13	170
4	Apr. 22-72	156
	May 10	156
	May 23	231
	June 13	154

TABLE 4. – QUALITATIVE FLORAL AND FAUNAL ANALYSIS

LOCATION	LOGY BAY			PORTUGAL COVE		
POOL NUMBER	1A	1B	4	1	3	4
FLORA						
Fucus distichus edentatus				*		
Fucus distichus distichus	*	*			*	*
Monostroma grevillei	*			*	*	
Cladophora rupestris					*	
Ralfsia fungiformis	*				*	
Verrucaria and Cyanophytes	*	*	*		*	*
Hildenbrandia prototypus					*	
Clathromorphum circumscriptum		*		*	*	
Corallina officinalis				*		
Acrosiphonia arcta				*		
Chordaria flagelliformis				*		
Pilayella littoralis	*	*				
Melanosiphon intestinalis	*	*			*	*
Rhizoclonium riparium		*				*
Dictyosiphon foeniculaceus	*			*		*
Chondrus crispus				*		
Prasiola crispa				*		
Elachista lubrica				*		
TOTAL NUMBER OF SPECIES	7	6	1	10	8	5
FAUNA						
Littorina saxatilis	*	*		*	*	*
Littorina obtusata	*	*		*	*	*
Littorina littorea	*			*	*	
Jaera ischiosetosa	*	*		*	*	
Acmaea testudinalis		*		*		
Mytilus edulis	*	*	*	*	*	*
Amphipoda	*	*	*		*	
Thais lapillus	*	*		*	*	
Strongylocentrotus drobachiensis				*	*	
Metridium dianthus				*		
Nereis pelagica				*	*	
Asterias vulgaris				*		
Tonicella marmorea				*		
Volsella modiolus				*		
Hiatella arctica				*		
Balanus balanoides				*		
Hyale nilssoni	*				*	
Gammarellus angulosus	*					
Lepidonatus squamatus	*			*	*	
TOTAL NUMBER OF SPECIES	10	7	2	16	11	3

Fauna - Seasonal Observations

A year survey was made in order to compare the 2 lowest pools at Logy Bay with the 2 lowest pools at Portugal Cove. Although samples were obtained for each month of the year the results have been grouped into four sampling periods, June-July-August (J-J-A), September-October-November (S-O-N), December-January-February-(D-J-F), and March-April-May (M-A-M). Values (No./150cm^2) within these sampling periods were averaged to obtain numbers which are shown inside or following the histogram bars (Fig. 24-27). Histogram bars (Figs. 24-27) represent the % of the population observed within the specified grid section.

Species which were sampled in detail will be discussed separetely in the following section.

Littorina saxatilis - The distribution of Littorina saxatilis at Logy Bay remained relatively stable throughout the annual sampling period although the actual number of individuals decreased from J-J-A of 1971 where there were 125 (station 1) individuals in pool 1A which were distributed from the top to the bottom of the pool. (48 in grid section A and 77 in section B), At station 2, 146 individuals were found with a similar distribution. There was a tendency for more individuals to occur at the lower levels of the pool at both stations. However, in this same pool during the M-A-M sampling of 1972 there were 126 individuals at station 1 which were all located in grid section B. (Fig. 26) Although 36 individuals were sampled at station 2, 82% of those also occurred in grid section B.

Observation of Littorina saxatilis in pool 1B indicated that during most sampling periods Littorina was evenly distributed throughout

196 in S-O-N. (Fig. 27-Station 1, App. S) Results at station 2 for the same time periods were 127 and 80 respectively. No results were obtained for this pool at station 1 during D-J-F because the pool was frozen during this period. Samples from the M-A-M sampling period showed that following the freezing of the pool the number of individuals had been reduced to 81 at station 1 and 38 at station 2.

Portugal Cove distribution was not similar to that at Logy Bay. In pool 1 at Portugal Cove 13 individuals were observed during the J-J-A period, and no individuals during the S-O-N, D-J-F and M-A-M periods. (Fig. 24 Station 1, App. K) Similar results were obtained at station 2.

In pool 3 at Portugal Cove (Fig. 25) the distribution of Littorina followed that in pool 1B at Logy Bay (Fig. 27) although there were a larger number of individuals present probably due to the dense algal growth in pool 3.

Thais lapillus - Thais lapillus were rarely found at Logy Bay. Stable populations were found only at Portugal Cove where they were most abundant in pool 3. A total of 15 individuals have been included in the results. (Fig. 25) At Portugal Cove no preference for a particular pool depth was evident.

Mytilus edulis - Mytilus edulis is known to be tolerant of low salinity (Ganning 1971). There were 43 individuals found in pool 3 at station 1 (Fig. 25) at Portugal Cove during the J-J-A sampling. Pool 1 (Fig. 24) contained only 30 individuals during the same period with only 2 individuals during the S-O-N period at Station 1.

At Logy Bay the location of the mussel belt (Mytilus edulis) of stratification compared closely with the elevation of pool 1A which was approximately 0.5m. above the mussel line. Therefore this pool contained the most stable population of Mytilus edulis. There were individuals of this species present throughout the year at both stations although the number present dropped from a high of 151 in J-J-A to 3 in M-A-M. (Station 1 - Fig. 26) As demonstrated in Fig. 26, of the 151 individuals in the pool during J-J-A period 150 were located in the deepest areas of the pool (Station 1, section B). Similarly at station 2, 60 out of 62 individuals were observed in the deepest areas of the pool. When the population declined in S-O-N and D-J-F there tended to be a distribution in which there were more individuals in the top layer (Section A) of the pool. The following spring (M-A-M period) although there were only 3 individuals at station 1 all were located in the deepest areas of the pool. However at station 2 the reverse was true where of 9 individuals 8 were located in section A of the grid.

In pool 1B the population dropped from a high of 10 individuals in J-J-A to 1 in M-A-M at station 1. A similar but more gradual decline occurred at station 2.

Jaera ischiosetosa - Logy Bay - In J-J-A 331 individuals were sampled in pool 1A at station 1. (Fig. 26) This number declined steadily to 0 in D-J-F and 3 in M-A- M sampling period. A gradual decline from a high of 386 individuals in J-J-A also occurred at station 2. Similarly pool 1B (Fig. 27) showed a similar decline indicating that Jaera ischiosetosa were an important part of the rockpool ecosystem particularly during the months of J-J-A.

Portugal Cove - In pool 1 (Fig. 24), 64 Jaera ischiosetosa were recorded during J-J-A. The graph, however, does indicate the presence of a resident population as shown by Fig. 25 describing pool No. 3. Although a quantitative value has not been recorded for D-J-F, when the surface layer of ice was removed, they were found to be plentiful. A decline in population from J-J-A to M-A-M also occurred as can be seen in Fig. 25, which shows 968 individuals evenly distributed throughout J-J-A and only 99 in the pool during M-A-M at station 1. Results for station 2 also indicate that there were 1387 individuals during J-J-A and only 297 during S-O-N. The dense algal growth in pool 3 may be responsible for the large number of individuals. However, pool 1B which also contained large numbers of individuals did not contain a comparable growth of algae.

Other species which occurred rarely at Portugal Cove and Logy Bay but which were not sampled quantitatively were Littorina littorea, Stronglocentrotus drobachiensis, Acmea testudinalis, Metridium dianthus and certain Amphipod species.

Figure 24 Fauna - Annual Survey - Pool 1 - Portugal Cove.

Figure 25 Fauna - Annual Survey - Pool 3 - Portugal Cove.

Figure 26 Fauna - Annual Survey - Pool 1A- Logy Bay.

Figure 27 Fauna - Annual Survey - Pool 1B- Logy Bay.

Histogram bars represent % of population observed within the specified grid section.

Numbers inside of, or following histogram bars indicate number of individuals per 150 cm^2.

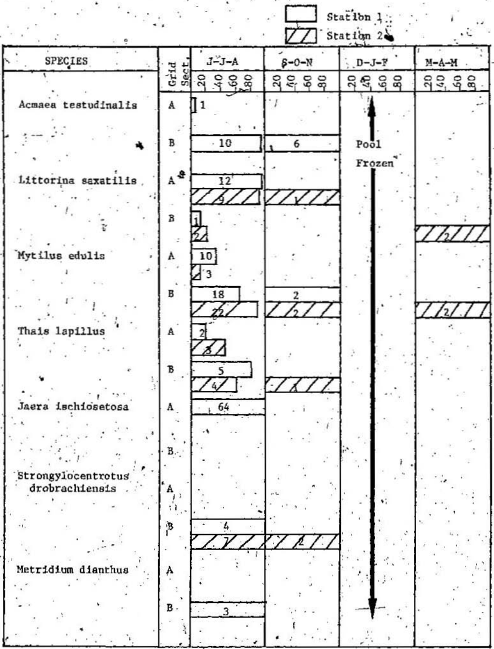


Fig. 24 - Fauna - Annual Survey - Pool 1 - Portugal Cove

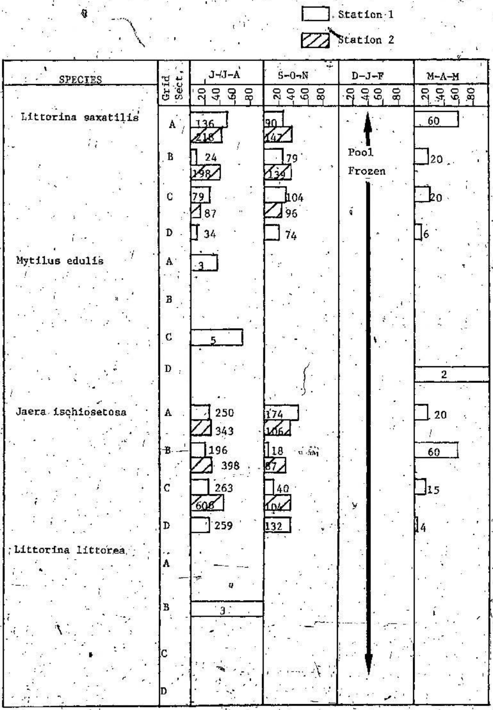

Station 1
Station 2
SPECIES
Grid Sect.
J-J-A
S-O-N
D-J-F
M-A-M
20 40 60 80
Littorina saxatilis
A
136
218
90
147
60
B
24
198
79
139
20
C
79
87
104
96
20
D
34
74
6
Pool
Frozen
Mytilus edulis
A
3
B
C
5
D
2
Jaera ischiosetosa
A
250
343
174
106
20
B
196
398
18
87
60
C
263
608
40
104
15
D
259
132
4
Littorina littorea
A
B
3
C
D

Fig. 25

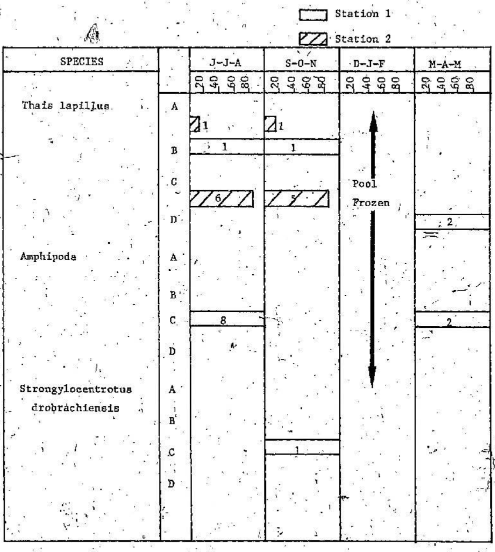


Figure 25 Fauna - Annual Survey - Pool 3 - Portugal Cove.

FIG. 25 Cont'd

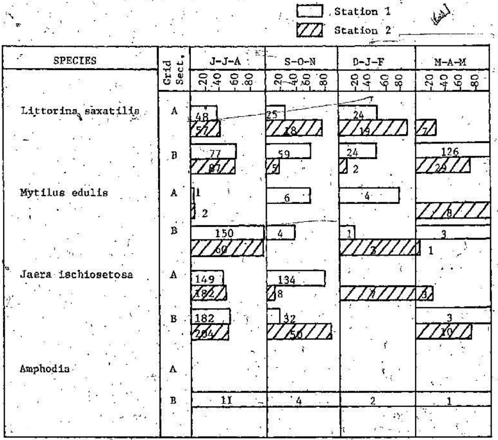


Fig. 26 - Fauna - Annual Survey

Pool 1A - Logy Bay.

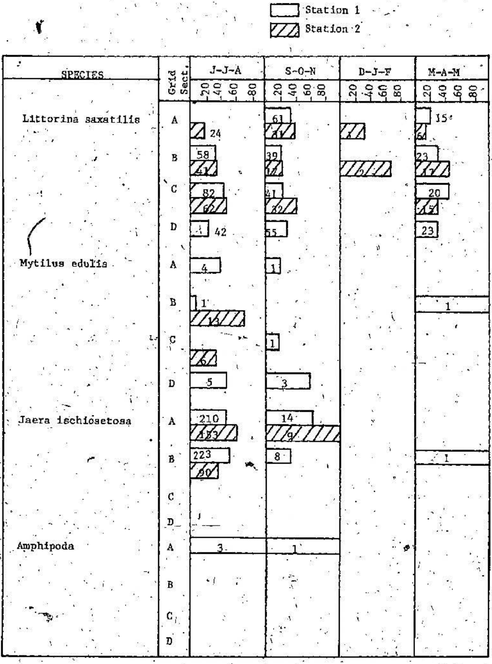


Fig. 27 – Fauna – Annual Survey – Pool 1B
Logy Bay.

Flora - Seasonal Observations

Flora of pools at Logy Bay and Portugal Cove were sampled with the use of the sampling grid at 2 stations as previously described. Flora were sampled in two areas in each pool. Thus each species is described by two histogram bars referring to station 1 and station 2.

Fucus distichus distichus - ~~Logy Bay - Only in~~ pool 1A (Fig. 28) was a resident population observed. The population remained constant during all sampling periods with the exception of a decline in coverage in M-A-M. At station 1 (Fig. 29, App. Q) for the first three sample periods coverage was estimated to be between 53.6 and 70% in areas below mid-depth of the pool. Coverage of only 24.8 - 30 % was found during the same periods in areas of the pool above mid-depth. At station 2 (Fig. 28) coverage of Fucus was relatively constant from the top to bottom of the pool although there was a tendency for the coverage estimates to be slightly higher in the areas above mid-depth.

Portugal Cove - A significant population of Fucus distichus distichus was found only in pool No. 3 where this alga was abundant (Fig. 29, App. M). Observations were made for all months except D-J-F when ice conditions prevented quantitative sampling. As demonstrated by (Fig. 29) the largest coverage areas were found in grid section B. However there is a tendency for Fucus distichus distichus growth to be concentrated within grid sections B and C which were mid-depth sections of the grid.

Ralfsia fungiformis - Ralfsia occured most frequently in pool No. 3 at Portugal Cove. (Fig. 29) in pool 3 a resident population was observed throughout the year. At station 1 coverage was relatively equal in all depth areas whereas station 2 showed a 37.2 - 45 % coverage in deepest areas opposed to a coverage of 13-25% in other areas of the pool, At Logy Bay Ralfsia fungiformis did occur in pool 1A where the results also indicated the preference of Ralfsia for deeper areas of the pool. (Fig. 28).

Clathromorphum circumscriptum - This species was most abundant in pool No. 1 at Portugal Cove although small patches were observed in pool 3. The highest coverage values were obtained in the B section of the grid where 100% coverage was often observed at both stations. Coralline algae was most frequently found in deeper areas of the pool (Fig. 30).

Corallina officinalis - This species occurred only in pool No. 1 at Portugal Cove. Distribution was in reverse to that of Clathromorphum circumscriptum. (Fig. 30). There was a definite tendency to find much higher coverage values in the shallow areas of the pool rather than deeper areas. Corallina officinalis was observed to be dwarfed and matted. Clathromorphum circumscriptum often provided attachment for Corallina officinalis.

Monostroma grevillei - Monostroma grevillei was found in pool 1 at Portugal Cove throughout the J-J-A, S-O-N and M-A-M sampling periods (Fig. 30). It was observed to grow only in the shallow areas of the pool and declined steadily from a high coverage of 30-35% in M-A-M to 0-5% in S-O-N indicating that this is a plant of the spring flora.

Verrucaria and Cyanophyta - Verrucaria and Cyanophyta was observed growing in many tidepools. This mixture was identified as containing several Cyanophytes and Verrucaria which could only be sampled by breaking off pieces of rock on which it grew. This plant was a resident in pool 1B at Logy Bay where there was a tendency for this alga to be concentrated in the deeper sections of the pool. However distribution tended to be constant from the top to the bottom of the pool.

Hildenbrandia prototypus - Thisspecies occured only in pool No. 3 at Portugal Cove. Samples from station 1 (Fig. 29, App. M) in this pool indicated that this alga had a coverage value that ranged between 10 and 26.3 % in the top layers of the pool. However at station 2 (Fig. 29, App. N) this species was completely restricted to the lower grid section (Section C) during the same periods. Coverage values do indicate that this species was more abundant during the J-J-A and S-O-N than in M-A-M.

Pilayella littoralis - In the southern most point of its range (N.J.) this alga is common on rocks and coarse algae in the spring and becomes rare later during the year. (Taylor, 1973) Results obtained from tide pool samples indicate that the population coverage was highest in the J-J-A sampling period. (Fig. 28, App. Q) In pool 1A Logy Bay coverage was between 31.8 and 40 % at all pool depths during J-J-A observations. This species disappeared when pool water level was lowest (Section B) and reappeared during M-A-M.

Rhizoclonium riparium - This alga was found in pool 1B at Logy Bay during all observations. However its coverage values varied greatly from one period to another indicated by average values for the J-J-A, S-O-N and M-A-M seasons. Arrows indicate periods when average coverage was unusually high. (Fig. 31) This alga formed a mat over the pool from time to time. Heavy seas with high tides would almost completely clearthis alga from the pool. (App. S and T)

Figure 28 Flora - Annual Survey - Pool 1A - Logy Bay.

Figure 29 Flora - Annual Survey - Pool 3 - Portugal Cove.

Figure 30 Flora - Annual Survey - Pool 1 - Portugal Cove.

Figure 31 Flora - Annual Survey - Pool 1B - Logy Bay.

Histogram bars represent % of population observed within the specified grid section.

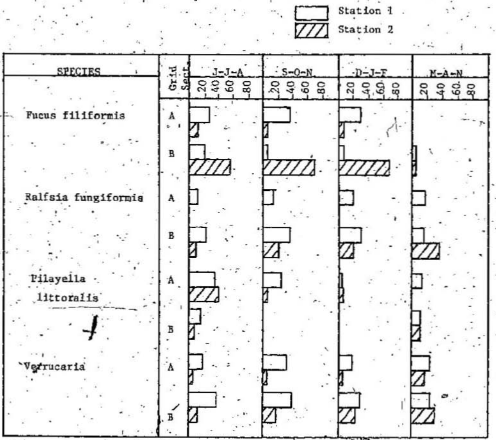


Fig. 28 -- Flora - Annual Survey

Pool 1A - Logy Bay.

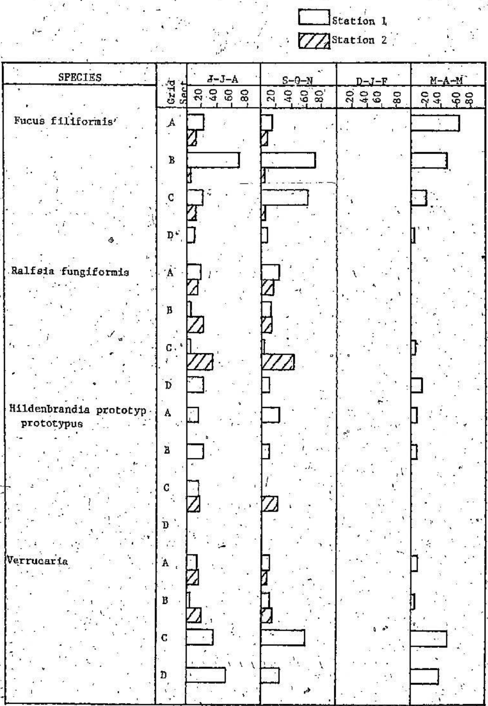

Station 1
Station 2
SPECIES
Grid Sect
J-J-A
S-O-N
D-J-F
M-A-M
20 40 60 80
Fucus filiformis
Ralfsia fungiformis
Hildenbrandia prototyp prototypus
Verrucaria
A
B
C
D

Fig. 29

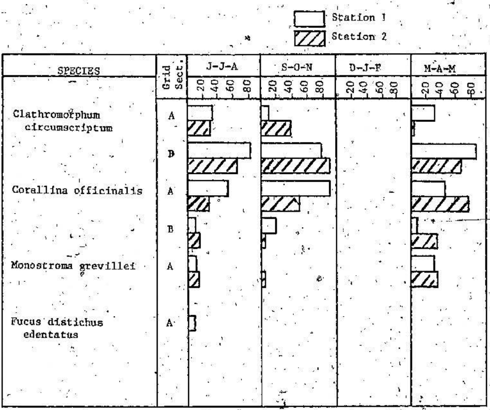


Fig. 30 - Flora - Annual Survey

Pool 1 - Portugal Cove.

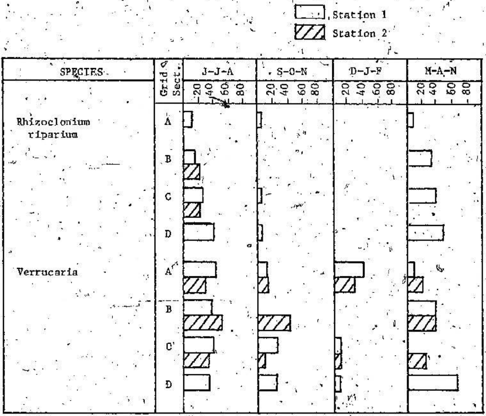


Fig. 31 - Flora - Annual Survey

Pool 1B - Logy Bay.

RESULTS 11 - POOL CLEAROUT

When the annual observations had ended flora and fauna were cleared from the pools. The emphasis for this quantitative clearout of pools was placed on the two lowest pools in each area, at Portugal Cove pools No. 1 and 3 and pools 1A, 1B at Logy Bay.

Fauna have been described in two sections:

1. Unattached fauna (Logy Bay and Portugal Cove).

2. Attached fauna (a) Logy Bay (b) Portugal Cove.

1. Unattached Fauna (Logy Bay & Portugal Cove)

The number of unattached fauna strained from each pool and total dry weights for each species in each pool have been recordded. (Table 5)

Gammarellus angulosis - Pools 1A and 1B at Logy Bay yielded 319 individuals while only 5 were obtained from pools 1 and 3 at Portugal Cove. Gammarellus angulosis was not found in the highest pools in either area. However the average dry weight indicates that the individuals found in pool 1 at Portugal Cove with an average dry weight of .003g, were larger than those found in pool 1A at Logy Bay with an average dry weight of .0007g. (Table 5)

Calliopus laevivsculis - Calliopus laevivsculis was also found to be restricted to low pools and was more plentiful at Logy Bay (133) than at Portugal Cove (24). This species also showed a greater dry weight / individual at Logy Bay. (Table 5)

Gammarus duebeni - Pool 4 at Logy Bay contained a permanent population of Gammarus duebeni. 1437 individuals wefe strained from this pool. The absence of this species from other pools suggests that it has a preference for high pools of low salinity. The average dry weight of each individual was .0047g. Results also show that this pool contained the greatest number of individuals per cm^2 due to the well established Gammarus duebeni population.

Gammarus oceanicus - This species was not common in any pools but the largest number of individuals found in a pool occured in pool 1 at Portugal Cove where 6 were sampled. Only 1 larger individual was found in pool 3A at Logy Bay.

Hyale nilsoni - Pool 3 at Portugal Cove provided the best environment for Hyale nilsonni where 49 individuals were found. Pools 1A, 1B (L.B.) and 1 (P.C.) each contained 4 individuals.

TABLE 5 - POOL CLEAROUT - ANALYSIS OF DRY WEIGHTS FOR UNATTACHED FAUNA

LOGY BAY SPECIES	POOL 1A TOTAL No.	POOL 1A AVERAGE DRY WT. (g)	POOL 1A TOTAL DRY WT. (g)	POOL 1B TOTAL No.	POOL 1B AVERAGE DRY WT. (g)	POOL 1B TOTAL DRY WT. (g)	POOL 4 TOTAL No.	POOL 4 AVERAGE DRY WT. (g)	POOL 4 TOTAL DRY WT. (g)
Gammarellus angulosus	139	$7.1X10^{-5}$	.009	180	$5.6X10^{-5}$	.01	-	-	
Calliopius laevivsculus	130	$1.2X10^{-3}$	.156	3	-		-	-	
Gammarus oceanicus	1	$4.0X10^{-3}$	.004	-	-		-	-	
Hyale nilssoni	4	-		4	-		-	-	
Gammarus duebeni	-	-		-	-		1437	$4.7X10^{-2}$	67.54
TOTAL	274	$5.27X10^{-3}$	.169	187	$5.6X10^{-5}$	.01	1437	$4.7X10^{-2}$	67.54
	POOL 1			POOL 3			POOL 4		
Gammarellus angulosus	3	$3.0X10^{-3}$	.009	2	$5.0X10^{-4}$	.001			
Calliopius laevivsculus	20	$7.0X10^{-4}$	.014	4	$2.5X10^{-4}$	.001			
Gammarus oceanicus	6	$1.8X10^{-2}$	.108	-	-				
Hyale nilssoni	4	-		49	-				
TOTAL	33	$2.17X10^{-2}$	.131	55	$2.0X10^{-3}$	.002			

II. ATTACHED FAUNA

(a) Logy Bay - Pools 1A and 1B were completely cleared of all attached individuals and the figures obtained represent the total number of individuals in the pool. (Fig. 32 - Table 6).

In a comparison of the total populations within the pools certain species were found in greater abundance in one of the two pools. Mytilus edulis and Thais lapillus were found in greater abundance in pool 1A whereas Littorina saxatilis was observed in pool 1B with 1447 individuals as compared to 949 in pool 1A.

Littorina saxatilis - Littorina showed a preference for the mid-depth areas of pools 1A and 1B. (Figs. 26 & 27). Pool 1A showed that 87.14% of the individuals were found below a depth of 6 cms. In pool 1B, 56.73% of the individuals were collected from the 6-25 cm. depth.

Mytilus edulis - Mytilus edulis was also found at mid-depth levels in pool 1A where 85.2% of the individuals were attached below 11 cm. Also in pool 1B there were more individuals collected from the 21-25 and 26-30 cm. depths.

Thais lapillus - Thais lapillus was also collected from pool 1A where 70.6% of those collected were from the two mid-depth levels of the pool (6-10 and 11-15 cms.). Since only two individuals were collected in pool 1B at Logy Bay it is difficult to establish a pattern of distribution within the pools. The 17 individuals sampled from pool 1A and 2 from pool 1B indicate that conditions in pool 1A were more suitable for this species. (Fig. 32 - Table 6).

TABLE 6 - Distribution of attached species in pools 1A and 1B.

LOGY BAY

Pool No.	Depth cm	NUMBER Littorina saxatilis	Mytilus edulis	Thais lapillus
1B	0-5	168	24	1
	6-10	162	1	
	11-15	294	31	
	16-20	274	44	
	21-25	253	52	1
	26-30	117	63	
	31-35	179	37	
TOTAL		1447	252	2
1A	0-5	122	47	3
	6-10	280	65	6
	11-15	305	406	6
	16-20	242	235	2
TOTAL		948	753	17

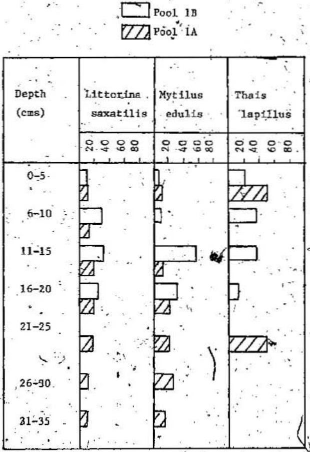


Fig. 32

Number and Distribution of Attached Fauna at Time of Clearout - Logy Bay.

Portugal Cove

(b) Samples of attached fauna during the pool clearout at Portugal Cove do not represent the total number of individuals in the pool as at Logy Bay. Samples obtained represent the total number sampled from a 150 cm^2 grid within each contour interval,(Fig. 33 - Table 7)

Littorina obtusata - In pool 1 Littorina obtusata showed a preference for the top 5 cms of pool depth as 76.16 % of the individuals sampled were located within the sample obtained from the 0-5 cms.depth. (Fig. 33 - Table 7)

In pool 3 at Portugal Cove of the 13 individuals observed 11 were located at the 21-25 cm level. Thus Littorina obtusata showed a preference for the lowest pool at Portugal Cove.

Littorina saxatilis - Only 32 were sampled from pool 1 but 327 were taken in pool 3. Distribution of Littorina saxatilis in pool 3 indicated that 42.29 % of the population was concentrated within the 21-25 cm level.

Mytilus edulis - Only 13 individuals were observed in pool 1 and 8 in pool 3. Those individuals taken were evenly distributed from top to bottom of the pools.

Thais lapillus - Thais lapillus was taken from pools 1 and 3. Histogram bars (Fig. 33) demonstrate, that the 10 individuals sampled were located at a depth of 16-30 cms.

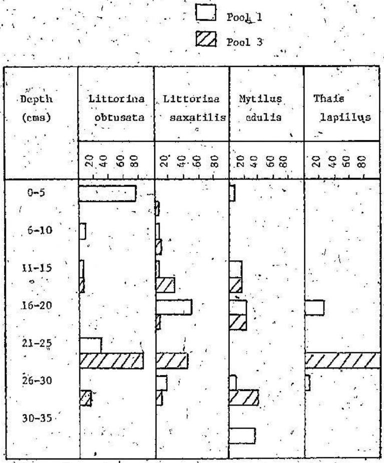


Fig. 33

Figure 33 Number and Distribution of Attached Fauna at Time of Clearout - Portugal Cove.

TABLE 7 – Number and Distribution of Attached Fauna at Time of Clearout at Portugal Cove.

PORTUGAL COVE

Pool No.	Depth cm	Littorina obtusata	Littorina saxatilis	Mytilus edulis	Thais lapillus
		NUMBER			
1	0–5	246		4	
	5–10	34	1		
	10–15	10	1	2	
	15–20	3	17	3	2
	20–25	30			
	25–30		13	4	6
TOTAL		323	32	13	8
3	0–5		14		
	5–10		20		
	10–15	1	69	1	
	15–20		9	1	
	20–25	11	96		2
	25–30	1	15	3	
	30–35		4	3	
TOTAL		13	227	8	2

FLORA

During the pool clearout some samples of flora were taken. Those species which could be accurately sampled and weighed were cleared from the pools, dried and weighed. However, certain species such as Clathromorphum circumscriptum could not be sampled because of their structure and growth pattern.

Portugal Cove - All plants were sampled and collected according to species and depth at which they were located.

As indicated by dry weight values (App. X) in pool 1 at Portugal Cove Corallina officinalis was the dominant alga. Maximum growth for this species occurred between the 6 and 20 cm. depth levels.

Chordaria flagelliformis grew best at mid-depth where total dry weight was 0.4g within the 11-15 contour interval. Chondrus crispus was found only in the 0-5 cm. contour interval where the dry weight was 0.4g.

In pool 3 at Portugal Cove Fucus distichus distichus and Cladophora rupestris were sampled quantitatively during the pool clearout. (Fig. 34, App. X). Both species were found to be more plentiful at the 21-25 cm. level of the pool where, for Fucus distichus distichus, 90.56% of the total dry weight for that pool was found. Cladophora rupestris was found to be concentrated at about the same level, as 83.23% of the total dry weight for this species was taken from within the 21-30 cm. level of depth. Thus, according to these results, it must be stated that the higher levels of this pool were not suited for substantial growth of these species.

Logy Bay - The only floral species cleared from pools at Logy Bay during the pool clearout was Fucus distichus distichus in pool 1A. (App. W)

In pool 1A the dry weight measurements are distributed evenly throughout the first 3 contour intervals whereas only 5% of the dry weight was accounted for in the lowest depth. It should be noted that due to the shape of the pool a collection of 35.62 g from the 10-15 contour interval indicates a much denser growth than would a 35-62 g weight from the 0-5 contour interval. Fucus distichus distichus was represented only by scattered plants in pool 1B.

BIOMASS

The total biomass of pools was also recorded for those organisms which were sampled during the pool clearout. Results for attached fauna and flora at Portugal Cove have been computed from 150 cm^2 samples. Results from Logy Bay are those recorded at the time of the clearout when the whole pool was sampled. An estimate of the average biomass per cm^2 of surface area was obtained for pool 1 and 3 at Portugal Cove and 1A and 1B at Logy Bay. (App. Y) Pool at Portugal Cove supported a greater biomass than those at Logy Bay. (Fig. 34)

Figure 34 - BIOMASS - Clearout

	PORTUGAL COVE		LOGY BAY	
	1	3	1A	1B
Littorina obtusata	106.060	343.400	-	-
Mytilus edulis	49.500	222.000	54.000	10.410
Thais lapillus	31.680	1616.000	4.170	.520
Hiatella arctica		4654.080		
Volsella modiolus		1220.080		
Nereis pelogica		24.240		
Littorina saxatilis		117.160	17.820	14.120
Acmaea testudinalis		286.840		
Gammarellus angulosus	.009	.001	.009	.010
Calliopius laeviusculus	.140	.001	.156	-
Gammarus oceanicus	.108		.004	.010
Gammarus duebeni				6.754
Corallina officinalis	436.820			
Chordaria flagelliformis	108.900			
Chondrus crispus	37.620			
Fucus distichus distichus	8.580			
Monostroma grevillei	1.320			
Fucus distichus distichus		642.300	93.420	2.720
		2145.240		
TOTAL	810.737g	11271.842g	169.659g	34.524g
Av. Biomass/cm^2	8.10g/cm^2	18836g/cm^2	1.23g/cm^2	.22g/cm^2

RESULTS III

Portugal Cove

Twelve hour survey 1 was completed on July 23, 1971 a sunny day on which high tide occurred at 8 a.m. Throughout the survey the ocean remained calm with 20-30 cm waves hitting the surrounding coastline. At high tide water only entered the lowest pool. Survey No. 2 at Portugal Cove occurred on July 5, 1972 a day with a high tide at 2 a.m.

Observation of graph survey No. 1 (Fig. 35, App. Z, A',E') shows that temperature increased steadily in pool 1 although it was under the influence of an incoming tide from 1 p.m. to 6 p.m. Surveys of pool contact with the sea (App. F') show that this pool received a complete replacement of water 45 times during the period from 9 a.m. to 9:15 a.m. Observation of the pool - sea contact figures at 8:00 also show that pool contact was frequent. Following 11:00 a.m. the pool received no contact with the sea. This isolation from the sea and 13.3 hours of sunshine attributed to the sharp rise in pool temperature during the day.

During 12 hour survey 2 which presented different meterological conditions of fog and overcast skies temperature rise was depressed. Due to an unusally calm sea no contact was made by the sea. Thus temperature remained relatively constant. (Fig. 35, App. C')

Figure 35. 12 Hour Surveys - Portugal Cove.

- Salinity (ppt)
- pH
- Temperature (^{o}C)
- Frequency of Water entry into pool 1.

Pool 1 ———

Pool 3 — — —

Pool 4 ....

Air —·—·

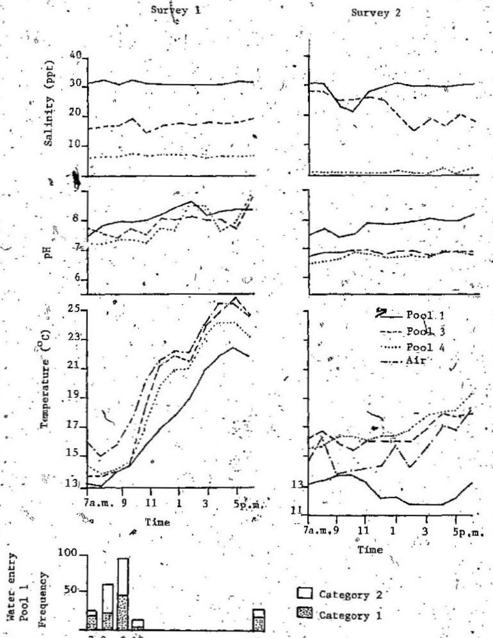

Survey 1
Survey 2
Salinity (ppt)
pH
Temperature (°C)
Pool 1
Pool 3
Pool 4
Air
7a.m. 9 11 1 3 5p.m.
Time
Water entry Pool 1
Frequency
7 8 9 10 a.m.
6p.m.
Category 2
Category 1

Fig.35

SALINITY

Results of salinity sampling from survey 1 (App. D') show that although the pool received 13.3 hours of sunshine with a high tide at 8 a.m., salinity values varied around an average of 31.6 $mgO_2/1$. .03 inches of rain in the morning may be responsible for the decrease in salinity in the surface layer during survey 2. (App. D') Pool 3 was less influenced by diurnal tides. (Fig. 35)

Pools 3 and 4 during survey 1 showed increases in temperature, pH, and salinity throughout the twelve hour observation period. Observations of water entering pools (App. F') showed that this pool had no contact with the sea during the twelve hour period. During survey 2 salinity decreased, pH remained constant and temperature increased only slightly due to the overcast rainshower conditions which existed on that day.

Salinity stratifications were much more pronounced in pool 3 than pool 1 during both twelve hour surveys, (Fig. 36) A large decline in the salinity of the top layer in pool 1 during survey 2 is attributed to showers which occurred during the morning and resulted in a reduction of salinity in the top layer. The increase in salinity following this decrease is due to the occurrance of a high tide at 2 p.m. which replenished the pool with fresh sea water of a higher salinity. Thus the lack of salinity stratifications in the pool must be attributed to its proximity to the sea.

In comparison pool 3 received no contact with the sea at high tide. Thus during both surveys salinity stratification is apparent. On both cases the bottom layers of water had salinity values approximately 20 ‰ higher for the increase in salinity.

Figure 36. 12 Hour Survey - Stratification - Portugal Cove.

This graph shows changes in salinity from 7 a.m. to 6 p.m. in pools 1 and 3 at Portugal Cove.

Survey 1 - Top ______

Survey 1 - Bottom _ _ _

Survey 2 - Top ....

Survey 2 - Bottom _._.

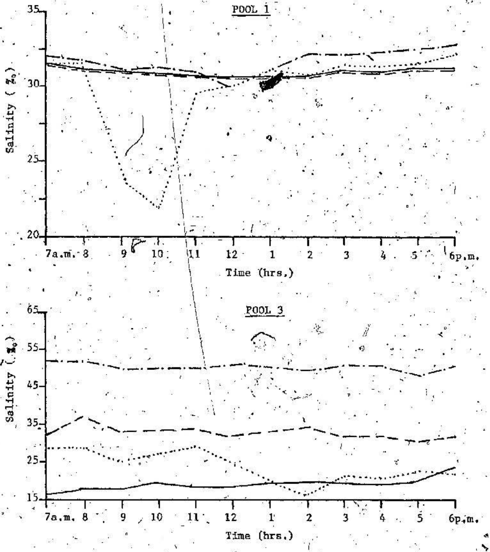

POOL 1
Salinity (‰)
35
30
25
20
7a.m.
8
9
10
11
12
1
2
3
4
5
6p.m.
Time (hrs.)
POOL 3
Salinity (‰)
65
55
45
35
25
15
7a.m.
8
9
10
11
12
1
2
3
4
5
6p.m.
Time (hrs.)

Fig.36

LOGY BAY

Twelve hour survey 1 was completed on July 14, 1971 on a clear day while survey 2 was completed on an overcast day. High tide occurred at 11:55 a.m. during survey 1 and 11:20 a.m. during survey 2. (Fig. 37)

Temperature - Results from surveys indicate that at this particular time the pools were not greatly influenced by the tidal cycles. Pool 1A received five complete changes of water (App. F') but the water temperature tended to increase. During both surveys the incoming tide tended to decelerate the temperature increase in the surface layers of the pool. (App. K',L') Similar pool temperatures were found in pool 1A at Logy Bay. (Fig. 37)

pH - Survey 1 indicated that in pools 1A, 1B and 4 pH increased steadily during the day although pools 1B and 4 increased only slightly. (App. D & E) (Fig. 37)

Salinity - Observation of salinity stratifications at Logy Bay closely approximated those at Portugal Cove. Pool proximity to sea again had an affect on the stratifications bhat occurred within the pools. (Fig. 37)

Figure 37. 12 Hour Surveys - Logy Bay.

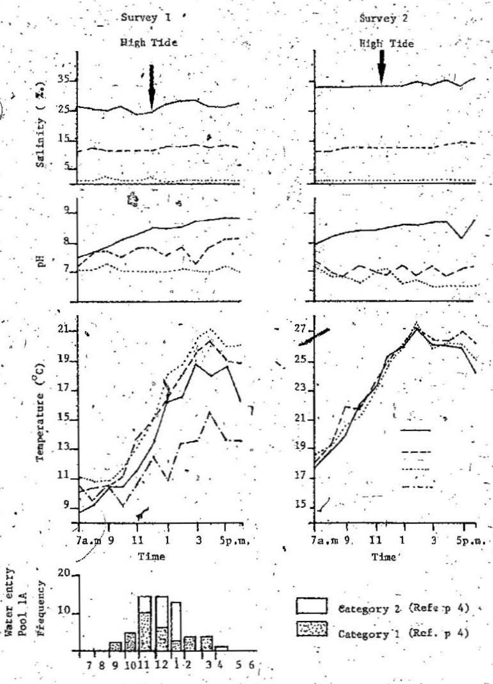
- Salinity (‰)
- pH
- Temperature
- Frequency of Water entry into pool 1A.

Pool 1A ______

Pool 1B _ _ _ _

Pool 4 ....

Air _._._.



Survey 1
High Tide
Survey 2
High Tide
Salinity (‰)
35
25
15
5
pH
9
8
7
Temperature (°C)
21
19
17
15
13
11
9
27
25
23
21
19
17
15
7a.m 9 11 1 3 5p.m.
Time
7a.m 9. 11 1 3 5p.m.
Time
Water entry
Pool 1A
Frequency
20
10
7 8 9 10 11 12 1 2 3 4 5 6
Category 2 (Ref. p 4)
Category 1 (Ref. p 4)

Fig. 37

DISCUSSION

Comparison of the six tidepools suggests that the occurrence and abundance of the flora and fauna can be correlated with physical and chemical observations.

The pools at Portugal Cove contain more species and a higher biomass/cm.^{2} than the pools at Logy Bay, but fewer individuals. This can be related to the greater wave exposure (environmental stress) at Logy Bay. A number of species were found only at Portugal Cove or in much greater abundance, at Portugal Cove than at Logy Bay. These include the algae Fucus edentatus, Cladophora officinalis, and the animals Metridium dianthus, Nereis pelagica, Asterias vulgaris, and Tonicella marmorea. Only Prasiola crispa and Elachistea lubrica were found at Logy Bay and not at Portugal Cove. Logy Bay has a more severe environment due to the more extreme conditions of wave exposure to which tidepool organisms are exposed, and has a lower number of species than Portugal Cove.

Similarly the number of species decreased as pool elevation increased in both locations, correlated with the greater emersion and consequent severity of environmental conditions. Thus, as emersion increases, fewer fresh and salt water species are able to survive in the tidepool environment (Ganning 1971).

A decline in the number of species in pools did not result in a decrease in pool biomass/cm^2. Pools located in the mid-littoral zone with the relatively moderate conditions had the largest biomass/cm^2.

Thus, the biomass of a tidepool is related to the moderated conditions for those species which can exist in a pool rather than on species diversity (Fig. 34).

PHYSICAL AND CHEMICAL POOL CHARACTERISTICS

Temperature:

As distance from the sea and height above sea level increased, the temperatures of the top layers of water in the pools more closely approximated the air temperature and thus became more extreme for the organisms.

Results from 12 hour surveys of pool temperature indicate that pool temperature ~~tends to increase~~ during the day although pools of lower elevation are more under influence of the ocean. Ganning (1971) has found that temperature increases more rapidly in the morning than it decreased in the afternoon. Results obtained from Logy Bay and Portugal Cove indicate that temperature rises very gradually reaching maximum between 4:00 p.m. and 5:00 p.m. on a clear sunny day. During the winter all pools froze. As reported by Ganning (1971) larger pools were found with unfrozen salt water at the bottom.

Ganning (1971a) also listed other factors which affect temperature variations in tidepools such as heat accumulation in the bedrock surrounding the pool and wind direction.

Salinity

Dahl (1956) has stated that as salinity decreases in a system, a transition from marine to brackish water occurs and a decrease in number of marine species follows. In this study, the average salinity of tide pools decreased as pool height increased, and the number of marine species decreased. Thus, although tide pools do not provide a gradual salinity change, a decrease in the number of marine species is observed in a step-manner from one pool to another. Carpelan (1967) has found that organisms capable of tolerating increases in salinity can also tolerate reductions in salinity. Species which can tolerate great increase or decrease in salinity can build up large numbers due to lack of competition. Pool 4 at Logy Bay demonstrated this fact. The only macroscopic species to have a stable population in pool 4 at Logy Bay where salinity often was less than 10 p.p.t. was Gammarus duebeni. No fresh water species were collected during the study.

Dahl (1944) has stated that salinity, when it increased above 12 p.p.t. caused Gammarus duebeni to leave the pool. These results are not in agreement with those by Ganning (1971) and Forsman (1951) or those obtained at Logy Bay in pool 4 where occasional increases in salinity to greater than 30 p.p.t. did not reduce the population. Beadle and Cragg (1940a) have stated, however, that Gammarus duebeni has a tolerance range from pure seawater to water with a trace of salt.

Biebl (1962) has stated that Fucus can tolerate a salinity range up to 3 times that of seawater. This was not observed during the sampling as the highest salinity observed in a pool with Fucus was pool 3 at Portugal Cove where salinity was 43.9 p.p.t. Thus, salinity cannot be considered to have been a limiting factor for Fucus.

pH

The pH of a rockpool is affected by the amount of algae present

(Ganning 1971). In pools sampled at Logy Bay and Portugal Cove this was not strikingly evident as pools with abundant algae only showed higher pH values on some occasions. Contrary to the conclusions of D.de Verville (1935) no variation in pH between winter and summer was found. Also, Klugh (1924) has stated that pool elevation has an effect on pH but the elevation of a pool was not observed to be correlated with variations in pH in this study.

Gail (1919) has reported that when the temperature of pool water is 24°C or greater with a pH between 7 and 8.6, Fucus starts to die. Decaying Fucus was found in pool 3 at Portugal Cove where pH was constantly between 7 and 8.6 during the months of June and August, when temperatures greater than 24°C were recorded on 7 of 33 occasions.

Although there was only a slight decrease in the coverage of Fucus in this pool during the months of J-J-A, the alga appeared to be rotting and changing color. Other pools which contained Fucus did not show this discoloration. It is concluded that this alga in pool 3 was adversely affected by the increase of pH and temperature beyond its acceptable range.

%Oxygen Saturation

% Oxygen saturation of the pools varied little during the year. Reductions in temperature will increase oxygen saturation. Maximum % oxygen saturation values of 195 % and 300 % have been reported by Pyefinch (1943) and Utinomi (1950) respectively. Maximum saturation value found at Portugal Cove was 24 % in pool 3 which contained greatest algae/cm.^{2} of all pools studied.

Diurnal variations in oxygen saturation (App. M) indicate that mg.O_2/l. decline during the night, with minimum values of 1.97 - 3.33 mg.O_2/l. indicating the lack of photosynthesis. Stratification of oxygen in pools usually disappears at night but oxygen gradients have formed by early morning. Similar variations in oxygen stratification were reported by Ganning (1971). However, on occasion increased in mg.O_2/l. were recorded during the night due to changes in temperature and salinity, particularly in pool 4 at Logy Bay. When reductions in mg.O_2/l. did occur at night they were greater in bottom layers of pool water than inthe top layer indicating that organisms in shallow areas of a pool will be exposed to higher oxygen concentrations for a longer period of time than would those organisms in deeper areas of the pool.

STRATIFICATION IN POOLS

Throughout the study certain species were found more frequently or with greater coverage at particular levels within the tide pools.

In the majority of pools studied organisms were restricted to particular levels within the pools. Ganning (1971) has stated that in his studies of Baltic rockpool systems, little evidence of pool depth preferences of organisms were found. This restriction of a species to a particular level within a pool may be related to inter-specific competition or to physical-chemical conditions.

Ganning (1971) has noted that salinity stratification was only found in low pools after extremely calm of rainy weather. It should be noted that results obrained for Portugal Cove and Logy Bay do not demonstrate great variations in degree of salinity stratification. However, as pool elevation increased the degree of stratification becomes greater. Ganning (1971) has noted that moderate winds, convection and biological activity tend to destroy salinity stratifications. The shallowness of most pools studied here may be responsible for the lack of constant salinity stratification within the pools.

Ganning (1971) has reported that pH gradients are distinct within pools when they are influenced by sunshine but are less so during cloudy periods. Although this did occur on some occasions at Logy Bay the number of observations was not significant.

During the 12 hour survey 1, at Portugal Cove, pools 3 and4 showed that pH at the bottom of the pools was constantly higher than that of the surface water. However, in pool 1 at Portugal Cove this was observed on only 3 of 12 occasions. In other cases the pH of surface water was higher than that at the bottom. This can be attributed to two factors. First, algal growth was more dense in pool 1 than either of pools 3 or 4. In fact, variations in pH from top to bottom of pools may be directly related to the amount of algal growth.

In the pools studied in both areas 21% of observations made showed that temperature of the bottom layer of the pool was higher than that of the top layer. A burning glass effect which causes temperature of bottom pool water to be higher than that at the top was reported by McGregor (1965) in New Zealand rockpools, and Ganning (1971) in Baltic rockpools. McGregor (1965) has explained the burning glass effect as being caused by salinity of surface water being less than that of bottom water. Since this condition was observed at Logy Bay and Portugal Cove on 23 out of 28 occasions the burning glass effect could explain the increased bottom temperatures in the pools studied. The bottom layer of water in the pool may also have been warmer because of the substration which consisted of dark rocks which can absorb sunlight.

Flora and Fauna of Pools - Stratification and Relation to Physical Factors.

In the following, each pool including the flora and fauna and the physical factors affecting them has been discussed as a unit. This section also includes a description of some species which were mainly restricted in their distribution to one of the three pools in each area. These species were also discussed in relation to physical factors.

LOGY BAY

Pool 1A

Pool 1A at Logy Bay was the most wave exposed pool studied during the year and this caused the ice conditions to be less severe than in other pools studied. Coverage of the pool with ice during February was minimal compared to that found in Portugal Cove.

Littorina saxatilis was numerous throughout the 12 month survey. The abundant algae in this pool provided a constant food supply for this species. This, combined with temperature and salinity conditions where lethal levels were never reached (Gowanloch 1926), enabled this species to be well established in the pool.

In the clearout, Littorina saxatilis was found to be a dominant faunal component (Table XV) and preference for the lower pool depths has been established from annual and clearout results. This is in contrast to results for pool 3 at Portugal Cove where Littorina saxatilis was restricted to mid-depth areas of the pool. The concentration of Fucus distichus distichus in lower pool depths has also been established. The lack of an upper limit caused by fluctuations in pool water depth may also have enabled this alga to survive in very shallow pool areas. The proximity of this pool to the ocean, resulting in frequent pool - ocean contact kept the depth of this pool relatively constant. This may account for the lack of a well defined Fucus distichus distichus band as was found in pool 3 at Portugal Cove. The lack of any detrital matter or an abundant Verrucaria growth at a particular depth on the pool substrate may also have enabled Fucus distichus distichus zygotes to become attached and begin to develop. The coverage of Fucus remained constant throughout the year with the exception of M-A-M when the average values were greatly reduced. During this period Fucus distichus distichus was found only in the deeper areas and here coverage was only 20%. The freezing of the pool during the winter may be responsible for the drop in coverage. Pilayella littoralis was found to be a plant of the spring flora (Taylor 1937) in pool 1A.

At the time of the pool clearout both Littorina saxatilis and Mytilus edulis were found in greatest quantity in deep pool layers. Since one of the most important adaptations of these species is attachment, this must be considered to also be a factor which caused this stratification of organisms, since the deeper areas of the pool would provide more protection from wave action.

Of the free swimming fauna present at time of clearout Gammarellus angulosus and Calliopus laevivsculus were most common. However, in comparison to pool 1 at Portugal Cove the size of these animals varied. Gammarellus angulosus found at Logy Bay were greater in number than those at Portugal Cove, but those at Logy Bay were smaller individuals. Calliopus laevivsculus were also greater in number at Logy Bay than Portugal Cove, but those at Logy Bay were also larger individuals. Thus, the number of individuals a pool can support is dependent on their number and size and these results indicate that larger Gammarellus angulosus are better adapted to the Logy Bay area since here a sustained productive population existed with young and mature individuals. This species is also known to be abundant in areas of high exposure (Steele, D.H. & V.J. Steele - 1972) which may be responsible for the larger population at Logy Bay. Gammarus oceanicus and Hyale nilssoni were found in pool 1A, but as in pool 1 at Portugal Cove their numbers were very small.

LOGY BAY

Pool 1B

The degree of exposure to wave action of this pool closely resembles that of pool 3 at Portugal Cove. In general, however, ice conditions at Logy Bay were not as severe as those at Portugal Cove where sea ice was pushed and washed up onto the tidepool zone. A band of exposed rock surface existed around the shallow areas of this pool. Fluctuations in water level may be responsible for the lack of algal cover in shallow areas. Although a Fucus distichus distichus plant did occur occasionally in this pool conditions were evidently not suitable for this species and a population did not become established.

On one occasion Rhizoclonium riparium formed a dense mat over the pool. However, Rhizoclonium riparium disappeared completely during the months of D-J-F but Verrucaria, although it became reduced, was present in the pool throughout all sampling periods. The ability of this alga to withstand extremes of salinity may be responsible for its presence in this pool.

The largest resident population of animals consisted of

Littorina saxatilis whose population numbers remained stable from June (192) to November (196). The following spring the population of Littorina had been reduced to 81 individuals. The heavy ice cover could be responsible for the decrease in population during the winter months. Migration experiments by Gowanloch (1926) also indicate that migrations away from the upper intertidal zone to the low tide area occur.

Although Jaera ischiosetosa were found in the pool during J-J-A, their numbers were insignificant for the rest of the sampling year/ Jaera ischiosetosa were also never found in the deep areas of the pool.

Pool 4

This pool had the most extreme environmental conditions and the only organisms found were Verrucaria microscopic Cyanophytes and Gammarus duebeni. No indications of plant stratification were found. Gammarus duebeni were usually found in the deepest areas of the pool often buried in the 5 -10 cms. 66 detrital materiall. On a few occasions dead Mytilus edulis and Acmaea testudinalis were found in this pool. These were possibly transported by wave action during storms or herring gulls.

PORTUGAL COVE

Pool 1

The dominant forms of algae were Corallina officinalis and Clathromorphum circumscriptum. As reported by Taylor (1937) Corallina officinalis was found to have short crowded blades which formed a mat over the areas of the pool substrate which it covered. Greatest coverage of Corallina officinalis was recorded during August and September in the top section of the sampling grid demonstrating the preference of this alga for shallow areas of the pool. Clathromorphum circumscriptum was most abundant in the deepest areas of the pool with maximum coverage values recorded during July and August. Ballantine (1961) has found Corallina officinalis to be common in pools on semi-exposed coasts where wave action is reduced. Therefore, variations in wave exposure must be considered to be responsible for Corallina officinalis distribution..

Monostroma grevillei is a plant of the spring flora in tidepools (Taylor 1937). The M-A-M sampling period showed the greatest coverage of this alga in pool 1.

Littorina obtusata was abundant in the shallow areas of the pool due to the sheltered conditions. Ballantine (1961) has found Littorina obtusata to be common only in sheltered coastal areas.

During the pool clearout 33 Amphipods were found including Gammarus oceanicus which is known to be absent from exposed rocky shores where there is little loose rock (Steele, V.J. & Steele, D.H. - 1972) which explains the small numbers found in this pool. Gammerellus angulosus which is most abundant with high exposure (Steele, D.H. & Steele, V.J. - 1972) was only represented by 3 individuals. The dominant amphipod found during this pool clearout was Callippius laeviusculus.

Pool 3

Fucus distichus distichus was the most abundant alga in this pool throughout the sampling period and occured at a depth of 10-20 cms. Rarely were plants found in quantity above or below this ring. As described previously the condition of this species was affected by periodic high pH temperatures. (p. 98)

Fucus distichus distichus occurred more frequently in the sheltered environment of pool 3 than in pool 1. The upper limit of growth for this species in pool 3 can be attributed to the fluctuation in pool depth which varied from 15.24 to 36.6 cms. The reduction in this species as pool depth increased below 20 cms, may have been caused by competition with other species of which covered the substrate at depths below 20 cms. reducing opportunity for attachment of Fucus zygotes. The absence of Fucus distichus distichus from the deeper pool areas did not appear to be related to any physical factors of temperatures, pH or salinity as all were in the acceptable range for this species. Verrucaria tended to increase coverage as depth increased and the presence of this species on a rock surface might hinder attachment of Fucus distichus distichus.

Ralfsia fungiformis and Verrucaria were found growing in areas which were 20-30 cms. deep. These species were not restricted to these areas but throughout both the year and during pool clearout they were found in greatest abundance at this depth. This may have been due to the stagnation of the deepest parts of the pool and an accumulation of pool debris. Previous studies on Ralfsia indicate that it is most frequently found in shallow water (Prescott 1968). The presence of tidepools has enabled Ralfsia to live in areas of higher elevation in the littoral where they can be continually submerged in the shallow water of tidepools. The reason for their great abundance at a depth of 2-30 cms. may be related to optimal light requirements for Ralfsia fungiformis.

Littorina saxatilis individuals were found in greatest quantity above and within the Fucus distichus distichus band that existed in the pool. The presence of a food supply, Fucus and its epiphytes, may be responsible for this tendency. The greatest population found within the pool was during the S-O-N sampling period. In pool 3 this species was the dominant animal, since out of 250 individuals of attached animals collected 227 were Littorina saxatilis.

Maximum temperature of 43°C and a minimum salinity of 15‰ are the lethal levels for this species (Gowlanloch 1926). A lethal temperature level was not reached during the seasonal observations. However, in pool 3 lethal salinity levels were occasionally reached and are correlated with a decline in the number of individuals during those periods. On some occasions a drop in salinity below 15‰ at a particular pool level would cause a decline in the population of this species throughout the pool.

Mytilus edulis whose maximum growth rate is when specimens are submerged to a depth of one foot (Newcombe 1935), was also found to be present in the pool but this species did not maintain a population throughout the year.

Observation of Isopods indicated that a positive correlation existed between sunlight and isopod distribution. On sunny days most isopods were found in the shallow areas of the pools, whereas on cloudy dull days they tended to be found from mid-depth to the bottom of the pool. This distribution pattern did not seem to be related to pool temperature. It is also possible that the amount of light entering the pool directly affects the behaviour of these animals. Observations on the oxygen content of the pool at different levels indicate that there are differences in dissolved oxygen and these may cause isopods to move from one level to another.

The greatest number of isopods in the pool occurred in July and August with a decrease in numbers in S-O-N and a smaller number in M-A-M of the following year. This suggests an annual cycle within the pool with maximum numbers in summer and minimum numbers in D-J-F period.

Although no definite identifications of the isopods were made during the annual sampling periods the pool clearout indicated that all isopods collected were Jaera ischiosetosa. An annual life cycle has been reported by Steele D.H. & Steele, V.J. (1972) with breeding occurring in spring and summer. As previously stated the largest numberoof isopods in the pool was found during July and August indicating that breeding had taken place followed by a reduction in the number of individuals.

Pool 4

This pool was similar to pool 4 at Logy Bay except that Verrucaria was more patchy and two species of green algae occurred seasonally.

Stratification of plants was observed with Pseudendoclonium submarinum and Rhizoclonium riparium. Rhizoxlonium riparium was restricted mainly to the bottom of the pool and *Pseudendoclonium submarinum* was restricted to the shallow areas. *Gammarus duebeni* was observed in this pool particularly when *Rhizoclonium riparium* became abundant.

SUMMARY

1. Species which would normally be restricted to the submerged zone are able to live higher in the littoral due to their ability to adapt to tidepool conditions.
2. The amount of wave exposure to which a coast is subjected will affect the stratification in pools since a more exposed coast provides more opportunity for mixing.
3. Organisms which occur in tidepools are often restricted to a specific depth within that pool due to competition or physical factors which exist.
4. Tidepool height is negatively correlated with the number of species due to the smaller number of species which are able to withstand severe conditions.
5. Tidepools which have the largest biomass are not necessarily those most influenced by the ocean but are pools in which moderate conditions of exposure and submergence exist.
6. As pool elevation increases temperature is more influence by air temperature and less by the temperature of the ocean.
7. Salinity of pools decreases as elevation increases as pools high in the littoral are influenced more by rainfall than evaporation.
8. While some species are found living in both tidepools and the surrounding area others are not able to take advantage of the less severe tidepool environment.

9. Meteorological conditions affect all physical factors but daily fluctuations in temperatures are greater than changes in other physical factors.

10. Increased wave exposure is negatively correlated with the number of species in tidepools, but is not correlated with pool biomass.

11. Increased wave exposure is correlated with larger numbers of fewer species inhabiting the tidepools.

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APPENDIX A

ELEVATION OF POOLS

(Height above mean sea level)

PORTUGAL COVE

Pool 4 - 3.47 m

Pool 3 - 1.90 m

Pool 1 - 1.23 m

LOGY BAY

Pool 4 - 5.41 m

Pool 1B - 2.85 m

Pool 1A - 1.94 m

APPENDIX B

Pool Depth and Depth of Samples Obtained.

PORTUGAL COVE				LOGY BAY			
DATE	4	3	1	DATE	4	1B	1A
28-v-1971	14.24	34.54	26.03	19-v-1971	41.91	43.18	27.94
6-vi	23.87	37.92	29.21	26-v	39.37	42.92	27.94
11-vi	20.32	36.30	29.21	2-vi	44.45	44.45	36.83
18-vi	22.35	34.29	32.76	9-vi	41.27	43.81	31.24
25-vi	26.03	37.78	31.60	16-vi	45.08	43.81	29.97
2-vii	25.71	36.51	31.11	23-vi	40.00	38.73	27.30
9-vii	24.13	35.24	27.62	30-vi	43.49	44.45	28.60
29-vii	33.65	33.65	28.89	7-vii	46.35	43.81	29.46
13-viii	35.24	35.24	33.02	21-vii	45.40	43.49	28.24
20-viii	34.92	34.92	29.84	28-viii	42.86	39.37	28.57
27-viii	34.29	34.29	31.43	12-viii	42.70	39.30	29.30
3-ix	35.80	35.80	22.00	18-viii	44.45	41.91	33.65
10-ix	36.50	36.50	25.70	25-viii	44.13	44.45	29.21
24-ix	36.50	36.50	25.10	1-ix	44.45	43.81	-
22-x	36.50	36.50	31.50	8-ix	44.20	43.20	29.50
2-xii	36.60	36.60	30.40	22-ix	43.20	42.50	27.90
12-ii-1972	-	-	26.40	3-xi	45.30	43.50	31.50
19-ii	-	37.00	27.20	2-xii	45.00	42.60	43.00
18-iii	-	36.20	28.10	12-ii-1972	-	23.50	36.00
22-iv	23.70	26.00	23.70	16-iii	Fr.	Fr.	Fr.
10-v	30.70	35.00	30.20	21-iv	46.00	38.40	30.80
23-v	23.70	35.50	32.20	27-iv	45.50	38.50	29.10
13-vi	23.60	35.60	30.30	15-v	39.00	43.00	27.80
				28-vi	40.50	38.50	24.60
AVERAGE DEPTH	28.80	35.60	28.90	AVERAGE DEPTH	30.37	41.35	43.39

APPENDIX C

Temperatures - Logy Bay

DATE	SEA TEMP.	POOL 4 AIR	POOL 4 TOP 0 cm	POOL 4 MID 21.69cm	POOL 4 BOT 43.39cm	POOL 1B AIR	POOL 1B TOP 0 cm	POOL 1B MID 20.67cm	POOL 1B BOT 41.35cm	POOL 1A AIR	POOL 1A TOP 0 cm	POOL 1A MID 15.18cm	POOL 1A BOT 30.37cm
19v	3.0	15	15.4	12.5	13	17	16	14.5	14.5	18	16	12.5	11
26v		12.2	11.1	11.1	11.4	12.2	13	11.9	11.8	12	12.5	11	10.5
2vi	5.5	8	14	17.9	17.0	8.1	11.1	13	13.2	8	6.8	7	6.8
9vi	6.0	9.1	10.0	10.2	10.1	7.1	9.8	9.7	10.0	7	6.9	6.9	6.9
16vi	5.0	24.1	20.9	19.9	18	24.9	22	24	20	25	14.1	13.5	12
23vi	8.0	15.6	23	22.1	21.3	15.2	24	22.9	22	18.9	26	23	19.9
30vi	8.0	13.1	15.1	15.9	15.2	11.9	14.7	14.2	14	11.9	9.9	9.2	9.1
7vii	8.0	17.9	18.9	19.1	17.1	19.1	20.4	19.5	18.4	17.7	17.8	18.9	16.1
21vii	10.0	24	21.9	21.2	19.9	22.3	21.2	21.2	21.2	22.1	20.1	21.7	18.9
28vii	12.0	12.1	21.1	21.5	20.8	18.9	22.1	22.3	22.1	18.9	21.1	21.2	19.5
12viii	14.0	27.5	25.9	25.2	23.7	27.5	26.2	26.5	25.9	26.4	26.1	25.9	23.6
18viii	16.0	15.7	17.1	17.2	18.1	16.4	16.1	17.1	18.9	16.4	16.0	16.0	16.0
25viii	13.0	23.3	24.5	23.6	22	25.1	23.5	27.1	25.9	25.3	22.4	24.7	21.0
1ix	12.5	16.4	18.8	18.5	17.5	16.3	15.5	15.5	15.5				
8ix	11.5	22.9	20.1	18.5	16.9	22.4	20.2	18.5	18.1	21.5	18.2	17.5	15.5
22ix		21.7	20.3	19.5	17.9	21.5	20.6	20.4	19.9	20.9	19.5	18.9	15.5
3xi		6.7	6.1	5.5	6.3	6.5	6.1	5.5	6.1	8.5-1	6.1	6.1	6.1
2xii	5.5	-1	.8	.9	1.1	-1	2	2.5	2.8				
12ii72						-1.9	-1.8	-1.4			-16.2	-1.5	-1.4
16iii	-1.0	2.2	2.2	2.2							.2	.2	.2
21iv	0.0	1.9	3	2.3	3.5	1.9	2.9	2.5	2.6	1.9	2.5	2.8	3.2
27iv	0.0		4.5	6.5	6.5		4	6.7	6.5		4.5	5.2	4.9
15v	3.0	24.1	15	13.5	11.9	24.1	15.2	14	12.5	24.1	14.5	13.6	10.4
28vi	11.5	25.5	24.1	23.0	22.1	25.5	24.1	24.0	23.5	25.5	24.1	24	22.1

APPENDIX D

Temperatures - Portugal Cove.

DATE	POOL 4 TOP	POOL 4 MIDDLE	POOL 4 BOTTOM	POOL 3 TOP	POOL 3 MIDDLE	POOL 3 BOTTOM	POOL 1 TOP	POOL 1 MIDDLE	POOL 1 BOTTOM
	0	14.4	28.9	0	17.8	35.6	0	14.4	28.8
28-v-1971	32.4			33.8	33.4	33.4	32Q4	31.6	32.0
4-vi	.8	.7	26.8	33.6	32.6	33.8	31.6	30.4	30.6
11-vi	2.2	3.3	14.2	31	30.6	30.8	29.8	30.0	29.0
18-vi	2.1	2.0	10.9	29.8	10.5	30.1	29.1	28.7	28.2
25-vi	30	29.8	29.8	29.1	30.2	30	30.20	29.6	30.0
2-vii	2.8	29.2	28.6	28.6	28.2	28.1	28.1	28.1	28.1
9-vii	10.0	22.3	27.1	16.0	33.1	10.0	30.2	30.2	30.2
29-vii	10.2	10.1	10.1	31.7	32.5	33.4	30.3	29.9	29.4
13-viii	1.7	1.8	8.4	10.3	32.1	35.7	29.4	29.2	29.4
20-viii	28.9	28.9	29.3	28.0	28.5	28.6	27.3	28.0	28.0
27-viii	16.7	30.2	30.3	31.1	31.1	31.1	30.8	30.8	30.8
3-ix	27.0	27.2	27.1	26.4	22.2	27.1	25.8	24.9	25.2
10-ix	19.4	24.6	28.8	29.9	29.2	28.8	28.8	28.8	28.8
24-ix	28.5	29.0	28.9	29.1	29.5	29.1	30.1	29.6	30.0
22-x	30.2	30.9	30.4	30.3	28.8	30.4	28.4	28.4	29.0
2-xii	27.5	31.4	31.4	31.8	30.9	32.4	32.0	32.0	32.0
12-ii-1972	-	-	-	-	-	-	34.8	34.8	37.0
19-ii	-	-	-	28.2	30.8	37.4	29.8	26.5	29.7
18-iii	-	-	-	10.3	27.6	35.5	19.9	27.6	27.9
22-iv	30.0	30.0	30.6	29.1	29.5	29.5	29.7	29.7	29.7
10-v	4.9	24.3	31.7	29.0	31.5	31.1	29.1	29.9	30.0
23-v	3.6	22.2	28.5	19.4	33.8	37.8	32.3	32.0	31.7
13-vi	1.9	14.4	20.9	21.3	41.0	43.9	29.8	33.5	33.5

APPENDIX E

Salinity - Portugal Cove

	POOL 4			POOL 3			POOL 1		
DATE	TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM
	0	14.4	28.9	0	17.8	35.6	0	14.4	28.8
28-v-1971				33.8	33.4	33.4	32.4	31.6	32.0
4-vi	.8	.78	26.8	33.6	32.6	33.8	31.6	30.4	30.6
11-vi	2.2	3.3	14.2	31	30.6	30.8	29.8	30.0	29.0
18-vi	2.1	2.04	10.9	29.8	10.5	30.1	29.1	28.7	28.2
25-vi	30	29.8	29.8	29.1	29.9	30.2	30.20	29.6	30.0
2-vii	2.8	29.2	28.6	28.6	28.2	28.1	28.1	28.1	28.1
9-vii	10.0	22.3	27.1	16.0	33.1	31.8	30.2	30.2	30.2
29-vii	20.2	10.1	10.1	31.7	32.5	33.4	30.3	29.9	29.4
13-viii	1.7	1.8	8.4	10.3	32.1	35.7	29.4	29.2	29.4
20-viii	28.9	28.9	29.3	28.0	28.5	28.6	27.3	28.0	28.0
27-viii	16.7	30.2	30.3	31.1	31.1	31.1	30.8	30.8	30.8
3-ix	27.0	27.2	27.1	26.4	22.2	27.1	25.8	24.9	25.2
10-ix	19.4	24.6	28.8	29.9	29.2	28.8	28.8	28.8	28.8
24-ix	28.5	29.0	28.9	29.1	29.5	29.1	30.1	29.6	30.0
22-x	30.2	30.9	30.4	30.3	28.8	30.4	28.4	28.4	29.0
2-xii	27.5	31.4	31.4	31.8	30.9	32.4	32.0	32.0	32.0
12-ii-1972	-	-	-	-	-	-	34.8	34.8	37.0
19-iii	-	-	-	28.2	30.8	37.4	29.8	26.5	29.7
18-iii	-	-	-	10.3	27.6	35.5	19.9	27.6	27.9
22-iv	30.0	30.3	30.6	29.1	29.5	29.5	29.7	29.7	29.7
10-v	4.9	24.3	31.7	29.0	31.5	31.1	29.1	29.9	30.0
23-v	3.6	22.2	28.5	19.4	33.8	37.8	32.3	32.0	31.7
13-vi	1.9	14.4	20.9	21.3	41.0	43.9	29.8	33.5	33.5

APPENDIX F

Salinity - Logy Bay

	POOL 4			POOL 1B			POOL 1A		
DATE	TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM
	0	21.69	43,39	0	20.67	41,35	0	15,18	30,37
M-26-1971	7.20	8.90	21,0	30.6	31,3	30,5	27,8	26,8	27,4
J- 2	3.20	55.70	12,0	13,3	26,2	28,2	30,0	29,8	30,4
9	9.2	6.5	6.5	6.1	32,2	33.0	32.4	32,6	33.0
16	3.1	4.1	5,1	21,2	30,2	30,9	32.0	31,7	31,8
23	4.5	4.1	4.1	28.4	30.0	30.6	38.5	42,2	42,9
30	4.2	4.4	3.5	31,0	30,7	30,6	31,6	30,7	31,3
J- 7	2.3	2,6	2,8	14,4	25,1	26,0	6,2	28,9	29,2
21	.9	.9	.9	14,8	17,3	22,2	9,4	24,9	29,1
28	1.1	1.1	1.1	19.0	18,9	19.1	24.5	25,9	28,0
A-12	.6	.6	.6	12,6	22,7	26,2	33,9	34,8	34,8
18	1.7	1.7	1.7	10.5	12,4	23.7	26,9	27,7	29,9
25	.9	.9	.8	21.6	26.9	29.7	14,3	28,5	28,8
S- 1	3.2	3.1	2,8	30,5	30.3	30,3	-	-	-
8	3.2	2.6	2.8	24,8	25,0	30,9	28,8	30,9	31,4
22	5.9	5.9	6,0	-	28,2	28.4	27,4	30,3	29,7
N- 3	20.8	24.3	27,3	23.8	26,8	28,9	26,2	26,3	26,4
D- 2	13.7	14.3	31.8	33.8	33.0	33.2	-	-	-
F-12-1972	-	-	-	32,3	32.3	32.6	31,2	29,6	31,7
M-16	1.6	1.6	1,6	-	-	-	,6	,6	,6
A-21	29.8	30.4	31.5	29.4	29.8	30,9	29,1	29,2	29,9
A-27	9.9	31.5	32.3	8,9	30,4	30,4	6,9	28,1	28,2
M-15	12.1	18,1	30,6	23.4	31,7	32,3	27,2	31,4	32,1
J-28	8.0	8.1	18,9	15.6	15,1	21,0	42,1	42,1	40,9

APPENDIX G

Tidal Levels

PORTUGAL COVE SAMPLING DATE	PORTUGAL COVE WATER LEVEL OF SEA AT 1500 hrs.	LOGY BAY SAMPLING DATE	LOGY BAY WATER LEVEL OF SEA AT 1500 hrs.
28-v-71	- 30.48 cms	19-v-1971	+ 8.13 cms
6-vi	+ 3.05	26-v	- 48.77
11-vi	- 39.62	2-vi	+ 15.24
18-vi	+ 18.29	9-vi	- 21.34
25-vi	- 45.72	16-vi	+ 15.24
2-vii	+ 18.29	23-vi	- 45.72
9-vii	- 48.77	30-vi	+ 3.05
29-vii	+ 3.05	7-vii	- 27.43
13-viii	+ 21.34	21-vii	- 27.43
20-viii	- 39.62	28-vii	- 3.05
27-viii	- 3.05	12-viii	+ 15.24
3-ix	- 15.24	18-viii	+ 18.29
10-ix	+ 3.05	25-viii	- 24.98
24-ix	- 15.24	1-ix	+ 24.38
22-x	- 33.53	8-ix	- 39.62
2-xii	- 39.62	22-ix	- 42.67
12-ii-1972	- 6.10	3-xi	- 39.62
19-ii	- 36.58	2-xii	- 39.58
18-iii	- 57.91	12-ii-1972	- 6.10
22-iv	0	16-iii	- 64.01
10-v	0	21-iv	
23-v	+ 3.05	27-iv	
13-vi	- 45.72	15-v	- 57.91
		19-vi	
		28-vi	
		13-vi	

Mean water level at St. John's Reference port (Index No. 0905) - 76 cm.

APPENDIX H

pH - Portugal Cove

	POOL 4			POOL 3			POOL 1		
DATE	TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM
	0	14,4	28.9	0	17.8	35.6	0	14.4	28,8
28-vi-1971	–	–	–	8,6	8,6	8,6	8,3	8,4	8,3
4-vi	7.1	6.9	7.9	8.4	8.4	6,8	8,0	8,0	7.8
11-vi	6.8	6.7	6.8	7.1	7.7	8.0	7,2	7,5	7.5
18-vi	6.9	6.8	8.4	8.1	7.0	7.4	7.8	7.8	7.8
25-vi	8.0	7.5	7.9	7.8	7.9	7.7	7.9	7.8	7.7
2-vii	7.1	8.1	8.3	7.5	8.2	8.1	7.5	7.7	7.8
9-vii	8.5	8.2	8.9	6,7	8.5	8,0	8,21	8.1	8.1
29-vii	7.6	7.5	7.3	8.5	7.7	7.6	7.9	7.9	7.4
13-viii	6.5	6.5	6.7	6.3	7.5	7,0	6.8	7,0	6.9
20-viii	8.3	7.9	7.6	8.2	8.3	7.3	7.7	7.9	7.9
27-viii	7.9	8.6	8.1	8.5	8.5	8,6	7.9	7.9	7.9
3-ix	8.3	8.3	8.2	8.7	8.7	6.6	7.9	7.9	7.9
10-ix	7.7	8.2	8.0	8.25	8.2	8.4	7,8	7.8	7.8
24-ix	8.0	7.8	7.5	8.1	8,1	8.1	7.6	7.0	7.6
22-x	8.1	8.1	8.1	8.2	8.2	8.3	7.7	7.9	7.9
2- xii	8.0	8.0	8.1	7.7	7.7	8.0	7.8	8.0	7.7
12-ii-1972	–	–	–	–	–	–	7.8	7.9	7.7
19-ii	–	–	–	7.5	7.8	8.1	7.9	7.9	7.9
18-iii	–	–	–	8,6	8,2	–	8.3	8.5	8.3
22-iv	8.1	7.9	8.5	8.6	8.5	8.4	7.9	7,9	7.9
10-v	8.0	8.9	8.7	8.4	8.6	8.9	7.6	7.8	7.9
23-v	8.7	9.1	9.1	8.5	8.7	8.5	7.8	7.9	7,9
13-vi	8.1	7.8	8.9	7.4	8.1	8,0	8.1	8.3	8.3

APPENDIX I

pH - Logy Bay

DATE	POOL 4			POOL 1B			POOL 1A		
	TOP 0	MIDDLE 21,69	BOTTOM 43,39	TOP 0	MIDDLE 20,67	BOTTOM 41,35	TOP 0	MIDDLE 15,18	BOTTOM 30,37
M - 4-71	9.31	-	-	9.65	-	-	9.41	-	-
9	9.30	-	-	9.61	-	-	9.55	-	-
19	9.39	-	-	9.50	-	-	9.36	-	-
26	10.1	10.2	10.54	9.85	9.96	9.92	5.13	9.49	9.51
J - 2	7.51	8.41	9.10	7.88	8.20	7.91	7.89	7.91	7.91
9	8.00	7.41	6.71	7.14	7.85	7.76	7.60	7.68	7.69
16	8.20	8.70	8.91	8.30	8.62	8.30	7.38	7.15	8.27
23	8.31	8.45	8.15	8.54	8.50	8.51	7.87	8.58	8.41
30	8.30	7.30	7.05	8.10	8.05	8.05	8.00	7.95	7.86
J - 7	6.82	6.40	6.72	7.83	8.19	7.34	6.52	8.12	8.25
21	7.00	7.31	6.78	8.20	8.41	7.95	8.30	8.51	6.70
28	8.81	8.71	6.60	8.49	8.51	8.20	7.72	8.17	7.10
A - 12	6.50	6.52	6.40	7.21	8.29	8.41	8.72	8.75	7.55
18	7.60	7.41	6.51	8.01	8.41	8.75	7.80	7.99	7.91
25	7.70	7.95	6.25	8.12	8.55	8.46	8.42	8.82	8.61
S - 1	8.10	7.40	6.65	8.00	8.04	8.10	-	-	-
8	7.95	7.65	6.38	8.30	8.19	8.50	8.51	8.78	8.60
22	8.20	8.05	6.71	8.30	8.27	8.20	8.72	8.75	8.27
N - 3	8.14	8.10	8.37	7.89	7.99	8.10	7.70	7.28	7.75
D - 2	7.46	7.75	8.21	8.00	8.05	8.05	Fr	Fr	Fr
F - 12-72	Fr	Fr	Fr	7.71	7.77	7.81	7.95	7.79	8.10
M - 16	7.39	7.39	7.39	Fr	Fr	Fr	7.26	7.26	7.26
M - 21	8.05	8.05	8.01	8.01	8.00	8.02	8.02	8.04	8.10
A - 27	7.95	8.19	8.20	7.68	7.20	8.20	7.10	8.20	8.19
M - 15	8.32	8.81	8.71	8.10	8.35	8.30	8.50	8.41	8.42
J - 19	7.55	8.45	8.26	7.65	7.66	7.40	7.60	8.24	8.15

APPENDIX J

mg O_2/l- Logy Bay and Portugal Cove

LOGY BAY

DATE '72	POOL 4 BOTTOM 43.39	POOL 4 MIDDLE 21.69	POOL 4 TOP 0	POOL 1B BOTTOM 41.35	POOL 1B MIDDLE 20.67	POOL 1B TOP 0	POOL 1A BOTTOM 30.37	POOL 1A MIDDLE 15.18	POOL 1A TOP 0	POOL DEPTH
Feb. 12	Fr	Fr	Fr	17.29	18.24	17.44	18.40	18.40	19.52	
Mar. 17	Fr	Fr	12.48	Fr	Fr	Fr	Fr	Fr	13.76	
Apr. 21	14.72	12.96	11.68	11.52	11.52	11.20	13.92	11.68	12.16	
Apr. 27	15.20	16.32	13.44	16.57	18.08	12.8	16.80	19.68	14.08	
May 15	12.48	24.48	10.88	15.84	16.8	13.6	21.92	24.0	12.96	
June 20	10.7	17.9	10.5	7.2	8.7	8.5	8.5	9.6	16.0	
June 13	10.3	10.2	10.8	12.2	10.5	15.2	9.1	11.01	10.3	
Aug. 15	-	7.84	12.00	11.68	8.48	6.40	10.40	9.28	6.88	

Fr - indicates pool was frozen during sample period.

APPENDIX J - Cont'd

mg O_2/1- L[redacted] and Portugal Cove

PORTUGAL COVE Mg O_2/1

DATE '72	POOL 4 BOTTOM 28.9	POOL 4 MIDDLE 14.4	POOL 4 TOP 0	POOL 3 BOTTOM 35.6	POOL 3 MIDDLE 17.8	POOL 3 TOP 0	POOL 1 BOTTOM 28.8	POOL 1 MIDDLE 14.4	POOL 1 TOP 0	POOL DEPTH
Feb. 12	Fr	Fr	Fr	Fr	Fr	Fr	14.22	14.22	14.22	
Feb. 19	Fr	Fr	Fr	17.5	16.04	21.12	17.44	17.96	17.35	
Mar. 18	Fr	Fr	Fr	19.84	17.44	19.52	20.48	20.16	17.12	
Apr. 22	12.64	21.28	13.60	14.08	17.12	17.12	12.67	12.67	12.67	
May 10	22.56	18.72	12.00	9.76	9.92	9.76	10.88	10.56	10.56	
May 23	28.6	27.0	12.6	14.5	21.6	12.75	11.80	11.20	11.48	
June 13	16.0	12.7	11.4	11.4	16.5	10.5	19.7	20.3	19.3	
Aug. 23				8.32	7.84	8.96				

Fr - indicates pool was frozen during sample period

APPENDIX K

Biota - Seasonal Survey - Station 1 - Pool 1 - Portugal Cove (No./cm^2)

PORTUGAL COVE	JUNE	JUNE	JULY	JULY	JULY	JULY	AUG	SEPT	OCT	DEC	FEB	MAR	MAY	JUNE	JUNE
POOL #1	4-71	18-71	2-71	9-71	23-71	30-71	27-71	22-71	22-71	21-71	19-71	18-72	23-72	13-72	19-72
STATION 1															
Grid Section A															
Fucus distichus edentatus	15	18	5	12	30	8	–	–				–	–	–	–
Monostroma grevillei	10	1	–	12	10	–	–	–				–	60	20	15
Corallina officinalis	42	42	60	30	30	30	80	90				25	70	70	75
Clathromorphum circumscriptum	5	18	40	46	55	55	20	10				45	20	25	10
Acrosiphonia arcta	–	–	–	–	–	–	–	–	Pool			–	10	5	–
Acmaea testudinalis	–	–	–	1	–	–	–	–				–	–	–	–
Littorina saxatilis	4	–	–	2	–	6	–	–	Frozen			–	–	–	–
Littorina littorea	–	–	–	–	–	–	–	10				–	–	–	–
Mytilus edulis	3	6	–	1	–	–	–	–				–	–	7	2
Thais lapillus	–	2	–	–	–	–	–	–				–	–	–	–
Jaera ischiosetosa	–	–	–	–	–	64	–	–				–	–	–	–
Grid Section B															
Corallina officinalis	24	20	10	5	5	5	5	20				10	20	2	0
Clathromorphum circumscriptum	54	70	80	100	100	100	100	80				85	90	90	100
Acrosiphonia arcta	–	–	–	–	–	–	–	–				5	10	5	–
Chordaria flagelliformis	–	–	–	–	–	–	–	–	Pool			–	5	6	60
Acmaea testudinalis	1	1	–	1	1	3	3	6	Frozen			–	–	–	–
Littorina saxatilis	–	–	–	–	–	–	–	–				–	–	–	–
Mytilus edulis	8	5	–	1	2	2	–	2				–	–	–	–
Thais lapillus	–	–	–	2	1	–	2	1				–	–	–	–
Strongylocentrotus drobrachiensis	1	1	–	1	–	1	–	–				–	–	–	–
Metridium dianthus	1	–	–	1	–	–	1	1				–	–	2	–

APPENDIX L

Biota - Seasonal Survey - Station 2 - Pool 1 - Portugal Cove (No./cm^2)

PORTUGAL COVE	JUNE	JUNE	JULY	JULY	JULY	AUG	SEPT	OCT	DEC	FEB	MAR	MAY	JUNE
POOL #1	4-71	18-71	9-71	16-71	30-71	27-71	22-71	22-71	21-71	19-71	18-72	23-72	19-72
STATION 2													
Grid Section A													
Clathromorphum circumscriptum	30	30	30	30	40	40	40				2	2	20
Corallina officinalis	5	24	15	10	15	55	50				75	80	75
Acrosiphonia arcta	6	18	10	20	50	2	-				20	20	10
Monostroma grevillei	60	24	12	5	0	-	5				-	70	-
Tonicella marmorea	-	-	-	-	1	-	-				-	-	-
Acmarea testudinalis	-	-	1	-	-	-	-		Pool		-	-	-
Mytilus edulis	-	3	-	-	-	-	-				-	-	50
Thais lapillus	-	2	-	-	1	-	-		Frozen		-	-	-
Littorina saxatilis	2	3	2	2	-	-	1				-	-	-
Grid Section B													
Clathromorphum circumscriptum	48	45	75	78	80	80	90				65	50	50
Corallina officinalis	5	12	5	10	10	10	10				5	5	10
Acrosiphonia arcta	-	-	-	-	-	-	-				-	10	-
Monostroma grevillei	-	-	-	-	-	-	-				15	5	-
Acmaea testudinalis	2	1	2	1	3	5	1		Pool		-	-	-
Mytilus edulis	14	6	1	-	-	1	-				2	-	52
Thais lapillus	-	-	-	-	4	-	1		Frozen		-	-	-
Littorina saxatilis	2	-	-	-	-	-	-				2	-	-
Stronglocentrotus drobrachiensis	1	1	1	2	1	1	2				-	-	-

APPENDIX M

Biota - Seasonal Survey - Station 1 - Pool 3 Portugal Cove (No./cm^2)

PORTUGAL COVE POOL #3	JUNE 4-71	JUNE 11-71	JUNE 18-71	JUNE 25-71	JULY 2-71	JULY 9-71	JULY 20-71	AUG 20-71	SEPT 3-71	SEPT 10-71	SEPT 24-71	OCT 22-71	DEC 21-71	FEB 19-72	MAR 18-72	MAY 23-72	JUNE 19-72	AUG 19-72
STATION 1																		
Grid Section A																		
Fucus distichus distichus	24	31	24	30	27	20	15	15	15	10	10	25			55	70	50	50
Ralfsia fungiformis	3	12	18	24	20	10	30	35	35	30	25	10			-	-	-	-
Hildenbrandia prototypus	15	9	20	24	35	15	10	10	10	15	20	60			10	10	10	20
Cladophora rupestris	12	25	20	12	10	5	2	5	6	10	5	5	Pool		-	5	30	45
Verrucaria	5	18	12	12	15	30	15	20	25	20	5	-	Frozen		10	00	5	-
Littorina saxatilis	-	11	2	6	38	1	26	52	41	9	10	30			-	60	60	40
Mytilus edulis	-	1	-	-	-	1	1	-	-	-	-	-			-	100	85	30
Jaera ischiosetosa	-	2	1	7	104	10	54	72	32	36	64	42			5	15	30	60
Grid Section B																		
Fucus distichus distichus	70	48	72	66	78	70	75	85	60	70	70	95			-	100	90	-
Ralfsia fungiformis	-	-	-	-	-	-	5	10	25	20	20	-			-	-	-	-
Hildenbrandia prototypus	6	35	30	35	25	25	20	10	10	7	10	15			5	10	5	24
Cladophora rupestris	-	-	-	-	-	-	-	5	10	10	10	6			-	5	20	25
Verrucaria	-	-	-	-	-	-	10	20	20	10	10	5			5	5	10	-
Littorina saxatilis	-	3	3	-	12	-	-	6	20	5	-	54			-	20	120	70
Littorina littorea	-	1	1	-	1	-	-	-	-	-	-	-			-	-	-	-
Thais lapillus	-	-	-	1	-	-	-	-	-	-	1	-			-	-	-	-
Littorina obtusata	-	-	-	-	-	-	-	-	-	-	-	52			-	-	-	-
Jaera ischiosetosa	-	2	-	-	27	5	108	54	36	36	-	2			60	25	90	6
Grid Section C																		
Fucus distichus distichus	18	6	18	12	25	30	30	30	45	65	65	80			20	20	60	-
Ralfsia fungiformis	-	-	-	-	-	20	15	-	-	5	-	-			-	15	15	-
Hildenbrandia prototypus	24	40	20	15	15	15	10	5	-	-	-	-			-	-	-	5
Cladophora rupestris	-	-	-	-	-	-	-	10	5	10	5	10			-	5	30	20
Verrucaria	10	10	48	60	75	30	25	50	40	65	65	70			55	50	40	10
Clathromorphum circumscriptum	-	10	12	20	17	20	30	30	20	15	15	15			-	10	-	2
Littorina saxatilis	-	-	-	-	-	-	25	54	9	2	7	86			5	15	40	24
Mytilus edulis	-	1	2	2	-	-	-	-	-	-	-	-			-	-	-	-
Amphipoda	-	-	1	2	5	-	-	-	-	-	-	2			-	-	-	-
Jaera ischiosetosa	-	56	20	1	-	10	102	74	18	18	4	-			5	10	29	2

APPENDIX M Cont'd

Biota - Seasonal Survey - Station 1 - Pool 3 - Portugal Cove (No./cm^2)

PORTUGAL COVE POOL #3	JUNEQ 4-71	JUNE 11-71	JUNE 18-71	JUNE 25-71	JULY 2-71	JULY 99-71	JULY 20-71	AUG 20-71	SEPT 3-71	SEPT 10-71	SEPT 24-71	OCT 22-71	DEC 21-71	FEB 19-72	MAR 18-72	MAY 23-72	JUNE 19-73	AUG 19-72
STATION 1 Cont'd																		
<u>Grid Section D</u>																		
Fucus distichus distichus	-	-	15	20	30	5	2	2	5	10	15	10			-	5	10	10
Ralfsia fungiformis	-	15	40	45	15	20	40	30	20	10	10	15			60	70	60	10
Cladophora rupestris	-	-	-	-	-	-	-	-	10	25	25	25			-	5	10	30
Verrucaria	100	80	70	50	30	40	20	50	20	20	25	40			65	10	60	40
Littorina saxatilis	1	2	-	-	3	-	6	32	10	-	-	64			-	6	15	30
Mytilus edulis	-	-	-	-	-	-	-	-	-	-	-	-			-	2	-	-
Thais lapillus	-	-	-	-	-	-	-	-	-	-	-	-			-	2	-	-
Jaera ischiosetosa	-	10	40	1	1	45	108	54	-	72	60	-			2	2	-	3

APPENDIX N

Biota - Seasonal Survey - Station 2 - Pool 3 - Portugal Cove (No./cm^2)

PORTUGAL COVE	JUNE	JUNE	JUNE	JUNE	JULY	JULY	JULY	JULY	AUG	SEPT	OCT
POOL #3	4-71	11-71	18-71	25-71	2-71	9-71	29-71	30-71	27-71	3-71	22-71
SECTION 2											
Grid Section A											
Ralfsia fungiformis	5	5	6	-	6	5	7	20	15	15	15
Monostroma grevillei	2	2	6	-	-	-	-	-	-	-	-
Cladophora rupestris	2	2	12	-	10	-	-	-	-	-	-
Fucus distichus dis distichus	5	15	24	-	20	10	10	15	10	10	10
Verrucaria	-	5	20	-	35	25	15	5	5	5	10
Littorina saxatilis	74	5	2	7	41	6	2	56	25	63	84
Jaera ischiosetosa	3	3	2	2	86	51	128	54	54	74	32
Thais lapillus	-	-	-	1	-	-	-	-	-	-	1
Grid Section B											
Ralfsia fungiformis	-	-	-	-	10	-	-	5	5	7	10
Cladophora rupestris	20	5	18	15	30	10	15	10	10	10	10
Verrucaria	10	6	35	40	20	25	30	25	15	10	15
Littorina saxatilis	36	15	24	30	35	5	13	15	25	49	70
Fucus distichus distichus	5	10	12	12	7	5	3	2	1	1	1
Jaera ischiosetosa	6	1	24	1	57	26	32	128	36	72	15
Amphipoda	1	1	-	-	-	-	-	-	-	1	-
Grid Section C											
Ralfsia fungiformis	-	20	40	30	25	45	50	65	60	6060	30
Cladophora rupestris	12	10	12	20	15	5	5	5	5	5	5
Littorina saxatilis	3	11	-	-	12	-	-	-	61	32	64
Fucus distichus distichus	5	15	10	12	7	20	18	10	55	5	5
Jaer ischiosetosa	10	2	420	2	19	1	134	-	18	101	3
Thais lapillus	2	1	-	-	-	-	3	-	-	-	5
Hildenbrandia prototypus	-	-	-	15	10	15	20	30	25	35	15
Strongylocentrotus drobrachiensis	-	-	-	-	-	-	-	-	-	-	3

APPENDIX O

Biota - Seasonal Survey - Station 1 - Pool 4 - Portugal Cove (No./cm^2)

APPENDIX P

Seasonal Survey - Station 2 - Pool 4 - Portugal Cove

PORTUGAL COVE POOL #4	JUNE 4-71	JUNE 11-71	JUNE 18-71	JUNE 24-71	JULY 2-71	JULY 9-71	JULY 23-71	JULY 30-71	AUG 27-71	SEPT 3-71	SEPT 9-71	SEPT 22-71	OCT 22-71	DEC 21-71	FEB 19-71	MAR 18-71	APR 28-72	JUNE 19-72
STATION 1 & 2 Grid Section A																		
Pseudendoclonium submarinum	18	70	42	42	70	40	50	40	45	70	80	70	90	-	-		90	80
Rhizoclonium riparium	-	2	-	-	-	-	-	-	-	-	-	-	-	Pool			-	20
Melanosiphon intestinalis	-	-	-	-	-	-	-	-	-	-	-	-	-	Frozen			1	-
Littorina saxatilis	5	-	-	-	7	-	-	- -	-	-	-	-	-				-	-
Grid Section B																		
Pseudendoclonium submarinum	30	5	12	18	25	10	-	-	5	40	40	40	60				20	-
Rizoclonium riparium	-	48	42	54	60	40	50	40	50	30	30	30	20				30	70
Melanosiphon intestinalis	-	-	-	-	-	-	-	-	-	-	-	-	-				15	-
Littorina saxatilis	-	4	-	11	-	-	-	-	1	-	-	-	-				-	-
Gammarus duebeni	-	-	-	1	-	-	3	1	3	1	2	-	1				-	-
Mytilus edulis	-	-	-	-	-	-	- -	-	-	-	-	1	2				-	-

APPENDIX Q

Biota - Seasonal Survey - Station 1 - Pool 1A - Logy Bay (No./cm^2)

LOGY BAY POOL #1A	JUNE 2-71	JUNE 9-71	JUNE 16-71	JUNE 23-71	JULY 7-71	JULY 21-71	JULY 28-71	AUG 12-71	AUG 25-71	SEPT 8-71	SEPT 22-71	NOV 3-71	DEC 2-71	APR 21-72	MAY 15-72	JUNE 28-72
STATION 1																
Grid Section A																
Fucus distichus distichus	25	15	24	30	30	30	25	20	25	35	35	35	30	-	-	10
Pilayella littoralis	42	40	60	40	26	15	12	12	40	35	30	2	3	15	10	10
Melanosiphon intestinalis	15	15	5	-	-	-	-	-	-	-	-	-	-	-	5	10
Cladophora rupestris	-	-	-	10	12	6	-	-	-	-	-	-	-	10	10	5
Verrucaria	10	101	10	15	12	30	35	35	20	30	35	20	20	20	25	25
Ralfsia fungiformis	-	20	-	-	10	-	-	6	10	10	10	20	20	15	15	5
Mytilus edulis	-	-	-	-	1	-	-	-	-	1	-	5	4	-	-	-
Littorina saxatilis	-	1	9	3	4	5	4	15	7	8	3	15	4	-	-	-
Jaera ischiosetosa	-	-	-	-	1	10	12	126	-	32	54	48	-	-	-	-
Grid Section B																
Fucus distichus distichus	24	25	24	30	25	20	20	15	15	10	5	5	5	2	0	2
Pilayella littoralis	3	25	18	30	30	10	10	6	-	-	-	-	-	7	10	-
Verrucaria	40	40	40	40	35	35	35	30	35	35	45	30	30	30	20	30
Littorina saxatilis	7	7	9	1	7	5	6	16	2	13	26	20	20	3	23	8
Littorina obtusata	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Mytilus edulis	5	10	22	25	27	23	23	9	6	4	-	-	1	3	-	1
Amphipoda	-	-	-	2	1	3	-	1	4	1	-	3	2	-	1	4
Ralfsia fungiformis	-	-	-	-	15	15	15	35	30	35	35	35	30	15	30	25
Jaera ischiosetosa	-	-	-	-	4	4	36	72	64	16	16	-	-	-	3	-

APPENDIX R

Biota - Seasonal Survey - Station 2 - Pool 1A - Logy Bay (No./cm^2)

LOGY BAY POOL #1A	JUNE 2-71	JUNE 9-71	JUNE 16-71	JUNE 23-71	JULY 7-71	JULY 21-71	JULY 28-71	AUG 12-71	AUG 25-71	SEPT 8-71	SEPT 22-71	NOV 3-71	DEC 2-71	APR 21-71	MAY 15-72	JUNE 28-72
STATION 2																
Grid Section A																
Fucus distichus distichus	25	10	18	15	10	6	5	5	10	7	-	-	7	-	-	-
Pilayella littoralis	70	75	60	40	30	30	25	25	10	5			5	2	-	-
Verrucaria	-	-	-	-	7	15	15	12	6	5			5	10	20	20
Monostroma grevillei	-	-	-	-	-	-	-	-	-	-			-	2	-	-
Littorina saxatilis	-	3	9	9	3	10	5	12	6	18			19	3	4	20
Amphipoda	2	-	-	-	-	-	-	-	-	-			-	-	-	-
Jaera ischiosetosa	-	-	-	-	4	72	36	54	16	8			7	-	3	11
Mytilus edulis	-	-	-	-	1	-	1	-	-	-			-	-	8	-
Grid Section B																
Fucus distichus distichus	62	60	36	54	60	55	45	40	70	70			70	5	-	-
Pilayella littoralis	10	15	10	18	15	10	10	5	-	-			-	15	5	-
Verucaria	-	5	-	20	15	10	15	20	15	20			25	40	20	40
Ralfsia fungiformis	-	-	-	-	3	15	10	15	20	20			20	-	75	25
Littorina Saxatilis	16	12	12	2	2	14	15	2	12	5			2	9	20	7
Mytilus edulis	-	-	7	20	25	-	3	-	5	-			1	2	-	1
Jaera ischiosetosa	-	-	-	9	-	83	-	64	48	50			-	-	10	5

Biota - Seasonal Survey - Station 1 - Pool 1B - Logy Bay (No./cm^2)

LOGY BAY	JUNE	JUNE	JUNE	JUNE	JUNE	JULY	JULY	JULY	AUG	AUG	AUG	SEPT	SEPT	SEPT	NOV	DEC	APR	MAY	JUNE
POOL #1B	2-71	9-71	16-71	23-71	30-71	7-71	21-71	28-71	12-71	18-71	25-71	1-71	8-71	22-71	3-71	3-71	121-72	15-72	28-72
STATION 1																			
Grid Section A																			
Rhizoclonium riparium	10	7	6	5	6	8	8	15	25	25	-	-	5	2	1	-	-	2	10
Verucaria	65	42	30	24	36	35	35	45	55	50	40	10	10	10	10	40	-	5	2
Melanosiphon intestinalis	4	2	2	4	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Jaera ischiosetosa	-	1 1	2 2	2	-	7	16	90	10	64	18	3	1	5	5	-	-	-	6
Amphipóda	2	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	2
Littorina saxatilis	1	3	-	6	5	4	3	7	11	7	6	10	10	37	4	-	10	5	9
Mytilus edulis	1	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Grid Section B																			
Rhizoclonium riparium	5	12	18	18	3	3	5	10	20	-	-	1	1	-	-	-	6	50	10
Verucaria	50	55	42	50	42	45	40	35	30	-	-	-	-	-	-	-	45	30	35
Melanosiphon intestinalis	20	4	3	3	-	-	-	-	-	70	2	0	1	1	-	-	1	-	-
Jaera ischiosetosa	1	-	-	-	-	-	32	126	-	- 64	-	-	8	-	-	-	-	-	1
Littorina saxatilis	13	2	1	12	9	3	3	-	-	5	-	-	9	19	11	-	11	-	12
Mytilus edulis	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Grid Section C																			
Rhizoclonium riparium	4	18	18	18	4	8	10	15	30	100	-	-	2	-	1	-	7	70	10
Verucaria	50	60	40	30	33	30	50	40	40	30	30	30	25	25	15	10	-	-	-
Melanosiphon intestinalis	4	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Littorina saxatilis	16	9	7	22	6	3	3	5	2	-	6	12	12	12	5	-	16	-	4
Mytilus edulis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Grid Section D																			
Rhizoclonium riparium	10	18	18	18	15	12	15	60	100	100	-	-	-	1	2	-	7	90	15
Verucaria	20	10	15	35	35	30	50	40	40	40	30	25	25	25	20	10	45	40	40
Melanosiphon intestinalis	10	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fucus edentatus edentatus	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Littorina saxatilis	5	4	2	2	3	5	1	3	5	-	12	20	20	7	8	-	19	-	4
Mytilús edulis	1	-	-	-	-	-	-	1	1	-	2	1	-	2	-	-	-	-	-

APPENDIX T

Biota - Seasonal Survey - Station 2 - Pool 1B - Logy Bay (No./cm^2)

LOGY BAY POOL #1B	JUNE 2-71	JUNE 9-71	JUNE 16-71	JUNE 23-71	JUNE 30-71	JULY 7-71	JULY 21-71	JULY 28-71	AUG 12-71	AUG 18-71	AUG 25-71	SEPT 8-71	SEPT 22-71	NOV 3-71	DEC 3-71	APR 21-72	MAY 15-72	JUNE 28-72	AUG 14-72
STATION 2																			
Grid Section A																			
Rhizoclonium riparium	4																		
Melanosiphon intestinalis	4	15	10	4	-	-	-	-	-	-	-	-	-	-	-	-	40	-	-
Littorina saxatilis	2	3	1	-	9	-	-	7	1	-	1	16	6	9	1	-	6	12	0
Verrucaria	65	35	25	24	30	25	35	45	40	60	30	10	5	11	30	-	40	50	30
Littorina obtusata	-	7	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jaera ischiosetosa	-	-	-	-	-	7	10	54	18	64	-	3	-	6	-	-	-	-	25
Grid Section B																			
Verrucaria	40	40	42	50	44	40	60	60	60	70	30	40	40	40	10	-	75	45	35
Rhizoclonium riparium	-	4	-	-	-	-	-	-	10	20	-	-	-	-	-	-	-	40	4
Fucus distichus distichus	10	5	5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Melanosiphon intestinalis	11	5	2	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Littorina saxatilis	10	5	8	5	5	2	3	3	-	-	-	10	3	4	2	-	17	8	4
Jaera ischiosetosa	-	-	-	-	1	2	2	16	15	50	4	-	-	-	-	-	-	-	-
Mytilus edulis	-	-	7	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Grid Section C																			
Rhizoclonium riparium	-	40	20	18	6	7	10	10	30	60	-	-	-	-	-	-	-	30	35
Verrucaria	40	40	30	32	24	30	35	40	30	40	30	10	10	5	10	-	50	45	20
Melanosiphon intestinalis	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-
Xantharia	-	-	-	-	-	-	-	-	-	-	6	10	12	12	—	-	-	-	-
Littorina saxatilis	3	5	4	5	13	6	-	12	8	-	6	13	12	7	-	-	15	10	3
Mytilus edulis	-	2	1	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-

APPENDIX U

Biota - Seasonal Survey - Station 1 - Pool 4 - Logy Bay (No./cm^2)

APPENDIX V

Biota - Seasonal Survey - Station 2 - Pool 4 - Logy Bay (No./cm^2)

LOGY BAY	JUNE	JUNE	JUNE	JULY	JULY	AUG	AUG	SEPT	SEPT	SEPT	NOV	DEC	APR
POOL #4	2-71	16-71	23-71	7-71	21-71	18-71	25-71	1-71	8-71	22-71	3-71	2-71	21-71
STATION 1													
Grid Section A													
Verrucaria	100	100	100	100	90	90	95	100	100	100	45	-	190
Gammarus duebeni	-	-	-	1	2	-	-	-	-	1	1	2	-
Grid Section B													
Verrucaria	100	100	100	100	2	100	7	2	-	-	-	-	100
Gammarus duebeni	-	-	-	2	-	1	-	2	-	1	1	-	-
Mytilus edulis	3	-	1	-	-	-	-	-	-	-	-	-	-
Grid Section C													
Verrucaria	100	100	100	100	-	100	-	-	-	-	-	-	100
Mytilus edulis	6	1	1	-	-	-	-	-	-	-	2	6	-
Gammarus duebeni	2	5	4	1	-	3	18	8	9	12	2	1	-
Acmaea testudinalis	1	-	-	-	-	-	-	-	-	-	-	-	-
STATION 2													
Grid Section A													
Verrucaria	100	100	100	40	30	100	100	100	-	-	35	-	-
Gammarus duebeni	-	-	-	1	-	-	-	-	-	-	-	2	-
Grid Section B													
Verrucaria	100	100	100	40	-	100	-	-	-	-	-	-	-
Gammarus duebeni	-	-	-	-	1-	2	1	1	1	1	1	-	-
Mytilus edulis	1	-	-	-	-	-	-	-	-	-	-	-	-
Grid Section C													
Verrucaria	100	100	100	100	-	-	-	-	-	-	-	-	-
Gammarus duebeni	-	2	3	3	-	5	2	4	8	-	-	1	1
Mytilus edulis	2	1	1	-	-	-	-	-	-	-	4	4	-

APPENDIX W

Clearout - Floral Summary - Logy Bay

Fucus distichus distichus

DEPTH (cms)	DRY WEIGHT (g/depth interval) POOL 1A	POOL 1B
0-5	25.00	-
6-10	27.95	-
11-15	35.62	-
16-20	4.85	.80
21-25	-	1.69
25-30		.23
TOTAL	93.42	2.72

APPENDIX X

Clearout - Floral Summary - Portugal Cove (g/depth interval)

	Corallina officinalis	*Chordaria flagelliformis*	*Chondrus Crispus*	*Fucus distichus distichus*		*Monostroma grevelli*	*Cladophora rupestris*
Pool No.	1	1	1	1	3	1	3
Depth							
0-5	0.02	0.414			0.07		0.18
6-10	2.183	0.02			0.08		0.04
11-15	1.983	-	0.393				0.07
16-20	1.930	0.05	0.18				0.14
21-25	0.01	0.07		0.13	1.44		2.72
26-30	0.06	.003				0.02	1.70
31-35	-						0.46
36-40							
TOTAL	6.186	1.657	0.573	0.13	1.59	0.02	5.31

APPENDIX Y

Calculation of biomass /cm^2.

$$\text{Biomass/cm}^2 = \frac{\text{Total coverage or No. of individuals/pool}}{\text{Total surface area of pool (cm}^2\text{)}}$$

APPENDIX Z

12 Hour Survey #1 - pH - Portugal Cove

POOL NO.	DEPTH OF SAMPLE	7 am	8 am	9 am	10 am	11 am	12 am	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
	TOP	7.23	7.20	7.30	7.30	7.20	7.71	7.65	8.45	8.46	7.61	7.79	8.85
4	MIDDLE	8.65	8.59	8.51	8.30	8.15	7.72	8.59	7.45	8.14	8.51	8.41	7.62
	BOTTOM	8.45	8.55	8.-5	8.56	8.20	8.19	8.65	8.74	8.81	8.75	8.62	8.95
	TOP	7.69	7.55	7.40	7.71	7.49	8.05	7.99	8.15	8.05	8.01	7.82	8.28
3	MIDDLE	8.11	8.40	8.40	8.49	8.56	8.50	8.00	8.61	8.11	8.59	8.70	8.72
	BOTTOM	7.68	8.05	8.05	8.32	8.39	8.21	8.45	8.61	8.61	8.70	8.62	8.61
	TOP	7.45	7.76	7.95	7.91	8.00	8.21	8.45	8.65	8.17	8.35	8.40	8.39
1	MIDDLE	8.02	7.90	7.71	7.82	8.00	8.28	8.25	8.35	8.15	8.41	8.41	8.16
	BOTTOM	7.71	7.71	7.88	7.91	7.95	7.90	8.11	8.15	8.20	8.21	8.25	8.10

APPENDIX A'

12 Hour Survey #2 - pH - Portugal Cove

POOL NO.	DEPTH OF SAMPLE	7 am	8 am	9 am	10 am	11 am	12 am	1 pm	2 pm	3 pm	4 pm	5 pm	6pm
	TOP	6.60	6.65	6.85	6.96	6.85	6.85	6.95	6.90	6.91	7.01	6.99	6.91
4	MIDDLE	7.01	6.81	6.81	6.91	7.01	6.85	6.81	6.75	6.95	6.75	6.78	6.85
	BOTTOM	7.10	7.25	7.05	7.25	7.15	7.00	6.90	7.15	7.01	7.20	7.31	6.90
	TOP	6.78	6.91	6.95	7.00	7.00	6.91	7.00	7.10	6.90	7.01	7.00	7.00
3	MIDDLE	6.65	6.59	6.85	6.45	6.51	6.90	6.34	7.17	6.41	6.41	6.37	6.65
	BOTTOM	7.25	7.05	7.25	7.19	7.05	7.25	7.05	7.00	7.16	7.34	7.15	7.16
	TOP	7.50	7.75	7.41	7.55	7.91	7.90	7.91	8.00	8.10	8.02	8.06	8.20
1	MIDDLE	7.52	7.75	7.85	7.65	7.75	8.10	7.99	7.99	8.10	8.10	8.06	8.17
	BOTTOM	7.61	7.61	7.41	7.45	7.70	7.81	7.85	7.99	8.00	8.01	7.69	8.09

APPENDIX B'

12 Hour Survey #1 - Temperature - Portugal Cove

POOL NO.	DEPTH OF SAMPLE	7 am	8 am	9 am	10 am	11 am	12 am	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
	AIR	16.2	15.2	15.9	17.5	20.0	21.5	22.2	22.1	23.9	24.9	26.1	24.6
	TOP	14.6	14.0	14.2	14.9	17.2	19.8	20.9	21.0	23.1	24.1	24.1	23.2
4	MIDDLE	16.2	16.1	16.9	16.2	17.1	18.9	20.0	22.0	22.0	23.2	24.2	23.7
	BOTTOM	17.4	17.1	17.1	17.2	17.8	19.5	20.0	10.5	22.1	23.1	23.1	23.2
	AIR	16.2	15.2	15.9	17.5	20.0	21.5	22.2	22.1	23.9	24.9	26.1	24.6
3	TOP	13.8	13.8	14.0	15.8	18.5	21.0	22.0	21.5	24.0	25.5	25.5	24.7
	MIDDLE	19.1	19.1	19.1	19.1	20.2	22.0	22.7	23.2	24.9	25.8	25.6	26.9
	BOTTOM	19.5	19.5	19.1	19.5	20.2	21.1	21.1	21.9	22.3	23.1	22.1	23.2
	AIR	16.2	15.2	15.9	17.5	20.0	21.5	22.2	22.1	23.9	24.9	26.1	24.6
1	TOP	14.6	14.0	14.2	14.9	17.2	19.8	20.9	21.0	23.1	24.1	24.1	23.2
	MIDDLE	16.2	16.1	16.9	16.2	17.1	18.9	20.0	22.0	22.0	23.2	24.2	23.7
	BOTTOM	17.4	17.1	17.1	17.2	17.8	19.5	20.0	20.5	22.1	23.1	23.1	23.2

APPENDIX C'

12 Hour Survey #2 - Temperature - Portugal Cove

POOL NO.	DEPTH OF SAMPLE	7 am	8 am	9 am	10 am	11 am	12 am	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
	AIR	15.1	16.6	14.1	14.3	14.5	14.6	16.0	14.5	15.9	17.5	17.1	18.5
4	TOP	15.6	15.8	16.3	16.5	16.2	16.5	16.5	17.0	17.9	18.1	18.3	19.5
	MIDDLE	15.6	16.5	16.9	16.5	16.2	16.2	16.5	17.0	17.1	18.0	18.2	18.5
	BOTTOM	17.1	17.1	16.9	16.7	16.5	16.9	17.0	17.3	17.5	17.9	18.1	18.4
	AIR	15.0	16.6	14.1	14.3	14.5	14.6	16.0	14.5	15.9	17.5	17.1	18.5
3	TOP	16.5	16.8	16.0	15.6	16.1	16.1	16.0	16.1	17.0	17.9	17.9	18.1
	MIDDLE	19.1	19.1	19.1	19.0	17.0	20.1	19.9	18.1	19.5	19.9	20.2	20.2
	BOTTOM	19.5	19.5	19.5	20.0	19.7	19.5	19.5	19.9	19.5	19.5	20.2	20.1
	AIR	15.1	16.6	14.1	14.3	14.5	14.6	16.0	14.5	15.9	17.5	17.1	18.5
1	TOP	13.5	13.6	14.0	14.0	13.5	12.3	12.5	12.0	12.1	12.1	12.5	12.5
	MIDDLE	13.2	13.0	13.1	13.1	13.0	12.5	12.4	12.0	12.1	12.1	12.6	13.0
	BOTTOM	12.5	13.0	12.7	12.5	12.5	12.5	12.4	12.0	12.1	12.1	12.0	12.5

APPENDIX D'

12 Hour Survey #1 - Salinity - Portugal Cove

POOL NO.	DEPTH OF SAMPLE	7 am	8 am	9 am	10 am	11 am	12 am	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
	TOP	6.00	6.50	6.40	7.90	6.70	7.10	7.30	7.40	6.40	7.50	7.40	7.80
4	MIDDLE	12.9	12.3	11.5	10.9	8.80	11.1	10.8	7.00	8.60	9.5	10.0	9.00
	BOTTOM	20.2	21.3	20.4	19.7	19.3	20.8	18.6	17.8	17.4	17.1	16.1	16.5
	TOP	15.8	16.8	16.4	18.4	16.2	17.5	18.0	18.0	18.1	18.5	19.9	20.5
3	MIDDLE	31.6	32.6	30.3	31.2	31.7	28.1	31.6	31.4	30.3	29.6	29.8	31.5
	BOTTOM	31.8	35.6	33.4	33.4	33.4	32.8	33.0	34.0	32.4	32.8	31.3	31.8
	TOP	31.7	31.6	31.3	31.9	31.7	31.2	31.7	31.1	31.5	31.7	31.7	31.6
1	MIDDLE	31.4	31.3	30.6	31.9	31.8	31.8	27.9	31.7	31.5	31.5	31.9	32.0
	BOTTOM	31.5	31.5	30.7	32.2	31.8	32.0	31.7	31.7	31.5	31.4	32.2	32.0

APPENDIX E'

12 Hour Survey #2 - Salinity - Portugal Cove

POOL NO.	DEPTH OF SAMPLE	7 am	8 am	9 am	10 am	11 am	12 am	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
	TOP	1.5	1.3	1.3	1.3	1.3	1.4	2.0	1.4	1.3	2.3	1.4	2.1
4	MIDDLE	1.3	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.6
	BOTTOM	2.1	2.7	3.1	2.3	2.7	2.7	1.4	1.7	1.3	2.8	1.5	1.6
	TOP	29.0	29.0	25.6	26.7	27.5	25.2	21.5	16.1	20.1	18.8	21.6	19.5
3	MIDDLE	47.0	44.6	44.6	47.0	46.3	48.6	44.8	36.0	45.8	41.0	42.2	34.6
	BOTTOM	51.9	51.9	51.0	51.7	50.9	51.9	51.0	50.4	51.0	50.3	48.6	50.3
	TOP	31.5	31.3	23.6	21.9	28.1	30.3	30.9	30.7	30.9	31.0	30.9	31.3
1	MIDDLE	31.3	31.3	31.3	29.5	31.2	30.6	31.2	31.4	31.0	31.4	29.9	31.4
	BOTTOM	31.7	31.5	31.3	31.4	31.4	30.2	30.9	31.3	31.0	31.2	31.6	31.4

APPENDIX F'

Splash Survey – Portugal Cove & Logy Bay – Survey #1

12 HOUR SURVEY #1 (PORTUGAL COVE & LOGY BAY)

CATEGORY 1 – Water caused mixing as it entered the pool.

CATEGORY 2 – Water caused partial mixing as it entered the pool.

LOGY BAY

TIME	CATEGORY	FREQUENCY POOL 1A	1B	4
7 a.m.	–	–	–	–
8 a.m.	–	–	–	–
9 a.m.	2	2	–	–
10 a.m.	2	4	1	–
11 a.m.	2	11	4	–
	1	2	–	–
12 a.m.	1	5	–	–
	2	9	3	–
1 p.m.	1	2	–	–
	2	11	3	–
2 p.m.	2	3	–	–
3 p.m.	2	3	–	–
4 p.m.	2	1	–	–
5 p.m.	–	–	–	–
6 p.m.	–	–	–	–

PORTUGAL COVE

TIME	CATEGORY	FREQUENCY POOL 1	3	4
7 a.m.	1	17	–	–
	2	9	–	–
8 a.m.	1	21	–	–
	2	38	–	–
9 a.m.	1	45	–	–
	2	49	–	–
10 a.m.	1	2	–	–
	2	12	–	–
11 a.m.	–	–	–	–
12 a.m.	–	–	–	–
1 p.m.	–	–	–	–
2 p.m.	–	–	–	–
3 p.m.	–	–	–	–
4 p.m.	–	–	–	–
5 p.m.	–	–	–	–
6 p.m.	1	12	–	–

APPENDIX G'

12 Hour Survey #1 - pH - Logy Bay

POOL NO.	DEPTH OF SAMPLE	7 am	8 am	9 am	10 am	11 am	12 am	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
	TOP	7.10	7.10	7.30	7.01	7.01	7.01	7.01	7.11	7.01	7.05	7.15	7.03
4	MIDDLE	7.00	7.00	7.00	7.05	7.05	7.05	7.79	8.50	7.60	7.19	7.20	7.29
	BOTTOM	7.10	7.10	6.65	6.49	6.81	6.79	7.00	7.30	7.60	7.06	7.25	6.80
	TOP	7.19	7.71	7.70	7.46	7.80	7.81	7.45	7.79	7.20	7.82	8.09	8.08
1B	MIDDLE	8.40	8.39	8.49	8.49	8.49	8.49	8.54	8.52	8.52	8.52	8.10	8.35
	BOTTOM	8.09	8.21	8.20	8.20	8.00	8.00	6.61	7.72	7.60	8.15	8.10	7.29
	TOP	7.35	7.71	7.95	8.09	8.26	8.45	8.50	8.55	8.65	8.71	8.80	8.79
1A	MIDDLE	7.80	7.85	8.05	8.24	8.02	8.50	8.45	8.50	8.67	8.69	8.78	8.81
	BOTTOM	7.71	7.73	8.00	8.10	8.35	8.80	8.41	8.45	8.41	8.54	8.61	8.49

APPENDIX H'

12 Hour Survey #2 - pH - Logy Bay

POOL NO.	DEPTH OF SAMPLE	7 am	8 am	9 am	10 am	11 am	12 am	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
	TOP	7.25	6.89	6.90	6.59	6.89	7.10	6.60	6.75	6.50	6.45	6.50	6.55
4	MIDDLE	6.50	6.50	6.55	6.61	6.55	6.48	6.50	6.45	6.52	6.40	6.51	6.40
	BOTTOM	6.55	6.41	6.45	6.39	6.52	6.10	6.25	6.41	6.40	6.50	6.35	6.42
	TOP	7.39	7.70	6.90	7.20	7.70	6.95	7.20	6.90	7.21	6.95	7.15	7.22
1B	MIDDLE	7.92	8.15	8.26	7.98	8.35	8.29	7.90	8.25	8.29	8.55	8.10	8.19
	BOTTOM	7.91	-	6.71	6.71	7.70	8.20	7.41	8.31	8.41	7.20	6.75	6.80
	TOP	7.95	8.23	8.32	8.39	8.41	8.49	8.62	8.61	8.72	8.65	8.24	8.69
1A	MIDDLE	8.00	8.20	8.32	8.21	8.41	8.39	8.55	8.61	8.75	8.76	8.72	8.71
	BOTTOM	7.39	7.41	8.10	7.10	7.95	8.38	8.18	8.35	7.55	8.05	8.41	8.59

APPENDIX I'

12 Hour Survey #1 - Salinity - Logy Bay

POOL NO.	DEPTH OF SAMPLE	7 am	8 am	9 am	10 am	11 am	12 am	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
	TOP	1.5	1.4	1.5	1.0	1.4	1.5	1.4	1.4	1.5	1.4	1.5	1.6
4	MIDDLE	1.4	1.5	1.4	1.4	1.4	1.3	1.5	2.1	1.8	1.5	1.4	1.4
	BOTTOM	1.5	1.5	1.4	1.4	1.5	1.5	1.4	2.3	1.5	1.4	1.5	1.4
	TOP	11.0	12.2	11.0	10.9	10.9	11.2	11.6	12.4	12.6	12.4	12.8	12.2
IB	MIDDLE	23.7	23.7	23.9	23.9	24.3	24.0	23.8	23.9	23.6	22.2	22.6	22.2
	BOTTOM	26.0	25.8	26.2	25.7	25.9	25.6	25.0	-	25.8	23.9	24.0	23.7
	TOP	26.8	25.2	25.2	26.8	23.4	24.6	27.6	28.4	28.2	26.3	26.6	27.4
IA	MIDDLE	29.0	29.2	28.9	28.2	29.0	29.0	29.0	28.3	28.4	27.2	26.7	26.5
	BOTTOM	29.8	29.6	27.2	28.9	28.8	28.2	28.2	28.2	29.6	26.6	28.0	28.0

APPENDIX J'

12 Hour Survey #2 - Salinity - Logy Bay

POOL NO.	DEPTH OF SAMPLE	7 am	8 am	9 am	10 am	11 am	12 am	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
	TOP	.70	.60	.70	.70	.70	.80	.70	.60	.60	.80	.70	.70
4	MIDDLE	.60	.60	.60	.60	.60	.60	.60	1.8	.60	.70	.60	.60
	BOTTOM	.60	.60	.60	.60	.60	.70	.60	.60	.60	.70	.60	.60
	TOP	10.8	11.1	11.6	11.7	11.7	11.9	12.2	12.2	12.6	12.7	13.7	13.1
1B	MIDDLE	15.1	25.1	19.3	22.2	21.0	20.5	17.0	19.8	22.7	22.7	17.5	16.9
	BOTTOM	29.1	28.8	26.6	26.7	27.0	27.8	27.1	26.6	26.1	27.9	27.3	25.8
	TOP	32.9	33.1	33.0	33.4	33.1	33.4	33.1	33.8	32.9	33.6	33.1	34.8
1A	MIDDLE	33.4	32.9	33.4	33.1	33.6	34.0	33.4	33.8	34.8	35.1	34.8	34.8
	BOTTOM	35.8	33.5	33.5	33.4	33.3	33.4	33.4	33.9	34.9	34.8	33.7	35.6

APPENDIX K'

12 Hour Survey - Temperature - Logy Bay

POOL NO.	DEPTH OF SAMPLE	7 am	8 am	9 am	10 am	11 am	12 am	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
4	AIR	10.5	9.5	10.5	8.2	10.6	12.6	10.9	13.2	13.1	15.6	13.6	13.6
	TOP	11	10.9	10.9	11.7	13.2	15.1	18.0	18.6	20.6	21.1	19.9	20.1
	MIDDLE	11	11.1	11.1	11.8	13.0	14.5	17.1	18.2	20.1	20.5	19.9	19.2
	BOTTOM	11.9	11.8	12.0	11.9	13.6	14.5	16.5	18.2	18.7	20.1	19.1	18.5
1B	AIR	10.5	9.5	10.5	8.2	10.6	12.6	10.9	13.2	13.5	15.6	13.6	13.6
	TOP	10.1	10.4	10.7	11/2	13.5	15.0	16.2	18.1	19.6	20.3	19.1	19.0
	MIDDLE	12.9	12.9	13.4	13.2	14.9	15.8	18.4	20.5	21.9	22.9	19.1	23.1
	BOTTOM	13.9	14.1	14.2	14.1	15.4	16.1	18.1	20.2	21.4	21.1	20.5	20.5
1A	AIR	10.5	9.5	10.5	8.2	10.6	12.6	10.9	13.2	13.5	15.6	13.6	13.6
	TOP	8.8	9.1	10.5	10.5	11.5	13.5	16.1	16.5	18.7	18.0	18.5	16.1
	MIDDLE	9.4	10.1	9.5	11.0	11.6	13.9	15.0	15.2	17.1	18.0	17.2	16.1
	BOTTOM	10.1	10.1	10.5	10.9	11.9	12.7	14.0	14.1	15.1	15.6	15.5	15.2

APPENDIX L

12 Hour Survey #2 - Temperature - Logy Bay

POOL NO.	DEPTH OF SAMPLE	7 am	8 am	9 am	10 am	11 am	12 am	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
4	AIR	18.1	20.5	23.1	21.0	22.4	22.9	25.6	27.0	28.2	27.5	28.0	27.0
	TOP	18.5	19.2	20.5	21.1	23.1	24.8	25.9	26.7	25.9	26.3	26.0	25.1
	MIDDLE	18.5	18.9	19.5	19.9	21.1	23.1	24.1	24.5	25.2	25.1	25.7	25.4
	BOTTOM	19.0	19.1	19.5	19.9	20.8	21.5	23.1	23.7	23.7	24.0	24.5	24.5
1B	AIR	18.5	20.0	21.9	20.7	21.0	22.1	22.5	26.5	27.9	28.5	27.9	28.1
	TOP	18.1	19.1	21.9	21.7	23.5	24.9	26.0	27.0	26.2	26.2	27.0	26.0
	MIDDLE	19.9	20.2	21.1	21.8	22.2	23.9	25.2	26.1	26.5	26.9	27.8	27.1
	BOTTOM	20.2	20.5	20.2	21.8	22.1	23.8	24.1	25.1	25.9	25.5	25.7	25.1
1A	AIR	18.1	20.5	23.1	21.0	22.4	22.9	25.6	27.0	28.2	27.5	28.0	27.0
	TOP	18.5	19.2	20.5	21.1	23.1	24.8	25.9	26.7	25.9	26.3	26.0	25.1
	MIDDLE	18.5	18.9	19.5	19.9	21.1	23.1	24.1	24.5	25.2	25.1	25.7	25.4
	BOTTOM	19.0	19.1	19.5	19.9	20.8	21.5	23.1	23.7	23.7	24.0	24.5	24.5

APPENDIX M'

Logy Bay and Portugal Cove - Night Survey - Oxygen - mgO_2/litre

OXYGEN (Night Survey)

LOGY BAY						PORTUGAL COVE					
POOL	DEPTH	9 p.m.	12 p.m.	3 a.m.	6 a.m.	POOL	DEPTH	9 p.m.	12 p.m.	3 a.m.	6 a.m.
1A	TOP	6.05	5.90	4.31	4.54	1	TOP	5.30	5.07	4.70	5.36
	BOTTOM	6.28	5.15	1.97	2.12		BOTTOM	-	-	-	-
1B	TOP	5.68	4.69	4.84	4.31	3	TOP	5.30	4.92	5.60	5.51
	BOTTOM	5.30	4.66	5.16	4.47		BOTTOM	5.90	5.30	4.39	5.00
4	TOP	3.33	3.95	3.92	4.63	4	TOP	5.15	5.00	4.93	4.54
	BOTTOM	2.72	3.93	3.33	6.21		BOTTOM	5.37	4.74	4.25	4.84