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PHYSICAL AND CHEMICAL PARAMETERS OF SEVERAL OYSTER GROWING AREAS IN TASMANIA

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Summary

Physical and chemical parameters at five Pacific oyster (*Crassostrea gigas*) growing areas in Tasmania - Pittwater, Pipeclay Lagoon, Little Swanport, Georges Bay and Simpsons Bay - were measured as part of a study to determine the carrying capacity of the areas for oyster farming. This has provided valuable environmental data for these areas. The hydrodynamic regimes at each area except Simpsons Bay were studied, including high and low water volumes, flushing rates, flow rates and depth contours. Temperature, salinity and concentrations of nitrates, phosphates, silicates and chlorophyll a were measured monthly at several sites in each area. The change in these parameters over different time scales also was examined at two sites in Pittwater and indicated temporal and spatial variability in the environmental parameters measured. Intensive sampling for nutrients and chlorophyll a around the oyster farms in each area did not show any clear trends in concentrations.

A comparison of the environmental conditions and the production of oysters from each growing area shows that Pipeclay Lagoon is by far the most productive, and that it has comparatively shallow water and rapid flushing rate. This suggests that a rapid turnover of oceanic water is important for supplying food to the oysters. Chlorophyll a and nutrient concentrations, however, were similar at all growing areas.

Table of Contents

1. Introduction

This Technical Report provides environmental information on 5 estuaries and bays in Tasmania. The data were collected as part of a program to estimate and develop predictive models of carrying capacities of several Tasmanian Pacific oyster (*Crassostrea gigas*) farming areas.

Commercial Pacific oyster culture has developed rapidly in Tasmania in the last two decades from 12 farms in 1977 to 99 oyster leases in 1996 occupying an area of 1510 ha. Production of oysters from Tasmanian farms has increased from 0.95 million dozen in 1984 to 3.4 million dozen in 1996/97, which is estimated to be worth approximately $12.1 million to the Tasmanian economy.

Oysters are grazers which feed on small suspended particulate matter that they filter out from the water column. They mostly consume microscopic phytoplankton, and also detrital matter (Quayle, 1988; Grant et al, 1993), and they deposit pseudofaeces and true faeces (collectively called biodeposits) on the bottom. Benthic organisms utilise these biodeposits and they play an important role in nutrient remineralization. In areas of intense cultivation oysters can have a significant effect on the quantity and composition of phytoplankton in the water column and on the flux of particulate matter from the water column to the sediment. They can also have a marked impact on the nutrient balance of an area. Oysters release significant quantities of ammonium and dissolved phosphorous as a result of their metabolism. There are import feedback processes whereby nutrients released by oysters stimulate primary production, and resuspended biodeposits are consumed by the oysters. Harvesting of oysters also results in the removal of significant quantities of nutrients from the system, and oysters are considered to play a major role in controlling eutrophication in several estuaries overseas, e.g. Chesapeake Bay (Newell, 1988).

In recent years oyster farmers in several Tasmanian growing areas have become increasingly concerned about the ability of the natural environment to support the greater numbers of oysters being farmed. Where several farms are close together in the one bay there has been disagreement amongst some farmers over the number of oysters that could be produced from the system. For example, in one growing area a farmer was applying for an extension to his lease area while his neighbour was arguing that an increase in oyster numbers would slow the growth and reduce the condition of all oysters in the area. Similarly, in another major growing area where there are well established oyster farms in the upper reaches of the estuary, 11 applications for new farms have been received for the lower section of the estuary. The established oyster farmers believe that any new farms in the lower estuary would significantly reduce their production, whereas the applicants maintain that the farms downstream would have little effect on those already in existence.

The number of oysters that can be grown successfully in a farming area largely depends on the quantity and quality of food available in the water for the oysters to feed on. If the number of oysters being farmed exceeds the feeding capability (carrying capacity) of an area then the growth rate will be reduced and good condition (fatness) much more difficult to attain and maintain. This has deleterious ramifications on cash flow for farmers because the oysters take longer to reach market size and the farmers can't reliably harvest oysters throughout the year.

Carrying Capacity has been defined as the stock density at which production levels are maximised without negatively affecting growth rates (Carver and Mallet, 1990). There are many factors which affect the carrying capacities of oyster growing areas and require investigation for estimates of production to be made. Of particular importance is information on the hydrodynamics of the growing area and hence supply of food, the production of food in the water, the food requirements of oysters throughout the year and the growth rates of oysters at various stocking levels. Other factors which can have a significant effect on carrying capacities are biomass of other filter feeders in the area, and environmental conditions which affect oyster growth rates and algal food production.

In 1990-91 the Tasmanian Aquaculture Co-operative Society (which was primarily a co-operative of oyster growers) approached the then Division of Sea Fisheries for assistance in determining the carrying capacity of several oyster growing areas in southern Tasmania. They asked for studies to be conducted to determine the carrying capacity of areas at present and potentially in the future under intensive cultivation. This would enable them to expand their operations and allow new farms to enter the industry without jeopardising existing operations.

At the same time the Division of Sea Fisheries was trying to assess the potential oyster production of growing areas to promote sustainable development of the industry. They wished to encourage expansion of oyster operations to maximise the economic benefits of oyster farming to the Tasmanian economy. The Division also was receiving requests from some industry members to set production limits on farms in areas of intensive oyster farming activity.

An investigation of carrying capacities of several oyster growing areas in Tasmania by the Division of Sea Fisheries (now the Marine Resources Division) commenced in 1991. This was supplemented with funding from the Fishing Industry Research and Development Corporation (FRDC) in 1992-95 to develop a predictive model of carrying capacities of oyster farming areas in Tasmania. The final report to FRDC by Crawford et al (1996) provides details of the data collected on environmental parameters, oyster feeding rates, and the predictive model developed.

As part of this research, detailed information was obtained on the physico-chemical parameters of five bays and estuaries in Tasmania, and these results are presented in this report. Although this information was collected in relation to oyster production, it is valuable baseline data which is relevant to other studies and environmental management of these areas.

Both the Tasmanian and Commonwealth State of Environment reports have highlighted the paucity of information available on estuarine and marine embayment environments in Tasmania. Basic details, largely obtained from 1:100,000 maps, were listed by Bucher and Saenger (1989) in their inventory of Australian estuaries. Three large estuaries, the Derwent, Macquarie Harbour and Tamar estuaries, which are known to have suffered substantial environmental degradation have been studied to a limited extent. However, with the exception of a current study coordinated by CSIRO on the Huon estuary, very little is known of the status of other Tasmanian estuaries and marine embayments. This report aims to extend the information available on estuaries and embayments in Tasmania by making available hydrographic and nutrient data collected from Pittwater, Pipeclay Lagoon, Little Swanport, Georges Bay and Simpsons Bay.

2. Methods

2.1 Sampling Sites

The five areas in Eastern and Southeastern Tasmania that were chosen for study are shown in Fig. 1. They were generally chosen because controversy existed in some way over the use of the area for oyster farming. All of the areas, except Simpsons Bay, contain substantial marine farming operations.

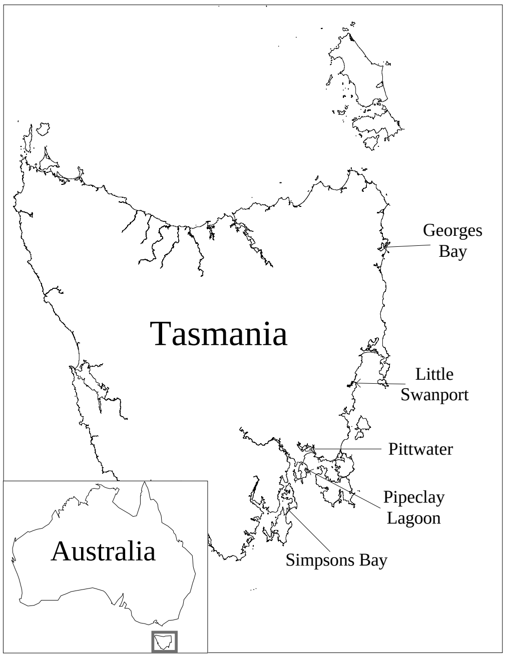


Fig. 1. Location of the five oyster growing areas.

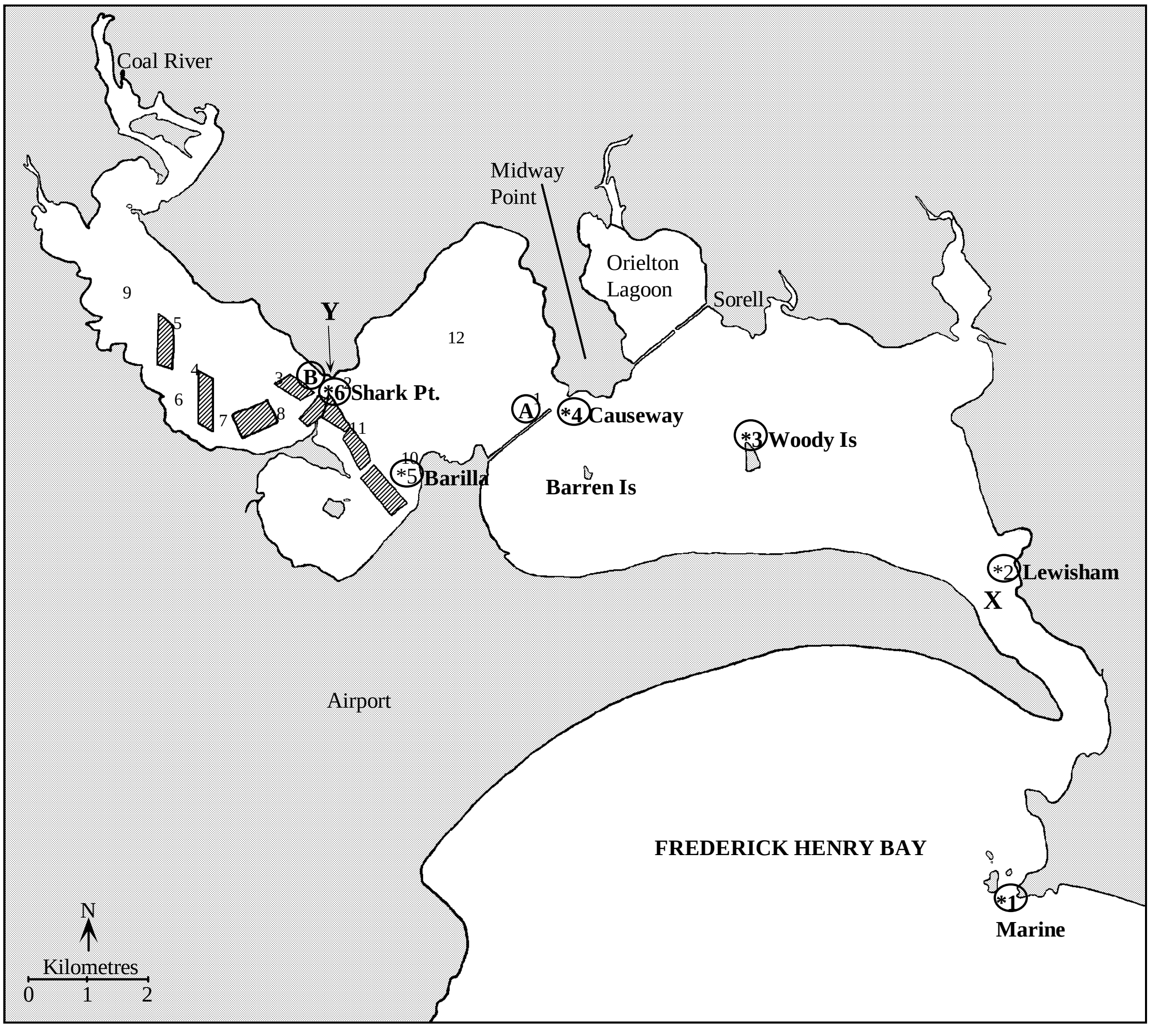
Pittwater (Fig. 2) located at 42°50’ South, 147°32’ East, is a complicated estuarine system because the causeway located in the middle of the estuary restricts the water flow to the upper through a narrow channel. This area also underwent a change in freshwater flow patterns when the Craigbourne dam was built on the Coal River, upstream of the oyster growing area, in 1986 which resulted in previous sporadic flooding of the area being replaced by a constant and reduced flow into the estuary, except for rare large flood events. There are seven oyster leases occupying an area of 108.2 ha above the causeway, and a further 11 applications have been received for leases below the causeway and one above. Production of oysters from the seven leases in Upper Pittwater increased rapidly from 1985 and peaked in 1989 at 8.7 million market sized oysters. The number of oysters harvested from this area then declined to around 5 million in 1992, reportedly due to a decrease in productivity of the area observed by the farmers, rose again in 1993-95 and in 1996 5.3 million oysters were marketed and 768,000 juveniles produced for ongrowing from the area .

Pipeclay Lagoon (Fig. 3) is a shallow marine inlet located at 147°31’ East, 42°58’ South and area of 5.32 km^2 with no permanent freshwater inflow. There are 7 leases in the lagoon growing almost entirely Pacific oysters and occupying an area of 48.3 ha. Production of oysters from Pipeclay Lagoon has steadily increased over the last 10 years from almost 1 million in 1985 to over 8 million in 1995.

The oyster growing area in Little Swanport, located at 42°20’ South, 148°00’ East, (Fig. 4) is in an estuarine system characterised by sporadic flooding. There are 3 leases spread out along the estuary on which are grown Pacific oysters; total area of leases is 79.8 ha. Over the last 5 years these leases have produced approximately 3-4 million oysters per annum.

Georges Bay (Fig. 5) on the East Coast is an estuarine system with a very narrow opening to the sea, and periodic flooding occurs in the Georges River. All the shellfish farming is located within Moulting Bay, an offshoot of the main estuary, located at 41°20’South and 148°15’ East. There are 4 leases occupying a total area of 40.5 ha. At least 2 leases have been only partly developed until recently and although the Pacific oyster is the main species grown, most leases contain other types of shellfish including native flat oysters (*Ostrea angasi*), mussels (*Mytilus edulis*) and clams (*Katylesia* sp.). In the 1995/96 growing season 4.4 million oysters and 32,000 kg of mussels were produced from the 4 leases.

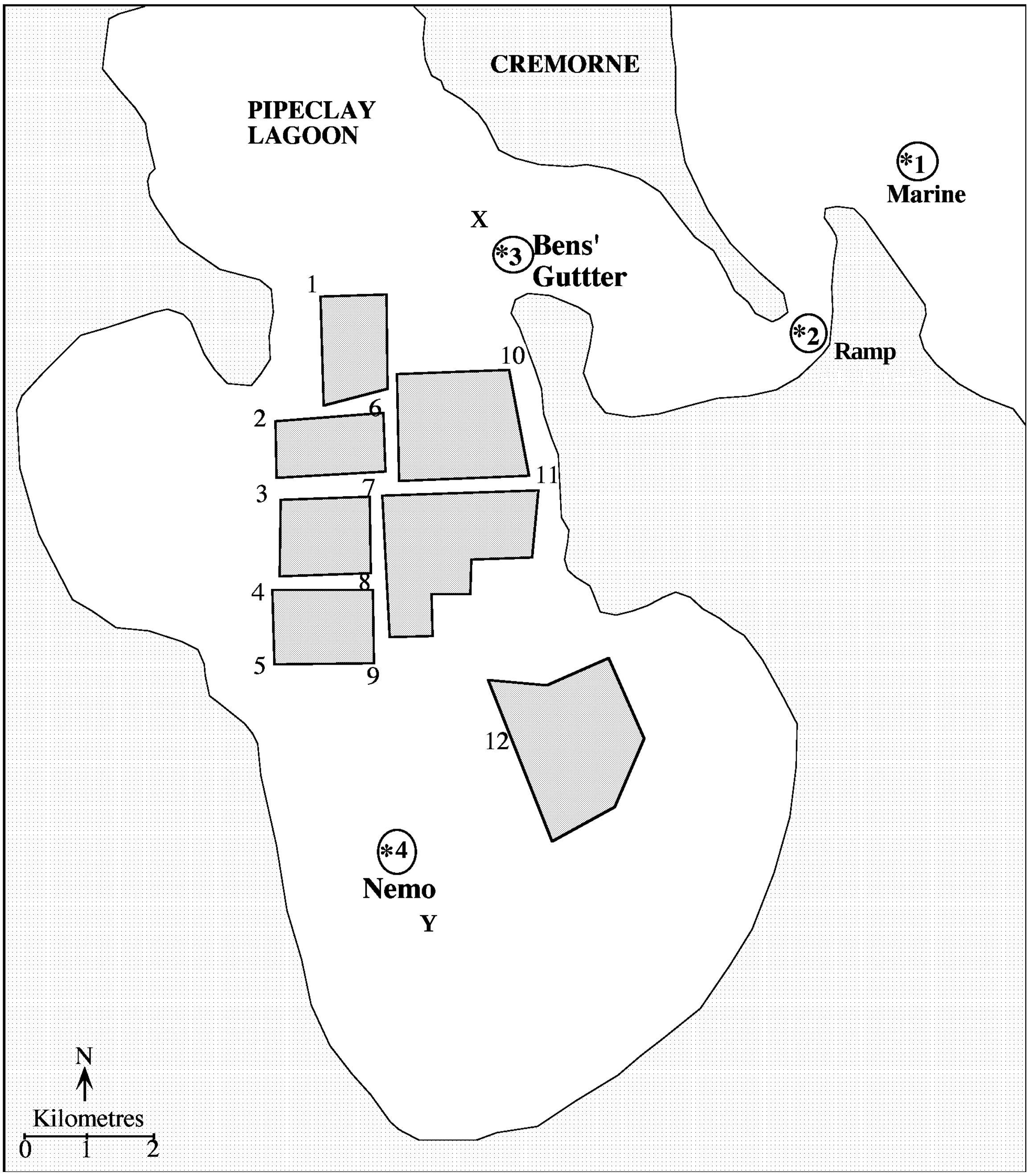
Simpsons Bay (Fig. 6) in the D'Entrecasteaux Channel contains three small shellfish farms at the head of the bay. These farms occupy an area of 42.4 ha but are only partly developed for Pacific oysters. The bay consists of extensive shallow sand flats, is fairly exposed and productivity of the area is considered to be low (DPIF Marine Farming Development Plans for Tasmania - D’Entrecasteaux Channel, 1997)). Production from these leases has increased rapidly since 1993 and reached 171,000 oysters in 1995.



Legend:

[hatched box]	Shellfish lease area
***1** to ***6**	Monthly sample sites
1 to **12**	Intensive sampling sites
X and **Y**	Sites for estimates of primary production
A and **B**	Sampling sites over time

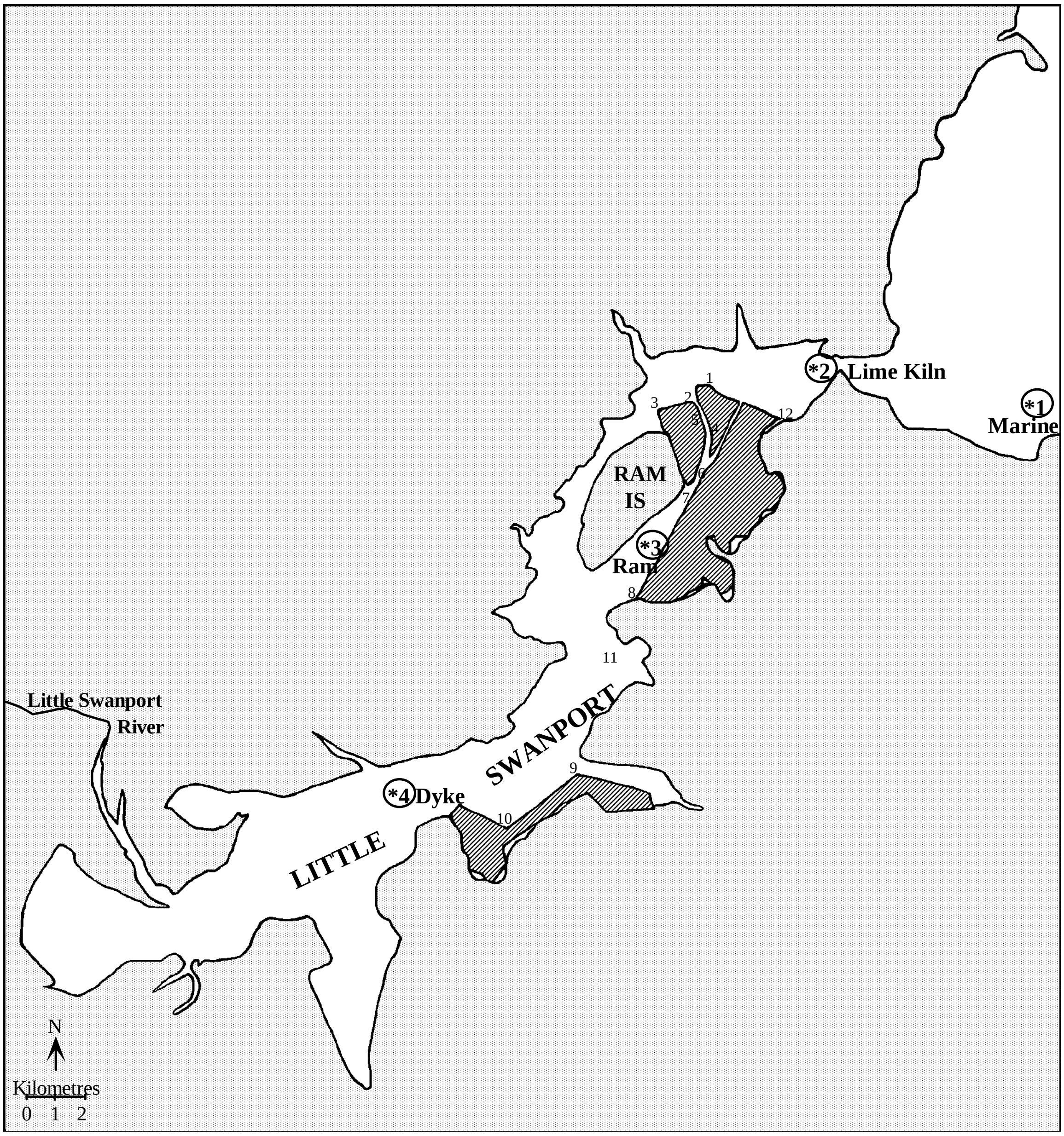
Fig. 2. Pittwater growing area.



Legend:

	Shellfish lease area
***1** to ***4**	Monthly sample sites
1 to **12**	Intensive sampling sites
X and **Y**	Sites for estimates of primary production

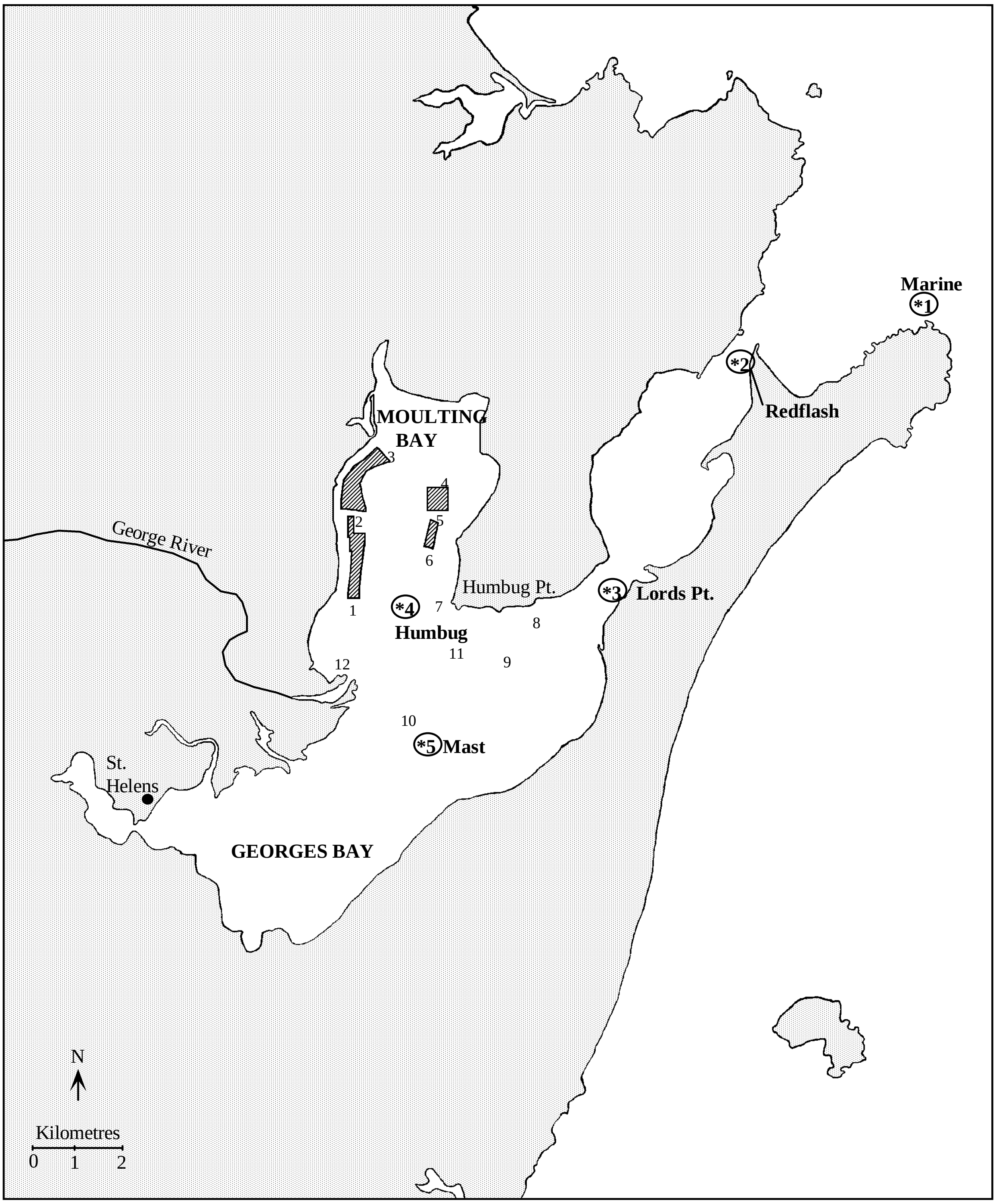
Fig. 3. Pipeclay Lagoon growing area.



Legend:

(hatched box)	Shellfish lease area
***1** to ***4**	Monthly sample sites
1 to **12**	Intensive sampling sites

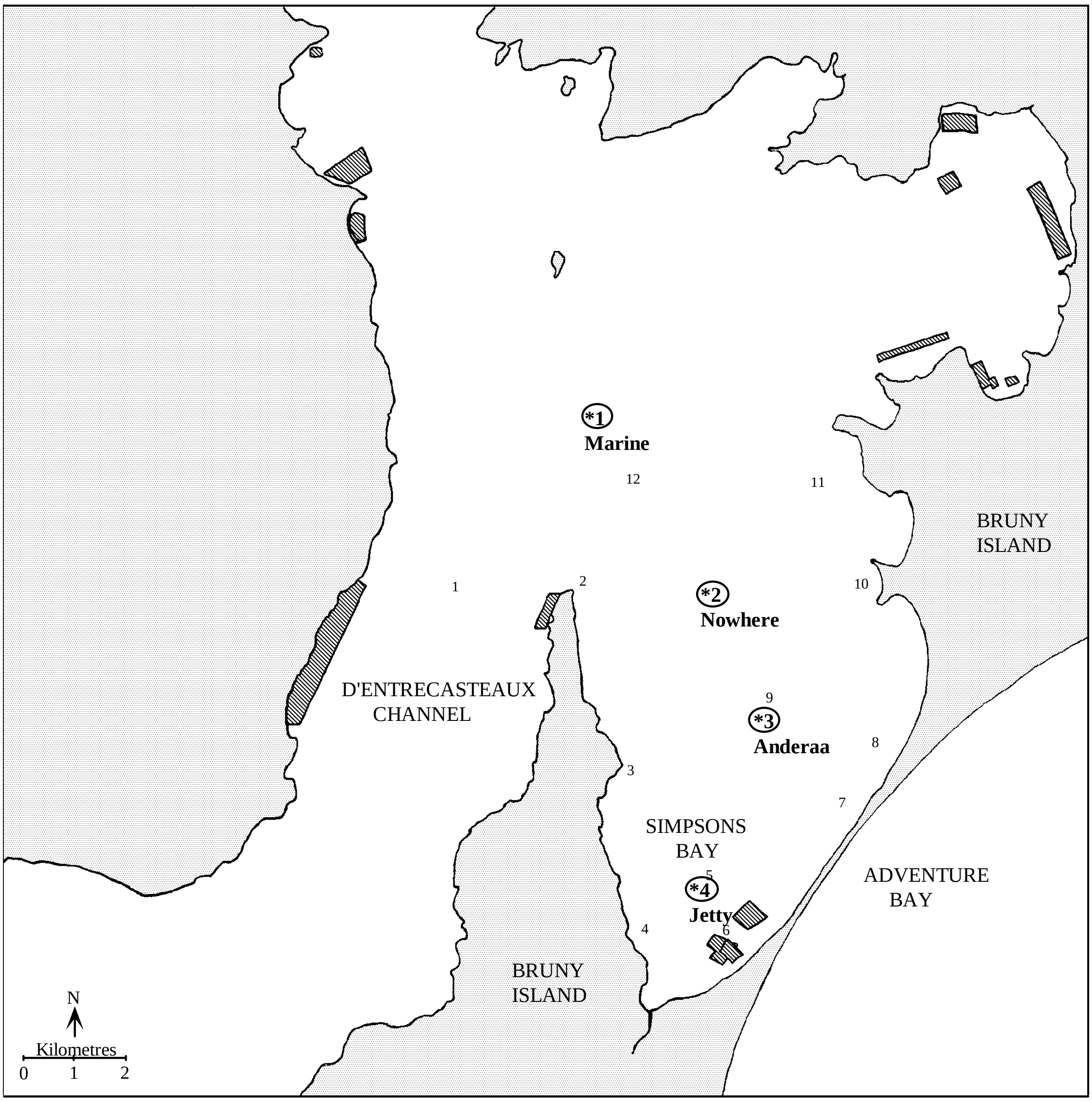
Fig. 4. Little Swanport growing area.



Legend:

(hatched box)	Shellfish lease area
***1** to ***5**	Monthly sample sites
1 to **12**	Intensive sampling sites

Fig. 5. Georges Bay growing area.



Legend:

(hatched box)	Shellfish lease area
***1** to ***4**	Monthly sample sites
1 to **12**	Intensive sampling sites

Fig. 6. Simpsons Bay growing area.

2.2 Hydrodynamics of Growing Areas

Four oyster growing areas were selected for detailed hydrodynamic studies, Pittwater, Pipeclay Lagoon, Little Swanport and Georges Bay.

All growing areas were divided into 17 or 34 segments according to the requirements of a one-dimensional hydrodynamic model which was being developed to predict carrying capacities of the growing areas. The segments were determined by drawing a line along the main channel up the estuary and dividing this distance into segments of equal length, with the segment boundaries being drawn at right angles to the line along the main channel. Water volumes and movements were calculated for each sector.

Depth contours throughout the growing areas were determined by measuring depths along transects using a depth sounder in a boat and from aerial photographs. Soundings were taken relative to an arbitrary datum point, which were later adjusted to correspond to datum at Hobart. These measured depths at a known tidal height were converted to depths that would occur at a theoretical maximum tidal height of 2 m. This was done to standardise all soundings as they were made at different stages of the tidal cycle and for different tides. A bathymetric chart was produced for each growing area at a 2 m high tide. The area of water at depth intervals of 0.5 or 1 m for a 2 m high tide was calculated for each sector, initially by comparing the weight of paper covering a known area to the weight covering the area in question. Later a planimeter was used to determine the area of water at each depth. The volumes of water in each sector were determined by multiplying the area by the tidal height calculated at each depth interval. Tidal material for Hobart was supplied by the National Tidal Facility.

Streamlines, i.e. direction of flow near the surface at various points throughout the growing area were determined for flood and ebb tides, initially by noting the direction of movement of rope deployed from a stationary boat, and later by using a biplanar cross constructed of aluminium circles 60 cm diameter at right angles to one another and attached by rope to an anchored line. The biplanar cross was placed approximately one metre below the surface and the direction was recorded from the position of floats attached to the biplanar cross and to the anchored line. This was repeated over several tides.

From the information collected on volumes a model was developed to estimate the volume of water in each sector of the growing area for any given tidal height. This enabled total volumes, tidal prisms and flushing rates to be calculated for any sized tide.

$$\text{Volume of water (V) in a sector} = \Sigma\ \text{area}(y) \times (y-(2-\text{tidal ht.}))$$

where y = depth from 0.5m, 1m, 2m, ... to maximum depth.

The total volume for the bay was calculated from the sum of the positive volumes in each sector. From the calculated volumes at given high and low tides, tidal prisms, exchange rates, and flow rates were estimated as follows:

$$\text{Tidal prism} = \text{high water volume} - \text{low water volume}$$

$$\text{Exchange rate} = \frac{\text{tidal prism}}{\text{high tide volume}}$$

$$\underset{\text{(tidal cycle)}}{\text{Flushing time}} = \frac{\text{low water vol.} + \text{prism}}{\text{prism}}$$

Average flow (tonnes/m^2) = volume transgressed segment/cross sectional area

where cross sectional area = average width x average depth at mid tide

Average velocity (m/s) = Flow/6.25/3600

This model was checked by measuring real water flow rates using an Ultrasonic Sensordata current meter deployed from a dinghy at different depths during both flood and ebb tides. Measurements were made at several stations at the entrance of each growing area, and extrapolated to the rest of the area. The current meter measured flow rates in three planes which were averaged. From the measurements of water velocity and the profile of the transect, the volume of water (area x velocity) could be determined. These observed values were compared with predicted values determined using the model, to assess the accuracy of the model.

2.3 Nutrient and Food Concentrations in Growing Areas

From four to six sampling stations were sampled at each site approximately monthly for varying periods of time. Pittwater was chosen as the main sampling site and was monitored approximately monthly for 40 months, whereas problems relating to carrying capacity which were restricting development in Simpsons Bay were settled privately and so it was only sampled for nine months. Stations were selected to be representative of water movements within each growing area, and generally ranged from the mouth of the bay or estuary to the upper reaches above the oyster growing area. Water samples were collected on the ebb tide just before low water.

The monthly sampling program consisted of deploying integrated water sample bottles to sample at 1m depth at each station. The sample bottles, which were specifically developed by project team members as a modification of the samplers designed by Fabris et al (1982), screened out large particles on a 500 µm mesh, and slowly filled to capacity of 6 l over one hour. At each station near surface water temperatures and salinities were recorded using a temperature-conductivity meter.

The water samples collected were processed in the laboratory within twenty four hours, and mostly on the day of collection. Replicate 10 ml samples were collected and frozen for later nutrient analysis. Approximately one litre of water sample was filtered through 47 mm Whatman GF/C filters, pore size 1.2µm, and the filter with concentrate was frozen for subsequent chlorophyll a analysis.

The oyster farming areas at each site were also intensively sampled over a short period of time on one to several occasions to investigate the spatial changes in nutrients and chlorophyll a within and around the growing area. These sampling stations are shown on the respective maps for each site (Figs. 2-6). 2 l water samples were collected at 1 m depth as quickly as possible from each station, with all stations being sampled in less than one hour. The water samples were analysed as described for the monthly samples.

The changes in nutrient and chlorophyll a concentrations over time also were investigated at two stations at Pittwater, one just above the causeway (Station A) and one near the oyster leases above Shark Point (Station B) (see Fig. 2). Replicate water samples were collected every hour for 12 hours, followed by every two hours for the next 12 hours. They were then collected every day on the ebb tide for one week, followed by once a week for four weeks. Because we did not have large numbers of integrated water samplers, replicate 2 l water samples were collected in plastic bottles during the 24 hour sampling period. Integrated sample bottles were also used twice during this period, and then for all subsequent sampling. All samples collected every one or two hours over 24 hours were filtered immediately after collection and the filtrate was frozen. Water temperature and salinity were recorded on each sampling occasion.

The temperature and salinity profiles with depth were measured at all stations of each site except Simpsons Bay on two occasions using a CTD Profiler.

2.3.1 Analytical Methods

Nutrients, Nitrate + nitrite (NOX) $NO_3 + NO_2$ -N, nitrite NO_2 -N, phosphate PO_4 -P and silicate SiO_4 -Si, were analysed using a Skalar segmented flow analyser. Nitrate nitrogen was calculated from NOX minus nitrite values. Low concentration nutrient standards were used to calibrate the nutrient concentrations in the water samples. Silicates were measured from November 1993.

Chlorophyll a concentrations were determined using a modified APHA (1985) Standard Method 1002G. Frozen filters were torn into small pieces, 90% acetone was added, and the sample was sonicated, then centrifuged at high speed. Absorbance of the extract was read at 663nm and 750nm. The extract was then acidified with dilute hydrochloric acid and the absorbance read again at these wavelengths. Chlorophyll a values (µg/l) were calculated using the following formula from Parsons et al (1984):

$$\text{Chl a} = \frac{(\text{Ab663 nm} - \text{Ab750 nm}) \times 11.41 \times (\text{mls 90\% acetone})}{\text{litres seawater}}$$

where Ab = absorbance

3. Results

3.1 Hydrodynamics of growing areas

3.1.1 Pittwater

The hydrodynamics in Pittwater are complicated because of the Sorell Causeway which channels the flow of water to the upper reaches of Pittwater where the oyster farms are located, and because of another causeway which until recently severely reduced the flow of water into Orielton Lagoon. The Sorell Causeway is 1.5 km long with an opening of approximately 500 m for the water to flow through. Pittwater estuary is approximately 17 km long and was divided into 34 sectors (Fig. 7). The depth contours (Fig. 8a & b) show extensive sandflats with a narrow channel roughly in the centre of the estuary. Results from the predictive model for water volumes given in Table 1 include the total area and total high and low water volumes, flows and average velocities for each sector. More information on the calculation of water volumes at the different depths in each sector is shown in Table 3 on the hydrodynamics of Pipeclay Lagoon; this water body is smaller and less complicated than Pittwater. The volumes calculated for Pittwater using the annual average high tide and low tide values for Hobart for 1993 (Table 1) show that the average tidal prism (i.e. volume of water moving in and out on each tide) for the whole estuary is 23.4 million m^3, with 11 million flowing out of Upper Pittwater (Causeway to Head). The average flushing is 4.36 tidal cycles or just over two days. Water velocities were not as high in Pittwater as Pipeclay Lagoon or Little Swanport, averaging 9 cm sec^{-1}. Streamlines (Fig. 9a & b) showing the direction of flow near the surface indicate some water circulation around the causeways.

Table 1 Hydrodynamics of Pittwater

Pittwater Volumes **Annual Average High Tide 1.555 m**
Annual Average Low Tide 0.995 m

Sector	Total area (km2)	Dist. from head (km)	HW vol (1000m^3)	LW vol (1000m^3)	Tidal Prism	Cum prism	Vol trans. seg.	Vol at Mid tide	Cross sect. area (m^2)	Av. width (m)	Av. Mid Tide Depth (m)	Flow m	Av. Velocity m/s
			VOLUMES (1000m^3)										
1	1.03	0.46	817.38	373.98	443.40	443.40	0.00	595.68	1294.97	2241.99	0.58	0.00	0.00
2	0.71	0.92	981.34	625.33	356.00	799.40	443.40	803.34	1746.38	1552.15	1.13	253.90	0.01
3	0.81	1.38	1167.50	777.19	390.31	1189.72	799.40	972.35	2113.80	1753.35	1.21	378.18	0.02
4	0.78	1.84	1097.36	738.05	359.31	1549.02	1189.72	917.71	1995.01	1695.87	1.18	596.34	0.03
5	0.87	2.30	1704.05	1299.66	404.39	1953.42	1549.02	1501.85	3264.90	1897.07	1.72	474.45	0.02
6	1.32	2.76	2839.42	2142.82	696.60	2650.02	1953.42	2491.12	5415.49	2874.35	1.88	360.71	0.02
7	1.24	3.22	2560.70	1898.41	662.29	3312.31	2650.02	2229.56	4846.87	2701.89	1.79	546.75	0.02
8	1.48	3.68	2536.38	1872.90	663.48	3975.79	3312.31	2204.64	4792.69	3219.27	1.49	691.12	0.03
9	1.23	4.14	2328.99	1767.78	561.21	4537.00	3975.79	2048.39	4453.01	2673.14	1.67	892.83	0.04
10	1.78	4.60	2515.62	1754.03	761.59	5298.58	4537.00	2134.82	4640.92	3880.37	1.20	977.61	0.04
11	2.92	5.06	6088.60	4602.58	1486.02	6784.60	5298.58	5345.59	11620.84	6352.31	1.83	455.96	0.02
12	1.77	5.52	4535.41	3714.92	820.49	7605.10	6784.60	4125.16	8967.75	3851.63	2.33	756.56	0.03
13	1.44	5.98	4935.05	4144.83	790.21	8395.31	7605.10	4539.94	9869.43	3133.04	3.15	770.57	0.03
14	1.94	6.44	6863.34	5801.88	1061.46	9456.77	8395.31	6332.61	13766.55	4225.29	3.26	609.83	0.03
15	1.86	6.90	5414.48	4421.04	993.43	10450.21	9456.77	4917.76	10690.78	4052.83	2.64	884.57	0.04
16	1.11	7.36	3019.51	2421.15	598.36	11048.57	10450.21	2720.33	5913.76	2414.45	2.45	1767.10	0.08
17	0.74	7.82	1558.34	1173.32	385.02	11433.59	11048.57	1365.83	2969.20	1609.63	1.84	3721.06	0.17
18	2.05	8.37	3101.84	2047.57	1054.26	12487.85	11433.59	2574.70	5597.18	4461.58	1.25	2042.74	0.09
19	2.58	8.91	3736.68	2457.63	1279.05	13766.91	12487.85	3097.15	6732.94	5599.43	1.20	1854.74	0.08
20	1.61	9.46	2650.60	1786.21	864.39	14631.30	13766.91	2218.41	4822.62	3503.39	1.38	2854.65	0.13
21	1.85	10.00	2945.85	1923.88	1021.96	15653.26	14631.30	2434.86	5293.18	4012.43	1.32	2764.18	0.12
22	1.67	10.55	2722.50	1799.64	922.86	16576.12	15653.26	2261.07	4915.37	3623.16	1.36	3184.55	0.14
23	2.11	11.09	3332.14	2212.72	1119.41	17695.53	16576.12	2772.43	6027.02	4581.35	1.32	2750.30	0.12
24	2.00	11.64	3821.94	2764.86	1057.09	18752.61	17695.53	3293.40	7159.56	4341.80	1.65	2471.59	0.11
25	1.27	12.18	2342.41	1678.02	664.39	19417.00	18752.61	2010.21	4370.03	2754.80	1.59	4291.19	0.19
26	1.18	12.73	2351.64	1746.75	604.89	20021.89	19417.00	2049.19	4454.77	2575.14	1.73	4358.70	0.19
27	1.89	13.27	3402.66	2447.57	955.09	20976.98	20021.89	2925.12	6358.95	4102.26	1.55	3148.62	0.14
28	1.54	13.82	3610.99	2789.79	821.21	21798.18	20976.98	3200.39	6957.37	3353.67	2.07	3015.07	0.13
29	0.70	14.36	2104.74	1732.63	372.10	22170.29	21798.18	1918.68	4171.05	1527.12	2.73	5226.06	0.23
30	0.65	14.91	3279.38	2945.78	333.61	22503.89	22170.29	3112.58	6766.48	1407.34	4.81	3276.49	0.15
31	0.56	15.45	3137.10	2918.23	218.87	22722.76	22503.89	3027.66	6581.88	1227.68	5.36	3419.07	0.15
32	0.43	16.00	2482.14	2298.67	183.47	22906.23	22722.76	2390.41	5196.54	928.25	5.60	4372.67	0.19
33	0.47	16.54	2746.12	2532.56	213.57	23119.80	22906.23	2639.34	5737.69	1018.08	5.64	3992.24	0.18
34	0.51	17.09	3085.86	2849.15	236.71	23356.50	23119.80	2967.50	6451.10	1107.91	5.82	3583.85	0.16
TOTAL	**46.12**		**101818.04**	**78461.54**	**23356.50**						**AVERAGE**	**2080.71**	**0.09**

SUMMARY	**Bay**
HW (m^3)=	**101,818,044**
LW (m^3)=	**78,461,540**
PRISM (m^3)=	**23,356,504**
AREA (km^2)=	**46.12**
FLUSHING TIME (tidal cycle)	**4.36**
EXCHANGE RATE	**22.94%**

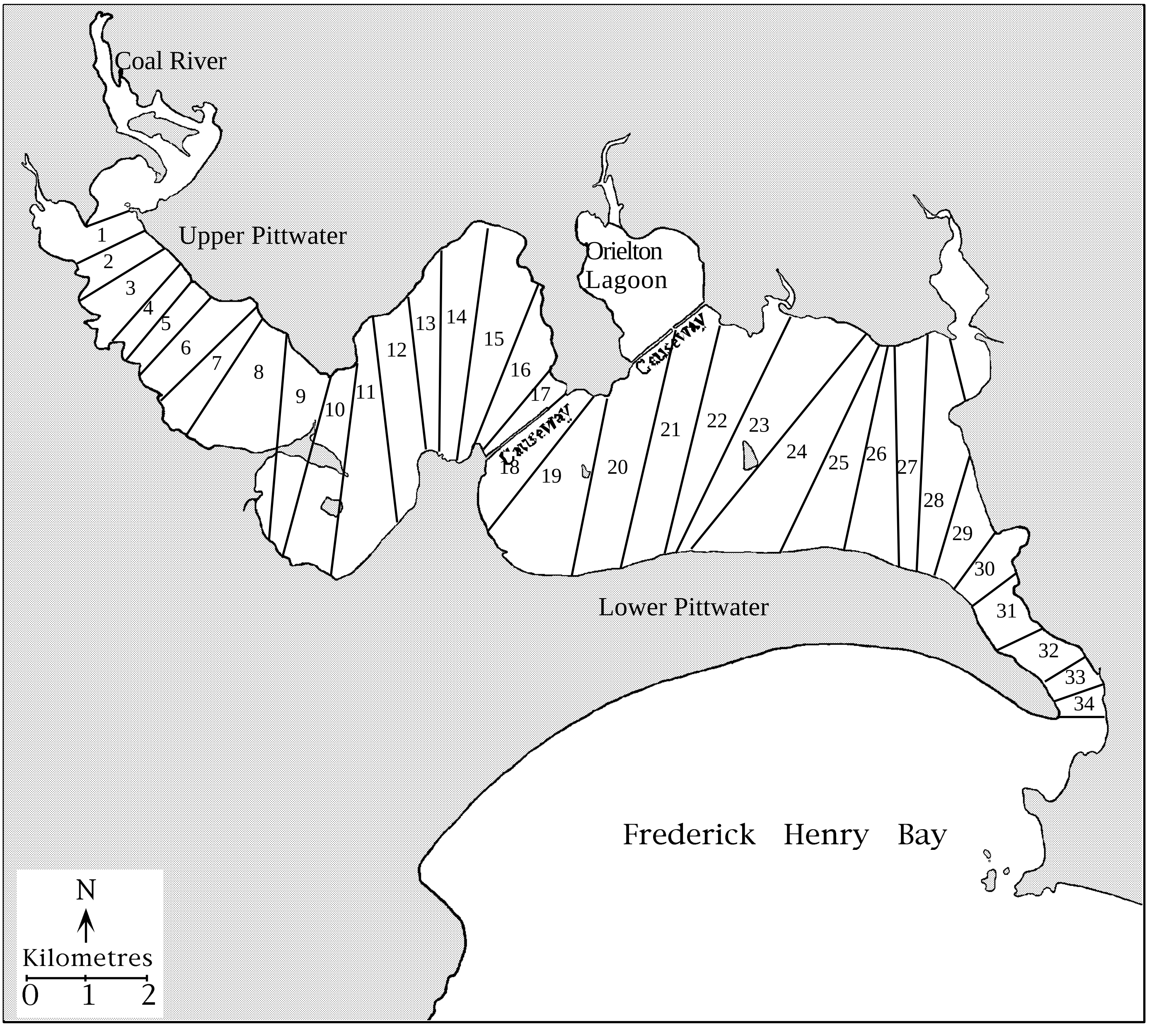


Fig. 7. Upper and Lower Pittwater sectors.

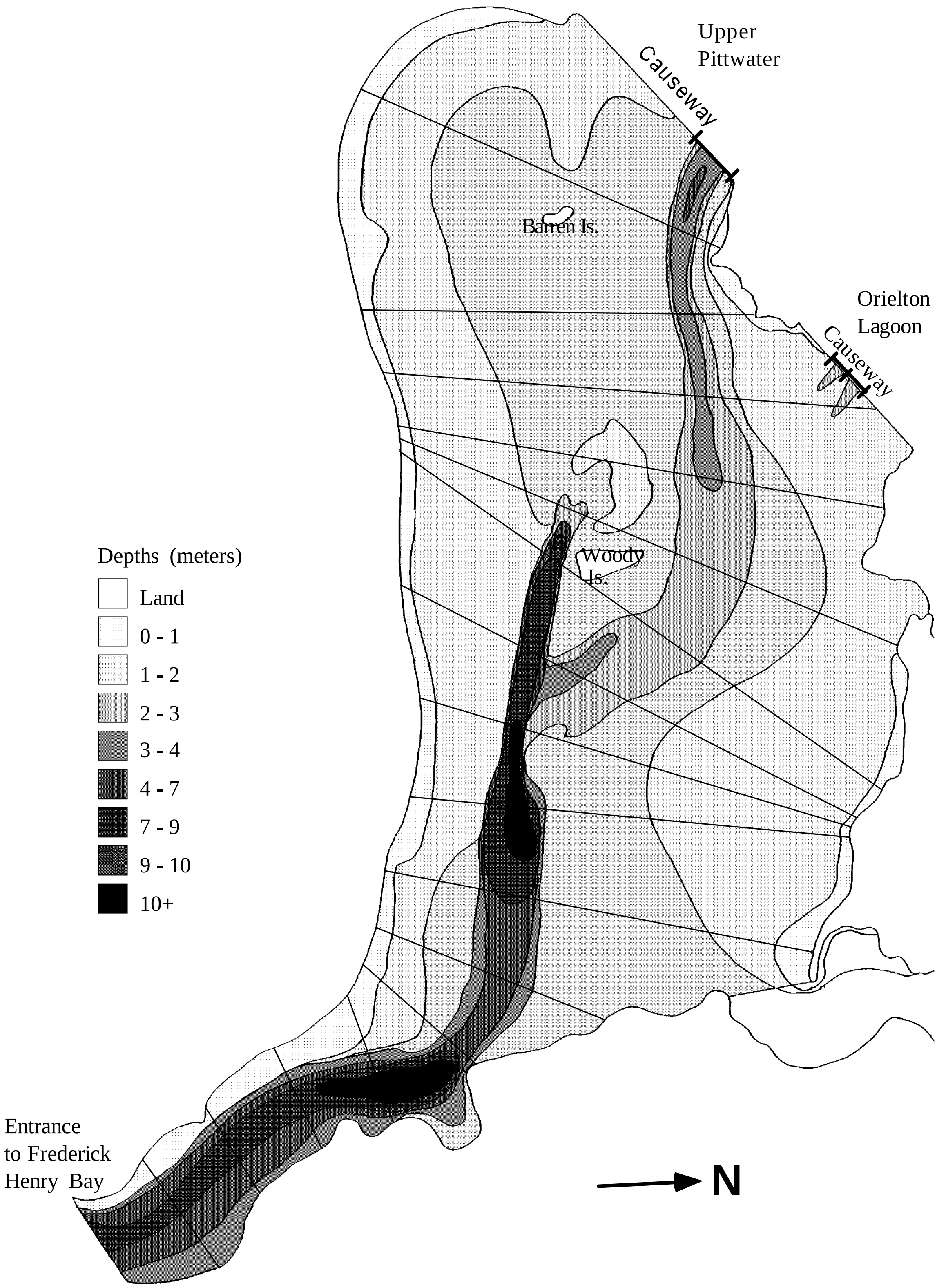


Fig. 8a. Depth contours of lower Pittwater.

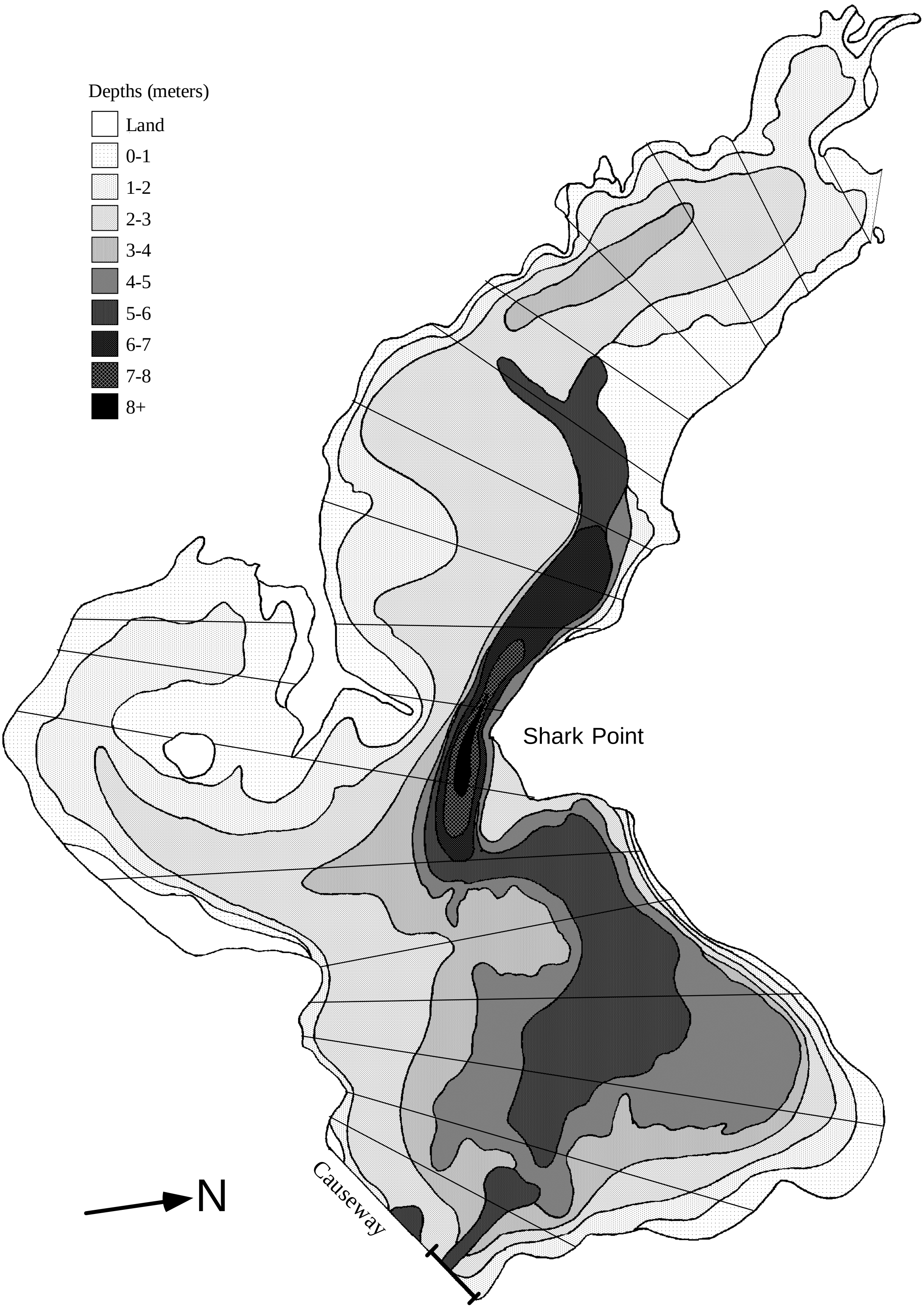


Fig. 8b. Depth contours for upper Pittwater.

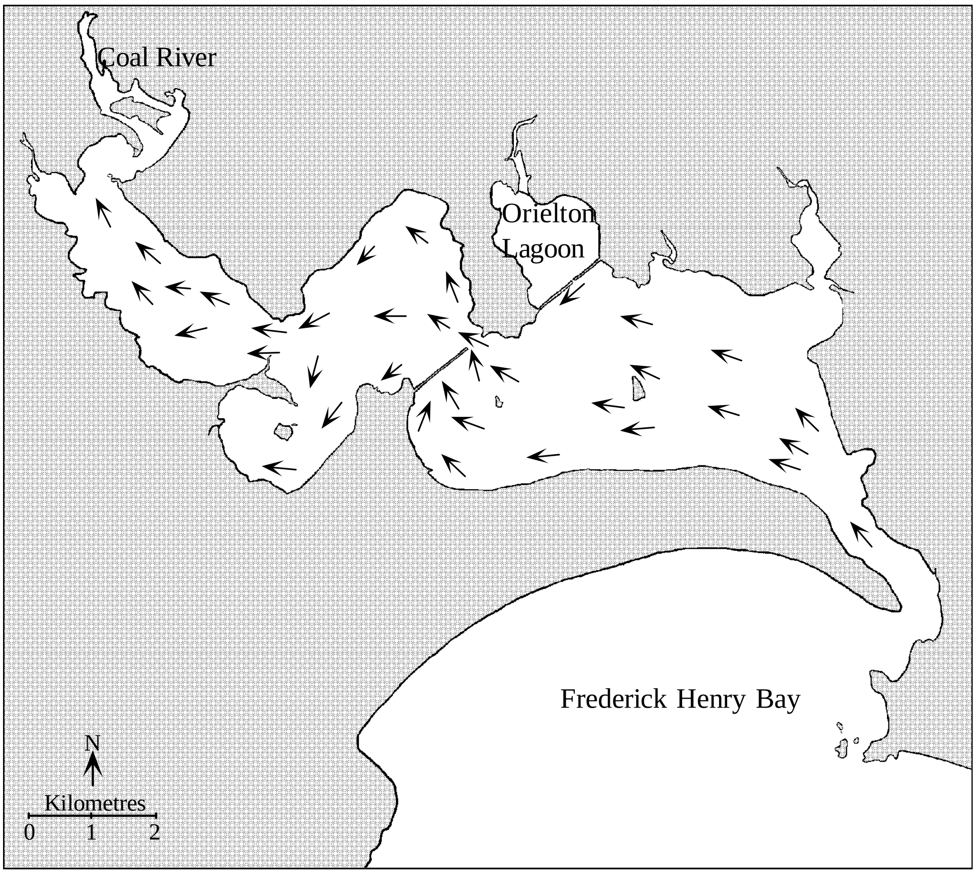


Fig. 9a. Direction of flow near the surface on Pittwater flood tide.

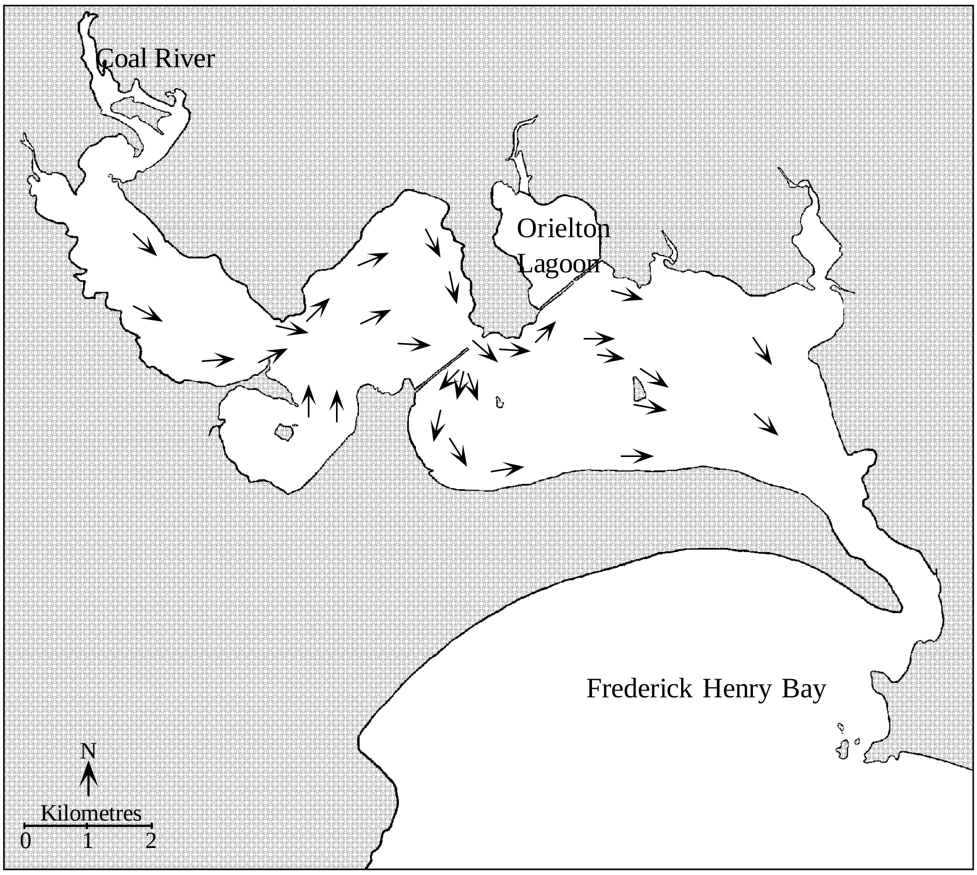


Fig. 9b. Direction of flow near the surface on Pittwater ebb tide.

3.1.2 Pipeclay Lagoon

Location of sectors and depth contours presented in Fig. 10 & 11 show that Pipeclay Lagoon is very shallow with only a small area greater than 2 m in depth. Results from the predictive model for water volumes given in Table 3 include the area and volumes at each depth (0.5, 1, 2, 3, and 4 m) for each sector. The average high water volume was almost 7 million m3, and low water 1.8 million. The average tidal prism was 5.1 million m^3 over an area of 5 km^2. The average flushing time was 1.4 tidal cycles so the water in Pipeclay Lagoon is generally exchanged at least once a day. Water velocity in the lagoon showed a marked increase from the extensive shallow sand flats at the head of the lagoon to the narrow entrance channel.

The direction of flow of near surface water during flood and ebb tides (streamlines) as shown in Fig. 11 indicate that during the flood tide, water mostly enters through the main channel and spreads out over the intertidal flats with some circulation in and around the deep hole at the head of the lagoon. Conversely, during the ebb the water drains from the sandflats at the head into the deeper hole and then out through the main channel.

A comparison of predicted to observed tidal prisms for Pipeclay Lagoon (Table 2) indicates that the predicted values are a good approximation for observed values.

Table 2. Predicted and observed tidal prisms in Pipeclay Lagoon.

DATE	PREDICTED PRISM	OBSERVED PRISM	%PRE/OBS
2/8/91	1688749	1925655	87.70
26/2/91	4880337	4956336	98.47
25/3/91	2676290	2837984	94.30
26/3/91	4174305	4115613	101.43

Table 3. Hydrodynamics of Pipeclay Lagoon

Pipeclay Lagoon **Annual Average High Tide 1.55m**
Annual Average Low Tide 0.995 m

Sector	Total Area (km2)	High Water Vol m^3) at each Depth (m) 0.50	1.00	1.50	2.00	3.00	4.00	Total HW Vol 1000m^3	Low Water Vol (1000m^3) at each Depth (m) 0.50	1.00	1.50	2.00	3.00	4.00	Total LW Vol 1000m^3	Tidal Prism	Dist from head km	Cum prism	Vol trans. seg 1000m^3	Vol at Mid tide	Cross sect. area m^2	Flow m	Av. vel m/s
1	0.216	56.45	102.63	-	-	-	-	159.07	-	-	-	-	-	-	0.00	159.07	0.25	159.07	0.00	79.54	318.15	0.00	0.00
2	0.303	20.53	225.78	53.88	-	-	-	300.19	-	-	10.78	-	-	-	10.78	289.41	0.50	448.49	159.07	155.48	621.93	255.78	0.01
3	0.400	17.96	179.60	177.03	#####	46.18	-	523.40	-	-	35.41	41.05	27.71	-	104.17	419.24	0.75	867.72	448.49	313.79	1255.14	357.32	0.02
4	0.416	15.39	87.23	200.13	51.31	415.64	-	769.71	-	-	40.03	20.53	249.39	-	309.94	459.77	1.00	1327.50	867.72	539.83	2159.30	401.85	0.02
5	0.354	15.39	97.50	123.15	#####	261.70	-	610.64	-	-	24.63	45.16	157.02	-	226.81	383.83	1.25	1711.33	1327.50	418.72	1674.89	792.59	0.04
6	0.308	15.39	200.13	76.97	10.26	61.58	-	364.33	-	-	15.39	4.11	36.95	-	56.45	307.89	1.50	2019.21	1711.33	210.39	841.55	2033.54	0.09
7	0.216	23.09	123.15	30.79	-	76.97	-	254.01	-	-	6.16	-	46.18	-	52.34	201.66	1.75	2220.88	2019.21	153.17	612.69	3295.64	0.15
8	0.390	15.39	118.02	261.70	-	200.13	-	595.24	-	-	52.34	-	120.08	-	172.42	422.83	2.00	2643.71	2220.88	383.83	1535.32	1446.52	0.06
9	0.457	17.96	148.81	307.89	-	200.13	-	674.78	-	-	61.58	-	120.08	-	181.65	493.13	2.25	3136.84	2643.71	428.22	1712.87	1543.44	0.07
10	0.344	25.66	107.76	246.31	-	61.58	-	441.30	-	-	49.26	-	36.95	-	86.21	355.09	2.50	3491.93	3136.84	263.75	1055.02	2973.25	0.13
11	0.493	25.66	246.31	246.31	-	92.37	-	610.64	-	-	49.26	-	55.42	-	104.68	505.96	2.75	3997.89	3491.93	357.66	1430.64	2440.82	0.11
12	0.559	38.49	302.75	207.82	-	107.76	20.53	677.35	-	-	41.56	-	64.66	14.37	120.59	556.76	3.00	4554.65	3997.89	398.97	1595.87	2505.14	0.11
13	0.149	17.96	51.31	38.49	-	107.76	-	215.52	-	-	7.70	-	64.66	-	72.35	143.17	3.25	4697.81	4554.65	143.94	575.74	7910.87	0.35
14	0.113	12.83	46.18	-	-	107.76	20.53	187.30	-	-	-	-	64.66	14.37	79.02	108.27	3.50	4806.09	4697.81	133.16	532.64	8819.85	0.39
15	0.139	10.26	20.53	100.06	-	61.58	41.05	233.48	-	-	20.01	-	36.95	28.74	85.69	147.78	3.75	4953.87	4806.09	159.59	638.35	7528.94	0.33
16	0.072	10.26	10.26	46.18	-	15.39	20.53	102.63	-	-	9.24	-	9.24	14.37	32.84	69.79	4.00	5023.66	4953.87	67.73	270.94	18284.09	0.81
17	0.072	5.13	10.26	-	-	76.97	102.63	194.99	-	-	-	-	46.18	71.84	118.02	76.97	4.25	5100.63	5023.66	156.51	626.03	8024.59	0.36
TOTAL	**5.00**	**343.8**	**2078.2**	**2116.7**	**277.1**	**1893.5**	**205.3**	**6914.6**	**0.0**	**0.0**	**423.3**	**110.8**	**1136.1**	**143.7**	**1814.0**	**5100.6**		**51161.3**	**46060.62**	**4364.27**	**AVERAGE**	**68614.23**	**0.18**

TOTAL	**High Water Volume (m3)**	**6,914,584**
TOTAL	**Low water Volume (m3)**	**1,813,956**
TOTAL	**Prism (m3)**	**5,100,628**
TOTAL	**Area (km2)**	**5.00**
FLUSHING	**TIME (tidal cycles)**	**1.36**

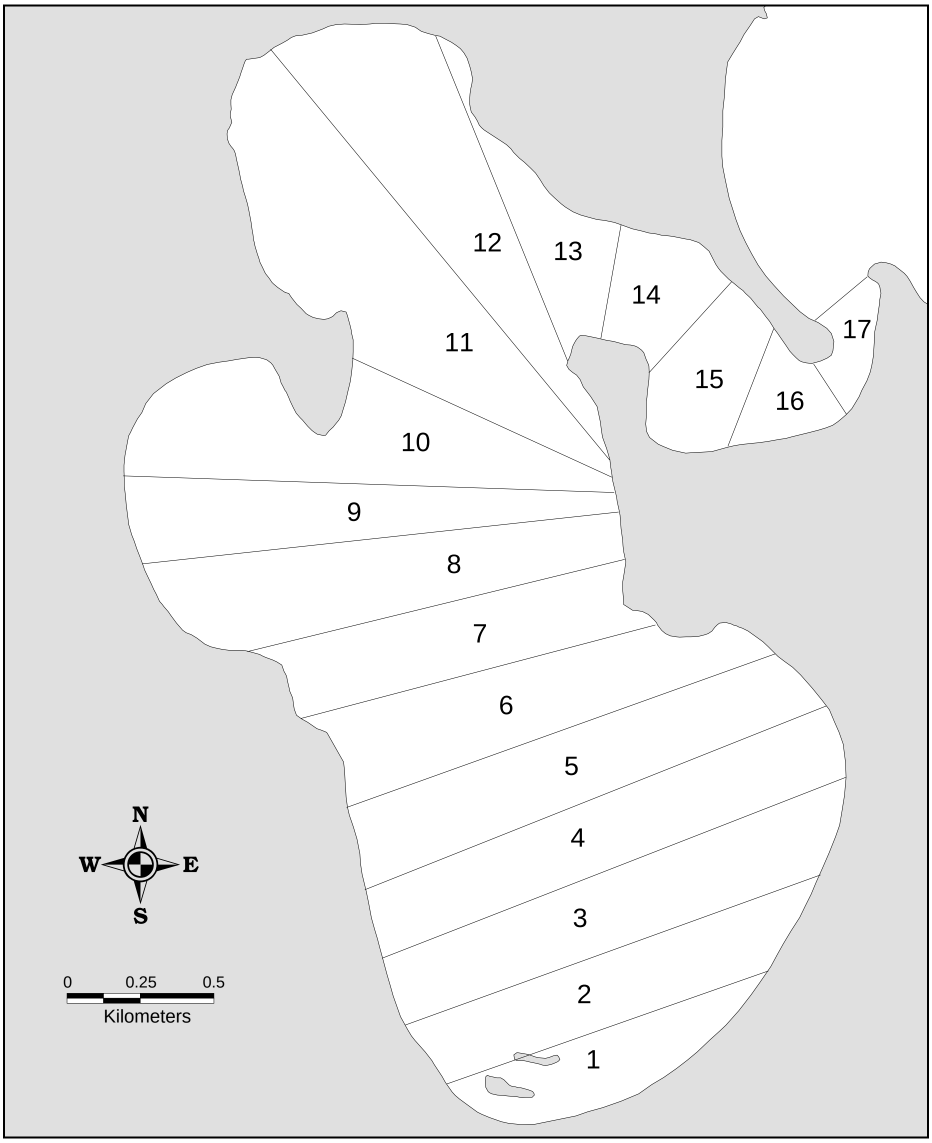


Fig. 10. Pipeclay lagoon sectors.

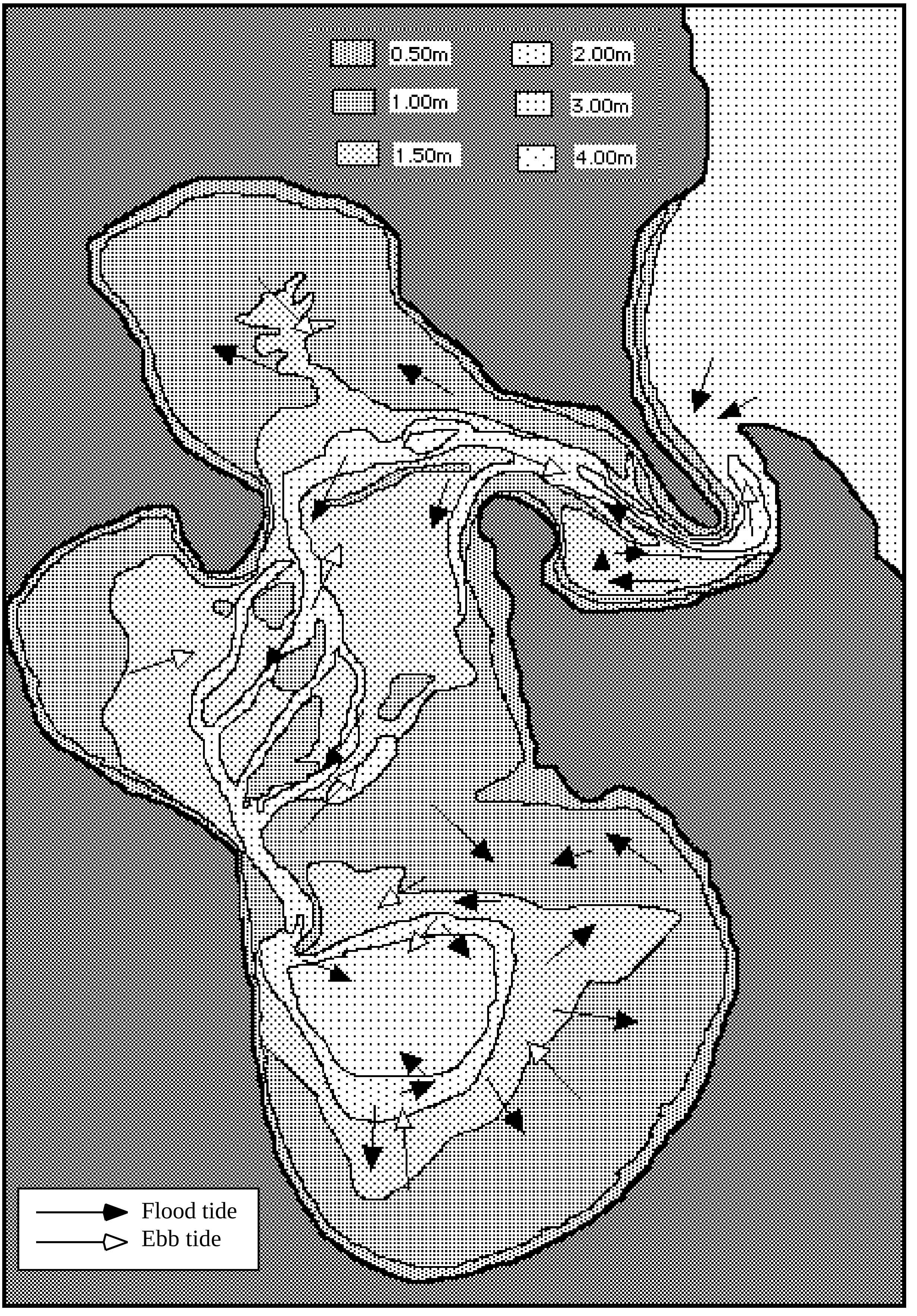


Fig. 11. Pipeclay Lagoon tidal streamlines.

3.1.3 Little Swanport

The estuary was divided into 34 segments as shown in Fig. 12a and from the hydrodynamic studies the high tide volume of Little Swanport is estimated to be 7.9 million cubic metres with a tidal prism of 3.4 million m^3 (Table 4). The depth contours at Little Swanport (Fig. 12b) showed that much of the area is relatively shallow except for a deeper channel in the middle section of the estuary. The area is calculated to be approximately 6.3 km^2 and the flushing time is 2.3 tidal cycles or just over a day. Streamlines in Little Swanport indicated good movement of water around the estuary on each tidal cycle with some circulation of water around Ram Island (Fig. 13a & 13b)

Table 4: Hydrodynamics of Little Swanport

Little Swanport

HW 1.29m
LW 0.46m

						VOLUMES (1000t)					
Sector	**Total Area (km^2)**	**HW vol (1000t)**	**LW vol (1000t)**	**Tidal Prism**	**Dist. from head (m)**	**Cum prism**	**Vol. trans. seg.**	**Vol at Mid tide**	**Cross sec. Area (m2)**	**Flow tonnes/m2**	**Mean vel (u) m/s**
1	0.06	0.00	0.00	0.00	217	0.00	0.00	0.00	0		
2	0.21	15.86	0.00	15.86	433	15.86	0.00	2.88	13	0	0.000
3	0.24	60.88	0.00	60.88	650	76.74	15.86	17.29	80	199	0.007
4	0.16	69.02	0.00	69.02	867	145.76	76.74	20.89	96	796	0.026
5	0.15	68.59	0.00	68.59	1,084	214.36	145.76	21.61	100	1,462	0.048
6	0.09	26.58	2.02	24.56	1,300	238.91	214.36	9.91	46	4,687	0.154
7	0.06	9.43	0.00	9.43	1,517	248.34	238.91	1.44	7	35,943	1.182
8	0.06	14.15	0.00	14.15	1,734	262.49	248.34	2.88	13	18,681	0.614
9	0.40	296.48	125.17	171.31	1,950	433.81	262.49	192.18	887	296	0.010
10	0.49	196.08	18.88	177.20	2,167	611.00	433.81	72.68	335	1,294	0.043
11	0.31	141.90	18.21	123.69	2,384	734.69	611.00	61.12	282	2,166	0.071
12	0.17	83.03	24.37	58.67	2,601	793.36	734.69	42.27	195	3,767	0.124
13	0.17	125.34	20.99	104.35	2,817	897.71	793.36	59.71	276	2,879	0.095
14	0.11	118.32	46.35	71.97	3,034	969.68	897.71	77.75	359	2,502	0.082
15	0.10	139.76	67.55	72.21	3,251	1041.89	969.68	101.04	466	2,080	0.068
16	0.23	368.14	218.27	149.88	3,467	1191.77	1041.89	285.28	1,316	791	0.026
17	0.20	346.35	208.75	137.60	3,684	1329.37	1191.77	272.18	1,256	949	0.031
18	0.34	600.37	375.74	224.63	3,901	1554.00	1329.37	478.36	2,207	602	0.020
19	0.09	239.39	169.63	69.76	4,117	1623.76	1554.00	203.81	940	1,652	0.054
20	0.13	339.92	241.11	98.81	4,334	1722.57	1623.76	288.82	1,333	1,218	0.040
21	0.15	334.64	227.83	106.80	4,551	1829.37	1722.57	278.41	1,285	1,341	0.044
22	0.17	483.36	355.51	127.86	4,768	1957.23	1829.37	416.74	1,923	951	0.031
23	0.19	727.59	577.97	149.62	4,984	2106.85	1957.23	651.30	3,005	651	0.021
24	0.18	452.84	325.26	127.58	5,201	2234.43	2106.85	385.79	1,780	1,183	0.039
25	0.16	324.54	217.85	106.68	5,418	2341.11	2234.43	267.02	1,232	1,813	0.060
26	0.16	238.47	145.13	93.34	5,634	2434.45	2341.11	185.07	854	2,741	0.090
27	0.15	306.60	206.74	99.86	5,851	2534.31	2434.45	252.36	1,164	2,091	0.069
28	0.26	436.40	256.61	179.78	6,068	2714.09	2534.31	338.60	1,562	1,622	0.053
29	0.27	324.33	131.92	192.41	6,285	2906.50	2714.09	216.86	1,001	2,712	0.089
30	0.28	477.36	270.52	206.85	6,501	3113.34	2906.50	366.05	1,689	1,721	0.057
31	0.19	267.60	131.00	136.60	6,718	3249.95	3113.34	188.89	872	3,572	0.117
32	0.14	122.63	48.56	74.06	6,935	3324.01	3249.95	75.78	350	9,294	0.306
33	0.11	69.19	25.45	43.75	7,151	3367.76	3324.01	42.55	196	16,931	0.557
34	0.07	81.94	47.19	34.74	7,368	3402.50	3367.76	62.85	290	11,612	0.382
TOTAL	**6.32**	**7907.09**	**4504.59**	**3402.50**					**AVERAGE**	**4,249**	**0.140**

SUMMARY	**LITTLE SWANPORT**
HW (m3)=	**7,907,087.61**
LW (m3)=	**4,504,585.13**
PRISM (m3)=	**3,402,502.48**
AREA (km2)=	**6.32**
FLUSHING TIME= (tidal cycle)	**2.32**
EXCHANGE RATE=	**43%**

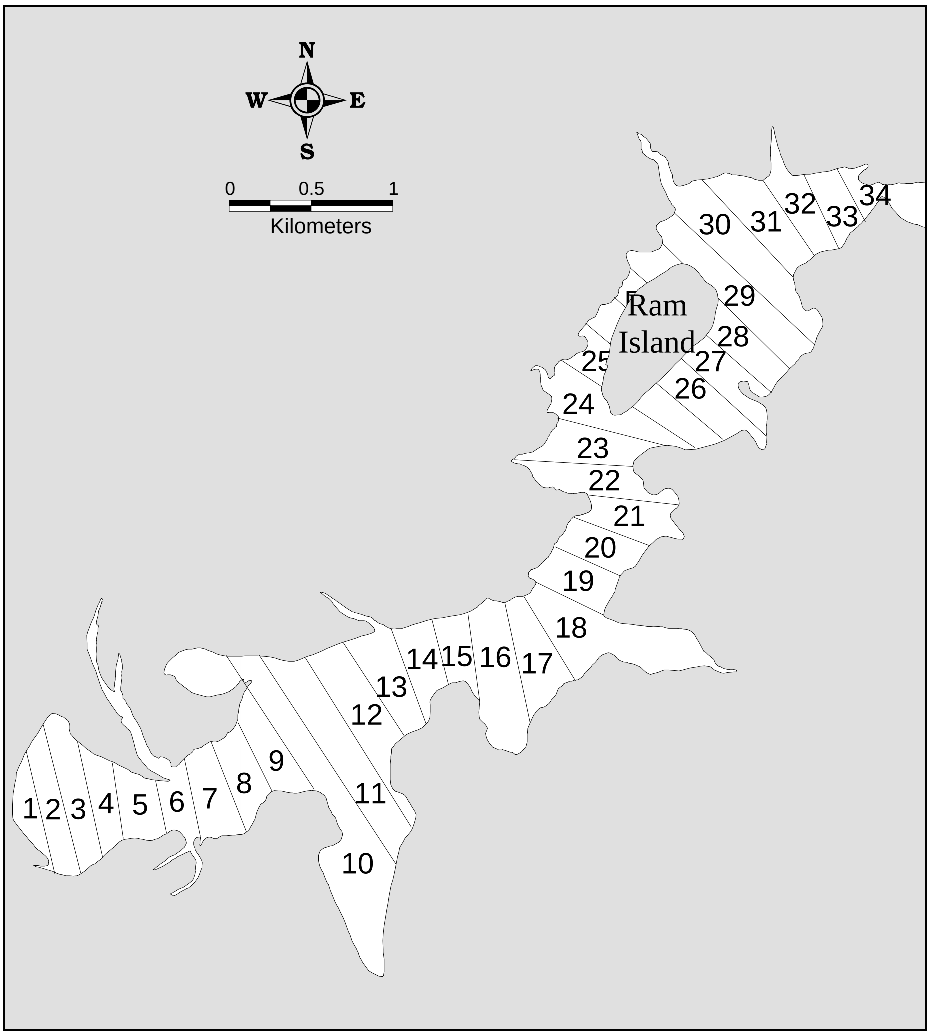


Fig. 12a. Little Swanport sectors.

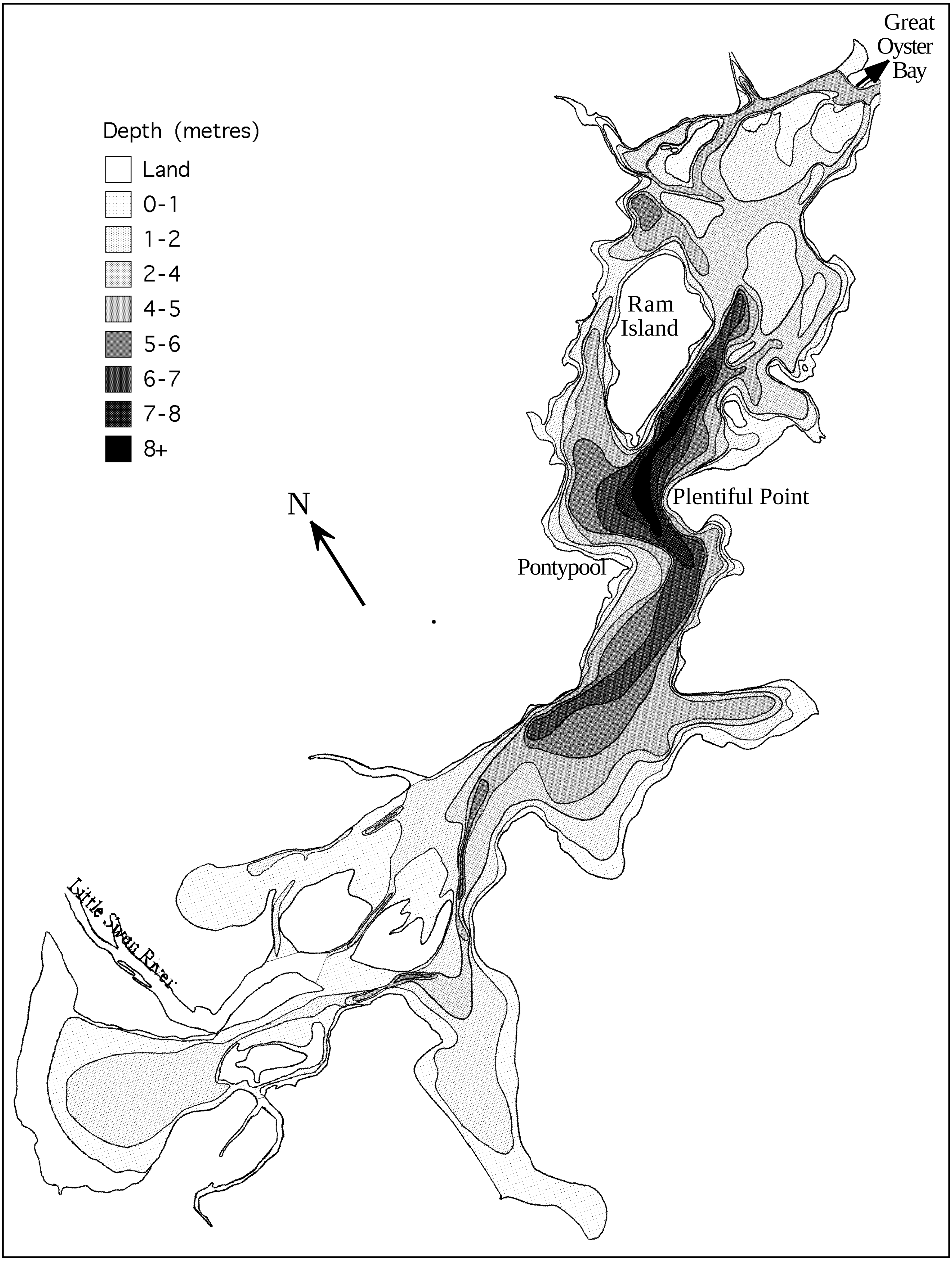


Fig. 12b. Depth contours at Little Swanport.

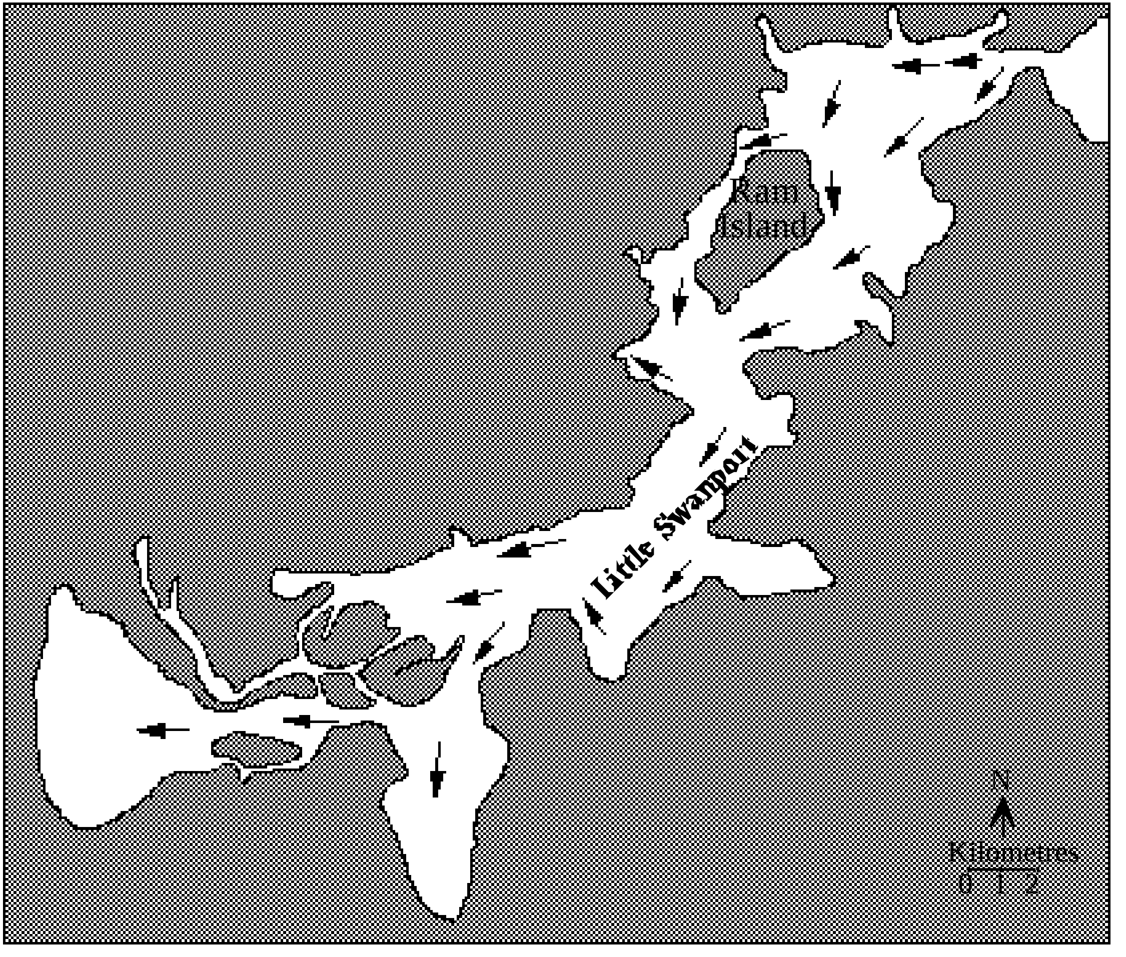


Fig. 13a. Little Swanport flood tide streamlines.

Fig. 13b. Little Swanport ebb tide streamlines.

3.1.4 Georges Bay

The bathymetric map for Georges Bay (Fig. 14) shows the relatively shallow and narrow opening to the ocean at the St Helens Bar, and the wider and deeper sections in the upper reaches of the bay. The oyster farms are located in Moulting Bay which is a shallow offshoot of the main bay. Water depths in Moulting Bay rarely exceed 4m. The hydrodynamics of Georges Bay, excluding Moulting Bay, show a high tide volume of approximately 115 million m^3 and a tidal prism of around 12 million m^3 (Table 5). The area was calculated to be 14.1 km^2 and the flushing time approximately 10 tidal cycles. The mean velocity in each sector increased substantially from the head of Georges Bay towards the narrow entrance and reached a maximum level of 31 cm sec^{-1} near the entrance.

Moulting Bay has an area of 4.2 km^2 and a high tide volume of approximately 21 million m^3 (Table 6). The exchange rate of Moulting Bay with Georges Bay was estimated to be 17.5%, slightly higher than the exchange rate of Georges Bay with the open sea. The mean velocity in each sector was low and the average of 1 cm sec^{-1} was significantly less than the average for Georges Bay of 8.5 cm sec^{-1}. The streamlines in Moulting Bay (Fig. 15) showed that on a flood tide water generally flooded in across the entire bay except in the Humbug Point area where water was flowing out of Moulting Bay into Georges Bay close to the point. Streamlines on an ebb tide indicated a circular pattern of water movement with much of the water on the eastern side of the bay moving around the head of the bay and flowing out into Georges Bay along the western shore, except in the Humbug Point area where the water was flowing out of the Bay along the eastern shore.

Table 5 Georges Bay, not including Moulting Bay

Georges Bay **High tide 1.69m**
Low tide 0.74m

					VOLUME (1000m^3)						
Sector	**Area (km2)**	**HW vol (1000m^3)**	**LW vol (1000m^3)**	**Tidal Prism**	**Dist. from head (m)**	**Cum prism**	**Vol. trans. seg.**	**Vol at Mid tide**	**Cross sec. Area (m^2)**	**Flow m**	**Mean vel (u) m/s**
34	0.100	735.86	643.37	92.50	238	92.50	0.00	688.83	2894.24	0.00	0.000
33	0.218	1429.71	1233.17	196.55	476	289.05	92.50	1328.33	5581.24	16.57	0.001
32	0.266	1055.75	859.86	195.89	714	484.94	289.05	940.71	3952.58	73.13	0.003
31	0.322	2703.51	2402.45	301.05	952	785.99	484.94	2551.43	10720.28	45.24	0.002
30	0.666	5913.19	5316.24	596.96	1190	1382.95	785.99	5603.99	23546.18	33.38	0.001
29	0.789	8240.23	7531.78	708.44	1428	2091.39	1382.95	7873.57	33082.22	41.80	0.002
28	0.789	8382.23	7694.41	687.82	1666	2779.21	2091.39	8019.67	33696.10	62.07	0.003
27	0.592	4914.08	4428.66	485.43	1904	3264.64	2779.21	4648.05	19529.61	142.31	0.006
26	0.566	5027.29	4566.75	460.54	2142	3725.18	3264.64	4773.69	20057.54	162.76	0.007
25	0.414	3751.49	3388.88	362.60	2380	4087.78	3725.18	3560.85	14961.57	248.98	0.011
24	0.471	4592.39	4166.49	425.90	2618	4513.68	4087.78	4374.78	18381.45	222.39	0.010
23	0.541	5936.30	5472.46	463.84	2856	4977.52	4513.68	5698.17	23941.89	188.53	0.008
22	0.624	3825.89	3354.07	471.82	3094	5449.34	4977.52	3568.23	14992.54	332.00	0.015
21	0.446	4909.09	4502.02	407.06	3332	5856.41	5449.34	4705.56	19771.24	275.62	0.012
20	0.428	7655.14	7264.60	390.53	3,570	6246.94	5856.41	7459.87	31344.00	186.84	0.008
19	0.177	2804.24	2648.79	155.45	3,808	6402.39	6246.94	2726.52	11455.95	545.30	0.024
18	0.625	10664.33	10077.08	587.24	4,046	6989.63	6402.39	10370.70	43574.39	146.93	0.007
17	0.794	10613.28	9885.50	727.78	4,284	7717.41	6989.63	10246.29	43051.63	162.35	0.007
16	0.584	6384.87	5845.94	538.93	4,522	8256.33	7717.41	6110.75	25675.40	300.58	0.013
15	0.523	4480.39	4004.55	475.84	4,760	8732.18	8256.33	4236.26	17799.42	463.85	0.021
14	0.531	2325.32	1830.95	494.37	4,998	9226.55	8732.18	2075.03	8718.62	1001.55	0.045
13	0.261	821.41	598.80	222.61	5,236	9449.16	9226.55	702.33	2950.95	3126.64	0.139
12	0.122	646.00	535.32	110.67	5,474	9559.83	9449.16	589.11	2475.24	3817.47	0.170
11	0.148	500.97	380.90	120.07	5,712	9679.90	9559.83	434.72	1826.57	5233.75	0.233
10	0.287	669.76	463.71	206.05	5,950	9885.95	9679.90	546.54	2296.37	4215.30	0.187
9	0.427	895.53	582.49	313.04	6,188	10198.99	9885.95	711.03	2987.52	3309.08	0.147
8	0.409	737.43	441.01	296.42	6,426	10495.41	10198.99	561.24	2358.16	4324.98	0.192
7	0.388	640.05	343.56	296.49	6,664	10791.90	10495.41	470.05	1975.02	5314.08	0.236
6	0.444	758.73	490.91	267.82	6,902	11059.72	10791.90	578.20	2429.39	4442.22	0.197
5	0.322	779.51	550.34	229.17	7,140	11288.89	11059.72	641.60	2695.82	4102.55	0.182
4	0.340	794.47	553.91	240.56	7,378	11529.45	11288.89	649.32	2728.23	4137.81	0.184
3	0.226	549.14	364.92	184.22	7,616	11713.68	11529.45	447.70	1881.09	6129.15	0.272
2	0.139	460.08	343.14	116.94	7,854	11830.61	11713.68	396.95	1667.87	7023.14	0.312
1	0.113	590.49	493.22	97.27	8,092	11927.89	11830.61	538.75	2263.65	5226.35	0.232
TOTAL	**14.093**	**115188.145**	**103260.259**	**11927.886**					**AVERAGE**	**1913.374**	**0.085**

SUMMARY	**GEORGES BAY**
HW (m3)=	**115,188,145**
LW (m3)=	**103,260,259**
PRISM (m3)=	**11,927,886**
AREA (km2)=	**14.093**
FLUSHING TIME= (tidal cycle)	**9.66**
EXCHANGE RATE=	**10%**

Table 6 Moulting Bay

Moulting Bay **High tide 1.69m**
Low Tide 0.74m

VOLUMES (1000m^3)

Sector	**Total Area (m^2)**	**HW vol (1000m^3)**	**LW vol (1000m^3)**	**Tidal Prism**	**Dist. from head (m)**	**Cum prism**	**Vol trans seg.**	**Vol at Mid tide**	**Cross sec. Area (m^2)**	**Flow m**	**Mean vel (u) m/s**
44	0.383	**381.93**	**136.06**	245.86	283	245.863	0	223.25	788.88	0.00	0.000
43	0.314	**848.60**	**566.18**	282.43	566	528.289	245.863	702.73	2483.16	99.01	0.004
42	0.470	**1461.08**	**1050.19**	410.89	849	939.179	528.289	1244.75	4398.40	120.11	0.005
41	0.444	**1736.52**	**1340.16**	396.36	1132	1335.54	939.179	1530.56	5408.33	173.65	0.008
40	0.470	**2112.60**	**1681.12**	431.48	1415	1767.021	1335.54	1892.21	6686.24	199.74	0.009
39	0.462	**2530.62**	**2107.50**	423.12	1698	2190.142	1767.021	2314.40	8178.09	216.07	0.010
38	0.383	**1937.86**	**1589.22**	348.64	1981	2538.783	2190.142	1758.89	6215.15	352.39	0.016
37	0.366	**1341.25**	**1009.14**	332.11	2264	2870.894	2538.783	1170.53	4136.16	613.80	0.027
36	0.342	**2062.57**	**1758.00**	304.58	2547	3175.471	2870.894	1904.08	6728.19	426.70	0.019
35	0.688	**7011.47**	**6429.61**	581.87	2830	3757.34	3175.471	6698.79	23670.63	134.15	0.006
TOTAL	**4.32**	**21424.50**	**17667.16**	**3757.34**					**AVERAGE**	**233.56**	**0.01**

HW (m^3)=	**21,424,502.8**
LW (m^3)=	**17,667,162.8**
PRISM (m^3)=	**3,757,340.0**
AREA (km^2)=	**4.3**
FLUSHING TIME= (tidal cycles)	**5.70**
EXCHANGE RATE=	**17.54%**

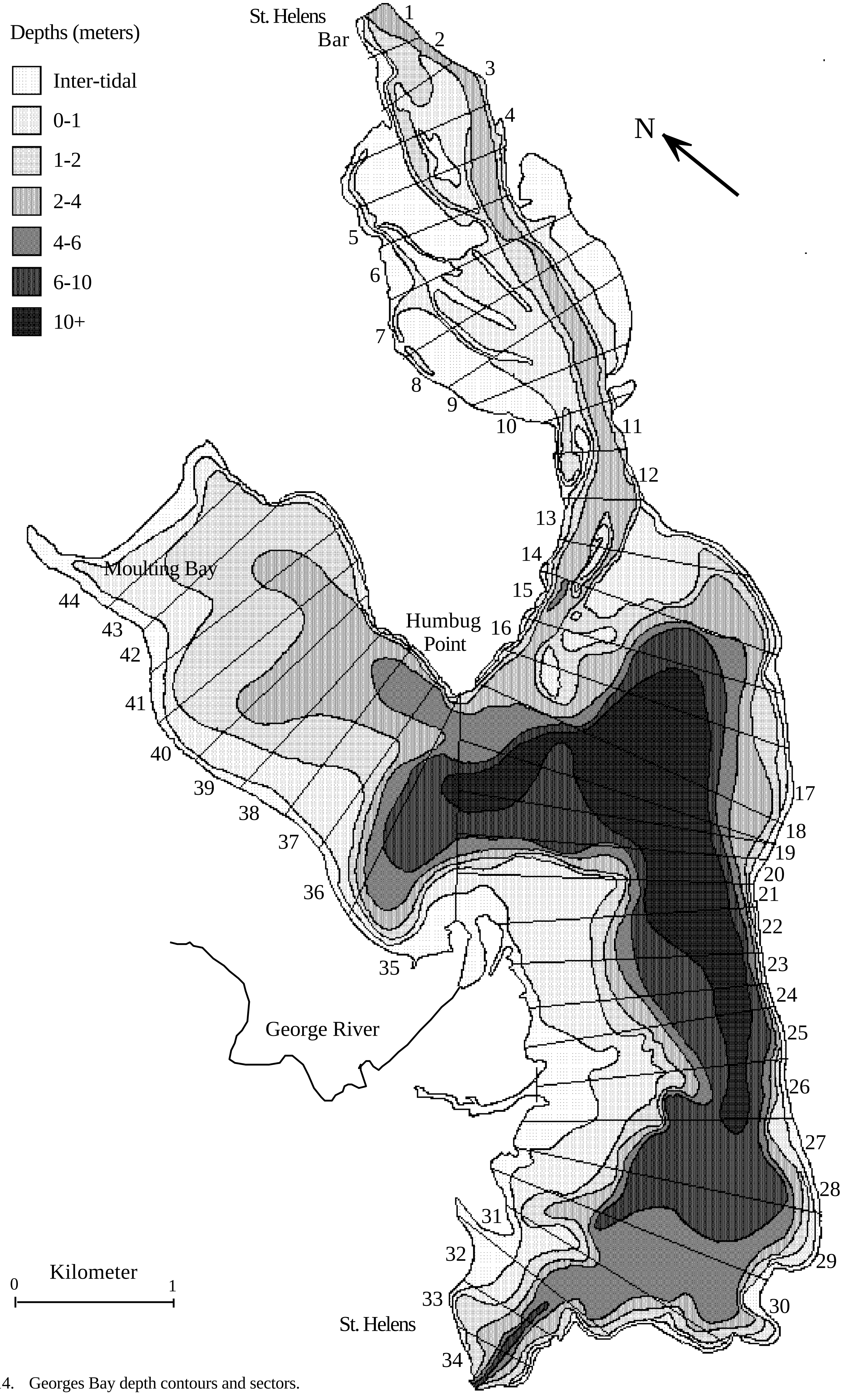


Fig. 14. Georges Bay depth contours and sectors.

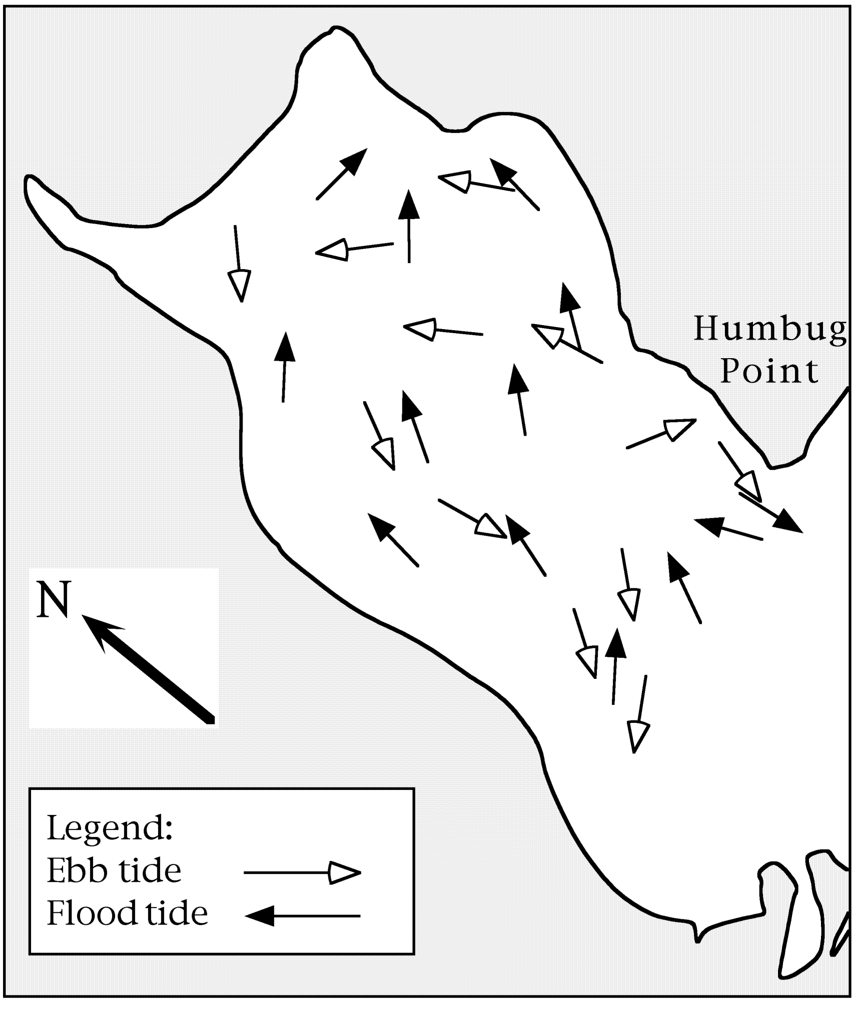


Fig. 15. Moulting Bay tidal streamlines.

3.2 Temperature, Salinity, Nutrient and Food Concentrations in Growing Areas

The raw data for temperature, salinity, nutrients and chlorophyll a measurements at approximately 1m depth at each site are give in Appendix 1. The profiles of temperature and salinity at sites in each growing area showed that in the shallow estuarine and embayment waters investigated there was complete mixing of the water column.

3.2.1 Pittwater

Temperatures showed typical annual variation, although higher summer temperatures were recorded in the summer of 1992/93 than in the other years (Fig. 16a). The highest summer and lowest winter temperatures were recorded at the Barilla station where the water is very shallow and the oyster farms are located, but otherwise there was little variation in temperature between stations. Salinities at all stations in the estuary were higher than the marine conditions experienced at the Marine station except in Spring 1992 and in January 1994 (Fig. 16b). In fact, they became more hypersaline the further up the estuary, except for some months in winter and spring. The Barilla station regularly experienced the most hypersaline conditions.

Chlorophyll a levels were mostly in the range of 1 - 4 µg/l, except for a peak in February 1992, and at most stations in summer 1993 - winter 1994 (Fig. 17a). Generally the upper reaches of Pittwater had higher chlorophyll a levels than the lower estuary and marine stations. There were no distinct temporal trends. Nitrate concentrations also generally were low, at less than 10 µg/l, except for peaks at some stations in August - September 1991 and February - March 1992 (Fig. 17b).

Phosphate concentrations were generally in the range 5-15 µg/l and there were no clear trends between the stations, except for the Marine station having higher concentrations on several occasions during the first 12 months of sampling (Fig. 18a). Silicate concentrations were quite varied during the short sampling period with no clear patterns except that they were often lowest at the Marine station (Fig. 18b).

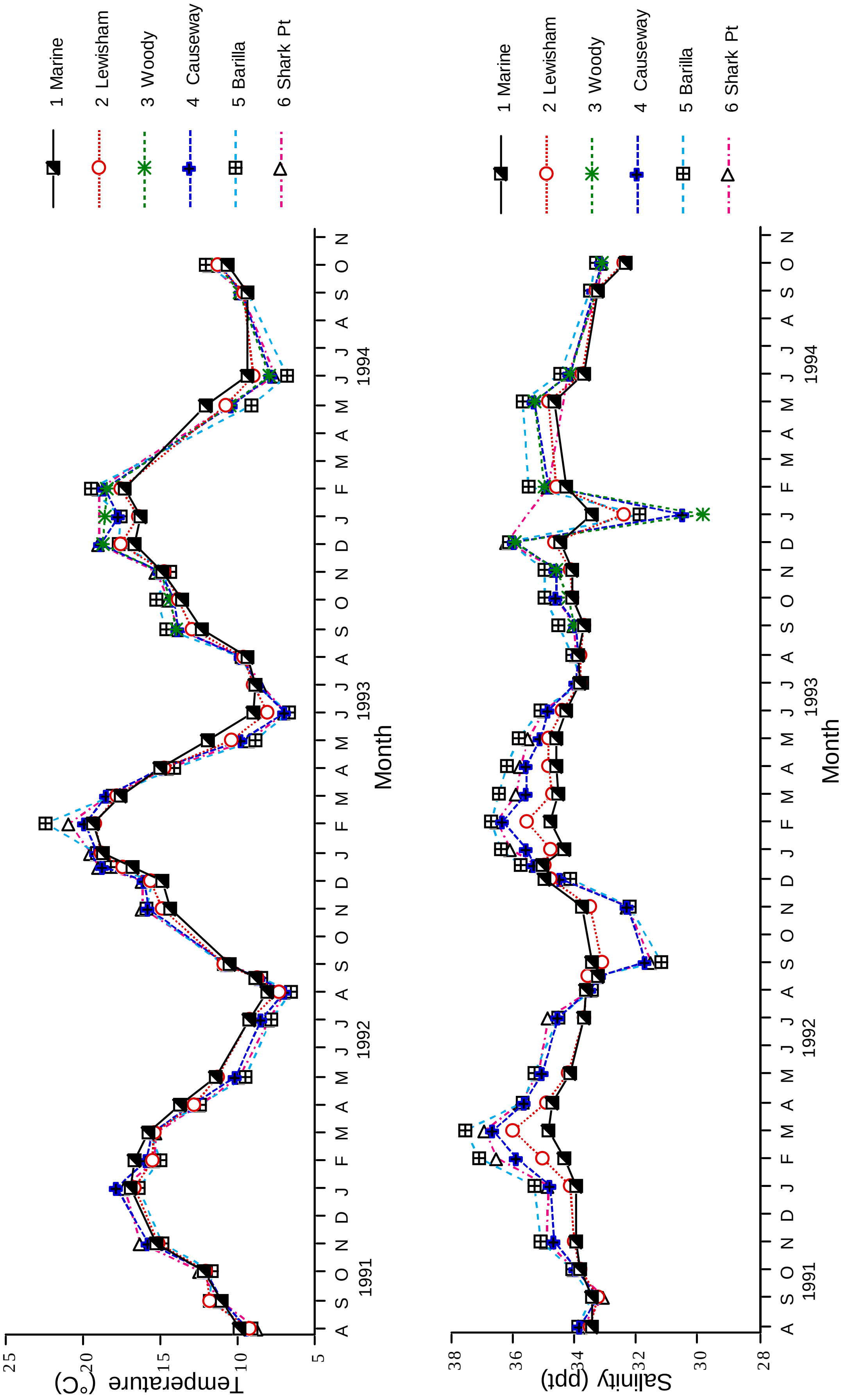


Fig. 16 a & b. Temperature and salinity at Pittwater

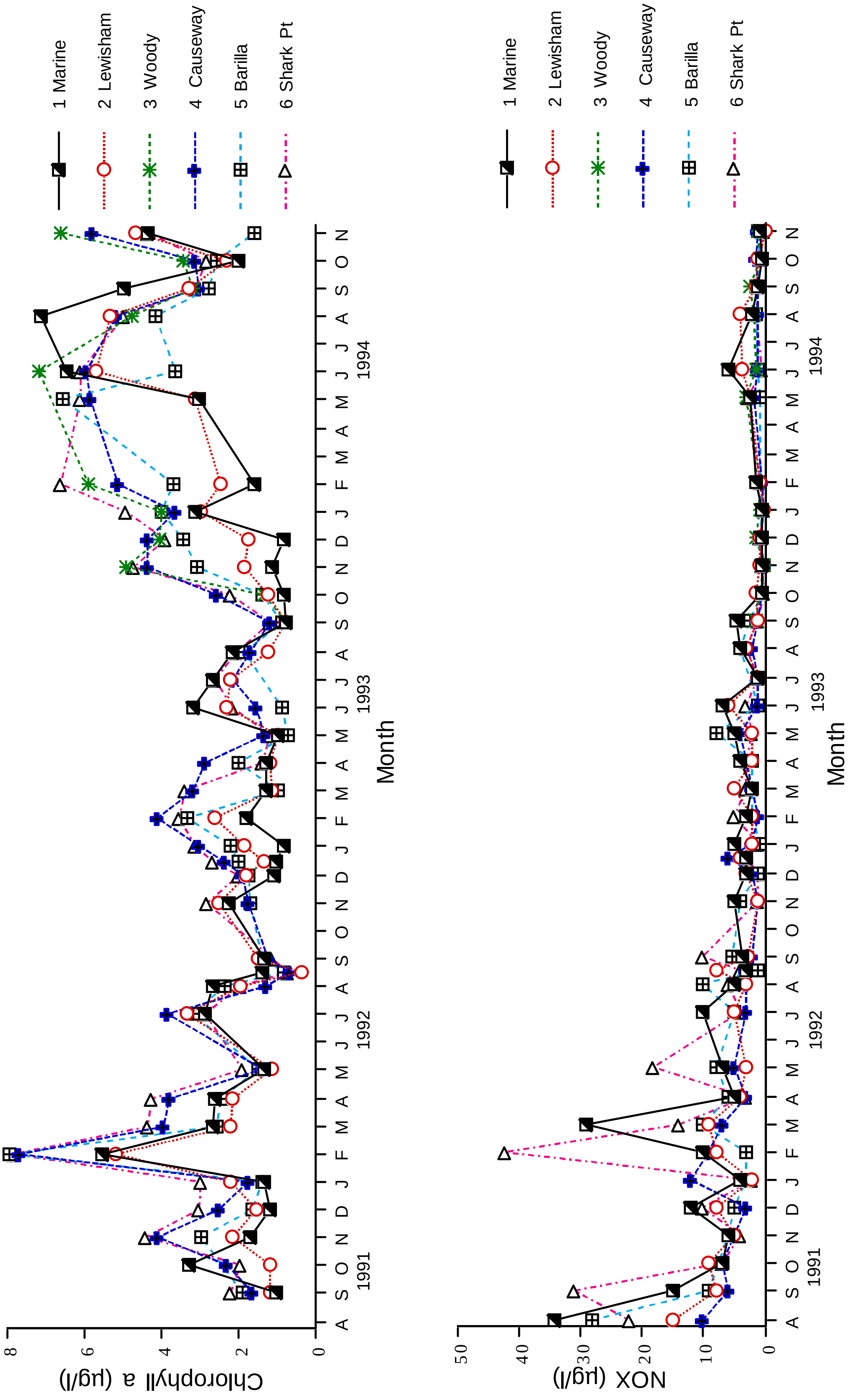


Fig. 17 a & b. Chlorophyll a and NOX in Pittwater.

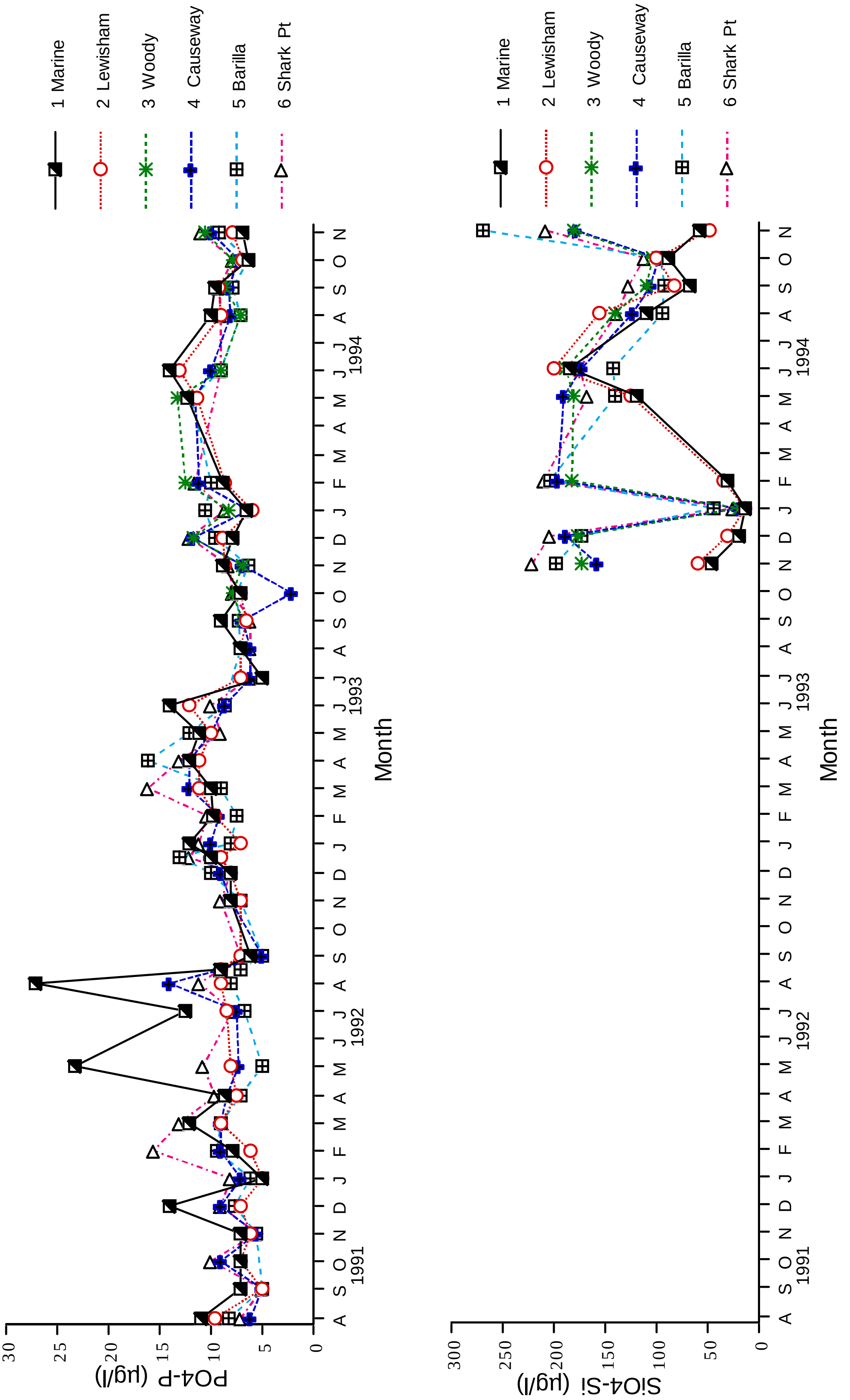


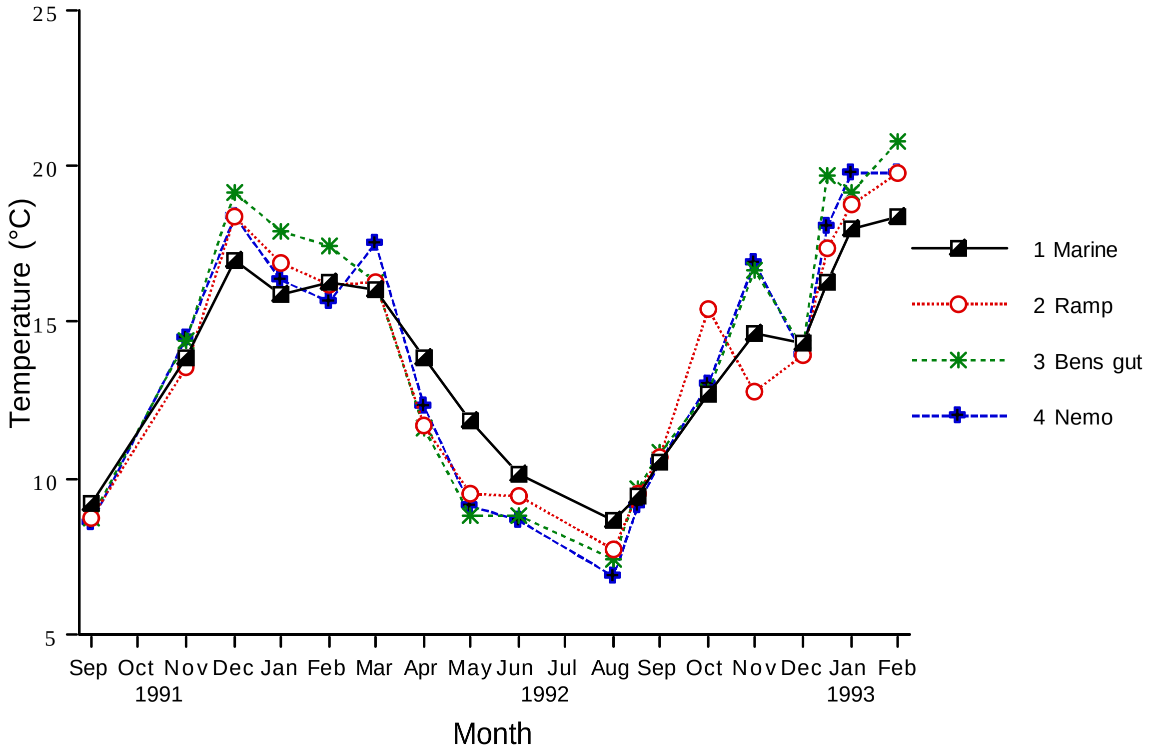
Fig. 18 a & b. PO_4-P and SiO_4-Si in Pittwater.

3.2.2 Pipeclay Lagoon

Temperatures showed typical seasonal variations, ranging from 6.9 - 20.8 °C, with little difference between the stations (Fig. 19a). Salinities also showed a seasonal trend although the difference between summer and winter was at most 3 ppt. (Fig. 19b). They were higher at the shallow stations in summer than at the Marine station, and higher salinities were recorded in the summer of 1993 than 1992.

Chlorophyll a concentrations generally ranged from 1 to 4 µg/l with no distinct trends between stations (Fig. 20a). There was a slight increase in the summer of 1991/92, dropping to lower levels in winter, except for a relatively high level recorded at station 3 Bens Gutter in September. Values then rose again over summer 1992/93. NOX nitrogen concentrations ranged from 0.5 to 22 µg/l; highest levels were generally recorded in winter and declined in Spring. Peaks were recorded at the Marine station on several occasions (Fig. 20b).

Phosphate concentrations at all stations were mostly within the range of 5-12 µg/l during the sampling period, except for a peak at Bens Gutter station in December 1991 and at Nemo station in January 1993 (Fig. 21). Silicate concentrations were not measured at this site.



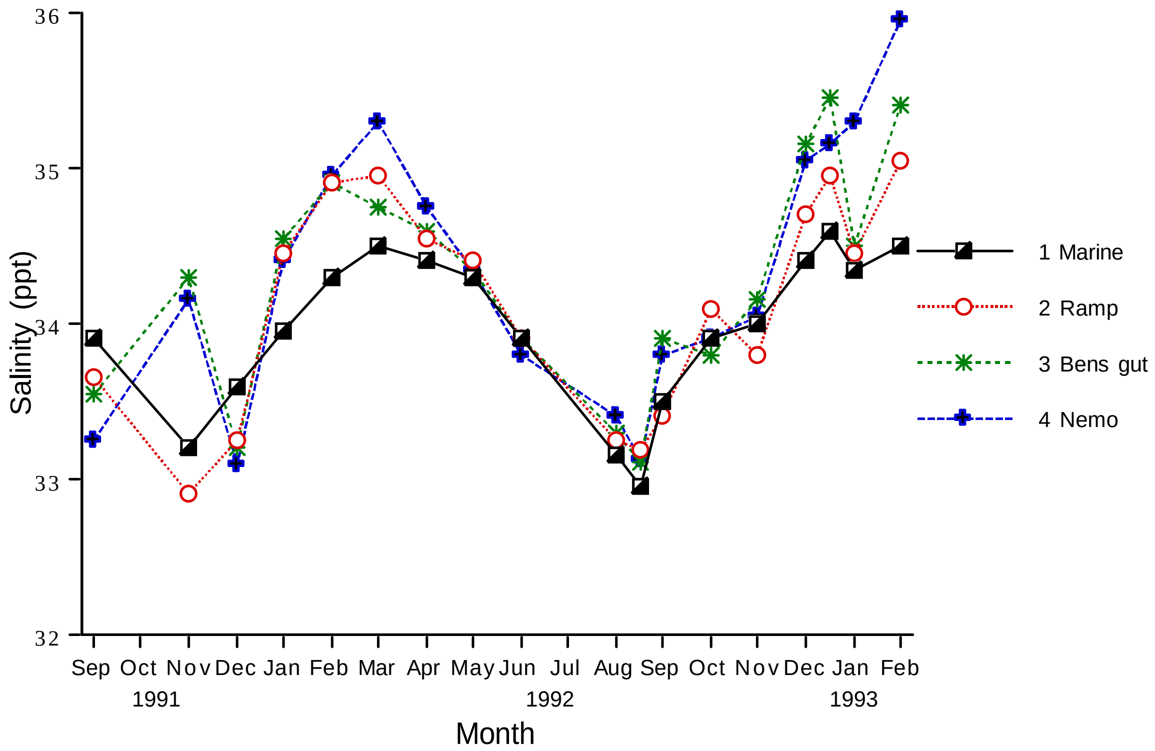
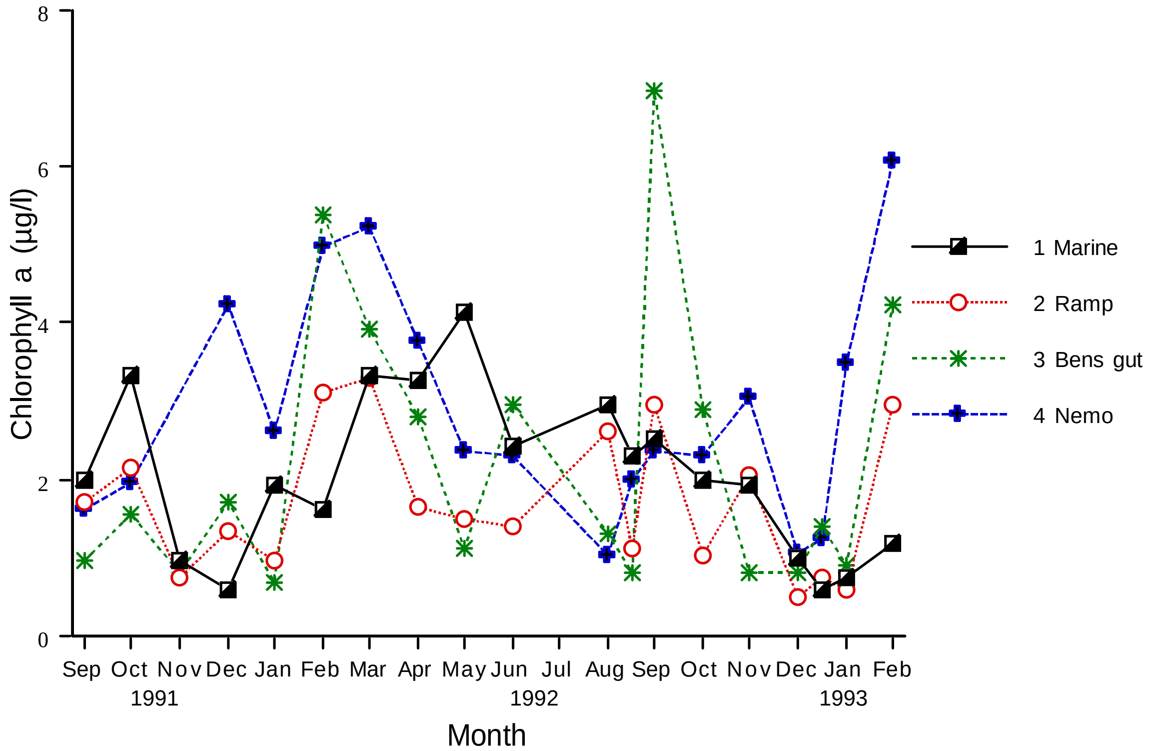


Fig. 19 a & b. Temperature and Salinity in Pipeclay Lagoon.



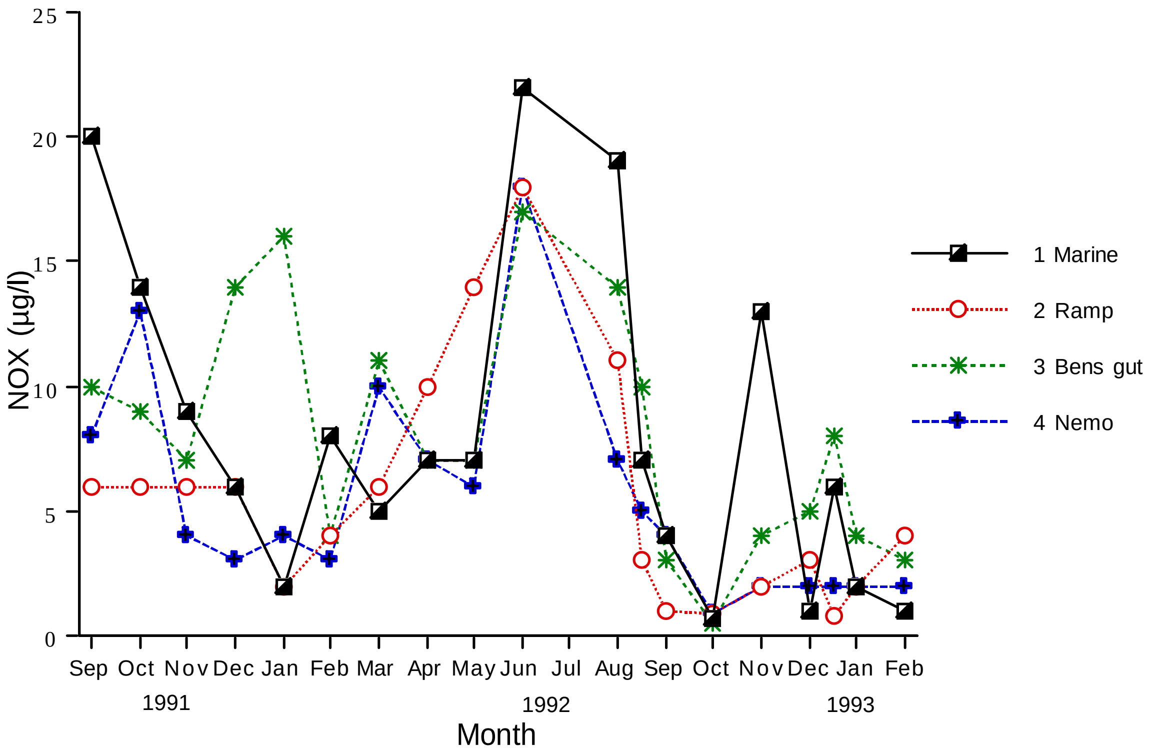


Fig. 20 a & b. Chlorophyll and NOX in Pipeclay Lagoon.

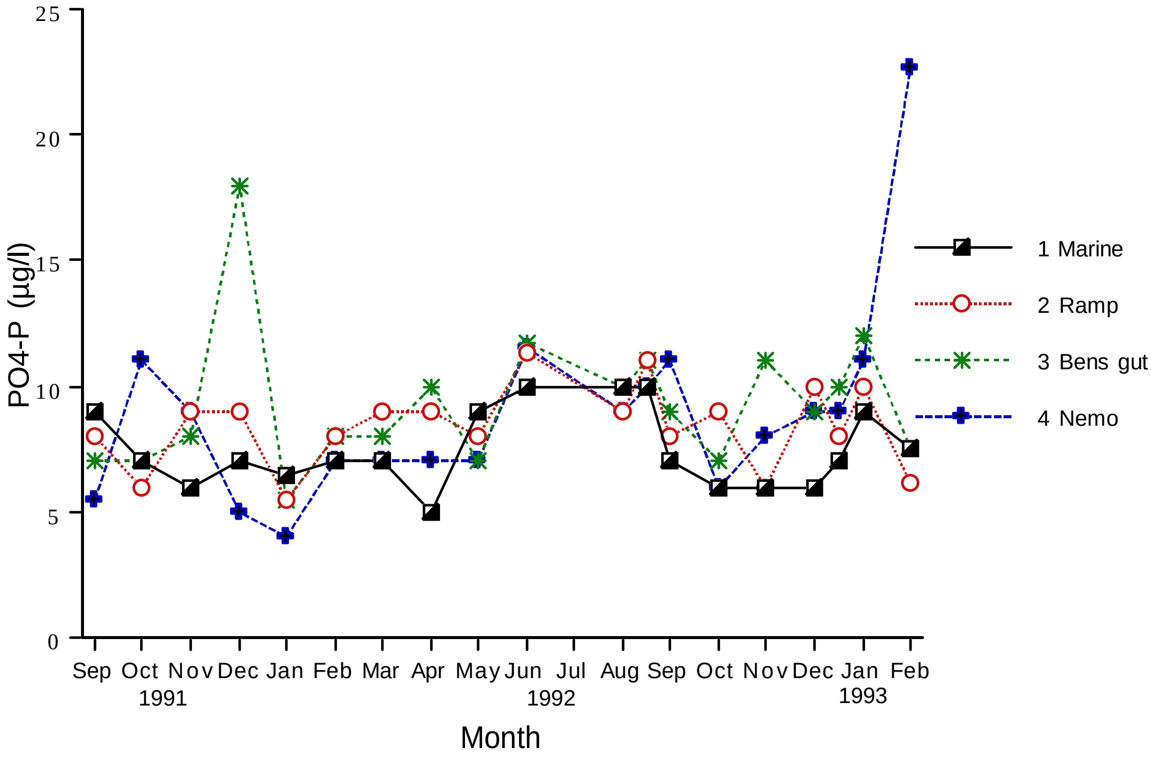


Fig. 21. PO_4-P in Pipeclay Lagoon.

3.2.3 Little Swanport

Temperatures varied from 8.9 - 20.8 °C with the Marine station having the least seasonal variation (Fig. 22a). Salinity at the Marine station was constantly around 35 ppt and significantly lower salinities were recorded at the other sites on several occasions during periods of heavy rainfall and freshwater flow into the estuary. Lowest salinities were generally recorded at station 4 Dyke which was furthest up the estuary (Fig. 22b).

Chlorophyll a concentrations were mostly in the range of 1 - 4 µg/l (Fig. 23a). High concentrations were recorded at station 4 Dyke in January and April 1991, and they were generally lowest at the Marine station. NOX nitrogen concentrations were consistently low except for very high values at all stations except Marine in December 1991 when there was a large freshwater inflow into the estuary (Fig. 23b).

Phosphate concentrations were within the range 4 - 14 µg/l for all stations, except for peaks at the Marine and Ram stations in January 1992 (Fig. 24). They were often highest at the Marine station. Silicate concentrations were not recorded at this site.

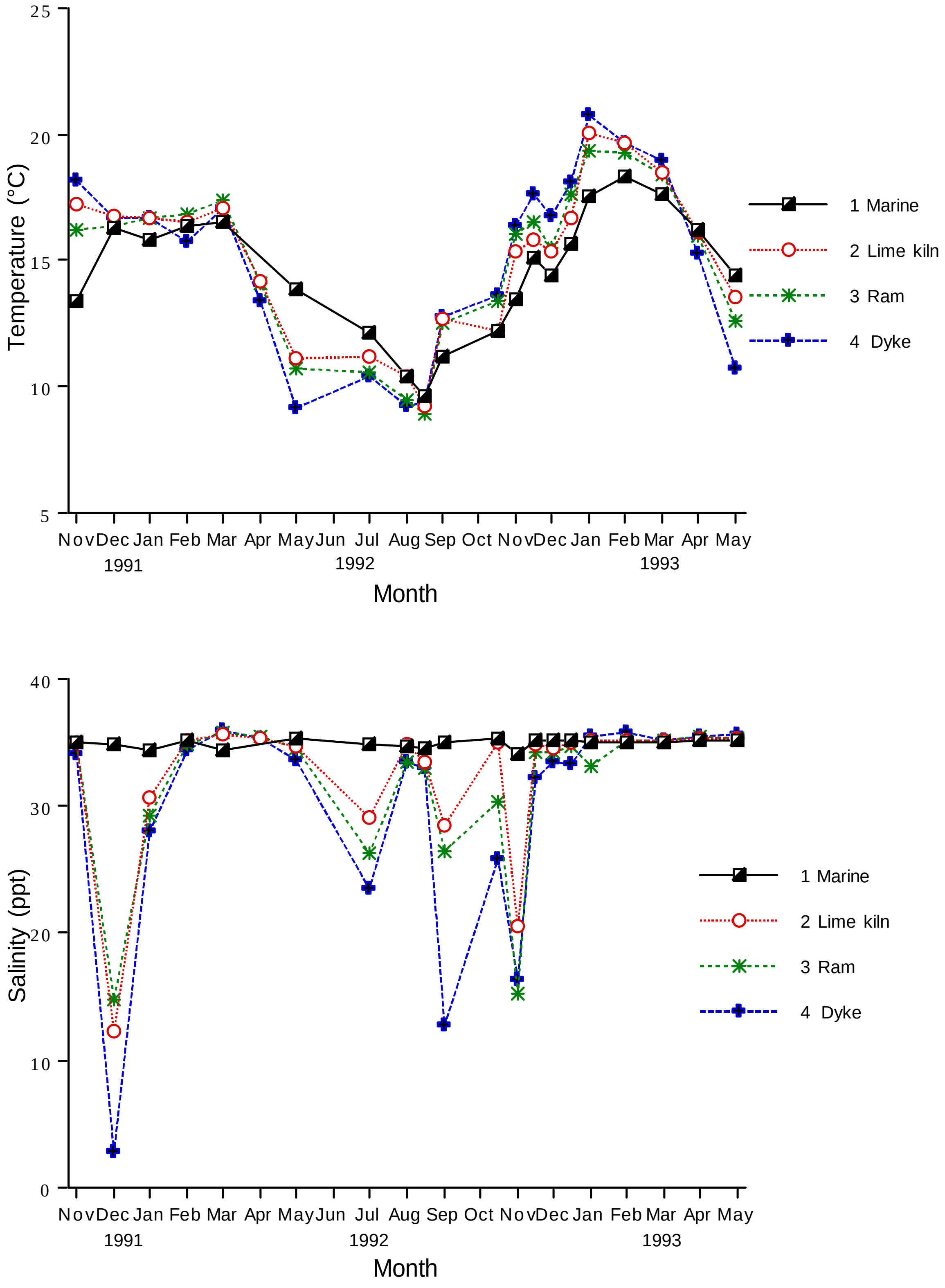


Fig. 22 a & b. Temperature and Salinity in Little Swanport.

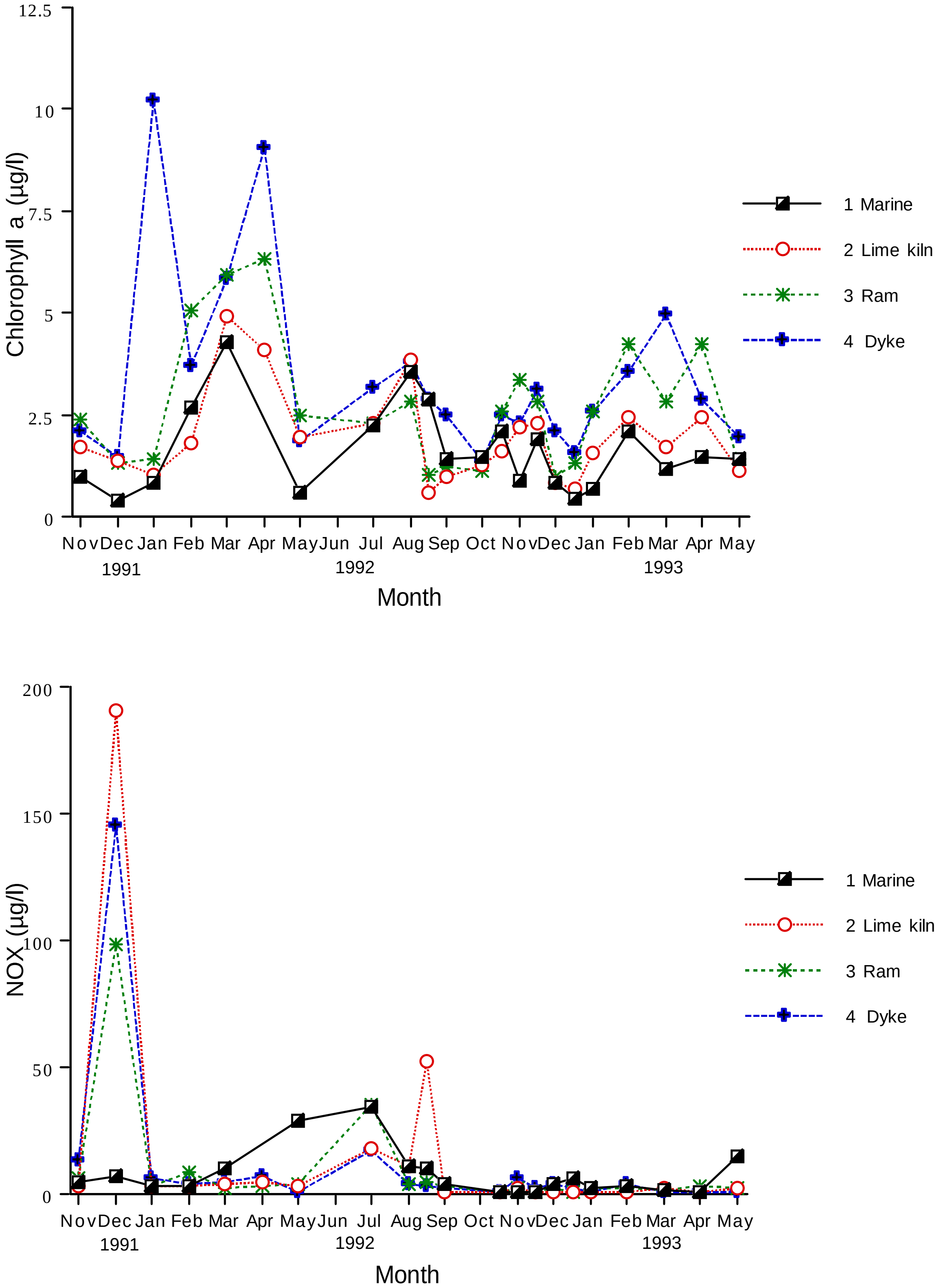


Fig. 23 a & b. Chlorophyll a and NOX in Little Swanport.

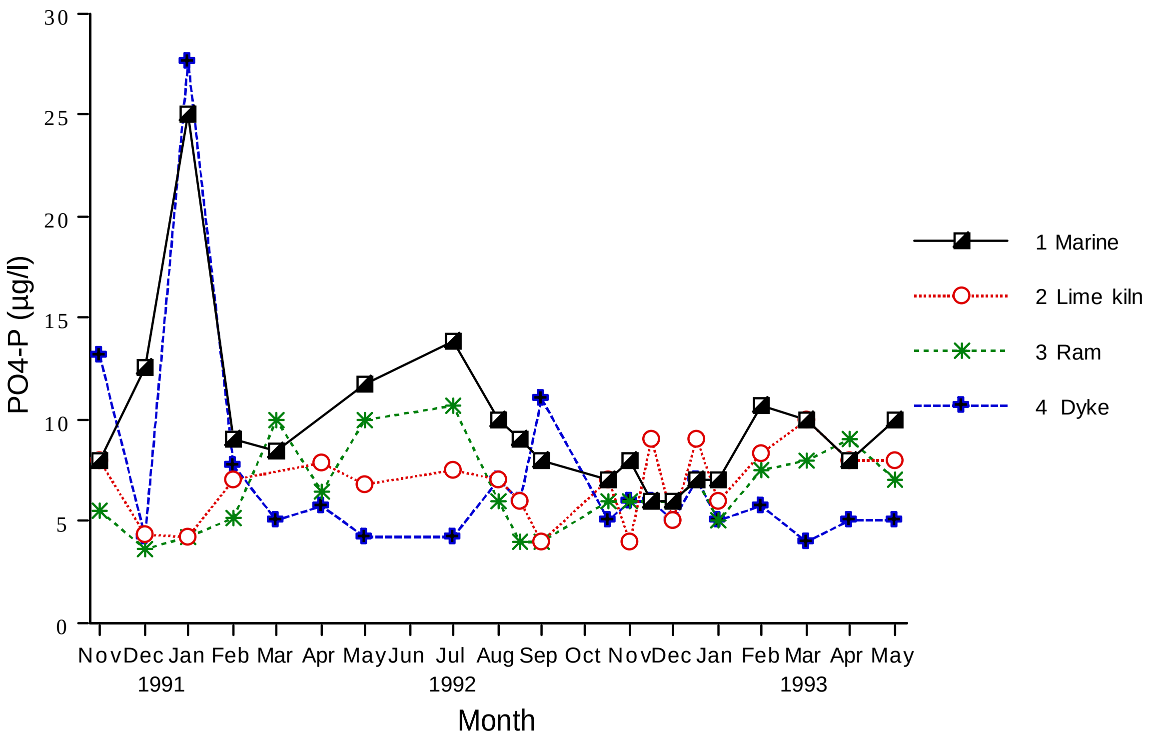


Fig 24. PO_4-P in Little Swanport.

3.2.4 Georges Bay

Temperatures in Georges Bay showed a typical annual trend with temperatures highest in late spring and summer and lowest in winter (Fig. 25a). The Marine station showed the moderating influence of oceanic waters with a reduced range in temperatures. Salinities at sites inside Georges Bay fluctuated depending on the rainfall, although the salinities only varied by at most around 3 ppt during the sampling period, with the lowest salinities generally occurring at the stations nearest the Georges River outflow (Fig. 25b). The Marine station had the least variation in salinities during the sampling period.

Chlorophyll a concentrations were generally within the range of 1 - 4 µg/l for all stations during the sampling period except for a very high reading at the Mast station in July 1993 (Fig. 26a). Chlorophyll a concentrations increased at all stations in February 1994. NOX nitrogen concentrations increased at most stations from April until July and then declined to low levels during Spring and Summer (Fig. 26b). The Marine station had the highest NOX concentrations in most months.

No distinct trends in phosphate concentration were observed during the sampling period (Fig. 27a). They generally ranged between 5 and 15 µg/l, with the Marine station having the highest levels in most months. Silicate concentrations increased at almost all stations during the short sampling period (Fig. 27b). They were significantly lower at the Marine station than all other stations.

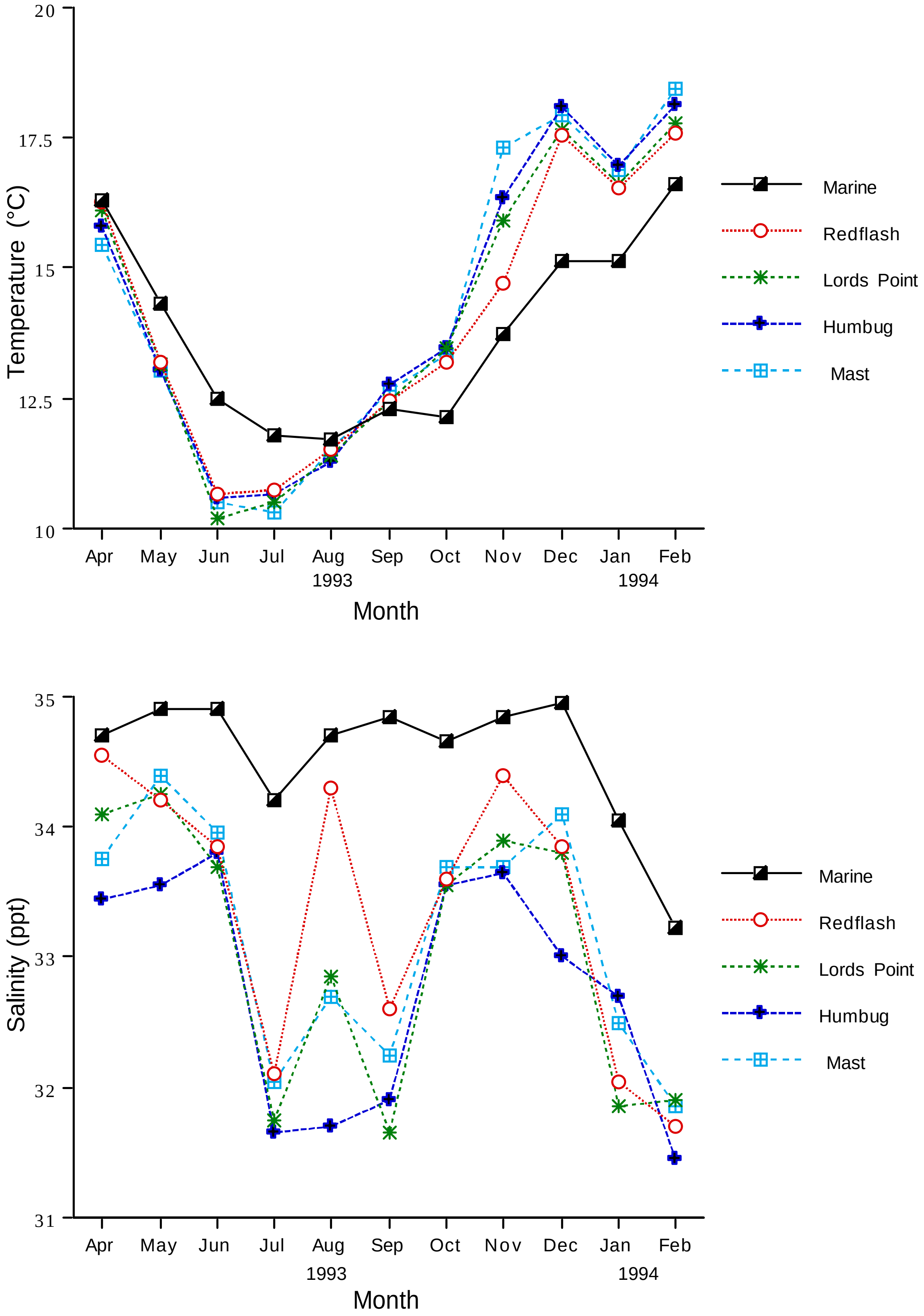
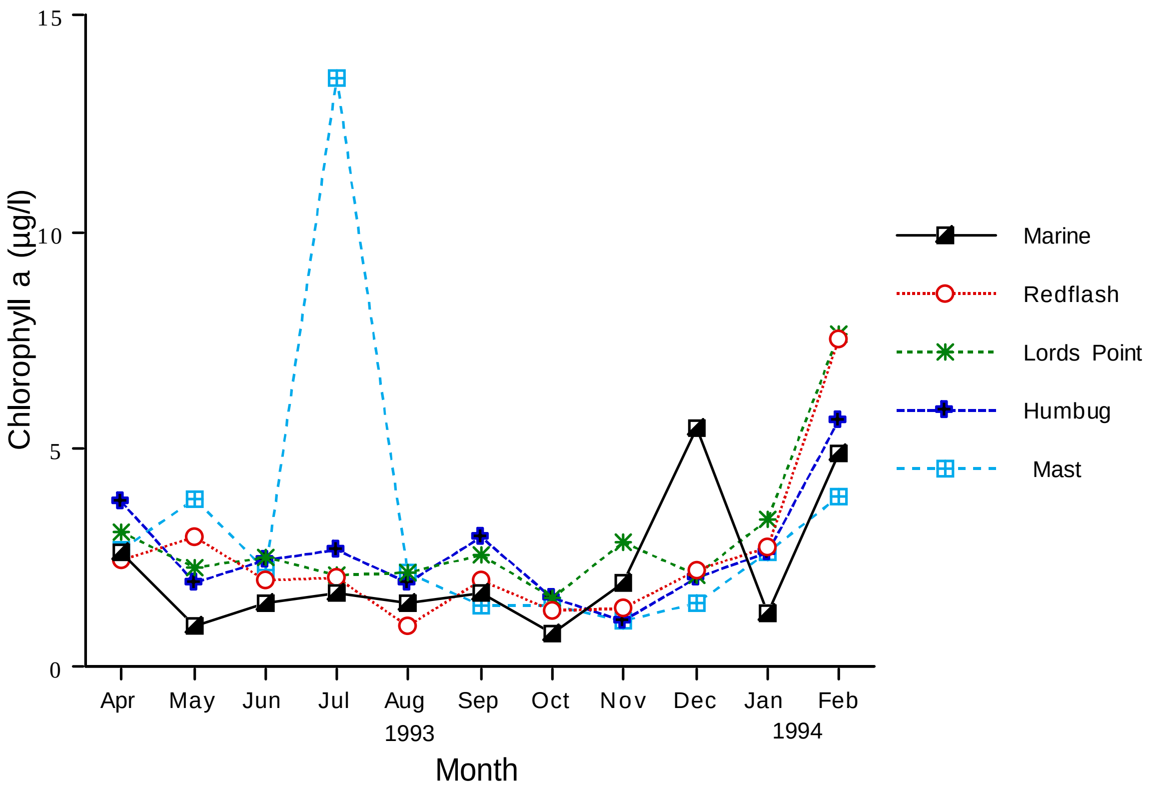


Fig. 25 a & b. Temperature and Salinity Georges Bay.



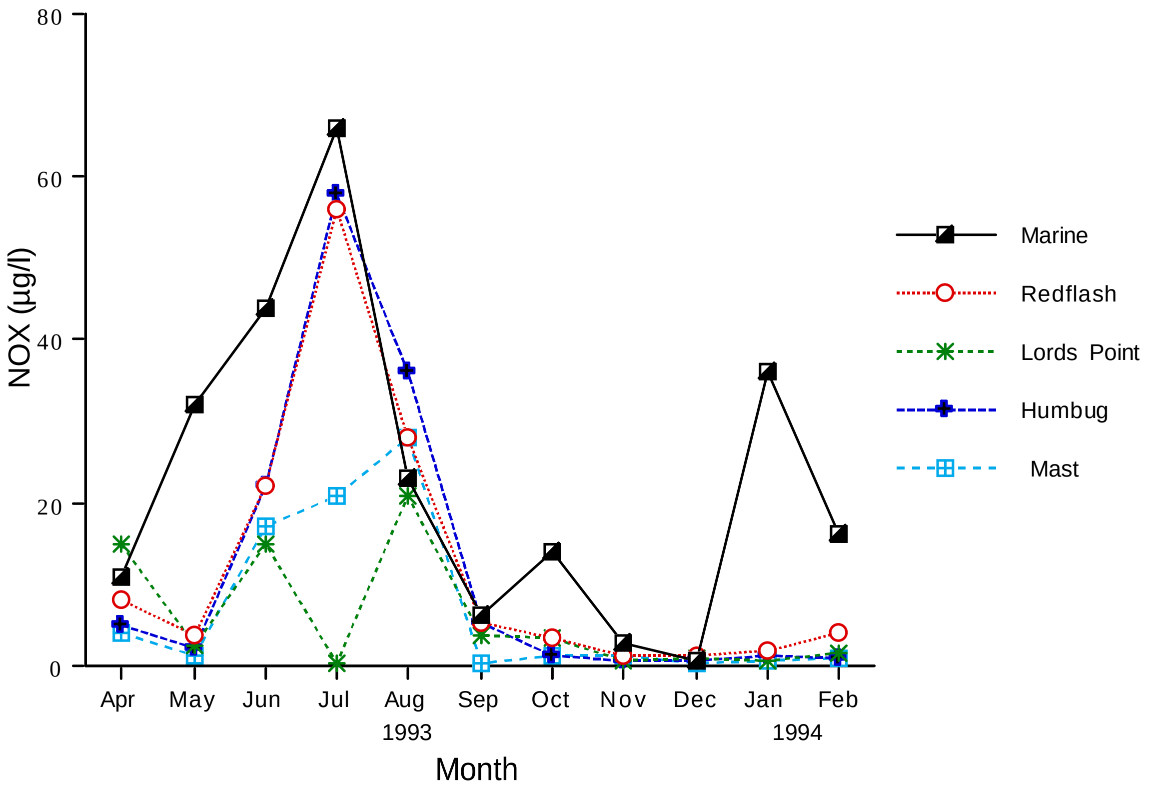


Fig. 26 a & b. Chlorophyll a and NOX in Georges Bay.

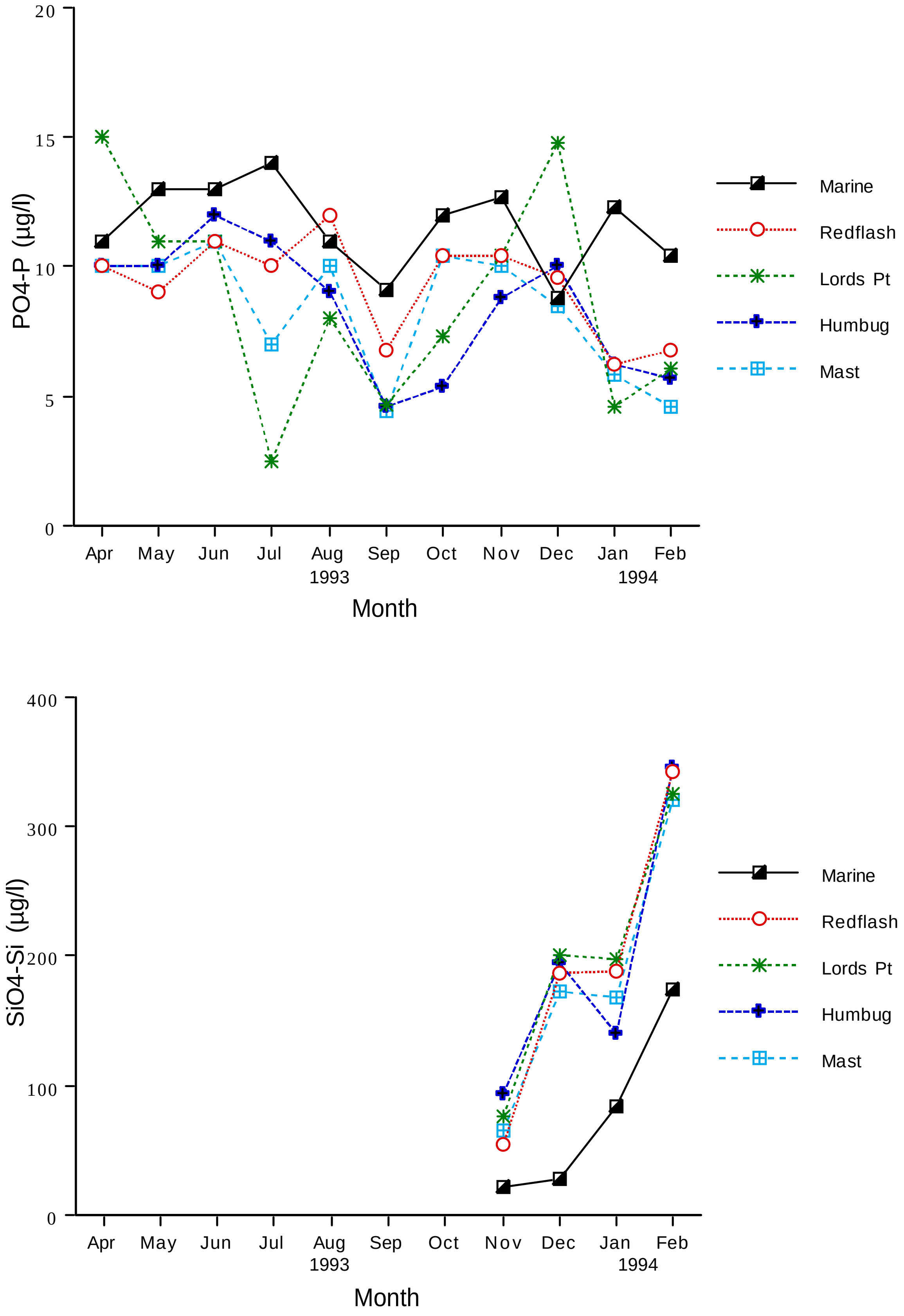


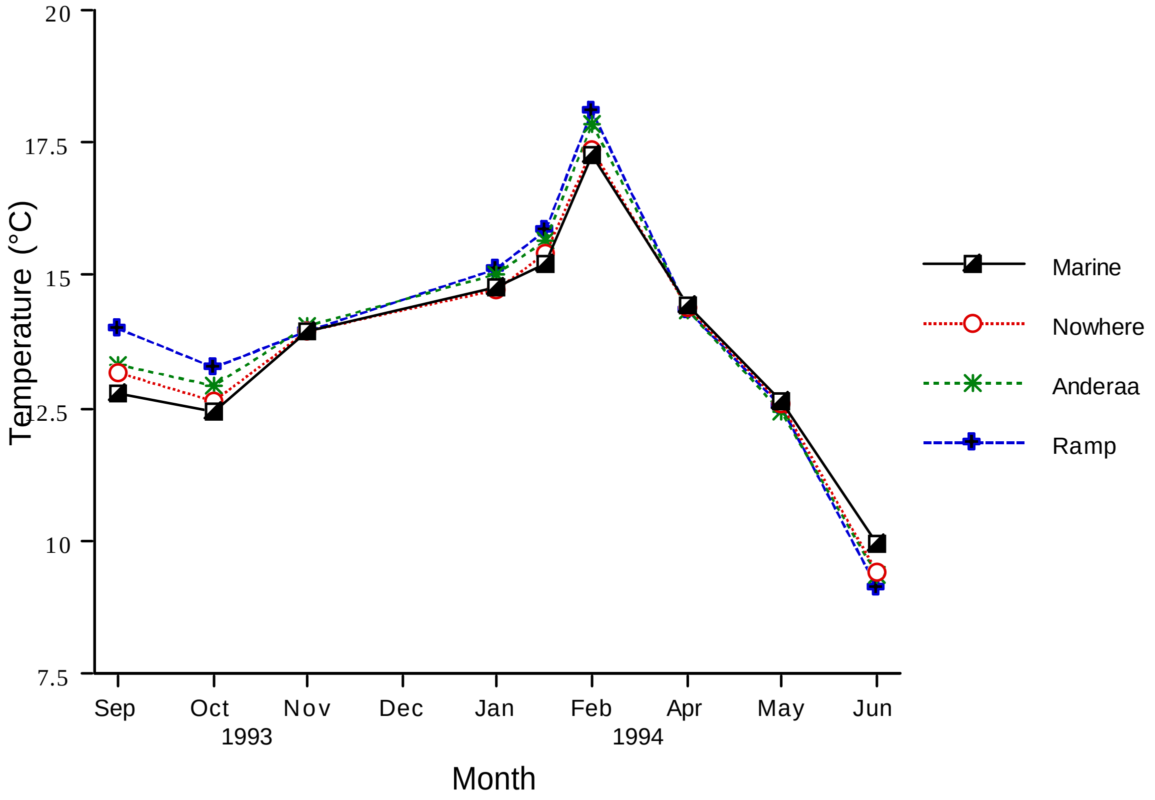
Fig. 27 a & b. PO_4-P and SiO_4-Si in Georges Bay.

3.2.5 Simpsons Bay

During the 9 month sampling period temperatures peaked in January and there was little variation between the stations (Fig. 28a). Salinities were high and similar between the stations except for January and June 1994 when salinities were highest at the Marine station and lowest towards the head of the bay (Fig. 28b).

Chlorophyll a concentrations generally increased during the sampling period from low levels to peaks of 8-12 µg/l at the Anderaa and Nowhere stations in June (Fig. 29a). NOX nitrogen concentrations were consistently low except for high peaks at all stations on the last sampling occasion in June (Fig. 29b).

Phosphate concentrations were similar from September to December, lowest in January and then generally increased until June (Fig. 30a). Silicate levels peaked in December, were low in January - February, and then increased until June (Fig. 30b).



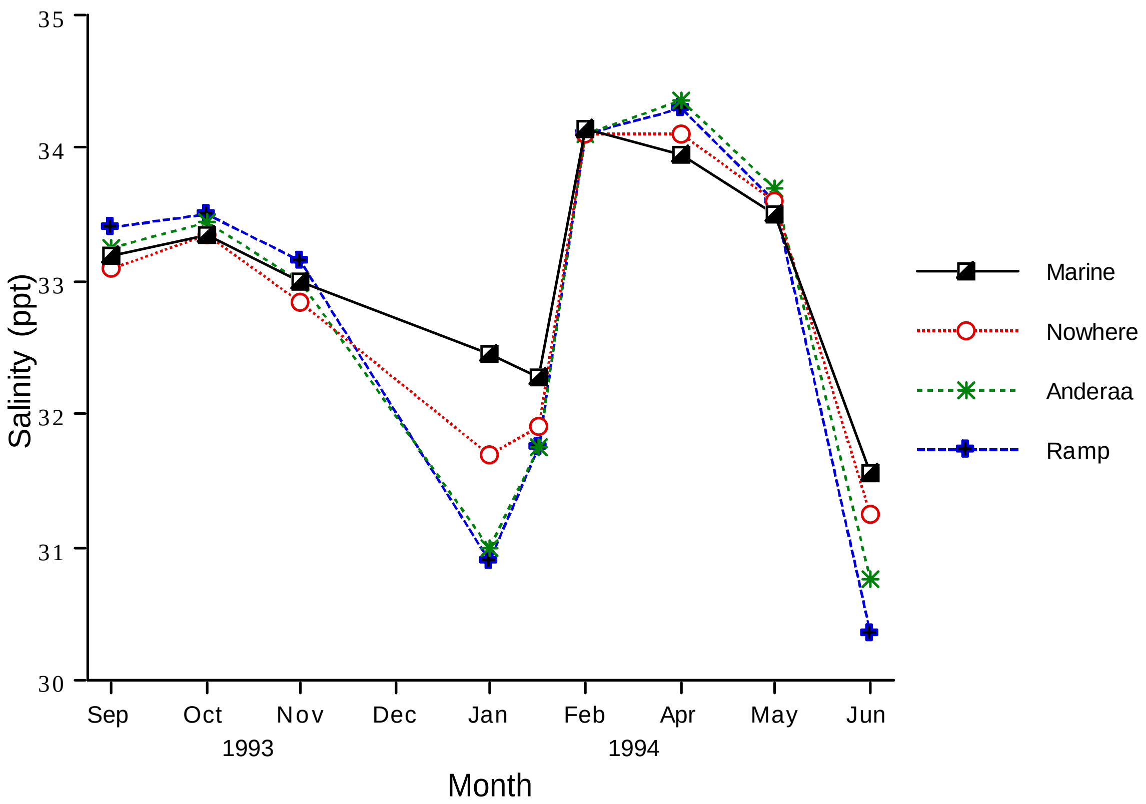


Fig. 28 a & b. Temperature and Salinity in Simpsons Bays.

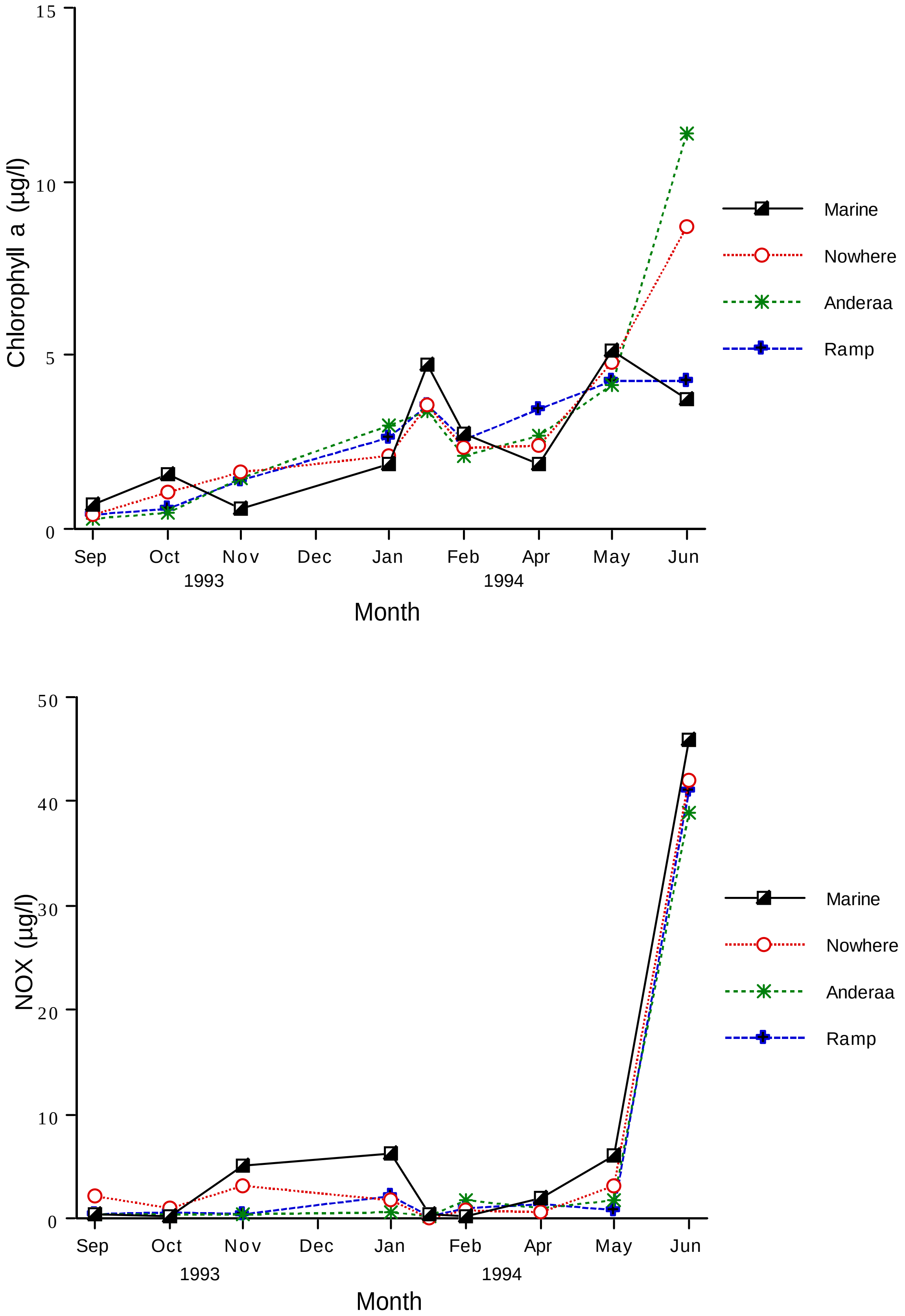
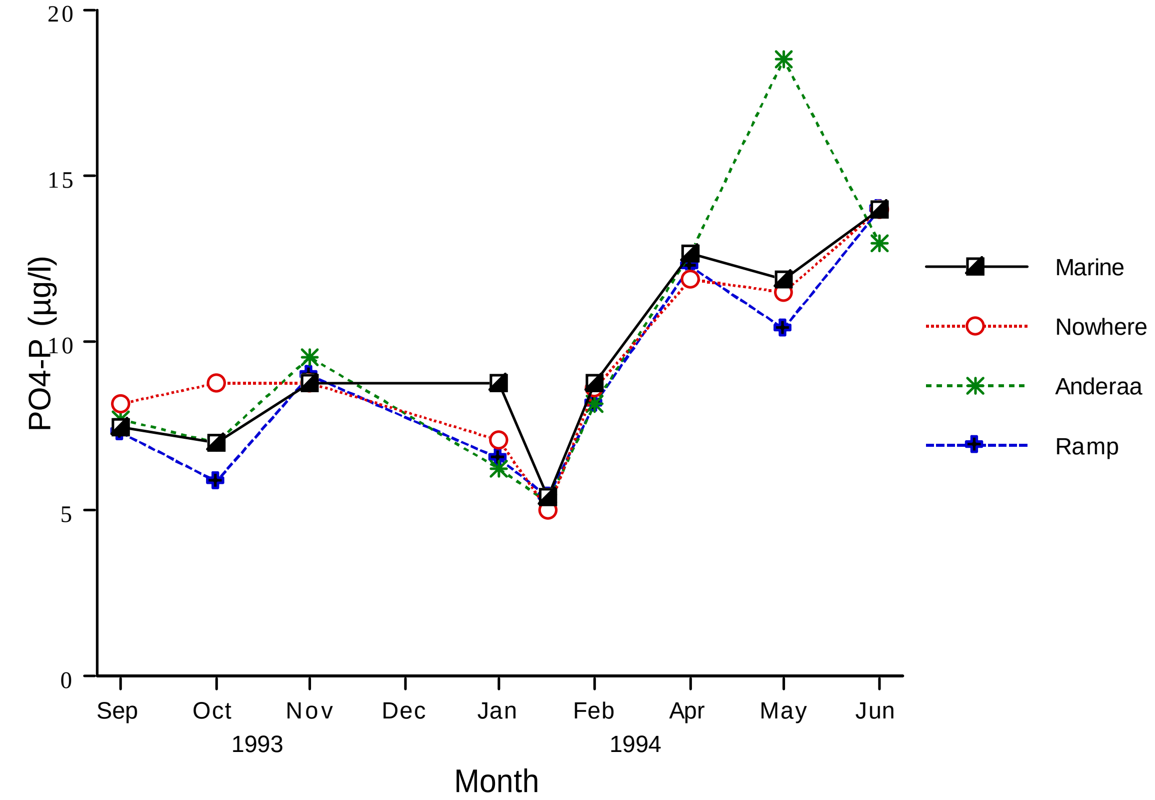


Fig. 29 a & b. Chlorophyll a and NOX in Simpsons Bay.



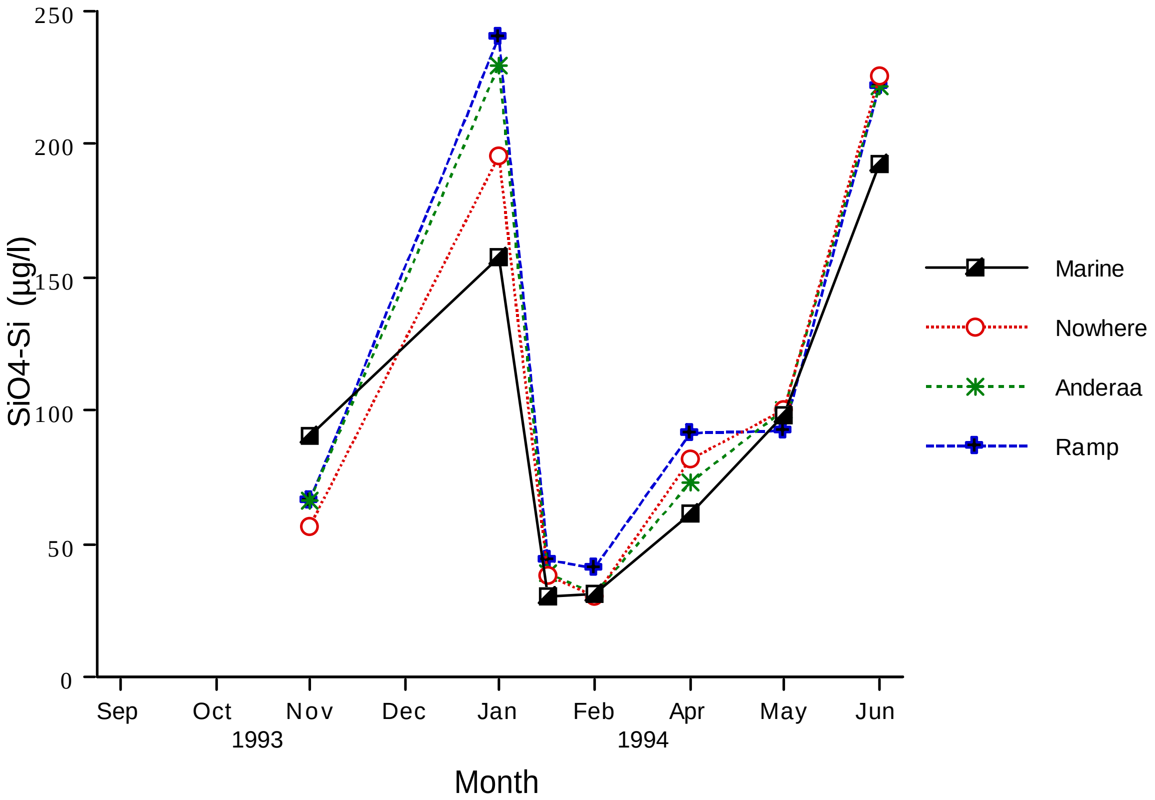


Fig. 30 a & b. PO_4-P and SiO_4-Si in Simpsons Bay.

3.2.6 Comparisons of Physical and Chemical Parameters Between Areas.

It is interesting to compare some of the physical and chemical characteristics of the different oyster growing areas which can then be related to oyster growing methods and oyster production at each site. Some of the more notable differences are as follows. Georges Bay had an obviously smaller annual range in temperature (10.2-18.5 °C) than at the other stations, with Pittwater and Pipeclay Lagoon having the greatest range (approx. 6.5-21 °C). Georges Bay also had the greatest differences in temperatures between stations with the Marine station having temperatures significantly lower in summer and higher in winter than at the others. Similar, but less obvious trends were apparent at Little Swanport and Pipeclay Lagoon, whereas there was little difference between stations at Pittwater and Simpsons Bay.

There were some interesting differences in salinity regimes between the sites. At the estuarine sites of Georges Bay and Little Swanport the Marine station almost always had the highest salinities, and the other stations had salinities at varying levels below the Marine values, depending on the amount of recent rain. By contrast, salinities at Pittwater and Pipeclay Lagoon were regularly higher inside the estuary and marine inlet, respectively, than at the Marine station, indicating substantial evaporation. This was particularly pronounced at Pittwater.

Generally chlorophyll a levels were within the range of 0.5 - 4 µg/l at all sites, with peaks approaching bloom conditions occurring periodically, but most commonly in late summer. Chlorophyll a concentrations tended to be lower at the Marine station than other stations at most sites, especially the estuarine sites.

Nitrate + nitrite measurements were mostly around 10 µg/l at all sites with some irregular large peaks. They were more often above this value at the Pipeclay Lagoon and Georges Bay sites than the others. In Pittwater they were consistently low from Spring 1992 to Spring 1994.

Chlorophyll a peak concentrations generally occurred in the same month or just after peaks in nitrate concentrations, and at the estuarine sites of Little Swanport and Georges Bay these high values often occurred after heavy rains resulting in low salinities. An exception is the higher chlorophyll a concentrations recorded at Pittwater in 1994 when nitrate values were low. During this period chlorophyll a concentrations were sometimes high at the Marine station indicating a more oceanic influence on chlorophyll a levels.

Phosphate concentrations were routinely within the range of 4 -15 µg/l, with slightly lower values at Pipeclay Lagoon and Little Swanport. There were no apparent trends between seasons or between stations at each site.

Of the few measurements of silicates, results were varied, generally between 20 - 250 µg/l, and they were often lowest at the Marine station at the three sites investigated. The higher turbidity of the estuaries and shallow embayments probably contributed to the higher silicate levels in these areas compared with the Marine stations.

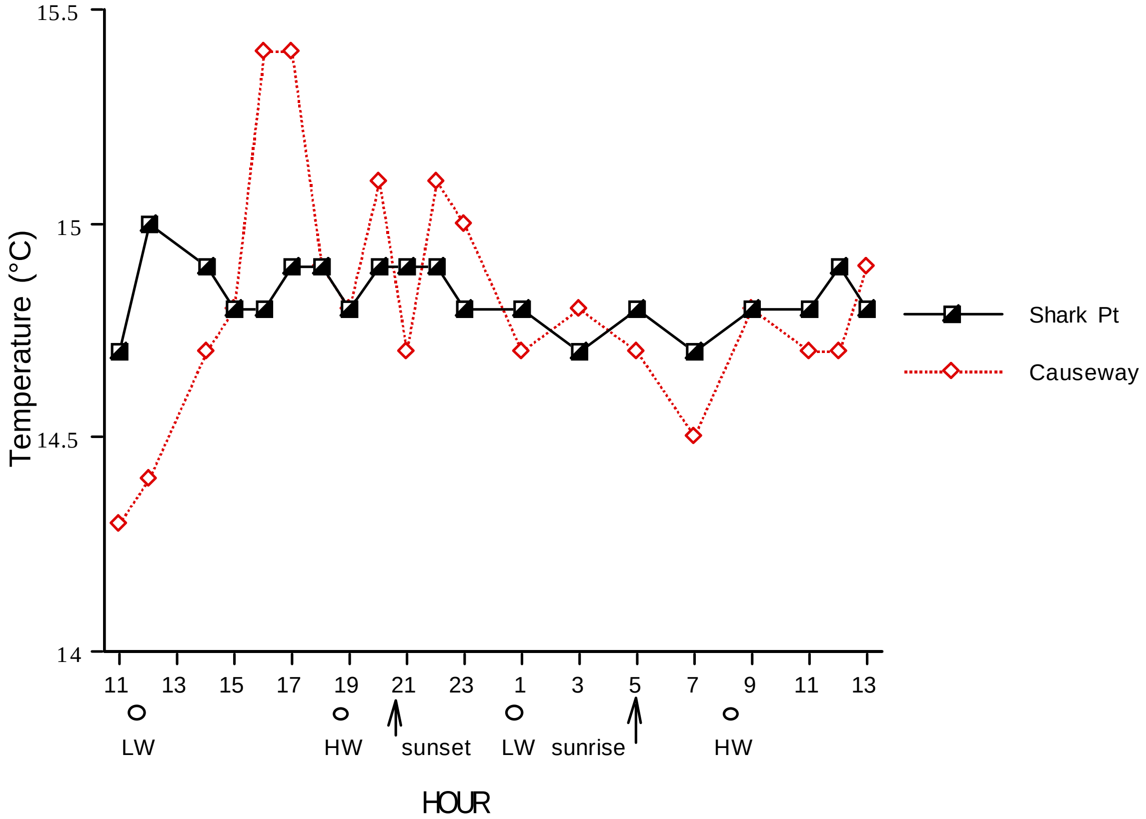
For the two sites where nutrient and chlorophyll a concentrations were recorded over several years, substantial annual variations were observed. Nitrate and nitrite values at Pittwater and Pipeclay Lagoon declined each year from 1991 to 1993, whereas annual phosphate concentrations increased slightly. Annual mean chlorophyll a values were higher in 1994 than in 1991-93 at Pittwater, and slightly higher in 1992 than 1991 at Pipeclay Lagoon.

3.3 Sampling over time (24 h, daily and weekly) in Pittwater

Temperature and salinity were less variable over 24 hours at Station A, Shark Point, than at Station B on the northern side of the Causeway (Fig. 31a & b). The drop in salinity at the Causeway around high tide is presumably due to the inflow of water from Frederick Henry Bay through the Causeway which is then dispersed around Upper Pittwater where the salinity is often higher due to evaporation. Chlorophyll a values were higher at Shark Point than the Causeway possibly because of primary production in upper Pittwater, and did not exhibit a consistent pattern over 24 h (Fig. 32a). They varied by up to 4 µg/l over 24 hours, excluding the unexplained low values at 1600 h. Nitrate values were low over the 24 h except for a unexplained large variation at the Causeway site at the start of the experiment (Fig. 32b). There was little variation between the two sites except after high tide when nitrate concentrations were higher at the Causeway than Shark Point, indicating that the main source of nitrogen at this time was from oceanic waters. Phosphate values showed little variation, although they were slightly lower at the Causeway than at Shark Point on most occasions (Fig. 33a). Silicates were significantly lower at the Causeway than at Shark Point at all sampling times and especially around high water (Fig. 33b).

Fluctuations in chemical parameters of sea water over days and months were similar to the 24 h sampling in that most parameters recorded a lower value at the Causeway site than at Shark Point. Temperature fluctuated by almost 3°C and salinity by 1 ppt during the month in a similar manner at both sites (Fig. 34a & b). Chlorophyll a concentrations were highest at Shark Point for the first few days and then at the Causeway for the remainder of the month (Fig. 35a). They varied by about 5 µg/l during the month, with the extreme values being only one week apart. Nitrates were low and showed limited temporal or spatial fluctuations, except for the last sampling (Fig. 35b). Mean phosphate values varied by approximately 4 ug/l and silicates by 125 ug/l during the month of sampling and generally in a similar manner at both sites, with higher concentrations recorded at Shark Point than the Causeway on nearly all occasions (Fig. 36a & b).

These results of sampling at two sites approximately 3 km apart over time indicate temporal variability and spatial patterns in environmental parameters. Over 24 hours chlorophyll a, phosphate, silicate and salinity values were generally higher at the station further up the estuary near the oyster leases than at the Causeway. This spatial pattern, however, was not so apparent over a month of sampling, especially for nitrate and chlorophyll a concentrations. These results also indicate that some parameters, e.g. chlorophyll a, show considerable temporal variability and ideally should be measured using automatic data loggers.



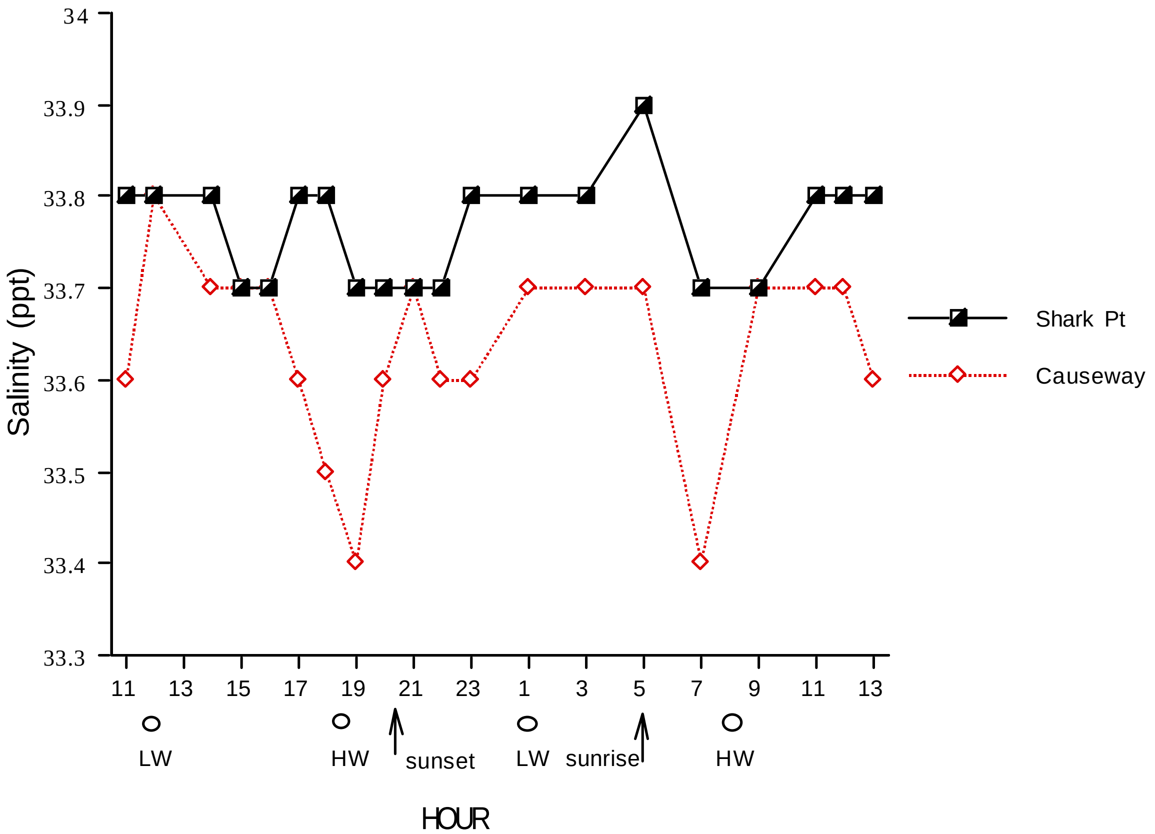
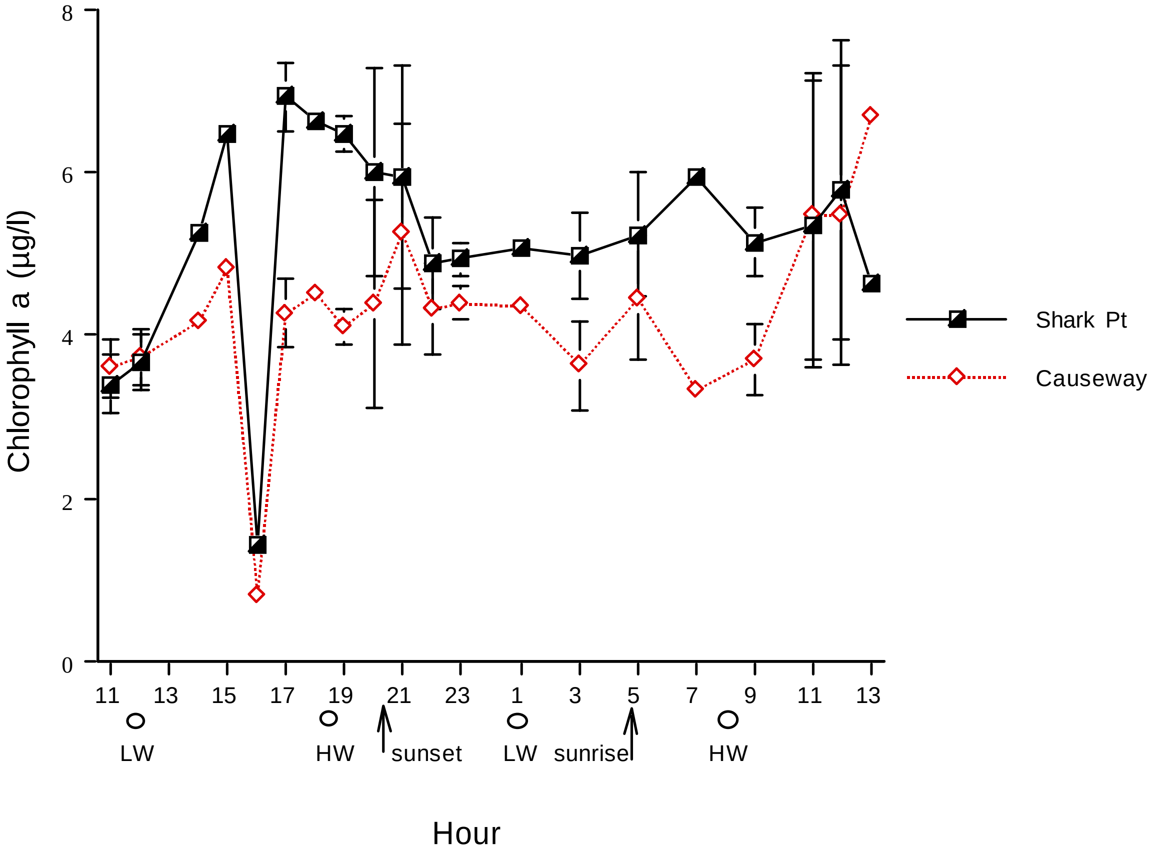


Fig. 31 a & b. Temperature and Salinity in Pittwater over 24 hours



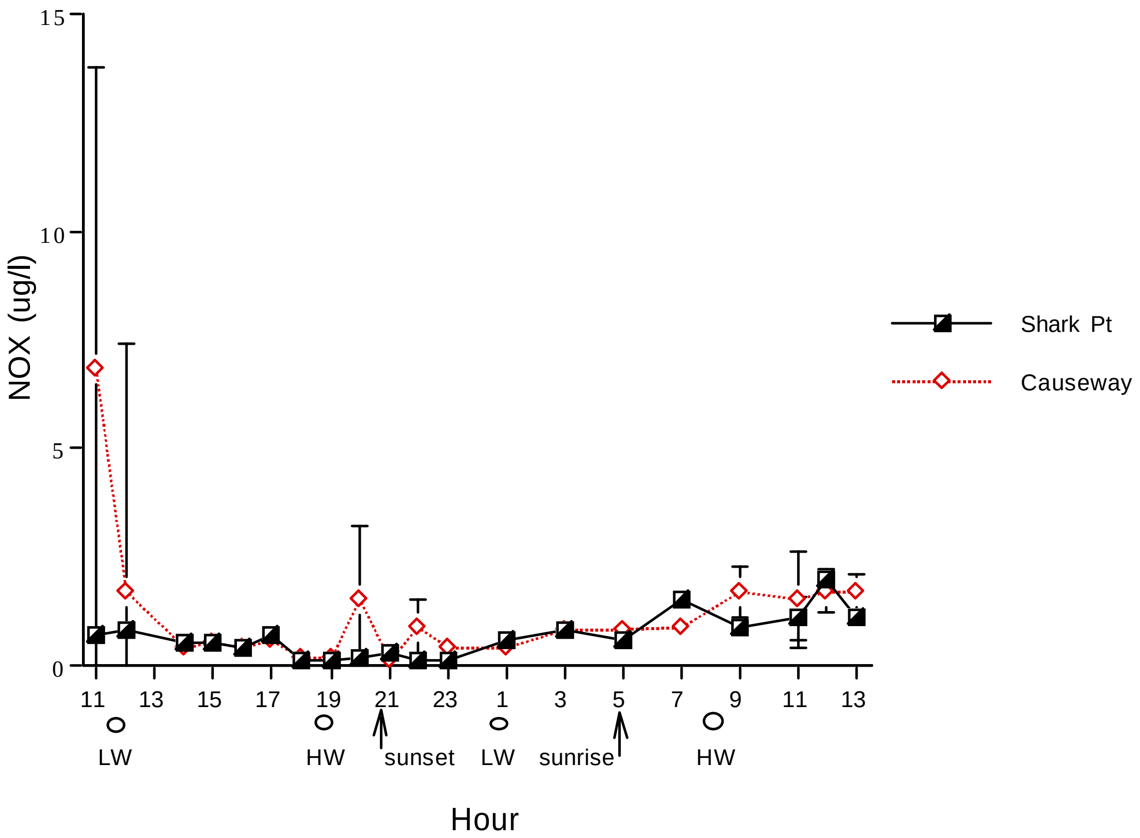
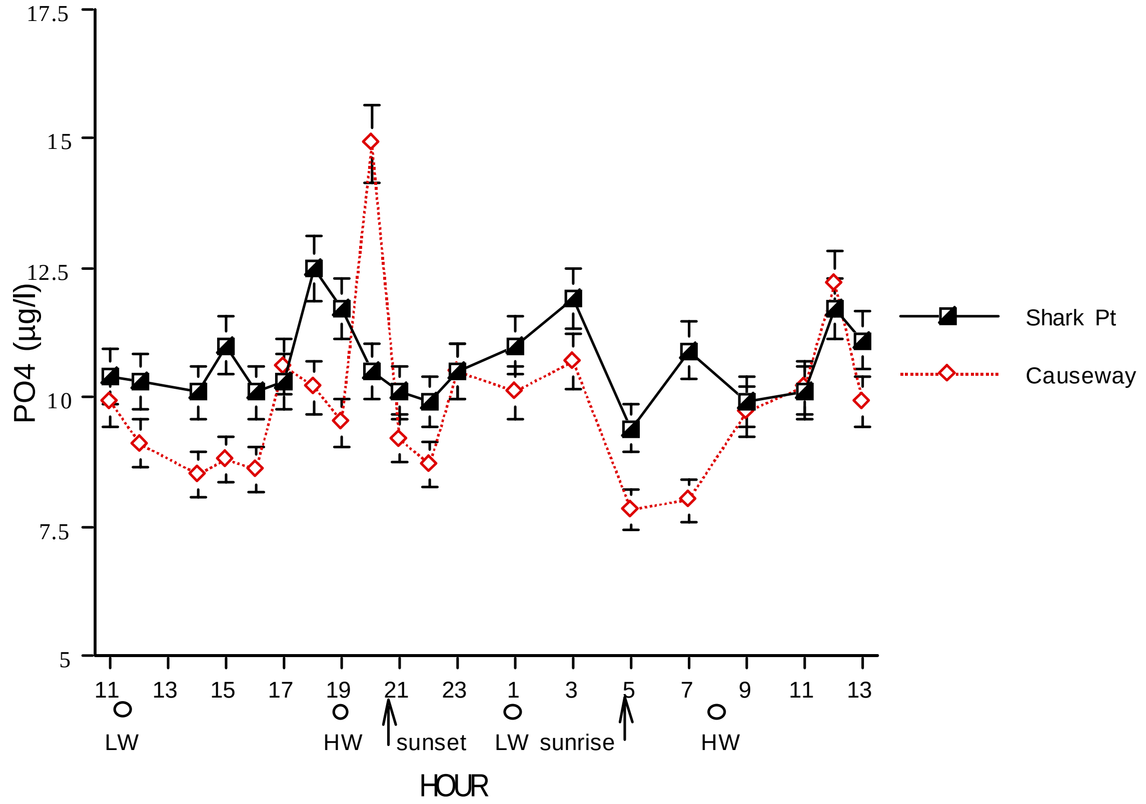


Fig. 32 a & b. Mean Chlorophyll a and NOX in Pittwater over 24 hrs



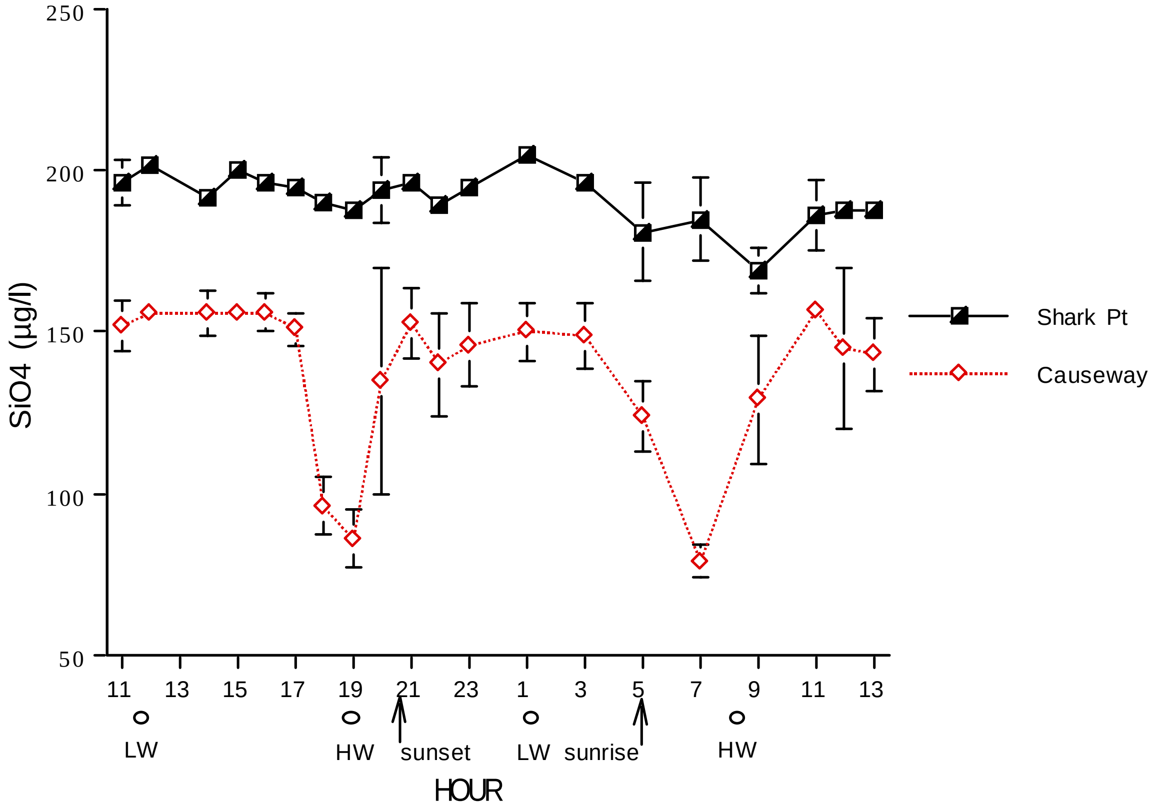
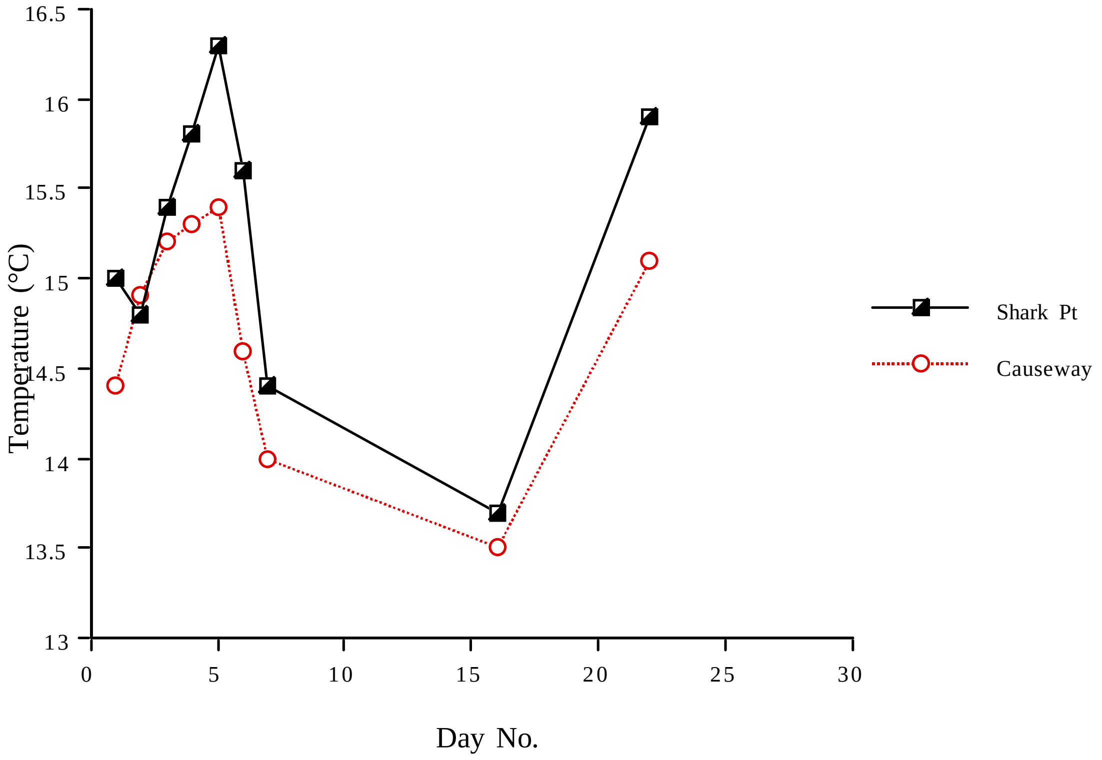


Fig. 33 a & b. Mean PO4-P and SiO4-Si in Pittwater over 24 hours



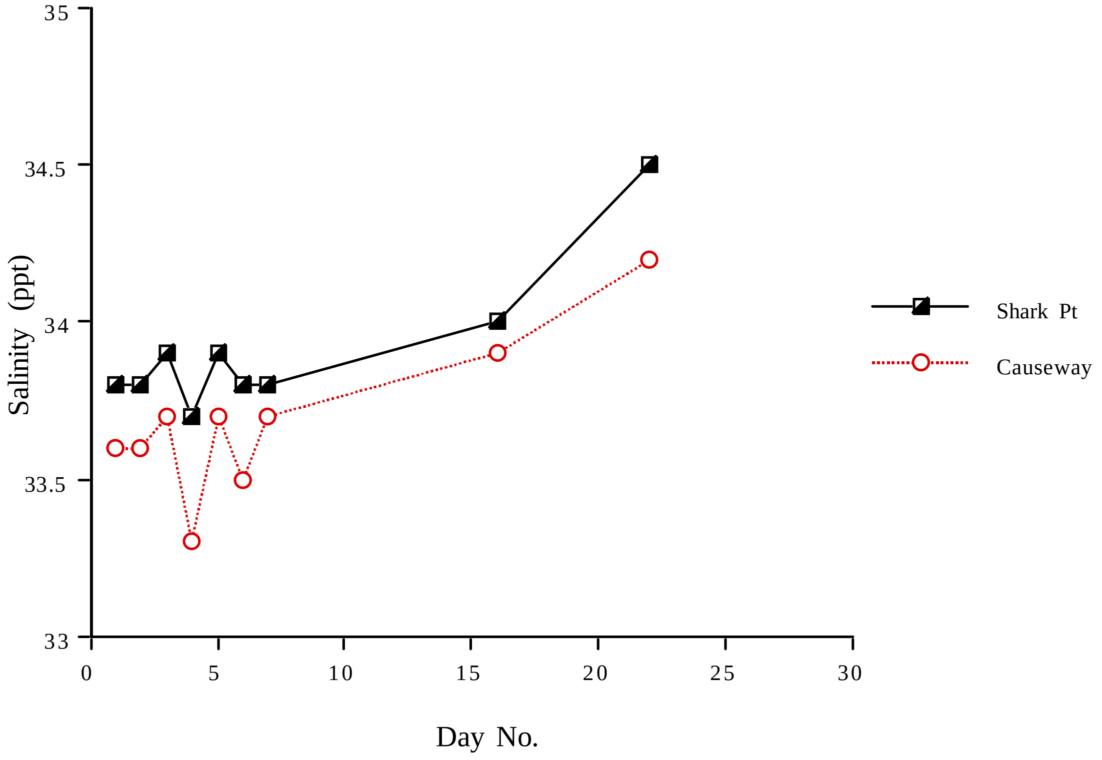


Fig. 34 a & b. Temperature and salinity in Pittwater over four weeks.

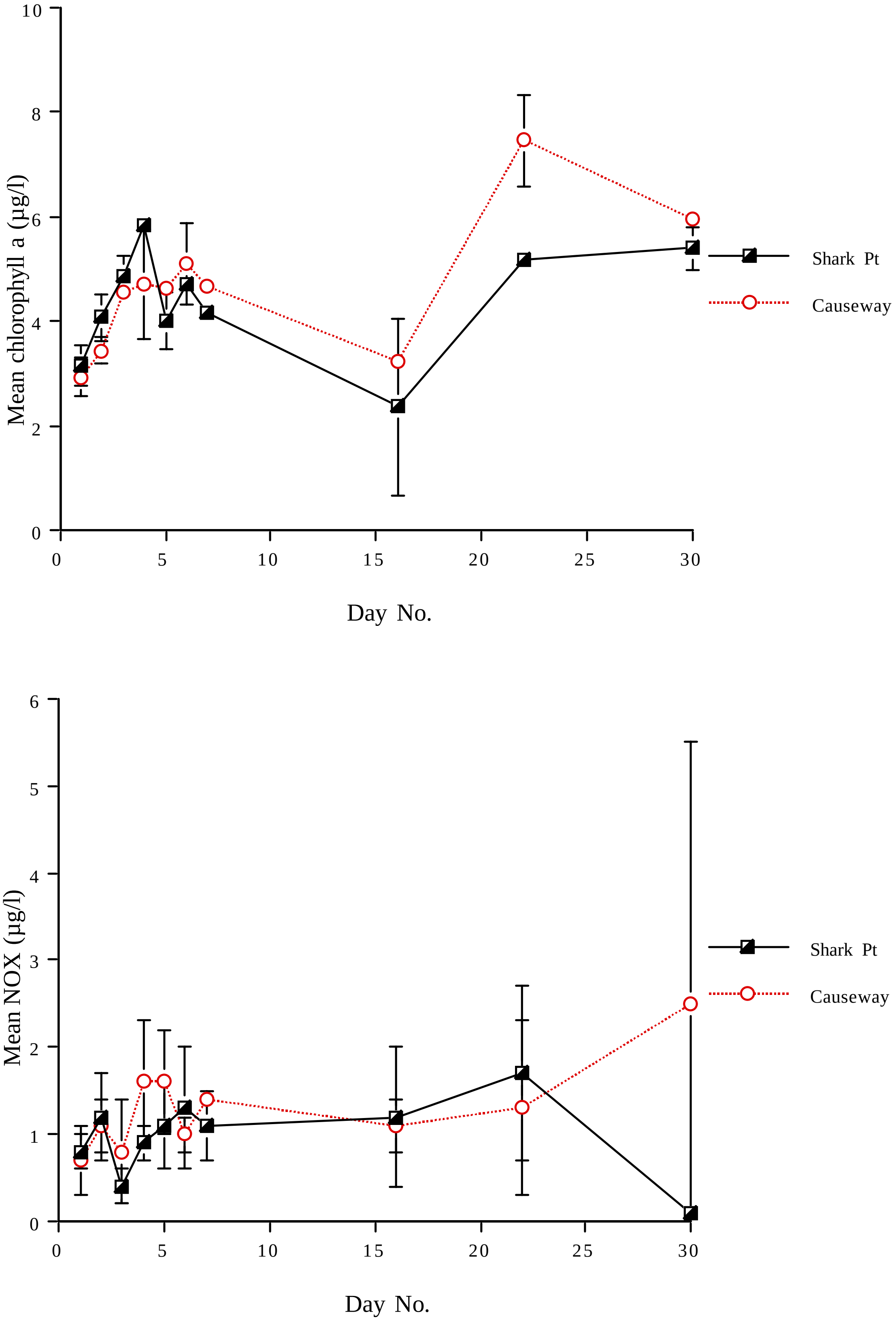
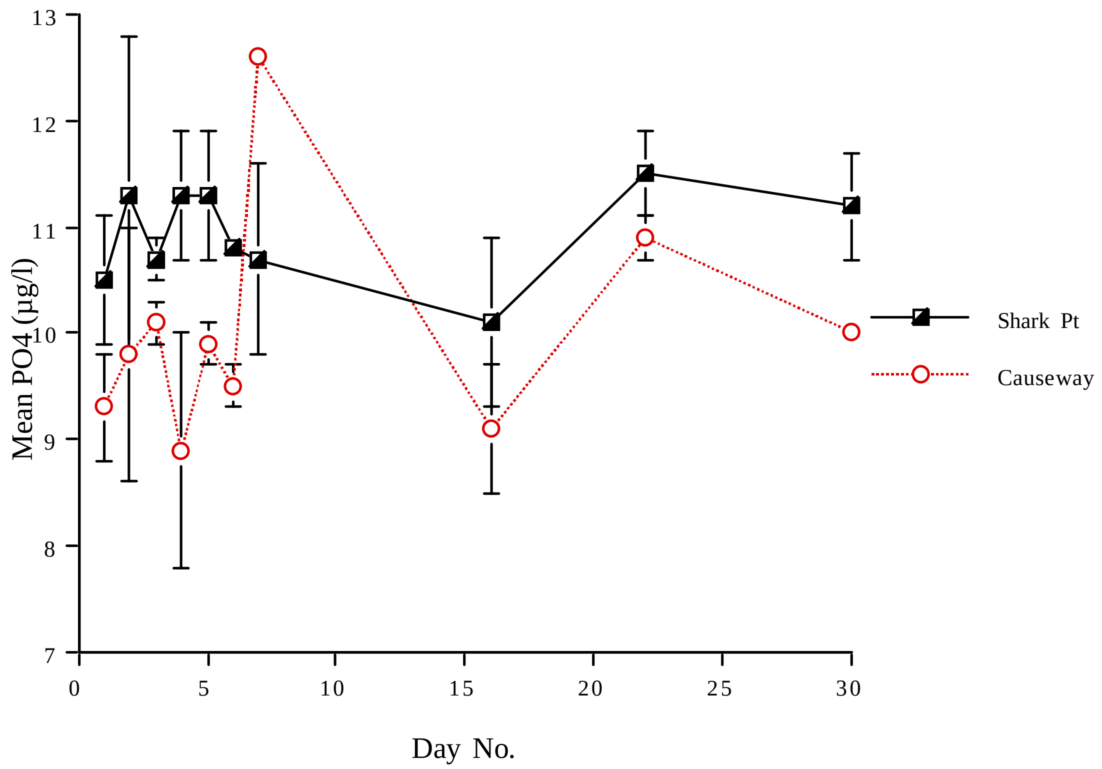


Fig. 35 a & b. Mean Chlorophyll a and NOX in Pittwater over four weeks.



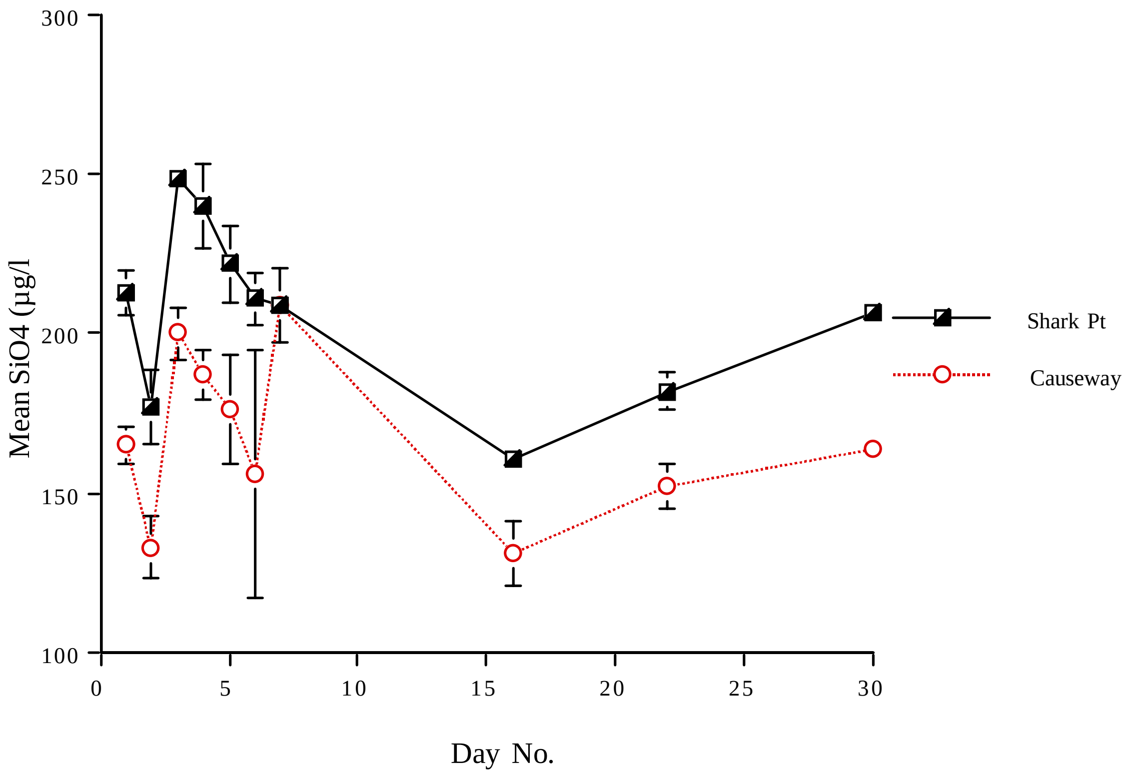


Fig. 36 a & b. Mean PO_4-P and SiO_4-Si in Pittwater over four weeks.

3.4 Intensive Sampling Around the Leases

Results of intensive sampling around the leases are presented in Appendix 2.

The limited sampling at Pittwater did not indicate any changes in nutrient concentrations around the leases.

At Pipeclay Lagoon the temperature and salinity data were similar around the 6 leases close together, whereas the temperature was higher in spring and lower in winter at the southern most lease where there are extensive shallow mudflats. Chlorophyll a and nitrates showed no clear patterns whilst phosphates tended to be highest at the stations furthest away from the inflowing water in the group of 6 leases. Overall there were no clear trends to indicate that the oysters on the leases closest to the inflowing water were removing all the food from the water before it reached the oysters furthest away.

At Little Swanport there were no apparent changes in nutrient concentrations around the leases except for a tendency for chlorophyll a concentrations to be higher at the stations furthest up the estuary.

Temperatures and salinities at Georges Bay showed little variation around the leases. Chlorophyll a levels varied substantially over the sampling periods and showed bloom conditions in June 1993 and February 1995 (after rainfall). The chlorophyll a concentrations on some occasions were noticeably higher in Moulting Bay than in Georges Bay proper.

No clear trends in data were apparent at Simpsons Bay, probably because the bay is large and the oyster farms comparatively small.

4. Discussion

The hydrodynamic data collected clearly display the different physical environments encountered in each growing area. Pittwater was the largest estuary investigated and the most affected by human interference on water flow into the area. The Craigbourne Dam which was built in 1986 on the Coal River upstream of Pittwater has resulted in limited and controlled release of freshwater into Pittwater, and large influxes of freshwater only occur every few years after exceptionally heavy rainfall and extensive flooding. A large causeway built between Upper and Lower Pittwater also restricts water flow to a narrow channel. Sanitary surveys conducted by the Tasmanian Shellfish Quality Assurance Program which correlated bacterial concentrations in shellfish growing waters with rainfall in the Coal River catchment initially classified the shellfish growing area as “Approved Conditional” for harvesting of shellfish because of significant concentrations of bacteria in the water after predictable regular rainfall (Tyler et al, 1986). This classification, however, was changed to “Approved” in 1992 because of a dramatic improvement in water quality which was attributed largely to the Craigbourne Dam collecting and storing most of the rainfall in the catchment, and stopping major flooding flushing bacteria into the oyster growing area (Brown and Mitchell, 1992).

The oyster farmers in Upper Pittwater are concerned that the reduction in flow, especially periodic flooding, into Pittwater has reduced the influx of nutrients which support phytoplankton growth, and has led to a decrease in productivity and hence oyster production from the area (Brown and Mitchell, 1992; pers. comm. with Pittwater oyster farmers). Prior to the construction of the Craigbourne Dam flooding of the Pittwater estuary (to less than 27 ppt) occurred on average 5-6 times per year (TasQAP, unpublished data), but during the period of this study, 1991-1994 the salinity was always above 32 ppt except for two occasions and the lowest recording was 29.8 ppt. Chemical data collected by the CSIRO in Upper Pittwater around the time that Pacific oysters were introduced into this area clearly showed that nitrate concentrations were much higher when the salinity was low due to flooding (CSIRO, 1952, 1957a, 1957b).

The hydrological data for Pittwater show an exchange rate of 23% on each tidal cycle. However, the regular hypersaline conditions in Upper Pittwater and the higher levels of primary production near the oyster leases than close to the mouth of the estuary (Crawford et al, 1996) suggest that the water in Upper Pittwater is not being regularly exchanged with oceanic water. Harris (1968) described interference points in Pittwater where the flood tidal current meets residual ebb tidal currents resulting in strong turbulence and whirlpools in the water. Further research is required to determine the rate of exchange of Upper Pittwater with Lower Pittwater and oceanic water, and of localised circulation patterns around the bays of Upper Pittwater and near the oyster leases.

The Little Swanport estuary is much smaller than Pittwater and is less complex hydrodynamically. It has a higher exchange rate of 43% and marked reduction in salinity occurs after heavy rainfalls, mostly in Winter and Spring. The decline in salinity has been correlated with flooding in the area and a reduction in water quality so that this growing area was classified as “Approved Conditional” by the Tasmanian Shellfish Quality Assurance Program (Mitchell, 1988). This was upgraded to “Approved” in 1995 because additional sampling had shown that water quality deterioration occurred rarely and could be predicted from rainfall levels and salinity reduction (Brown and McCosh, 1995).

The exchange rate at Georges Bay of 10% was lower than the other growing areas studied, largely because of a very narrow entrance and sand bar to the open sea, and the large volume of the bay. Moulting Bay where the oyster leases are located is a small shallow offshoot of Georges Bay and has a higher exchange rate of 17.5%. This area is also affected by periodic flooding from the Georges River, and the salinity inside Georges Bay, similar to Little Swanport was always lower than at the oceanic site just outside the bay. Salinity at the oyster leases has been recorded to fall as low as 7 parts per thousand (Mitchell, 1989). This growing area was classified as “Approved Conditional” on the western side of Moulting Lagoon because of intermittent microbial pollution largely from the Georges River, and “Approved” on the eastern side.

Pipeclay Lagoon was the only marine inlet in which the water circulation patterns were investigated. It was a small, shallow inlet with a rapid flushing rate of 1.4 tidal cycles with Frederick Henry Bay. There is no permanent freshwater inflow into the lagoon and the oyster leases have been classified as “Approved” (Brown and Mitchell, 1991).

The hydrodynamic data collected for each growing area are important in determining the rate of replenishment of food for the oysters and hence oyster production. An extensive study to model carrying capacities of *Crassostrea gigas* in the Marennes-Oleron Bay in France by Raillard and Menesguen (1994) concluded that the hydrodynamic regime of the bay strongly controlled the carrying capacity of the shellfish system, and the validity of their model was limited mainly by the description of physical transport of food for the oysters. Grant et al (1993) also considered that information on the physical exchange of water and hence transport of food was paramount in both field and modelling studies of bivalve aquaculture.

An initial objective of the FRDC research project was to develop a generalised model of carrying capacity which would be applicable with specific minor modifications to existing and potential intensive shellfish farms in Tasmania. However, it was concluded by Crawford et al (1996) that such a generalised model was not achievable because of the significant differences in hydrodynamic regimes and physical characteristics of each growing area. To produce relatively accurate estimates of carrying capacity of an area, detailed site specific data are required over a lengthy period of time because environmental parameters can fluctuate significantly from year to year. Studies of carrying capacity are thus costly because of the time and effort required to collect the necessary site specific information. Extensive studies conducted in New Zealand to investigate factors affecting mussel condition and hence carrying capacity also showed significant variability in environmental parameters between sites and emphasised the importance of obtaining site-specific environmental data to determine mussel condition (Hickman et al, 1991).

A comparison of the physical parameters and the production of oysters from each growing area (Table 7) clearly shows that Pipeclay Lagoon is currently the most productive of the five areas investigated, producing up to 8.2 million oysters per annum from 48 ha compared with 6.2 million from 108 ha at Pittwater. The leases at Georges Bay have only recently approached full development and have produced 4.4 million from 40.5 ha and the potential for further expansion is currently being assessed. Little

Swanport produces 3-4 million oysters per annum from 80 ha and no further development in this area is planned, where as Simpsons Bay is still being developed.

Table 7. Growing area characteristics and oyster production

Growing Area Locations	Area (km^2)	Tidal Prism ($10^6 m^3$)	Flushing Time (tidal cycles)	Lease Area (ha)	Oyster Production (10^6)	Oyster Production / Lease Area (10^6/ha)
Pittwater	46.1	23.4	4.4	108	6.2	0.057
Pipeclay Lagoon	5.0	5.1	1.4	48	8.2	0.171
Little Swanport	6.3	3.4	2.3	80	3.5	0.044
Georges Bay / Moulting Bay	18.4	15.7	9.7/5.7	40.5	4.4	0.109

Noteably different features of Pipeclay Lagoon compared with the other growing areas are its shallowness and rapid flushing rate of 1.4 tidal cycles. Chlorophyll a levels were generally similar to other areas, although nitrate levels were slightly higher on several occasions, and peaked at the Marine station. This suggests that the rapid exchange rate of water is of major importance in supplying food to the oysters. This food supply is of oceanic origin because Pipeclay Lagoon has no freshwater inflow and the turnover rate is too high for primary production in the lagoon to be a significant contributor of food to the oysters.

Although the flushing rate in Pittwater of 4.4 tidal cycles and current flow rates were lower than in Pipeclay Lagoon, the chlorophyll a levels were similar. However the composition of the phytoplankton and the nutritional value of the oyster food in the two areas is not known. A factor that may affect the markedly different production levels from the two areas is probably the amount of suspended inorganic matter in the water. The turbidity of the water in Upper Pittwater has regularly been observed to be much higher than at Pipeclay Lagoon and the substrate is generally finer in Pittwater, especially in the upper estuary. Harris (1968) described Upper Pittwater as predominantly fine sands, with some sandy silt, and sand and clay-silt. His data indicated that the wind-driven waves and low tidal currents of 5-10cm/sec in shallow water which commonly occur in Pittwater would be capable of carrying very fine sand and silt in suspension. In the feeding studies conducted by Crawford et al (1996), the percentage of particulate inorganic matter measured in the water column and in the oyster faeces was always higher at Pittwater (76.8% and 85.3% respectively) than Pipeclay Lagoon (69.2% and 76.1% respectively). It has been observed in several bivalves that the growth rate peaks at a moderate food concentration and then declines as the food density increases (Malouf and Bricelj, 1989). In the Pacific oyster Barille and Prou (1993) observed a negative effect of turbidity on growth at high seston levels typical of tidal flows in estuaries.

The production of oysters from Little Swanport was also low but there are insufficient data available to determine whether this area has reached its full production potential. Georges Bay is relatively productive considering the lower flushing rate of 10 tidal cycles and it appears that the input of nutrients from the Georges River and human activities in the area influence the productivity of the area. Very high levels of chlorophyll a were recorded on several occasions indicating sporadic high nutrient inputs into the estuary, possibly from the sewerage treatment plant.

The physical and chemical parameters measured at the two stations towards the head of the estuary in Pittwater over 24 hours and over 4 weeks indicated substantial spatial and temporal variability. Results from the site at the causeway indicated a greater influence of tidal flows and oceanic waters than the site 3 km further upstream which showed evidence of reduced flushing such as generally higher salinities, chlorophyll a, phosphates and silicates. The variability observed in these results suggests that more frequent sampling is required, preferably using in situ automatic data loggers which provide continuous recordings. These data highlight the difficulty in estimating carrying capacity of growing areas from limited data because large variability is common. Gibbs et al (1992) who assessed the nutrient and chlorophyll a concentrations in mussel farming areas of Pelorus Sound, New Zealand also observed large variability due to complex hydrodynamic regimes. They observed concentration changes over short time periods associated with tidal fronts to longer periods (days to months) associated with freshwater floods, retention times and oceanic exchange.

Food availability for filter feeders is often estimated from chlorophyll a levels in the water. However, chlorophyll a concentrations are not always a good indicator of the food available for oysters, because the oysters may be selectively feeding or the algae present may be of poor nutritional value for oysters (Grant et al, 1993). In this study the chlorophyll a concentrations were generally similar between growing areas, and for example there were no obvious differences in chlorophyll a concentrations between Pittwater and Pipeclay Lagoon, but the oyster production from the two areas was markedly different. A study by Hickman et al (1991) of the relationship between farmed mussels and food availability in Pelorus-Kenepuru Sound in New Zealand found that on an industry-wide scale abiotic factors (temperature and salinity) were more highly correlated with mussel condition than factors measuring food availability (chlorophyll a, carbon and particulates), but at lower ambient food levels mussel condition was strongly associated with food concentrations. Furthermore, the fact that there were no clear patterns of chlorophyll a depletion around the leases indicates that chlorophyll a may not be a good measure of food availability. By contrast, Navarro et al (1991) found that food concentrations, measured as particulate organic matter, and oyster scope for growth consistently decreased from the front (closest to oceanic food resources) to the back of mussel cultivation rafts in Spain.

Oysters have been observed to have other sources of food and, for example, may consume substantial quantities of detrital matter (Quayle, 1988). Recent studies overseas have shown that the microphytobenthos can be a major food source for cultured bivalves (Smaal and Zurburg, 1997). A study of the diet of Pacific oysters at Little Swanport by van den Enden (1994) found that chlorophyll a concentrations in the water column were an overestimate of total food available because the oysters selectively fed on benthic diatoms and higher plant detritus, particularly from seagrass (*Zostera* sp.). The diet of Pacific oysters at Pittwater was observed by Hallegraeff et al (1988) to be mainly diatoms, including benthic diatoms, and reprocessed detritus and pseudofaeces were probably an additional food source.

A study of the nutrients in nearby Derwent River estuary in 1993 (Coughanowr, 1995) found similar to slightly lower chlorophyll a levels in the lower estuary, but nitrate + nitrite levels were generally marginally higher and in the range of 10-15 ug N/l except for periodic large peaks, whilst orthophosphate levels were similar between the estuaries studied. Although DIN:DIP ratios indicated that nitrogen potentially limits algal growth in the Derwent Estuary, a study by Hallegraeff and Westwood (1994) led to the conclusion that light limitation by turbid waters and humic substances was more likely to limit algal growth than nutrient shortage. As discussed above, it is also likely that turbid waters in the Pittwater oyster growing areas resulting from substantial wind driven circulation may have a significant inhibitory effect on algal production and oyster growth. Brett (1992) found that Orielton Lagoon which has restricted water exchange with Pittwater had much higher chlorophyll a levels and phosphate concentrations were twice as high, but nitrate concentrations were similar to the rest of Pittwater. She concluded that Orielton Lagoon was nitrogen-limited and the sewage treatment plant was the main source of nutrients.

This study has provided environmental data which are useful for determining which conditions are important for high oyster production. These results also are relevant to the environmental management of the areas studied.

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Appendix 1

Temperature, salinity, nutrients and chlorophyll a in oyster growing areas.

1.1 Pittwater

Date	**Station**	**Temp °C**	**Salinity (ppt)**	**Chla (µg/L)**	**NOX(µg/l)**	**NO3(µg/l)**	**NO2(µg/l)**	**PO4(µg/l)**	**Si04(µg/l)**
27/8/91	1 Marine	9.80	33.40	-	34.00	31.40	2.60	10.90	-
27/8/91	2 Lewisham	9.15	33.45	-	15.00	12.20	2.80	9.50	-
27/8/91	3 Causeway	9.35	33.80	-	10.00	8.80	1.20	6.00	-
27/8/91	4 Barilla	9.10	33.85	-	28.00	25.10	2.90	8.10	-
27/8/91	5 Shark Pt	8.65	33.75	-	22.00	16.60	5.40	7.00	-
	mean	**9.06**	**33.71**	-	**18.75**	**15.68**	**3.08**	**7.65**	-
24/9/91	1 Marine	10.90	33.40	1.04	15.00	12.80	2.20	7.00	-
24/9/91	2 Lewisham	11.70	33.20	1.19	8.00	5.80	2.20	5.00	-
24/9/91	3 Causeway	10.90	33.25	1.63	6.00	4.90	1.10	5.00	-
24/9/91	4 Barilla	11.75	33.40	1.91	9.00	5.60	3.40	5.00	-
24/9/91	5 Shark Pt	11.10	33.05	2.20	31.00	26.60	4.40	5.00	-
	mean	**11.36**	**33.23**	**1.73**	**13.50**	**10.73**	**2.78**	**5.00**	-
17/10/91	1 Marine	12.10	33.80	3.30	7.00	5.70	1.30	7.00	-
17/10/91	2 Lewisham	12.05	33.80	1.19	9.00	5.90	3.10	7.00	-
17/10/91	3 Causeway	11.95	33.90	2.32	7.00	3.80	3.20	9.00	-
17/10/91	4 Barilla	11.55	34.05						-
17/10/91	5 Shark Pt	12.35	34.00	1.94	7.00	4.70	2.30	10.00	-
	mean	**11.98**	**33.94**	**1.82**	**7.67**	**4.80**	**2.87**	**8.67**	-
28/11/91	1 Marine	15.20	33.90	1.71	6.00	2.00	4.00	7.00	-
28/11/91	2 Lewisham	15.10	34.00	2.15	5.00	2.00	3.00	6.00	-
28/11/91	3 Causeway	15.65	34.65	4.08	5.00	2.00	3.00	5.50	-
28/11/91	4 Barilla	14.75	35.10	2.97	6.00	4.00	2.00	5.50	-
28/11/91	5 Shark Pt	16.25	34.90	4.39	4.00	2.60	1.40	5.50	-
	mean	**15.44**	**34.66**	**3.40**	**5.00**	**2.65**	**2.35**	**5.63**	-
17/12/91	1 Marine	-	-	1.20	12.00	11.00	1.00	14.00	-
17/12/91	2 Lewisham	-	-	1.56	8.00	5.20	2.80	7.00	-
17/12/91	3 Causeway	-	-	2.52	3.00	2.80	0.20	9.00	-
17/12/91	4 Barilla	-	-	1.64	5.00	4.00	1.00	7.60	-
17/12/91	5 Shark Pt	-	-	3.02	10.00	9.40	0.60	9.00	-
	mean	-	-	**2.18**	**6.50**	**5.35**	**1.15**	**8.15**	-
13/1/92	1 Marine	16.80	33.95	1.33	4.00	1.70	2.30	5.00	-
13/1/92	2 Lewisham	16.55	34.10	2.22	2.00	1.50	0.50	5.00	-
13/1/92	3 Causeway	17.70	34.75	1.76	12.00	7.80	4.20	7.00	-
13/1/92	4 Barilla	16.35	35.30	1.39	3.00	1.60	1.40	6.00	-
13/1/92	5 Shark Pt	17.20	34.80	2.97	2.00	1.50	0.50	8.00	-
	mean	**16.95**	**34.74**	**2.09**	**4.75**	**3.10**	**1.65**	**6.50**	-
26/2/92	.	16.65	34.30	5.56	10.00	8.90	1.10	7.80	-
26/2/92	2 Lewisham	15.50	35.05	5.19	8.00	3.80	4.20	6.00	-
26/2/92	3 Causeway	15.85	35.85	7.71	9.00	6.00	3.00	9.00	-
26/2/92	4 Barilla	14.95	37.10	7.93	3.00	2.80	0.20	9.30	-
26/2/92	5 Shark Pt	15.30	36.50	7.86	42.00	40.80	1.20	15.50	-
	mean	**15.40**	**36.13**	**7.18**	**15.50**	**13.35**	**2.15**	**9.95**	-
25/3/92	1 Marine	15.75	34.85	2.67	29.00	25.00	4.00	12.00	-
25/3/92	2 Lewisham	15.35	36.00	2.22	9.00	5.50	3.50	9.00	-
25/3/92	3 Causeway	15.40	36.65	3.97	7.00	5.60	1.40	9.00	-
25/3/92	4 Barilla	15.60	37.50	2.58	10.00	5.30	4.70	9.00	-
25/3/92	5 Shark Pt	15.20	36.90	4.36	14.00	10.90	3.10	13.00	-
	mean	**15.39**	**36.76**	**3.28**	**10.00**	**6.83**	**3.18**	**10.00**	**-**

1.1 Pittwater

Date	**Station**	**Temp °C**	**Salinity (ppt)**	**Chla (μg/L)**	**NOX(μg/l)**	**NO3(μg/l)**	**NO2(μg/l)**	**PO4(μg/l)**	**Si04(μg/l)**
28/4/92	1 Marine	13.70	34.70	2.60	5.00	4.20	0.80	8.60	-
28/4/92	2 Lewisham	12.80	34.90	2.15	4.00	3.20	0.80	7.50	-
28/4/92	3 Causeway	12.85	35.60	3.80	3.00	2.40	0.60	8.30	-
28/4/92	4 Barilla	12.40	35.65	2.45	6.00	4.40	1.60	7.00	-
28/4/92	5 Shark Pt	12.40	35.75	4.25	3.00	2.70	0.30	9.50	-
	mean	**12.61**	**35.48**	**3.16**	**4.00**	**3.18**	**0.83**	**8.08**	**-**
26/5/92	1 Marine	11.40	34.15	1.33	7.00	5.10	1.90	23.10	-
26/5/92	2 Lewisham	11.20	34.20	1.11	3.00	1.60	1.40	8.00	-
26/5/92	3 Causeway	10.10	35.05	1.41	5.00	3.90	1.10	7.30	-
26/5/92	4 Barilla	9.40	35.25	1.48	8.00	6.40	1.60	5.00	-
26/5/92	5 Shark Pt	9.85	35.15	1.91	18.00	16.30	1.70	10.60	-
	mean	**10.14**	**34.91**	**1.48**	**8.50**	**7.05**	**1.45**	**7.73**	**-**
1/7/92	1 Marine	9.15	33.70	2.89	10.00	8.90	1.10	12.50	-
1/7/92	2 Lewisham	9.20	33.70	3.34	5.00	3.80	1.20	8.40	-
1/7/92	3 Causeway	8.35	34.50	3.86	3.00	2.50	0.50	7.50	-
1/7/92	4 Barilla	7.75	34.50	3.19	5.00	3.80	1.20	6.70	-
1/7/92	5 Shark Pt	7.85	34.80	2.89	4.00	2.30	1.70	7.70	-
	mean	**8.29**	**34.38**	**3.32**	**4.25**	**3.10**	**1.15**	**7.58**	**-**
4/8/92	1 Marine	8.05	33.60	2.67	5.00	3.60	1.40	27.00	-
4/8/92	2 Lewisham	7.30	33.60	1.93	3.00	1.70	1.30	9.00	-
4/8/92	3 Causeway	6.80	33.45	1.26	3.00	2.10	0.90	14.00	-
4/8/92	4 Barilla	6.50	33.40	2.37	10.00	9.00	1.00	8.00	-
4/8/92	5 Shark Pt	6.80	33.40	1.93	6.00	4.20	1.80	11.00	-
	mean	**6.85**	**33.46**	**1.87**	**5.50**	**4.25**	**1.25**	**10.50**	**-**
26/8/92	1 Marine	8.75	33.22	1.41	3.00	2.80	0.20	9.00	-
26/8/92	2 Lewisham	8.65	33.52	0.37	8.00	7.70	0.30	9.00	-
26/8/92	3 Causeway	8.48	33.17	0.67	3.00	2.70	0.30	9.00	-
26/8/92	4 Barilla	8.45	33.38	0.83	1.00	0.80	0.20	7.00	-
26/8/92	5 Shark Pt	8.38	33.20	0.74	4.00	3.70	0.30	9.00	-
	mean	**8.49**	**33.32**	**0.65**	**4.00**	**3.73**	**0.28**	**8.50**	**-**
22/9/92	1 Marine	10.50	33.40	1.32	3.80	2.90	0.90	6.00	-
22/9/92	2 Lewisham	10.80	33.10	1.48	2.80	2.40	0.40	7.00	-
22/9/92	3 Causeway	10.70	31.70	1.24	2.10	1.30	0.80	5.00	-
22/9/92	4 Barilla	10.80	31.20	1.40	5.20	3.90	1.30	5.00	-
22/9/92	5 Shark Pt	10.60	31.50	1.15	10.00	9.40	0.60	7.00	-
	mean	**10.73**	**31.88**	**1.32**	**5.03**	**4.25**	**0.78**	**6.00**	**-**
4/11/92	1 Marine	14.35	33.75	2.26	5.00	4.90	0.10	8.00	-
4/11/92	2 Lewisham	14.75	33.50	2.50	1.00	1.00	0.00	7.00	-
4/11/92	3 Causeway	15.75	32.25	1.72	1.00	0.60	0.40	8.00	-
4/11/92	4 Barilla	15.85	32.20	1.71	4.00	3.60	0.40	7.00	-
4/11/92	5 Shark Pt	16.10	32.25	2.82	1.00	1.00	0.00	9.00	-
	mean	**15.61**	**32.55**	**2.18**	**1.75**	**1.55**	**0.20**	**7.75**	**-**
3/12/92	1 Marine	14.80	34.95	1.07	3.00	3.00	0.00	8.00	-
3/12/92	2 Lewisham	15.60	34.75	1.81	3.00	2.60	0.40	8.00	-
3/12/92	3 Causeway	16.00	34.45	1.90	2.00	1.90	0.10	9.00	-
3/12/92	4 Barilla	15.45	34.15	1.73	1.00	0.90	0.10	10.00	-
3/12/92	5 Shark Pt	16.05	34.30	1.98	1.00	0.90	0.10	8.00	-
	mean	**15.78**	**34.41**	**1.85**	**1.75**	**1.58**	**0.18**	**8.75**	**-**

1.1 Pittwater

Date	Station	Temp °C	Salinity (ppt)	Chla (µg/L)	NOX(µg/l)	NO3(µg/l)	NO2(µg/l)	PO4(µg/l)	Si04(µg/l)
17/12/92	1 Marine	16.70	35.00	1.04	3.00	2.50	0.50	10.00	-
17/12/92	2 Lewisham	17.40	34.95	1.33	4.00	3.30	0.70	9.00	-
17/12/92	3 Causeway	18.65	35.25	2.37	6.00	4.80	1.20	10.00	-
17/12/92	4 Barilla	18.15	35.75	2.00	3.00	1.80	1.20	13.00	-
17/12/92	5 Shark Pt	18.85	35.20	2.65	3.00	2.00	1.00	12.00	-
	mean	**18.26**	**35.29**	**2.09**	**4.00**	**2.98**	**1.03**	**11.00**	**-**
19/1/93	1 Marine	18.65	34.30	0.82	5.00	4.70	0.30	12.00	-
19/1/93	2 Lewisham	18.75	34.75	1.85	2.00	1.70	0.30	7.00	-
19/1/93	3 Causeway	19.00	35.55	3.04	2.00	1.80	0.20	10.00	-
19/1/93	4 Barilla	19.05	36.35	2.22	0.80	0.60	0.20	8.00	-
19/1/93	5 Shark Pt	19.40	36.05	3.14	1.00	0.70	0.30	11.00	-
	mean	**19.05**	**35.68**	**2.56**	**1.45**	**1.20**	**0.25**	**9.00**	**-**
17/2/93	1 Marine	19.25	34.75	1.78	3.00	2.88	0.12	9.80	-
17/2/93	2 Lewisham	19.15	35.55	2.60	2.00	1.75	0.25	9.60	-
17/2/93	3 Causeway	19.80	36.30	4.08	1.00	0.82	0.18	9.10	-
17/2/93	4 Barilla	22.35	36.70	3.34	2.00	1.50	0.50	7.50	-
17/2/93	5 Shark Pt	20.85	36.50	3.52	5.00	4.98	0.02	10.30	-
	mean	**20.54**	**36.26**	**3.38**	**2.50**	**2.26**	**0.24**	**9.13**	**-**
16/3/93	1 Marine	17.50	34.50	1.26	2.00	1.70	0.30	10.00	-
16/3/93	2 Lewisham	17.75	34.70	1.11	5.00	4.60	0.40	11.00	-
16/3/93	3 Causeway	18.40	35.55	3.18	2.00	1.70	0.30	12.00	-
16/3/93	4 Barilla	18.05	36.45	0.96	2.00	1.50	0.50	9.00	-
16/3/93	5 Shark Pt	18.25	35.85	3.41	3.00	2.40	0.60	16.00	-
	mean	**18.11**	**35.64**	**2.17**	**3.00**	**2.55**	**0.45**	**12.00**	**-**
14/4/93	1 Marine	14.90	34.60	1.26	4.00	3.80	0.20	12.00	-
14/4/93	2 Lewisham	14.70	34.80	1.19	2.00	1.80	0.20	11.00	-
14/4/93	3 Causeway	14.85	35.55	2.89	3.00	2.80	0.20	12.00	-
14/4/93	4 Barilla	14.10	36.20	2.00	2.00	1.80	0.20	16.00	-
14/4/93	5 Shark Pt	14.45	35.70	1.41	3.00	2.80	0.20	13.00	-
	mean	**14.53**	**35.56**	**1.87**	**2.50**	**2.30**	**0.20**	**13.00**	**-**
18/5/93	1 Marine	11.80	34.60	0.96	5.00	4.60	0.40	11.00	-
18/5/93	2 Lewisham	10.35	34.80	0.96	2.00	1.70	0.30	10.00	-
18/5/93	3 Causeway	9.70	35.10	1.33	4.00	3.70	0.30	10.00	-
18/5/93	4 Barilla	8.75	35.80	0.74	8.00	7.70	0.30	12.00	-
18/5/93	5 Shark Pt	9.15	35.45	1.19	2.00	1.80	0.20	9.00	-
	mean	**9.49**	**35.29**	**1.06**	**4.00**	**3.73**	**0.28**	**10.25**	**-**
16/6/93	1 Marine	8.95	34.25	3.19	7.00	6.10	0.90	14.00	-
16/6/93	2 Lewisham	7.95	34.40	2.30	6.00	5.40	0.60	12.00	-
16/6/93	3 Causeway	6.90	34.80	1.56	1.00	0.80	0.20	8.50	-
16/6/93	4 Barilla	6.55	35.10	0.89	1.00	0.80	0.20	8.50	-
16/6/93	5 Shark Pt	6.85	34.95	2.15	3.00	2.70	0.30	10.00	-
	mean	**7.06**	**34.81**	**1.72**	**2.75**	**2.43**	**0.33**	**9.75**	**-**
16/7/93	1 Marine	8.80	33.80	2.67	1.00	0.80	0.20	5.00	-
16/7/93	2 Lewisham	8.85	33.80	2.22	1.00	0.80	0.20	7.00	-
16/7/93	3 Causeway	8.60	33.90	2.15	1.00	0.70	0.30	6.00	-
16/7/93	4 Barilla	8.80	33.75	-	-	-	-	-	-
16/7/93	5 Shark Pt	8.40	33.80	2.60	1.00	0.80	0.20	6.00	-
	mean	**8.66**	**33.81**	**2.32**	**1.00**	**0.77**	**0.23**	**6.33**	**-**

1.1 Pittwater

Date	**Station**	**Temp °C**	**Salinity (ppt)**	**Chla (µg/L)**	**NOX(µg/l)**	**NO3(µg/l)**	**NO2(µg/l)**	**PO4(µg/l)**	**Si04(µg/l)**
12/8/93	1 Marine	9.35	33.85	2.13	4.00	3.30	0.70	7.00	-
12/8/93	2 Lewisham	9.55	33.80	1.21	3.00	2.30	0.70	7.00	-
12/8/93	3 Causeway	9.65	33.85	1.67	2.00	1.50	0.50	6.00	-
12/8/93	4 Barilla	9.70	34.05	1.85	4.00	3.50	0.50	7.00	-
12/8/93	5 Shark Pt	9.60	33.90	2.04	3.00	2.60	0.40	6.00	-
	mean	**9.63**	**33.90**	**1.69**	**3.00**	**2.48**	**0.53**	**6.50**	-
27/9/93	1 Marine	12.25	33.65	0.79	4.50	4.10	0.40	9.00	-
27/9/93	2 Lewisham	12.85	33.70	0.79	1.00	0.70	0.30	6.40	-
27/9/93	3 Woody	13.95	34.00	0.79	0.50	0.50	0.80	6.80	-
27/9/93	4 Causeway	13.75	33.95	1.19	1.10	0.80	0.30	7.00	-
27/9/93	5 Barilla	14.60	34.50	0.89	2.50	2.10	0.40	7.30	-
27/9/93	6 Shark Pt	13.80	34.00	1.19	1.00	0.80	0.20	6.00	-
	mean	**13.79**	**34.03**	**0.97**	**1.22**	**0.98**	**0.40**	**6.70**	**-**
25/10/93	1 Marine	13.50	34.05	0.82	0.40	0.40	0.00	7.00	-
25/10/93	2 Lewisham	13.80	34.05	1.24	1.30	1.30	0.00	7.00	-
25/10/93	3 Woody	14.25	34.20	1.32	0.80	0.80	0.00	7.70	-
25/10/93	4 Causeway	14.10	34.55	2.55	0.40	0.40	0.00	7.30	-
25/10/93	5 Barilla	15.15	34.95	1.40	0.60	0.60	0.00	7.50	-
25/10/93	6 Shark Pt	14.45	34.60	2.22	0.10	0.10	0.00	7.70	-
	mean	**14.35**	**34.47**	**1.75**	**0.64**	**0.64**	**0.00**	**7.44**	**-**
24/11/93	1 Marine	14.85	34.05	1.11	0.50	0.30	0.20	8.80	46.00
24/11/93	2 Lewisham	14.65	34.10	1.85	0.80	0.60	0.20	8.50	58.00
24/11/93	3 Woody	15.00	34.55	4.91	0.30	0.10	0.20	6.90	172.00
24/11/93	4 Causeway	14.90	34.55	4.36	0.30	0.10	0.20	6.90	156.00
24/11/93	5 Barilla	14.35	34.95	3.06	0.30	0.00	0.30	6.20	198.00
24/11/93	6 Shark Pt	15.15	34.55	4.73	0.50	0.30	0.20	8.10	220.00
	mean	**14.81**	**34.54**	**3.78**	**0.44**	**0.22**	**0.22**	**7.32**	**160.80**
22/12/93	1 Marine	16.60	34.45	0.83	0.60	0.60	0.00	7.70	18.50
22/12/93	2 Lewisham	17.50	34.65	1.76	0.80	0.80	0.00	8.70	30.70
22/12/93	3 Woody	18.60	35.90	4.03	1.40	1.40	0.00	11.60	176.00
22/12/93	4 Causeway	18.80	35.90	4.34	0.80	0.80	0.00	11.60	188.00
22/12/93	5 Barilla	17.60	36.10	3.43	0.90	0.90	0.00	9.60	172.00
22/12/93	6 Shark Pt	18.90	36.15	3.89	0.90	0.90	0.00	12.00	202.00
	mean	**18.28**	**35.74**	**3.49**	**0.96**	**0.96**	**0.00**	**10.70**	**153.74**
20/1/94	1 Marine	16.20	33.40	3.13	0.50	0.50	0.00	6.50	11.60
20/1/94	2 Lewisham	16.40	32.40	2.97	0.20	0.20	0.00	5.80	12.60
20/1/94	3 Woody	18.50	29.80	4.01	0.70	0.70	0.00	8.10	18.90
20/1/94	4 Causeway	17.60	30.50	3.63	0.30	0.30	0.00	6.20	17.90
20/1/94	5 Barilla	17.50	31.90	4.00	0.50	0.50	0.00	10.40	43.80
20/1/94	6 Shark Pt			4.91	0.20	0.20	0.00	8.50	24.10
	mean	**17.50**	**31.15**	**3.90**	**0.38**	**0.38**	**0.00**	**7.80**	**23.46**
22/2/94	1 Marine	17.30	34.25	1.60	1.30	1.30	0.00	8.80	29.00
22/2/94	2 Lewisham	17.55	34.60	2.48	0.80	0.80	0.00	8.60	33.00
22/2/94	3 Woody	18.40	34.95	5.92	1.20	1.20	0.00	12.50	181.00
22/2/94	4 Causeway	18.50	34.85	5.15	0.50	0.50	0.00	11.10	196.00
22/2/94	5 Barilla	19.45	35.45	3.69	0.80	0.80	0.00	10.00	202.00
22/2/94	6 Shark Pt	18.90	34.80	6.59	0.80	0.80	0.00	11.40	208.00
	mean	**18.56**	**34.93**	**4.77**	**0.82**	**0.82**	**0.00**	**10.72**	**164.00**

1.1 Pittwater

Date	Station	Temp °C	Salinity (ppt)	Chla (µg/L)	NOX(µg/l)	NO3(µg/l)	NO2(µg/l)	PO4(µg/l)	Si04(µg/l)
5/5/94	1 Marine	12.05	34.65	3.02	2.30	2.30	0.00	12.30	119.00
5/5/94	2 Lewisham	10.75	34.80	3.11	2.40	2.40	0.00	11.20	124.00
5/5/94	3 Woody	10.50	35.30	0.00	3.10	3.10	0.00	13.10	179.00
5/5/94	4 Causeway	10.35	35.30	5.86	1.90	1.90	0.00	11.50	189.00
5/5/94	5 Barilla	9.10	35.65	6.55	0.80	0.80	0.00	11.90	139.00
5/5/94	6 Shark Pt			6.09	2.60	2.60	0.00	-	166.00
	mean	**10.18**	**35.26**	**4.32**	**2.16**	**2.16**	**0.00**	**11.93**	**159.40**
21/6/94	1 Marine	9.30	33.70	6.48	5.80	2.30	1.00	14.00	183.00
21/6/94	2 Lewisham	8.90	33.75	5.68	3.80	2.40	0.80	13.00	200.00
21/6/94	3 Woody	7.85	34.10	7.19	1.40	3.10	0.20	9.00	188.00
21/6/94	4 Causeway	7.70	34.10	5.95	1.00	1.90	0.10	10.00	173.00
21/6/94	5 Barilla	6.70	34.45	3.64	1.00	0.80	0.20	9.00	142.00
21/6/94	6 Shark Pt	7.45	34.20	6.12	0.50	2.60	0.10	9.00	174.00
	mean	**7.72**	**34.12**	**5.72**	**1.54**	**2.16**	**0.28**	**10.00**	**175.40**
4/8/94	1 Marine	-	-	7.11	2.00	2.00	0.00	10.00	108.00
4/8/94	2 Lewisham	-	-	5.35	4.00	3.80	0.20	9.00	154.00
4/8/94	3 Woody	-	-	4.79	1.70	1.70	0.00	7.00	139.00
4/8/94	4 Causeway	-	-	5.19	1.00	1.00	0.00	8.00	122.00
4/8/94	5 Barilla	-	-	4.15	1.50	1.50	0.00	7.00	94.00
4/8/94	6 Shark Pt	-	-	4.95	1.50	1.50	0.00	9.00	138.00
	mean	-	-	**4.89**	**1.94**	**1.90**	**0.04**	**8.00**	**129.40**
2/9/94	1 Marine	9.30	33.20	4.97	1.20	1.20	0.00	9.60	66.00
2/9/94	2 Lewisham	9.60	33.30	3.28	1.40	1.40	0.00	9.20	81.00
2/9/94	3 Woody	9.75	33.30	3.19	2.50	2.50	0.00	8.50	109.00
2/9/94	4 Causeway	9.65	33.35	3.02	1.00	1.00	0.00	8.10	105.00
2/9/94	5 Barilla	9.35	33.50	2.75	1.40	1.40	0.00	7.70	92.00
2/9/94	6 Shark Pt	9.65	33.25	3.11	1.10	1.10	0.00	9.20	126.00
	mean	**9.60**	**33.34**	**3.07**	**1.48**	**1.48**	**0.00**	**8.54**	**102.60**
4/10/94	1 Marine	10.60	32.30	2.00	0.40	0.30	0.10	6.30	88.00
4/10/94	2 Lewisham	11.25	32.40	2.32	1.10	1.00	0.10	6.90	100.00
4/10/94	3 Woody	11.20	33.10	3.43	0.80	0.70	0.10	7.70	102.00
4/10/94	4 Causeway	11.10	33.10	3.11	1.30	1.20	0.10	7.30	98.00
4/10/94	5 Barilla	12.00	33.30	2.56	0.80	0.70	0.10	6.20	95.00
4/10/94	6 Shark Pt	11.70	33.10	2.80	0.70	0.40	0.30	7.70	110.00
	mean	**11.45**	**33.00**	**2.84**	**0.94**	**0.80**	**0.14**	**7.16**	**101.00**
29/11/94	1 Marine	-	-	4.35	0.90	-	-	6.90	57.00
29/11/94	2 Lewisham	-	-	4.69	0.00	-	-	7.70	47.00
29/11/94	3 Woody	-	-	6.61	1.20	-	-	10.40	180.00
29/11/94	4 Causeway	-	-	5.77	1.00	-	-	10.00	177.00
29/11/94	5 Barilla	-	-	1.59	1.10	-	-	9.20	268.00
29/11/94	6 Shark Pt	-	-	4.35	0.10	-	-	10.80	207.00
	mean	-	-	**4.60**	**0.68**	-	-	**9.62**	**175.80**

1.1 Pittwater

MEAN VALUE FOR EACH STATION

Date	Station	Temp °C	Salinity (ppt)	Chla (µg/L)	NOX(µg/L)	NO3(µg/L)	NO2(µg/L)	PO4(µg/L)	SiO4(µg/L)
1991	Marine	12.00	33.63	1.81	14.80	12.58	2.22	9.18	-
	Lewisham	12.00	33.61	1.52	9.00	6.22	2.78	6.90	-
	Causeway	11.96	33.90	2.64	6.20	4.46	1.74	6.90	-
	Barilla	11.79	34.10	2.17	12.00	9.68	2.33	6.55	-
	Shark Pt	12.09	33.93	2.89	14.80	11.98	2.82	7.30	-
	mean	**11.96**	**33.88**	**2.30**	**10.50**	**8.09**	**2.42**	**6.91**	**-**
1992	Marine	13.05	34.13	2.18	7.32	6.13	1.19	11.42	-
	Lewisham	12.93	34.28	2.33	4.80	3.46	1.34	8.45	-
	Causeway	13.05	34.39	2.64	4.68	3.47	1.21	8.59	-
	Barilla	12.64	34.62	2.42	4.93	3.69	1.24	7.75	-
	Shark Pt	12.88	34.48	2.96	9.00	7.98	1.03	10.03	-
	mean	**12.87**	**34.44**	**2.59**	**5.85**	**4.65**	**1.20**	**8.71**	-
									*SiO4
1993	Marine	13.87	34.24	1.47	3.08	2.77	0.31	9.44	32.25
	Lewisham	13.82	34.43	1.59	2.24	1.95	0.29	8.77	44.35
	Woody Is	15.45	34.66	2.76	0.75	0.50	0.25	8.25	174.00
	Causeway	14.04	34.96	2.70	1.55	1.33	0.22	8.87	172.00
	Barilla	14.09	35.41	1.89	2.19	1.91	0.28	8.96	185.00
	Shark Pt	14.10	35.13	2.62	1.96	1.74	0.22	9.59	211.00
	mean	**14.30**	**34.92**	**2.31**	**1.74**	**1.49**	**0.25**	**8.89**	**157.27**
1994	Marine	12.46	33.58	4.08	1.80	1.41	0.16	9.30	82.70
	Lewisham	12.41	33.54	3.73	1.71	1.71	0.16	8.93	93.95
	Woody Is	12.70	33.43	4.39	1.58	1.86	0.04	9.54	137.11
	Causeway	12.48	33.53	4.71	1.00	1.11	0.03	9.03	134.74
	Barilla	12.35	34.04	3.62	0.99	0.93	0.04	8.93	134.48
	Shark Pt	11.93	33.84	4.87	0.94	1.31	0.06	9.37	144.14
	mean	**12.37**	**33.68**	**4.26**	**1.24**	**1.39**	**0.07**	**9.16**	**128.88**

Note: Number of samples analysed varied between years.
Means are for Pittwater and do not include the Marine Station.
Sampling at Woody Island commenced in November 1993.
*SiO4 - Analysis for silicates commenced in November 1993.

1.2 Pipeclay Lagoon

Date	Station	Temp °C	Salinity (ppt)	Chla (µg/L)	NOX(µg/l)	NO3(µg/l)	NO2(µg/l)	PO4(µg/l)
23/9/91	1 Marine	9.20	33.90	2.00	20.00	18.00	2.00	9.00
23/9/91	2 Boat ramp	8.70	33.65	1.71	6.00	4.00	2.00	8.00
23/9/91	3 Bens gut	8.70	33.55	0.96	10.00	7.00	3.00	7.00
23/9/91	4 Nemo	8.60	33.25	1.63	8.00	5.60	2.40	5.50
	mean	**8.67**	**33.48**	**1.43**	**8.00**	**5.53**	**2.47**	**6.83**
17/10/91	1 Marine	0.00	0.00	3.34	14.00	9.30	4.70	7.00
17/10/91	2 Boat ramp	0.00	0.00	2.15	6.00	3.10	2.90	6.00
17/10/91	3 Bens gut	0.00	0.00	1.56	9.00	5.00	4.00	7.00
17/10/91	4 Nemo	0.00	0.00	1.95	13.00	9.00	4.00	11.00
	mean	**0.00**	**0.00**	**1.89**	**9.33**	**5.70**	**3.63**	**8.00**
19/11/91	1 Marine	13.85	33.20	0.96	9.00	6.00	3.00	6.00
19/11/91	2 Boat ramp	13.55	32.90	0.74	6.00	4.00	2.00	9.00
19/11/91	3 Bens gut	14.45	34.30	0.80	7.00	4.00	3.00	8.00
19/11/91	4 Nemo	14.50	34.15		4.00	3.30	0.70	9.00
	mean	**14.17**	**33.78**	**0.77**	**5.67**	**3.77**	**1.90**	**8.67**
18/12/91	1 Marine	17.00	33.60	0.59	6.00	1.80	4.20	7.00
18/12/91	2 Boat ramp	18.40	33.25	1.33	6.00	2.30	3.70	9.00
18/12/91	3 Bens gut	19.15	33.20	1.71	14.00	8.60	5.40	18.00
18/12/91	4 Nemo	18.40	33.10	4.22	3.00	1.90	1.10	5.00
	mean	**18.65**	**33.18**	**2.42**	**7.67**	**4.27**	**3.40**	**10.67**
15/1/92	1 Marine	15.90	33.95	1.93	2.00	1.40	0.60	6.40
15/1/92	2 Boat ramp	16.90	34.45	0.96	2.00	1.30	0.70	5.50
15/1/92	3 Bens gut	17.95	34.55	0.70	16.00	13.00	3.00	5.50
15/1/92	4 Nemo	16.35	34.40	2.62	4.00	2.00	2.00	4.00
	mean	**17.07**	**34.47**	**1.43**	**7.33**	**5.43**	**1.90**	**5.00**
27/2/92	1 Marine	16.30	34.30	1.63	8.00	4.00	4.00	7.00
27/2/92	2 Boatramp	16.20	34.90	3.11	4.00	2.80	1.20	8.00
27/2/92	3 Bens gut	17.45	34.90	5.39	4.00	2.60	1.40	8.00
27/2/92	4 Nemo	15.65	34.95	4.97	3.00	1.60	1.40	7.00
	mean	**16.43**	**34.92**	**4.49**	**3.67**	**2.33**	**1.33**	**7.67**
26/3/92	1 Marine	16.05	34.50	3.34	5.00	3.00	2.00	7.00
26/3/92	2 Boat ramp	16.30	34.95	3.30	4.00	2.70	1.30	9.00
26/3/92	3 Bens gut	16.25	34.75	3.92	11.00	9.00	2.00	8.00
26/3/92	4 Nemo	17.55	35.30	5.24	10.00	7.00	3.00	7.00
	mean	**16.70**	**35.00**	**4.15**	**8.33**	**6.23**	**2.10**	**8.00**
27/4/92	1 Marine	13.90	34.40	3.26	7.00	4.50	2.50	5.00
27/4/92	2 Boat ramp	11.70	34.55	1.66	6.00	4.20	1.80	9.00
27/4/92	3 Bens gut	11.65	34.60	2.81	7.00	4.70	2.30	10.00
27/4/92	4 Nemo	12.35	34.75	3.78	7.00	5.70	1.30	7.00
	mean	**11.90**	**34.63**	**2.75**	**6.67**	**4.87**	**1.80**	**8.67**
27/5/92	1 Marine	11.85	34.30	4.15	7.00	5.00	2.00	9.00
27/5/92	2 Boat ramp	9.50	34.40	1.48	10.00	5.50	4.50	8.00
27/5/92	3 Bens gut	8.85	34.35	1.11	7.00	4.00	3.00	7.00
27/5/92	4 Nemo	9.10	34.35	2.37	6.00	4.00	2.00	7.00
	mean	**9.15**	**34.37**	**1.66**	**7.67**	**4.50**	**3.17**	**7.33**

1.2 Pipeclay Lagoon

Date	Station	Temp °C	Salinity (ppt)	Chla (µg/L)	NOX(µg/l)	NO3(µg/l)	NO2(µg/l)	PO4(µg/l)
30/6/92	1 Marine	10.15	33.90	2.44	22.00	18.70	3.30	10.00
30/6/92	2 Boat ramp	9.40	33.90	1.41	14.00	11.50	2.50	11.30
30/6/92	3 Bens gut	8.80	33.90	2.97	17.00	14.00	3.00	11.70
30/6/92	4 Nemo	8.65	33.80	2.30	18.00	13.90	4.10	11.50
	mean	**8.95**	**33.87**	**2.22**	**16.33**	**13.13**	**3.20**	**11.50**
5/8/92	1 Marine	8.65	33.15	2.97	19.00	17.80	1.20	10.00
5/8/92	2 Boat ramp	7.70	33.25	2.60	18.00	16.50	1.50	9.00
5/8/92	3 Bens gut	7.40	33.30	1.32	14.00	12.70	1.30	10.00
5/8/92	4 Nemo	6.85	33.40	1.04	7.00	5.90	1.10	9.00
	mean	**7.32**	**33.32**	**1.65**	**13.00**	**11.70**	**1.30**	**9.33**
27/8/92	1 Marine	9.45	32.96	2.30	7.00	6.20	0.80	10.00
27/8/92	2 Boat ramp	9.55	33.18	1.11	11.00	10.20	0.80	11.00
27/8/92	3 Bens gut	9.65	33.11	0.82	10.00	9.20	0.80	11.00
27/8/92	4 Nemo	9.15	33.12	2.00	5.00	4.60	0.40	10.00
	mean	**9.45**	**33.14**	**1.31**	**8.67**	**8.00**	**0.67**	**10.67**
23/9/92	1 Marine	10.50	33.50	2.53	4.00	3.00	1.00	7.00
23/9/92	2 Boat ramp	10.70	33.40	2.97	3.00	2.00	1.00	8.00
23/9/92	3 Bens gut	10.80	33.90	6.98	3.00	2.00	1.00	9.00
23/9/92	4 Nemo	10.50	33.80	2.36	4.00	2.80	1.20	11.00
	mean	**10.67**	**33.70**	**4.10**	**3.33**	**2.27**	**1.07**	**9.33**
27/10/92	1 Marine	12.70	33.90	1.98	0.70	0.60	0.10	6.00
27/10/92	2 Boat ramp	12.80	33.80	2.06	0.90	0.80	0.10	6.00
27/10/92	3 Bens gut	12.80	33.80	2.89	0.50	0.40	0.10	7.00
27/10/92	4 Nemo	13.00	33.90	2.31	0.90	0.80	0.10	6.00
	mean	**12.87**	**33.83**	**2.42**	**0.77**	**0.67**	**0.10**	**6.33**
5/11/92	1 Marine	14.65	34.00	1.93	13.00	11.80	1.20	6.00
5/11/92	2 Boat ramp	15.45	34.10	1.04	1.00	0.90	0.10	9.00
5/11/92	3 Bens gut	16.70	34.15	0.82	4.00	3.80	0.20	11.00
5/11/92	4 Nemo	16.90	34.05	3.04	2.00	1.90	0.10	8.00
	mean	**16.35**	**34.10**	**1.63**	**2.33**	**2.20**	**0.13**	**9.33**
4/12/92	1 Marine	14.30	34.40	0.99	1.00	1.00	0.00	6.00
4/12/92	2 Boat ramp	13.95	34.70	0.49	2.00	1.80	0.20	10.00
4/12/92	3 Bens gut	14.20	35.15	0.82	5.00	4.80	0.20	9.00
4/12/92	4 Nemo	13.95	35.05	1.07	2.00	1.80	0.20	9.00
	mean	**14.03**	**34.97**	**0.80**	**3.00**	**2.80**	**0.20**	**9.33**
18/12/92	1 Marine	16.30	34.60	0.59	6.00	4.70	1.30	7.00
18/12/92	2 Boat ramp	17.40	34.95	0.74	3.00	2.00	1.00	8.00
18/12/92	3 Bens gut	19.70	35.45	1.41	8.00	7.20	0.80	10.00
18/12/92	4 Nemo	18.05	35.15	1.26	2.00	1.00	1.00	9.00
	mean	**18.38**	**35.18**	**1.14**	**4.33**	**3.40**	**0.93**	**9.00**
20/1/93	1 Marine	18.00	34.35	0.74	2.00	1.80	0.20	9.00
20/1/93	2 Boat ramp	18.80	34.45	0.59	0.80	0.60	0.20	10.00
20/1/93	3 Bens gut	19.20	34.50	0.89	4.00	3.50	0.50	12.00
20/1/93	4 Nemo	19.80	35.30	3.49	2.00	1.70	0.30	11.00
	mean	**19.27**	**34.75**	**1.66**	**2.27**	**1.93**	**0.33**	**11.00**

1.2 Pipeclay Lagoon

Date	Station	Temp °C	Salinity (ppt)	Chla (µg/L)	NOX(µg/l)	NO3(µg/l)	NO2(µg/l)	PO4(µg/l)
18/2/93	1 Marine	18.35	34.50	1.19	1.00	1.00	0.00	7.50
18/2/93	2 Boat ramp	19.75	35.05	2.97	2.00	1.51	0.49	6.20
18/2/93	3 Bens gut	20.80	35.40	4.23	3.00	2.60	0.40	7.50
18/2/93	4 Nemo	19.80	35.95	6.08	2.00	1.40	0.60	22.70
	mean	**20.12**	**35.47**	**4.43**	**2.33**	**1.84**	**0.50**	**12.13**

ANNUAL STATION AVERAGES

Date	Station	Temp °C	Salinity (ppt)	Chla (µg/L)	NOX(µg/l)	NO3(µg/l)	NO2(µg/l)	PO4(µg/l)
1991	Marine	13.35	33.57	1.72	12.25	8.78	3.48	7.25
(Sep - Dec)	Boat ramp	13.55	33.27	1.48	6.00	3.35	2.65	8.00
	Bens gut	14.10	33.68	1.26	10.00	6.15	3.85	10.00
	Nemo	13.83	33.50	2.60	7.00	4.95	2.05	7.63
	mean	**13.83**	**33.48**	**1.78**	**7.67**	**4.82**	**2.85**	**8.54**
1992	Marine	13.13	33.99	2.31	7.82	6.76	1.54	7.42
	Boat ramp	12.89	34.19	1.76	6.07	5.12	1.28	8.60
	Bens gut	13.25	34.30	2.46	8.19	7.25	1.47	9.02
	Nemo	12.93	34.31	2.64	5.45	4.35	1.38	8.12
	mean	**13.02**	**34.27**	**2.29**	**6.57**	**5.57**	**1.38**	**8.58**
1993	Marine	18.18	34.43	0.96	1.50	1.40	0.10	8.25
	Boat ramp	19.28	34.75	1.78	1.40	1.06	0.35	8.10
	Bens gut	20.00	34.95	2.56	3.50	3.05	0.45	9.75
	Nemo	19.80	35.63	4.78	2.00	1.55	0.45	16.85
	mean	**19.69**	**35.11**	**3.04**	**2.30**	**1.89**	**0.42**	**11.57**

Note: means are for Pipeclay and do not include the Marine station

1.3 Little Swanport

Date	Station	Temp °C	Salinity (ppt)	Chl a(μg/l)	NOX(μg/l)	NO3(μg/l)	NO2(μg/l)	PO4(μg/l)
18/11/91	1 Marine	13.40	35.00	0.96	5.00	4.20	0.80	8.00
18/11/91	2 Lime kiln	17.25	35.00	1.71	3.00	2.40	0.60	8.00
18/11/91	3 Ram	16.20	35.05	2.36	6.00	5.30	0.70	5.50
18/11/91	4 Dyke	18.15	34.10	2.08	13.00	10.50	2.50	13.20
	mean	**17.20**	**34.72**	**2.05**	**7.33**	**6.07**	**1.27**	**8.90**
16/12/91	1 Marine	16.30	34.85	0.37	7.00	6.30	0.70	12.60
16/12/91	2 Lime kiln	16.80	12.25	1.37	191.00	188.00	3.00	4.30
16/12/91	3 Ram	16.40	14.75	1.32	98.80	95.70	3.10	3.70
16/12/91	4 Dyke	16.70	2.80	1.48	145.00	141.50	3.50	4.20
	mean	**16.63**	**9.93**	**1.39**	**144.93**	**141.73**	**3.20**	**4.07**
14/1/92	1 Marine	15.80	34.35	0.82	3.00	2.20	0.80	25.00
14/1/92	2 Lime kiln	16.70	30.65	1.04	3.00	1.90	1.10	4.20
14/1/92	3 Ram	16.65	29.20	1.40	3.00	2.00	1.00	4.20
14/1/92	4 Dyke	16.65	28.05	10.22	6.00	3.60	2.40	27.70
	mean	**16.67**	**29.30**	**4.22**	**4.00**	**2.50**	**1.50**	**12.03**
25/2/92	1 Marine	16.35	35.25	2.67	3.00	2.40	0.60	9.00
25/2/92	2 Lime kiln	16.55	35.10	1.78	3.00	2.80	0.20	7.00
25/2/92	3 Ram	16.85	34.90	5.07	8.50	7.20	1.30	5.20
25/2/92	4 Dyke	15.75	34.35	3.71	4.00	1.90	2.10	7.80
	mean	**16.38**	**34.78**	**3.52**	**5.17**	**3.97**	**1.20**	**6.67**
27/3/92	1 Marine	16.55	34.40	4.30	10.00	7.30	2.70	8.50
27/3/92	2 Lime kiln	17.05	35.65	4.89	4.00	3.30	0.70	-
27/3/92	3 Ram	17.40	35.75	5.93	2.00	1.20	0.80	10.00
27/3/92	4 Dyke	17.10	35.95	5.83	5.00	4.70	0.30	5.00
	mean	**17.18**	**35.78**	**5.55**	**3.67**	**3.07**	**0.60**	**7.50**
29/4/92	1 Marine	-	-	-	-	-	-	-
29/4/92	2 Lime kiln	14.20	35.40	4.08	5.00	3.90	1.10	7.90
29/4/92	3 Ram	14.10	35.50	6.30	3.00	2.60	0.40	6.50
29/4/92	4 Dyke	13.40	35.40	9.05	7.00	6.40	0.60	5.80
	mean	**13.90**	**35.43**	**6.48**	**5.00**	**4.30**	**0.70**	**6.73**
28/5/92	1 Marine	13.90	35.40	0.59	29.00	23.00	6.00	11.80
28/5/92	2 Lime kiln	11.10	34.75	1.93	3.00	2.00	1.00	6.80
28/5/92	3 Ram	10.75	34.60	2.47	4.00	2.80	1.20	10.00
28/5/92	4 Dyke	9.15	33.65	1.85	1.00	0.60	0.40	4.20
	mean	**10.33**	**34.33**	**2.08**	**2.67**	**1.80**	**0.87**	**7.00**
2/7/92	1 Marine	12.10	34.80	2.22	34.00	30.00	4.00	13.90
2/7/92	2 Lime kiln	11.20	29.10	2.30	18.00	15.60	2.40	7.50
2/7/92	3 Ram	10.55	26.35	2.30	35.00	31.00	4.00	10.70
2/7/92	4 Dyke	10.45	23.50	3.15	17.00	13.70	3.30	4.20
	mean	**10.73**	**26.32**	**2.58**	**23.33**	**20.10**	**3.23**	**7.47**
2/8/92	1 Marine	10.40	34.70	3.56	11.00	8.80	2.20	10.00
2/8/92	2 Lime kiln	10.40	34.80	3.86	11.00	10.00	1.00	7.00
2/8/92	3 Ram	9.50	33.40	2.80	4.00	3.30	0.70	6.00
2/8/92	4 Dyke	9.20	33.40	3.80	4.00	2.80	1.20	7.00
	mean	**9.70**	**33.87**	**3.49**	**6.33**	**5.37**	**0.97**	**6.67**

1.3 Little Swanport

Date	Station	Temp °C	Salinity (ppt)	Chl a(µg/l)	NOX(µg/l)	NO3(µg/l)	NO2(µg/l)	PO4(µg/l)
25/8/92	1 Marine	9.60	34.52	2.89	10.00	9.70	0.30	9.00
25/8/92	2 Lime kiln	9.20	33.50	0.59	52.00	51.10	0.90	6.00
25/8/92	3 Ram	8.90	33.03	1.04	5.00	4.80	0.20	4.00
25/8/92	4 Dyke	9.40	33.05	2.89	3.00	2.50	0.50	6.00
	mean	**9.17**	**33.19**	**1.51**	**20.00**	**19.47**	**0.53**	**5.33**
24/9/92	1 Marine	11.20	35.00	1.40	4.00	3.80	0.20	8.00
24/9/92	2 Lime kiln	12.70	28.50	0.96	1.00	0.80	0.20	4.00
24/9/92	3 Ram	12.50	26.50	1.22	3.00	2.60	0.40	4.00
24/9/92	4 Dyke	12.80	12.80	2.47	2.00	1.30	0.70	11.00
	mean	**12.67**	**22.60**	**1.55**	**2.00**	**1.57**	**0.43**	**6.33**
1/10/92	1 Marine	-	-	1.48	-	-	-	-
1/10/92	2 Lime kiln	-	-	1.26	-	-	-	-
1/10/92	3 Ram	-	-	1.13	-	-	-	-
1/10/92	4 Dyke	-	-	1.36	-	-	-	-
	mean	-	-	**1.25**	-	-	-	-
15/10/92	1 Marine	12.20	35.30	1.90	0.70	-	0.00	6.00
15/10/92	2 Lime kiln	12.20	35.00	2.30	1.00	-	0.30	9.00
15/10/92	3 Ram	13.40	30.40	2.80	1.00	-	0.30	6.00
15/10/92	4 Dyke	13.60	25.80	3.10	2.00	-	0.60	6.00
	mean	**13.07**	**30.40**	**2.73**	**1.33**	-	**0.40**	**7.00**
4/11/92	1 Marine	13.45	34.15	0.89	1.00	1.00	0.00	8.00
4/11/92	2 Lime kiln	15.35	20.55	2.17	2.00	1.60	0.40	4.00
4/11/92	3 Ram	16.05	15.25	3.36	2.00	1.40	0.60	6.00
4/11/92	4 Dyke	16.35	16.30	2.31	6.00	5.50	0.50	6.00
	mean	**15.92**	**17.37**	**2.61**	**3.33**	**2.83**	**0.50**	**5.33**
20/11/92	1 Marine	15.10	35.10	2.10	0.60	-	0.60	7.00
20/11/92	2 Lime kiln	15.80	34.80	1.60	0.60	-	0.50	7.00
20/11/92	3 Ram	16.50	34.30	2.60	1.00	-	0.80	6.00
20/11/92	4 Dyke	17.60	32.20	2.50	0.60	-	0.60	5.00
	mean	**16.63**	**33.77**	**2.23**	**0.73**	-	**0.63**	**6.00**
2/12/92	1 Marine	14.45	35.20	0.82	4.00	3.50	0.50	6.00
2/12/92	2 Lime kiln	15.35	34.60	0.82	1.00	0.40	0.60	5.00
2/12/92	3 Ram	15.50	34.20	0.96	2.00	1.20	0.80	6.00
2/12/92	4 Dyke	16.80	33.40	2.08	4.00	2.80	1.20	5.00
	mean	**15.88**	**34.07**	**1.29**	**2.33**	**1.47**	**0.87**	**5.33**
16/12/92	1 Marine	15.65	35.20	0.44	6.00	5.30	0.70	7.00
16/12/92	2 Lime kiln	16.65	35.00	0.67	1.00	0.30	0.70	9.00
16/12/92	3 Ram	17.60	34.70	1.33	1.00	0.30	0.70	7.00
16/12/92	4 Dyke	18.10	33.25	1.56	2.00	1.00	1.00	7.00
	mean	**17.45**	**34.32**	**1.19**	**1.33**	**0.53**	**0.80**	**7.67**
18/1/93	1 Marine	17.55	34.95	0.67	2.00	1.80	0.20	7.00
18/1/93	2 Lime kiln	20.05	35.10	1.56	0.80	0.50	0.30	6.00
18/1/93	3 Ram	19.35	33.15	2.60	2.00	1.70	0.30	5.00
18/1/93	4 Dyke	20.80	35.50	2.60	0.80	0.50	0.30	5.00
	mean	**20.07**	**34.58**	**2.25**	**1.20**	**0.90**	**0.30**	**5.33**

1.3 Little Swanport

Date	Station	Temp °C	Salinity (ppt)	Chl a(µg/l)	NOX(µg/l)	NO3(µg/l)	NO2(µg/l)	PO4(µg/l)
16/2/93	1 Marine	18.30	35.00	2.08	3.00	2.50	0.50	10.70
16/2/93	2 Lime kiln	19.70	35.10	2.45	1.00	0.80	0.20	8.30
16/2/93	3 Ram	19.30	35.25	4.23	2.00	1.90	0.10	7.50
16/2/93	4 Dyke	19.70	35.80	3.56	4.00	3.70	0.30	5.80
	mean	**19.57**	**35.38**	**3.41**	**2.33**	**2.13**	**0.20**	**7.20**
15/3/93	1 Marine	17.65	35.00	1.19	1.70	1.50	0.20	10.00
15/3/93	2 Lime kiln	18.50	35.10	1.71	2.10	1.60	0.50	10.00
15/3/93	3 Ram	18.45	35.20	2.82	1.30	0.80	0.50	8.00
15/3/93	4 Dyke	18.95	35.20	4.97	0.80	0.30	0.50	4.00
	mean	**18.63**	**35.17**	**3.16**	**1.40**	**0.90**	**0.50**	**7.33**
15/4/93	1 Marine	16.20	35.25	1.48	1.00	0.80	0.20	8.00
15/4/93	2 Lime kiln	16.10	35.40	2.45	1.00	0.80	0.20	8.00
15/4/93	3 Ram	15.95	35.50	4.23	3.00	2.80	0.20	9.00
15/4/93	4 Dyke	15.30	35.50	2.89	1.00	0.70	0.30	5.00
	mean	**15.78**	**35.47**	**3.19**	**1.67**	**1.43**	**0.23**	**7.33**
20/5/93	1 Marine	14.40	35.20	1.41	15.00	12.20	2.80	10.00
20/5/93	2 Lime kiln	13.55	35.35	1.11	2.10	1.60	0.50	8.00
20/5/93	3 Ram	12.60	35.35	1.26	2.10	1.60	0.50	7.00
20/5/93	4 Dyke	10.75	35.60	1.93	0.80	0.50	0.30	5.00
	mean	**12.30**	**35.43**	**1.43**	**1.67**	**1.23**	**0.43**	**6.67**

ANNUAL STATION AVERAGES

1991	Marine	14.85	34.93	0.67	6.00	5.25	0.75	10.30
(Nov - Dec)	Lime kiln	17.03	23.63	1.54	97.00	95.20	1.80	6.15
	Ram	16.30	24.90	1.84	52.40	50.50	1.90	4.60
	Dyke	17.43	18.45	1.78	79.00	76.00	3.00	8.70
	mean	**16.92**	**22.33**	**1.72**	**76.13**	**73.90**	**2.23**	**6.48**
1992	Marine	13.60	34.87	1.89	8.95	9.46	1.43	9.94
	Lime kiln	13.74	31.31	4.44	7.61	7.81	0.82	5.99
	Ram	14.01	30.97	2.56	5.50	5.03	0.98	6.55
	Dyke	13.75	28.32	6.02	4.68	3.90	1.14	7.38
	mean	**13.83**	**30.20**	**4.34**	**5.93**	**5.58**	**0.98**	**6.64**
1993	Marine	16.82	35.08	1.36	4.54	3.76	0.78	9.14
(Jan - May)	Lime kiln	17.58	35.21	1.85	1.40	1.06	0.34	8.06
	Ram	17.13	34.89	3.03	2.08	1.76	0.32	7.30
	Dyke	17.10	35.52	3.19	1.48	1.14	0.34	4.96
	mean	**17.27**	**35.21**	**2.69**	**1.65**	**1.32**	**0.33**	**6.77**

Note: means are for Little Swanport and do not include the Marine station.

1.4 Georges Bay

Date	Station	Temp oC	Salinity (ppt)	Chl a (µg/l)	NOX(µg/l)	NO3(µg/l)	NO2(µg/l)	PO4(µg/l)	SIO4(µg/l)
27/4/93	1 Marine	16.30	34.70	2.60	11.00	10.00	1.00	11.00	-
27/4/93	2 Redflash	16.25	34.55	2.45	8.00	7.10	0.90	10.00	-
27/4/93	3 Lords Pt	16.10	34.10	3.11	15.00	14.30	0.70	15.00	-
27/4/93	4 Humbug	15.80	33.45	3.78	5.00	4.80	0.20	10.00	-
27/4/93	5 Mast	15.45	33.75	2.67	4.00	3.80	0.20	10.00	-
	mean	**15.90**	**33.96**	**3.00**	**8.00**	**7.50**	**0.50**	**11.25**	-
28/5/93	1 Marine	14.30	34.90	0.96	32.00	27.10	4.90	13.00	-
28/5/93	2 Redflash	13.20	34.20	2.97	3.80	3.30	0.50	9.00	-
28/5/93	3 Lords Pt	13.15	34.25	2.30	2.50	2.00	0.50	11.00	-
28/5/93	4 Humbug	13.05	33.55	1.93	2.10	1.80	0.30	10.00	-
28/5/93	5 Mast	13.05	34.40	3.86	1.30	1.00	0.30	10.00	-
	mean	**13.11**	**34.10**	**2.76**	**2.43**	**2.03**	**0.40**	**10.00**	-
29/6/93	1 Marine	12.50	34.90	1.48	44.00	40.20	3.80	13.00	-
29/6/93	2 Redflash	10.65	33.85	2.00	22.00	20.20	1.80	11.00	-
29/6/93	3 Lords Pt	10.20	33.70	2.52	15.00	13.70	1.30	11.00	-
29/6/93	4 Humbug	10.60	33.80	2.45	22.00	20.20	1.80	12.00	-
29/6/93	5 Mast	10.50	33.95	2.22	17.00	15.10	1.90	11.00	-
	mean	**10.49**	**33.83**	**2.30**	**19.00**	**17.30**	**1.70**	**11.25**	-
27/7/93	1 Marine	11.80	34.20	1.67	66.00	62.00	4.00	14.00	-
27/7/93	2 Redflash	10.75	32.10	2.04	56.00	51.60	4.40	10.00	-
27/7/93	3 Lords Pt	10.50	31.75	2.13	0.40	0.00	0.20	2.50	-
27/7/93	4 Humbug	10.65	31.65	2.69	58.00	53.60	4.40	11.00	-
27/7/93	5 Mast	10.30	32.05	13.54	21.00	18.50	2.50	7.00	-
	mean	**10.55**	**31.89**	**5.10**	**33.85**	**30.93**	**2.88**	**7.63**	-
27/8/93	1 Marine	11.70	34.70	1.48	23.00	22.00	1.00	11.00	-
27/8/93	2 Redflash	11.50	34.30	0.96	28.00	26.00	2.00	12.00	-
27/8/93	3 Lords Pt	11.40	32.85	2.15	21.00	19.00	2.00	8.00	-
27/8/93	4 Humbug	11.30	31.70	1.93	36.00	34.00	2.00	9.00	-
27/8/93	5 Mast	11.50	32.70	2.15	28.00	26.00	2.00	10.00	-
	mean	**11.43**	**32.89**	**1.80**	**28.25**	**26.25**	**2.00**	**9.75**	-
24/9/93	1 Marine	12.30	34.85	1.68	6.30	5.10	1.20	9.10	-
24/9/93	2 Redflash	12.45	32.60	1.98	5.30	4.60	0.70	6.80	-
24/9/93	3 Lords Pt	12.45	31.65	2.57	3.70	3.20	0.50	4.70	-
24/9/93	4 Humbug	12.75	31.90	2.97	5.30	3.00	2.30	4.60	-
24/9/93	5 Mast	12.65	32.25	1.38	0.30	0.10	0.20	4.40	-
	mean	**12.58**	**32.10**	**2.22**	**3.65**	**2.73**	**0.93**	**5.13**	**-**
20/10/93	1 Marine	12.15	34.65	0.74	14.00	12.30	1.70	12.00	-
20/10/93	2 Redflash	13.20	33.60	1.26	3.30	3.30	0.00	10.40	-
20/10/93	3 Lords Pt	13.45	33.55	1.56	3.30	3.30	0.00	7.30	-
20/10/93	4 Humbug	13.45	33.55	1.56	1.20	1.20	0.00	5.40	-
20/10/93	5 Mast	13.35	33.70	1.41	1.30	1.30	0.00	10.40	-
	mean	**13.36**	**33.60**	**1.45**	**2.28**	**2.28**	**0.00**	**8.38**	-
17/11/93	1 Marine	13.75	34.85	1.90	2.70	1.80	0.90	12.70	22.00
17/11/93	2 Redflash	14.70	34.40	1.32	1.30	0.80	0.50	10.40	54.00
17/11/93	3 Lords Pt	15.90	33.90	2.88	0.50	0.10	0.40	10.40	76.00
17/11/93	4 Humbug	16.35	33.65	1.07	0.50	0.20	0.30	8.80	94.00
17/11/93	5 Mast	17.30	33.70	1.07	1.40	1.20	0.20	10.00	66.00
	mean	**16.06**	**33.91**	**1.59**	**0.93**	**0.58**	**0.35**	**9.90**	**72.50**

1.4 Georges Bay

Date	Station	Temp oC	Salinity (ppt)	Chl a (µg/l)	NOX(µg/l)	NO3(µg/l)	NO2(µg/l)	PO4(µg/l)	SIO4(µg/l)
21/12/93	1 Marine	15.15	34.95	5.47	0.70	0.70	0.00	8.80	27.50
21/12/93	2 Redflash	17.55	33.85	2.22	1.40	1.40	0.00	9.60	186.00
21/12/93	3 Lords Pt	17.65	33.80	2.13	0.90	0.90	0.00	14.80	200.00
21/12/93	4 Humbug	18.10	33.00	2.04	0.60	0.60	0.00	10.00	194.00
21/12/93	5 Mast	17.95	34.10	1.48	0.30	0.30	0.00	8.50	173.00
	mean	**17.81**	**33.69**	**1.97**	**0.80**	**0.80**	**0.00**	**10.73**	**188.25**
19/1/94	1 Marine	15.15	34.05	1.24	36.00	33.80	2.20	12.30	84.00
19/1/94	2 Redflash	16.55	32.05	2.72	2.00	2.00	0.00	6.20	189.00
19/1/94	3 Lords Pt	16.60	31.85	3.38	0.50	0.50	0.00	4.60	198.00
19/1/94	4 Humbug	16.95	32.70	2.64	1.30	1.30	0.00	6.20	140.00
19/1/94	5 Mast	16.90	32.50	2.64	0.50	0.50	0.00	5.80	168.60
	mean	**16.75**	**32.28**	**2.84**	**1.08**	**1.08**	**0.00**	**5.70**	**173.90**
18/2/94	1 Marine	16.60	33.22	4.88	16.10	14.50	1.60	10.40	174.00
18/2/94	2 Redflash	17.60	31.70	7.54	4.20	3.90	0.30	6.80	342.00
18/2/94	3 Lords Pt	17.80	31.90	7.63	1.60	1.50	0.10	6.10	325.00
18/2/94	4 Humbug	18.15	31.45	5.68	0.80	0.80	0.00	5.70	346.00
18/2/94	5 Mast	18.45	31.85	3.90	0.80	0.80	0.00	4.60	321.00
	mean	**18.00**	**31.73**	**6.19**	**1.85**	**1.75**	**0.10**	**5.80**	**333.50**

MEAN VALUE FOR EACH STATION

Station	Temp oC	Salinity (ppt)	Chl a (µg/l)	NOX(µg/l)	NO3(µg/l)	NO2(µg/l)	PO4(µg/l)	SIO4(µg/l)
1 Marine	13.79	34.54	2.19	22.89	20.86	2.03	11.57	76.88
2 Redflash	14.04	33.38	2.50	12.30	11.29	1.01	9.29	192.75
3 Lords Pt	14.11	33.03	2.94	5.85	5.32	0.52	8.67	199.75
4 Humbug	14.29	32.76	2.61	12.07	11.05	1.03	8.43	193.50
5 Mast	14.31	33.18	3.30	6.90	6.24	0.66	8.34	182.15
mean	**14.19**	**33.09**	**2.84**	**9.28**	**8.47**	**0.80**	**8.68**	**192.04**

Note: means are for Georges Bay and do not include the Marine station.

1.5 Simpsons Bay

Date	Station	Temp oC	Salinity (ppt)	Chl a(µg/l)	NOX(µg/l)	NO3(µg/l)	NO2(µg/l)	PO4(µg/l)	SiO4(µg/l)
29/09/93	1 Marine	12.80	33.20	0.69	0.30	0.10	0.20	7.50	-
29/09/93	2 Nowhere	13.15	33.10	0.40	2.10	1.90	0.20	8.20	-
29/09/93	3 Anderaa	13.30	33.25	0.30	0.30	0.10	0.20	7.70	-
29/09/93	4 Boat Ramp	14.00	33.40	0.40	0.30	0.10	0.20	7.30	-
	mean	**13.48**	**33.25**	**0.36**	**0.90**	**0.70**	**0.20**	**7.73**	-
22/10/93	1 Marine	12.45	33.35	1.57	0.20	0.20	0.00	7.00	-
22/10/93	2 Nowhere	12.65	33.35	1.07	1.00	1.00	0.00	8.80	-
22/10/93	3 Anderaa	12.90	33.45	0.49	0.40	0.40	0.00	7.00	-
22/10/93	4 Boat Ramp	13.25	33.50	0.58	0.60	0.60	0.00	5.80	-
	mean	**12.93**	**33.43**	**0.71**	**0.67**	**0.67**	**0.00**	**7.20**	-
23/11/93	1 Marine	13.95	33.00	0.58	5.00	4.00	1.00	8.80	90.00
23/11/93	2 Nowhere	13.95	32.85	1.65	3.10	2.80	0.30	8.80	56.00
23/11/93	3 Anderaa	14.05	33.00	1.48	0.30	0.00	0.30	9.60	66.00
23/11/93	4 Boat Ramp	13.95	33.15	1.40	0.40	0.10	0.30	9.00	66.00
	mean	**13.98**	**33.00**	**1.51**	**1.27**	**0.97**	**0.30**	**9.13**	**62.67**
7/01/94	1 Marine	14.75	32.45	1.85	6.20	5.90	0.30	8.80	158.00
7/01/94	2 Nowhere	14.70	31.70	2.13	1.70	1.70	0.00	7.10	196.00
7/01/94	3 Anderaa	15.00	31.00	2.97	0.50	0.50	0.00	6.20	230.00
7/01/94	4 Boat Ramp	15.10	30.90	2.60	2.10	2.10	0.00	6.50	240.00
	mean	**14.93**	**31.20**	**2.56**	**1.43**	**1.43**	**0.00**	**6.60**	**222.00**
21/01/94	1 Marine	15.20	32.28	4.70	0.30	0.30	0.00	5.40	30.30
21/01/94	2 Nowhere	15.40	31.90	3.54	0.00	0.00	0.00	5.00	37.60
21/01/94	3 Anderaa	15.65	31.75	3.38	0.10	0.10	0.00	5.20	38.60
21/01/94	4 Boat Ramp	15.85	31.75	3.54	0.20	0.20	0.00	5.40	43.80
	mean	**15.63**	**31.80**	**3.49**	**0.10**	**0.10**	**0.00**	**5.20**	**40.00**
23/02/94	1 Marine	17.25	34.15	2.75	0.20	0.20	0.00	8.80	31.00
23/02/94	2 Nowhere	17.35	34.10	2.31	0.80	0.80	0.00	8.60	30.00
23/02/94	3 Anderaa	17.85	34.10	2.13	1.70	1.70	0.00	8.20	31.00
23/02/94	4 Boat Ramp	18.10	34.10	2.57	0.90	0.90	0.00	8.20	41.00
	mean	**17.77**	**34.10**	**2.34**	**1.13**	**1.13**	**0.00**	**8.33**	**34.00**
18/04/94	1 Marine	14.45	33.95	1.86	1.90	1.90	0.00	12.70	61.00
18/04/94	2 Nowhere	14.40	34.10	2.40	0.60	0.60	0.00	11.90	82.00
18/04/94	3 Anderaa	14.35	34.35	2.66	1.00	1.00	0.00	12.70	73.00
18/04/94	4 Boat Ramp	14.35	34.30	3.46	1.30	1.30	0.00	12.30	91.00
	mean	**14.37**	**34.25**	**2.84**	**0.97**	**0.97**	**0.00**	**12.30**	**82.00**
6/05/94	1 Marine	12.65	33.50	5.15	6.10	4.50	1.60	11.90	98.00
6/05/94	2 Nowhere	12.60	33.60	4.79	3.10	2.40	0.70	11.50	100.00
6/05/94	3 Anderaa	12.45	33.70	4.17	1.80	1.80	0.00	18.50	100.00
6/05/94	4 Boat Ramp	12.55	33.60	4.26	0.80	0.80	0.00	10.40	92.00
	mean	**12.53**	**33.63**	**4.41**	**1.90**	**1.67**	**0.23**	**13.47**	**97.33**
22/06/94	1 Marine	9.95	31.55	3.73	46.00	39.00	7.00	14.00	193.00
22/06/94	2 Nowhere	9.40	31.25	8.70	42.00	35.00	7.00	14.00	226.00
22/06/94	3 Anderaa	9.35	30.75	11.36	39.00	32.40	6.60	13.00	222.00
22/06/94	4 Boat Ramp	9.15	30.35	4.26	41.00	35.00	6.00	14.00	222.00
	mean	**9.30**	**30.78**	**8.11**	**40.67**	**34.13**	**6.53**	**13.67**	**223.33**

1.5 Simpsons Bay

MEAN VALUE FOR EACH STATION

Station	Temp oC	Salinity (ppt)	Chl a(μg/l)	NOX(μg/l)	NO3(μg/l)	NO2(μg/l)	PO4(μg/l)	SiO4(μg/l)
1 Marine	13.72	33.05	2.54	7.36	6.23	1.12	9.43	94.47
2 Nowhere	13.73	32.88	3.00	6.04	5.13	0.91	9.32	103.94
3 Anderaa	13.88	32.82	3.22	5.01	4.22	0.79	9.79	108.66
4 Boat Ramp	14.03	32.78	2.56	5.29	4.57	0.72	8.77	113.69
mean	**13.88**	**32.83**	**2.93**	**5.45**	**4.64**	**0.81**	**9.29**	**108.76**

Note: mean values are for Simpsons Bay and do not include the Marine station

1.6 Pittwater sampling over 24 hours

Time	Station	Temp °C	Salinity (ppt)	Chla (μg/L)	SDEV	NOX(μg/l)	SDEV	PO4(μg/l)	SDEV	SiO4(μg/l)	SDEV
11:34	A	14.7	33.80	3.40	1.14	0.70	0.31	10.40	0.85	196.00	6.93
11:55	B	14.3	33.60	3.60	0.36	6.80	7.03	9.90	1.52	152.00	8.08
12:50	A	15.0	33.80	3.68	0.00	0.80	0.29	10.30	1.03	202.00	3.51
13:15	B	14.4	33.80	3.74	0.35	1.70	5.74	9.10	0.46	156.00	4.04
14:10	A	14.9	33.80	5.27	0.80	0.50	0.31	10.10	0.46	192.00	1.15
14:25	B	14.7	33.70	4.18	0.17	0.40	0.21	8.50	0.75	156.00	6.56
15:05	A	14.8	33.70	6.48	0.13	0.50	0.12	11.00	0.78	200.00	0.00
15:17	B	14.8	33.70	4.84	0.06	0.50	0.31	8.80	0.06	156.00	1.73
16:06	A	14.8	33.70	1.42	0.08	0.40	0.06	10.10	0.50	196.00	1.15
16:18	B	15.4	33.70	0.81	0.17	0.40	0.00	8.60	0.56	156.00	6.11
17:03	A	14.9	33.80	6.94	0.38	0.70	0.31	10.30	0.76	195.00	0.00
17:19	B	15.4	33.60	4.27	0.42	0.60	0.17	10.60	1.96	151.00	5.29
18:06	A	14.9	33.80	6.64	0.17	0.10	0.06	12.50	0.92	190.00	2.31
18:22	B	14.9	33.50	4.52	0.08	0.20	0.06	10.20	0.60	96.00	8.66
19:07	A	14.8	33.70	6.47	0.27	0.10	0.12	11.70	0.50	188.00	3.51
19:22	B	14.8	33.40	4.10	0.22	0.20	0.06	9.50	0.70	86.00	9.45
20:07	A	14.9	33.70	6.00	0.26	0.20	0.17	10.50	0.23	194.00	9.81
20:21	B	15.1	33.60	4.38	1.28	1.50	1.65	14.90	6.28	135.00	34.53
21:13	A	14.9	33.70	5.94	0.08	0.30	0.21	10.10	0.61	196.00	1.73
21:40	B	14.7	33.70	5.25	1.36	0.10	0.00	9.20	1.89	153.00	11.02
22:13	A	14.9	33.70	4.88	0.68	0.10	0.06	9.90	0.50	189.00	4.16
22:28	B	15.1	33.60	4.32	0.56	0.90	0.55	8.70	0.78	140.00	15.72
23:09	A	14.8	33.80	4.94	0.36	0.10	0.00	10.50	0.31	195.00	4.04
23:28	B	15.0	33.60	4.40	0.20	0.40	0.20	10.50	0.95	146.00	12.50
1:16	A	14.8	33.80	5.08	0.27	0.60	0.06	11.00	0.42	205.00	3.06
1:33	B	14.7	33.70	4.36	0.07	0.40	0.12	10.10	0.74	150.00	8.72
3:12	A	14.7	33.80	4.98	0.44	0.80	0.21	11.90	1.04	196.00	2.00
3:27	B	14.8	33.70	3.63	0.54	0.80	0.21	10.70	0.52	149.00	9.87
5:11	A	14.8	33.90	5.24	0.29	0.60	0.06	9.40	0.56	181.00	15.13
5:23	B	14.7	33.70	4.46	0.77	0.80	0.26	7.80	0.25	124.00	11.06
7:05	A	14.7	33.70	5.94	0.38	1.50	0.32	10.90	1.10	185.00	12.70
7:22	B	14.5	33.40	3.32	0.17	0.90	0.06	8.00	0.40	79.00	5.03
9:03	A	14.8	33.70	5.15	0.13	0.90	0.26	9.90	0.74	169.00	7.02
9:17	B	14.8	33.70	3.71	0.43	1.70	0.62	9.70	0.12	129.00	20.43
11:00	A	14.8	33.80	5.36	1.38	1.10	0.49	10.10	0.56	186.00	11.14
11:17	B	14.7	33.70	5.47	1.76	1.50	1.06	10.20	0.28	157.00	1.41
12:09	A	14.9	33.80	5.80	0.88	2.00	0.15	11.70	0.87	188.00	2.00
12:26	B	14.7	33.70	5.49	1.84	1.70	0.47	12.20	4.50	145.00	25.48
13:09	A	14.8	33.80	4.63	3.14	1.10	0.20	11.10	1.00	188.00	0.00
13:27	B	14.9	33.60	6.69	0.14	1.70	0.35	9.90	0.46	143.00	11.02

1.7 Pittwater sampling over 4 weeks

Date	Station	Temp °C	Salinity (ppt)	Chla (μg/L)	STDEV	NOX(μg/l)	STDEV	PO4(μg/l)	STDEV	SiO4(μg/l)	STDEV
31/10/94	A	15.00	33.80	3.15	0.40	0.83	0.15	10.47	0.64	212.67	6.81
	B	14.37	33.63	2.93	0.36	0.70	0.36	9.27	0.50	164.67	5.69
1/11/94	A	14.83	33.80	4.07	0.46	1.17	0.46	11.27	1.50	176.67	11.55
	B	14.87	33.63	3.44	0.24	1.10	0.28	9.75	1.20	133.00	9.90
2/11/94	A	15.38	33.85	4.88	0.38	0.43	0.15	10.67	0.23	248.67	4.04
	B	15.23	33.72	4.57	0.19	0.83	0.58	10.13	0.23	199.67	8.08
3/11/94	A	15.78	33.68	5.83	0.13	0.93	0.23	11.30	0.56	239.67	12.66
	B	15.25	33.28	4.71	1.04	1.63	0.67	8.90	1.05	187.00	8.49
4/11/94	A	16.27	33.90	4.02	0.55	1.07	0.46	11.30	0.56	222.33	11.59
	B	15.40	33.68	4.63	0.13	1.57	0.57	9.87	0.23	175.67	17.10
5/11/94	A	15.58	33.78	4.71	0.18	1.27	0.65	10.80	0.00	211.33	7.77
	B	14.62	33.48	5.09	0.79	1.00	0.17	9.47	0.23	156.00	38.94
6/11/94	A	14.37	33.78	4.18	0.22	1.07	0.38	10.70	0.89	209.33	12.10
	B	14.03	33.70	4.65	0.22	1.40	-	12.60	-	209.00	-
15/11/94	A	13.68	33.95	2.37	1.69	1.23	0.84	10.13	0.83	161.33	2.89
	B	13.48	33.88	3.24	0.21	1.13	0.25	9.10	0.56	130.67	9.50
21/11/94	A	15.90	34.45	5.19	0.22	1.67	0.95	11.53	0.35	182.00	6.08
	B	15.07	34.20	7.46	0.87	1.27	0.96	10.93	0.23	152.33	7.23
29/11/94	A	-	-	5.39	0.40	0.10	0.00	11.15	0.49	207.00	0.00
	B	-	-	5.94	0.12	2.50	2.97	10.00	0.00	164.00	0.00

2.1 Pittwater

Date	Station	Temp oC	Salinity (ppt)	Chl a(μg/l)	NOX(μg/l)	NO3(μg/l)	NO2 (μg/l)	PO4(μg/l)
High water								
19/8/92	1	-	-	0.33	9.0	8.9	0.1	7.0
	2	-	-	0.99	10.0	9.9	0.1	7.0
	3	-	-	0.74	12.0	11.9	0.1	6.0
	4	-	-	0.74	11.0	10.9	0.1	6.0
	5	-	-	0.25	14.0	13.9	0.1	6.0
	6	-	-	0.66	15.0	14.9	0.1	6.0
	7	-	-	0.25	15.0	14.9	0.1	6.0
	8	-	-	0.41	11.0	10.9	0.1	6.0
	9	-	-	0.66	16.0	15.9	0.1	6.0
	10	-	-	0.74	12.0	11.9	0.1	6.0
	11	-	-	0.74	12.0	11.9	0.1	6.0
	12	-	-	0.74	11.0	10.9	0.1	6.0
10/3/93	1	16.5	35.2	1.29	3.0	2.7	0.3	10.2
	2	16.5	35.6	1.64	1.0	0.9	0.1	10.0
	3	16.4	35.7	1.72	0.5	0.4	0.1	11.8
	4	16.2	35.9	1.07	3.0	2.6	0.4	12.6
	5	16.3	35.8	1.93	2.0	1.7	0.3	13.1
	6	16	35.9	0.89	0.5	0.4	0.1	9.5
	7	16.6	35.9	0.74	1.0	0.9	0.1	10.4
	8	15.8	35.8	0.44	1.0	0.8	0.2	12.7
	9	16.1	35.9	1.38	2.0	1.9	0.1	20.0
	10	16.5	35.6	1.09	0.2	0.1	0.1	11.8
	11	16.5	35.6	1.09	2.0	1.9	0.1	18.2
	12	16.7	35.5	1.78	0.5	0.4	0.1	9.8
6/5/93	1	12.2	35.5	3.87	-	-	-	-
	2	11.8	35.8	3.85	-	-	-	-
	3	11.8	35.6	2.88	-	-	-	-
	4	11.8	35.8	3.96	-	-	-	-
	5	11.8	35.8	3.56	-	-	-	-
	6	11.8	35.8	2.75	-	-	-	-
	7	11.6	35.9	4.00	-	-	-	-
	8	12.0	35.8	3.80	-	-	-	-
	9	12.1	35.7	3.49	-	-	-	-
	10	12.0	35.6	2.97	-	-	-	-
	11	12.2	35.6	3.54	-	-	-	-
	12	12.2	35.6	3.30	-	-	-	-

2.1 Pittwater

Date	Station	Temp oC	Salinity (ppt)	Chl a(μg/l)	NOX(μg/l)	NO3(μg/l)	NO2 (μg/l)	PO4(μg/l)
Low Water								
22/9/92	1	10.7	31.7	1.15	6.0	4.6	6.0	-
	2	10.6	31.5	1.40	-	-	-	-
	3	10.4	31.5	1.32	5.0	3.9	8.0	-
	4	10.5	31.1	1.15	1.0	0.4	4.0	-
	5	10.6	31.3	1.24	4.0	3.1	22.0	-
	6	10.4	31.2	1.15	0.9	0.5	6.0	-
	7	10.3	31	1.40	2.0	1.7	6.0	-
	8	10.5	31.3	1.24	4.0	2.7	6.0	-
	9	10.5	30.5	1.32	12.0	11.6	6.0	-
	10	10.7	31.7	1.24	-	-	-	-
	11	10.7	31.3	1.40	2.0	0.7	6.0	-
	12	10.5	31.7	1.24	-	-	-	-
4/11/92	1	15.7	32.3	3.08	0.7	0.5	10.0	-
	2	15.8	32.2	3.62	1.0	0.9	10.0	-
	3	15.5	32.1	3.36	1.0	0.9	8.0	-
	4	16.4	32.2	3.52	1.0	0.9	10.0	-
	5	16.3	32.2	2.97	1.0	0.8	10.0	-
	6	16.2	32.1	3.83	0.7	0.6	9.0	-
	7	16.5	32.1	3.21	0.4	0.3	9.0	-
	8	15.9	32.1	2.60	1.0	0.9	8.0	-
	9	16.4	32	2.97	1.0	0.9	9.0	-
	10	15.4	32.3	3.09	1.0	0.9	6.0	-
	11	15.8	32.2	2.60	2.0	2.0	10.0	-
	12	15.7	32.2	2.72	1.0	1.0	9.0	-

2.2 Pipeclay

Date	Station	Temp oC	Salinity (ppt)	Chl a(μg/l)	NOX(μg/l)	NO3(μg/l)	NO2(μg/l)	PO4(μg/l)
High Water								
27/10/92	1	13.2	33.8	2.64	1.4	1.2	0.2	6.0
	2	13.2	33.8	1.48	0.7	0.5	0.2	6.0
	3	13.2	33.9	1.48	0.9	0.8	0.1	6.0
	4	13.2	33.8	1.40	1.6	1.1	0.5	7.0
	5	13.2	33.8	1.48	0.7	0.5	0.2	6.0
	6	13.0	33.9	1.57	0.7	0.6	0.1	7.0
	7	13.0	33.9	1.48	1.4	1.2	0.2	6.0
	8	13.0	33.7	0.99	0.9	0.7	0.2	7.0
	9	13.3	33.9	1.07	1.4	1.1	0.3	7.0
	10	12.9	33.8	2.64	0.5	0.3	0.2	6.0
	11	13.3	33.9	2.06	0.5	0.4	0.1	6.0
	12	14.2	34.5	2.80	1.4	1.1	0.3	7.0
11/3/93	1	16.8	34.4	0.49	0.5	0.4	0.1	9.2
	2	16.7	34.4	0.49	0.2	0.1	0.1	10.0
	3	16.7	34.5	0.41	0.2	0.1	0.1	10.0
	4	16.6	34.5	0.41	0.2	0.1	0.1	10.9
	5	16.5	34.6	1.32	1.0	0.9	0.1	10.0
	6	16.7	34.4	1.81	1.0	0.8	0.2	8.3
	7	16.8	34.4	0.99	0.1	0.0	0.1	7.1
	8	16.7	34.4	1.02	0.5	0.4	0.1	9.0
	9	16.5	34.6	0.99	4.0	3.7	0.3	8.3
	10	16.6	34.3	1.81	0.2	0.2	0.0	7.5
	11	16.7	34.4	1.32	0.5	0.4	0.1	7.8
	12	16.5	34.8	1.40	1.0	0.8	0.2	7.5
8/7/93	1	9.7	33.6	3.71	20	19.3	0.7	12
	2	9.7	33.7	2.97	20	19.4	0.6	12
	3	9.7	33.7	2.55	20	19.3	0.7	12
	4	9.2	33.7	1.57	18	17.4	0.6	13
	5	8.7	33.8	1.40	20	19.2	0.8	23
	6	9.7	33.6	4.04	22	21.3	0.7	17
	7	9.7	33.8	2.55	13	12.6	0.4	10
	8	9.5	33.7	2.32	20	19.4	0.6	13
	9	8.4	33.8	1.24	15	14.3	0.7	15
	10	9.5	33.7	3.71	18	17.3	0.7	11
	11	9.5	33.8	1.73	20	19.3	0.7	13
	12	7.2	33.9	1.48	16	15.2	0.8	14

2.2 Pipeclay

Date	Station	Temp oC	Salinity (ppt)	Chl a(µg/l)	NOX (µg/l)	NO3 (µg/l)	NO2 (µg/l)	PO4 (µg/l)
Low Water								
23/9/92	1	10.8	33.9	1.48	-	-	-	-
	2	10.6	33.8	1.13	-	-	-	-
	3	10.6	33.8	1.22	-	-	-	-
	4	10.9	33.8	1.66	-	-	-	-
	5	11.0	33.7	1.83	-	-	-	-
	6	10.8	33.7	2.79	-	-	-	-
	7	11.1	33.7	0.87	-	-	-	-
	8	10.8	33.6	1.05	-	-	-	-
	9	11.4	33.7	1.48	-	-	-	-
	10	10.7	33.8	1.40	-	-	-	-
	11	10.9	33.7	0.26	-	-	-	-
	12	11.7	33.7	2.01	-	-	-	-
10/6/93	1	9.2	34.2	1.15	5.0	3.8	1.2	12.2
	2	9.1	34.1	1.32	4.0	3.5	0.5	10
	3	9.0	34.2	1.40	4.0	3.4	0.6	11.8
	4	8.8	34.3	1.24	4.0	3.5	0.5	12.6
	5	8.8	34.3	1.07	3.0	2.6	0.4	12.2
	6	10.6	34.0	2.72	2.0	1.8	0.2	8
	7	9.3	34.1	1.32	4.0	3.5	0.5	12.2
	8	9.1	34.2	0.99	5.0	4.0	1	11
	9	8.8	34.0	0.74	8.0	7.4	0.6	13.3
	10	11.0	33.9	3.79	0.5	0.4	0.1	7.8
	11	9.7	34.0	2.64	2.0	1.7	0.3	10
	12	9.1	34.1	2.39	4.0	3.4	0.6	10

2.3 Little Swanport

Date	Station	Temp°C	Salinity(ppt)	Chla (μg/l)	NOX(μg/l)	NO3(μg/l)	NO2(μg/l)	PO4(μg/l)
High Water								
15/10/92	1	12.2	35.0	3.13	1.0	1.0	0.0	10.0
	2	12.2	34.9	2.97	1.0	1.0	0.0	11.0
	3	12.4	34.1	3.13	0.7	0.7	0.0	9.0
	4	12.8	34.9	2.72	0.7	0.7	0.0	7.0
	5	12.7	34.9	2.88	1.0	0.9	0.1	7.0
	6	13.7	30.1	2.55	2.0	1.7	0.3	6.0
	7	14.1	25.1	1.65	4.0	3.6	0.4	6.0
	8	14.7	21.6	2.88	3.0	2.5	0.5	4.0
	9	15.7	23.5	2.55	2.0	1.4	0.6	6.0
	10	16.1	22.1	2.97	1.0	0.4	0.6	4.0
	11	14.1	25.5	2.14	1.0	0.5	0.5	7.0
	12	12.2	35.0	2.55	0.7	0.7	0.0	8.0
19/2/93	1	-	35.1	1.78	0.8	0.6	0.2	9.0
	2	-	35.1	2.74	1.3	1.0	0.3	9.0
	3	-	35.1	2.37	0.8	0.5	0.3	9.0
	4	-	35.1	3.04	2.1	1.4	0.7	8.0
	5	-	35.1	2.36	1.7	1.3	0.4	9.0
	6	-	35.2	2.97	7.1	6.8	0.3	9.0
	7	-	35.2	5.56	1.3	1.0	0.3	9.0
	8	-	35.4	4.89	0.8	0.5	0.3	9.0
	9	-	35.7	8.90	0.0	0.0	0.0	7.0
	10	-	35.7	7.12	0.4	0.1	0.3	8.0
	11	-	35.5	5.86	0.4	0.1	0.3	8.0
	12	-	35.1	2.70	0.4	0.2	0.2	9.0
25/2/93	1	16.2	35.3	7.18	0.8	0.6	0.2	6.0
	2	16.2	35.3	6.97	0.4	0.2	0.2	7.0
	3	16.3	35.2	7.30	1.0	0.4	0.6	7.0
	4	16.3	35.2	7.88	0.6	0.4	0.2	7.0
	5	16.3	35.2	7.27	0.6	0.4	0.2	6.0
	6	16.4	35.2	7.27	0.2	0.0	0.3	8.0
	7	16.4	35.3	6.30	0.0	0.0	0.2	8.0
	8	16.5	35.8	6.01	0.6	0.3	0.3	6.0
	9	16.7	35.3	9.05	5.0	4.0	1.0	8.0
	10	-	-	-	-	-	-	-
	11	16.5	35.5	8.75	0.8	0.2	0.6	4.0
	12	16.1	35.3	6.08	3.0	2.3	0.7	6.0
17/6/93	1	9.9	35.4	2.97	5.6	5.1	0.5	6.9
	2	10.0	35.5	3.54	5.8	5.2	0.6	4.0
	3	9.1	35.4	3.79	3.7	3.0	0.7	6.0
	4	9.3	35.3	4.37	2.6	2.2	0.4	6.5
	5	9.2	35.3	4.04	2.7	2.4	0.3	4.6
	6	8.8	35.5	2.72	10.2	8.9	1.3	9.8
	7	8.8	35.5	2.80	8.7	7.5	1.2	9.6
	8	8.8	35.5	2.80	9.5	8.2	1.3	9.6
	9	9.1	35.5	3.87	3.5	3.5	0.1	4.0
	10	8.0	35.6	4.45	0.5	0.5	0.1	4.0
	11	7.8	35.6	3.71	1.0	1.0	0.1	6.5
	12	10.5	35.3	2.14	4.0	3.5	0.5	8.5

2.3 Little Swanport

Date	Station	Temp°C	Salinity(ppt)	Chla (µg/l)	NOX(µg/l)	NO3(µg/l)	NO2(µg/l)	PO4(µg/l)
High Water continued								
26/7/93	1	10.9	35.0	1.21	21.0	18.3	2.7	9.0
	2	10.9	34.9	1.21	15.0	13.6	1.4	10.0
	3	10.9	34.9	1.30	15.0	13.7	1.3	3.0
	4	11.0	34.9	1.48	15.0	13.8	1.2	2.3
	5	11.0	34.9	1.48	14.0	12.7	1.3	5.0
	6	11.0	34.9	2.32	13.0	11.7	1.3	8.0
	7	10.2	34.5	2.22	4.0	3.5	0.5	2.3
	8	10.4	34.7	1.76	5.0	4.4	0.6	7.0
	9	10.1	34.1	4.45	1.0	0.8	0.2	4.0
	10	10.1	34.2	2.60	1.0	0.8	0.2	4.0
	11	10.2	34.6	2.13	4.0	3.6	0.6	7.0
	12	10.9	35.0	1.67	5.0	3.7	1.3	6.5
25/8/93	1	11.2	34.9	2.69	1.0	1.0	0.0	8.0
	2	11.2	34.9	2.41	1.0	1.0	0.0	10.0
	3	11.3	34.9	2.41	1.0	1.0	0.0	7.0
	4	11.5	34.8	2.50	2.0	2.0	0.0	8.0
	5	11.3	34.9	2.78	1.0	1.0	0.0	7.0
	6	11.8	34.8	1.85	2.0	2.0	0.0	6.0
	7	11.7	34.6	2.22	2.0	2.0	0.0	6.0
	8	11.8	34.7	1.76	1.0	1.0	0.0	6.0
	9	11.8	34.1	3.06	0.5	0.5	0.0	3.0
	10	11.8	34.1	3.15	2.0	2.0	0.0	3.0
	11	11.1	34.4	1.95	1.0	1.0	0.0	6.0
	12	11.4	34.8	2.97	0.3	0.3	0.0	7.0
23/9/93	1	11.9	34.9	1.19	0.4	0.0	0.4	8.5
	2	12.2	34.7	0.99	0.6	0.2	0.4	9.6
	3	12.2	34.7	0.99	0.5	0.1	0.4	8.5
	4	12.5	34.8	0.99	0.8	0.5	0.3	9.6
	5	12.3	34.8	0.89	0.4	0.1	0.3	8.3
	6	12.5	34.8	0.79	2.7	2.1	0.6	8.1
	7	13.0	34.1	1.19	0.8	0.5	0.3	6.0
	8	12.3	34.2	1.58	0.5	0.2	0.3	5.8
	9	12.7	34.0	3.36	0.2	0.0	0.2	3.5
	10	13.1	33.9	2.97	0.3	0.1	0.2	2.7
	11	12.5	33.7	1.78	0.6	0.4	0.2	3.8
	12	12.0	34.8	1.58	0.2	0.0	0.2	8.1

2.3 Little Swanport

Date	Station	Temp°C	Salinity(ppt)	Chla (µg/l)	NOX(µg/l)	NO3(µg/l)	NO2(µg/l)	PO4(µg/l)
Low Water								
1/10/92	1	11.5	29.7	1.3	-	-	-	-
	2	11.3	30.2	0.9	-	-	-	-
	3	11.7	28.2	1.3	-	-	-	-
	4	11.7	28.8	1.2	-	-	-	-
	5	11.8	29.1	1.1	-	-	-	-
	6	12	25.5	1.2	-	-	-	-
	7	12	26.3	1.2	-	-	-	-
	8	12	28.7	1.2	-	-	-	-
	9	11.9	25.1	1.2	-	-	-	-
	10	12.3	25.3	1.7	-	-	-	-
	11	11.9	24.5	1.5	-	-	-	-
	12	11.4	28.6	1.3	-	-	-	-
20/11/92	1	15.8	34.8	2.4	2	1.0	1.0	6.0
	2	15.8	34.9	1.6	2	1.4	0.6	7.0
	3	15.8	34.8	2.1	4	2.8	1.2	12.0
	4	16.1	34.7	2.8	3	2.3	0.7	10.0
	5	15.8	34.9	2.5	3	2.3	0.7	7.0
	6	16.4	34.4	2.9	4	3.0	1.0	5.0
	7	16.5	34.3	2.6	1	0.3	0.7	5.0
	8	16.7	34.1	3.8	1	0.5	0.5	10.0
	9	17.1	32.8	4.0	1	0.2	0.8	5.0
	10	17.1	32.6	3.2	0.6	0.1	0.5	5.0
	11	16.9	33.6	4.8	0.4	-0.2	0.6	5.0
	12	16	34.7	2.4	0.6	0.1	0.5	5.0

2.4 Georges Bay

Date	Station	Temp oC	Salinity (ppt)	Chl a(µg/l)	NOX(µg/l)	NO3(µg/l)	NO2(µg/l)	PO4(µg/l)	Si O4(µg/l)
High Water									
18/6/93	1	11.4	34.4	13.84	2.0	1.8	0.2	11.2	-
	2	10.8	34.4	23.16	0.5	0.5	<0.1	10.0	-
	3	10.8	34.4	15.08	0.3	0.3	<0.1	9.2	-
	4	10.9	34.4	13.51	0.4	0.4	<0.1	10.0	-
	5	10.8	34.3	9.48	0.8	0.8	<0.1	8.1	-
	6	11.1	34.3	14.83	0.8	0.8	<0.1	9.2	-
	7	11.2	34.3	4.20	1.6	1.1	0.5	10.4	-
	8	11.2	34.1	4.12	5.2	4.9	0.3	7.7	-
	9	11.0	33.9	3.79	6.1	5.8	0.3	10.4	-
	10	10.7	33.8	3.13	2.4	2.4	<0.1	9.2	-
	11	10.9	33.9	2.80	3.7	3.5	0.2	8.5	-
	12	11.2	34.3	7.17	1.1	1.1	<0.1	8.5	-
15/12/94	1	18.0	34.1	5.52	0.0	-0.3	0.3	9.8	52
	2	17.8	34.2	7.03	0.9	0.5	0.4	11.0	88
	3	17.9	34.1	4.77	0.0	-0.3	0.3	10.4	65
	4	17.9	34.1	4.52	0.5	0.2	0.3	10.0	53
	5	17.6	34.0	5.52	1.6	1.2	0.4	10.4	46
	6	17.6	34.1	6.65	3.1	2.7	0.4	12.9	46
	7	17.6	34.1	6.02	1.2	0.8	0.4	11.3	42
	8	17.7	34.2	5.77	1.9	1.6	0.3	10.0	46
	9	17.7	34.3	5.40	0.0	-0.3	0.3	9.6	25
	10	17.8	34.2	5.02	0.0	-0.3	0.3	11.7	31
	11	17.8	34.0	5.65	0.4	0.1	0.3	10.0	49
	12	17.8	34.1	6.28	0.5	0.1	0.4	11.3	44
	13	17.8	34.0	4.89	0.0	-0.3	0.3	9.6	40
9/2/95	1	18.1	27.0	16.79	11.9	10.6	1.3	4.0	624
	2	18.8	28.8	22.43	1.9	1.2	0.7	4.3	448
	3	18.2	29.9	35.77	1.3	0.7	0.6	6.7	386
	4	18.0	29.9	24.63	0.9	0.4	0.5	4.7	386
	5	17.9	29.6	21.02	1.3	1.0	0.3	4.0	395
	6	18.0	29.4	23.22	0.6	0.3	0.3	4.0	410
	7	18.2	29.2	20.24	0.6	0.4	0.2	3.8	419
	8	17.5	29.9	13.02	15.6	13.4	2.2	5.2	376
	9	17.5	29.5	12.55	14.4	12.2	2.2	4.3	405
	10	17.5	29.5	12.39	13.1	10.9	2.2	4.2	438
	11	17.9	29.2	22.28	4.4	3.7	0.7	3.5	407
	12	18.4	25.9	27.93	13.8	12.5	1.3	3.7	667

2.4 Georges Bay

Date	Station	Temp oC	Salinity (ppt)	Chl a(µg/l)	NOX(µg/l)	NO3(µg/l)	NO2(µg/l)	PO4(µg/l)	Si O4(µg/l)
Low Water									
26/8/93	1	11.5	32.5	1.88	39.0	37.0	2.0	10.0	-
	2	11.7	32.8	1.38	30.0	28.0	2.0	10.0	-
	3	10.8	33.0	1.88	18.0	16.0	2.0	9.0	-
	4	11.5	32.8	2.37	22.0	20.0	2.0	10.0	-
	5	11.2	32.5	2.27	23.0	21.0	2.0	9.0	-
	6	11.5	32.4	1.78	32.0	30.0	2.0	11.0	-
	7	11.5	32.5	1.29	43.0	41.0	2.0	10.0	-
	8	11.2	31.1	1.38	50.0	48.0	2.0	11.0	-
	9	11.3	31.6	1.38	42.0	40.0	2.0	10.0	-
	10	11.5	32.2	2.27	29.8	27.8	2.0	10.0	-
	11	11.3	32.2	1.98	40.0	38.0	2.0	9.0	-
	12	11.5	32.4	1.29	41.0	39.0	2.0	10.0	-
15/12/94	1	19.5	33.1	5.15	2.9	2.3	0.6	7.3	258
	2	20.4	34.2	3.39	1.2	0.7	0.5	8.8	146
	3	20.3	34.3	1.51	1.0	0.6	0.4	8.8	77
	4	18.6	34.1	3.01	0.0	-0.3	0.3	8.8	56
	5	18.4	34.2	3.77	0.2	-0.1	0.3	8.8	46
	6	18.3	34.3	4.39	0.1	-0.2	0.3	8.8	44
	7	18.6	34.3	4.39	0.0	-0.3	0.3	9.2	47
	8	18.2	34.3	4.14	0.0	-0.3	0.3	8.5	29
	9	17.6	34.3	5.77	0.1	-0.2	0.3	9.6	33
	10	18.1	34.3	3.51	0.0	-0.3	0.3	8.3	25
	11	18.2	34.3	3.89	0.0	-0.3	0.3	9.6	25
	12	19.1	34.1	3.26	0.2	-0.1	0.3	8.7	42
	13	18.4	34.2	3.77	0.0	-0.3	0.3	10.4	31
9/2/95	1	17.0	28.0	15.37	27.8	26.0	1.8	3.1	562
	2	18.0	29.0	8.47	48.1	46.3	1.8	3.7	843
	3	18.1	28.4	17.57	5.5	3.9	1.6	3.3	529
	4	17.4	29.1	15.37	20.7	17.7	3.0	3.0	738
	5	17.5	29.0	19.77	8.8	7.0	1.8	3.5	538
	6	17.2	28.5	19.45	20.7	17.8	2.9	3.3	733
	7	17.1	28.1	12.39	81.2	79.2	2.0	3.7	950
	8	17.2	28.5	26.36	65.6	62.9	2.7	3.7	950
	9	17.5	28.9	23.85	12.9	11.1	1.8	3.3	543
	10	17.5	28.6	16.16	4.5	3.1	1.4	3.0	410
	11	16.6	27.9	13.96	85.6	83.6	2.0	3.7	950
	12	17.4	28.8	14.59	61.9	59.9	2.0	4.3	950

2.5 Simpsons Bay

Date	Station	Temp oC	Salinity (ppt)	Chl a (µg/l)	NOX (µg/l)	NO3 (µg/l)	NO2 (µg/l)	PO4 (µg/l)
High Water								
18/8/93	1	10.2	33.2	1.15	29	25	4	12
	2	10	33.3	1.15	25	21	4	13
	3	9.8	33.2	1.07	19	16	3	10
	4	9.6	33.3	0.99	14	11	3	11
	5	9.5	33.2	1.24	16	13	3	11
	6	10.1	33.2	0.66	3	2	1	10
	7	10.1	33.2	1.24	12	10	2	9
	8	9.8	33.2	1.07	11	8	3	12
	9	9.8	33.2	1.32	19	16	3	12
	10	9.6	33.2	1.48	14	11	3	8
	11	9.8	33.2	1.40	16	13	3	9
	12	10.1	33.2	1.24	31	27	4	14
9/9/93	1	11.2	33.2	3.79	9	8	1	11
	2	11.5	33.1	2.55	11	10	1	13
	3	11.5	33	2.22	11	10	1	10
	4	11.2	33.2	1.40	18	16	2	11
	5	11.1	33.1	2.14	17	15	2	11
	6	11.5	33.4	1.32	18	16	2	12
	7	11.5	33.3	1.73	18	16	2	12
	8	11.2	33.2	1.48	15	13	2	11
	9	11.5	33.1	2.55	13	11	2	10
	10	11.3	33.3	2.88	15	13	2	10
	11	11.2	33.4	2.80	16	14	2	10
	12	11.0	33.4	1.90	20	18	2	12