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Reef

# Biological and Chemical Oceanographic Measurements in the Far Northern Great Barrier Reef - February 1990



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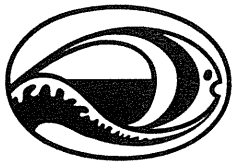

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# 1. INTRODUCTION

This report presents and summarises the results of biological and chemical oceanographic sampling carried out in the far northern Great Barrier Reef during February 1990. The region sampled (ca. 11-13°S), lies adjacent to the eastern side of Cape York Peninsula, locations on which are under consideration for national park declaration, the construction of a rocket launching facility and silica sand mining. As little is known regarding the biological and chemical oceanography of the region, a reconnaissance survey was carried out to obtain baseline data on hydrographic, nutrient and sediment characteristics of shelf waters and sediments. It is expected that the data presented herein will form part of the environmental assessment for development in, and conservation of, the region and serve as a basis for designing more detailed and focused water quality surveys.

Limited comparisons will be drawn with biological and chemical oceanographic data of similar type collected in the Torres Strait (Mitchell 1982) and in the vicinity of the Ribbon Reefs (ca. 14°S: Furnas unpublished). The Torres Strait data were collected in November-December 1979. Data from adjacent Gulf of Papua stations will not be considered herein. The Ribbon Reef data were collected in October 1987. Most of this latter group of stations were located in outer-shelf waters between Cooktown and Lizard Island. Three stations in this series were occupied in shelf waters between Lizard Island and Princess Charlotte Bay.

## 2. SAMPLING LOCATIONS

Fifty-three hydrographic stations (SHL02-SHL54) were occupied within the study area between 5 and 13 February 1990 (figure 1). Two additional stations (SHL01, SHL55) were occupied in the Great Barrier Reef lagoon between 14 and 15°S while the ship was in transit to and from the study area. The cruise track was laid out to cover inshore, outer-shelf and Coral Sea waters within and seaward of the three major coastal embayments in the latitude band sampled; Lloyd Bay, Temple Bay and Shelburne Bay.

A more extensive grid of stations (SHL46-SHL54) was sampled within Temple Bay on a single day (figure 2). Inshore stations in Lloyd and Shelburne Bays (stations 6, 7, 8, 33, 34, 35, 36) are used for comparison to see whether gross between-bay differences might exist. No attempt was made to sample the three bays in a statistically rigorous fashion as no information is currently available regarding oceanographic differences between the bays and water residence times within each of the bays. In the absence of such information, the interpretations of more detailed water sampling designs would be unwarranted.

A series of closely spaced stations (16-23) were occupied both inside and outside of the outer barrier reefs in the vicinity of Mantis Reef (12° 20'S), along with three 'oceanic' control stations (24-26) to assess whether nutrient enrichment of the reef-ocean boundary zone was associated with mixing through reef passes. In all, twelve stations were occupied seaward of the reef.

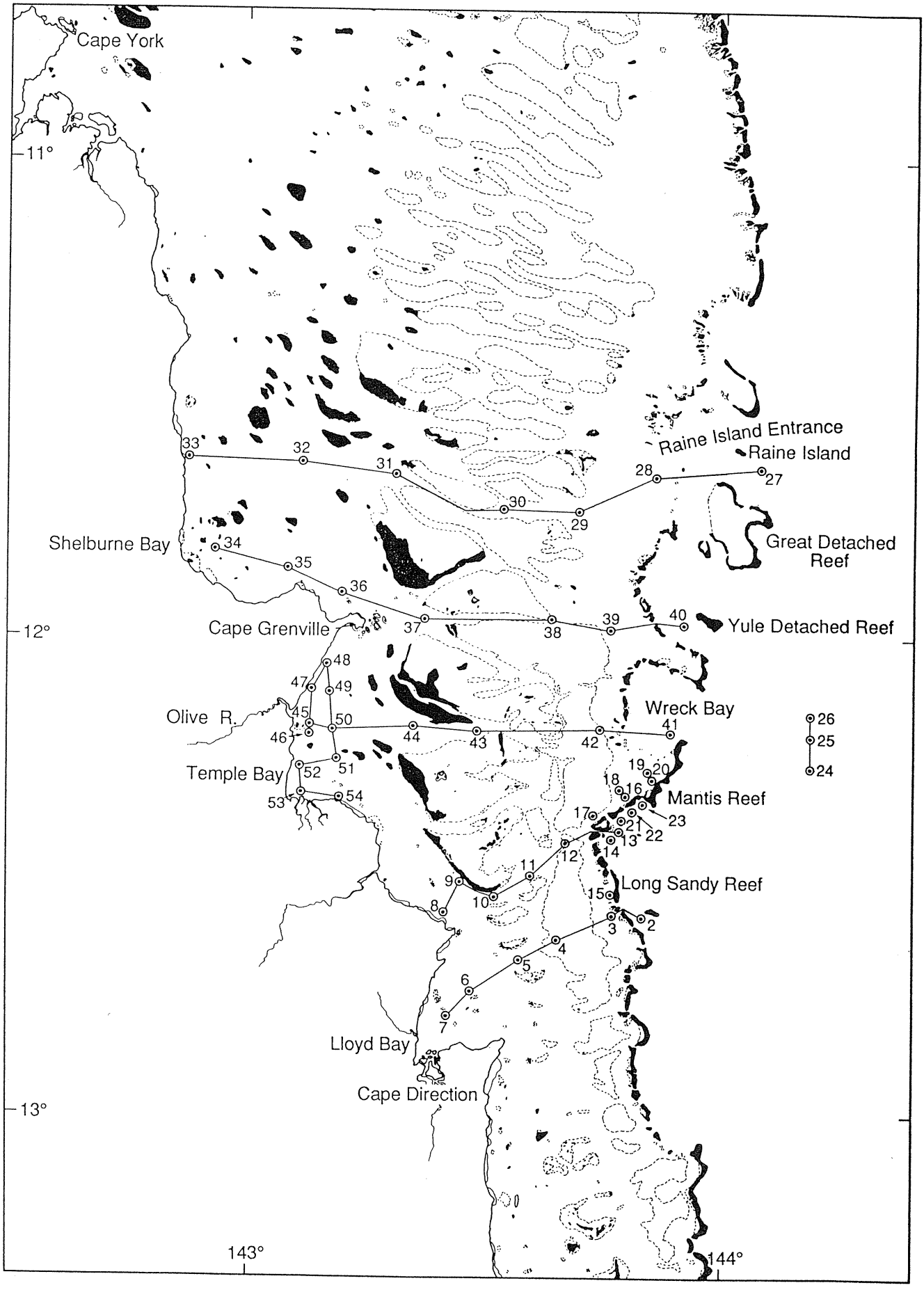


**Figure 1.** Hydrographic station locations in the far northern Great Barrier Reef

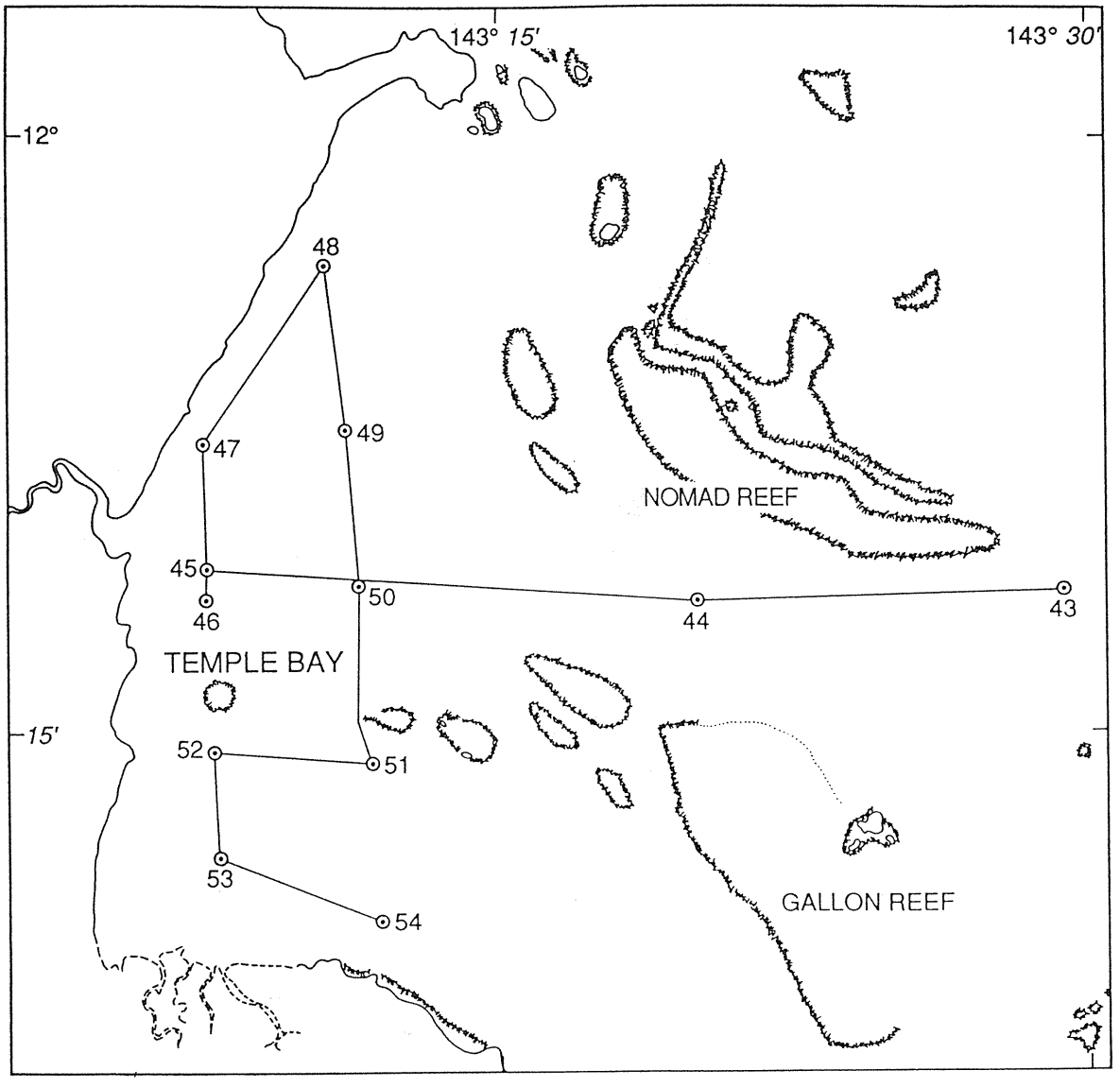


**Figure 2.** Hydrographic station locations in Temple Bay

## 3. SAMPLING PROCEDURES

Water samples (2-10) were collected with Niskin bottles through the full depth of the water column or upper 300 metres. The bottles were acid cleaned (1% v/v HCl) prior to the cruise and stored with leftover sample water in them between stations. CTD (conductivity/temperature/ depth) casts were made at eleven of the first thirteen stations with a Neil Brown SCTD. During the period, the performance of the instrument deteriorated. Salinity and temperature profiles from the CTD were calibrated against reversing thermometers and discrete salinity samples. Difficulties with the CTD primarily lay with the pressure (depth) sensor. CTD-derived depth estimates for salinity and temperature data at shelf stations are likely within one to two metres of the true depth. Given the weak vertical gradients observed, this should not be a problem for interpretation. At the two deeper stations (SHL02, SHL13), salinity and temperature data from below 25 metres is not used. After station SHL13, in situ temperatures were measured with reversing thermometers. Surface and near-bottom salinity samples were collected at most stations. Salinities were determined ashore with a Plessy 6230N salinometer calibrated against IAPSO standard seawater.

Subsurface irradiance profiles were measured at twenty-four (24) stations with a Biospherical QSP-200 underwater scalar (4 $\pi$) irradiance sensor. Surface irradiance was measured concurrently using a QSR-240 reference sensor (figures 3-5). The underwater sensor was lowered in one to five meter steps, with surface and subsurface irradiance being measured at each sampling depth. The instrument readings were digitised electronically and captured on a microcomputer. To the extent possible, readings were not taken while clouds obscured the sun.

Water column zooplankton stocks were sampled with duplicate bottom-to-surface vertical net tows at most stations. The net (0.5 m diameter, 73 µm mesh) was equipped with a Rigosha flow meter to estimate the volume of water filtered. Zooplankton samples collected in individual net tows were split once with a Folsom splitter. One split was filtered onto a disk of 73 µm nylon mesh and frozen in a petrie dish. The other split was preserved with formalin for archiving and later examination if warranted.

Following water sampling at most shelf stations, triplicate sediment samples were collected with a van Veen grab. The grab collected to a depth of ca. 10 cm over an area of 0.1 $m^2$.

Shortly after collection, subsamples of seawater for dissolved nutrient analyses were drawn from each Niskin bottle into an acid-soaked plastic syringe. The water was then immediately filtered through a Minisart N cellulose acetate filter cartridge (0.45 µm pore diameter) directly into acid-washed, sample-rinsed screw-capped polyethylene test tubes and plastic scintillation vials (in duplicate for each tube type). One cartridge could usually be used for an entire station without significant clogging. Approximately 10 ml of each seawater subsample was pre-filtered through the cartridge before filling the sample containers. The filled sample tubes were then immediately frozen for analysis ashore. Care was taken not to over-fill sample tubes/vials, or to tip tubes/vials while frozen or freezing.

Duplicate 100 ml subsamples were filtered onto 25 mm diameter Whatman GF/F filters for chlorophyll determinations (Parsons et al. 1984). At primary production stations, additional 100 ml subsamples were filtered onto polycarbonate membrane filters (Nuclepore 25 mm diameter - 2 µm and 10 µm pore diameter) to assess the contribution of pico- (< 2 µm fraction) and nano- (2-10 µm) phytoplankton to community biomass and productivity. After filtration, the filters were folded and deep-frozen in aluminium foil packets.

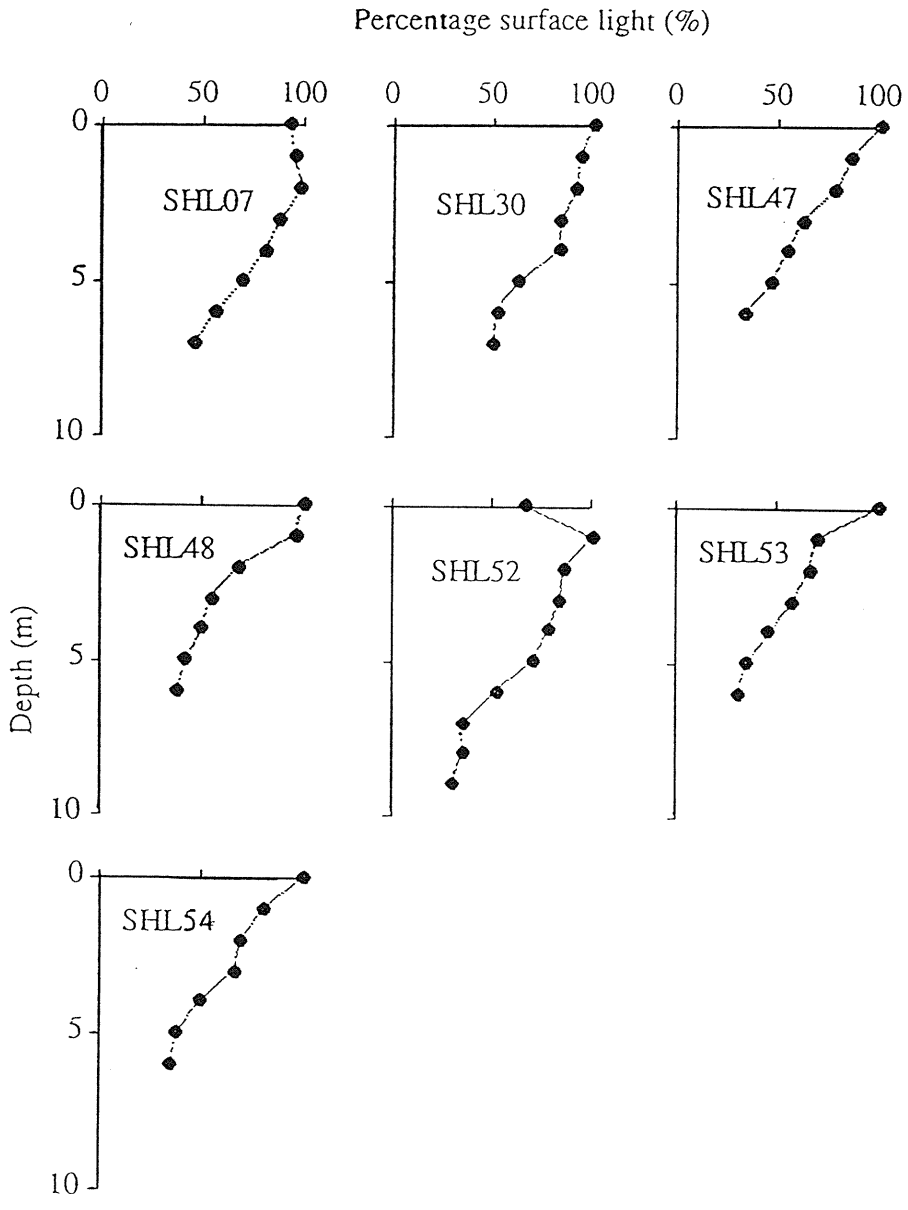


**Figure 3.** Light profiles for near-shore stations, < 10 m depth

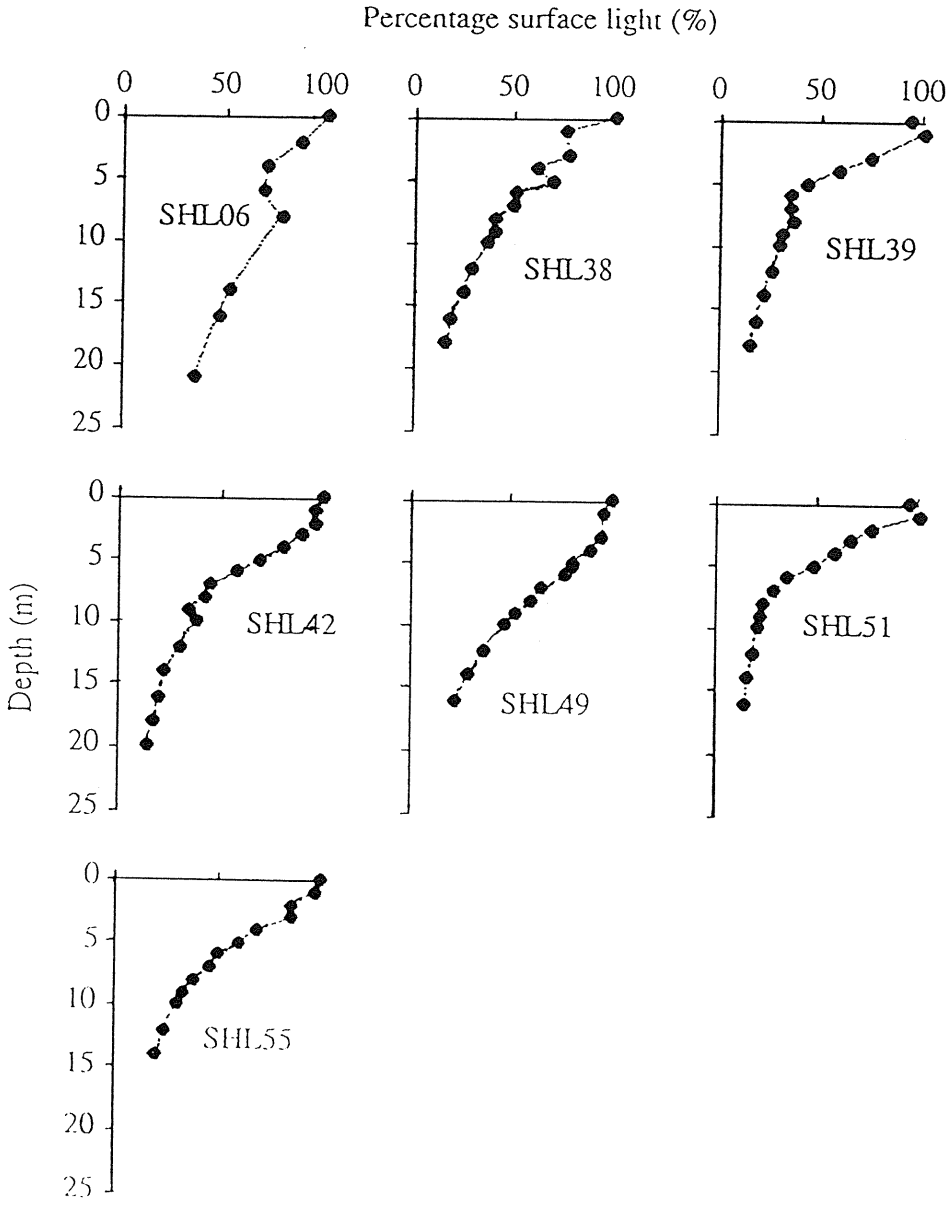


**Figure 4.** Light profiles for mid-shelf stations, 10-25 m depth

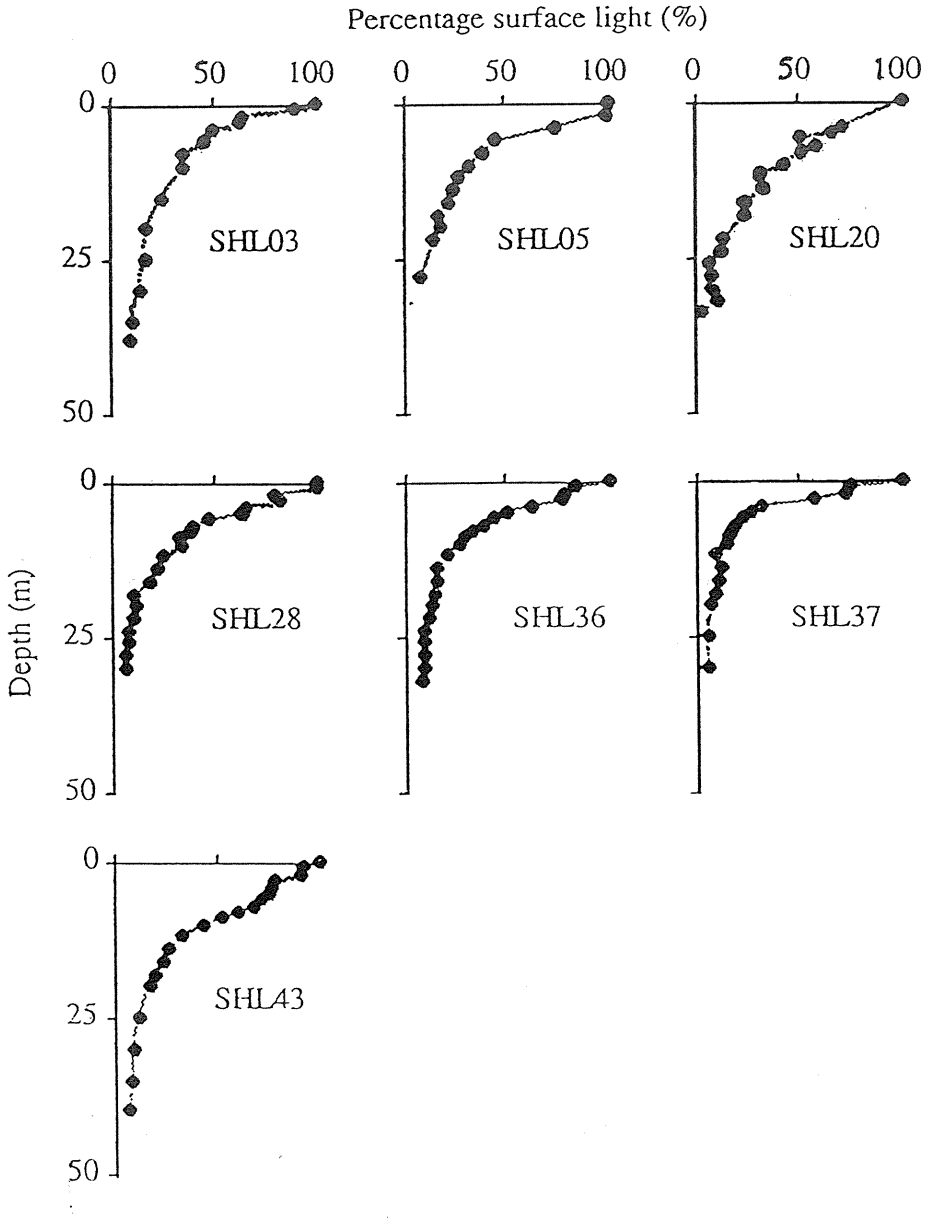


**Figure 5.** Light profiles for mid-shelf stations, 25-50 m depth

Duplicate 1 litre subsamples were filtered onto pre-weighed Nuclepore filters (47 mm diameter, 0.4 μm pore diameter) for suspended solids determinations. Absorption of water within the filters and filtered material was minimal. Filters were not rinsed with distilled water to avoid osmotic shock to cells caught on the filters. The filters were stored in pre-combusted glass scintillation vials at room temperature.

Duplicate 250 ml subsamples were filtered onto pre-combusted (400°C overnight) Whatman GF/F filters (25 mm diameter - nominal operational pore diameter 0.4 μm) for particulate nitrogen (PON) and particulate phosphorus (POP) determinations. The filters were folded, wrapped in pre-combusted foil and deep-frozen.

Duplicate 10 ml subsamples of bulk sediment were taken from one grab at each station for determination of sediment nitrogen and phosphorus. Care was taken in the subsampling to collect 'representative' subsamples of the dominant size fractions of sediment, avoiding obvious macrofauna, living macroalgae and chunks of coral rubble. The subsamples were placed in pre-combusted glass scintillation vials and frozen. Duplicated 200 ml subsamples of sediment were taken for grain-size analysis. The grain size subsamples were fixed with 10 ml of formalin.

## 4. ANALYTICAL PROCEDURES

Inorganic nutrient ($NH_4$, $NO_2$, $NO_3$, $PO_4$, $Si(OH)_4$) concentrations were determined by standard wet chemical methods (Treguer and LeCorre 1975) implemented on a segmented flow analyser (Ryle et al. 1981). Frozen samples were thawed in a microwave oven immediately prior to analysis. While this method results in lower blanks and variability for inorganic nitrogen and phosphorus species, it appears that silicate in the samples does not uniformly revert to a form detectable by the SFA chemistry within the short time between thawing and analysis. Accordingly, variability in the silicate values should be viewed with some caution. Dissolved organic nitrogen (DON) and dissolved organic phosphorus (DOP) concentrations were calculated by difference after oxidation (>= 7 hrs) of the organic matter in the water samples with UV radiation (Armstrong et al. 1966; Walsh 1989). Irradiated water samples were re-frozen until analysis, which results in negligible losses of inorganic nitrogen and phosphorus (Nowicki 1986). Total nitrogen was calculated from the sum of $NO_3$ and $NH_4$ in the irradiated samples (Walsh 1989).

Particulate nitrogen was determined by high-temperature combustion of the organic matter collected on glass-fibre filters using an ANTEK Nitrogen Analyser. The sample was ramp-heated (150°C $min^{-1}$) to 650°C in the primary combustion oven, with the combustion gases being passed through an oxygenated secondary oven (1050°C). The analyser was standardised with AR grade EDTA weighed out on an electronic microbalance. PON samples were lyophilised prior to analysis and stored in a dessicator. Procedure ('wet filter') blanks were analysed to correct for dissolved organic and inorganic nitrogen blotted into the filters plus systematic contamination introduced during storage and processing. Several drops of filtered seawater were blotted into clean, combusted filters, which were then sucked dry, stored and processed in parallel with sample filters. This correction was on the order of 0.25 µg nitrogen per filter. Freshly combusted glass-fibre filters were not measurably contaminated with nitrogen at the instrument attentuation settings used. Sediment nitrogen was determined by weighing ground (agate pestle) sediment (ca. 100 mg) into pre-combusted aluminium sample boats, which were then processed in a manner similar to filters.

Particulate phosphorus was determined by colorimetric means (Strickland and Parsons 1972) following acid-persulfate digestion (Menzel and Corwin 1965) of the organic matter in the samples (based upon suggestions from Smith et al. 1981). Filters were placed in acid-washed scintillation vials with 5 ml of five percent (w/v) potassium persulfate. The persulfate was refluxed to dryness by heating the vials in an aluminium heating block, using an acid-washed marble for a stopper. Following the digestion, the filter and residue were resuspended in 5 ml of deionized water and the filter pulverised to dissolve all soluble material. The solution was cleared by centrifugation and the inorganic phosphorus determined colormetrically in aliquots of the supernatant. Organic and inorganic phosphorus standards were run in parallel with each batch of filters. For sediments, weighted subsamples of agate-ground sediment were acidified with 25% (v/v) HCl in acid-cleaned scintillation vials and refluxed to dryness to remove all carbonates and extraneous volatile acid. The residue was then redissolved in five percent persulfate and re-refluxed again to dryness. The residue was redissolved in deionized water, cleared by centrifugation and the phosphorus determined colormetrically as above.

Chlorophyll on filters was determined fluorometrically after grinding in 90% (v/v) acetone (Strickland and Parsons 1972). Most samples were analysed at sea within days of collection and all samples were analysed within three weeks of collection.

Suspended solids concentrations were determined gravimetrically from the difference between loaded and unloaded filter weights after the filters were dried overnight at 80°C.

Filtered zooplankton biomass samples were dried for several days at 60°C. The zooplankton and netting were weighed, then zooplankton was scraped off and the filter re-weighed.

Grain size analysis of sediment samples was carried out following Folk (1974). Discriminations were made only to gravel (> 2 mm), sand (2-0.063 mm) and mud (< 0.063 mm) size fractions. Sediment samples were first treated overnight with hydrogen peroxide to remove organic matter. Percent gravel, sand and mud were determined gravimetrically following wet and dry sieving. Clay composition (expressed as a percent of mud) was determined by pipette analysis. Subsamples of the gravel size fraction were hand sorted to fragments derived from molluscs, echinoderms and segments of the calcareous green alga, *Halimeda*. A weighted 20 ml subsample of the mud fraction was acidified to dissolve all carbonate materials. The residue was collected on a pre-weighed filter, rinsed with deionized water, re-dried and re-weighed to estimate the contribution of $CaCO_3$ to the mud fraction.

## 5. PRIMARY PRODUCTION MEASUREMENTS

Water column primary production was estimated from the uptake of $^{14}$C-bicarbonate (Steelman Nielsen 1952). General experimental details are summarised in Furnas and Mitchell (1987). Briefly, subsurface water samples were collected with acid-cleaned Niskin Go-Flo bottles. Surface samples were collected with a clean plastic bucket or Go-Flo bottles. Nine 250 ml unscreened subsamples from up to six sampling depths (corresponding to 100, 50, 30, 20, 8 and 2 percent of surface irradiance) were spiked with 5 μCi (185 KBq) $^{14}$C-bicarbonate (Amersham). The bottles were incubated for four (4) hours in seawater cooled deck incubators with compartments screened by neutral shadecloth to match nominal in situ irradiance levels. Three of the nine bottles were wrapped in aluminium foil to be dark bottles. At the end of the incubation, sets of three bottles (two light, one dark) were filtered onto either Whatman GF/F (total population), 2 μm Nuclepore (> 2 μm fraction) and 10 μm Nuclepore filters (> 10 μm fraction). The filters were placed in scintillation vials and acidified with 0.1 ml of 1N HCl to remove inorganic carbon. Radioactivity remaining was counted by liquid scintillation spectrometry (96% efficiency). Hourly primary production rates were calculated accordingly to Strickland and Parsons (1972). Daily production was estimated by multiplying the total production measured during the four hour incubation period by two. Approximately half the daily irradiance dose occurs within the 1000-1400 hr period nominally used for incubations. Because of electronic problems, integrations of daily incoming irradiance could not be made. As cloud-free conditions largely prevailed, the previously determined factor of two was presumed to prevail. Areal production was estimated by trapezoidal integration.

## 6. RESULTS

Detailed hydrographic data from the stations are presented in the appendix tables. Depth-weighted mean water temperatures, nutrient, chlorophyll and suspended solid concentrations for all stations are summarised in table 1. Integrations for these mean values were extended to the bottom or fifty metres, whichever was shallower to minimise biases introduced by integrating enhanced sub-thermocline nutrient concentrations. Sediment characteristics are given in table 2. For comparative purposes, the water column averaged nutrient, chlorophyll and suspended solid concentrations are also presented in summary tables grouped geographically within the study area (tables 3-9). The allocation of individual stations to these groups is not exclusive. Means of depth-weighted average nutrient concentrations for Torres Strait and Cooktown stations are presented in table 10.

Shelf waters were reasonably well mixed by wind and tidal action. At most on-shelf stations, vertical gradients of all parameters measured were small. The one prominent exception to this general trend occurred at the shelfbreak station immediately inshore of Raine Island inlet (28), where a well-defined near-bottom intrusion (< 24°C in bottom water) was identified. Cooler near-bottom water was also detected at two shelfbreak stations (15, 16) just inside of the barrier and at one station (14) in the channel just outside a gap between two reefs, suggesting shelfbreak mixing of subthermocline waters.

Surface salinities at outer-shell stations (mean = 34.58 ppt) were significantly higher than at Coral Sea (34.47 ppt) and inner-shelf stations (34.44 ppt), although reasons for this were not resolved. Surface salinities at stations on the two northern transects (mean = 34.60 ppt) were higher than the two southern transects (34.44 ppt). Variability in water temperatures, particularly surface temperatures, was directly related to solar heating and the time of day for sampling. As a result, geographical variability in temperatures could not be established. On individual days, surface temperatures varied by as much as one to two degrees Celsius.

Slightly elevated concentrations of inorganic nutrient species were sporadically observed in near-bottom samples, but not on a consistent basis. The variability observed in water column concentrations of nutrient species at non-shelfbreak stations was of the order expected for sampling and analytical variability (Furnas et al. 1990).

Ammonium was the principal inorganic nitrogen species measured in shelf water column or Coral Sea mixed-layer water samples (table 1). Nitrate and nitrite concentrations were very low in the mixed layer at all stations, in many cases, at concentrations below detection limits. Collectively, inorganic nitrogen species ($NH_4$+$NO_2$+$NO_3$) were a relatively small component of total water column nitrogen (TN), averaging only 2.7±1.9 (1 s.d.) and 3.5±1.2 percent of TN, respectively at inner- (depth < 20 m) and outer-shelf depth (depth > 20 m) stations. Particulate (PON) and dissolved organic (DON) nitrogen comprised the major pools of water column nitrogen. PON averaged 49±14 and 48±13 percent, at inner- and outer-shelf stations, respectively.

The situation was somewhat different for phosphorus. Phosphate ($PO_4$) averaged 24±12 and 33±13 percent of total water column phosphorus (TP) stocks (depth-weighted) at inner- and outer-shelf stations, respectively. Depth-weighted dissolved organic phosphorus (DOP) concentrations averaged 16±8 (inner-shelf) and 10±10 (outer-shelf) percent of TP, respectively. Particulate phosphorus (POP) comprised the major water column phosphorus pool, averaging 61±10 (inner-shelf) and 57±12 (outer-shelf) percent of TP.

**Table 1.** Depth-weighted mean water column concentrations at far northern Great Barrier Reef stations, February 1990. Integrations were calculated out to fifty metres or the bottom, whichever was shallower.

| Station | Depth m | $NH_4$ | $NO_2$ | $NO_3$ | DON | PON µmol/l | $PO_4$ | DOP | POP | Si | Chl µg/l | Pha µg/l | S.S mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SHL01 | 20 | 0.07 | 0.00 | 0.03 | 7.13 | 5.11 | 0.00 | 0.10 | 0.28 | 1.13 | 0.48 | 0.17 | |
| SHL02 | 300 | 0.29 | 0.05 | 0.18 | 4.33 | 3.23 | 0.09 | 0.00 | 0.05 | 0.78 | 0.28 | 0.25 | 0.70 |
| SHL03 | 35 | 0.15 | 0.00 | 0.06 | 3.25 | 3.75 | 0.06 | 0.02 | 0.08 | 0.63 | 0.57 | 0.36 | 0.88 |
| SHL04 | 16 | 0.19 | 0.00 | 0.50 | 3.24 | 2.21 | 0.05 | 0.00 | 0.09 | 1.54 | 0.27 | 0.27 | 0.93 |
| SHL05 | 28 | 0.18 | 0.00 | 0.04 | 3.90 | 4.63 | 0.05 | 0.00 | 0.09 | 2.34 | 0.70 | 0.42 | 1.40 |
| SHL06 | 16 | 0.16 | 0.00 | 0.05 | 3.47 | 4.15 | 0.04 | 0.03 | 0.09 | 1.46 | 0.34 | 0.22 | 1.15 |
| SHL07 | 6 | 0.17 | 0.00 | 0.04 | 4.43 | 2.76 | 0.04 | 0.02 | 0.10 | 7.87 | 0.30 | 0.13 | 1.55 |
| SHL08 | 8 | 0.14 | 0.00 | 0.05 | 3.39 | 4.19 | 0.04 | 0.02 | 0.13 | 2.59 | 0.42 | 0.22 | 1.80 |
| SHL09 | 28 | 0.12 | 0.00 | 0.04 | 3.36 | 3.92 | 0.04 | 0.01 | 0.09 | 2.99 | 0.59 | 0.37 | 1.48 |
| SHL10 | 38 | 0.18 | 0.00 | 0.03 | 3.48 | 4.04 | 0.05 | 0.01 | 0.09 | 1.50 | 0.46 | 0.27 | 1.16 |
| SHL11 | 44 | 0.21 | 0.00 | 0.04 | 3.36 | 2.87 | 0.06 | 0.01 | 0.11 | 2.23 | 1.05 | 0.60 | 0.89 |
| SHL12 | 43 | 0.18 | 0.00 | 0.18 | 3.70 | 3.19 | 0.07 | 0.01 | 0.10 | 2.43 | 1.07 | 0.55 | |
| SHL13 | 300 | 0.18 | 0.00 | 0.05 | 4.48 | 3.54 | 0.08 | 0.00 | 0.09 | 0.02 | 1.17 | 0.59 | 0.74 |
| SHL14 | 57 | 0.25 | 0.00 | 0.34 | 4.41 | 4.39 | 0.06 | 0.05 | 0.10 | 0.10 | 0.90 | 0.52 | |
| SHL15 | 21 | 0.42 | 0.00 | 0.00 | 4.71 | 3.39 | 0.02 | 0.06 | 0.10 | 0.01 | 0.65 | 0.43 | 0.96 |
| SHL16 | 28 | 0.41 | 0.01 | 0.10 | 4.72 | 2.56 | 0.06 | 0.02 | 0.07 | 0.21 | 0.85 | 0.48 | 0.76 |
| SHL17 | 40 | 0.26 | 0.00 | 0.02 | 4.86 | 4.59 | 0.04 | 0.03 | 0.09 | 0.12 | 0.51 | 0.30 | 1.08 |
| SHL18 | 40 | 0.30 | 0.00 | 0.02 | 5.00 | 2.39 | 0.04 | 0.02 | 0.09 | 0.02 | 0.66 | 0.40 | 0.88 |
| SHL19 | 32 | 0.28 | 0.00 | 0.03 | 4.99 | 2.35 | 0.05 | 0.02 | 0.07 | 0.19 | 0.45 | 0.33 | 0.88 |
| SHL20 | 34 | 0.19 | 0.00 | 0.08 | 5.25 | 3.53 | 0.05 | 0.06 | 0.09 | 0.21 | 0.82 | 0.45 | 0.84 |
| SHL21 | 40 | 0.20 | 0.00 | 0.06 | 5.67 | 3.58 | 0.06 | 0.01 | 0.09 | 0.29 | 1.42 | 0.61 | 0.81 |
| SHL22 | 40 | 0.17 | 0.00 | 0.04 | 5.04 | 3.98 | 0.05 | 0.01 | 0.09 | 0.13 | 1.17 | 1.03 | 1.08 |
| SHL23 | 40 | 0.20 | 0.00 | 0.02 | 3.41 | 4.14 | 0.06 | 0.01 | 0.09 | 0.04 | 1.30 | 0.58 | 0.75 |
| SHL24 | 40 | 0.23 | 0.00 | 0.01 | 3.30 | 1.04 | 0.06 | 0.03 | 0.02 | 1.08 | 0.20 | 0.10 | 0.41 |
| SHL25 | 40 | 0.22 | 0.00 | 0.02 | 3.64 | 0.82 | 0.06 | 0.01 | 0.02 | 0.91 | 0.14 | 0.08 | 0.43 |
| SHL26 | 40 | 0.16 | 0.00 | 0.02 | 3.89 | 1.55 | 0.05 | 0.02 | 0.03 | 1.04 | 0.14 | 0.10 | 0.46 |
| SHL27 | 300 | 0.17 | 0.01 | 0.01 | 3.91 | 4.59 | 0.04 | 0.03 | 0.12 | 0.00 | 0.85 | 0.56 | 1.13 |
| SHL28 | 34 | 0.08 | 0.05 | 2.91 | 1.10 | 2.87 | 0.30 | 0.00 | 0.08 | 0.76 | 1.45 | 0.96 | 0.84 |
| SHL29 | 34 | 0.16 | 0.01 | 0.02 | 2.17 | 5.23 | 0.07 | 0.00 | 0.12 | 0.04 | 1.71 | 1.18 | 1.13 |
| SHL30 | 18 | 0.14 | 0.02 | 0.01 | 2.60 | 5.79 | 0.05 | 0.00 | 0.13 | 0.39 | 0.79 | 0.64 | 1.67 |
| SHL31 | 300 | 0.15 | 0.00 | 0.03 | 2.37 | 3.16 | 0.04 | 0.00 | 0.11 | 1.26 | 0.51 | 0.28 | 1.29 |
| SHL32 | 26 | 0.15 | 0.00 | 0.01 | 2.71 | 2.96 | 0.04 | 0.03 | 0.09 | 1.02 | 0.46 | 0.18 | 1.04 |
| SHL33 | 10 | 0.30 | 0.00 | 0.03 | 2.59 | 6.37 | 0.03 | 0.04 | 0.15 | 0.22 | 0.63 | 0.31 | 1.90 |
| SHL34 | 6 | 0.45 | 0.00 | 0.04 | 2.63 | 6.98 | 0.03 | 0.01 | 0.16 | 0.00 | 0.57 | 0.37 | 2.24 |
| SHL35 | 16 | 0.50 | 0.01 | 0.02 | 1.71 | 4.23 | 0.05 | | 0.13 | 0.55 | 0.48 | 0.18 | 1.26 |
| SHL36 | 36 | 0.19 | 0.00 | 0.03 | | 3.34 | 0.05 | | 0.10 | 0.97 | 0.58 | 0.21 | 0.96 |
| SHL37 | 34 | 0.18 | 0.00 | 0.05 | | 3.32 | 0.05 | | 0.10 | 0.78 | 0.77 | 0.38 | 1.34 |
| SHL38 | 18 | 0.15 | 0.00 | 0.03 | | 3.77 | 0.02 | | 0.12 | 0.21 | 0.89 | 0.46 | 0.96 |
| SHL39 | 18 | 0.21 | 0.00 | 0.02 | | 3.78 | 0.06 | | 0.11 | 0.14 | 0.98 | 0.51 | 0.96 |
| SHL40 | 300 | 0.18 | 0.02 | 0.02 | | 3.98 | 0.05 | | 0.11 | 0.00 | 0.89 | 0.52 | 0.75 |
| SHL41 | 300 | 0.17 | 0.01 | 0.10 | | 4.97 | 0.05 | | 0.11 | 0.10 | 1.19 | 0.79 | 0.69 |
| SHL42 | 20 | 0.08 | 0.00 | 0.06 | | 5.41 | 0.06 | | 0.12 | 0.44 | 1.59 | 0.88 | 0.77 |
| SHL43 | 44 | 0.09 | 0.00 | 0.04 | | 3.88 | 0.03 | | 0.09 | 0.54 | 0.24 | 0.14 | 0.99 |
| SHL44 | 27 | 0.09 | 0.00 | 0.05 | | 2.88 | 0.03 | | 0.10 | 1.62 | 0.30 | 0.18 | 1.24 |
| SHL45 | 9 | 0.09 | 0.00 | 0.04 | | 4.11 | 0.04 | | 0.11 | 2.28 | 0.30 | 0.14 | 1.41 |
| SHL46 | 10 | 0.14 | 0.00 | 0.04 | 6.64 | 6.23 | 0.04 | 0.04 | 0.12 | 3.03 | 0.49 | 0.28 | 1.23 |
| SHL47 | 7 | 0.15 | 0.00 | 0.04 | 5.38 | 4.05 | 0.04 | 0.02 | 0.09 | 2.84 | 0.43 | 0.20 | 0.87 |
| SHL48 | 6 | 0.10 | 0.00 | 0.05 | 5.36 | 3.95 | 0.05 | 0.03 | 0.08 | 3.41 | 0.41 | 0.17 | 0.99 |
| SHL49 | 16 | 0.11 | 0.00 | 0.04 | 5.69 | 2.35 | 0.03 | 0.04 | 0.07 | 1.57 | 0.34 | 0.16 | 0.78 |
| SHL50 | 16 | 0.12 | 0.00 | 0.03 | 5.15 | 3.18 | 0.04 | 0.01 | 0.07 | 1.30 | 0.34 | 0.14 | 0.87 |
| SHL51 | 14 | 0.13 | 0.00 | 0.03 | 5.22 | 3.58 | 0.12 | 0.01 | 0.09 | 1.97 | 0.44 | 0.17 | 1.32 |
| SHL52 | 9 | 0.09 | 0.00 | 0.03 | 4.57 | 4.32 | 0.02 | 0.06 | 0.13 | 1.72 | 0.52 | 0.21 | 1.54 |
| SHL53 | 6 | 0.09 | 0.00 | 0.02 | 4.91 | 4.83 | 0.02 | 0.03 | 0.12 | 1.38 | 0.50 | 0.23 | 2.09 |
| SHL54 | 6 | 0.12 | 0.00 | 0.04 | | 4.85 | 0.02 | | 0.12 | 1.31 | 0.48 | 0.25 | 1.76 |
| SHL55 | 12 | 0.13 | 0.00 | 0.02 | | 0.00 | 0.04 | | 0.00 | 0.83 | 0.31 | 0.15 | 0.73 |
| mean | | 0.19 | 0.00 | 0.10 | 4.07 | 3.72 | 0.05 | 0.02 | 0.10 | 1.14 | 0.66 | 0.38 | 1.09 |
| std dev | | 0.09 | 0.01 | 0.39 | 1.27 | 1.31 | 0.04 | 0.02 | 0.04 | 1.31 | 0.38 | 0.25 | 0.40 |
| n | | 55 | 55 | 55 | 43 | 55 | 55 | 42 | 55 | 55 | 55 | 55 | 52 |

**Table 2.** Characteristics of shelf sediments in the far northern Great Barrier Reef

| Station | Depth | Offshore | % gravel | % sand | % mud | clay | $CaCo_3$ | %N | %P | Gravel composition (% of particles) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | m | km | | w/w | | % of mud fraction | | w/w | | % mollusc | % echino. | % foram. | % Halimeda | % terrigen. |
| Lloyd Bay transect | | | | | | | | | | | | | | |
| 3 | 35 | 33 | 95.2 | 3.1 | 1.8 | 35.6 | 97.7 | 0.031 | 0.028 | 1.4 | 0.0 | 0.6 | 96.2 | 0.0 |
| 4 | 16 | 28 | 45.6 | 31.6 | 22.8 | 26.5 | 83.2 | 0.048 | 0.025 | 2.5 | 0.0 | 0.7 | 96.3 | 0.0 |
| 5 | 30 | 19 | 6.6 | 35.6 | 57.8 | 7.9 | 65.2 | 0.069 | 0.040 | 49.4 | 34.5 | 1.5 | 3.4 | 0.0 |
| 6 | 16 | 10 | 2.6 | 21.0 | 76.4 | 8.3 | 39.7 | 0.089 | 0.034 | 75.9 | 22.6 | 0.0 | 0.0 | 0.0 |
| 7 | 7 | 7 | 3.4 | 9.8 | 86.8 | 6.9 | 32.1 | 0.110 | 0.031 | 92.6 | 6.5 | 0.0 | 0.0 | 0.0 |
| Lloyd Bay transect | | | | | | | | | | | | | | |
| 8 | 7 | 3 | 7.6 | 20.8 | 71.6 | 10.2 | 33.6 | 0.097 | 0.016 | 87.9 | 9.5 | 0.5 | 0.0 | 0.5 |
| 9 | 29 | 10 | 8.5 | 55.1 | 36.4 | 12.5 | 30.5 | 0.074 | 0.023 | 44.1 | 10.0 | 0.4 | 0.0 | 39.7 |
| 10 | 38 | 14 | 3.6 | 49.1 | 47.3 | 10.3 | 51.2 | 0.078 | 0.032 | 73.3 | 14.4 | 0.0 | 0.0 | 10.7 |
| 11 | 44 | 24 | 4.9 | 47.6 | 47.5 | 7.8 | 68.1 | 0.066 | 0.037 | 56.7 | 8.5 | 1.1 | 28.3 | 0.0 |
| 12 | 43 | 34 | 35.4 | 59.0 | 5.6 | 57.1 | 93.1 | 0.037 | 0.031 | 5.5 | 0.0 | 8.5 | 82.9 | 0.0 |
| 16 | 38 | 59 | 39.3 | 59.3 | 1.4 | 22.0 | 97.1 | 0.063 | 0.025 | 3.1 | 0.0 | 20.7 | 73.6 | 0.0 |
| 17 | 30 | 46 | 64.6 | 35.1 | 0.3 | 40.9 | 94.7 | 0.051 | 0.034 | 23.1 | 0.4 | 20.7 | 28.2 | 0.0 |
| Shelburne Bay transect | | | | | | | | | | | | | | |
| 28 | 32 | 111 | 53.3 | 46.1 | 0.6 | 35.3 | 93.8 | 0.029 | 0.028 | 5.7 | 0.0 | 6.5 | 79.0 | 0.0 |
| 29 | 31 | 93 | 22.7 | 76.5 | 0.8 | 48.6 | 87.6 | 0.021 | 0.025 | 23.0 | 0.4 | 4.9 | 64.0 | 0.0 |
| 30 | 18 | 76 | 18.7 | 80.2 | 1.1 | 32.9 | 82.6 | 0.041 | 0.030 | 19.3 | 0.2 | 1.6 | 66.4 | 0.0 |
| 31 | 27 | 51 | 8.4 | 65.4 | 26.2 | 15.0 | 75.8 | 0.052 | 0.040 | 74.9 | 17.6 | 1.7 | 0.0 | 0.0 |
| 32 | 27 | 30 | 2.1 | 31.2 | 66.7 | 7.7 | 62.2 | 0.074 | 0.033 | 70.8 | 27.0 | 0.0 | 0.0 | 0.0 |
| 33 | 10 | 2 | 2.5 | 88.0 | 9.5 | 26.2 | 40.9 | 0.037 | 0.010 | 69.7 | 10.2 | 13.6 | 0.3 | 1.5 |

**Table 2** continued

| Station | Depth m | Offshore km | % gravel | % sand w/w | % mud | clay % of mud fraction | $CaCo_3$ | %N w/w | %P | Gravel composition (% of particles) % mollusc | % echino. | % foram. | % Halimeda | % terrigen. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Shelburne Bay transect | | | | | | | | | | | | | | |
| 34 | 7 | 7 | 3.1 | 78.7 | 18.2 | 15.1 | 43.7 | 0.038 | 0.017 | 69.0 | 9.3 | 16.8 | 0.0 | 0.8 |
| 35 | 18 | 6 | 2.4 | 76.3 | 21.3 | 15.3 | 43.0 | 0.041 | 0.018 | 76.9 | 14.7 | 0.8 | 0.2 | 2.7 |
| 36 | 36 | 8 | 5.5 | 63.1 | 31.4 | 11.8 | 47.3 | 0.056 | 0.029 | 63.8 | 22.7 | 0.0 | 0.0 | 5.2 |
| 37 | 38 | 15 | 19.0 | 53.7 | 27.3 | 10.2 | 69.5 | 0.065 | 0.042 | 74.7 | 6.4 | 0.5 | 0.2 | 1.2 |
| 38 | 20 | 45 | 28.7 | 68.6 | 2.7 | 41.3 | 94.3 | 0.157 | 0.030 | 4.3 | 0.2 | 1.1 | 93.2 | 0.0 |
| 39 | 20 | 59 | 66.2 | 24.8 | 9.0 | 17.6 | 96.6 | 0.031 | 0.028 | 6.2 | 0.2 | 1.2 | 85.9 | 0.0 |
| Temple Bay transect | | | | | | | | | | | | | | |
| 42 | 22 | 73 | 36.2 | 52.7 | 11.0 | 48.8 | 93.2 | 0.041 | 0.020 | 2.5 | 0.0 | 1.4 | 94.2 | 0.0 |
| 43 | 45 | 44 | 8.7 | 65.6 | 25.8 | 16.7 | 76.3 | 0.057 | 0.041 | 71.3 | 11.9 | 0.0 | 0.0 | 0.8 |
| 44 | 27 | 28 | 7.3 | 29.0 | 63.7 | 7.5 | 42.0 | 0.088 | 0.033 | 89.4 | 7.2 | 0.0 | 0.0 | 0.0 |
| 45 | 10 | 5 | 2.9 | 16.1 | 81.0 | 8.9 | 32.6 | 0.098 | 0.037 | 76.7 | 18.7 | 0.0 | 0.0 | 0.0 |
| Temple Bay - Inshore | | | | | | | | | | | | | | |
| 46 | 11 | | 4.6 | 16.8 | 78.6 | 7.7 | 35.9 | 0.094 | 0.035 | 77.0 | 17.2 | 0.3 | 0.0 | 0.5 |
| 47 | 7 | | 7.5 | 74.6 | 17.9 | 18.1 | 30.0 | 0.055 | 0.022 | 62.7 | 17.9 | 2.0 | 0.7 | 8.5 |
| 48 | 8 | | 3.3 | 73.6 | 23.1 | 12.4 | 32.6 | 0.070 | 0.026 | 44.1 | 13.6 | 1.3 | 0.0 | 37.8 |
| 49 | 18 | | 5.0 | 25.0 | 70.0 | 10.2 | 38.8 | 0.090 | 0.036 | 74.6 | 14.8 | 0.0 | 0.0 | 0.0 |
| 50 | 17 | | 4.6 | 23.4 | 72.0 | 9.1 | 44.9 | 0.090 | 0.036 | 79.7 | 17.6 | 0.0 | 0.0 | 0.0 |
| 51 | 15 | | 5.8 | 53.5 | 40.7 | 12.4 | 36.6 | 0.068 | 0.031 | 81.9 | 14.1 | 0.0 | 0.0 | 2.5 |
| 52 | 10 | | 14.6 | 34.5 | 50.9 | 10.6 | 39.6 | 0.081 | 0.033 | 84.4 | 14.1 | 0.2 | 0.0 | 0.0 |
| 53 | 7 | | 8.2 | 50.0 | 41.8 | 10.9 | 34.9 | 0.077 | 0.028 | 84.7 | 8.8 | 5.1 | 0.0 | 0.5 |
| 54 | 7 | | 13.7 | 66.6 | 19.7 | 16.0 | 32.6 | 0.068 | 0.026 | 72.9 | 5.0 | 4.3 | 0.1 | 15.2 |

**Table 3.** Depth-weighted mean water column concentrations for depths < 50 m at Coral Sea stations, February 1990

| Station | Depth m | $NH_4$ | $NO_2$ | $NO_3$ | DON | PON µmol/l | $PO_4$ | DOP | POP | Si | Chl µg/l | Pha µg/l | S.S. mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SHL02 | 300 | 0.29 | 0.05 | 0.18 | 4.3 | 3.2 | 0.09 | 0 | 0.05 | 0.78 | 0.28 | 0.25 | 0.70 |
| SHL13 | 300 | 0.18 | 0 | 0.05 | 4.5 | 3.5 | 0.08 | 0 | 0.09 | 0.02 | 1.17 | 0.59 | 0.74 |
| SHL14 | 57 | 0.25 | 0 | 0.34 | 4.4 | 4.4 | 0.06 | 0.05 | 0.10 | 0.10 | 0.90 | 0.52 | |
| SHL21 | 40 | 0.20 | 0 | 0.06 | 5.7 | 3.6 | 0.06 | 0.01 | 0.09 | 0.29 | 1.42 | 0.61 | 0.81 |
| SHL22 | 40 | 0.17 | 0 | 0.04 | 5.0 | 4.0 | 0.05 | 0.01 | 0.09 | 0.13 | 1.17 | 1.03 | 1.08 |
| SHL23 | 40 | 0.20 | 0 | 0.02 | 3.4 | 4.1 | 0.06 | 0.01 | 0.09 | 0.04 | 1.30 | 0.58 | 0.75 |
| SHL24 | 40 | 0.23 | 0 | 0.01 | 3.3 | 1.0 | 0.06 | 0.03 | 0.02 | 1.08 | 0.20 | 0.10 | 0.41 |
| SHL25 | 40 | 0.22 | 0 | 0.02 | 3.6 | 0.8 | 0.06 | 0.01 | 0.02 | 0.91 | 0.14 | 0.08 | 0.43 |
| SHL26 | 40 | 0.16 | 0 | 0.02 | 3.9 | 1.6 | 0.05 | 0.02 | 0.03 | 1.04 | 0.14 | 0.10 | 0.46 |
| SHL27 | 300 | 0.17 | 0.01 | 0.01 | 3.9 | 4.6 | 0.04 | 0.03 | 0.12 | 0 | 0.85 | 0.56 | 1.13 |
| SHL40 | 300 | 0.18 | 0.02 | 0.02 | | 4.0 | 0.05 | | 0.11 | 0 | 0.89 | 0.52 | 0.75 |
| SHL41 | 300 | 0.17 | 0.01 | 0.10 | | 5.0 | 0.05 | | 0.11 | 0.10 | 1.19 | 0.79 | 0.69 |
| mean | | 0.20 | 0.01 | 0.07 | 4.2 | 3.3 | 0.06 | 0.02 | 0.08 | 0.37 | 0.8 | 0.48 | 0.72 |
| std dev | | 0.039 | 0.015 | 0.097 | 0.74 | 1.41 | 0.014 | 0.016 | 0.037 | 0.440 | 0.485 | 0.294 | 0.236 |
| n | | 12 | 12 | 12 | 10 | 12 | 12 | 10 | 12 | 12 | 12 | 12 | 11 |

**Table 4.** Depth weighted mean water column concentrations at inshore stations (depth < 20 m), February 1990

| Station | Depth m | $NH_4$ | $NO_2$ | $NO_3$ | DON | PON µmol/l | $PO_4$ | DOP | POP | Si | Chl µg/l | Pha µg/l | S.S. mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SHL06 | 16 | 0.16 | 0 | 0.05 | 3.5 | 4.2 | 0.04 | 0.03 | 0.09 | 1.46 | 0.34 | 0.22 | 1.15 |
| SHL07 | 6 | 0.17 | 0 | 0.04 | 4.4 | 2.8 | 0.04 | 0.02 | 0.1 | 7.87 | 0.3 | 0.13 | 1.55 |
| SHL08 | 8 | 0.14 | 0 | 0.05 | 3.4 | 4.2 | 0.04 | 0.02 | 0.13 | 2.59 | 0.42 | 0.22 | 1.8 |
| SHL33 | 10 | 0.30 | 0 | 0.03 | 2.6 | 6.4 | 0.03 | 0.04 | 0.15 | 0.22 | 0.63 | 0.31 | 1.9 |
| SHL34 | 6 | 0.45 | 0 | 0.04 | 2.6 | 7.0 | 0.03 | 0.01 | 0.16 | 0 | 0.57 | 0.37 | 2.24 |
| SHL35 | 16 | 0.50 | 0.01 | 0.02 | 1.7 | 4.2 | 0.05 | | 0.13 | 0.55 | 0.48 | 0.18 | 1.26 |
| SHL36 | 36 | 0.19 | 0 | 0.03 | | 3.3 | 0.05 | | 0.1 | 0.97 | 0.58 | 0.21 | 0.96 |
| SHL45 | 9 | 0.09 | 0 | 0.04 | | 4.1 | 0.04 | | 0.11 | 2.28 | 0.3 | 0.14 | 1.41 |
| SHL46 | 10 | 0.14 | 0 | 0.04 | 6.6 | 6.2 | 0.04 | 0.04 | 0.12 | 3.03 | 0.49 | 0.28 | 1.23 |
| SHL47 | 7 | 0.15 | 0 | 0.04 | 5.4 | 4.1 | 0.04 | 0.02 | 0.09 | 2.84 | 0.43 | 0.2 | 0.87 |
| SHL48 | 6 | 0.10 | 0 | 0.05 | 5.4 | 4.0 | 0.05 | 0.03 | 0.08 | 3.41 | 0.41 | 0.17 | 0.99 |
| SHL49 | 16 | 0.11 | 0 | 0.04 | 5.7 | 2.4 | 0.03 | 0.04 | 0.07 | 1.57 | 0.34 | 0.16 | 0.78 |
| SHL50 | 16 | 0.12 | 0 | 0.03 | 5.2 | 3.2 | 0.04 | 0.01 | 0.07 | 1.3 | 0.34 | 0.14 | 0.87 |
| SHL51 | 14 | 0.13 | 0 | 0.03 | 5.2 | 3.6 | 0.12 | 0.01 | 0.09 | 1.97 | 0.44 | 0.17 | 1.32 |
| SHL52 | 9 | 0.09 | 0 | 0.03 | 4.6 | 4.3 | 0.02 | 0.06 | 0.13 | 1.72 | 0.52 | 0.21 | 1.54 |
| SHL53 | 6 | 0.09 | 0 | 0.02 | 4.9 | 4.8 | 0.02 | 0.03 | 0.12 | 1.38 | 0.5 | 0.23 | 2.09 |
| SHL54 | 6 | 0.12 | 0 | 0.04 | | 4.9 | 0.02 | | 0.12 | 1.31 | 0.48 | 0.25 | 1.76 |
| mean | | 0.18 | 0 | 0.04 | 4.4 | 4.3 | 0.04 | 0.03 | 0.11 | 2.03 | 0.45 | 0.21 | 1.4 |
| std dev | | 0.122 | 0.002 | 0.009 | 1.4 | 1.2 | 0.023 | 0.015 | 0.026 | 1.783 | 0.100 | 0.064 | 0.446 |
| n | | 17 | 17 | 17 | 14 | 17 | 17 | 13 | 17 | 17 | 17 | 17 | 17 |

**Table 5.** Depth-weighted mean water column concentrations at outer shelf stations (depth > 20 m), February 1990

| Station | Depth m | $NH_4$ | $NO_2$ | $NO_3$ | DON | PON µmol/l | $PO_4$ | DOP | POP | Si | Chl µg/l | Pha µg/l | S.S. mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SHL03 | 35 | 0.15 | 0 | 0.06 | 3.3 | 3.8 | 0.06 | 0.02 | 0.08 | 0.63 | 0.57 | 0.36 | 0.88 |
| SHL04 | 16 | 0.19 | 0 | 0.05 | 3.2 | 2.2 | 0.05 | 0 | 0.09 | 1.54 | 0.27 | 0.27 | 0.93 |
| SHL05 | 28 | 0.18 | 0 | 0.04 | 3.9 | 4.6 | 0.05 | 0 | 0.09 | 2.34 | 0.70 | 0.42 | 1.40 |
| SHL09 | 28 | 0.12 | 0 | 0.04 | 3.4 | 3.9 | 0.04 | 0.01 | 0.09 | 2.99 | 0.59 | 0.37 | 1.48 |
| SHL10 | 38 | 0.18 | 0 | 0.03 | 3.5 | 4.0 | 0.05 | 0.01 | 0.09 | 1.50 | 0.46 | 0.27 | 1.16 |
| SHL11 | 44 | 0.21 | 0 | 0.04 | 3.4 | 2.9 | 0.06 | 0.01 | 0.11 | 2.23 | 1.05 | 0.60 | 0.89 |
| SHL12 | 43 | 0.18 | 0 | 0.18 | 3.7 | 3.2 | 0.07 | 0.01 | 0.10 | 2.43 | 1.07 | 0.55 | |
| SHL15 | 21 | 0.42 | 0 | 0 | 4.7 | 3.4 | 0.02 | 0.06 | 0.10 | 0.01 | 0.65 | 0.43 | 0.96 |
| SHL16 | 28 | 0.41 | 0.01 | 0.10 | 4.7 | 2.6 | 0.06 | 0.02 | 0.07 | 0.21 | 0.85 | 0.48 | 0.76 |
| SHL17 | 40 | 0.26 | 0 | 0.02 | 4.9 | 4.6 | 0.04 | 0.03 | 0.09 | 0.12 | 0.51 | 0.30 | 1.08 |
| SHL18 | 40 | 0.30 | 0 | 0.02 | 5.0 | 2.4 | 0.04 | 0.02 | 0.09 | 0.02 | 0.66 | 0.40 | 0.88 |
| SHL19 | 32 | 0.28 | 0 | 0.03 | 5.0 | 2.4 | 0.05 | 0.02 | 0.07 | 0.19 | 0.45 | 0.33 | 0.88 |
| SHL20 | 34 | 0.19 | 0 | 0.08 | 5.3 | 3.5 | 0.05 | 0.06 | 0.09 | 0.21 | 0.82 | 0.45 | 0.84 |
| SHL28 | 34 | 0.18 | 0.05 | 2.91 | 1.1 | 2.9 | 0.30 | 0 | 0.08 | 0.76 | 1.45 | 0.96 | 0.84 |
| SHL29 | 34 | 0.16 | 0.01 | 0.02 | 2.2 | 5.2 | 0.07 | 0 | 0.12 | 0.04 | 1.71 | 1.18 | 1.13 |
| SHL30 | 18 | 0.14 | 0.02 | 0.01 | 2.6 | 5.8 | 0.05 | 0 | 0.13 | 0.39 | 0.79 | 0.64 | 1.67 |
| SHL31 | 300 | 0.15 | 0 | 0.03 | 2.4 | 3.2 | 0.04 | 0 | 0.11 | 1.26 | 0.51 | 0.28 | 1.29 |
| SHL32 | 26 | 0.15 | 0 | 0.01 | 2.7 | 3.0 | 0.04 | 0.03 | 0.09 | 1.02 | 0.46 | 0.18 | 1.04 |
| SHL36 | 36 | 0.19 | 0 | 0.03 | | 3.3 | 0.05 | | 0.10 | 0.97 | 0.58 | 0.21 | 0.96 |
| SHL37 | 34 | 0.18 | 0 | 0.05 | | 3.3 | 0.05 | | 0.10 | 0.78 | 0.77 | 0.38 | 1.34 |
| SHL38 | 18 | 0.15 | 0 | 0.03 | | 3.8 | 0.02 | | 0.12 | 0.21 | 0.89 | 0.46 | 0.96 |
| SHL39 | 18 | 0.21 | 0 | 0.02 | | 3.8 | 0.06 | | 0.11 | 0.14 | 0.98 | 0.51 | 0.96 |
| SHL42 | 20 | 0.08 | 0 | 0.06 | | 5.4 | 0.06 | | 0.12 | 0.44 | 1.59 | 0.88 | 0.77 |
| SHL43 | 44 | 0.09 | 0 | 0.04 | | 3.9 | 0.03 | | 0.09 | 0.54 | 0.24 | 0.14 | 0.99 |
| SHL44 | 27 | 0.09 | 0 | 0.05 | | 2.9 | 0.03 | | 0.10 | 1.62 | 0.30 | 0.18 | 1.24 |
| mean | | 0.19 | 0 | 0.16 | 3.6 | 3.6 | 0.06 | 0.02 | 0.10 | 0.90 | 0.76 | 0.45 | 1.06 |
| std dev | | 0.085 | 0.011 | 0.574 | 1.2 | 1.0 | 0.052 | 0.019 | 0.015 | 0.869 | 0.386 | 0.25 | 0.238 |
| n | | 25 | 25 | 25 | 18 | 25 | 25 | 18 | 25 | 25 | 25 | 25 | 24 |

**Table 6.** Depth-weighted mean water column concentrations at shelf stations on the two northern transects, February 1990

| Station | Depth m | $NH_4$ | $NO_2$ | $NO_3$ | DON | PON µmol/l | $PO_4$ | DOP | POP | Si | Chl µg/l | Pha µg/l | S.S. mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SHL28 | 34 | 0.18 | 0.05 | 2.91 | 1.1 | 2.9 | 0.30 | 0 | 0.08 | 0.76 | 1.45 | 0.96 | 0.84 |
| SHL29 | 34 | 0.16 | 0.01 | 0.02 | 2.2 | 5.2 | 0.07 | 0 | 0.12 | 0.04 | 1.71 | 1.18 | 1.13 |
| SHL30 | 18 | 0.14 | 0.02 | 0.01 | 2.6 | 5.8 | 0.05 | 0 | 0.13 | 0.39 | 0.79 | 0.64 | 1.67 |
| SHL31 | 300 | 0.15 | 0 | 0.03 | 2.4 | 3.2 | 0.04 | 0 | 0.11 | 1.26 | 0.51 | 0.28 | 1.29 |
| SHL32 | 26 | 0.15 | 0 | 0.01 | 2.7 | 3.0 | 0.04 | 0.03 | 0.09 | 1.02 | 0.46 | 0.18 | 1.04 |
| SHL33 | 10 | 0.30 | 0 | 0.03 | 2.6 | 6.4 | 0.03 | 0.04 | 0.15 | 0.22 | 0.63 | 0.31 | 1.90 |
| SHL34 | 6 | 0.45 | 0 | 0.04 | 2.6 | 7.0 | 0.03 | 0.01 | 0.16 | 0 | 0.57 | 0.37 | 2.24 |
| SHL35 | 16 | 0.50 | 0.01 | 0.02 | 1.7 | 4.2 | 0.05 | | 0.13 | 0.55 | 0.48 | 0.18 | 1.26 |
| SHL36 | 36 | 0.19 | 0 | 0.03 | | 3.3 | 0.05 | | 0.10 | 0.97 | 0.58 | 0.21 | 0.96 |
| SHL37 | 34 | 0.18 | 0 | 0.05 | | 3.3 | 0.05 | | 0.10 | 0.78 | 0.77 | 0.38 | 1.34 |
| SHL38 | 18 | 0.15 | 0 | 0.03 | | 3.8 | 0.02 | | 0.12 | 0.21 | 0.89 | 0.46 | 0.96 |
| SHL39 | 18 | 0.21 | 0 | 0.02 | | 3.8 | 0.06 | | 0.11 | 0.14 | 0.98 | 0.51 | 0.96 |
| mean | | 0.23 | 0.01 | 0.27 | 2.2 | 4.3 | 0.07 | 0.01 | 0.12 | 0.53 | 0.82 | 0.47 | 1.30 |
| std dev | | 0.123 | 0.015 | 0.833 | 0.6 | 1.4 | 0.0775 | 0.017 | 0.023 | 0.424 | 0.395 | 0.315 | 0.431 |
| n | | 12 | 12 | 12 | 8 | 12 | 12 | 7 | 12 | 12 | 12 | 12 | 12 |

**Table 7.** Depth-weighted mean water column concentrations at stations on the southern transects, February 1990

| Station | Depth m | $NH_4$ | $NO_2$ | $NO_3$ | DON | PON µmol/l | $PO_4$ | DOP | POP | Si | Chl µg/l | Pha µg/l | S.S. mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SHL03 | 35 | 0.15 | 0 | 0.06 | 3.3 | 3.8 | 0.06 | 0.02 | 0.08 | 0.63 | 0.57 | 0.36 | 0.88 |
| SHL04 | 16 | 0.19 | 0 | 0.05 | 3.2 | 2.2 | 0.05 | 0 | 0.09 | 1.54 | 0.27 | 0.27 | 0.93 |
| SHL05 | 28 | 0.18 | 0 | 0.04 | 3.9 | 4.6 | 0.05 | 0 | 0.09 | 2.34 | 0.70 | 0.42 | 1.40 |
| SHL06 | 16 | 0.16 | 0 | 0.05 | 3.5 | 4.2 | 0.04 | 0.03 | 0.09 | 1.46 | 0.34 | 0.22 | 1.15 |
| SHL07 | 6 | 0.17 | 0 | 0.04 | 4.4 | 2.8 | 0.04 | 0.02 | 0.10 | 7.87 | 0.30 | 0.13 | 1.55 |
| SHL08 | 8 | 0.14 | 0 | 0.05 | 3.4 | 4.2 | 0.04 | 0.02 | 0.13 | 2.59 | 0.42 | 0.22 | 1.80 |
| SHL09 | 28 | 0.12 | 0 | 0.04 | 3.4 | 3.9 | 0.04 | 0.01 | 0.09 | 2.99 | 0.59 | 0.37 | 1.48 |
| SHL10 | 38 | 0.18 | 0 | 0.03 | 3.5 | 4.0 | 0.05 | 0.01 | 0.09 | 1.50 | 0.46 | 0.27 | 1.16 |
| SHL11 | 44 | 0.21 | 0 | 0.04 | 3.4 | 2.9 | 0.06 | 0.01 | 0.11 | 2.23 | 1.05 | 0.60 | 0.89 |
| SHL12 | 43 | 0.18 | 0 | 0.18 | 3.7 | 3.2 | 0.07 | 0.01 | 0.10 | 2.43 | 1.07 | 0.55 | |
| SHL15 | 21 | 0.42 | 0 | 0 | 4.7 | 3.4 | 0.02 | 0.06 | 0.10 | 0.01 | 0.65 | 0.43 | 0.96 |
| mean | | 0.19 | 0.00 | 0.05 | 3.7 | 3.6 | 0.05 | 0.02 | 0.10 | 2.33 | 0.58 | 0.35 | 1.22 |
| std dev | | 0.080 | 0.000 | 0.045 | 0.5 | 0.7 | 0.013 | 0.017 | 0.013 | 2.039 | 0.274 | 0.145 | 0.321 |
| n | | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 10 |

**Table 8.** Depth-weighted mean water column concentrations at stations within Temple Bay, February 1990

| Station | Depth m | $NH_4$ | $NO_2$ | $NO_3$ | DON | PON µmol/l | $PO_4$ | DOP | POP | Si | Chl µg/l | Pha µg/l | S.S. µg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SHL45 | 9 | 0.09 | 0 | 0.04 | | 4.1 | 0.04 | | 0.11 | 2.28 | 0.30 | 0.14 | 1.41 |
| SHL46 | 10 | 0.14 | 0 | 0.04 | 6.6 | 6.2 | 0.04 | 0.04 | 0.12 | 3.03 | 0.49 | 0.28 | 1.23 |
| SHL47 | 7 | 0.15 | 0 | 0.04 | 5.4 | 4.1 | 0.04 | 0.02 | 0.09 | 2.84 | 0.43 | 0.20 | 0.87 |
| SHL48 | 6 | 0.10 | 0 | 0.05 | 5.4 | 4.0 | 0.05 | 0.03 | 0.08 | 3.41 | 0.41 | 0.17 | 0.99 |
| SHL49 | 16 | 0.11 | 0 | 0.04 | 5.7 | 2.4 | 0.03 | 0.04 | 0.07 | 1.57 | 0.34 | 0.16 | 0.78 |
| SHL50 | 16 | 0.12 | 0 | 0.03 | 5.2 | 3.2 | 0.04 | 0.01 | 0.07 | 1.30 | 0.34 | 0.14 | 0.87 |
| SHL51 | 14 | 0.13 | 0 | 0.03 | 5.2 | 3.6 | 0.12 | 0.01 | 0.09 | 1.97 | 0.44 | 0.17 | 1.32 |
| SHL52 | 9 | 0.09 | 0 | 0.03 | 4.6 | 4.3 | 0.02 | 0.06 | 0.13 | 1.72 | 0.52 | 0.21 | 1.54 |
| SHL53 | 6 | 0.09 | 0 | 0.02 | 4.9 | 4.8 | 0.02 | 0.03 | 0.12 | 1.38 | 0.50 | 0.23 | 2.09 |
| SHL54 | 6 | 0.12 | 0 | 0.04 | | 4.9 | 0.02 | | 0.12 | 1.31 | 0.48 | 0.25 | 1.76 |
| mean | | 0.11 | 0 | 0.036 | 5.4 | 4.1 | 0.04 | 0.03 | 0.10 | 2.08 | 0.43 | 0.20 | 1.29 |
| std dev | | 0.02 | 0 | 0.008 | 0.6 | 1.0 | 0.029 | 0.017 | 0.023 | 0.773 | 0.076 | 0.047 | 0.428 |
| n | | 10 | 10 | 10 | 8 | 10 | 10 | 8 | 10 | 10 | 10 | 10 | 10 |

**Table 9.** Depth-weighted mean water column concentrations at inshore stations in Shelburne and Lloyd Bays, February 1990

| Station | Depth m | $NH_4$ | $NO_2$ | $NO_3$ | DON | PON µmol/l | $PO_4$ | DOP | POP | Si | Chl µg/l | Pha µg/l | S.S. mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SHL06 | 16 | 0.16 | 0 | 0.05 | 3.5 | 4.2 | 0.04 | 0.03 | 0.09 | 1.46 | 0.34 | 0.22 | 1.15 |
| SHL07 | 6 | 0.17 | 0 | 0.04 | 4.4 | 2.8 | 0.04 | 0.02 | 0.10 | 7.87 | 0.30 | 0.13 | 1.55 |
| SHL08 | 8 | 0.14 | 0 | 0.05 | 3.4 | 4.2 | 0.04 | 0.02 | 0.13 | 2.59 | 0.42 | 0.22 | 1.80 |
| SHL33 | 10 | 0.30 | 0 | 0.03 | 2.6 | 6.4 | 0.03 | 0.04 | 0.15 | 0.22 | 0.63 | 0.31 | 1.90 |
| SHL34 | 6 | 0.45 | 0 | 0.04 | 2.6 | 7.0 | 0.03 | 0.01 | 0.16 | 0 | 0.57 | 0.37 | 2.24 |
| SHL35 | 16 | 0.50 | 0.01 | 0.02 | 1.7 | 4.2 | 0.05 |  | 0.13 | 0.55 | 0.48 | 0.18 | 1.26 |
| SHL36 | 36 | 0.19 | 0 | 0.03 |  | 3.3 | 0.05 |  | 0.10 | 0.97 | 0.58 | 0.21 | 0.96 |
| mean |  | 0.27 | 0 | 0.04 | 3.0 | 4.6 | 0.04 | 0.02 | 0.12 | 1.95 | 0.47 | 0.23 | 1.55 |
| std dev |  | 0.148 | 0.004 | 0.011 | 0.9 | 1.5 | 0.008 | 0.011 | 0.027 | 2.751 | 0.126 | 0.081 | 0.457 |
| n |  | 7 | 7 | 7 | 6 | 7 | 7 | 5 | 7 | 7 | 7 | 7 | 7 |

**Table 10.** Means and standard deviations of depth-weighted mean mixed-layer nutrient and chlorophyll concentrations in the Torres Strait and the Ribbon Reefs

| | $NH_4$ | $NO_2$ | $NO_3$ | DON µmol/l | $PO_4$ | DOP | $Si(OH)_4$ | Chlorophyll µg/l |
|---|---|---|---|---|---|---|---|---|
| Torres Strait and far northern GBR - November/December 1979 | | | | | | | | |
| mean | 0.58 | 0.05 | 0.33* | 4.20 | 0.1* | 0.13 | 3.36 | 0.41 |
| std. dev | 0.34 | 0.04 | 0.13* | 1.08 | 0.03* | 0.05 | 1.82 | 0.22 |
| no. stations | 19 | 20 | 19* | 19 | 19* | 19 | 20 | 20 |
| Ribbon Reefs (Cooktown - Lizard Island - Princess Charolette Bay) - October 1987 | | | | | | | | |
| mean | 0.02 | < 0.01 | 0.06 | | 0.01 | | 0.06 | 0.31 |
| std. dev | 0.03 | < 0.01 | 0.09 | | 0.02 | | 0.07 | 0.13 |
| no. stations | 63 | 63 | 63 | | 63 | | 63 | 52 |

* One Torres Strait Station (10) excluded: mean $NO_3$=4.93 µM, mean $PO_4$=2.71 µM

The degree of horizontal spatial variability of individual nutrient species and water column parameters within the defined sub-areas was assessed in a pair-wise comparison between sub-areas using one-way analyses of variance (Sokal and Rohlf 1981). Because of the complex bathymetry and current patterns within the region and because transects were only occupied once, a more detailed spatial analysis would be unwarranted. As mixed-layer concentrations of all parameters fluctuated within relatively small ranges and individual values were smoothed by the depth weighting process, the data were not transformed. One outlying nitrate water column mean (station 34) was deleted from the working data set. Results of the pairwise comparisons are given in table 11.

Coherent spatial distributions of nutrient species within the study area are not readily apparent. Statistically significant differences between mean concentrations of individual nutrient species were found between geographically defined groups of stations. In most cases, these differences between group means are relatively small and the apparent spatial gradients do not apply to all species of a particular nutrient element. For most dissolved nutrient species, standard deviations for group means are of similar order to analytical precision of individual analyses. In the absence of more detailed information on circulation and nutrient process rates within the area, it would appear that spatial trends in concentrations of nutrients were very weak, if they existed at all, during the period of the survey.

**Table 11.** Pairwise comparisons (one-way ANOVA) between depth-weighted mean water column nutrient concentrations in the far northern Great Barrier Reef and adjoining waters. Values shows are probabilities < 0.1 for incorrect rejection of the hypothesis that the means of the grouped stations are equal. Gaps indicate the lack of a significant difference ($p > 0.1$)

| | | $NH_4$ | $NO_2$ | $NO_3$ | DON | PON | $PO_4$ | DOP | POP | Si | Chl a | S.S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | vs. | | | | | | | | | | | |
| Coral Sea | Inshore (< 20 m) | | 0.001 | | | 0.050 | 0.004 | | 0.009 | 0.004 | 0.006 | <.001 |
| Coral Sea | Outer-shelf (> 20 m) | 0.004 | | | | | | | 0.020 | 0.055 | | 0.001 |
| Inshore (< 20 m) | Outer-shelf (> 20 m) | | | | | 0.037 | | 0.097 | 0.069 | 0.010 | 0.002 | 0.003 |
| Temple Bay | Outer bays inshore | 0.004 | 0.010 | 0.029 | <.001 | | | | 0.079 | | | |
| North transects | Southern transects | | | | <.001 | | | | 0.023 | 0.007 | | |
| North transects | Torres Strait | 0.002 | 0.001 | | | | | <.001 | | <.001 | 0.001 | |
| All Shelburne | Torres Strait | <.001 | <.001 | 0.014 | | | 0.036 | <.001 | | <.001 | 0.009 | |
| All Shelburne | Ribbon Reefs | <.001 | 0.067 | | | | <.001 | | | <.001 | <.001 | |

Some comparisons between groups of stations are worthy of note, however. Not surprisingly, suspended solids concentrations at shelf stations were significantly higher than in the Coral Sea. Chlorophyll concentrations at both inshore and Coral Sea stations were higher than in the Coral Sea. Chlorophyll concentrations at both inshore and Coral Sea stations were higher than on the outer shelf. Higher concentrations of chlorophyll might be expected inshore. The higher Coral Sea chlorophyll concentrations, measured at stations immediately outside of the reef, appear due to exchange through gaps between shelfbreak reefs (Wolanski et al. 1988) which pulls sub-thermocline nutrients into the surface mixed layer. Alternative mechanisms for nutrient mixing in the reef-ocean boundary include geostrophically forced transport through reef gaps (Nof and Middleton 1989) or tidal pumping due to internal waves (Thompson and Wolanski 1984).

Mean water column concentrations of dissolved nutrients within the study area were generally lower than concentrations of the same species within the Torres Strait (sampled in November 1979) and higher than concentrations in the Lizard Island-Ribbon Reef region (sampled in October 1987; table 10). Chlorophyll concentrations in the study area were, on the whole, higher than to the north and south. Inferences about a north-south gradient of nutrient levels within the far northern Great Barrier Reef, however, should be tempered with caution. Subtle, but significant evolution has occurred since 1979 with regard to the handling and analysis of dissolved nutrient samples by the Australian Institute of Marine Science Laboratory Services group, which generally has led to a drop in measured concentrations as contamination sources have been controlled. The Ribbon Reef nutrient samples were analysed at sea directly after sample collection, which is likely to have reduced sources of contamination arising from sample storage. These systematic differences are believed to be small in absolute magnitude, but nonetheless, are of similar order to the apparent differences between data sets.

Primary production rates in the study area (table 12) were high relative to areal rates measured in the central Great Barrier Reef (Furnas and Mitchell 1987, 1990). The bulk of standing crop and primary production was attributable to picoplankton (> 2 µm size fraction). Production rates within the study area were higher than rates measured within the Great Barrier Reef

lagoon immediately prior to and following the sampling period (SHL001 - 15.5°S, SHL005 - 14.5°S). The highest areal production rates, surprisingly, were measured at the two production stations (SHL027 - Raine Island, SHL041 - Wreck Bay) occupied outside of the reef. The high production rates at these stations appear due to three factors: higher phytoplankton standing crops (chlorophyll concentrations) at these stations, deeper euphotic zones at offshore stations (75-90 m vs. 15-35 m) and occurrence of high production rates to deeper depths within the euphotic zone. Production rates at these two stations were the highest non-cyclone affected production rates measured to date by the Biological Oceanography group in Great Barrier Reef waters. Lower areal production rates in inshore waters largely reflect the shallower depth of the water column (euphotic zone). At all stations, appreciable levels of irradiance penetrated to the sea floor (figures 3-6). In no case did near-bottom scalar irradiance at near-shore stations fall below 20% of surface irradiance during the cruise.

**Table 12.** Chlorophyll standing crops ($mg/m^2$) and mid-day hourly water column primary production rates (mg $C/m^2/hr$) in the far northern Great Barrier Reef and adjacent waters of the Coral Sea. Mean chlorophyll concentrations will differ from hydrographic stations due to different sampling depths used. Daily primary production can be estimated by multiplying the mid-day hourly rates by eight.

| Station | | Total | > 10 µm fraction | 10-2 µm fraction | < 2 µm fraction |
|---|---|---|---|---|---|
| Shl 01 (GBR lagoon ca. 15°S) | | | | | |
| | Chlorophyll | 9.5 | 1.8 | 1.2 | 6.5 |
| | Production | 89.6 | 3.5 | 8.8 | 78.9 |
| Shl 03 | Chlorophyll | 18.3 | 7.8 | 1.6 | 9.0 |
| | Production | 381.3 | 61.1 | 44.2 | 276.0 |
| Shl 09 | Chlorophyll | 15.1 | 7.5 | 3.3 | 4.2 |
| | Production | 215.5 | | | |
| Shl 16 | Chlorophyll | 21.0 | 9.2 | 8.8 | 2.9 |
| | Production | 185.6 | | | |
| Shl 19 | Chlorophyll | 19.3 | 6.3 | 6.7 | 6.3 |
| | Production | 284.7 | 40.0 | 36.4 | 208.3 |
| Shl 27 | Chlorophyll | 65.9 | | | 15.8 |
| | Production | 1001.9 | 129.9 | 157.2 | 714.8 |
| Shl 35 | Chlorophyll | 7.1 | 2.1 | 0.9 | 4.1 |
| | Production | 133.6 | 9.9 | 6.2 | 117.5 |
| Shl 41 | Chlorophyll | | | | |
| | Production | 957.5 | 40.8 | 206.5 | 710.3 |
| Shl 55 (GBR lagoon ca. 14°S) | | | | | |
| | Chlorophyll | 3.7 | 2.7 | 0.3 | 0.8 |
| | Production | 75.0 | 5.5 | 5.3 | 64.2 |

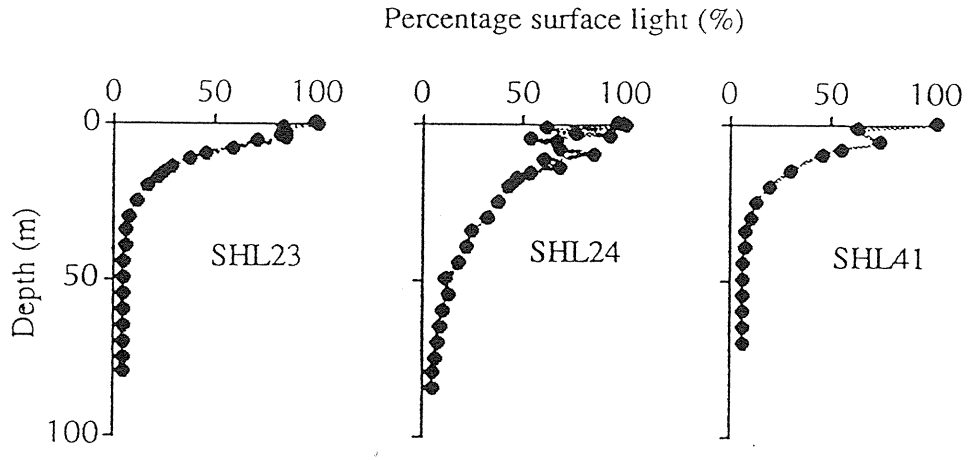


**Figure 6.** Light profiles from stations, 50-100 m depth

Near bottom irradiance levels at mid- and outer-shelf stations ranged from > 25 to < 5 percent of surface irradiance. In all cases, readily measurable light was reaching the bottom and accounted for the growth of benthic algae.

Zooplankton standing crop (mg $m^{-3}$ dry weight) exhibited a distinct inshore (mean = 26.3) - outer shelf (18.7) - Coral Sea (8.9) gradient. No significant north-south or Temple Bay-other bays differences were observed. A taxonomic analysis of the populations collected has not been made.

Not surprisingly, clear onshore-offshore gradients were observed in sediment grain size and particle characteristics (figure 7). Nearshore sediments had higher contents of terrigenous minerals and lower carbonate contents than offshore sediments. The carbonate content of sediments ranged from > 90 percent by weight at the shelfbreak to 30-40 percent at nearshore stations. The gravel sizer fraction dominated surficial sediments at outer-shelf stations. At inshore stations, this fraction was largely comprised of mollusc fragments, while degraded fragments of the calcareous green alga, *Halimeda*, were more important on the outer shelf. In contrast, muds were relatively more important at nearshore sediments.

The phosphorus content of sediments (figure 8 Top) generally peaked at mid-shelf stations. The lower phosphorus content of inshore sediments was probably due to the lower carbonate content and hence phosphorus binding capacity of the sediments. With one exception, the nitrogen content of sediments declined with distance from shore. The high nitrogen content of that one sample was most likely due to the inadvertent inclusion of an organism in the material analysed. Otherwise, differences between transects were slight, if any.

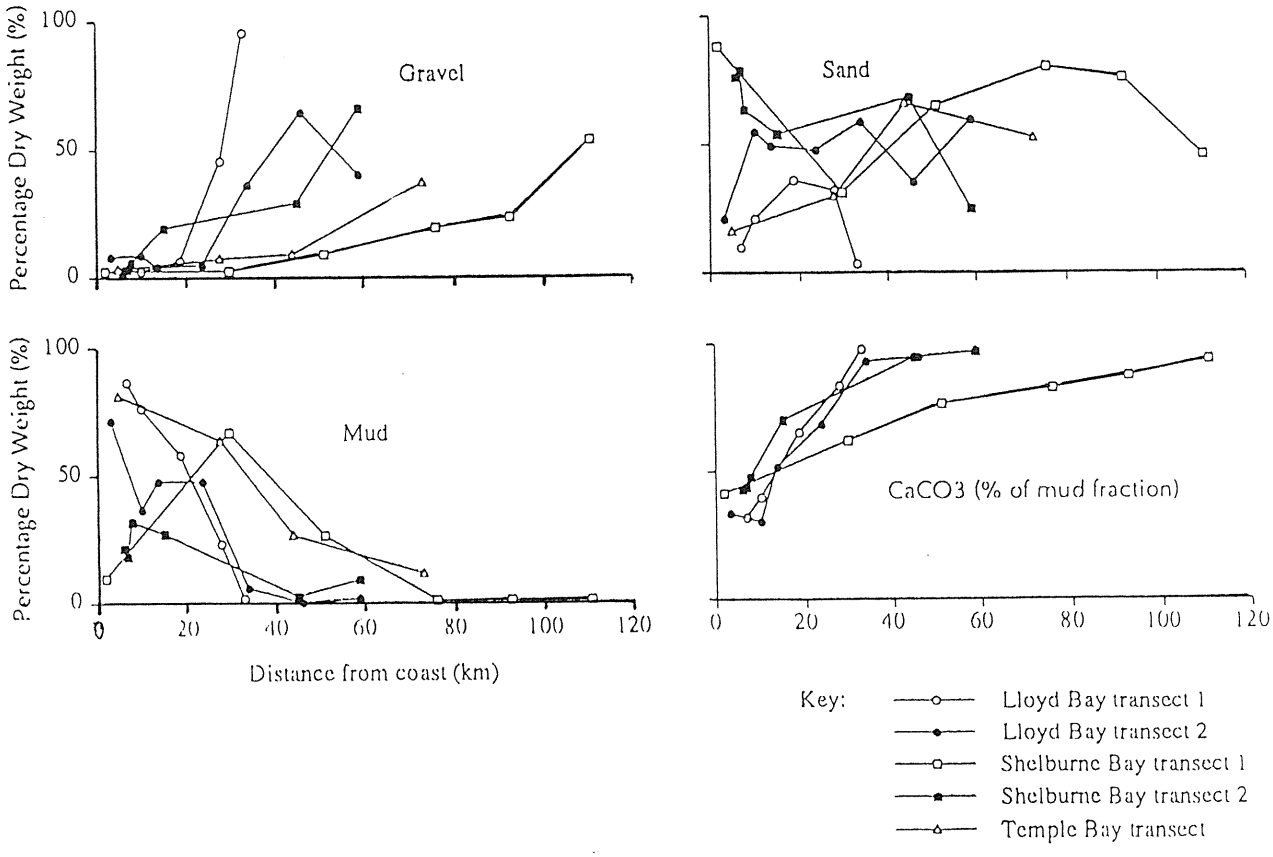


**Figure 7.** Grain size characteristics and $CaCO_3$ (as % of mud fraction) of shelf sediments in relation to distance from coast

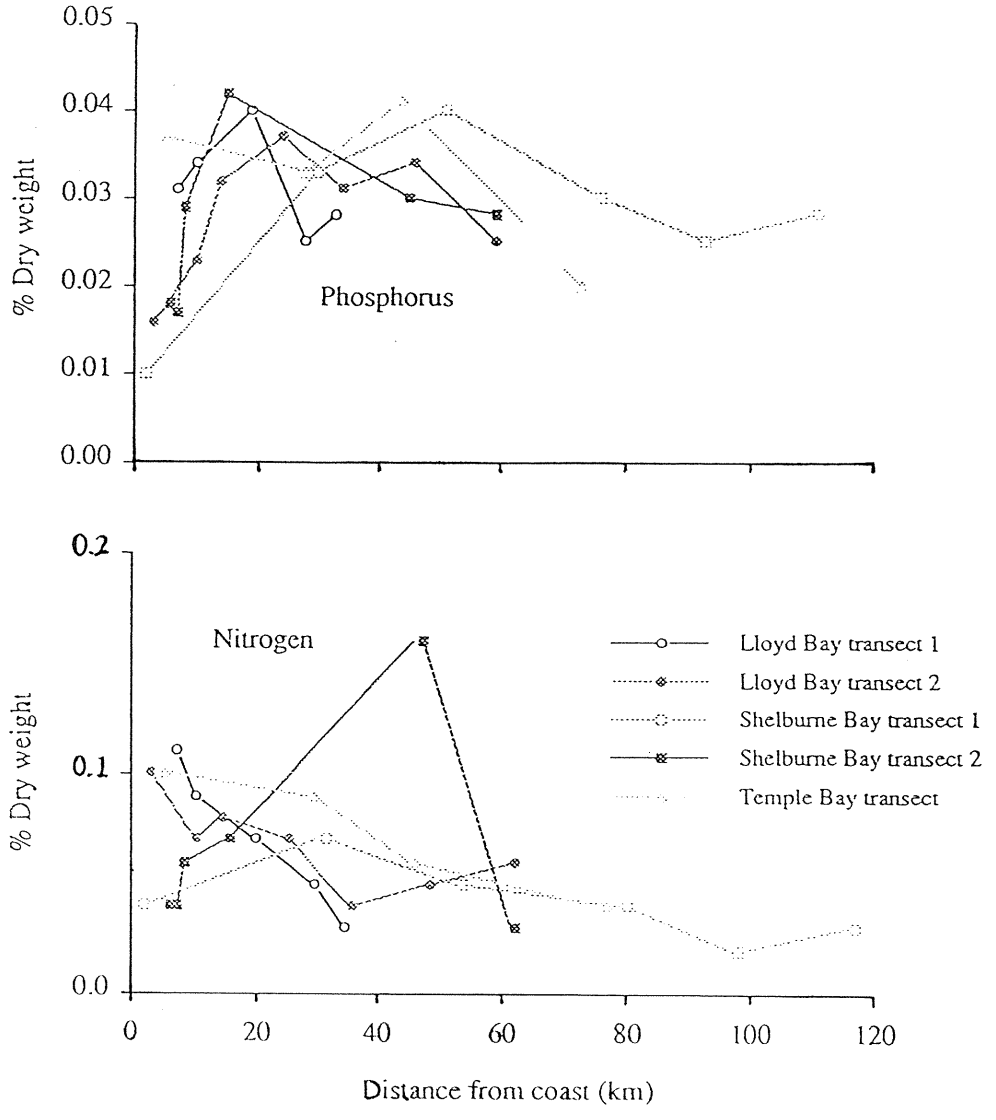


**Figure 8.** Nitrogen and phosphorus content of surficial sediments in relation to distance from coast

## 7. DISCUSSION

Concentrations of dissolved inorganic fixed nitrogen and phosphorus in waters of the far northern Great Barrier Reef during February 1990 were low and did not exhibit clear spatial gradients. Dissolved organic and particular nitrogen and phosphorus species dominated water column nutrient inventories. The resolution of dissolved silicate distributions is constrained by variability introduced from the freezing and thawing of samples. As the data set presented herein summarises the results from only a single cruise, it is not possible to say whether any of the apparent shelf-scale spatial patterns observed for any individual water column nutrient species are stable or ephemeral. The sampling was carried out within a period of low wind energy and high isolation. As a result, the vertical temperature differences observed at shelf stations are largely due to diel heating and low vertical mixing rates.

Under more energetic tradewind conditions, horizontal and vertical variability would be expected to be smaller.

Under the low-wind stress conditions which prevailed during the sampling period, inshore waters in Temple Bay, Lloyd Bay and Shelburne Bay were clear, with little evidence of sediment resuspension and no evidence of cross-shelf dispersal of fresh waters from the small local coastal rivers. The water clarity at inshore stations reflects the moderate productivity of these waters and their low-nutrient status under calm conditions. Water column nutrient and suspended sediment concentrations under high-energy, tradewind conditions are unknown.

Intrusive shelfbreak upwelling was observed at three stations, one (28) just inside of Raine Island entrance and two south of Wreck Bay, just inside of the outer barrier. Near bottom temperatures at station SHL28 were nearly 5°C lower than surface temperatures measured elsewhere and nitrate concentrations were sharply elevated (> 4 μM $NO_3$). Vertical temperature and nitrate gradients were much smaller at the other two stations. Thompson and Wolanski (1984) proposed that upwelling near Raine Island was, in part, driven by tidal fluctuations in the depth of the thermocline.

Statistically significant differences were observed between the present data set and nutrient data collected earlier in the Torres Strait and Lizard Island - Cooktown regions (Mitchell 1982; Furnas unpublished). Absolute differences between mean water column concentrations were relatively small, however. Restraint should be applied in examining these apparent between-study (geographical) differences because of systematic offsets between data sets related to sample collection, processing and analytical procedures.

Northern Great Barrier Reef shelf waters were reasonably productive. Video examination of the benthos showed substantial beds of macroalgae on the outer shelf, dominated in particular by *Halimeda* meadows described elsewhere in the northern Great Barrier Reef by Drew and Abel (1988). Water column areal primary production rates (0.13-0.38 gm C $m^{-2}hr^{-1}$) on the northern shelf were among the highest measured to date anywhere in the Great Barrier Reef (Furnas and Mitchell 1987, 1990). Shelf rates measured within the Great Barrier Reef lagoon between 14 and 15°S going to and from the study area were within the range normally seen for central Great Barrier Reef shelf productivity values (Furnas and Mitchell 1990). The highest areal production rates (0.61-0.67 g C $m^{-2}hr^{-1}$; approx. = 0.5-5.3 g C $m^{-2}d^{-1}$) were measured at two deep-water stations (27, 41) immediately outside of the barrier reef. These two high production rates were similar to production rates measured after Cyclone Winifred (3-4 g C $m^{-2}day^{-1}$). Mid-water chlorophyll concentrations (1.5-1.8 μg $l^{-1}$) at stations 27 and 41 were higher than normally observed at stations outside the reef in the central Great Barrier Reef (Furnas and Mitchell 1986) and were embedded within the top portion of relatively shallow themocline. Phytoplankton within these high-chlorophyll layers were therefore exposed to reasonably high

irradiance levels and elevated nutrient inputs from the nutricline immediately below. Both of the highly productive stations were located within embayments in the outer barrier (Raine Island Entrance, Wreck Bay).

Nutrient pumping mechanisms responsible for the apparent high reef-ocean boundary layer productivity are not fully resolved. Wolanski et al. (1988) invoked mixing from tidally forced jets of water through reef gaps or tidally pumped shelfbreak upwelling (Thompson and Wolanski 1984). Alternatively, Nof and Middleton (1989) suggested geostrophic mechanisms to raise subthermocline waters onto the shelf. Local, topographically controlled upwelling processes may therefore have contributed to the high productivity within the bays. Whatever the mechanism, there is evidence that high boundary layer productivity resulting may be localised or episodic in nature (Furnas and Mitchell 1990).

The cross-shelf changes in sediment characteristics reflect the relative contributions of terrestrial and 'reef-associated' processes to sediment composition. Inshore sediments contained higher percentages of non-carbonate muds while mid-shelf and offshore sediments were dominated by gravels formed from degraded *Halimeda* segments and carbonate muds derived from the *Halimeda* gravels or nearby reefs. It is likely that the bulk of the *Halimeda* gravels were formed in situ, whether or not the sediments were currently covered with living *Halimeda* at the time. The nitrogen content of the sediments was relatively low and in general, declined seaward across the shelf, while sediment phosphorus contents showed no clear cross-shelf gradient. The nitrogen and phosphorus contents measured were similar in magnitude to those measured by Alongi (1989) in the central Great Barrier Reef.

In summary, the area of shelf between 11 and 13°S appears to be pristine in character. Major external sources of nutrients to shelf waters include shelf-break upwelling and the small coastal rivers in the region. At the time of sampling, the shelfbreak upwelling was restricted to the immediate shelfbreak, while any riverine inputs were minimal. There was no clear evidence of freshwaters or other watermass parameter from the Gulf of Papua. The character of inshore waters, particularly within Temple Bay was excellent during the present study and likely varies in response to wind-driven resuspension, cyclonic disturbances and to a more limited extent, terrestrial runoff. Despite low dissolved nutrient concentrations, shelf and adjoining waters were moderately to highly productive. The composition and nutrient status of shelf sediments, however, reflect local sources of sediment materials and the lack of pronounced nutrient loading, suggesting that organic material reaching the bottom from the water column is rapidly recycled.

Dissolved nutrient concentrations within the study area were lower than in the Torres Strait and higher than in the Cooktown region. However, systematic differences between the three data sets compared cannot be ruled out as yet.

## ACKNOWLEDGMENTS

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# APPENDIX

**AIMS Hydrographic Data**
**Shelburne Bay Cruise**

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL001** CTD file: shl001.met AIMS Tape No.: 950

Date: 04/02/90 Time start: 08:32 hrs Time finish: 10:15 hrs Depth 22 m Zooplankton dry wt.: 17.01 mg/m3

Latitude: 15 deg 37.4' Swell ht: .1 m Wind speed: 15 knots

Longitude: 145 deg 24.1' Swell dir: 280 deg Wind dir: 285 deg

| | | | Nutrients | | | | | | | | | Chl | Pha | Chl | Pha | Chl | Pha | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Σ | Σ | <10 µg/l | <10 | <2 | <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 29.32 | 34.43 | .10 | .00 | .03 | 6.5 | 5.4 | .01 | .06 | .53 | 1.17 | .45 | .16 | .12 | .07 | .09 | .04 | |
| 4.0 | 29.33 | 34.43 | .05 | .00 | .02 | 9.4 | 3.7 | .00 | .21 | .12 | 1.08 | .49 | .16 | .09 | .05 | .05 | .03 | |
| 8.0 | 29.32 | 34.43 | .07 | .00 | .03 | 5.6 | 5.8 | .00 | .06 | .16 | 1.24 | .45 | .15 | .12 | .05 | .06 | .02 | |
| 12.0 | 29.32 | 34.43 | .05 | .00 | .03 | 6.5 | 5.9 | .01 | .03 | .53 | .98 | .48 | .19 | .16 | .06 | .08 | .03 | |
| 20.0 | 29.32 | 34.43 | | | | | | | | .08 | | .50 | .17 | .17 | .11 | .24 | .17 | |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL002** CTD file: shl002.met AIMS Tape No.: 950

Date: 05/02/90 Time start: 07:30 hrs Time finish: 08:27 hrs Depth 457 m Zooplankton dry wt.: 1.99 mg/m3

Latitude: 12 deg 36.2' Swell ht: .1 m Wind speed: 10 knots

Longitude: 143 deg 51.3' Swell dir: 280 deg Wind dir: 250 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 28.83 | 34.59 | .27 | .01 | .01 | 5.3 | 4.1 | .06 | .00 | .07 | .98 | .18 | .07 | | | | | .83 |
| 25.0 | 28.13 | 34.64 | .29 | .01 | .01 | 4.4 | 3.3 | .06 | .00 | .04 | .65 | .26 | .20 | | | | | .74 |
| 50.0 | 25.93 | 34.91 | .31 | .15 | .69 | 4.4 | 2.0 | .17 | .00 | .03 | .83 | .43 | .54 | | | | | .50 |
| 75.0 | 25.15 | 34.99 | .30 | .17 | 2.97 | 3.3 | 1.4 | .35 | .00 | .02 | 1.83 | .25 | .28 | | | | | .55 |
| 100.0 | 23.79 | 35.17 | .28 | .02 | 4.35 | 4.2 | 1.2 | .52 | .00 | .02 | 3.56 | .09 | .20 | | | | | .53 |
| 125.0 | 22.64 | | .31 | .03 | 4.35 | 4.3 | .9 | .65 | .00 | .02 | 1.45 | .04 | .11 | | | | | .75 |
| 150.0 | 21.02 | | .21 | .00 | 4.38 | 5.4 | .9 | .85 | .00 | | 2.48 | .02 | .11 | | | | | .43 |
| 200.0 | 17.97 | | 1.86 | .29 | 4.21 | 4.4 | .0 | .53 | .00 | | 3.68 | .02 | .04 | | | | | |
| 250.0 | 15.94 | | 1.85 | .44 | 6.11 | 5.6 | .0 | .66 | .07 | | 5.65 | .01 | .03 | | | | | |
| 300.0 | 13.38 | | 2.12 | .00 | 9.78 | 1.0 | .0 | .61 | .02 | | 7.64 | .02 | .02 | | | | | |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL003** CTD file: shl003.met AIMS Tape No.: 950

Date: 05/02/90 Time start: 09:01 hrs Time finish: 10:25 hrs Depth 35 m Zooplankton dry wt.: 6.44 mg/m3

Latitude: 12 deg 37.6' Swell ht: .7 m Wind speed: 14 knots

Longitude: 143 deg 46.7' Swell dir: 250 deg Wind dir: 250 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients µmol/l | | | | | | | | | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | | | | | | | |
| 0.0 | 28.59 | 34.58 | .10 | .00 | .05 | 4.7 | 4.0 | .05 | .05 | .09 | .15 | .44 | .35 | .18 | .18 | .18 | .14 | .99 |
| 10.0 | 28.40 | 34.60 | .08 | .00 | .05 | 3.3 | 4.6 | .05 | .02 | .09 | .81 | .50 | .34 | .20 | .15 | .26 | .19 | .91 |
| 20.0 | 28.26 | 34.62 | .20 | .00 | .04 | 3.1 | 3.5 | .05 | .01 | .07 | .83 | .60 | .35 | | | | | .86 |
| 30.0 | 27.93 | 34.66 | .18 | .00 | .08 | 3.1 | 2.7 | .07 | .00 | .06 | .49 | .73 | .39 | | | | | .88 |
| 35.0 | 28.26 | 34.66 | .18 | .01 | .15 | 2.6 | 3.4 | .09 | .00 | .06 | .53 | .65 | .41 | .28 | .16 | .31 | .16 | .68 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL004** CTD file: shl004.met AIMS Tape No.: 950

Date: 05/02/90 Time start: 11:10 hrs Time finish: 11:45 hrs Depth 16 m Zooplankton dry wt.: 26.66 mg/m3

Latitude: 12 deg 39.2' Swell ht: .0 m Wind speed: 4 knots

Longitude: 143 deg 40.5' Swell dir: deg Wind dir: 250 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 | Pha <10 | Chl <2 | Pha <2 | Susp. solids |
| | | | µmol/l | | | | | | | | | | | µg/l | | | | mg/l |
| 0.0 | 29.22 | 34.50 | .19 | .00 | .05 | 3.6 | 4.5 | .04 | .00 | .07 | 1.65 | .31 | .21 | | | | | .94 |
| 8.0 | 29.02 | 34.53 | .19 | .00 | .05 | 3.4 | .0 | .05 | .00 | .09 | 2.25 | .17 | .27 | | | | | .86 |
| 16.0 | 28.63 | 34.57 | .19 | .00 | .05 | 3.2 | 4.3 | .05 | .00 | .09 | .00 | .43 | .32 | | | | | 1.06 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL005** CTD file: shl005.met AIMS Tape No.: 950

Date: 05/02/90 Time start: 12:29 hrs Time finish: 13:22 hrs Depth 31 m Zooplankton dry wt.: 49.49 mg/m3

Latitude: 12 deg 40.7' Swell ht: .0 m Wind speed: 0 knots

Longitude: 143 deg 35.0' Swell dir: deg Wind dir: deg

| Depth m | Temp deg C | Salinity ppt | Nutrients NH4 µmol/l | NO2 µmol/l | NO3 µmol/l | DON µmol/l | PON µmol/l | DIP µmol/l | DOP µmol/l | POP µmol/l | Si µmol/l | Chl Σ µg/l | Pha Σ µg/l | Chl <10 µg/l | Pha <10 µg/l | Chl <2 µg/l | Pha <2 µg/l | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 29.52 | 34.45 | .21 | .00 | .04 | 4.5 | 4.3 | .05 | .00 | .07 | 1.96 | .33 | .20 | | | | | .96 |
| 10.0 | 29.10 | 34.52 | .20 | .00 | .04 | 3.4 | 4.6 | .05 | .01 | .08 | 1.59 | .38 | .26 | | | | | 1.24 |
| 20.0 | 28.87 | 34.55 | .14 | .00 | .05 | 5.0 | 4.6 | .06 | .00 | .11 | 2.88 | 1.00 | .54 | | | | | 1.55 |
| 28.0 | 28.85 | 34.55 | .18 | .01 | .03 | 2.9 | 4.9 | .05 | .00 | .10 | 3.45 | 1.29 | .84 | | | | | 2.00 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL006 CTD file: shl006.met AIMS Tape No.: 950

Date: 05/02/90 Time start: 14:00 hrs Time finish: 14:42 hrs Depth 17 m Zooplankton dry wt.: 26.15 mg/m3

Latitude: 12 deg 43.1' Swell ht: .1 m Wind speed: 8 knots

Longitude: 143 deg 29.2' Swell dir: 50 deg Wind dir: 45 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 29.96 | 34.36 | .17 | .00 | .05 | 3.5 | 3.6 | .04 | .04 | .08 | 2.18 | .20 | .13 | | | | | .91 |
| 8.0 | 29.36 | 34.46 | .16 | .00 | .05 | 3.7 | 3.7 | .03 | .04 | .05 | .34 | .20 | .14 | | | | | .98 |
| 16.0 | 29.26 | 34.44 | .17 | .00 | .05 | 3.3 | 5.4 | .05 | .00 | .17 | 2.97 | .75 | .48 | | | | | 1.74 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL007** CTD file: shl007.met AIMS Tape No.: 950

Date: 05/02/90 Time start: 15:15 hrs Time finish: 15:50 hrs Depth 8 m Zooplankton dry wt.: mg/m3

Latitude: 12 deg 47.4' Swell ht: .1 m Wind speed: 12 knots

Longitude: 143 deg 25.4' Swell dir: 90 deg Wind dir: 80 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 | Pha <10 | Chl <2 | Pha <2 | Susp. solids |
| | | | µmol/l | | | | | | | | | | | µg/l | | | | mg/l |
| 0.0 | 30.68 | 34.27 | .16 | .00 | .04 | 6.4 | 2.1 | .02 | .04 | .08 | 9.78 | .23 | .13 | | | | | 1.39 |
| 3.0 | 30.11 | 34.32 | .17 | .00 | .04 | 2.9 | 2.8 | .04 | .01 | .09 | 9.01 | .23 | .08 | | | | | 1.41 |
| 6.0 | 29.71 | 34.37 | .17 | .00 | .06 | 6.0 | 3.1 | .05 | .03 | .13 | 3.68 | .51 | .23 | | | | | 1.97 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL008 CTD file: shl008.met AIMS Tape No.: 950

Date: 06/02/90 Time start: 07:30 hrs Time finish: 07:55 hrs Depth 8 m Zooplankton dry wt.: mg/m3

Latitude: 12 deg 35.6' Swell ht: .0 m Wind speed: 6 knots

Longitude: 143 deg 24.4' Swell dir: deg Wind dir: 180 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients NH4 µmol/l | NO2 µmol/l | NO3 µmol/l | DON µmol/l | PON µmol/l | DIP µmol/l | DOP µmol/l | POP µmol/l | Si µmol/l | Chl Σ µg/l | Pha Σ µg/l | Chl <10 µg/l | Pha <10 µg/l | Chl <2 µg/l | Pha <2 µg/l | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 29.77 | 34.37 | .17 | .00 | .05 | 3.5 | 4.3 | .04 | .02 | .12 | 2.57 | .40 | .25 | | | | | 1.93 |
| 8.0 | 29.78 | 34.37 | .12 | .00 | .05 | 3.5 | 4.0 | .04 | .03 | .14 | 2.61 | .43 | .20 | | | | | 1.68 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL009** CTD file: shl009.met AIMS Tape No.: 950

Date: 06/02/90 Time start: 08:20 hrs Time finish: 09:25 hrs Depth 26 m Zooplankton dry wt.: 19.71 mg/m3

Latitude: 12 deg 30.6' Swell ht: .0 m Wind speed: 6 knots

Longitude: 143 deg 26.8' Swell dir: deg Wind dir: 240 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 | Pha <10 | Chl <2 | Pha <2 | Susp. solids |
| | | | µmol/l | | | | | | | | | | | µg/l | | | | mg/l |
| 0.0 | | | .11 | .00 | .04 | 3.6 | 5.3 | .03 | .03 | .08 | .83 | .21 | .17 | .08 | .09 | .11 | .10 | 1.14 |
| 8.0 | | | .08 | .00 | .04 | 2.9 | 4.8 | .03 | .02 | .08 | 3.71 | .34 | .26 | .13 | .15 | .14 | .13 | 1.07 |
| 14.0 | | | .18 | .00 | .05 | 2.6 | 4.0 | .05 | .00 | .11 | 2.86 | .67 | .36 | .18 | .15 | .50 | .36 | 1.48 |
| 20.0 | | | .14 | .00 | .05 | 2.7 | 4.3 | .04 | .00 | .13 | 3.81 | .71 | .52 | .40 | .31 | .63 | .43 | 2.00 |
| 28.0 | | | .09 | .00 | .04 | 6.8 | .0 | .06 | .01 | | 2.66 | .97 | .63 | .57 | .48 | .70 | .60 | 1.66 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL010 CTD file: AIMS Tape No.:

Date: 06/02/90 Time start: 09:58 hrs Time finish: 10:49 hrs Depth 38 m Zooplankton dry wt.: 13.11 mg/m3

Latitude: 12 deg 33.1' Swell ht: .0 m Wind speed: 8 knots

Longitude: 143 deg 30.5' Swell dir: deg Wind dir: 220 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients µmol/l | | | | | | | | | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | | | | | | | |
| 0.0 | 29.15 | 34.45 | .15 | .00 | .04 | 3.9 | 3.6 | .06 | .00 | .10 | 1.62 | .26 | .19 | | | | | .88 |
| 10.0 | 29.19 | 34.44 | .18 | .00 | .03 | 2.9 | 4.1 | .05 | .01 | .08 | 1.05 | .25 | .15 | | | | | 1.22 |
| 20.0 | 29.02 | 34.42 | .19 | .00 | .03 | 3.8 | 3.8 | .05 | .02 | .09 | 2.95 | .31 | .18 | | | | | 1.17 |
| 30.0 | 28.92 | 34.48 | .19 | .00 | .03 | 4.2 | 4.1 | .05 | .02 | .08 | .83 | .56 | .34 | | | | | 1.20 |
| 38.0 | 28.22 | 34.58 | .18 | .00 | .04 | 3.1 | 4.5 | .06 | .00 | .11 | .34 | 1.43 | .74 | | | | | 1.25 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL011 CTD file: AIMS Tape No.:

Date: 06/02/90 Time start: 11:28 hrs Time finish: 11:58 hrs Depth 44 m Zooplankton dry wt.: mg/m3

Latitude: 12 deg 29.6' Swell ht: .0 m Wind speed: 6 knots

Longitude: 143 deg 36.0' Swell dir: deg Wind dir: 230 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients NH4 µmol/l | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 29.08 | 34.45 | .23 | .00 | .04 | 3.4 | 3.9 | .04 | .01 | .09 | 1.35 | .38 | .27 | | | | | .91 |
| 15.0 | 28.51 | 34.55 | .20 | .00 | .04 | 3.7 | .0 | .06 | .00 | .10 | 1.69 | .65 | .43 | | | | | .98 |
| 30.0 | 28.08 | 34.62 | .22 | .00 | .03 | 3.4 | 4.4 | .06 | .01 | .13 | 3.43 | 1.32 | .75 | | | | | .84 |
| 44.0 | 27.98 | 34.65 | .19 | .00 | .04 | 3.4 | 4.5 | .07 | .01 | .13 | 1.87 | 2.04 | .98 | | | | | .79 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL012** CTD file: shl012.met AIMS Tape No.: 950

Date: 06/02/90 Time start: 12:37 hrs Time finish: 13:17 hrs Depth 43 m Zooplankton dry wt.: 16.74 mg/m3

Latitude: 12 deg 25.5' Swell ht: .0 m Wind speed: 0 knots

Longitude: 143 deg 42.2' Swell dir: deg Wind dir: deg

| Depth m | Temp deg C | Salinity ppt | Nutrients NH4 µmol/l | NO2 µmol/l | NO3 µmol/l | DON µmol/l | PON µmol/l | DIP µmol/l | DOP µmol/l | POP µmol/l | Si µmol/l | Chl Σ µg/l | Pha Σ µg/l | Chl <10 µg/l | Pha <10 µg/l | Chl <2 µg/l | Pha <2 µg/l | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 29.07 | 34.50 | .22 | .00 | .04 | 3.6 | 2.6 | .06 | .04 | .08 | 2.27 | .37 | .19 | | | | | |
| 15.0 | 28.42 | 34.55 | .19 | .00 | .05 | 3.0 | 4.0 | .05 | .02 | .11 | .16 | 1.10 | .58 | | | | | |
| 30.0 | 27.80 | 34.68 | .16 | .00 | .12 | 4.7 | 3.0 | .08 | .00 | .10 | 5.43 | 1.44 | .72 | | | | | |
| 43.0 | 27.11 | 34.80 | .17 | .03 | .74 | 4.0 | 2.0 | .12 | .00 | .07 | 1.37 | 1.00 | .51 | | | | | |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL013** CTD file: AIMS Tape No.:

Date: 06/02/90 Time start: 13:50 hrs Time finish: 15:05 hrs Depth 350 m Zooplankton dry wt.: 3.98 mg/m3

Latitude: 12 deg 24.6' Swell ht: .0 m Wind speed: 3 knots

Longitude: 143 deg 48.3' Swell dir: deg Wind dir: 280 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients NH4 µmol/l | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 28.45 | | .14 | .00 | .05 | 4.6 | 2.8 | .06 | .00 | .09 | .00 | 1.39 | .58 | | | | | .70 |
| 25.0 | 28.26 | | .17 | .00 | .05 | 4.5 | 4.1 | .09 | .01 | .10 | .00 | 1.11 | .63 | | | | | .81 |
| 50.0 | 28.04 | | .25 | .00 | .06 | 4.8 | 3.0 | .07 | .00 | .08 | .07 | 1.08 | .52 | | | | | .62 |
| 75.0 | 27.73 | | .27 | .00 | .09 | 5.7 | 2.6 | .07 | .00 | .09 | .24 | .78 | .50 | | | | | .56 |
| 100.0 | 27.33 | | .51 | .03 | .24 | 4.6 | 3.0 | .09 | .00 | .08 | .27 | 1.42 | .75 | | | | | .76 |
| 125.0 | 26.72 | | .28 | .02 | .30 | 4.3 | 1.3 | .09 | .00 | .07 | .57 | .85 | .50 | | | | | .60 |
| 150.0 | | | .34 | .02 | .26 | 4.4 | 1.6 | .11 | .00 | .03 | .77 | .51 | .49 | | | | | .42 |
| 200.0 | | | .17 | .03 | 4.35 | 4.8 | .0 | .51 | .00 | | 2.41 | .11 | .21 | | | | | |
| 250.0 | 21.28 | | .20 | .01 | 4.36 | 5.0 | .0 | .72 | .00 | | 6.79 | .04 | .09 | | | | | |
| 300.0 | | | .21 | .02 | 4.36 | 5.4 | .0 | .90 | .00 | | 4.00 | .04 | .06 | | | | | |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL014 CTD file: AIMS Tape No.:

Date: 07/02/90 Time start: 13:04 hrs Time finish: 13:38 hrs Depth 58 m Zooplankton dry wt.: 9.94 mg/m3

Latitude: 12 deg 24.6' Swell ht: .0 m Wind speed: 2 knots

Longitude: 143 deg 41.4' Swell dir: deg Wind dir: 320 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients NH4 µmol/l | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ µg/l | Pha Σ | Chl <10 | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 29.37 | 35.08 | .24 | .00 | .01 | 4.6 | 4.1 | .03 | .05 | .08 | .00 | .40 | .36 | | | | | |
| 10.0 | 28.71 | | .22 | .00 | .01 | 4.0 | 4.4 | .02 | .14 | .12 | .00 | .50 | .44 | | | | | |
| 20.0 | 28.33 | | .27 | .00 | .01 | 5.1 | 4.8 | .03 | .04 | .13 | .00 | .88 | .50 | | | | | |
| 30.0 | 27.88 | | .27 | .00 | .06 | 5.2 | 5.1 | .04 | .03 | .11 | .00 | 1.48 | .68 | | | | | |
| 40.0 | 27.08 | | .26 | .01 | .76 | 4.6 | 4.0 | .11 | .00 | .07 | .27 | 1.07 | .60 | | | | | |
| 50.0 | | | .24 | .03 | 1.75 | 3.9 | 2.7 | .20 | .00 | .05 | .47 | .70 | .39 | | | | | |
| 57.0 | 25.65 | 34.58 | .33 | .05 | 2.21 | 3.6 | 2.4 | .25 | .00 | .04 | .95 | .51 | .42 | | | | | |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL015** CTD file: AIMS Tape No.:

Date: 07/02/90 Time start: 14:00 hrs Time finish: 14:30 hrs Depth 20 m Zooplankton dry wt.: mg/m3

Latitude: 12 deg 33.2' Swell ht: .0 m Wind speed: 5 knots

Longitude: 143 deg 41.3' Swell dir: deg Wind dir: 320 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 29.54 | 34.53 | .43 | .00 | .00 | 5.4 | 2.6 | .02 | .05 | .08 | .00 | .37 | .31 | | | | | .81 |
| 5.0 | 28.90 | | .35 | .00 | .00 | 5.3 | 3.6 | .02 | .08 | .10 | .00 | .65 | .40 | | | | | .93 |
| 10.0 | 28.80 | | .46 | .00 | .00 | 4.8 | 3.9 | .02 | .06 | .10 | .02 | .69 | .43 | | | | | .83 |
| 15.0 | 28.78 | | .40 | .00 | .00 | 4.8 | 3.2 | .02 | .05 | .10 | .00 | .74 | .52 | | | | | .96 |
| 21.0 | 27.88 | 34.55 | .52 | .00 | .01 | 5.4 | 2.8 | .03 | .07 | .09 | .07 | .68 | .41 | | | | | 1.37 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL016 CTD file: AIMS Tape No.:

Date: 08/02/90 Time start: 04:40 hrs Time finish: 09:18 hrs Depth 38 m Zooplankton dry wt.: mg/m3

Latitude: 12 deg 20.1' Swell ht: .0 m Wind speed: 12 knots

Longitude: 143 deg 48.8' Swell dir: deg Wind dir: 270 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients µmol/l NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 28.08 | 34.66 | .46 | .00 | .06 | 5.0 | 2.4 | .06 | .03 | .09 | .00 | .78 | .49 | .57 | .28 | .53 | .44 | .73 |
| 10.0 | 27.72 | | .36 | .01 | .12 | 5.2 | 2.8 | .06 | .00 | .09 | .25 | .74 | .53 | .63 | .41 | | | .79 |
| 18.0 | 27.71 | | .37 | .01 | .08 | 5.0 | 2.3 | .06 | .02 | .08 | .25 | .90 | .49 | .54 | .31 | .84 | .51 | .79 |
| 22.0 | 27.67 | | .48 | .02 | .09 | 5.2 | 2.5 | .06 | .02 | .01 | .28 | .81 | .52 | .62 | .31 | .67 | .82 | .74 |
| 28.0 | 27.57 | 34.79 | .47 | .02 | .15 | 5.2 | 2.5 | .07 | .03 | .08 | .24 | .78 | .36 | .49 | .23 | .61 | .34 | .73 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL017** CTD file: AIMS Tape No.:

Date: 08/02/90 Time start: 16:25 hrs Time finish: 17:55 hrs Depth 40 m Zooplankton dry wt.: 13.16 mg/m3

Latitude: 12 deg 21.7' Swell ht: .0 m Wind speed: 10 knots

Longitude: 143 deg 45.1' Swell dir: deg Wind dir: deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 29.51 | 34.57 | .29 | .00 | .01 | 6.5 | 4.6 | .03 | .02 | .09 | .23 | .27 | .19 | | | | | .90 |
| 10.0 | 28.76 | | .27 | .00 | .02 | 5.0 | 4.6 | .05 | .01 | .10 | .14 | .40 | .25 | | | | | 1.40 |
| 20.0 | 28.57 | | .24 | .00 | .02 | 4.8 | 4.4 | .04 | .03 | .09 | .14 | .50 | .30 | | | | | 1.15 |
| 30.0 | 28.42 | | .25 | .00 | .01 | 4.8 | 4.7 | .04 | .05 | .09 | .06 | .58 | .33 | | | | | .93 |
| 40.0 | 28.25 | 34.64 | .23 | .00 | .03 | 4.8 | 4.4 | .04 | .04 | .09 | .04 | .84 | .43 | | | | | .77 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL018** CTD file: AIMS Tape No.:

Date: 09/02/90 Time start: 08:00 hrs Time finish: 08:25 hrs Depth 30 m Zooplankton dry wt.: 14.15 mg/m3

Latitude: 12 deg 19.6' Swell ht: .0 m Wind speed: 8 knots

Longitude: 143 deg 48.7' Swell dir: deg Wind dir: 270 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients NH4 µmol/l | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 28.38 | 34.62 | .27 | .00 | .02 | 5.2 | 4.4 | .04 | .03 | .10 | .01 | .56 | .30 | | | | | .79 |
| 20.0 | 28.35 | 34.69 | .30 | .00 | .02 | 5.2 | .0 | .04 | .02 | .09 | .03 | .62 | .36 | | | | | .91 |
| 40.0 | 27.98 | | .31 | .00 | .04 | 5.4 | 5.0 | .06 | .02 | .10 | .03 | .84 | .58 | | | | | .90 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL019** CTD file: AIMS Tape No.:

Date: 09/02/90 Time start: 08:36 hrs Time finish: 09:15 hrs Depth 32 m Zooplankton dry wt.: 17.35 mg/m3

Latitude: 12 deg 19.4' Swell ht: .0 m Wind speed: 8 knots

Longitude: 143 deg 47.3' Swell dir: deg Wind dir: 270 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 28.67 | 34.57 | .29 | .00 | .02 | 5.3 | 3.3 | .06 | .03 | | .00 | .35 | .22 | .18 | .16 | .29 | .19 | .93 |
| 16.0 | 28.56 | | .28 | .00 | .03 | 4.9 | 3.0 | .04 | .02 | .10 | .00 | .37 | .25 | .17 | .16 | .22 | .15 | .86 |
| 32.0 | 28.02 | 34.69 | .27 | .00 | .03 | 6.0 | .0 | .06 | .01 | .08 | .78 | .90 | .50 | .78 | .39 | .25 | .20 | .88 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL020** CTD file: AIMS Tape No.:

Date: 09/02/90 Time start: 09:22 hrs Time finish: 10:05 hrs Depth 38 m Zooplankton dry wt.: 11.75 mg/m3

Latitude: 12 deg 20.6' Swell ht: .0 m Wind speed: 6 knots

Longitude: 143 deg 47.0' Swell dir: deg Wind dir: 270 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients NH4 µmol/l | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 28.70 | 34.65 | .18 | .00 | .02 | 5.7 | 3.7 | .03 | .04 | .08 | .02 | .32 | .23 | | | | | .84 |
| 15.0 | 27.55 | | .18 | .00 | .07 | 5.7 | 3.4 | .06 | .03 | .10 | .29 | .97 | .49 | | | | | .86 |
| 34.0 | | 34.77 | .22 | .00 | .15 | 4.6 | 3.5 | .06 | .12 | .08 | .22 | .96 | .55 | | | | | .82 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL021** CTD file: AIMS Tape No.:

Date: 09/02/90 Time start: 10:43 hrs Time finish: 11:07 hrs Depth 240 m Zooplankton dry wt.: 24.56 mg/m3

Latitude: 12 deg 22.8' Swell ht: .0 m Wind speed: 4 knots

Longitude: 143 deg 48.2' Swell dir: deg Wind dir: 225 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 28.09 | 34.71 | .23 | .00 | .02 | 5.1 | 3.1 | .06 | .02 | .08 | .06 | .89 | .48 | | | | | .83 |
| 20.0 | 27.87 | | .17 | .00 | .02 | 6.2 | 4.1 | .05 | .02 | .11 | .08 | 1.53 | .64 | | | | | .89 |
| 40.0 | 26.84 | 34.87 | .21 | .00 | .20 | 5.9 | 3.0 | .10 | .00 | .08 | .94 | 1.73 | .69 | | | | | .64 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL022 CTD file: AIMS Tape No.:

Date: 09/02/90 Time start: 11:18 hrs Time finish: 11:36 hrs Depth 278 m Zooplankton dry wt.: 13.94 mg/m3

Latitude: 12 deg 22.2' Swell ht: .0 m Wind speed: 4 knots

Longitude: 143 deg 49.2' Swell dir: deg Wind dir: 225 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 28.19 | 34.71 | .17 | .00 | .01 | 5.2 | 3.1 | .04 | .02 | .09 | .06 | .80 | .50 | | | | | 1.21 |
| 20.0 | 27.75 | | .16 | .00 | .03 | 5.4 | 4.5 | .05 | .01 | .10 | .13 | 1.00 | 1.44 | | | | | 1.13 |
| 40.0 | 27.16 | 34.84 | .19 | .00 | .09 | 4.8 | 3.6 | .07 | .00 | .08 | .21 | 1.88 | .73 | | | | | .84 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL023** CTD file: AIMS Tape No.:

Date: 09/02/90 Time start: 11:48 hrs Time finish: 12:24 hrs Depth 390 m Zooplankton dry wt.: 14.53 mg/m3

Latitude: 12 deg 21.4' Swell ht: .0 m Wind speed: 4 knots

Longitude: 143 deg 50.2' Swell dir: deg Wind dir: 225 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 28.58 | 34.75 | .26 | .00 | .02 | 5.6 | 4.3 | .05 | .00 | .08 | .06 | .69 | .34 | | | | | .68 |
| 20.0 | 27.68 | | .17 | .00 | .01 | 3.1 | 4.2 | .06 | .02 | .10 | .00 | 1.48 | .59 | | | | | .80 |
| 40.0 | 27.37 | 34.84 | .19 | .00 | .03 | 2.5 | 3.7 | .07 | .00 | .09 | .10 | 1.56 | .79 | | | | | .73 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL024 CTD file: AIMS Tape No.:

Date: 09/02/90 Time start: 14:25 hrs Time finish: 14:55 hrs Depth 0 m Zooplankton dry wt.: 3.48 mg/m3

Latitude: 12 deg 16.0' Swell ht: .0 m Wind speed: 6 knots

Longitude: 144 deg 11.0' Swell dir: deg Wind dir: 270 deg

| | | | Nutrients µmol/l | | | | | | | | | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | | | | | | | |
| 0.0 | 30.03 | 34.05 | .22 | .00 | .01 | 3.8 | 1.4 | .03 | .04 | .02 | 1.69 | .19 | .10 | | | | | .29 |
| 20.0 | 28.76 | | .25 | .00 | .02 | 3.5 | .8 | .07 | .02 | .02 | .53 | .21 | .11 | | | | | .48 |
| 40.0 | 26.73 | 34.91 | .21 | .00 | .01 | 3.1 | 1.1 | .07 | .03 | .02 | 1.58 | .19 | .09 | | | | | .40 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL025 CTD file: AIMS Tape No.:

Date: 09/02/90 Time start: 15:12 hrs Time finish: 15:36 hrs Depth 0 m Zooplankton dry wt.: 7.01 mg/m3

Latitude: 12 deg 12.0' Swell ht: .0 m Wind speed: 4 knots

Longitude: 144 deg 11.0' Swell dir: deg Wind dir: 270 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 | Pha <10 | Chl <2 | Pha <2 | Susp. solids |
| | | | µmol/l | | | | | | | | | | | µg/l | | | | mg/l |
| 0.0 | 30.38 | 34.05 | .23 | .00 | .02 | 3.4 | 1.4 | .04 | .02 | .02 | 1.95 | .17 | .09 | | | | | .59 |
| 20.0 | 28.17 | | .21 | .00 | .02 | 4.1 | .6 | .07 | .00 | .02 | .55 | .12 | .07 | | | | | .40 |
| 40.0 | 26.36 | 34.93 | .23 | .00 | .02 | 3.7 | .4 | .07 | .02 | .02 | .60 | .17 | .09 | | | | | .31 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL026** CTD file: AIMS Tape No.:

Date: 09/02/90 Time start: 16:05 hrs Time finish: 16:23 hrs Depth 0 m Zooplankton dry wt.: 6.86 mg/m3

Latitude: 12 deg 8.0' Swell ht: .0 m Wind speed: 4 knots

Longitude: 144 deg 11.0' Swell dir: deg Wind dir: 270 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | | 34.09 | .21 | .00 | .01 | 3.3 | 2.1 | .04 | .05 | .02 | 1.89 | .19 | .08 | | | | | .58 |
| 20.0 | 28.57 | | .14 | .00 | .02 | 4.8 | 1.2 | .05 | .01 | .03 | .84 | .12 | .12 | | | | | .42 |
| 40.0 | 28.35 | 34.91 | .14 | .00 | .02 | 3.1 | 1.6 | .08 | .00 | .03 | .58 | .14 | .09 | | | | | .41 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL027** CTD file: AIMS Tape No.:

Date: 10/02/90 Time start: 08:23 hrs Time finish: 09:38 hrs Depth 463 m Zooplankton dry wt.: mg/m3

Latitude: 11 deg 37.7' Swell ht: .0 m Wind speed: 5 knots

Longitude: 144 deg 4.8' Swell dir: deg Wind dir: 315 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients NH4 µmol/l | NO2 µmol/l | NO3 µmol/l | DON µmol/l | PON µmol/l | DIP µmol/l | DOP µmol/l | POP µmol/l | Si µmol/l | Chl Σ µg/l | Pha Σ µg/l | Chl <10 µg/l | Pha <10 µg/l | Chl <2 µg/l | Pha <2 µg/l | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 28.47 | | .18 | .00 | .01 | 4.2 | 3.7 | .04 | .05 | .09 | .00 | .42 | .29 | .39 | .22 | .36 | .23 | 1.39 |
| 25.0 | 28.38 | | .16 | .02 | .01 | 4.0 | 4.2 | .04 | .02 | .12 | .00 | .60 | .43 | .52 | .40 | .44 | .37 | 1.02 |
| 50.0 | 27.72 | | .19 | .02 | .02 | 4.1 | 6.1 | .05 | .01 | .15 | .00 | 1.78 | 1.09 | | | | | 1.11 |
| 75.0 | 25.56 | | .16 | .24 | 2.12 | 3.2 | 1.7 | .25 | .00 | .05 | 1.17 | .53 | .60 | .41 | .34 | .37 | .32 | .53 |
| 100.0 | 24.33 | | .13 | .07 | 5.13 | 1.5 | .7 | .48 | .00 | .00 | 1.74 | .21 | .35 | | | | | .55 |
| 125.0 | 23.06 | | .14 | .03 | 5.24 | 1.2 | .2 | .59 | .00 | .00 | 1.93 | .21 | .23 | | | | | .41 |
| 150.0 | 21.55 | | .15 | .02 | 5.26 | 2.0 | .1 | .67 | .00 | .00 | 2.31 | .06 | .10 | | | | | .50 |
| 200.0 | 17.56 | | .18 | .04 | 5.24 | 4.1 | .0 | .94 | .00 | | 3.81 | .04 | .04 | | | | | |
| 250.0 | | | .23 | .00 | 5.28 | 4.4 | .0 | .97 | .00 | | 4.28 | .04 | .06 | | | | | |
| 300.0 | 14.80 | | .15 | .01 | 5.27 | 5.7 | .0 | 1.16 | .00 | | 6.01 | .02 | .04 | | | | | |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL028** CTD file: AIMS Tape No.:

Date: 10/02/90 Time start: 10:58 hrs Time finish: 11:42 hrs Depth 38 m Zooplankton dry wt.: mg/m3

Latitude: 11 deg 38.8' Swell ht: .0 m Wind speed: 0 knots

Longitude: 143 deg 51.6' Swell dir: deg Wind dir: deg

| Depth m | Temp deg C | Salinity ppt | Nutrients µmol/l | | | | | | | | | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | | | | | | | |
| 0.0 | 28.23 | 34.77 | .14 | .02 | .00 | 2.3 | 4.2 | .05 | .02 | .11 | .00 | 1.36 | .99 | | | | | 1.05 |
| 10.0 | 26.11 | | .19 | .04 | 1.18 | 1.9 | 4.5 | .15 | .00 | .12 | .35 | 2.57 | 1.56 | | | | | 1.01 |
| 20.0 | 24.03 | | .19 | .06 | 4.28 | .7 | 2.0 | .41 | .00 | .05 | 1.14 | 1.01 | .72 | | | | | .70 |
| 30.0 | 23.63 | | .20 | .05 | 4.94 | .6 | 1.2 | .47 | .00 | .04 | 1.19 | .72 | .56 | | | | | .74 |
| 34.0 | 23.62 | 35.35 | .17 | .05 | 4.95 | .9 | 1.0 | .48 | .00 | .04 | 1.31 | .75 | .56 | | | | | .46 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL029** CTD file: AIMS Tape No.:

Date: 10/02/90 Time start: 12:35 hrs Time finish: 13:50 hrs Depth 35 m Zooplankton dry wt.: mg/m3

Latitude: 11 deg 42.0' Swell ht: .0 m Wind speed: 8 knots

Longitude: 143 deg 42.8' Swell dir: deg Wind dir: 270 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 28.69 | 34.71 | .17 | .01 | .03 | 2.7 | 5.2 | .07 | .00 | .10 | .17 | .99 | .77 | | | | | 1.12 |
| 12.0 | 28.20 | | .16 | .00 | .03 | 2.1 | 5.6 | .05 | .00 | .12 | .00 | 1.75 | 1.28 | | | | | 1.16 |
| 24.0 | 28.11 | | .14 | .02 | .02 | 2.0 | 4.7 | .09 | .00 | .13 | .03 | 1.90 | 1.28 | | | | | 1.15 |
| 34.0 | 28.13 | 34.75 | .17 | .03 | .00 | 2.9 | 5.4 | .06 | .00 | .14 | .00 | 2.05 | 1.18 | | | | | 1.00 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL030 CTD file: AIMS Tape No.:

Date: 10/02/90 Time start: 15:05 hrs Time finish: 15:26 hrs Depth 18 m Zooplankton dry wt.: mg/m3

Latitude: 11 deg 40.0' Swell ht: .0 m Wind speed: 6 knots

Longitude: 143 deg 33.0' Swell dir: deg Wind dir: 315 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients µmol/l NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 29.69 | 34.69 | .16 | .00 | .04 | 2.9 | 5.9 | .04 | .00 | .14 | .47 | .82 | .65 | | | | | 1.70 |
| 9.0 | 29.77 | | .14 | .03 | .00 | 2.7 | 5.8 | .04 | .00 | .12 | .36 | .78 | .70 | | | | | 1.81 |
| 18.0 | 29.83 | 34.69 | .12 | .04 | .00 | 2.6 | 5.3 | .10 | .00 | .13 | .38 | .79 | .53 | | | | | 1.36 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL031** CTD file: AIMS Tape No.:

Date: 10/02/90 Time start: 17:16 hrs Time finish: 17:29 hrs Depth 36 m Zooplankton dry wt.: mg/m3

Latitude: 11 deg 40.0' Swell ht: .2 m Wind speed: 15 knots

Longitude: 143 deg 17.7' Swell dir: 45 deg Wind dir: 45 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 | Pha <10 | Chl <2 | Pha <2 | Susp. solids |
| | | | µmol/l | | | | | | | | | | | µg/l | | | | mg/l |
| 0.0 | 30.06 | 34.52 | .11 | .00 | .03 | 2.8 | 3.3 | .05 | .00 | .12 | 1.21 | .42 | .16 | | | | | 1.17 |
| 10.0 | 29.79 | | .11 | .00 | .03 | 2.3 | 3.2 | .04 | .00 | .11 | 1.25 | .39 | .35 | | | | | 1.30 |
| 20.0 | 29.66 | | .18 | .00 | .03 | 2.5 | 2.5 | .03 | .00 | .10 | 1.28 | .63 | .29 | | | | | 1.27 |
| 27.0 | 29.67 | 34.61 | .21 | .00 | .01 | 2.4 | 4.0 | .03 | .01 | .10 | 1.33 | .68 | .26 | | | | | 1.47 |
| 125.0 | | | 1.38 | 1.05 | 3.25 | | .0 | 3.01 | | | .00 | | | | | | | |
| 150.0 | | | .79 | .11 | 5.55 | | .0 | .34 | | | 4.16 | | | | | | | |
| 200.0 | | | .77 | .15 | 9.12 | | .0 | .63 | | | 4.54 | | | | | | | |
| 250.0 | | | .80 | .20 | 10.32 | | .0 | .92 | | | 5.95 | | | | | | | |
| 300.0 | | | .71 | .30 | 12.28 | | .0 | .75 | | | 6.33 | | | | | | | |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL032 CTD file: AIMS Tape No.:

Date: 10/02/90 Time start: 18:40 hrs Time finish: 18:50 hrs Depth 28 m Zooplankton dry wt.: mg/m3

Latitude: 11 deg 39.0' Swell ht: .2 m Wind speed: 20 knots

Longitude: 143 deg 6.8' Swell dir: 315 deg Wind dir: 270 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients NH4 µmol/l | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 29.93 | 34.69 | .16 | .00 | .02 | 3.5 | 2.9 | .04 | .04 | .09 | .91 | .29 | .11 | | | | | .78 |
| 13.0 | 29.70 | | .15 | .00 | .01 | 2.5 | 3.1 | .03 | .03 | .10 | 1.05 | .49 | .17 | | | | | 1.04 |
| 26.0 | 29.64 | 34.69 | .15 | .00 | .01 | 2.8 | 2.6 | .04 | .03 | .09 | 1.09 | .59 | .26 | | | | | 1.29 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL033** CTD file: AIMS Tape No.:

Date: 10/02/90 Time start: 20:17 hrs Time finish: 20:28 hrs Depth 10 m Zooplankton dry wt.: mg/m3

Latitude: 11 deg 37.6' Swell ht: .0 m Wind speed: 5 knots

Longitude: 142 deg 52.6' Swell dir: deg Wind dir: 270 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 29.96 | 34.54 | .29 | .00 | .02 | 2.3 | 6.2 | .03 | .02 | .16 | .24 | .65 | .35 | | | | | 2.05 |
| 5.0 | 29.98 | | .28 | .00 | .03 | 3.1 | 6.4 | .03 | .05 | .15 | .22 | .62 | .30 | | | | | 1.87 |
| 10.0 | 29.93 | 34.58 | .36 | .00 | .03 | 2.8 | 6.3 | .03 | .03 | .14 | .21 | .65 | .29 | | | | | 1.79 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL034 CTD file: AIMS Tape No.:

Date: 11/02/90 Time start: 07:00 hrs Time finish: 07:18 hrs Depth 7 m Zooplankton dry wt.: 37.69 mg/m3

Latitude: 11 deg 49.5' Swell ht: .2 m Wind speed: 8 knots

Longitude: 142 deg 56.2' Swell dir: 225 deg Wind dir: 250 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients NH4 µmol/l | NO2 µmol/l | NO3 µmol/l | DON µmol/l | PON µmol/l | DIP µmol/l | DOP µmol/l | POP µmol/l | Si µmol/l | Chl Σ µg/l | Pha Σ µg/l | Chl <10 µg/l | Pha <10 µg/l | Chl <2 µg/l | Pha <2 µg/l | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 29.86 | 34.62 | .42 | .00 | .03 | 3.1 | 6.4 | .03 | .01 | .15 | .00 | .58 | .38 | | | | | 2.19 |
| 6.0 | 29.86 | 34.64 | .48 | .00 | .04 | 3.0 | 7.4 | .03 | .02 | .17 | .00 | .56 | .36 | | | | | 2.29 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL035** CTD file: AIMS Tape No.:

Date: 11/02/90 Time start: 08:15 hrs Time finish: 09:00 hrs Depth 18 m Zooplankton dry wt.: 21.70 mg/m3

Latitude: 11 deg 50.3' Swell ht: .2 m Wind speed: 10 knots

Longitude: 143 deg 4.7' Swell dir: 250 deg Wind dir: 240 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 29.98 | 34.51 | .55 | .00 | .03 | 2.3 | 4.8 | .04 | .01 | .13 | .57 | .39 | .15 | .23 | .10 | .29 | .11 | 1.29 |
| 8.0 | 30.01 | 34.62 | .44 | .02 | .02 | 2.0 | 3.6 | .06 | .00 | .13 | .53 | .37 | .13 | .23 | .10 | .18 | .09 | 1.42 |
| 12.0 | | 34.67 | | | | | | | | | | .44 | .17 | .23 | .11 | .33 | .13 | 1.63 |
| 16.0 | 30.04 | 34.88 | .47 | .00 | .03 | 2.8 | 3.4 | .05 | .02 | .13 | .50 | .43 | .18 | .19 | .09 | .30 | .12 | |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL036 CTD file: AIMS Tape No.:

Date: 11/02/90 Time start: 10:03 hrs Time finish: 10:44 hrs Depth 34 m Zooplankton dry wt.: 16.27 mg/m3

Latitude: 11 deg 53.1' Swell ht: .1 m Wind speed: 8 knots

Longitude: 143 deg 12.5' Swell dir: 270 deg Wind dir: 2 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients µmol/l NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 30.03 | 34.51 | .15 | .00 | .03 | | 3.3 | .05 | | .09 | .86 | .45 | .16 | | | | | .78 |
| 12.0 | 29.94 | | .14 | .00 | .04 | | 3.8 | .05 | | .09 | .86 | .55 | .21 | | | | | .77 |
| 24.0 | 29.80 | | .27 | .00 | .03 | | 3.0 | .05 | | .10 | 1.09 | .65 | .24 | | | | | 1.15 |
| 36.0 | 29.81 | 34.56 | .19 | .00 | .03 | | 2.9 | .04 | | .13 | 1.09 | .64 | .18 | | | | | 1.17 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL037** CTD file: AIMS Tape No.:

Date: 11/02/90 Time start: 12:02 hrs Time finish: 12:34 hrs Depth 38 m Zooplankton dry wt.: 32.76 mg/m3

Latitude: 11 deg 57.3' Swell ht: .0 m Wind speed: 4 knots

Longitude: 143 deg 22.1' Swell dir: deg Wind dir: 240 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients NH4 µmol/l | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 29.92 | 34.45 | .23 | .00 | .04 | | 3.7 | .04 | | .11 | .77 | .66 | .40 | | | | | 1.10 |
| 8.0 | 29.98 | | .13 | .00 | .03 | | 3.7 | .04 | | .10 | .77 | .79 | .35 | | | | | 1.34 |
| 18.0 | 29.73 | | .17 | .00 | .06 | | 3.0 | .06 | | .10 | .79 | .76 | .37 | | | | | 1.30 |
| 28.0 | 29.77 | | .20 | .01 | .06 | | 2.9 | .05 | | .09 | .79 | .82 | .42 | | | | | 1.57 |
| 34.0 | 29.73 | 34.46 | .19 | .00 | .09 | | 3.2 | .05 | | .09 | .82 | .76 | .35 | | | | | 1.19 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL038 CTD file: AIMS Tape No.:

Date: 11/02/90 Time start: 13:55 hrs Time finish: 14:56 hrs Depth 20 m Zooplankton dry wt.: 13.68 mg/m3

Latitude: 11 deg 57.0' Swell ht: .0 m Wind speed: 8 knots

Longitude: 143 deg 36.2' Swell dir: deg Wind dir: 310 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients NH4 µmol/l | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 29.74 | 34.59 | .16 | .00 | .02 | | 4.4 | .04 | | .12 | .18 | .71 | .40 | | | | | .90 |
| 9.0 | 29.58 | | .14 | .00 | .03 | | 3.4 | .01 | | .13 | .19 | .74 | .42 | | | | | .97 |
| 18.0 | 29.20 | 34.57 | .15 | .00 | .03 | | 3.8 | .03 | | .09 | .30 | 1.37 | .58 | | | | | 1.00 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL039 CTD file: AIMS Tape No.:

Date: 11/02/90 Time start: 15:40 hrs Time finish: 16:49 hrs Depth 20 m Zooplankton dry wt.: 26.72 mg/m3

Latitude: 11 deg 57.4' Swell ht: .0 m Wind speed: 5 knots

Longitude: 143 deg 45.5' Swell dir: deg Wind dir: 320 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 29.47 | 34.65 | .23 | .00 | .02 | | 3.9 | .05 | | .11 | .56 | .41 | .26 | | | | | 1.04 |
| 9.0 | 28.45 | | .23 | .00 | .03 | | 3.2 | .06 | | .10 | .00 | .79 | .39 | | | | | .91 |
| 18.0 | 27.89 | 34.77 | .14 | .01 | .02 | | 4.6 | .06 | | .13 | .00 | 1.92 | .99 | | | | | .96 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL040 CTD file: AIMS Tape No.:

Date: 11/02/90 Time start: 17:42 hrs Time finish: 18:25 hrs Depth 320 m Zooplankton dry wt.: 7.54 mg/m3

Latitude: 11 deg 57.9' Swell ht: .0 m Wind speed: 6 knots

Longitude: 143 deg 56.1' Swell dir: deg Wind dir: 320 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients NH4 µmol/l | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 28.10 | 34.78 | .21 | .00 | .03 | | 2.9 | .05 | | .10 | .00 | .68 | .46 | | | | | .70 |
| 25.0 | 27.89 | | .18 | .03 | .02 | | 4.6 | .05 | | .11 | .00 | .90 | .53 | | | | | .81 |
| 50.0 | 27.86 | | .14 | .01 | .03 | | 3.6 | .03 | | .11 | .00 | 1.09 | .58 | | | | | .68 |
| 75.0 | 26.42 | | .13 | .06 | 1.64 | | 2.4 | .16 | | .07 | .45 | .95 | .59 | | | | | .62 |
| 100.0 | 24.30 | | .14 | .09 | 4.75 | | .3 | .43 | | .02 | 1.44 | .22 | .38 | | | | | .40 |
| 125.0 | 23.37 | | .09 | .02 | 5.41 | 1.0 | .3 | .56 | .00 | .02 | 1.47 | .12 | .21 | | | | | .35 |
| 150.0 | 20.97 | | .07 | .00 | 5.44 | | .3 | .71 | | .02 | 1.98 | .05 | .08 | | | | | .32 |
| 200.0 | 17.53 | | .07 | .00 | 5.43 | | .0 | .94 | | | 3.60 | .02 | .05 | | | | | |
| 250.0 | | | .08 | .00 | 5.43 | | .0 | 1.11 | | | 5.46 | .00 | .01 | | | | | |
| 300.0 | 13.87 | 35.17 | .12 | .02 | 5.42 | | .0 | 1.14 | | | 5.92 | .04 | .06 | | | | | |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL041** CTD file: AIMS Tape No.:

Date: 12/02/90 Time start: 09:04 hrs Time finish: 10:38 hrs Depth 685 m Zooplankton dry wt.: 3.73 mg/m3

Latitude: 12 deg 10.8' Swell ht: .0 m Wind speed: 0 knots

Longitude: 143 deg 55.4' Swell dir: deg Wind dir: 320 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 | Pha <10 | Chl <2 | Pha <2 | Susp. solids |
| | | | µmol/l | | | | | | | | | | | µg/l | | | | mg/l |
| 0.0 | 28.62 | | .08 | .01 | .01 | 2.8 | 3.2 | .02 | .03 | .09 | .00 | .23 | .10 | .42 | | .26 | .15 | .76 |
| 25.0 | 27.47 | | .21 | .01 | .00 | | 6.5 | .03 | | .14 | .00 | 1.53 | .97 | | | | | .70 |
| 50.0 | 26.01 | | .16 | .03 | .40 | | 3.5 | .12 | | .08 | .41 | 1.47 | 1.12 | | | | | .61 |
| 75.0 | 25.44 | | .12 | .17 | 1.51 | | .9 | .26 | | .03 | 1.38 | .32 | .47 | | | | | .50 |
| 100.0 | 23.00 | | .08 | .02 | 5.39 | | .3 | .60 | | .02 | 1.60 | .12 | .19 | | | | | .50 |
| 125.0 | 20.76 | | .13 | .00 | 5.41 | 2.5 | .3 | .73 | .00 | .00 | 2.02 | .05 | .06 | | | | | .35 |
| 150.0 | 19.54 | | .15 | .00 | 5.41 | | .7 | .80 | | .01 | 2.42 | .04 | .07 | | | | | .28 |
| 200.0 | 18.44 | | .12 | .00 | 5.41 | | .0 | .84 | | | 3.01 | .03 | .05 | | | | | |
| 250.0 | | | .13 | .00 | 5.42 | | .0 | 1.05 | | | 6.35 | .02 | .02 | | | | | |
| 300.0 | 13.78 | | .11 | .00 | 5.42 | | .0 | 1.17 | | | 6.51 | .02 | .02 | | | | | |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL042 CTD file: AIMS Tape No.:

Date: 12/02/90 Time start: 11:42 hrs Time finish: 12:49 hrs Depth 22 m Zooplankton dry wt.: 18.57 mg/m3

Latitude: 12 deg 11.0' Swell ht: .0 m Wind speed: 2 knots

Longitude: 143 deg 43.0' Swell dir: deg Wind dir: 320 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients µmol/l | | | | | | | | | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | | | | | | | |
| 0.0 | 28.99 | 34.66 | .05 | .00 | .04 | 2.6 | 3.0 | .05 | .01 | .09 | .65 | .54 | .41 | | | | | .78 |
| 10.0 | 27.53 | | .09 | .00 | .06 | | 6.5 | .06 | | .13 | .14 | 1.68 | .94 | | | | | .76 |
| 20.0 | 27.40 | 34.94 | .07 | .00 | .07 | | 5.4 | .06 | | .14 | .82 | 2.45 | 1.24 | | | | | .79 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL043** CTD file: AIMS Tape No.:

Date: 12/02/90 Time start: 14:10 hrs Time finish: 14:45 hrs Depth 46 m Zooplankton dry wt.: 12.11 mg/m3

Latitude: 12 deg 11.4' Swell ht: .0 m Wind speed: 1 knots

Longitude: 143 deg 29.5' Swell dir: deg Wind dir: 270 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 29.38 | 34.60 | .07 | .00 | .04 | | 4.5 | .02 | | .09 | 1.10 | .32 | .15 | | | | | .92 |
| 12.0 | 29.49 | | .08 | .00 | .03 | | 3.5 | .03 | | .09 | .16 | .30 | .16 | | | | | 1.08 |
| 24.0 | 29.53 | | .09 | .00 | .04 | 2.6 | 3.4 | .03 | .05 | .10 | .37 | .23 | .15 | | | | | 1.16 |
| 36.0 | 29.58 | | .12 | .00 | .04 | | 4.3 | .04 | | .10 | .48 | .19 | .11 | | | | | .84 |
| 44.0 | 30.67 | 34.58 | .11 | .00 | .05 | | 4.1 | .04 | | .08 | 1.45 | .15 | .07 | | | | | .71 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL044** CTD file: AIMS Tape No.:

Date: 12/02/90 Time start: 15:48 hrs Time finish: 16:15 hrs Depth 27 m Zooplankton dry wt.: 8.56 mg/m3

Latitude: 12 deg 11.7' Swell ht: .0 m Wind speed: 10 knots

Longitude: 143 deg 20.1' Swell dir: deg Wind dir: 40 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 | Pha <10 | Chl <2 | Pha <2 | Susp. solids |
| | | | µmol/l | | | | | | | | | | | µg/l | | | | mg/l |
| 0.0 | 30.69 | 34.54 | .11 | .00 | .05 | | 1.4 | .02 | | .08 | 1.66 | .10 | .03 | | | | | .86 |
| 10.0 | 29.87 | | .09 | .00 | .05 | | 3.0 | .03 | | .07 | 1.19 | .43 | .32 | | | | | 1.03 |
| 20.0 | 29.68 | | .09 | .00 | .04 | 2.5 | 3.4 | .04 | .98 | .14 | 2.35 | .26 | .12 | | | | | 1.62 |
| 27.0 | 29.66 | 34.53 | .10 | .00 | .04 | | 3.1 | .04 | | .10 | 1.01 | .29 | .12 | | | | | 1.45 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL045** CTD file: AIMS Tape No.:

Date: 12/02/90 Time start: 17:25 hrs Time finish: 17:40 hrs Depth 10 m Zooplankton dry wt.: 21.93 mg/m3

Latitude: 12 deg 10.9' Swell ht: .3 m Wind speed: 12 knots

Longitude: 143 deg 7.6' Swell dir: 60 deg Wind dir: 60 deg

| | | | Nutrients | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 30.29 | 34.32 | .10 | .00 | .04 | | 3.5 | .03 | | .09 | 2.39 | .34 | .17 | | | | | 1.09 |
| 9.0 | 29.74 | 34.39 | .07 | .00 | .03 | | 4.6 | .04 | | .13 | 2.16 | .26 | .10 | | | | | 1.73 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL046 CTD file: AIMS Tape No.:

Date: 13/02/90 Time start: 08:27 hrs Time finish: 08:45 hrs Depth 11 m Zooplankton dry wt.: 32.58 mg/m3

Latitude: 12 deg 11.7' Swell ht: .0 m Wind speed: 5 knots

Longitude: 143 deg 7.6' Swell dir: deg Wind dir: 310 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 | Pha <10 | Chl <2 | Pha <2 | Susp. solids |
| | | | µmol/l | | | | | | | | | | | µg/l | | | | mg/l |
| 0.0 | 29.94 | 34.28 | .09 | .00 | .05 | 5.8 | 4.2 | .03 | .05 | .12 | 3.59 | .42 | .24 | | | | | .93 |
| 10.0 | 29.02 | 34.35 | .18 | .00 | .03 | 7.7 | 8.1 | .05 | .03 | .12 | 2.47 | .56 | .31 | | | | | 1.52 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL047** CTD file: AIMS Tape No.:

Date: 13/02/90 Time start: 09:08 hrs Time finish: 09:22 hrs Depth 7 m Zooplankton dry wt.: mg/m3

Latitude: 12 deg 7.8' Swell ht: .0 m Wind speed: 5 knots

Longitude: 143 deg 7.5' Swell dir: deg Wind dir: 310 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients µmol/l | | | | | | | | | Chl Σ µg/l | Pha Σ µg/l | Chl <10 µg/l | Pha <10 µg/l | Chl <2 µg/l | Pha <2 µg/l | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | | | | | | | |
| 0.0 | 29.93 | 34.43 | .15 | .00 | .04 | 5.3 | 4.1 | .04 | .03 | .10 | 2.44 | .44 | .22 | | | | | .91 |
| 7.0 | 29.93 | 34.44 | .14 | .00 | .03 | 5.6 | 3.9 | .04 | .02 | .09 | 3.23 | .42 | .18 | | | | | .83 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL048 CTD file: AIMS Tape No.:

Date: 13/02/90 Time start: 09:52 hrs Time finish: 10:11 hrs Depth 7 m Zooplankton dry wt.: 32.73 mg/m3

Latitude: 12 deg 3.3' Swell ht: .0 m Wind speed: 0 knots

Longitude: 143 deg 10.7' Swell dir: deg Wind dir: 310 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients µmol/l NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 29.98 | 34.49 | .10 | .00 | .05 | 5.6 | 3.9 | .05 | .00 | .08 | 4.81 | .39 | .13 | | | | | 1.06 |
| 6.0 | 29.91 | 34.49 | .11 | .00 | .05 | 5.3 | 3.9 | .04 | .06 | .08 | 2.02 | .43 | .21 | | | | | .92 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL049** CTD file: AIMS Tape No.:

Date: 13/02/90 Time start: 10:35 hrs Time finish: 10:59 hrs Depth 18 m Zooplankton dry wt.: 20.12 mg/m3

Latitude: 12 deg 7.4' Swell ht: .0 m Wind speed: 0 knots

Longitude: 143 deg 11.1' Swell dir: deg Wind dir: 310 deg

| Depth m | Temp deg C | Salinity ppt | Nutrients µmol/l | | | | | | | | | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | | | | | | | |
| 0.0 | 29.94 | 34.45 | .09 | .01 | .03 | 5.5 | 1.7 | .03 | .04 | .07 | 1.55 | .27 | .14 | | | | | .85 |
| 8.0 | 29.74 | | .11 | .00 | .04 | 5.2 | 2.5 | .03 | .04 | .07 | 1.58 | .33 | .16 | | | | | .70 |
| 16.0 | 29.70 | 34.44 | .11 | .00 | .05 | 7.2 | 2.5 | .03 | .04 | .07 | 1.55 | .41 | .18 | | | | | .88 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL050** CTD file: AIMS Tape No.:

Date: 13/02/90 Time start: 11:20 hrs Time finish: 11:40 hrs Depth 17 m Zooplankton dry wt.: 16.83 mg/m3

Latitude: 12 deg 11.4' Swell ht: .0 m Wind speed: 6 knots

Longitude: 143 deg 11.4' Swell dir: deg Wind dir: 20 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 | Pha <10 | Chl <2 | Pha <2 | Susp. solids |
| | | | µmol/l | | | | | | | | | | | µg/l | | | | mg/l |
| 0.0 | 30.07 | 34.45 | .17 | .00 | .04 | 5.3 | 2.8 | .03 | .04 | .06 | 1.38 | .29 | .10 | | | | | .73 |
| 8.0 | 29.77 | | .10 | .00 | .03 | 5.1 | 3.4 | .06 | .00 | .07 | 1.29 | .33 | .13 | | | | | .92 |
| 16.0 | 29.71 | 34.45 | .12 | .00 | .03 | 5.3 | 2.9 | .03 | .01 | .07 | 1.22 | .41 | .20 | | | | | .92 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL051** CTD file: AIMS Tape No.:

Date: 13/02/90 Time start: 12:10 hrs Time finish: 12:30 hrs Depth 15 m Zooplankton dry wt.: 32.86 mg/m3

Latitude: 12 deg 15.8' Swell ht: .0 m Wind speed: 6 knots

Longitude: 143 deg 11.8' Swell dir: deg Wind dir: 20 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 30.31 | 34.40 | .09 | .00 | .03 | 4.9 | 2.6 | .02 | .03 | .08 | 2.09 | .34 | .12 | | | | | 1.11 |
| 7.0 | 29.82 | | .14 | .00 | .03 | 5.6 | 4.2 | .20 | .00 | .09 | 1.98 | .47 | .19 | | | | | 1.42 |
| 14.0 | 29.80 | 34.40 | .13 | .01 | .01 | 5.1 | 3.1 | .05 | .01 | .09 | 1.82 | .49 | .19 | | | | | 1.35 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL052** CTD file: AIMS Tape No.:

Date: 13/02/90 Time start: 13:23 hrs Time finish: 13:42 hrs Depth 10 m Zooplankton dry wt.: 22.80 mg/m3

Latitude: 12 deg 15.5' Swell ht: .0 m Wind speed: 6 knots

Longitude: 143 deg 7.8' Swell dir: deg Wind dir: 20 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 30.62 | 34.39 | .09 | .01 | .02 | 4.8 | 3.8 | .02 | .00 | .10 | 1.78 | .40 | .14 | | | | | 1.45 |
| 9.0 | 30.01 | 34.37 | .08 | .00 | .04 | 4.4 | 4.7 | .03 | .12 | .15 | 1.66 | .64 | .27 | | | | | 1.63 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

**Station Code: SHL053** CTD file: AIMS Tape No.:

Date: 13/02/90 Time start: 14:00 hrs Time finish: 14:18 hrs Depth 7 m Zooplankton dry wt.: 24.73 mg/m3

Latitude: 12 deg 18.2' Swell ht: .0 m Wind speed: 6 knots

Longitude: 143 deg 8.0' Swell dir: deg Wind dir: 60 deg

| | | | Nutrients | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
| | | | µmol/l | | | | | | | | | | | | | | | |
| 0.0 | 30.86 | 34.42 | .08 | .00 | .03 | 4.7 | 4.2 | .02 | .02 | .09 | 1.46 | .37 | .19 | | | | | 1.41 |
| 6.0 | 30.28 | 34.41 | .09 | .01 | .02 | 5.2 | 5.4 | .02 | .04 | .14 | 1.30 | .62 | .28 | | | | | 2.77 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL054 CTD file: AIMS Tape No.:

Date: 13/02/90 Time start: 14:42 hrs Time finish: 15:00 hrs Depth 7 m Zooplankton dry wt.: 36.01 mg/m3

Latitude: 12 deg 19.8' Swell ht: .0 m Wind speed: 0 knots

Longitude: 143 deg 12.0' Swell dir: deg Wind dir: deg

| Depth m | Temp deg C | Salinity ppt | Nutrients NH4 µmol/l | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 µg/l | Pha <10 | Chl <2 | Pha <2 | Susp. solids mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | 34.54 | .15 | .00 | .05 | | 4.1 | .02 | | .10 | .92 | .38 | .21 | | | | | 1.45 |
| 6.0 | 30.28 | 34.52 | .08 | .00 | .02 | | 5.5 | .03 | | .14 | 1.70 | .59 | .28 | | | | | 2.07 |

# AIMS Hydrographic Data, Shelburne Bay Cruise

Station Code: SHL055 CTD file: AIMS Tape No.:

Date: 14/02/90 Time start: 08:30 hrs Time finish: 08:54 hrs Depth 12 m Zooplankton dry wt.: 23.15 mg/m3

Latitude: 14 deg 33.6' Swell ht: .0 m Wind speed: 6 knots

Longitude: 144 deg 57.2' Swell dir: deg Wind dir: 45 deg

| | | | Nutrients | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth m | Temp deg C | Salinity ppt | NH4 | NO2 | NO3 | DON | PON | DIP | DOP | POP | Si | Chl Σ | Pha Σ | Chl <10 | Pha <10 | Chl <2 | Pha <2 | Susp. solids |
| | | | µmol/l | | | | | | | | | µg/l | | | | | | mg/l |
| 0.0 | 29.61 | 34.81 | .20 | .00 | .04 | | .0 | .05 | | | .73 | .29 | .16 | .23 | .09 | .24 | .09 | .76 |
| 4.0 | 29.65 | 34.78 | .08 | .00 | .02 | | .0 | .05 | | | .86 | .31 | .14 | .21 | .08 | .26 | .10 | .82 |
| 8.0 | 29.61 | 34.80 | .17 | .00 | .02 | | .0 | .04 | | | .89 | .31 | .16 | .22 | .09 | .26 | .12 | .68 |
| 12.0 | 29.59 | 34.81 | .09 | .00 | .02 | | .0 | .04 | | | .77 | .34 | .15 | .25 | .10 | .23 | .09 | .61 |