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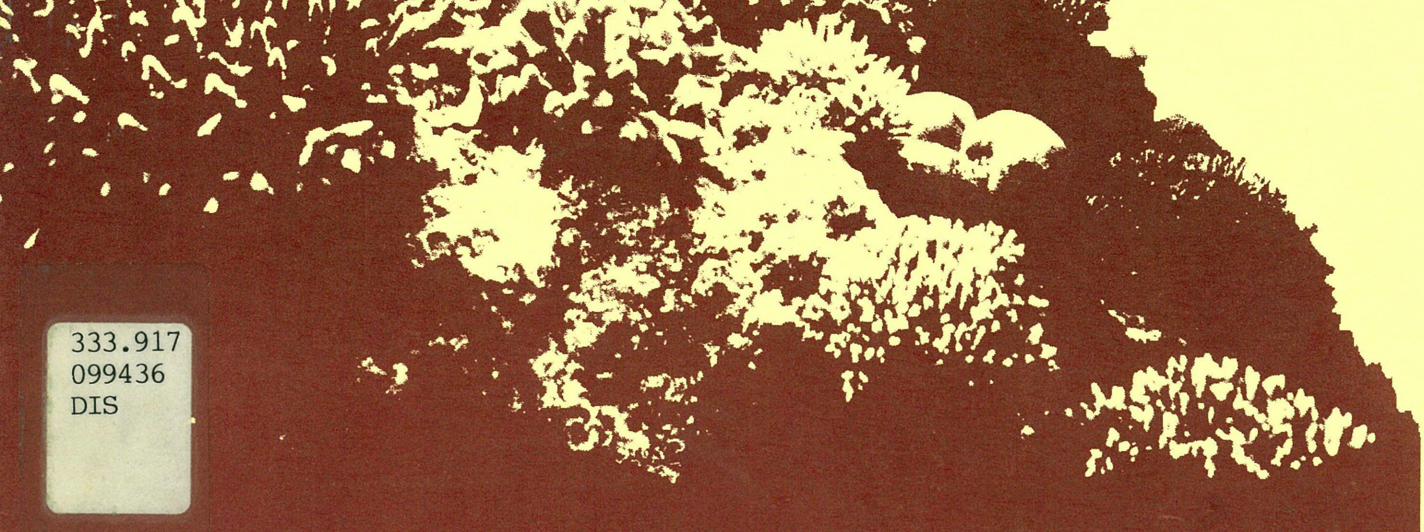

Great Barrier Reef Marine Park Authority

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A REPORT TO THE GREAT BARRIER REEF MARINE PARK AUTHORITY

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Introduction

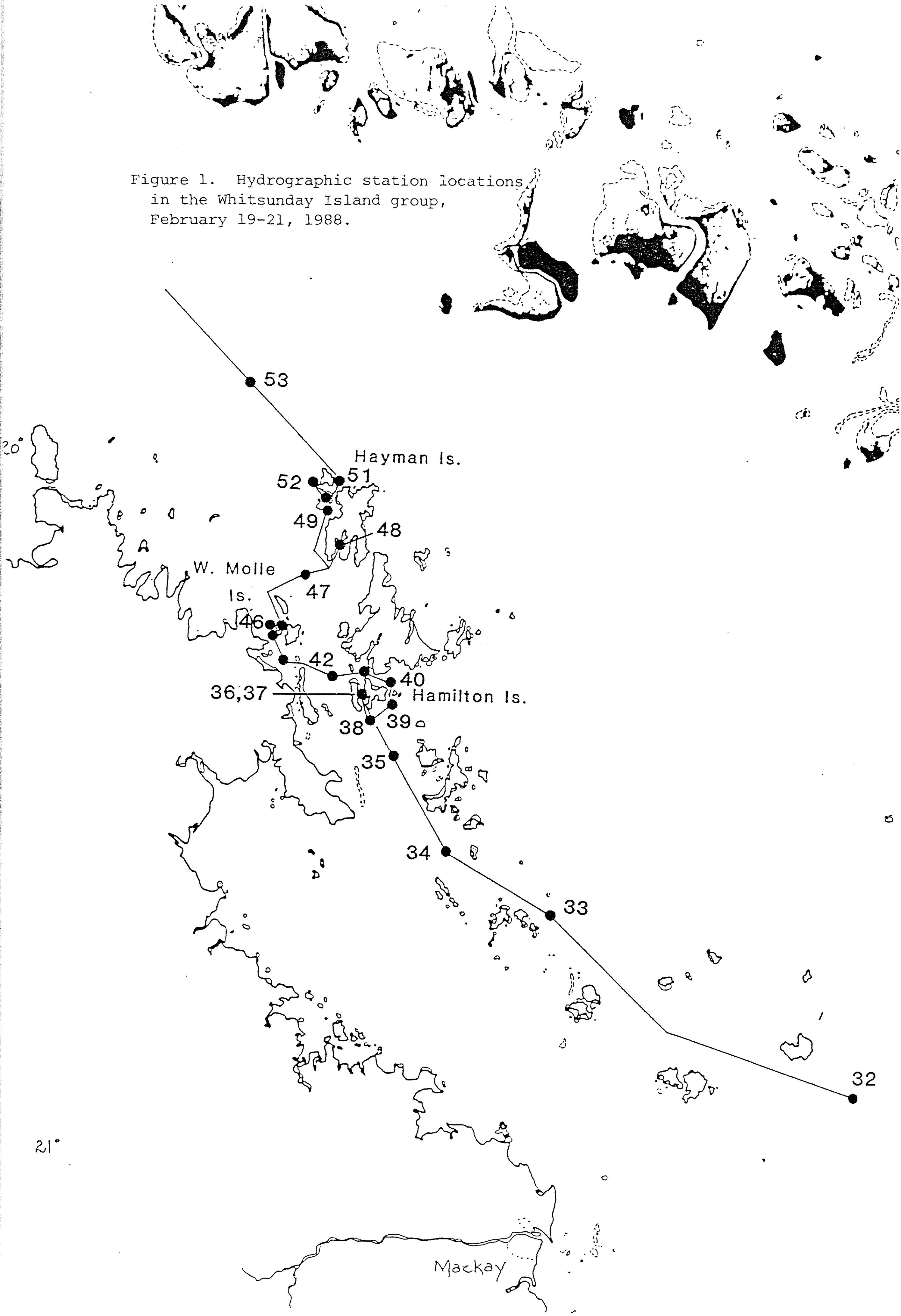
This report summarizes the results of hydrographic sampling of physical properties and nutrient determinations made on water samples and water column particulate matter collected in February, 1988 during an oceanographic survey through the Whitsunday Island group. The survey was carried out to obtain background data on concentrations of chlorophyll, organic and inorganic nitrogen (N), phosphorus (P), and inorganic silicate (Si) in waters of the Whitsunday Island group. For comparative purposes, hydrographic and nutrient data from ten stations occupied in inter-reefal and lagoonal waters of the central and southern GBR during January, 1987 and February, 1988 are also presented.

Sampling Locations

Twenty-one (21) hydrographic stations were occupied within the Whitsunday Island group between February 19 and 21, 1988 (Figure 1). The cruise track was laid out to sample the widest range of conditions possible in the time available. In particular, stations were occupied in the vicinity of Hamilton Island (stas. 36-41), West Molle Island (stas. 43-46) and Hayman Island (stas. 50-52), which have significant resort development, as well as in the open water between islands. One station, SWA48, was occupied within Nara Inlet, an enclosed bay frequently used as an anchorage for cruising boats.

For comparative purposes, data from stations occupied during January, 1987 in open waters off Townsville (COT07, COT12, COT18 and COT20) and in inter-reefal and lagoon waters of the southern GBR during February, 1988 (SWA21, SWA23, SWA25, SWA30, SWA31 and SWA53) is included. These stations were arbitrarily selected for inclusion in this report because dissolved organic and particulate nutrient determinations

Figure 1. Hydrographic station locations in the Whitsunday Island group, February 19-21, 1988.



comparable to those carried out at stations in the Whitsunday group were made. All nutrient species were not determined at every station.

Sampling Procedures

Full water column profiles of temperature, salinity and underwater scalar (4π) irradiance were obtained at all stations with an AIMS-constructed CTD profiler and attached Biospherical QSP-200 underwater irradiance sensor. Underwater irradiance measurements were corrected for variations in surface irradiance with a Biospherical QSR-240 reference sensor. The underwater instruments were lowered at 1 m sec^{-1} and data was sampled at approximately 3 Hz. The raw data were processed to obtain corrected underwater values, then interpolated to values at a 1-meter depth interval for interpretation and analysis. Plots of profiled hydrographic variables are given for each station in the data summary.

Following each CTD-light profile, discrete water samples were collected from four (4) to ten (10) depths through the water column with Niskin bottles. Shortly after collection, unfiltered water samples (ca. 15 ml) were drawn from each sampling bottle into acid-washed scintillation vials, which were immediately deep frozen for later analysis of dissolved inorganic nutrient (NH_4, NO_2, NO_3, PO_4, $Si(OH)_4$) concentrations ashore. At a number of stations, additional water samples were collected and filtered through ashed glass-fiber filters (Whatman GF/F) into acid-washed plastic sample vial and frozen for dissolved organic nitrogen (DON) and dissolved organic phosphorus (DOP) analysis. DOP analyses were not run on the COT or southern GBR shelf samples. Duplicate 100 ml subsamples of water were filtered onto Whatman GF/F filters and frozen for chlorophyll determinations. Duplicate 250 ml subsamples from each sampling depth were filtered onto ashed GF/F filters for particulate nitrogen (PON) determinations.

Duplicate 100 ml subsamples were filtered onto ashed Whatman GF/F filters for particulate organic phosphorus (POP) determinations. Samples for POP analyses were not collected in 1987, nor in 1988 samples collected outside of the Whitsunday group.

Analytical procedures

Inorganic nutrient (NH_4, NO_2, NO_3, PO_4, $Si(OH)_4$) concentrations were determined by "standard" wet chemical methods implemented on a segmented flow analyzer (Ryle et al., 1981). Water samples for inorganic nutrient analyses were not prefiltered, as filtered samples, even when filtration was carried out by the cleanest possible methods, are often contaminated with small amounts of ammonium. For the dissolved organic nutrient analyses, the filtration apparatus (Millipore Swinnex) was soaked in 0.5 N HCl prior to and between uses and filters (ashed Whatman GF/F) were washed with a small volumes of sample prior to collection.

Dissolved organic nitrogen and phosphorus concentrations were calculated by difference after oxidation of organic matter in the water samples by UV radiation (Armstrong et al., 1966). Water samples were oxidized overnight in a La Jolla Scientific UV irradiator, cooled and analyzed for total N and P as nitrate and phosphate. Prior to analysis for NO_3 or PO_4, oxizided samples were re-frozen or stored refrigerated, which results in negligible loss of the nitrate and phosphate (e.g. Nowicki, 1986).

Particulate nitrogen was determined by high temperature combustion of the organic matter caught on glass-fiber filters with an ANTEK Nitrogen Analyzer. The instrument was standardized with EDTA. Samples were stored frozen and lyophilized prior to analysis. Dissolved organic and inorganic nitrogen in water adsorbed to the filters and contaminating nitrogen introduced during sample storage and drying were corrected for by analyzing "wet filter blanks" stored and run in a manner similar to the unknown samples. Freshly combusted glass-fiber filters were not measurably contaminated with nitrogen at the instrument attenuation levels used.

Particulate phosphorus was determined by inorganic phosphate analysis (Strickland and Parsons, 1972) after high temperature combustion (1hr at 450°C) and acid persulfate chemical oxidation (Menzel and Corwin, 1965) of particulate matter collected on ashed Whatman GF/F filters.

Chlorophyll a and phaeophytin concentrations were determined by fluorometry (Strickland and Parsons, 1972) after grinding of the filters in 90% v/v acetone.

Concentrations of all dissolved and particulate nutrient species were converted to µmoles per liter (µM) for comparative purposes.

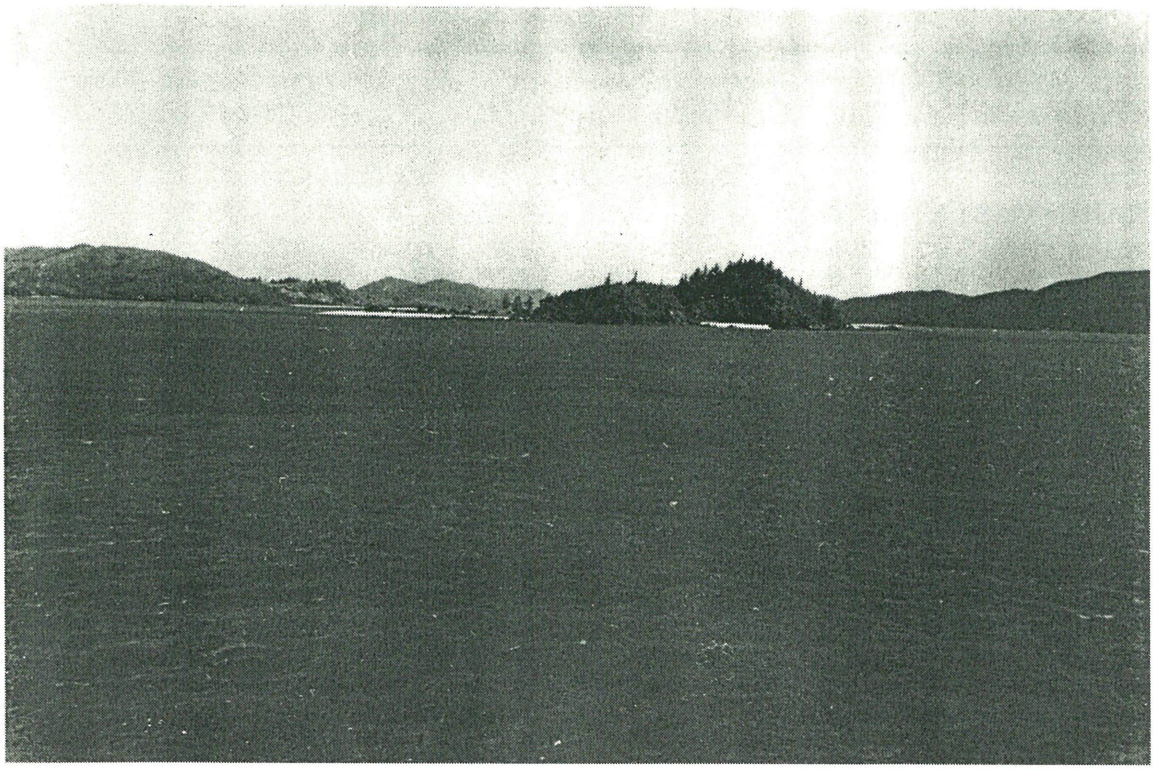
Results and Discussion

Water masses within the Whitsunday Island group were well mixed by tidal currents and highly turbid as compared to lagoonal and inter-reefal waters of the central and southern GBR. Only slight variations in vertical temperature and salinity structure are evident in profiles taken within the Whitsunday Island group. Salinities were somewhat higher than in outer-shelf waters of the central and southern GBR, likely due to evaporation in shallow inshore waters. Maximum vertical differences in temperature and salinity were on the order of 0.1°C and 0.1 ppt, respectively.

Whereas a considerable proportion of surface light normally penetrates to the bottom in open outer-shelf and inter-reefal waters (40-50 m). sub-surface light in the central Whitsunday Island group was attentuated below measurable levels (ca. 0.3 percent of surface irradiance) in the upper 10-15 m. This turbidity is largely due to resuspension of bottom sediments by tidal currents flowing between islands (e.g. Wolanski and Hamner. 1988). Boils of sediment were observed at stations along the western side of Hamilton Island and in the waters surrounding West Molle Island (plates 1 and 2). The very small discontinuities (ca. 0.3°C) in vertical temperature profiles observed at a number of stations within the Whitsundays result from the full absorption of sunlight within a thin surface layer. It is likely that these discontinuities are diurnal features and are erased by mixing overnight. Waters at the southern and northern ends of Whitsunday Island group. particularly around Hayman Island, were considerably clearer than around Hamilton Island and West Molle Island. The apparent rapid attenuation of light at some stations outside of the Whitsundays is due to the early hour of the sampling. while the sun was at a low angle. One station (SWA30) was occupied at night.

Dissolved inorganic nutrient concentrations in water samples collected within the Whitsunday Island group were generally higher than in samples collected in open shelf waters (Table 1). but with the exception of silicate, differences between the group means of Whitsunday and open shelf stations were not significant. Because of the well mixed nature of the water column. both around the Whitsunday Islands and in shelf waters, vertical differences in concentration were usually small. The highest inorganic nutrient concentrations were found within the central Whitsunday Islands (stas. 35-47). This was also the area of highest turbidity. with visible sediment resuspension at a number of stations.

Plates 1 and 2. Resuspended sediment near West Molle Island, 20 February 1988.



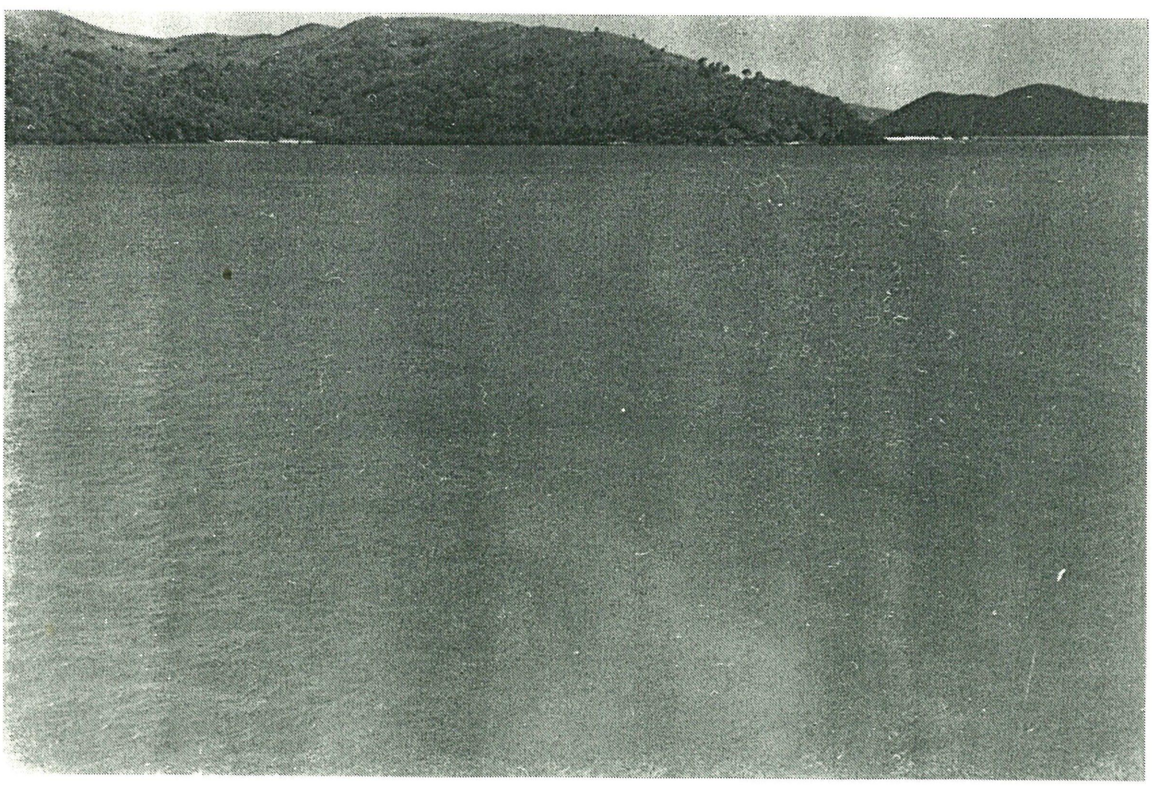


Table 1. Depth-weighted mean water column chlorophyll and nutrient concentrations at stations in the Whitsunday Island group and comparative stations in shelf waters.

Sta.	chl µg/l	NO_2	NO_3	NH_4	DON	PON µM	PO_4	DOP	POP	Si
WHITSUNDAY STATIONS										
SWA32	1.10	ND	0.08	0.03		2.0	0.24		0.12	1.39
SWA33	1.02	ND	0.03	0.26			0.18			1.06
SWA34	1.73	ND	0.03	0.32		2.3	0.20		0.07	1.31
SWA35	1.24	0.01	0.05	0.38			0.25			1.53
SWA36	1.38	ND	0.17	0.19	4.4	1.9	0.23	0.45	0.08	1.70
SWA37	1.23	ND	0.28	0.10	4.3	1.9	0.25	0.38	0.06	1.69
SWA38	1.29	ND	0.19	0.04			0.24			1.58
SWA39	1.72	ND	0.10	0.03		2.4	0.24			1.50
SWA40	1.24	ND	0.14	0.03	5.1		0.24	0.35		1.56
SWA41	1.23	ND	0.21	0.39	4.2	2.0	0.22	0.36	0.07	1.74
SWA42	1.01	ND	0.30	0.45	3.8	1.9	0.22	0.36	0.08	1.86
SWA43	1.07	ND	0.44	0.31		1.6	0.22		0.08	2.11
SWA44	1.18	ND	0.42	0.28	3.7	2.1	0.23	0.41	0.11	2.09
SWA45	1.18	ND	0.46	0.38	3.0	2.2	0.27	0.43	0.10	2.47
SWA46	1.27	ND	0.43	0.30	4.6	2.3	0.26	0.45	0.11	2.48
SWA47	1.32	0.01	0.17	0.29		2.3	0.26		0.15	1.81
SWA48	0.80	ND	0.09	0.28		2.3	0.22		0.07	2.41
SWA49	0.99	ND	0.12	0.12	3.9	1.6	0.23	0.59	0.10	1.33
SWA50	0.86	ND	0.13	0.10		1.5	0.29		0.12	1.38
SWA51	0.83					1.8			0.11	
SWA52	0.94	ND	0.10	0.10		1.7	0.19		0.05	1.37
Mean	1.17	--	0.20	0.22	4.1	2.0	0.23	0.42	0.09	1.72
1 S.D.	0.25	--	0.14	0.14	0.6	0.3	0.03	0.07	0.03	0.41
SHELF STATIONS										
COT07	0.73	ND	0.04	0.04	7.6	1.5	0.14			0.79
COT12	0.48	ND	0.03	0.06	8.3	1.5	0.12			1.05
COT18		ND	ND	0.13	7.9	1.6	0.13			0.68
COT20	0.87	0.03	0.18	0.11	5.8	1.8	0.20			0.78
SWA21	0.65	ND	0.38	0.16	3.6	2.2	0.24	0.55		0.48
SWA23	0.60				4.5	1.3		0.78		
SWA25	0.57	ND	0.08	0.07	4.2	1.3	0.14	0.56		0.39
SWA30	0.68	ND	0.09	0.11			0.17			1.50
SWA31	0.69	ND	0.11	0.15	4.3	1.4	0.15	0.55	0.04	1.67
SWA53	0.86	ND	0.08	0.25			0.18	0.10		1.03
Mean	0.68	--	0.11	0.12	5.8	1.6	0.16	0.61	0.07	0.93
1 S.D.	0.13	--	0.11	0.06	1.9	0.3	0.04	0.12		0.43

Phytoplankton standing crop, as indicated by chlorophyll, was significantly higher at stations in the Whitsunday Island group than at stations surrounding the islands and at those stations selected for comparison.

Ammonium (NH_4) and nitrate (NO_3) were consistently present in detectable quantities at most shelf and all Whitsunday Island group stations. On average, ammonium and nitrate concentrations were twice concentrations in open shelf waters, but the differences were not statistically significant. Mean water column concentrations of both nitrogen species were highest (> 0.3 µM) at the stations located around the Molle Islands (stas. 41-47), while with relatively few exceptions, measured nitrate and ammonium concentrations were below 0.2 µM at open shelf stations. No clear pattern was apparent as to whether nitrate or ammonium was the most abundant nitrogen species. High nitrate concentrations were measured in a near-bottom layer of intruded Coral Sea water at station COT20 (January, 1987). Nitrite (NO_2) concentrations were consistently at or below the levels of detection at all stations, despite the presence of detectable nitrate, which by itself suggested active aerobic nitrification in the water column or surficial sediments.

Concentrations of dissolved inorganic phosphorus (DIP) were relatively constant, both between and within stations (Table 1). DIP concentrations at stations within the Whitsunday group were somewhat higher than in open shelf waters, but the difference overall was not significant. It is unclear to what extent the small differences observed between depths at individual stations reflect real differences or normal sampling and analytical variability.

Ratios of dissolved inorganic nitrogen ($NH_4+NO_2+NO_3$) to inorganic phosphorus (DIN/DIP: Table 2) at both Whitsunday and shelf stations were considerably and consistently less than the Redfield Ratio (15-16 by atoms) characteristic of healthy, rapidly growing phytoplankton. This indicates that in the absence of additional external sources of nitrogen or mineralization of dissolved and particulate organic nitrogen in situ, increases in phytoplankton biomass are constrained by a shortage of nitrogen relative to available phosphorus. The highest DIN/DIP ratios (2.7-3.5) were measured at six stations (SWA41-46) within the central Whitsundays, largely due to a local increase in nitrate concentrations at these stations. In most cases, integrated water column DIN/DIP ratios were < 2.

Dissolved organic nitrogen and phosphorus (DON and DOP) comprised the largest water column N and P pools, exceeding 60 and 56 percent of total water column nitrogen and phosphorus, respectively (Table 3). DOP concentrations at stations in open shelf waters were slightly higher than concentrations within the Whitsunday Island group, but the difference was not significant. Overall, DOP concentrations were approximately four times dissolved inorganic phosphorus (DIP) concentrations in shelf waters and twice DIP levels within the Whitsunday Island group. The lower DOP/DIP ratio within the Whitsunday area reflects an increase in DIP concentrations at these stations rather than a decline in DOP.

When all data points are considered, DON made up a significantly higher proportion of water column nitrogen in open shelf waters than in the Whitsunday group. The higher mean concentrations in shelf waters, however, reflect anomalously high individual sample values in the COT station (07, 12, 18 and 20) profiles. If these high values are due to contamination of individual samples and are excluded, there was no significant difference between DON concentrations at open shelf and Whitsunday stations. DON concentrations, both in Whitsunday Island group and open shelf waters fell within the range summarized by Crossland (1983) for a range of coral reef systems.

Concentrations of particulate phosphorus (POP) at stations in the Whitsunday Island group were low and not correlated with fluctuations in phytoplankton biomass as indicated by chlorophyll (Figure 2). POP data is only available for one station outside of the Whitsundays, so no comparisons with shelf waters are warranted at this time. POP concentrations are similar to the limited range of data summarized by Crossland (1983) for three reef systems. POP/chlorophyll ratios ranged between 0.038 and 0.144 µmoles/µg with an overall mean of 0.084. Higher POP/chlorophyll ratios were more frequently found at stations away from the central Whitsundays, largely because chlorophyll concentrations were lower. POP stocks averaged 11.6 percent of total water column phosphorus and concentrations of DIP were consistently on the order of twice POP concentrations.

Different relationships between particulate nitrogen (PON) and chlorophyll were observed in shelf and Whitsunday Island group samples (Figure 3). In shelf waters, fluctuations in chlorophyll concentrations were uncorrelated with PON concentrations. This pattern suggests phytoplankton growth in the absence of sufficient dissolved inorganic nitrogen stocks to support stochiometric protein synthesis, maintaining a constant cellular composition plus dilution with detrital nitrogen. In contrast, variations in levels of PON within Whitsunday Island samples were correlated ($p \geq 0.01$) with changes in chlorophyll concentration. The slope of the functional regression for the Whitsunday group data points (1.8 µM PON/µg chlorophyll; Ricker, 1973) is higher than observed in nutrient replete phytoplankton cultures (general range 0.5-1.0 µM PON/µg chlorophyll) and eutrophic estuaries (e.g. Furnas and Smayda, in review). Given the observed scatter in the data and the relatively large proportion of non-

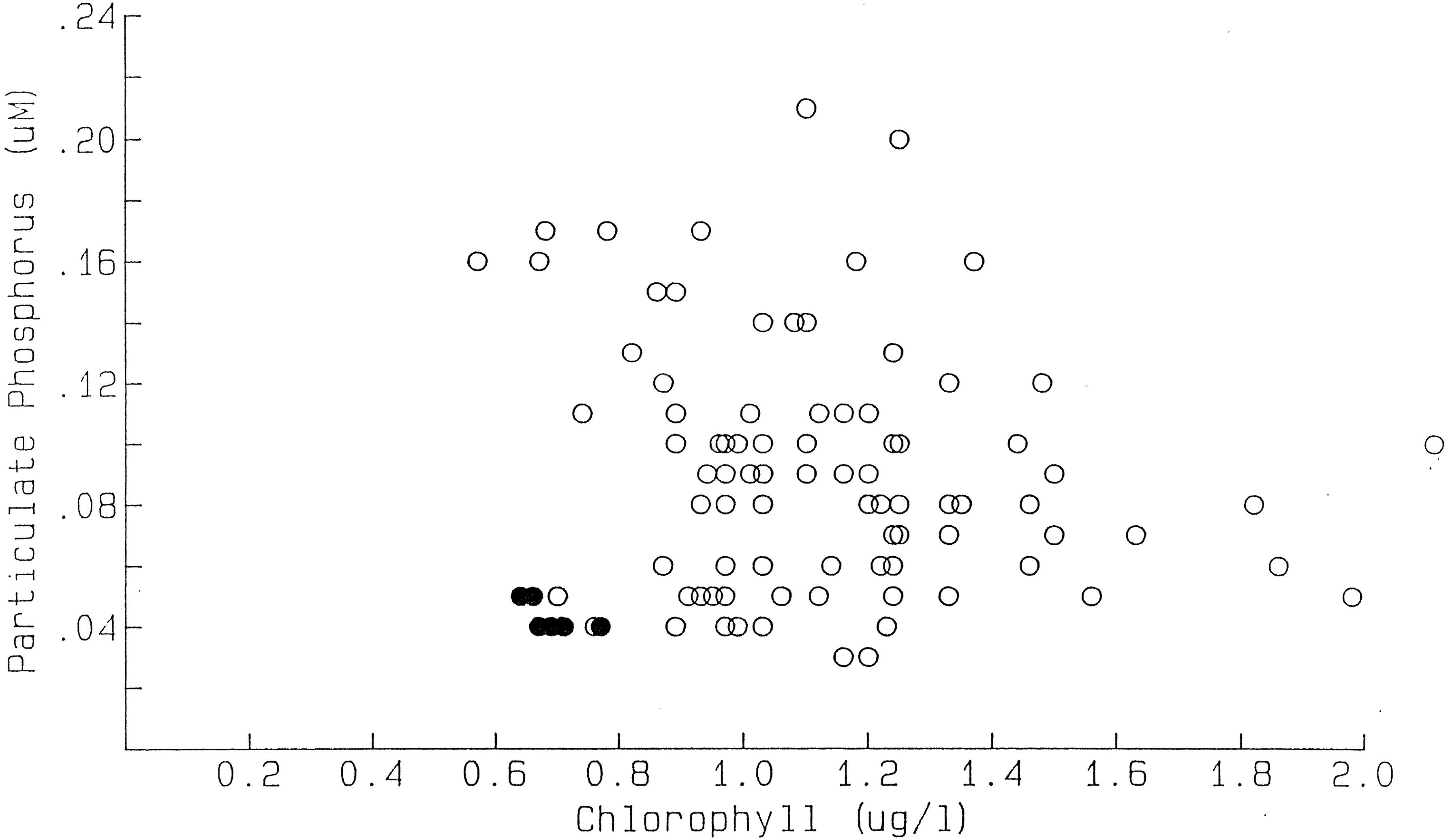


Figure 2. The relationship between measured concentrations of particulate phosphorus (POP) and chlorophyll at shelf stations (closed symbols) and stations within the Whitsunday Island group (open symbols)

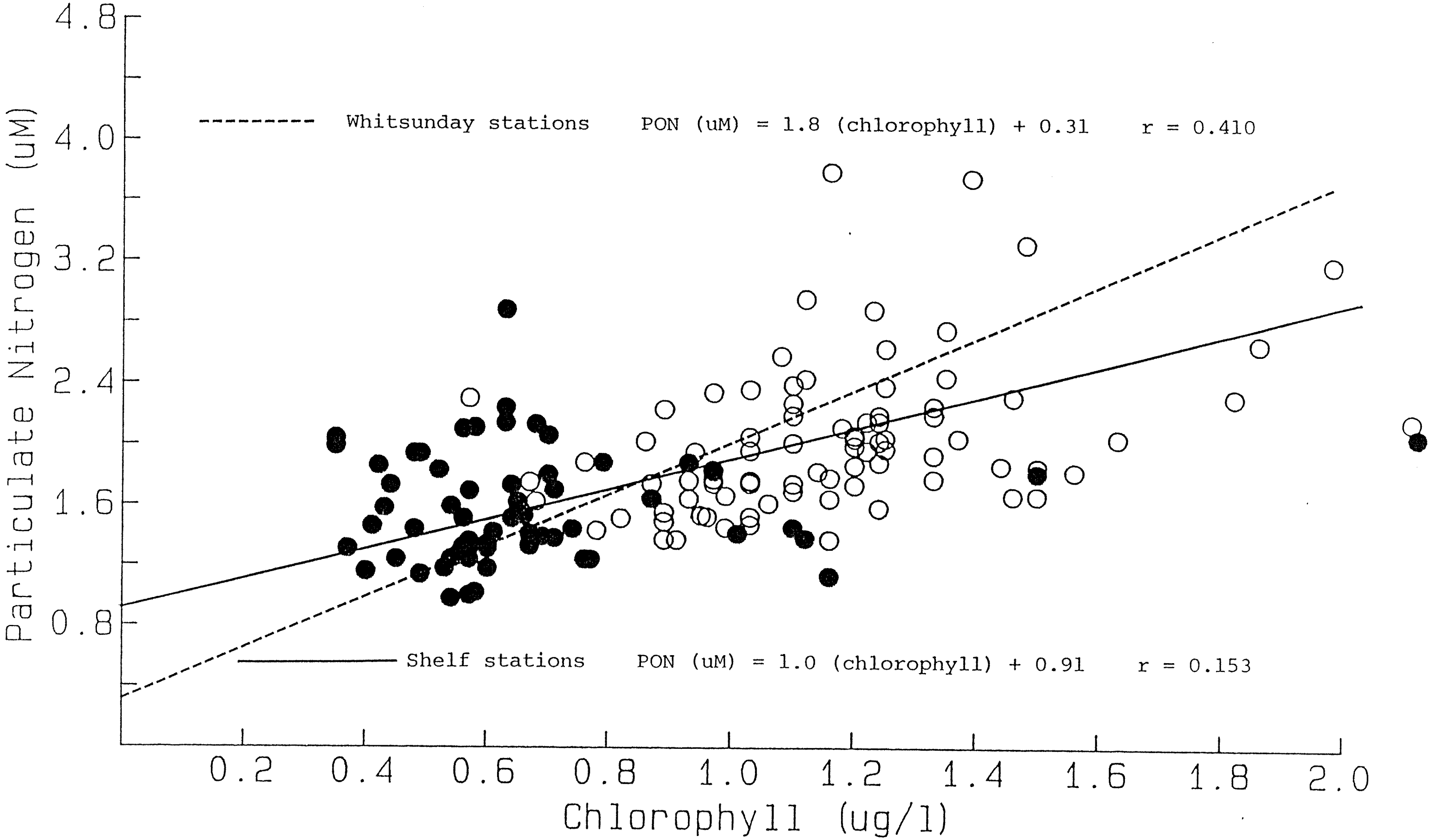


Figure 3. Relationships between measured concentrations of particulate nitrogen (PON) and chlorophyll at shelf stations (closed symbols) and stations within the Whitsunday Island group (open symbols). Regressional lines are functional (GM) regressions (Ricker, 1973).

phytoplankton nitrogen within the PON pool, it is unlikely that regression analyses using chlorophyll would be a suitable tool for determining relative fractions of algal and non-algal nitrogen in Whitsunday Island water masses. Because of this dilution of both POP and PON by non-algal N and P, no significant relationship between PON and POP is apparent (Figure 4). PON/POP ratios ranged between 12 and 36.6 by atoms, with a mean of 24.

General Conclusions

Dissolved nutrient concentrations within the Whitsunday Island group are generally higher than in open shelf and lagoonal waters of the central and southern Great Barrier Reef (Table 4), but not greatly so. Higher nutrient concentrations, particularly of nitrate may be found on the outer shelf during intrusions of Coral Sea sub-thermocline waters (Andrews and Furnas, 1986). The highest nutrient concentrations measured within the Whitsunday Island group were not associated with islands having a significant degree of resort development. Rather, elevated nutrient concentrations appear to be related to the tidal resuspension of bottom sediments with their associated porewaters and detrital particulates. The relative local impact of nutrient inputs from point and non-point discharges will be likely mitigated in many places by the persistent background presence of most nutrient species at concentrations somewhat greater than in open shelf waters. Nutrient concentrations in samples collected near a known sewer outfall at Hamilton Island (stas. 36, 37) were similar to concentrations in samples collected at some distance from any known discharge point (e.g. stas 34,46,49) in the central Whitsundays. This was not surprising, given the high current velocities and turbulence which prevailed during the sampling.

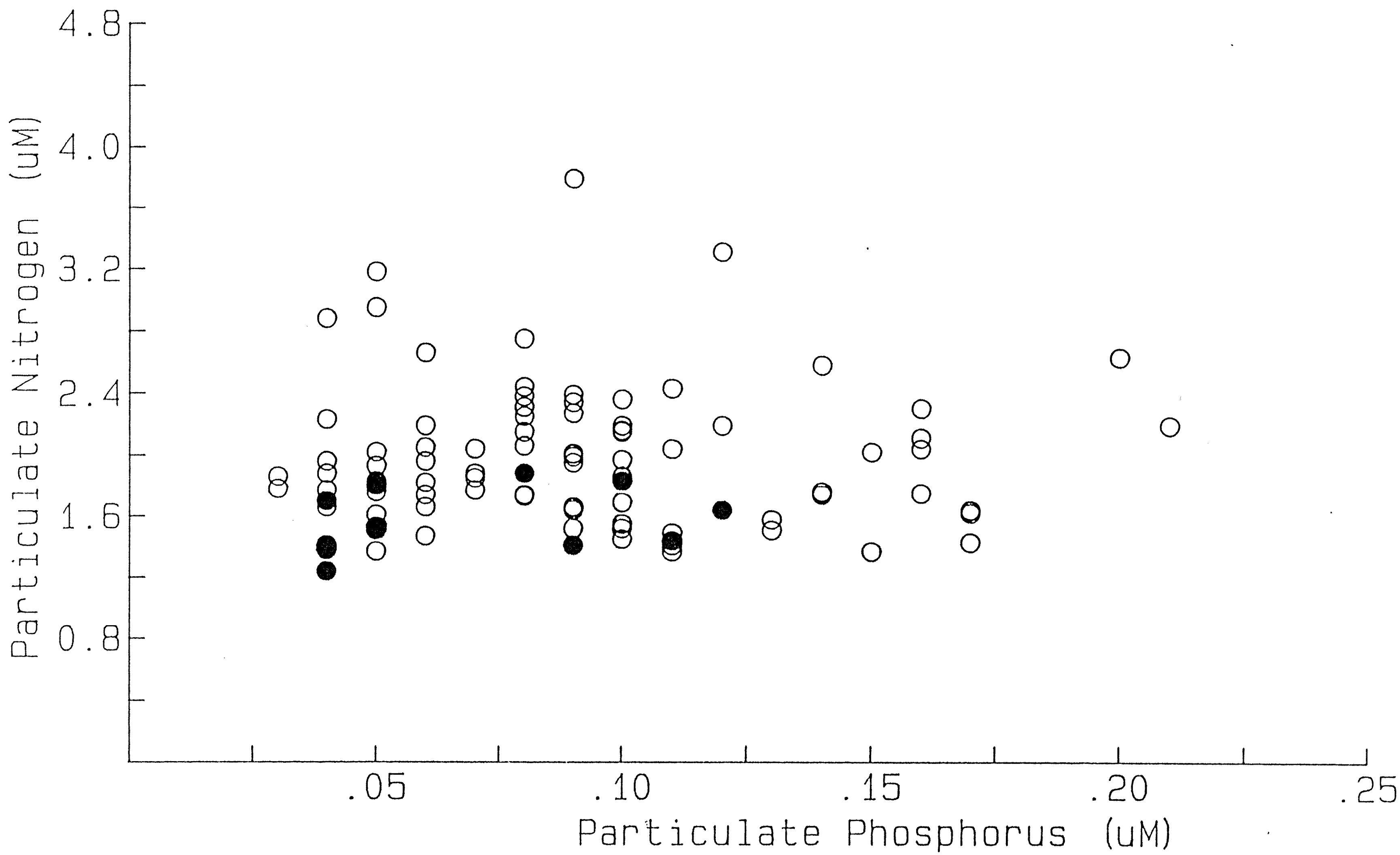


Figure 4. The relationship between measured concentrations of particulate nitrogen (PON) and particulate phosphorus (POP) at stations within the Whitsunday Island group (open symbols) and at one shelf station (closed symbols).

Table 4. Mean near-surface (0-15 m) concentrations of chlorophyll and dissolved inorganic nutrients in mid-shelf waters of the central GBR and within two mid-shelf reef lagoons (Davies, Old). Data summarized from Furnas and Mitchell (1984, 1988).

	Chlorophyll μg/l	NO_2	NO_3	NH_4 μM	PO_4	$Si(OH)_4$
Shelf waters						
mean	0.35	0.00	0.02	0.15	0.16	1.06
1 S.D.	0.42	0.01	0.04	0.12	0.05	0.56
no sta.	76	76	76	75	76	74
Reef lagoons						
mean	0.37	0.04	0.39	0.15	0.17	1.23
1 S.D.	0.32	0.04	0.33	0.15	0.04	0.46
no sta.	14	13	13	12	13	13

The closest analog to the observed turbidity of waters within the Whitsunday Island group caused by tidal resuspension of bottom sediments may be the conditions observed in shelf waters following disturbances by cyclones (M. Furnas, unpubl. data). After these disturbances, regional increases in dissolved nutrient, particularly nitrogen levels, have been measured, coupled with decreases in water clarity and increases in phytoplankton biomass (measured as chlorophyll). Dissolved nutrient, in particular nitrogen concentrations, appear to remain at elevated levels for some time after these disturbance events due to supression of phytoplankton growth by low light levels in situ. Because of tidal stirring, the Whitsunday Island group may be subject to a continuous or near-continuous "cyclonic" type of resuspension disturbance, with resulting impacts on water turbidity, nutrient concentrations and speciation. The analogy to cyclonic disturbance, however, is not entirely straightforward. Nitrite (NO_2) concentrations were consistently below measurable levels at all but two Whitsunday group stations, while clearly elevated nitrite concentrations were measured after two cyclones. The discrepancy is puzzling. Nitrite is an intermediary in the aerobic conversion of ammonium to nitrate by bacteria and the reduction of nitrate by phytoplankton. Its formation is enhanced by elevated ammonium concentrations, inputs of ammonium from mineralization of organic-N (e.g. McCarthy et. al., 1983) and low in situ light levels such as would be found in turbid waters.

Dissolved organic nitrogen and phosphorus comprised the bulk of water column N and P. Mean concentrations of DON from both Whitsunday group and shelf stations in the central GBR are not significantly different from mean concentrations measured earlier in shelf waters near Lizard Island (Barnes and Crossland, 1983) or the Torres Strait and western Gulf of Papua (Mitchell, 1982) using similar methods (Table 5). Recent findings (Suzuki et al., 1985), however, suggest that analytical methods for DON relying on wet-chemical oxidative or reductive methods may substantially underestimate the

Table 5. Mean concentrations of dissolved organic nitrogen (DON), dissolved organic phosphorus (DOP) and particulate nitrogen (PON) measured at open water stations in the GBR.

	DON µM-N	DOP µM-P	PON µM-N
Whitsunday Islands			
mean	3.9	0.42	2.0
1 S.D.	0.9	0.12	0.5
n	47	49	87
Central and Southern GBR			
mean	4.8	0.56	1.6
1 S.D.	1.5	0.19	0.4
n	45	14	71
Lizard Island[a]			
mean	4.7		1.2
1 S.D.	1.8		0.6
n	36		44
Torres Strait and Western Gulf of Papua[b]			
mean	4.2	0.12	
1 S.D.	2.0	0.09	
n	228	221	

[a] from Barnes and Crossland, 1983
[b] from Mitchell, 1982

amount of DON present. The composition and activity of this additional DON is not yet resolved. Such a discrepancy in the methods, however, would further reinforce the fact that dissolved inorganic N species readily taken up by phytoplankton usually constitute a very small proportion of total fixed nitrogen in GBR waters.

In contrast, DOP levels measured at Whitsunday and southern GBR stations were nearly four times those measured in the Torres Strait and Gulf of Papua. It is not clear whether this is a real difference or represents a methodological artifact. DIP concentrations in Whitsunday Island waters were similar to concentrations measured in off-reef samples collected near Lizard Island (mean = 0.21 ± 0.07 μM; Barnes and Crossland, 1983), but higher than concentrations measured in the Torres Strait (mean = 0.11 ± 0.08 μM; Mitchell, 1982) and in open shelf waters of the central GBR (Furnas and Mitchell, 1984).

At stations where comparisons were possible, DIN never exceeded 15 percent of total water column N and DIP was never more than 36 percent of total water column P. The importance of DON, PON, DOP and POP in water column nutrient cycling cannot be resolved from the present data set. The relatively high lower boundary for measured PON concentrations (ca. 0.9 μM) and estimated intercepts for PON vs chlorophyll regressions (ca. 1 μM) indicate that a substantial proportion of the PON in the water column is not in the form of phytoplankton. What proportion bacteria, zooplankton and protozoans contribute is unknown. The presence of high background concentrations of non-living organic N has also been observed in lagoonal waters of Tikehau atoll, French Polynesia (Charpy, 1985). Concentrations of PON in GBR waters were of similar order to those measured in Tikehau Lagoon (Charpy, 1985), but considerably higher than measured at Eniwetok Atoll (Gerber and Marhall, 1974). Lower threshold concentrations of POP are considerably lower than for nitrogen, but the scatter in the

POP data precludes estimation of an algal contribution. POP concentrations in waters of the Whitsunday Island group were generally lower than those measured in Tikehau lagoon (Charpy, 1985).

Some Comments and Suggestions

The data presented is really only a preliminary reconnaissance through the Whitsunday Island group and caution should be exercised when applying the data to specific water quality problems.

There is some concern that elevated levels of phosphate in reefal waters may be detrimental to coral growth and productivity (Kinsey and Davies, 1979). This survey was not carried out to resolve whether observed phosphate levels were detrimental to reefs or corals in the Whitsunday group. Dissolved inorganic phosphate concentrations in waters of the Whitsunday group are higher than in open shelf waters of the GBR, but similar to DIP concentrations within reef flat or reef lagoon waters (Barnes and Crossland, 1983; Furnas and Mitchell, 1988). The apparent high concentrations of DOP as compared to earlier measurements in the northern GBR are of some interest. It is recommended that additional measurements of DOP be carried out to confirm these values. It is also recommended that experiments should be carried out to assess rates at which DOP is mineralized and the DOP pool turns over, as only indirect estimates of phosphate utilization can be inferred from static pool measurements. This applies to the other nutrients as well.

Acknowledgements

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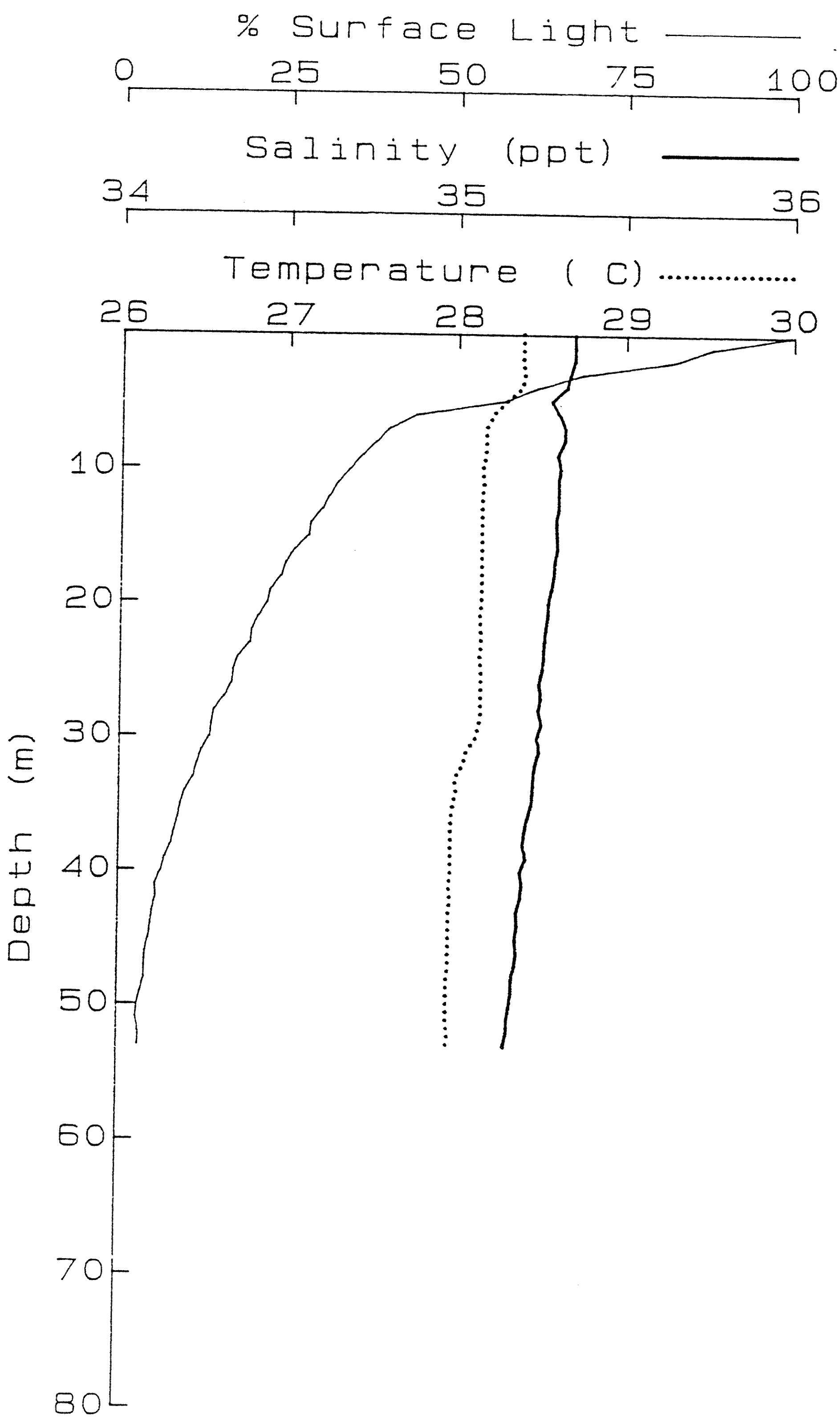
Appendix. Hydrographic, chlorophyll and nutrient data from stations in the Whitsunday Island group and selected comparative stations in the central and southern GBR. The hydrographic and U/W light data is shown as obtained from CTD profiles. Individual temperature and salinity values shown with the nutrient data were taken from the profile data files.

COTO7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0
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100
Salinity (ppt)
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36
Temperature (C)
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Depth (m)
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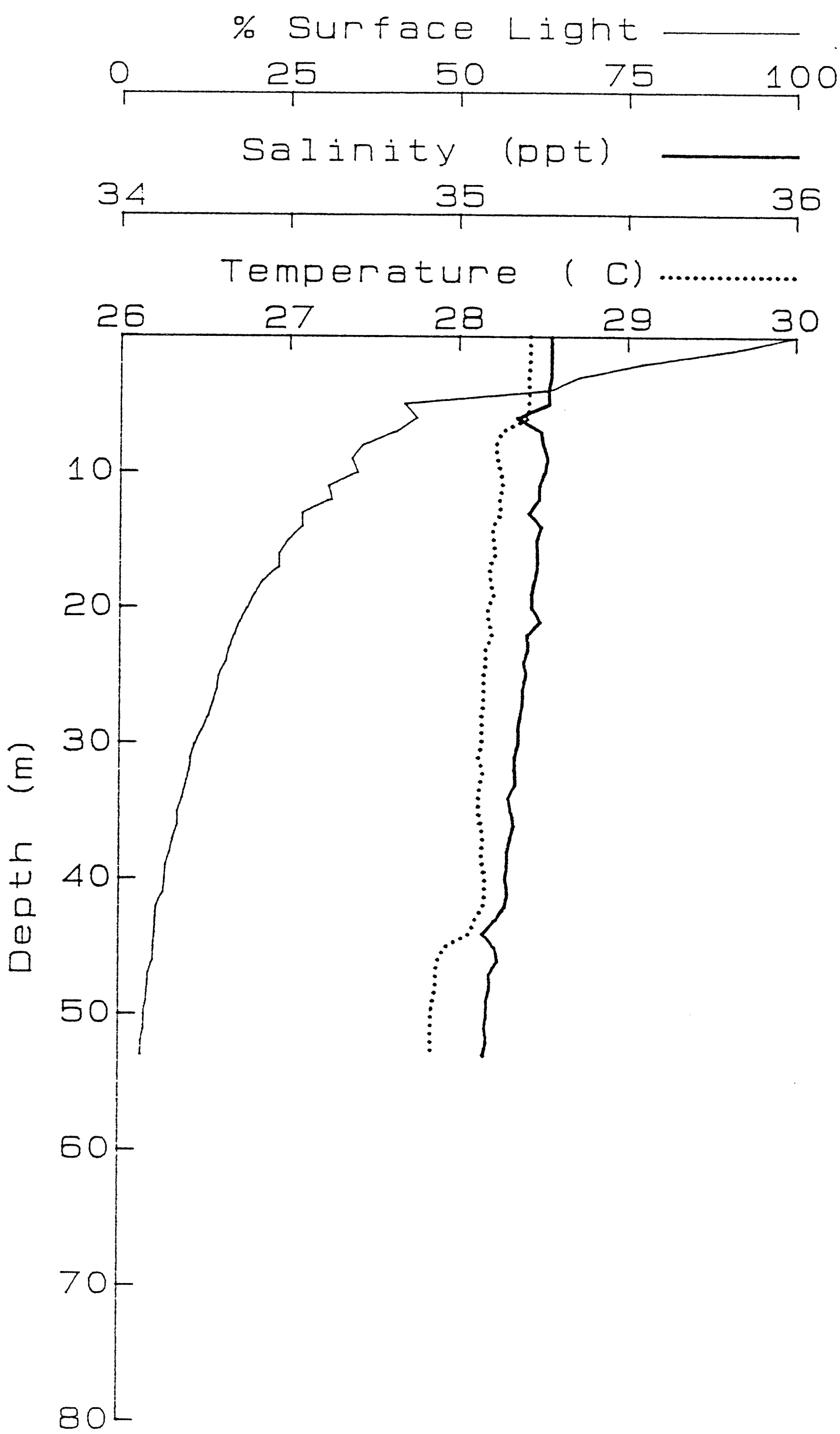
COT Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
7	3 Jan 87	19° 01.9′ S	147° 54.0′ E	59 m

Time arr	Time left	Wind sp	Wind dir	Swell ht	Swell dir
1305	1345	13 knots	30°	0.3 m	45°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	28.39	35.33	0.40	0.00	0.00	0.03	0.20	4.6	1.2	0.14			0.71
10	28.15	35.31	0.43	0.05	0.00	0.03	0.00	4.8	1.6	0.12			0.63
20	28.15	35.27	0.37	0.18	0.00	0.03	0.00	5.2	1.3	0.14			0.62
30	28.12	35.24	0.58	0.09	0.00	0.03	0.00	4.6	2.1	0.13			0.62
40	27.98	35.20	1.16	0.15	0.00	0.03	0.03	3.9	1.1	0.15			0.78
50	27.96	35.17	1.10	0.36	0.00	0.10	0.09	7.2	1.5	0.15			1.32
59	27.96	35.15	1.12	0.12	0.00	0.03	0.06	38.3	1.4	0.15			0.86

COT12



% Surface Light
0
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100
Salinity (ppt)
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36
Temperature (C)
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Depth (m)
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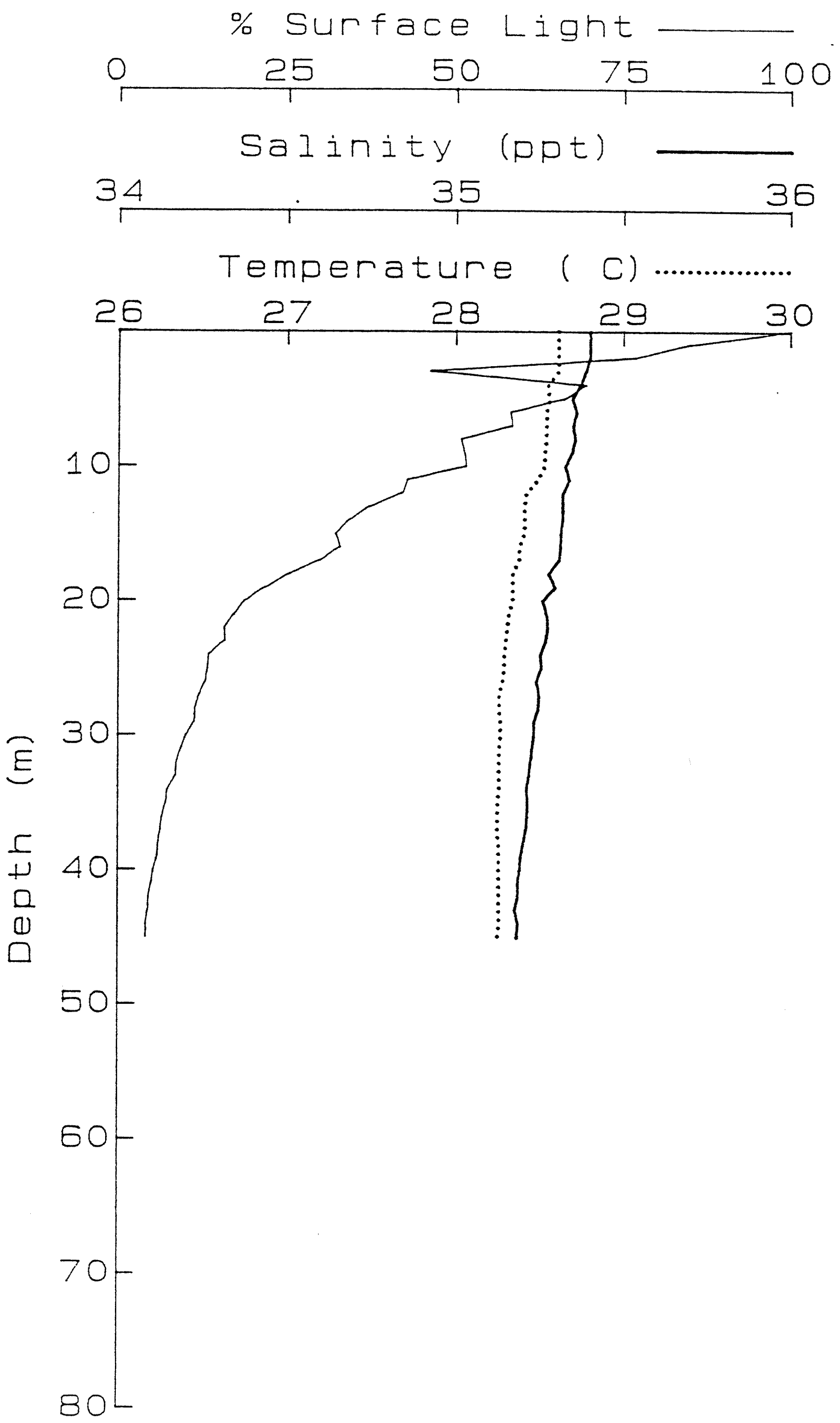
COT Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
12	4 Jan 87	18° 49.3′ S	147° 31.5′ E	52 m

Time arr	Time left	Wind sp	Wind dir	Swell ht	Swell dir
0955	1045	10 knots	50°	0.5 m	45°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (μM)	PO_4	DOP	POP	SiO
0	28.42	35.27	0.35	0.01	0.00	0.03	0.08	5.3	2.1	0.13			0.96
5	28.41	35.27	0.42	0.01	0.00	0.03	0.00	5.6	1.9	0.13			1.06
10	28.25	35.25	0.35	0.02	0.00	0.03	0.02	2.9	2.0	0.10			0.92
15	28.21	35.23	0.45	0.01	0.00	0.03	0.09	39.1	1.2	0.12			1.03
20	28.17	35.22	0.53	0.11	0.00	0.03	0.00	5.2	1.2	0.11			1.00
25	28.15	35.20	0.41	0.01	0.00	0.03	0.03	3.8	1.5	0.11			1.24
30	28.14	35.18	0.57	0.07	0.00	0.03	0.19	4.5	1.2	0.11			0.89
35	28.12	35.16	0.49	0.01	0.00	0.03	0.03	4.1	1.1	0.13			1.38
40	28.16	35.14	0.55	0.06	0.00	0.03	0.03	5.1	1.3	0.13			1.01
45	27.92	35.11	0.76	0.08	0.00	0.03	0.16	4.2	1.2	0.13			0.79

COT18



% Surface Light
0
25
50
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100
Salinity (ppt)
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36
Temperature (C)
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Depth (m)
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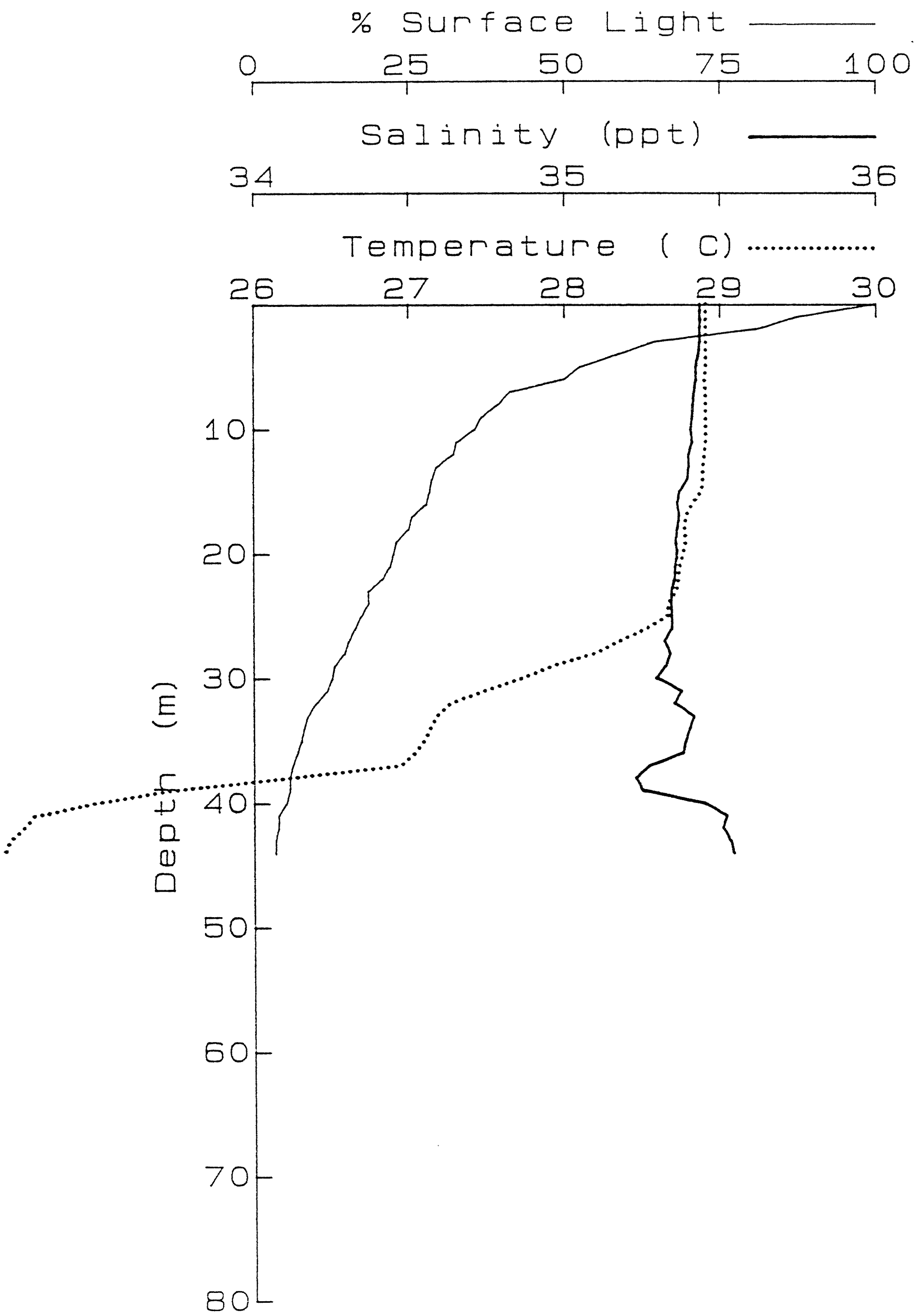
COT Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
18	8 Jan 87	19° 25.5′ S	148° 03.8′ E	43 m

Time arr	Time left	Wind sp	Wind dir	Swell ht	Swell dir
0918		4 knots	60°	0.7 m	145°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	28.61	35.40			0.00	0.00	0.59	14.5	1.6	0.17			0.65
5	28.56	35.35			0.00	0.00	0.04	3.7	1.5	0.12			0.61
10	28.53	35.33			0.00	0.00	0.01	5.4	1.1	0.10			0.63
15	28.41	35.31			0.00	0.00	0.12	8.1	2.0	0.10			0.51
20	28.34	35.26			0.00	0.00	0.22	20.6	1.5	0.12			0.79
25	28.29	35.26			0.00	0.00	0.09	4.9	1.5	0.15			0.80
30	28.27	35.23			0.00	0.00	0.00	5.9	1.5	0.13			0.89
35	28.25	35.22			0.00	0.00	0.00	5.6	1.9	0.13			0.55
40	28.26	35.19			0.00	0.00	0.36	7.1	1.6	0.17			0.82
45	28.25	35.18			0.00	0.00	0.00	5.2	1.4	0.13			0.39

COT20



% Surface Light
0
25
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75
100
Salinity (ppt)
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36
Temperature (C)
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Depth (m)

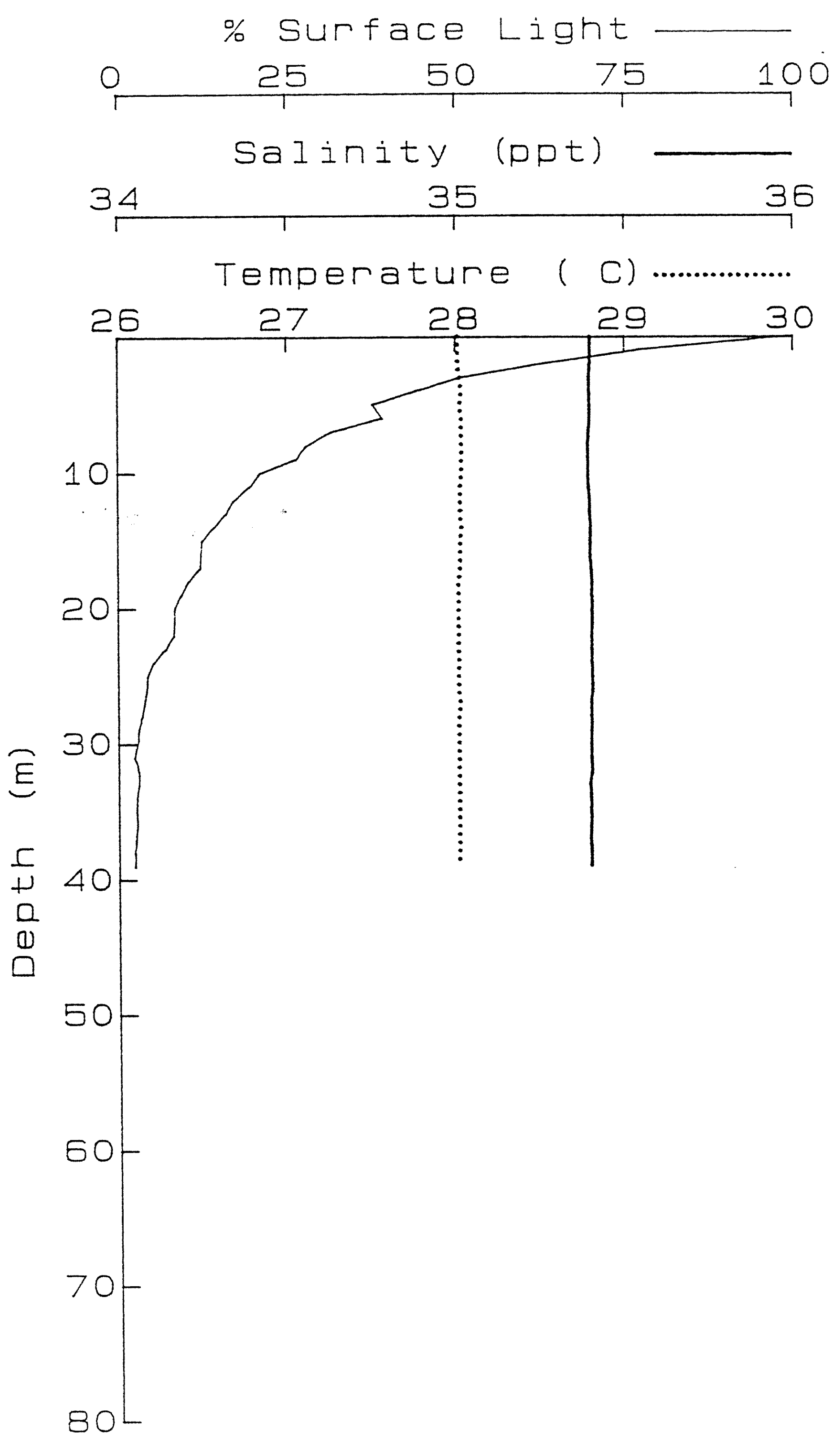
COT Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
20	10 Jan 87	18° 31.0´ S	146° 43.3´ E	43 m

Time arr	Time left	Wind sp	Wind dir	Swell ht	Swell dir
0815	0914	8 knots	45°	m	°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m³)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	28.91	35.44	0.49	0.01	0.00	0.00	0.10	12.9	1.9	0.09			0.51
5	28.91	35.42	0.64	0.01	0.00	0.00	0.14	5.4	1.7	0.09			0.73
10	28.91	35.41	0.48	0.10	0.00	0.00	0.06	8.5	1.4	0.12			0.64
15	28.88	35.37	0.48	0.26	0.00	0.00	0.13	7.2	1.9	0.09			0.70
20	28.78	35.36	0.52	0.00	0.00	0.00	0.34	4.1	1.8	0.16			1.16
25	28.66	35.34	0.44	0.01	0.00	0.00	0.12	2.2	1.7	0.12			0.80
30	27.73	35.29	0.65	0.02	0.00	0.00	0.02	3.1	1.6	0.13			0.55
35	27.10	35.39	1.50	0.00	0.00	0.08	0.02	4.7	1.8	0.17			0.53
40	24.97	35.45	2.12	0.17	0.09	0.75	0.10	7.4	2.1	0.84			0.84
43	24.40	35.54	2.70	0.25	0.50	2.95	0.03	7.8	1.9	0.49			2.30

swa21



% Surface Light
0
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100
Salinity (ppt)
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35
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Temperature (C)
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Depth (m)
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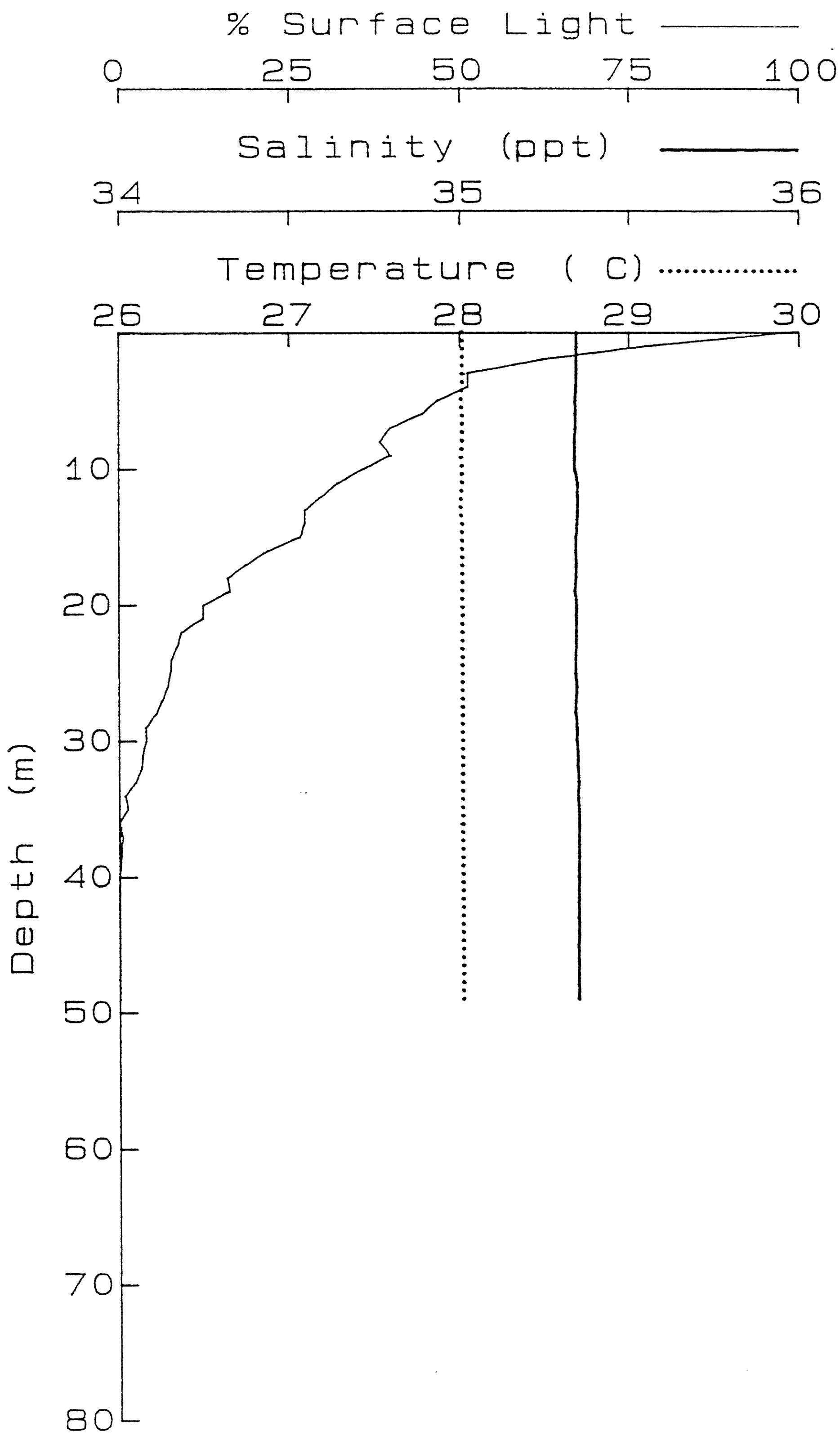
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
21	12 Feb 88	21° 05.3′ S	151° 32.6′ E	41 m

Time arr	Time left	Wind sp	Wind dir	Swell ht	Swell dir
0820	0905	14 knots	70°	m	°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	28.02	35.40	0.79	0.09	0.00	0.41	0.47	3.5	1.9	0.19	0.34		0.33
5	28.03	35.40	0.68	0.09	0.00	0.35	0.11	4.9	2.1	0.13	0.59		0.33
10	28.04	35.40	0.70	0.12	0.00	0.34	0.05	3.6	2.1	0.25	0.66		0.53
20	28.02	35.41	0.56	0.12	0.00	0.41	0.13	3.4	2.1	0.30	0.54		0.53
25	28.02	35.41	0.63	0.02	0.00	0.35	0.13	3.6	2.2	0.27	0.76		0.53
35	28.02	35.40	0.63	0.00	0.00	0.45	0.28	2.6	2.1	0.22	0.41		0.48
41	28.02	35.40	0.63	0.15	0.00	0.34	0.03	4.6	2.9	0.26	0.31		0.48

swa23



% Surface Light
0
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Salinity (ppt)
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Temperature (C)
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Depth (m)
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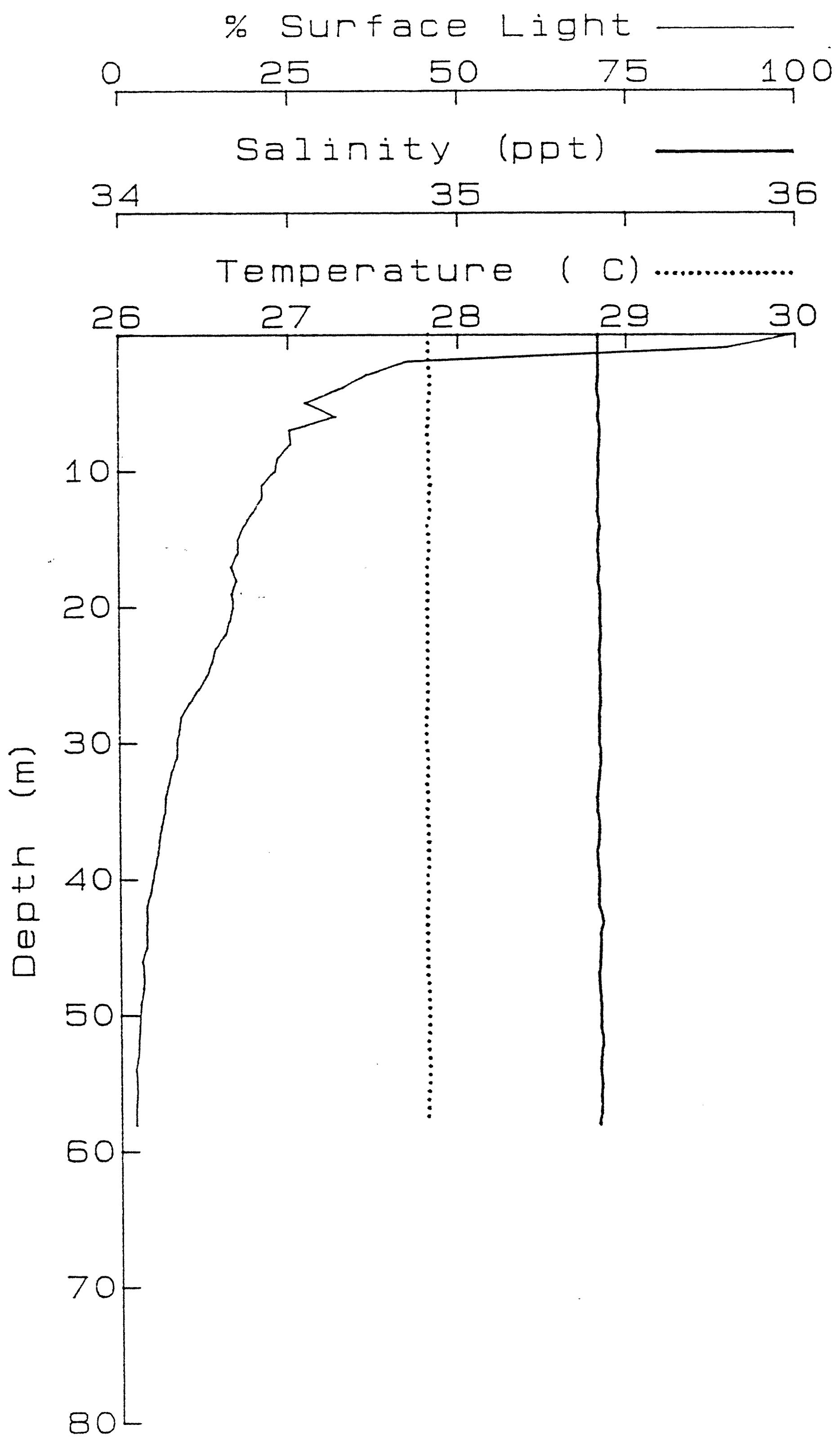
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
23	14 Feb 88	21° 08.4′ S	151° 30.7′E	48 m

Time arr	Time left	Wind sp	Wind dir	Swell ht	Swell dir
0835	0918	12 knots	90°	0.2 m	90°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (μM)	PO_4	DOP	POP	SiO
0	28.02	35.35	0.57	0.03					1.7				
5	28.01	35.34	0.56	0.06					1.3				
10	28.02	35.34	0.61	0.07					1.4				
20	28.02	35.35	0.60	0.06					1.3				
30	28.02	35.35	0.67	0.01					1.3				
40	28.02	35.35	0.60	0.07					1.2				
50	28.02	35.35	0.54	0.01					1.0				

swa25



% Surface Light
0
25
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100
Salinity (ppt)
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Temperature (C)
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Depth (m)
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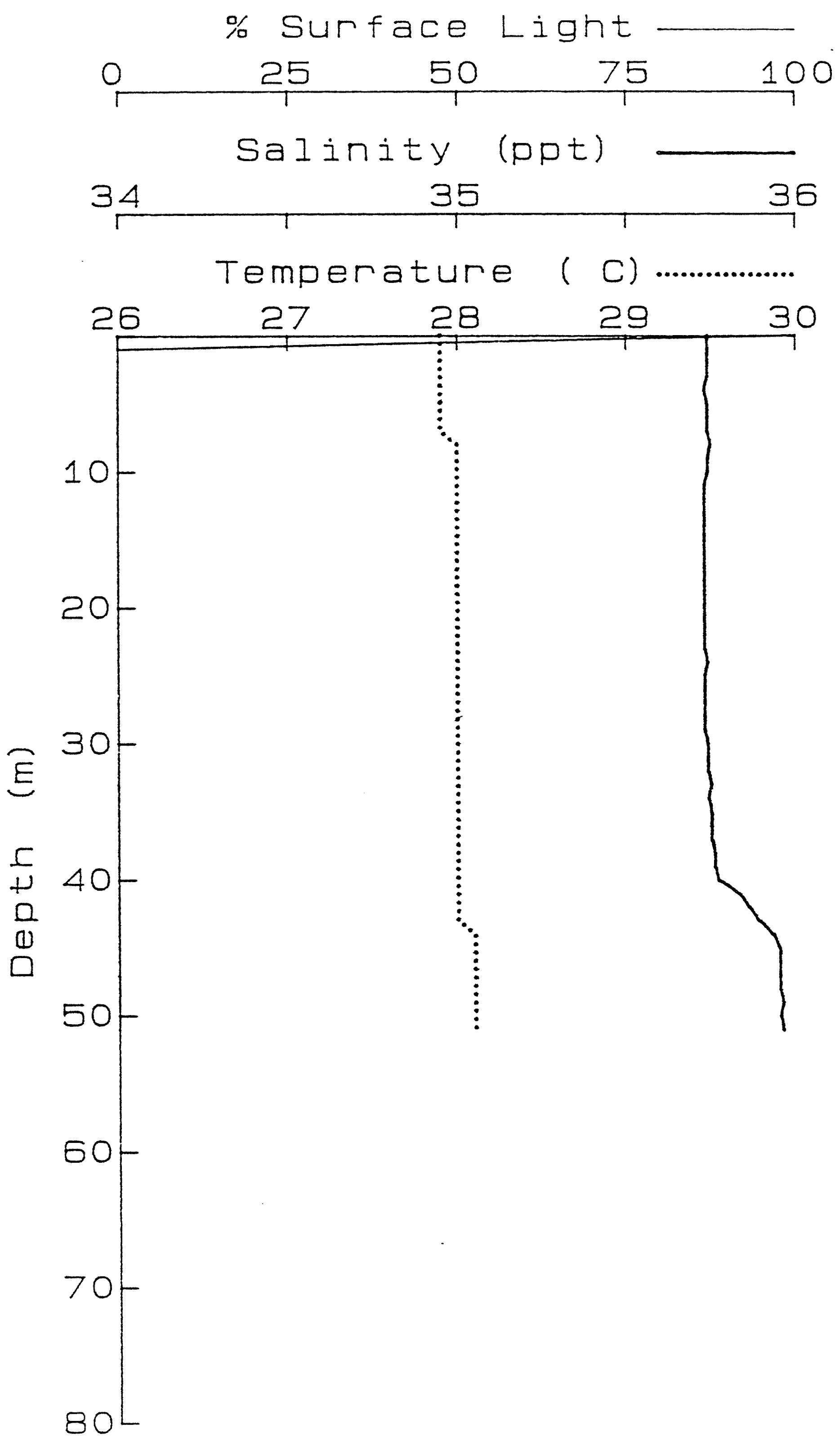
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
25	16 Feb 88	21° 39.3′ S	151° 43.3′ E	58 m

Time arr	Time left	Wind sp	Wind dir	Swell ht	Swell dir
1115	1200	20 knots	135°	1.5 m	135°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	27.83	35.42	0.54	0.05	0.00	0.08	0.07	5.5	1.2	0.17	0.79		0.36
5	27.83	35.42	0.54	0.00	0.00	0.09	0.07	4.1	1.6	0.17	0.45		0.36
10	27.83	35.42	0.58	0.00	0.00	0.09	0.05	2.2	1.0	0.17	0.40		0.40
25	27.82	35.42	0.60	0.00	0.00	0.08	0.04	4.7	1.3	0.16	0.33		0.40
35	27.81	35.41	0.56	0.00	0.00	0.07	0.22	3.0	1.5	0.07	0.61		0.33
50	27.82	35.42	0.57	0.04	0.00	0.09	0.00	3.2	1.4	0.14	0.84		0.43
58	27.80	35.41	0.57	0.02	0.00	0.08	0.00	3.9	1.0	0.14	0.75		0.43

SWA 30



% Surface Light
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Salinity (ppt)
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Temperature (C)
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Depth (m)
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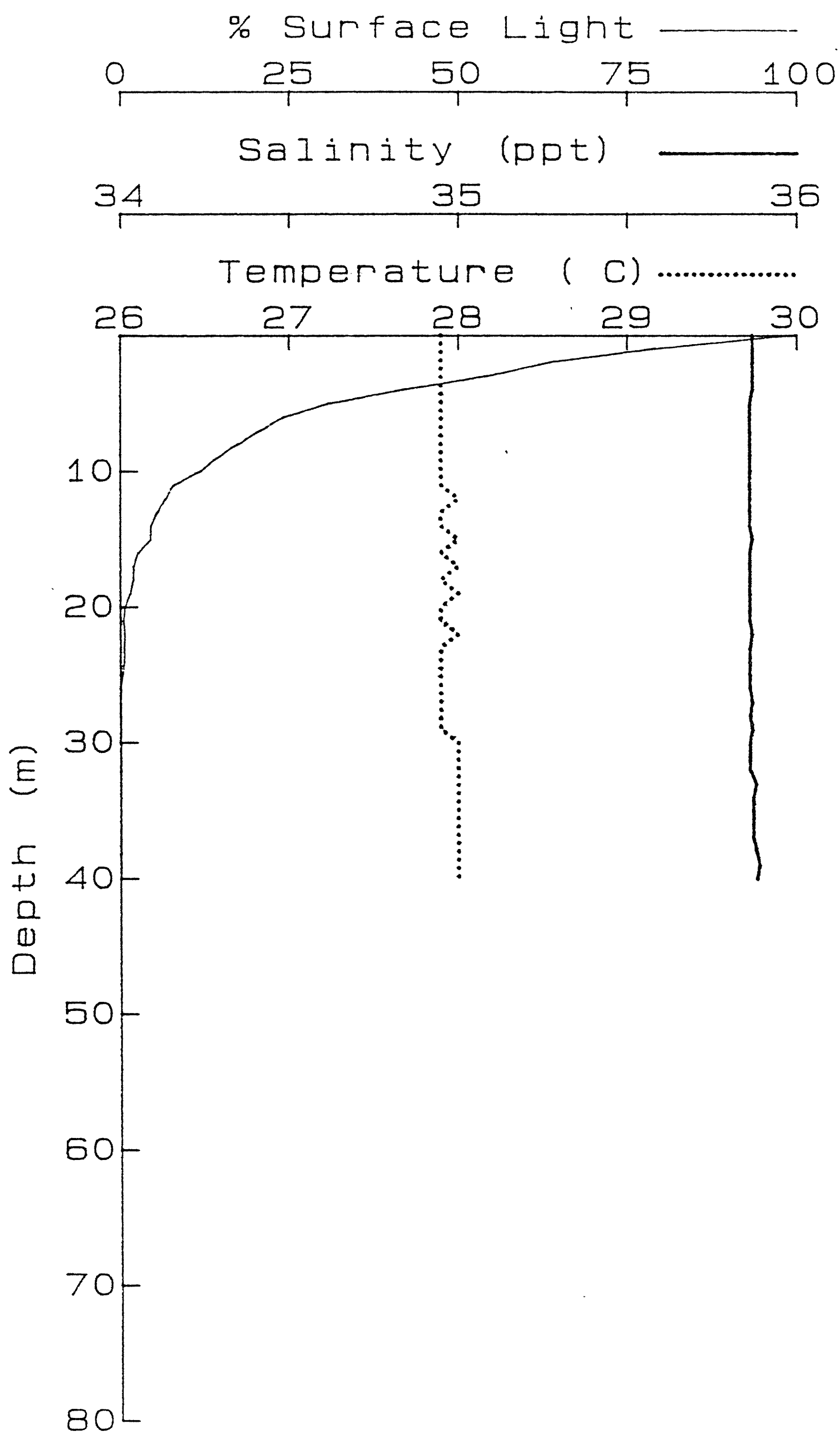
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
30	18 Feb 88	21° 14.6′ S	150° 08.0′ E	53 m

Time arr	Time left	Wind sp	Wind dir	Swell ht	Swell dir
2202	2228	20 knots	135°	3.0 m	135°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	27.99	35.74	0.70	0.27	0.00	0.08	0.07			0.17			1.52
10	28.00	35.75	0.72	0.24	0.00	0.09	0.07			0.17			1.50
20	28.00	35.73	0.76	0.20	0.00	0.09	0.07			0.16			1.43
30	28.01	35.74	0.67	0.17	0.00	0.07	0.16			0.17			1.29
40	28.03	35.78	0.61	0.17	0.00	0.09	0.16			0.17			1.54
50	28.11	35.96	0.59	0.22	0.00	0.15	0.12			0.19			1.97

SWA 31



% Surface Light
0
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Salinity (ppt)
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Temperature (C)
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Depth (m)
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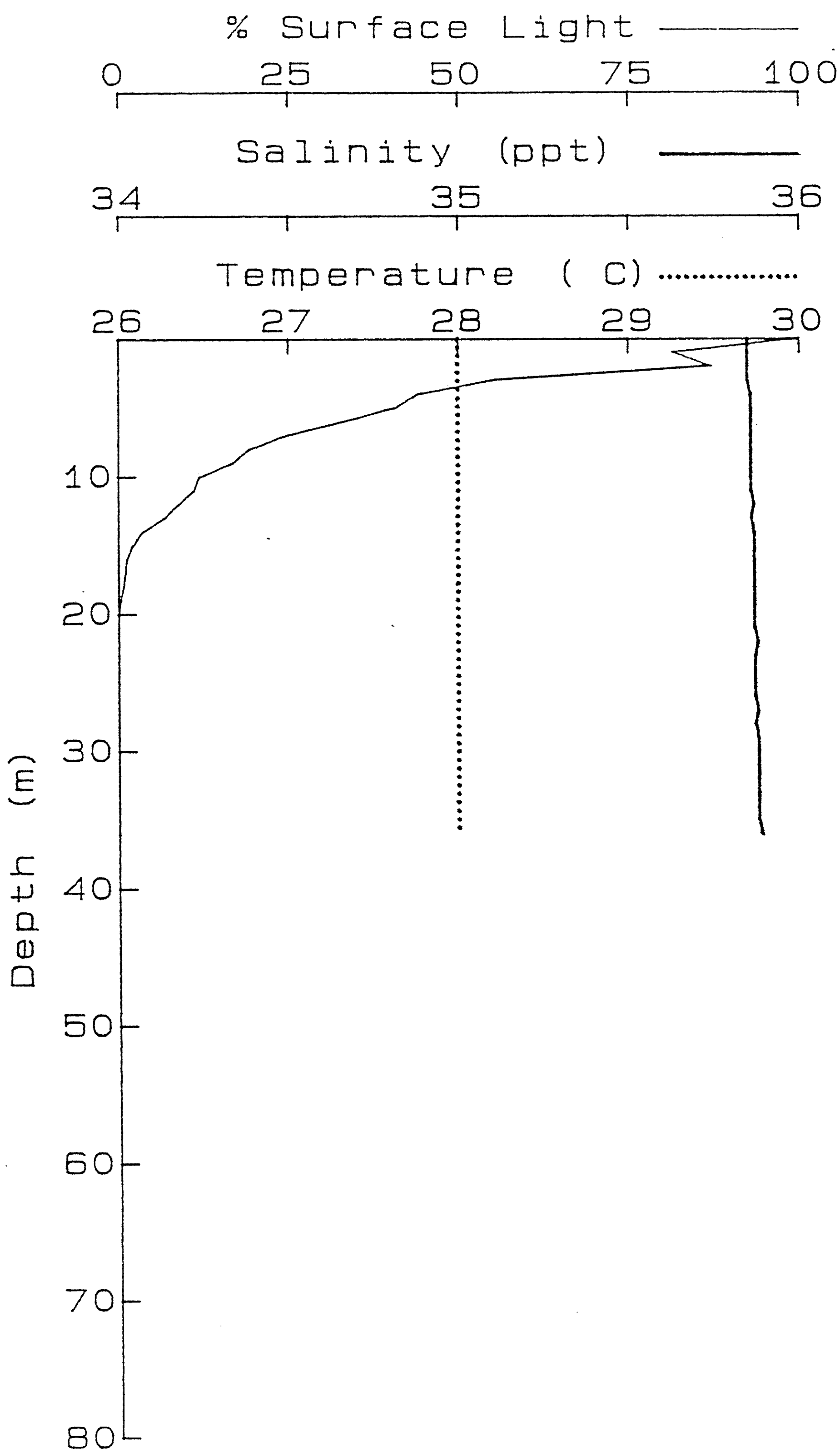
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
31	19 Feb 88	20° 51.6′ S	149° 31.8′ E	40 m

Time arr	Time left	Wind sp	Wind dir	Swell ht	Swell dir
0833	0909	20 knots	135°	2.0 m	135°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m³)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	27.98	35.87	0.71	0.13	0.00	0.10	0.12	5.3	1.7	0.17	0.93	0.04	1.81
5	27.99	35.87	0.77	0.11	0.00	0.11	0.08	3.7	1.2	0.18	0.37	0.04	1.59
10	27.99	35.86	0.69	0.10	0.00	0.09	0.29	1.6	1.4	0.16	0.33	0.04	1.43
15	28.00	35.87	0.67	0.06	0.00	0.10	0.04	5.2	1.4	0.17	0.65	0.04	1.94
20	27.99	35.87	0.71	0.11	0.00	0.11	0.10	4.0	1.4	0.17	0.47	0.04	1.57
30	28.00	35.87	0.66	0.08	0.00	0.11	0.25	5.2	1.5	0.17	0.74	0.05	1.72
40	28.00	35.88	0.64	0.12	0.00	0.12	0.08	4.8	1.5	0.19	0.40	0.05	1.71

SWA 32



% Surface Light
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Salinity (ppt)
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Temperature (C)
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Depth (m)
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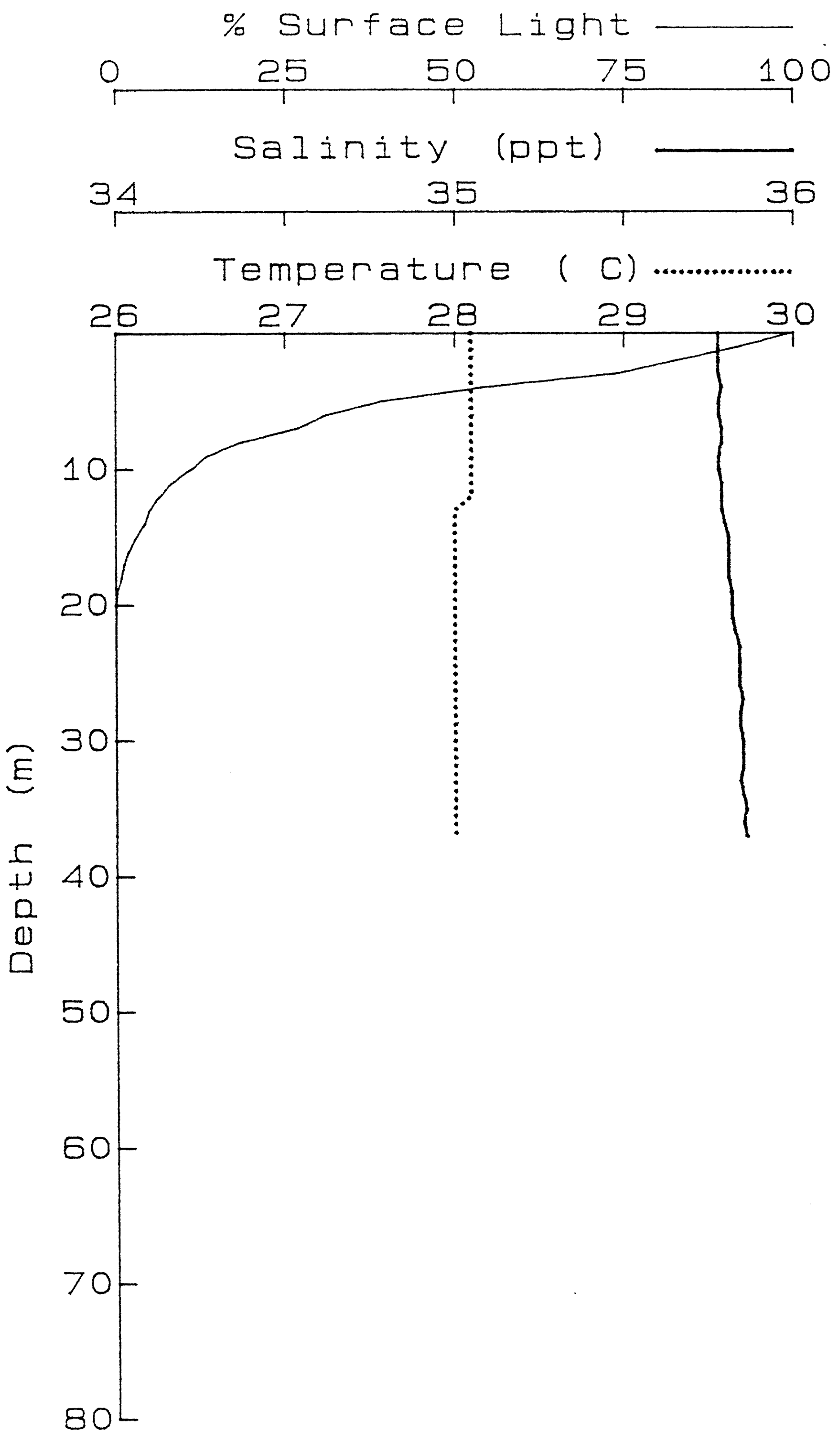
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
32	19 Feb 88	20° 47.4 'S	149° 21.7 'E	36 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
1020	1039	22 knots	135°	2.0 m	135°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	28.07	35.86	1.24	1.45	0.00	0.08	0.01		1.6	0.21		0.13	1.13
10	28.06	35.86	1.10	0.10	0.00	0.08	0.01		1.7	0.22		0.14	1.11
20	28.04	35.88	1.03	0.23	0.00	0.08	0.03		1.8	0.24		0.14	1.22
30	28.04	35.88	1.10	0.58	0.00	0.08	0.03		2.3	0.25		0.09	2.15
35	28.04	35.87	1.16	0.80	0.00	0.08	0.23		3.8	0.35		0.09	1.37

SWA 33



% Surface Light
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Salinity (ppt)
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Temperature (C)
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Depth (m)
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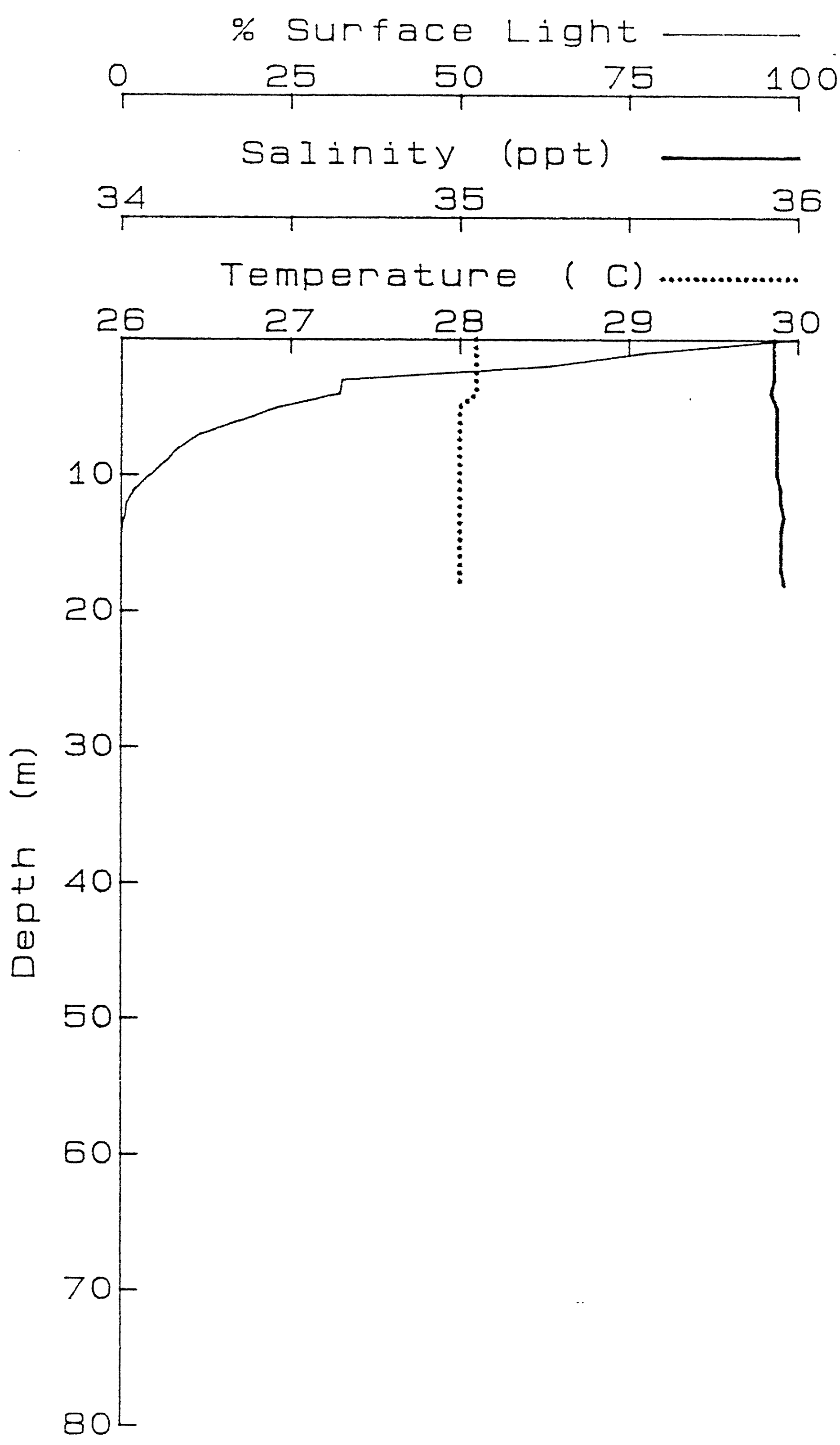
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
33	19 Feb 88	20° 40.7 ′S	149° 13.8 ′E	35 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
1157	1215	20 knots	135°	2.0 m	135°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m³)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	28.17	35.79	0.87	0.06	0.00	0.03	0.34			0.22			1.27
10	28.12	35.78	0.89	0.07	0.00	0.03	0.15			0.19			1.10
20	28.06	35.82	1.05	0.15	0.00	0.03	0.15			0.18			1.04
30	28.05	35.85	1.18	0.12	0.00	0.03	0.45			0.17			0.88
35	28.05	35.86	1.18	0.14	0.00	0.03	0.39			0.13			1.06

SWA 34


% Surface Light
0
25
50
75
100
Salinity (ppt)
34
35
36
Temperature (C)
26
27
28
29
30
Depth (m)
10
20
30
40
50
60
70
80

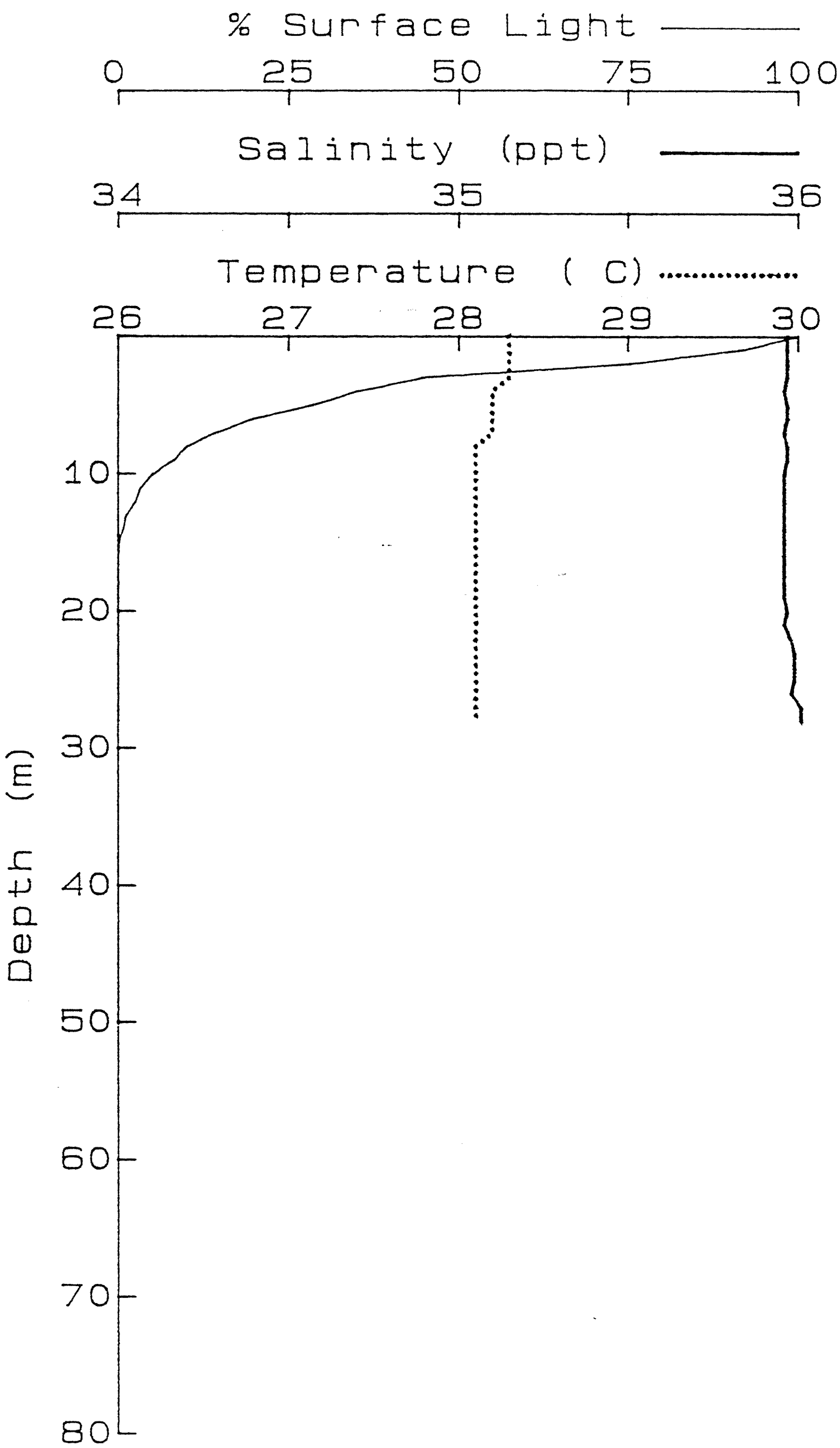
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
34	19 Feb 88	20° 35.2 ´S	149° 04.7 ´E	19 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
1316	1332	20 knots	135°	2.0 m	135°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (μM)	PO_4	DOP	POP	SiO
0	28.17	35.94	1.56	0.03	0.00	0.03	0.21		1.8	0.16		0.05	1.15
5	28.09	35.95	1.50	0.01	0.00	0.03	0.45		1.9	0.21		0.07	1.31
10	28.03	35.95	1.82	0.02	0.00	0.03	0.28		2.3	0.20		0.08	1.35
15	28.02	35.96	1.86	0.15	0.00	0.03	0.28		2.7	0.22		0.06	1.42
19	28.02	35.96	1.98	0.47	0.00	0.03	0.31		3.2	0.22		0.05	1.17

SWA 35


% Surface Light
0
25
50
75
100
Salinity (ppt)
34
35
36
Temperature (C)
26
27
28
29
30
Depth (m)
10
20
30
40
50
60
70
80

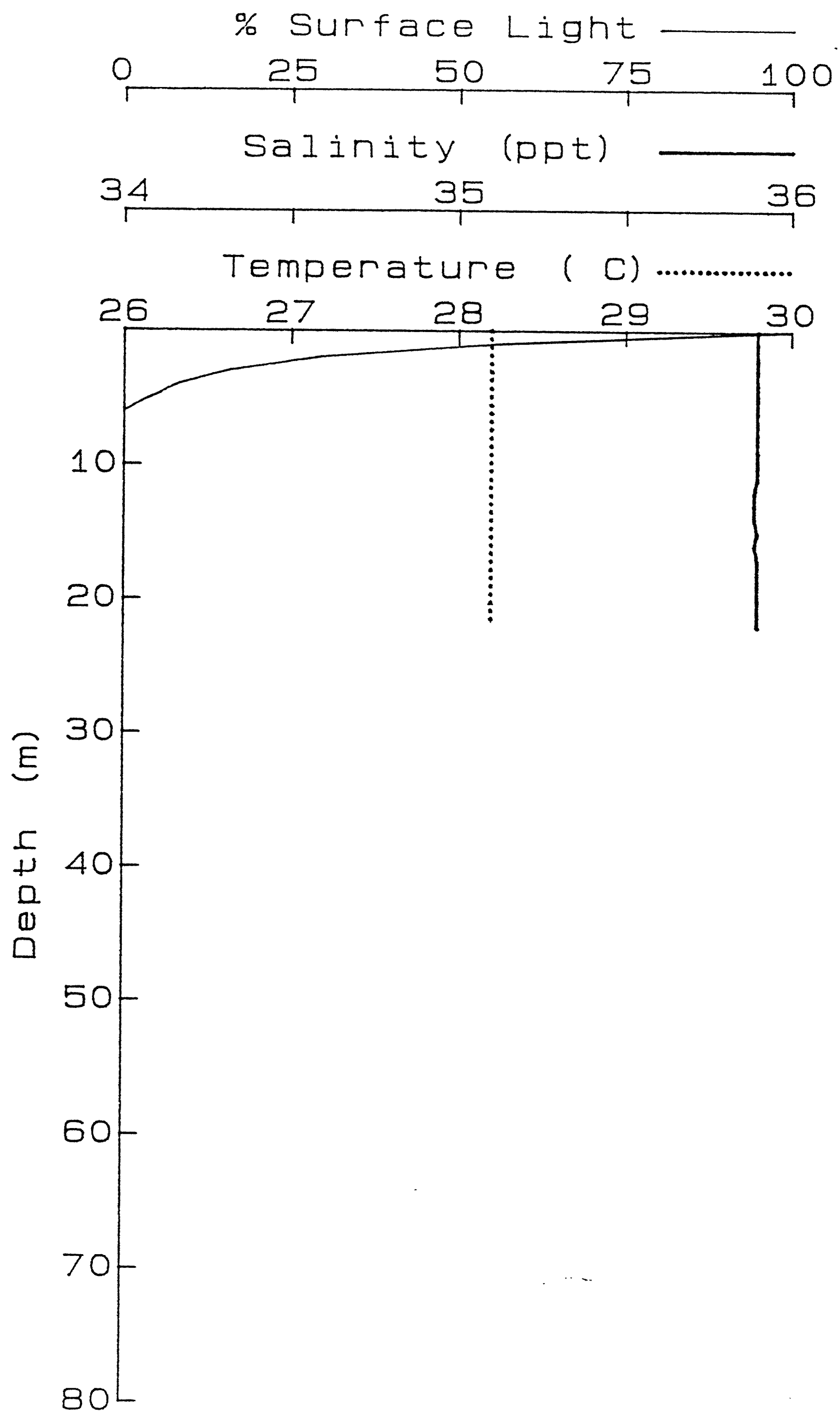
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
35	19 Feb 88	20° 27.1 ′S	148° 59.3 ′E	32 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
1427	1446	18 knots	135°	1.5 m	135°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	28.30	35.97	1.20	0.08	0.00	0.03	0.28			0.22			1.53
5	28.29	35.97	1.33	0.08	0.00	0.03	0.20			0.21			1.62
10	28.14	35.96	1.33	0.11	0.00	0.03	0.47			0.19			1.37
15	28.13	35.97	1.18	0.11	0.00	0.03	0.31			0.17			1.26
20	28.14	35.97	1.08	0.18	0.00	0.03	0.46			0.17			1.45
25	28.14	35.99	1.33	0.27	0.00	0.12	0.46			0.35			1.71
32	28.14	36.02	1.16	0.62	0.07	0.04	0.46			0.47			1.83

SWA 36



% Surface Light
0
25
50
75
100
Salinity (ppt)
34
35
36
Temperature (C)
26
27
28
29
30
Depth (m)
10
20
30
40
50
60
70
80

Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
36	19 Feb 88	20° 21.2 ′S	148° 56.7 ′E	19 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
1520	1538	14 knots	135°	m	135°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m³)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	28.22	35.90	1.25	0.39	0.00	0.16	0.34	3.0	2.0	0.24	0.31	0.10	1.65
5	28.22	35.90	1.50	0.39	0.00	0.19	0.23	5.1	1.7	0.24	0.62	0.09	1.72
10	28.22	35.90	1.33	0.39	0.00	0.16	0.18	4.6	2.3	0.22	0.33	0.08	1.64
15	28.22	35.90	1.33	0.41	0.00	0.17	0.08	4.6	1.8	0.22	0.54	0.07	1.80
18	28.22	35.91	1.46	0.43	0.00	0.17	0.09	3.4	1.7	0.23	0.28	0.06	1.67

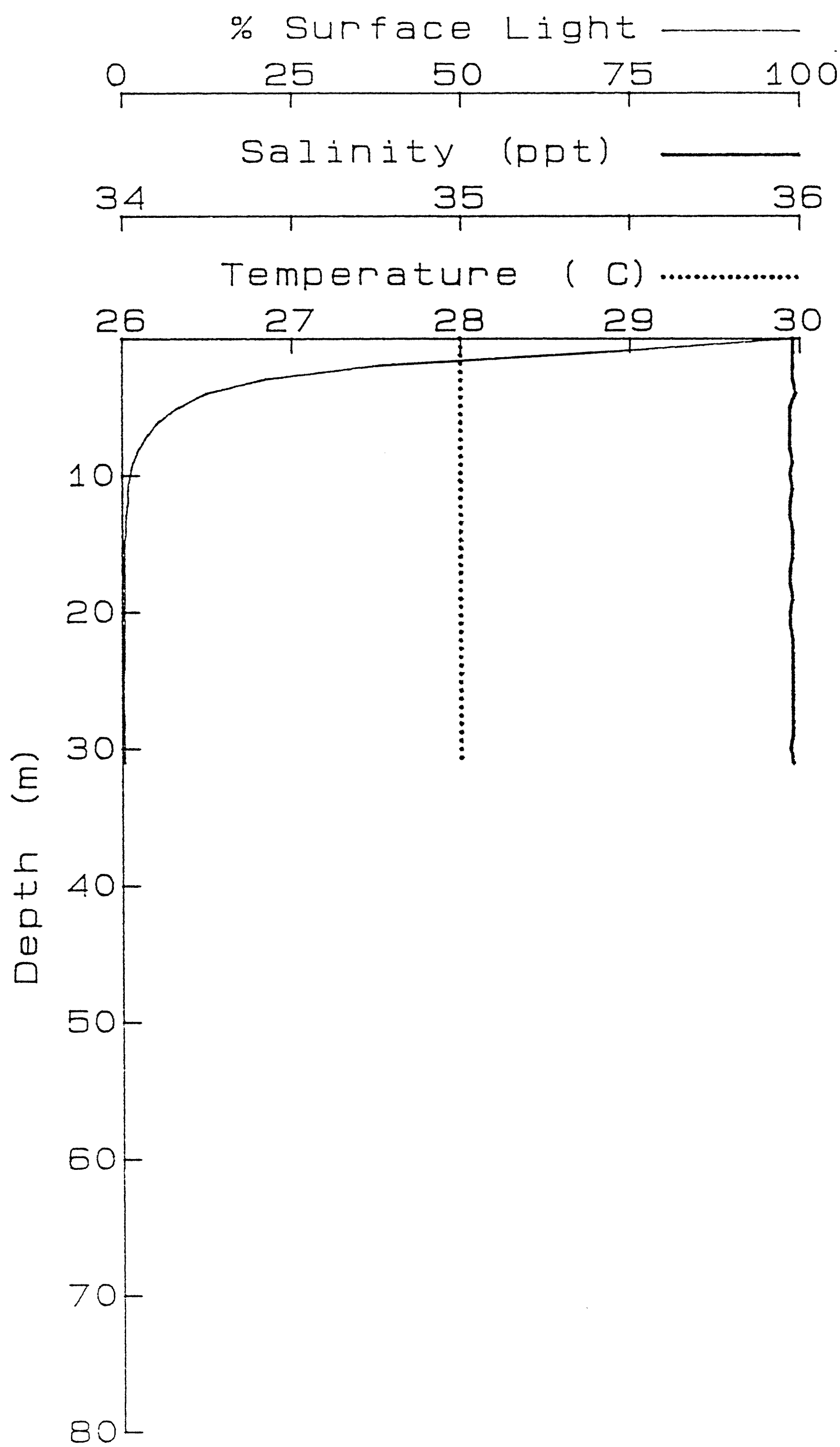
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
37	20 Feb 88	20° 21.5 ′S	148° 56.7 ′E	19 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
708	727	6 knots	135°	m	°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	28.03	35.95	1.20	0.27	0.00	0.23	0.16	5.5	2.0	0.22	0.29	0.11	1.47
5	28.02	35.96	1.20	0.19	0.00	0.27	0.09	4.4	1.7	0.20	0.47	0.08	1.58
10	28.03	35.95	1.33	0.30	0.00	0.30	0.16	3.6	1.9	0.28	0.39	0.05	1.79
15	28.03	35.95	1.24	0.24	0.00	0.29	0.07	3.9	2.0	0.28	0.36	0.05	1.74
20	28.03	35.96	1.16	0.21	0.00	0.28	0.07	4.3	1.8	0.24	0.44	0.03	1.72
25	28.04	35.95	1.22	0.18	0.00	0.31	0.07	5.2	2.0	0.26	0.24	0.06	1.75

SWA 38



% Surface Light
0
25
50
75
100
Salinity (ppt)
34
35
36
Temperature (C)
26
27
28
29
30
Depth (m)
10
20
30
40
50
60
70
80

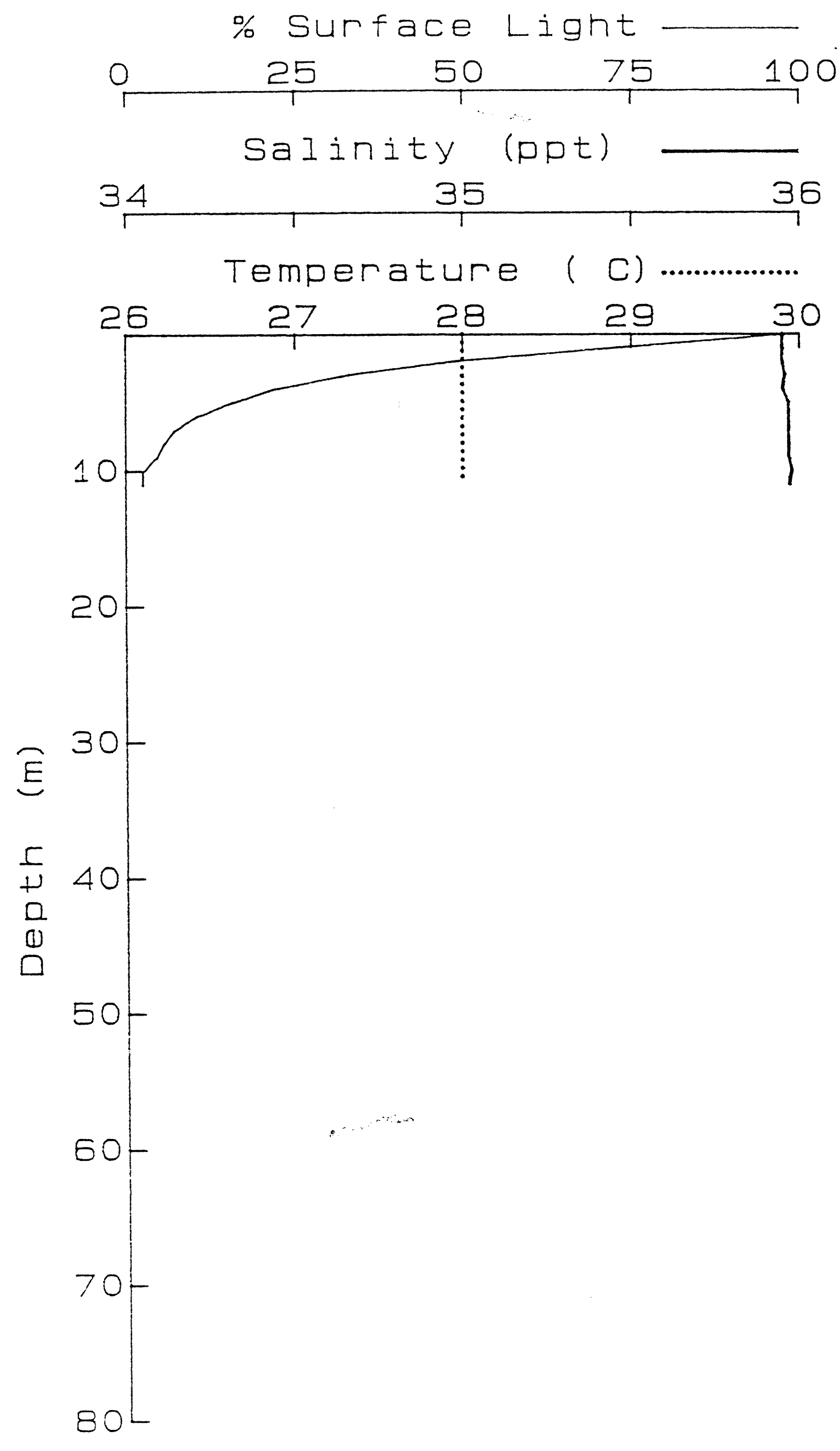
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
38	20 Feb 88	20° 23.0´S	148° 57.3´E	33 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
810	825	10 knots	135°	m	135°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (μM)	PO_4	DOP	POP	SiO
0	28.06	35.98	1.10	0.01	0.00	0.21	0.07			0.24			1.71
10	28.04	35.98	1.24	0.08	0.00	0.19	0.03			0.24			1.62
20	28.06	35.98	1.39	0.12	0.00	0.19	0.02			0.24			1.50
30	28.05	35.98	1.43	0.35	0.00	0.19	0.04			0.24			1.50

SWA 39



% Surface Light
0
25
50
75
100
Salinity (ppt)
34
35
36
Temperature (C)
26
27
28
29
30
Depth (m)
10
20
30
40
50
60
70
80

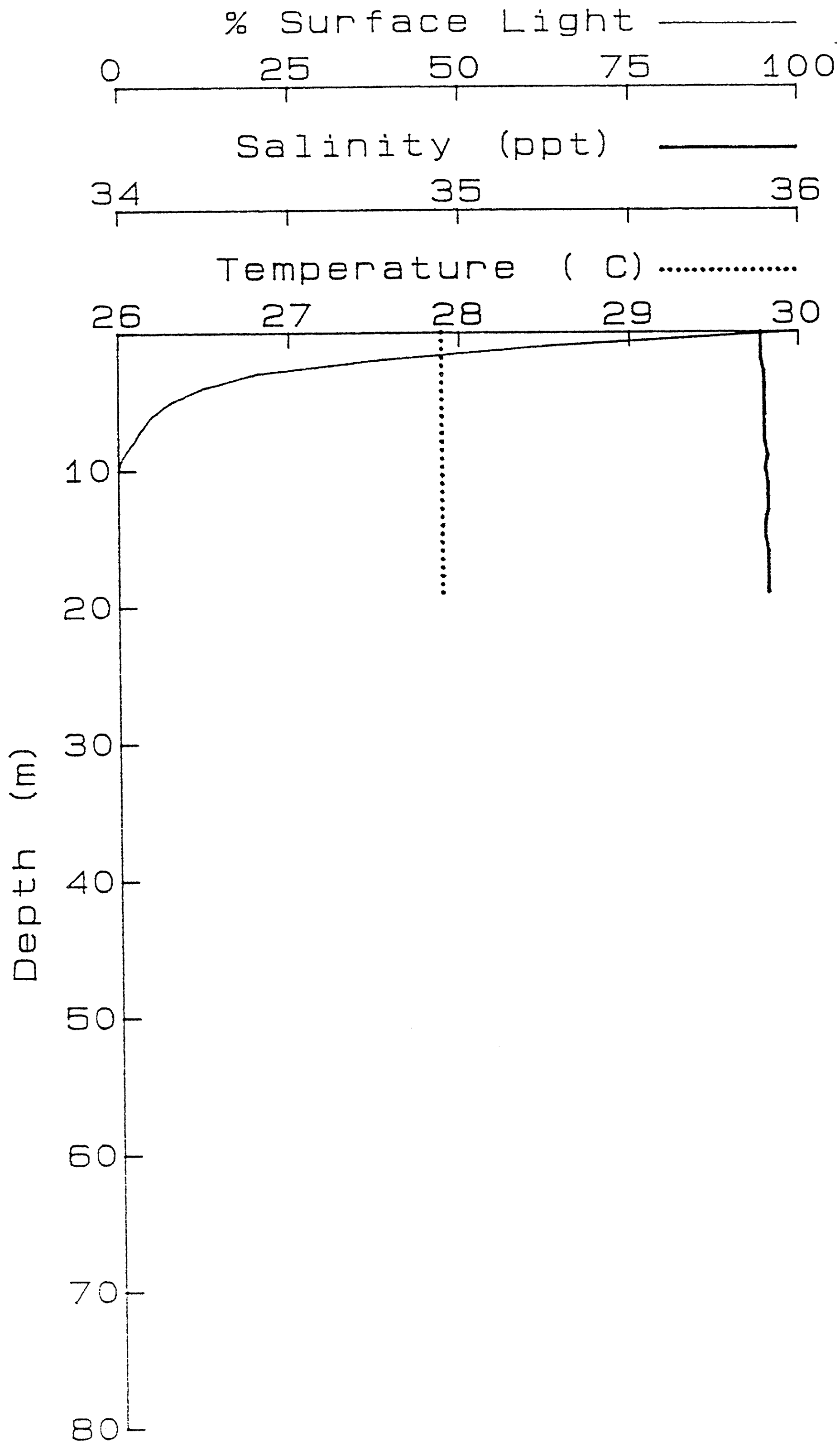
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
39	20 Feb 88	20° 21.0 ′S	148° 59.4 ′E	15 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
848	903	10 knots	135°	m	°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m³)	Phaeo	NO_2	NO_3	NH_4	DON	PON (μM)	PO_4	DOP	POP	SiO
0	28.08	35.96	1.35	0.00	0.00	0.10	0.07		2.8	0.24		0.08	1.56
4	28.05	35.95	2.11	0.00	0.00	0.10	0.01		2.2	0.24		0.10	1.38
8	28.07	35.97	1.63	0.03	0.00	0.10	0.04		2.0	0.25		0.07	1.61
12	28.07	35.97	1.48	0.05	0.00	0.11	0.04		3.3	0.22		0.12	1.46

SWA 40



% Surface Light
0
25
50
75
100
Salinity (ppt)
34
35
36
Temperature (C)
26
27
28
29
30
Depth (m)
10
20
30
40
50
60
70
80

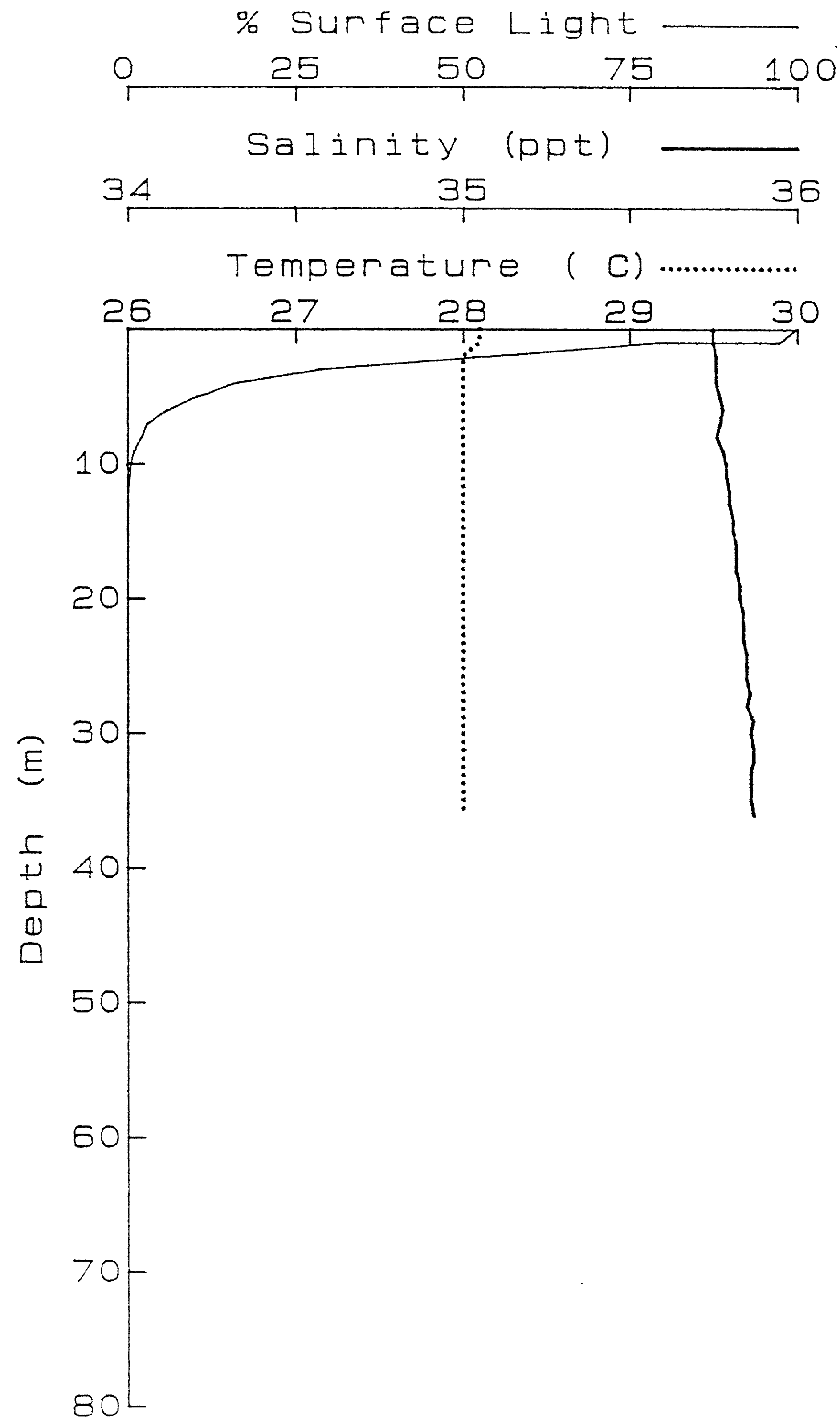
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
40	20 Feb 88	20° 20.6 ′S	148° 59.1 ′E	20 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
935	952	10 knots	135°	m	135°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	27.99	35.90	1.33	0.11	0.00	0.14	0.04	3.1		0.24	0.31		1.61
5	27.98	35.90	1.29	0.17	0.00	0.14	0.04	4.7		0.23	0.39		1.67
10	27.98	35.91	1.31	0.13	0.00	0.15	0.06	3.1		0.25	0.35		1.42
15	27.98	35.91	1.10	0.05	0.00	0.14	0.01	3.6		0.24	0.30		1.57
20	27.98	35.91	1.22	0.07	0.00	0.15	0.01	14.8		0.24	0.38		1.55

SWA 41



% Surface Light
0
25
50
75
100
Salinity (ppt)
34
35
36
Temperature (C)
26
27
28
29
30
Depth (m)
10
20
30
40
50
60
70
80

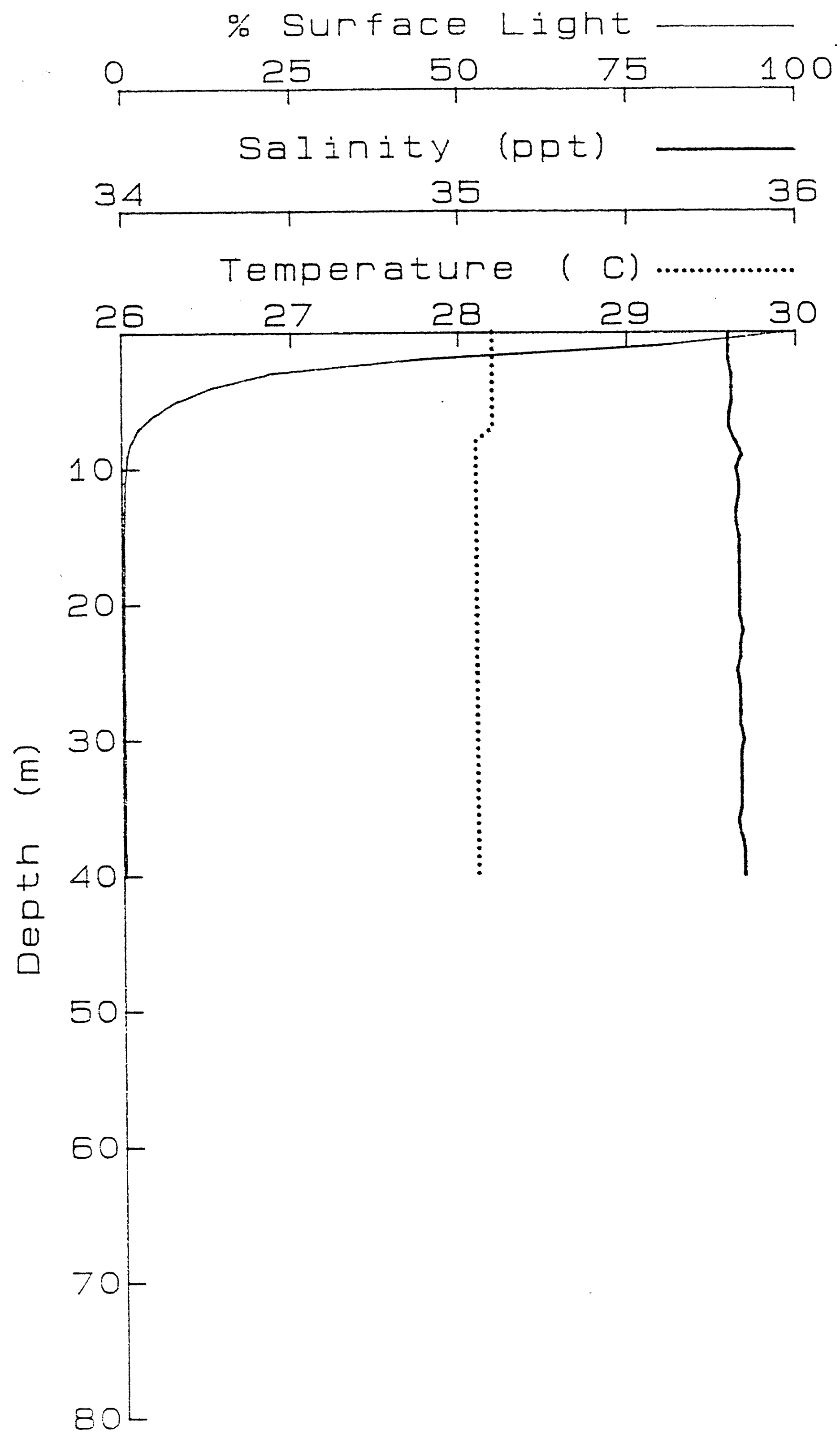
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
41	20 Feb 88	20° 19.7 'S	148° 57.0 'E	39 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
1029	1048	10 knots	135°	m	135°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (μM)	PO_4	DOP	POP	SiO
0	28.11	35.75	1.14	0.15	0.00	0.17	0.45	13.7	1.8	0.20	0.38	0.06	1.90
7	28.09	35.77	1.25	0.17	0.00	0.24	0.45	2.8	2.4	0.30	0.31	0.08	1.57
17	28.08	35.83	1.25	0.20	0.00	0.20	0.42	3.3	2.0	0.20	0.38	0.07	2.03
27	28.04	35.86	1.24	0.19	0.00	0.22	0.32	3.1	1.9	0.20	0.44	0.07	1.61
37	28.04	35.87	1.20	0.08	0.00	0.22	0.29	4.0	1.9	0.20	0.23	0.03	1.60

SWA 42



% Surface Light
0
25
50
75
100
Salinity (ppt)
34
35
36
Temperature (C)
26
27
28
29
30
Depth (m)
10
20
30
40
50
60
70
80

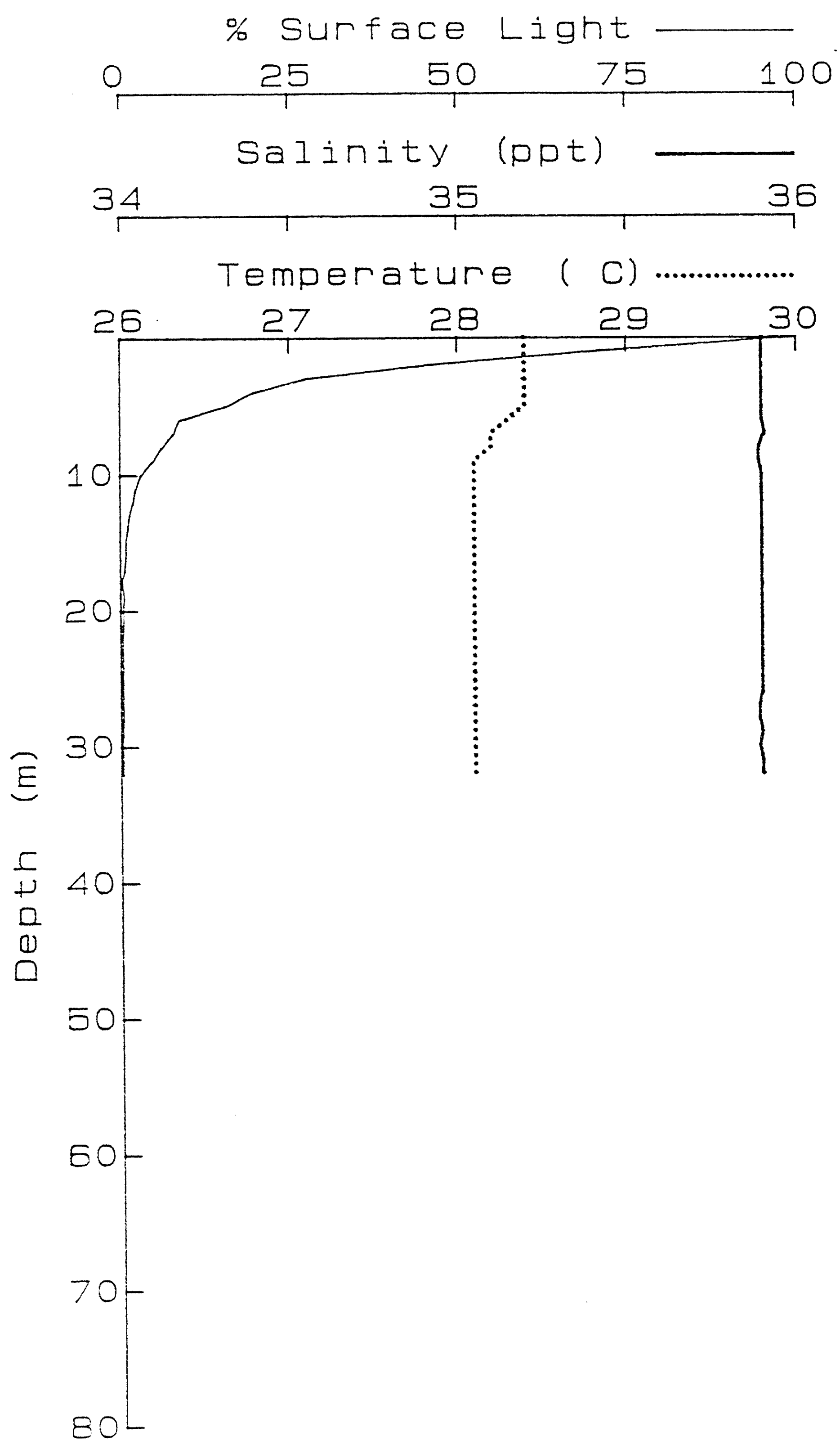
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
42	20 Feb 88	20° 20.2 'S	148° 54.1 'E	48 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
1115	1139	12 knots	180°	m	180°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	28.25	35.81	1.03	0.11	0.00	0.27	0.44	2.7	1.5	0.20	0.47	0.06	1.88
10	28.19	35.83	0.99	0.27	0.00	0.29	0.44	3.7	1.7	0.22	0.43	0.04	1.55
20	28.17	35.83	0.97	0.22	0.00	0.31	0.44	3.1	1.8	0.22	0.39	0.06	2.14
30	28.17	35.84	1.10	0.25	0.00	0.29	0.45	4.7	2.4	0.22	0.24	0.09	1.74
40	28.17	35.84	0.93	0.29	0.00	0.32	0.47	4.4	1.6	0.24	0.34	0.17	2.03
45	28.17	35.84	1.03	0.21	0.00	0.30	0.49	3.6	2.4	0.25	0.33	0.10	2.00

SWA 43



% Surface Light
0
25
50
75
100
Salinity (ppt)
34
35
36
Temperature (C)
26
27
28
29
30
Depth (m)
10
20
30
40
50
60
70
80

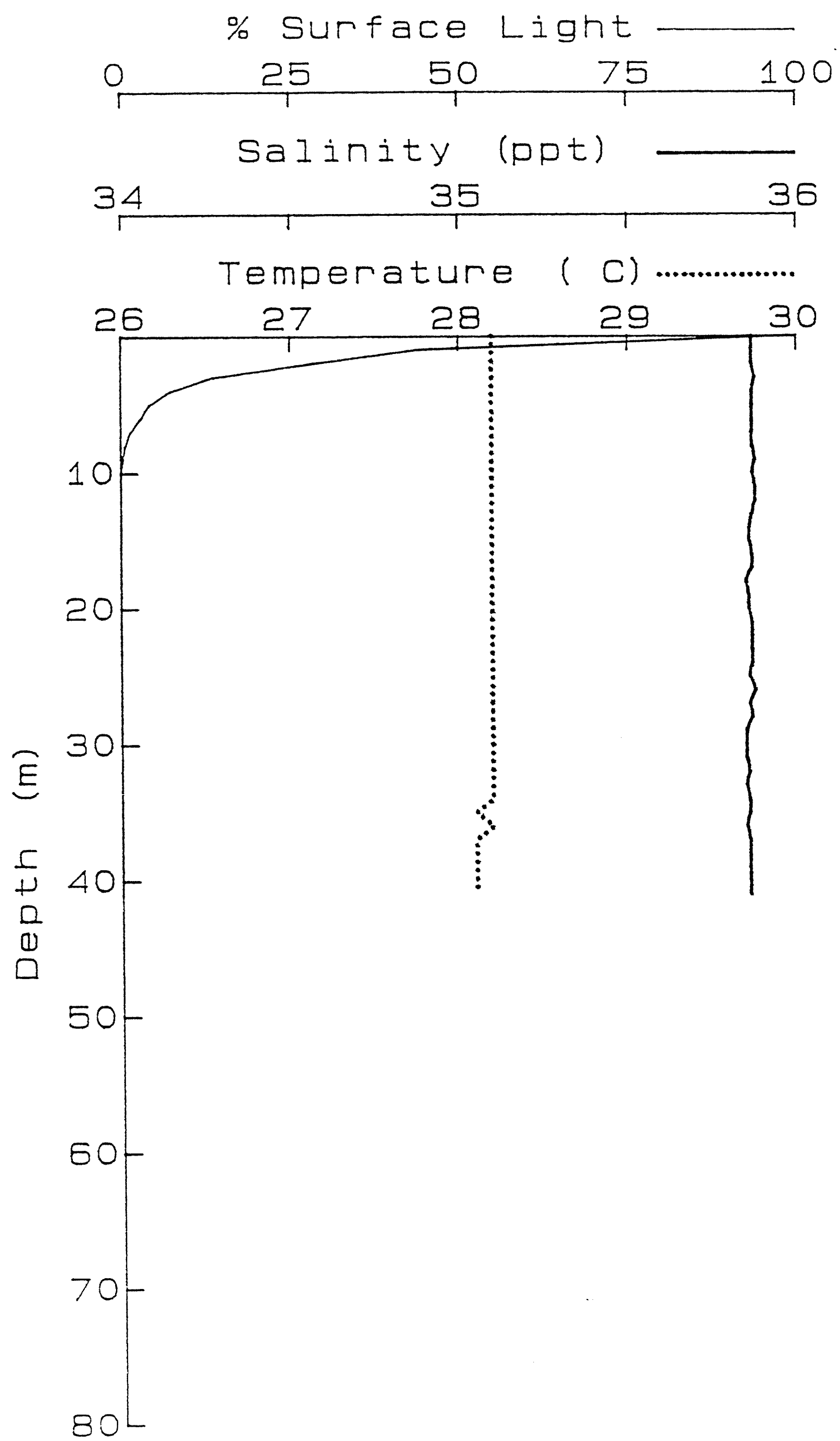
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
43	20 Feb 88	20° 18.5 'S	148° 49.8 'E	34 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
1310	1332	12 knots	135°	m	180°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	28.41	35.91	1.03	0.01	0.00	0.39	0.40		1.7	0.22		0.08	2.17
10	28.18	35.91	1.16	0.18	0.00	0.40	0.31		1.6	0.21		0.09	2.11
20	28.17	35.91	1.03	0.26	0.00	0.46	0.24		1.5	0.21		0.09	1.99
30	28.18	35.90	1.06	0.17	0.00	0.51	0.34		1.6	0.22		0.05	2.23
34	28.17	35.91	1.03	0.23	0.00	0.48	0.34		2.0	0.25		0.04	2.12

SWA 44



% Surface Light
0
25
50
75
100
Salinity (ppt)
34
35
36
Temperature (C)
26
27
28
29
30
Depth (m)
10
20
30
40
50
60
70
80

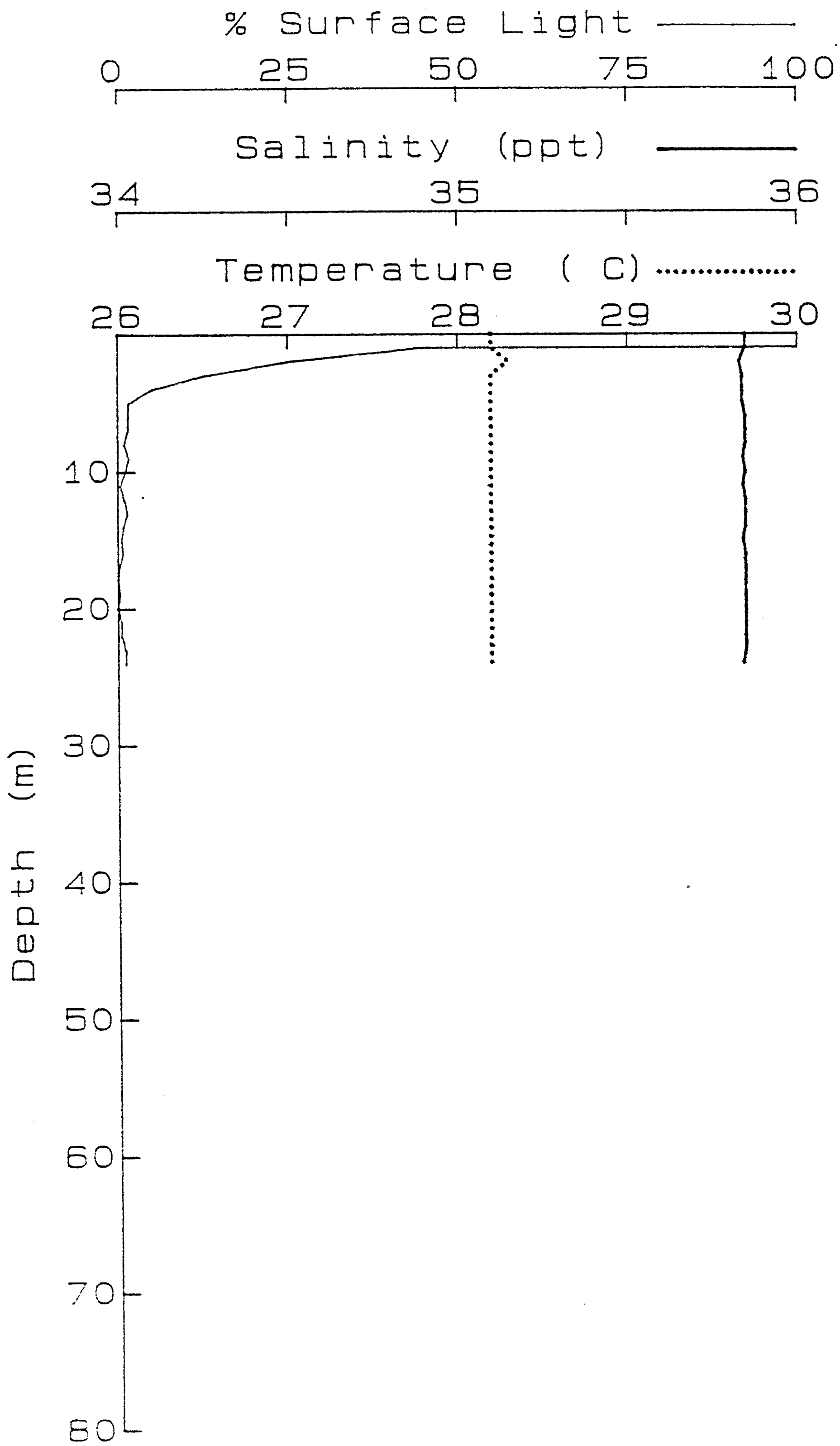
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
44	20 Feb 88	20° 16.1´S	148° 48.6´E	35 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
1400	1425	12 knots	135°	m	180°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (μM)	PO_4	DOP	POP	SiO
0	28.26	35.88	1.24	0.46	0.00	0.43	0.34	3.8	2.2	0.24	0.48	0.06	2.20
5	28.26	35.87	1.23	0.50	0.00	0.47	0.23	4.7	2.9	0.23	0.48	0.04	2.34
10	28.25	35.88	1.37	0.37	0.00	0.42	0.25	4.3	2.0	0.23	0.23	0.16	2.11
20	28.24	35.87	1.18	0.26	0.00	0.36	0.32	4.0	2.1	0.19	0.54	0.16	1.89
30	28.24	35.86	1.10	0.31	0.00	0.43	0.26	2.2	1.7	0.26	0.30	0.10	2.09
40	28.16	35.87	0.97	0.32	0.00	0.44	0.30	4.1	1.8	0.26	0.56	0.09	2.12

SWA 45


% Surface Light
0
25
50
75
100
Salinity (ppt)
34
35
36
Temperature (C)
26
27
28
29
30
Depth (m)
10
20
30
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60
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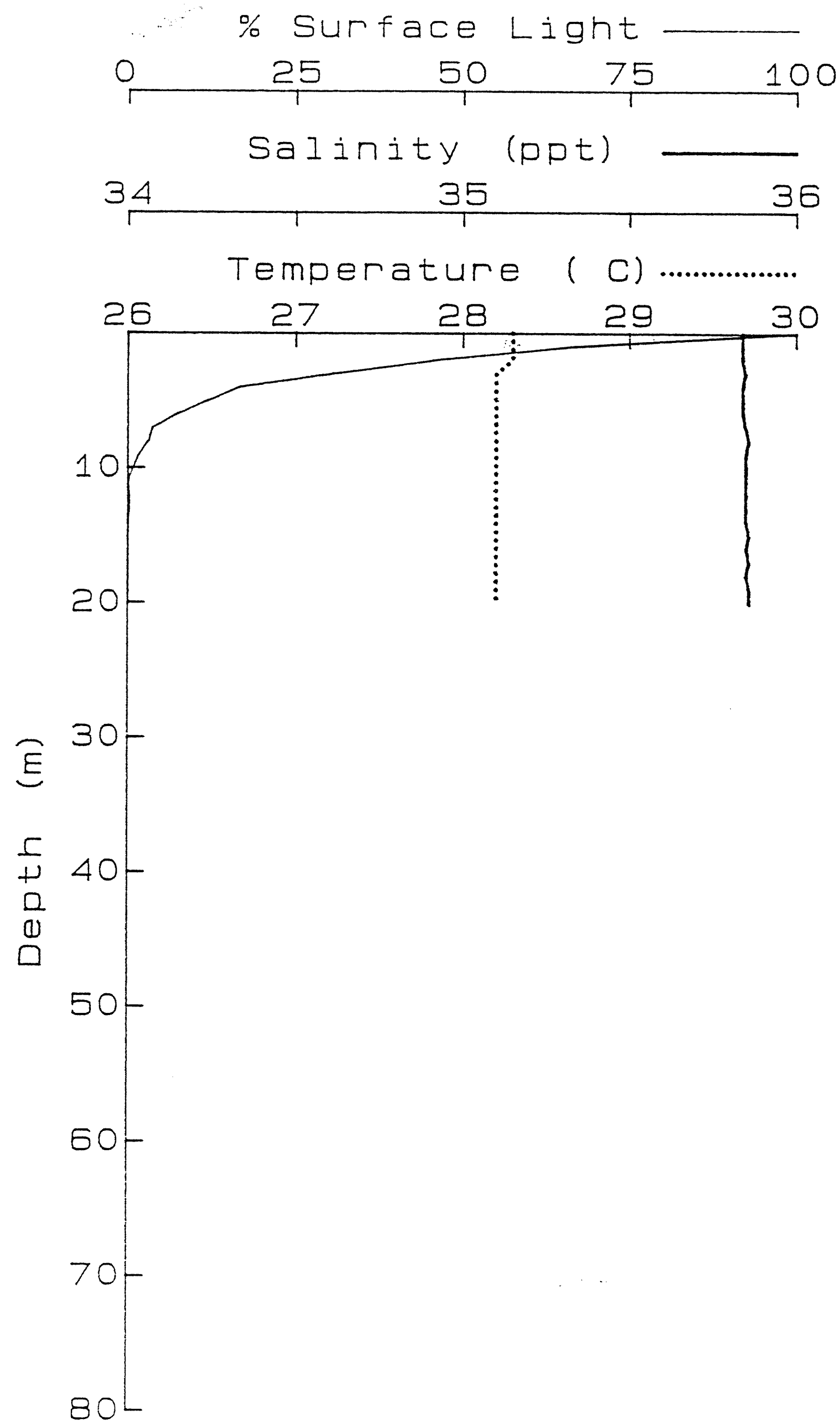
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
45	20 Feb 88	20° 15.5´S	148° 49.4´E	26 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
1502	1515	12 knots	135°	m	180°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	28.29	35.85	1.20	0.39	0.00	0.44	0.30	3.9	2.1	0.26	0.50	0.08	2.12
5	28.25	35.85	1.20	0.42	0.00	0.45	0.24	2.4	2.0	0.26	0.32	0.09	2.03
10	28.24	35.85	1.22	0.51	0.00	0.44	0.24	2.6	2.2	0.24	0.42	0.08	2.31
15	28.24	35.85	1.24	0.49	0.00	0.47	0.51	2.8	2.2	0.27	0.37	0.10	2.50
20	28.25	35.86	1.12	0.49	0.00	0.50	0.51	4.0	2.4	0.30	0.57	0.11	3.28
25	28.24	35.85	1.08	0.48	0.00	0.48	0.51	2.4	2.6	0.31	0.44	0.14	2.33

SWA 46



% Surface Light
0
25
50
75
100
Salinity (ppt)
34
35
36
Temperature (C)
26
27
28
29
30
Depth (m)
10
20
30
40
50
60
70
80

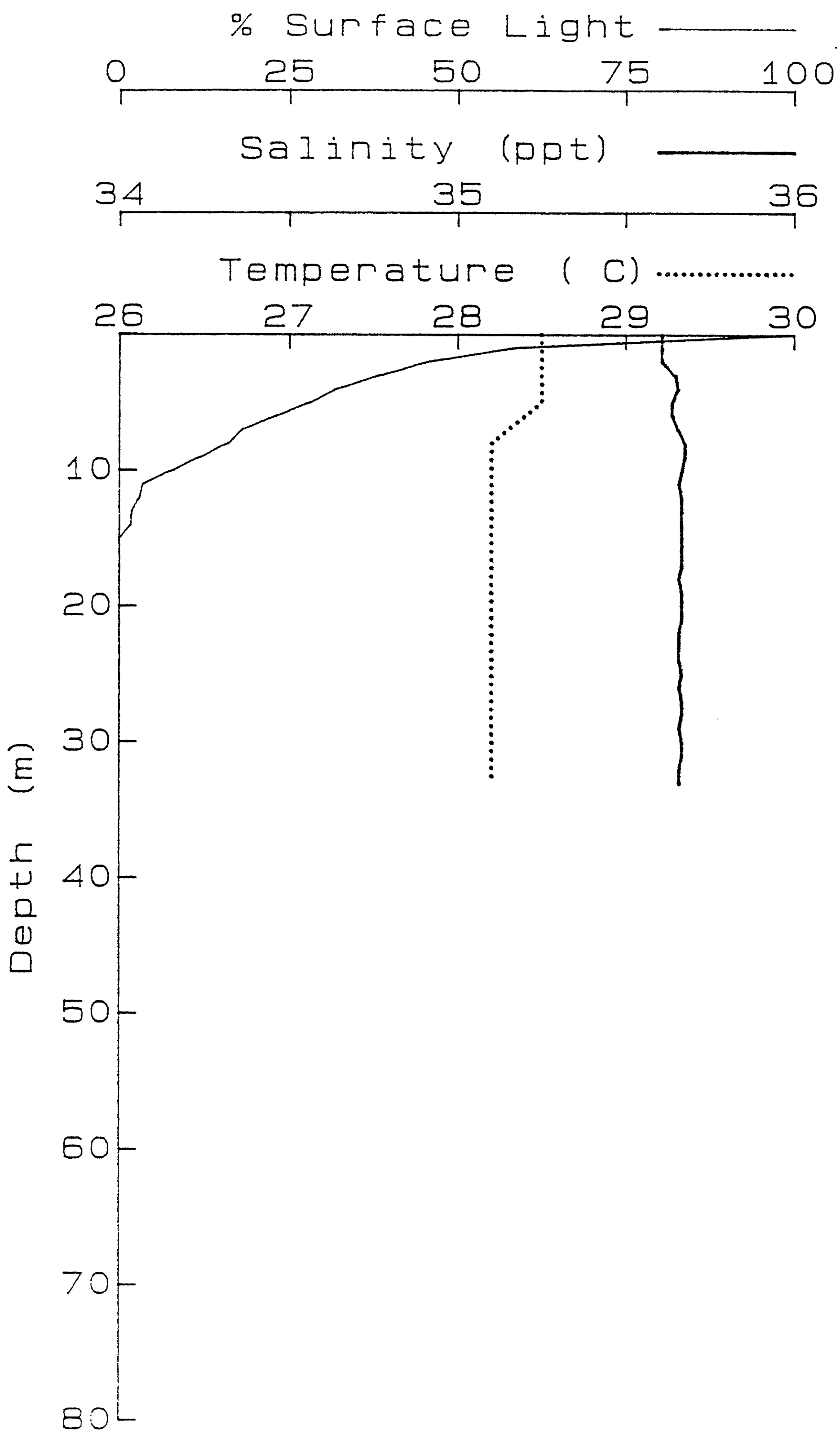
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
46	20 Feb 88	20° 14.5´S	148° 48.8´E	24 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
1548	1609	12 knots	140°	m	180°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2 (µM)	NO_3	NH_4	DON	PON	PO_4	DOP	POP	SiO
0	28.33	35.85	1.10	0.31	0.00	0.39	0.27	4.1	2.2	0.25	0.32	0.21	2.15
7	28.29	35.85	1.10	0.44	0.00	0.41	0.31	5.0	2.2	0.26	0.60	0.10	2.23
14	28.28	35.86	1.46	0.47	0.00	0.47	0.31	3.5	2.3	0.26	0.36	0.08	2.72
23	28.27	35.86	1.35	0.44	0.00	0.43	0.31	6.2	2.4	0.28	0.46	0.08	2.72

SWA 47



% Surface Light
0
25
50
75
100
Salinity (ppt)
34
35
36
Temperature (C)
26
27
28
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30
Depth (m)
10
20
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40
50
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70
80

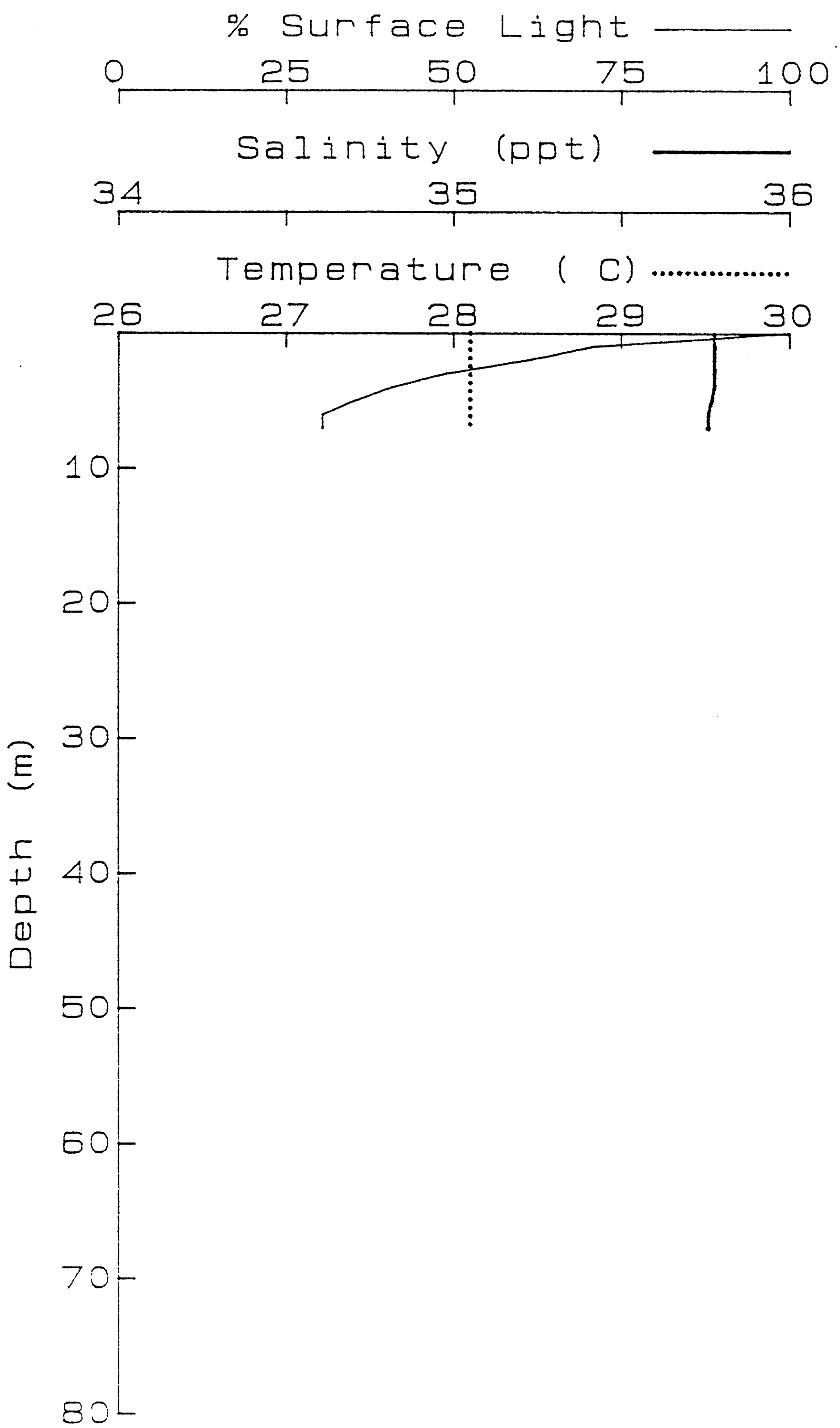
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
47	20 Feb 88	20° 11.9 ′S	148° 51.1 ′E	36 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
1638	1654	15 knots	140°	m	180°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	28.55	35.61	1.10	0.12	0.00	0.06	0.16		2.0	0.24		0.09	1.52
10	28.24	35.67	1.44	0.44	0.00	0.15	0.24		1.9	0.23		0.10	1.84
20	28.22	35.67	1.33	0.46	0.00	0.21	0.35		2.2	0.25		0.12	1.84
30	28.22	35.67	1.25	0.59	0.00	0.22	0.29		2.6	0.26		0.20	1.76
36	28.22	35.67	1.39	1.06	0.11	0.16	0.45		3.8	0.39		0.39	2.21

SWA 48



% Surface Light
0
25
50
75
100
Salinity (ppt)
34
35
36
Temperature (C)
26
27
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Depth (m)
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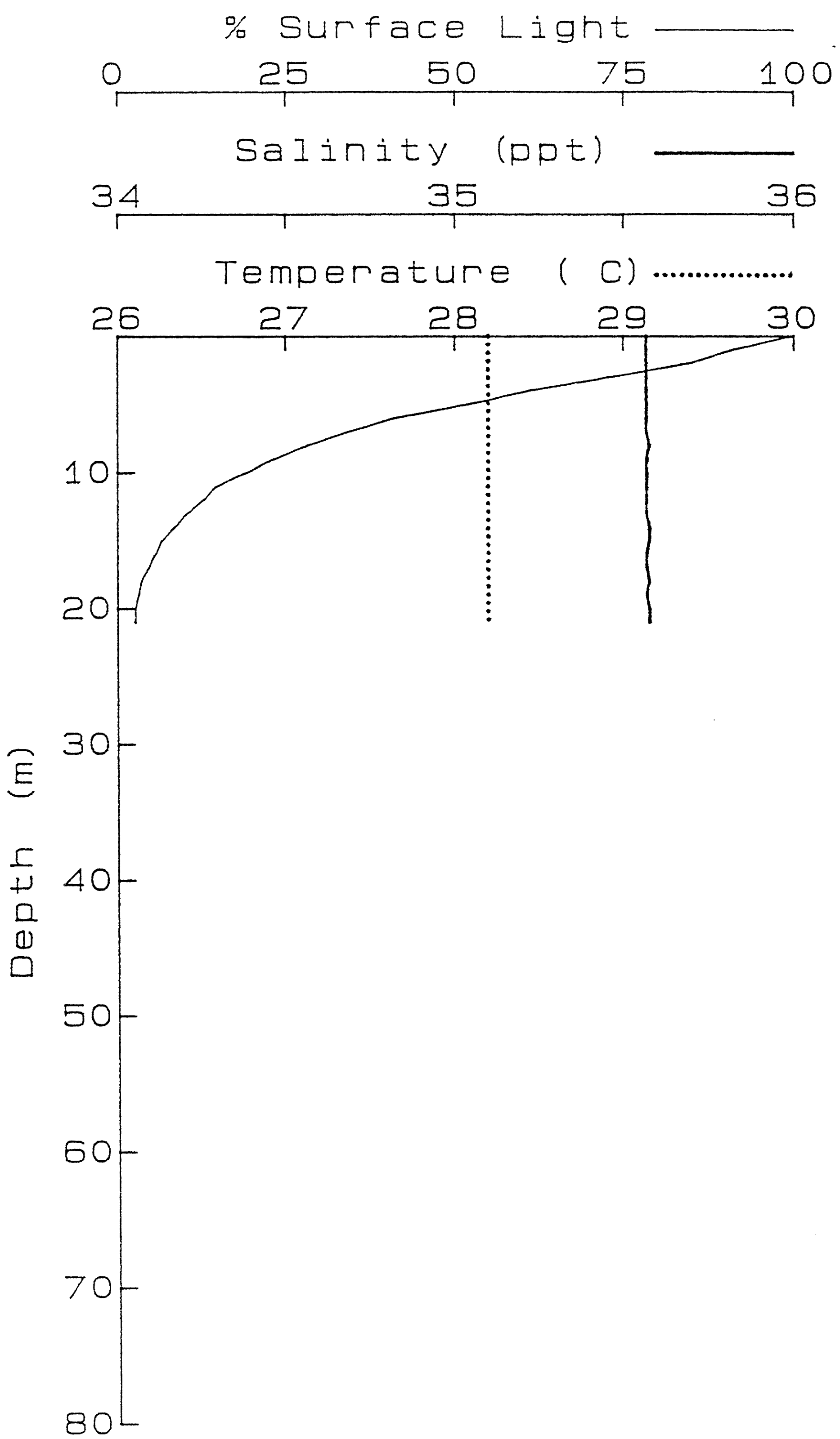
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
48	21 Feb 88	20° 08.8 ′S	148° 54.4 ′E	7 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
0920	0934	knots	°	m	180°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	28.19	35.78	0.57	0.14	0.00	0.09	0.31		2.3	0.20		0.16	2.19
4	28.19	35.78	0.76	0.24	0.00	0.08	0.23		1.9	0.21		0.04	2.10
8	28.14	35.77	1.12	0.47	0.00	0.12	0.37		3.0	0.27		0.05	3.25

SWA 49



% Surface Light
0
25
50
75
100
Salinity (ppt)
34
35
36
Temperature (C)
26
27
28
29
30
Depth (m)
10
20
30
40
50
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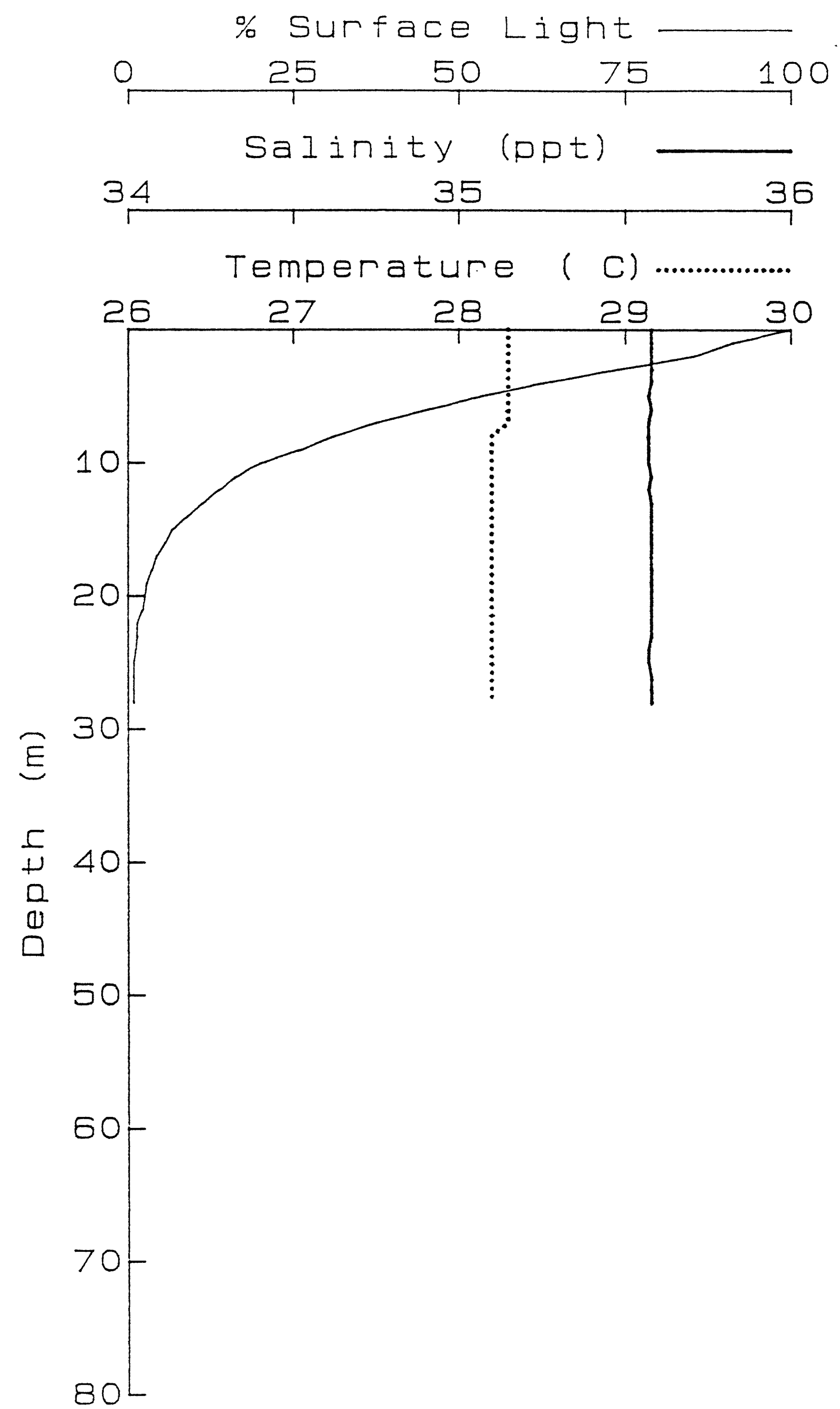
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
49	21 Feb 88	20° 06.0 ′S	148° 53.5 ′E	22 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
1028	1054	8 knots	180°	m	180°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	28.26	35.58	0.97	0.03	0.00	0.11	0.08	4.4	1.7	0.27	0.64	0.08	1.53
5	28.25	35.57	0.94	0.11	0.00	0.12	0.26	3.5	2.0	0.25	0.59	0.09	1.41
9	28.24	35.58	0.96	0.12	0.00	0.12	0.13	4.0	1.5	0.20	0.79	0.10	1.35
14	28.24	35.58	1.01	0.09	0.00	0.13	0.09	4.1	1.4	0.20	0.40	0.11	1.31
18	28.22	35.58	0.99	0.07	0.00	0.13	0.02	3.4	1.4	0.25	0.50	0.10	1.19
22	28.21	35.59	1.16	0.00	0.00	0.13	0.06	4.2	1.4	0.23	0.65	0.11	1.23

SWA 50



% Surface Light
0
25
50
75
100
Salinity (ppt)
34
35
36
Temperature (C)
26
27
28
29
30
Depth (m)
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30
40
50
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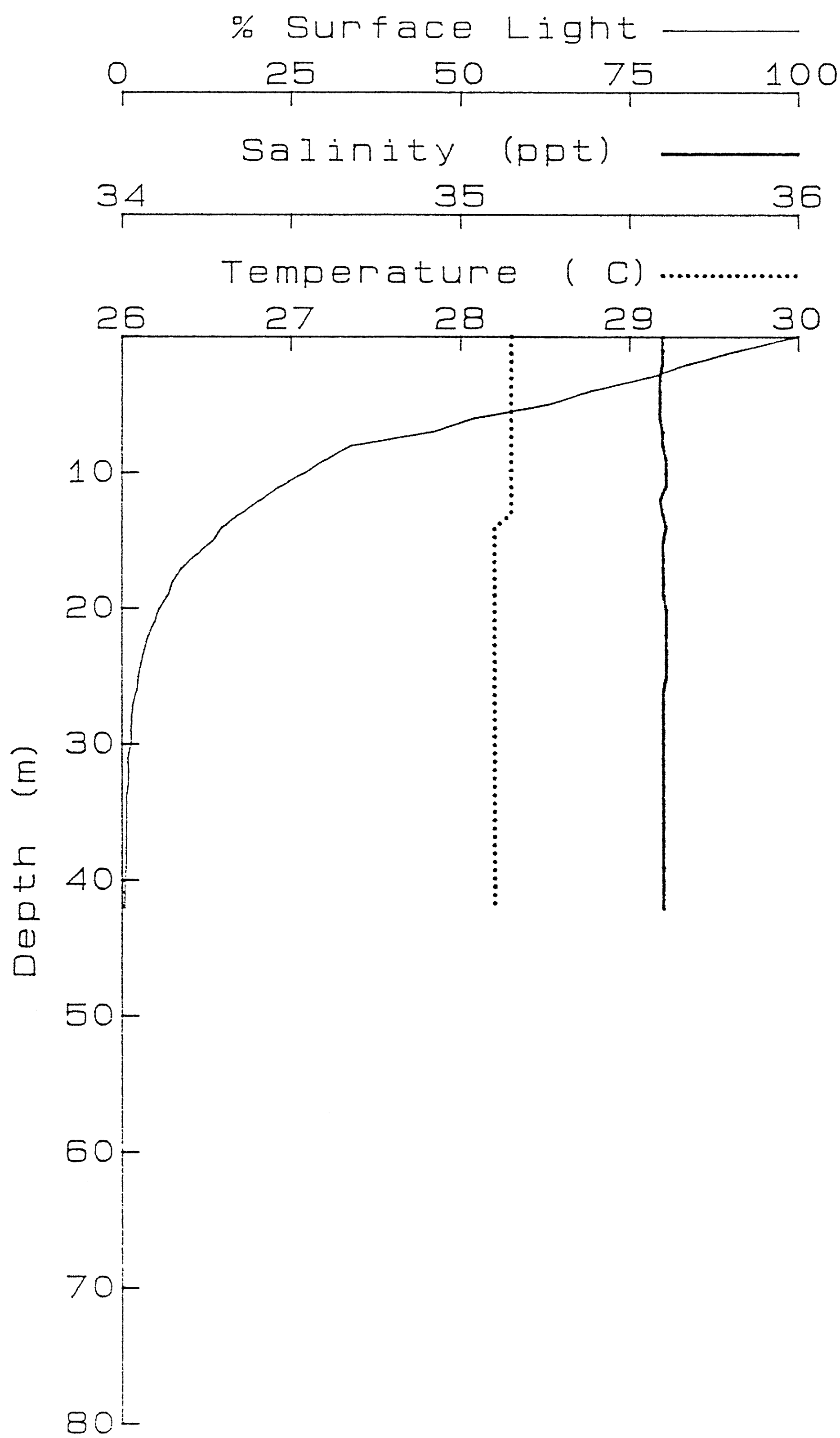
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
50	21 Feb 88	20° 04.3 ´S	148° 53.0 ´E	29 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
1121	1134	18 knots	135°	m	180°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	28.36	35.58	0.78	0.23	0.00	0.11	0.14		1.4	0.22		0.17	1.24
7	28.32	35.58	0.89	0.34	0.00	0.11	0.08		1.5	0.29		0.11	1.21
17	28.24	35.58	0.89	0.30	0.00	0.14	0.08		1.6	0.21		0.10	1.46
21	28.24	35.58	0.82	0.29	0.00	0.16	0.12		1.5	0.49		0.13	1.65
28	28.23	35.58	0.89	0.30	0.00	0.15	0.08		1.4	0.21		0.15	1.35

SWA 51


% Surface Light
0
25
50
75
100
Salinity (ppt)
34
35
36
Temperature (C)
26
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30
Depth (m)
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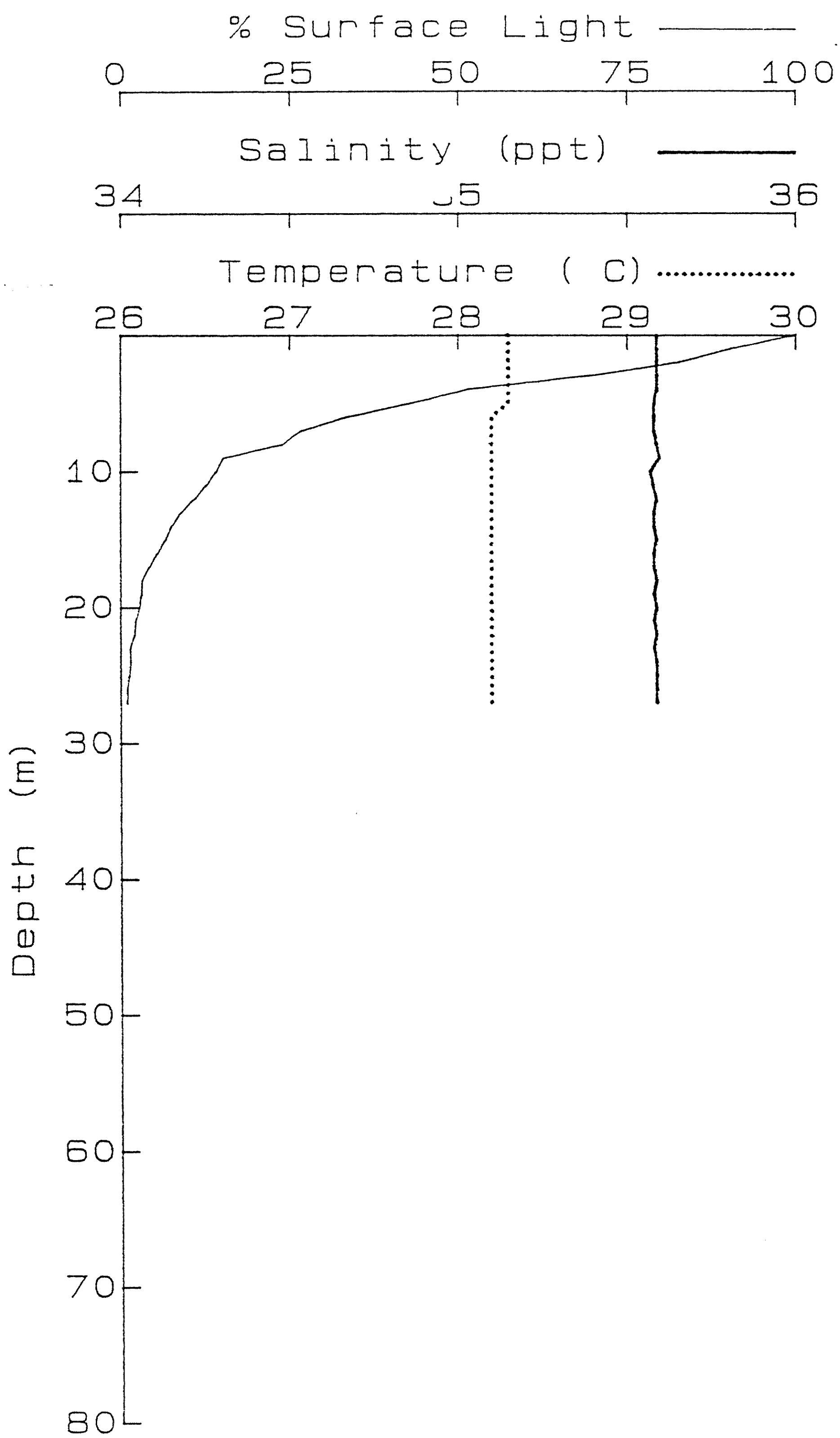
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
51	21 Feb 88	20° 03.2′ S	148° 54.6′ E	44 m

Time arr	Time left	Wind sp	Wind dir	Swell ht	Swell dir
1159	1218	20 knots	135°	m	180°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON (µM)	PON	PO_4	DOP	POP	SiO
0	28.37	35.60	0.67	0.20				4.1	1.8		0.73	0.16	
10	28.34	35.61	0.68	0.21				5.1	1.6		1.08	0.17	
20	28.26	35.62	0.86	0.24				6.6	2.0		0.67	0.15	
30	28.25	35.61	0.87	0.25				3.8	1.7		0.77	0.06	
40	28.25	35.61	0.95	0.23				5.5	1.5		0.77	0.05	
45	28.25	35.61	1.03	0.25				5.2	2.1		0.77	0.06	

SWA 52



% Surface Light
0
25
50
75
100
Salinity (ppt)
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36
Temperature (C)
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Depth (m)
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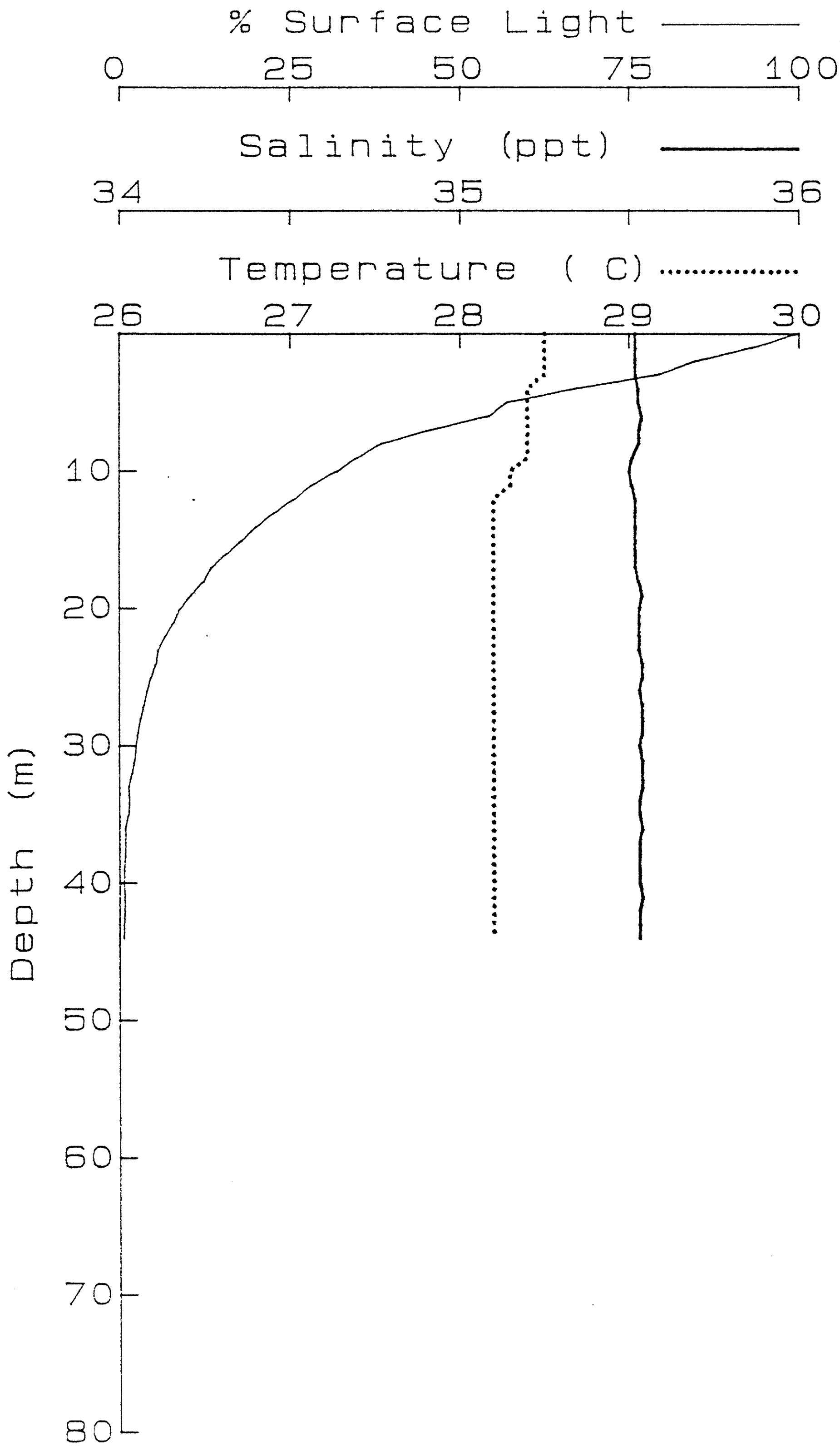
Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
52	21 Feb 88	20° 02.6 'S	148° 52.5 'E	28 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
1248	1307	20 knots	135°	m	180°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (μM)	PO_4	DOP	POP	SiO
0	28.38	35.59	0.89	0.15	0.00	0.09	0.31		2.2	0.21		0.04	1.28
7	28.27	35.58	0.97	0.30	0.00	0.09	0.10		1.8	0.18		0.05	1.33
14	28.24	35.59	0.93	0.31	0.00	0.10	0.09		1.8	0.18		0.05	1.51
21	28.24	35.59	0.91	0.16	0.00	0.10	0.03		1.4	0.19		0.05	1.31
28	28.24	35.59	0.97	0.17	0.00	0.12	0.07		1.8	0.19		0.04	1.38

SWA 53



% Surface Light
0
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75
100
Salinity (ppt)
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35
36
Temperature (C)
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Depth (m)
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Whitsunday Oceanographic Survey

Station	Date	Latitude	Longitude	Depth
53	21 Feb 88	20° 58.3 ´S	148° 43.4 ´E	46 m

Time arr.	Time left	Wind sp.	Wind dir	Swell ht.	Swell dir
1407	1427	20 knots	135°	0.7 m	135°

Depth (m)	Temp (°C)	Salin (ppt)	Chlor (mg/m^3)	Phaeo	NO_2	NO_3	NH_4	DON	PON (µM)	PO_4	DOP	POP	SiO
0	28.50	35.53	0.70	0.10	0.00	0.07	0.16		1.8	0.16		0.05	1.18
10	28.35	35.51	0.74	0.05	0.00	0.08	0.08		1.4	0.18		0.11	0.94
20	28.26	35.54	0.97	0.13	0.00	0.09	0.08		1.8	0.17		0.10	0.94
30	28.26	35.54	0.87	0.17	0.00	0.09	0.06		1.6	0.19		0.12	1.05
40	28.26	35.54	0.93	0.18	0.00	0.08	0.09		1.9	0.19		0.08	1.13
46	28.26	35.54	1.01	0.20	0.00	0.08	0.07		1.4	0.17		0.09	0.99