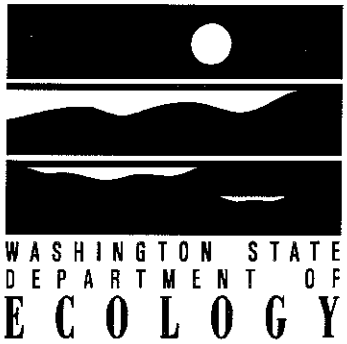

Marine Water Column Ambient Monitoring Program: Wateryear 1993 Data Report

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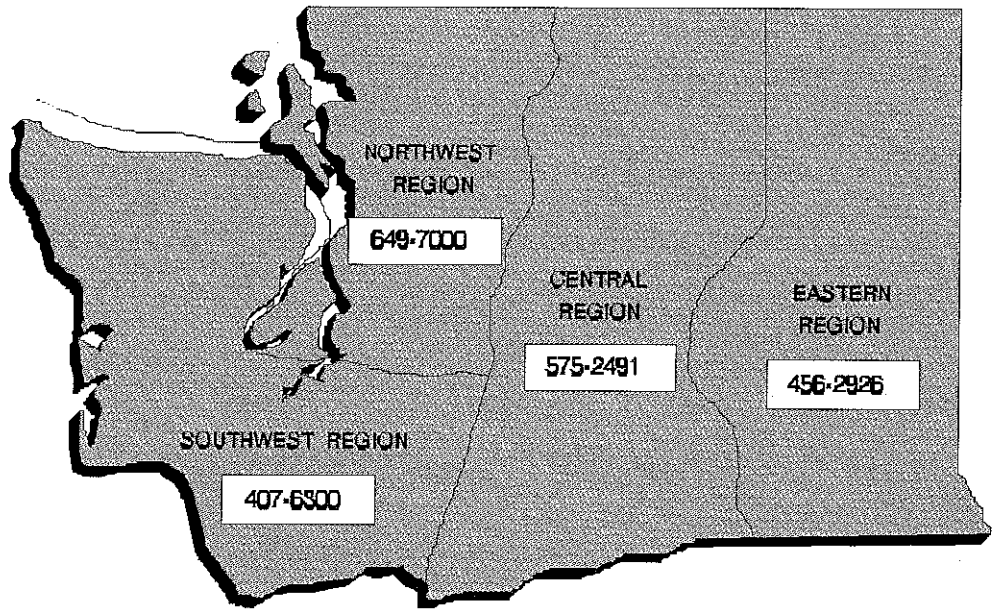

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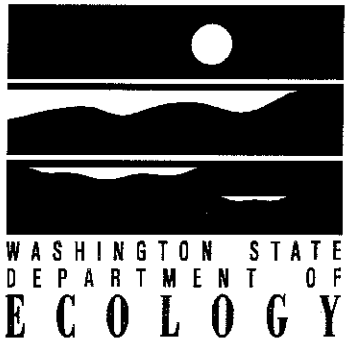

Marine Water Column Ambient Monitoring Program: Wateryear 1993 Data Report

prepared by
J.A. Newton, S.A. Bell,
and M.A. Golliet

Environmental Investigations
and Laboratory Services Program
Ambient Monitoring Program
Washington State Department of Ecology
Olympia, Washington 98504-7710

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TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

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ABSTRACT

The Marine Water Column Monitoring Program was initiated in 1967 to monitor ambient water quality in Puget Sound, Grays Harbor, and Willapa Bay. Data are currently collected monthly as part of an ongoing, long-term monitoring component to the program. During Wateryear 1993 (WY 1993 = October 1992 through September 1993), the Washington State Department of Ecology monitored water quality monthly at 23 stations in Puget Sound, five stations in Grays Harbor, and five stations in Willapa Bay. Of the 48 scheduled surveys for long-term monitoring, 43 were completed. Incomplete surveys resulted from inclement weather conditions (*i.e.*, low visibility and rough sea surface) that prevented sampling.

Climatic conditions of WY 1993 were characterized by lower than normal precipitation in the fall and winter and higher than normal in spring and early summer. Precipitation and air temperature anomalies show some correlation with anomalies in sea-surface temperature and salinity, particularly in May. The presumed effect of the 1992 El Nino is seen as a preponderance of higher sea temperatures in WY 1992, as compared to WY 1993. A slight increase in surface salinities may reflect two years of below normal precipitation.

The stratification characteristics of the water column were classified as persistent, seasonal, episodic, and weak. The majority of the Puget Sound monitoring stations were either persistently (9 out of 23 stations) or seasonally (8 out of 23 stations) stratified. The degree of stratification has implications for water column dissolved oxygen concentrations.

Dissolved oxygen (D.O.) concentrations < 5.0 mg/L were measured at six stations located in northern Puget Sound and in Hood Canal during WY 1993. At two of these stations D.O. concentrations were < 3.0 mg/L. Observations of low D.O. primarily occurred in late summer, and early fall. Similar D.O. conditions have been exhibited at these stations during the same seasons in previous wateryears. However, in WY 1993, two of the northern Puget Sound stations developed depressed D.O. levels during mid-summer (July) as well.

The seasonal cycle of increased chlorophyll *a* (chl *a*), decreased nutrients, and reduced euphotic zone depth was clearly seen for many of the stations in Puget Sound. The contribution of phytoplankton versus non-chl *a* containing particles (e.g., sediments) was assessed from examining linear regressions of the light extinction coefficient versus surface chl *a* concentration. High runoff months were identified as outliers to the regression. Some estuaries showed that chl *a* was not the major determinant of light extinction, presumably due to more constant suspended particle loads.

Fecal coliform bacteria counts > 14 organisms/100 mL were found at seven Puget Sound stations and three coastal stations during WY 1993. Most of these stations have shown these high counts in previous wateryears. Five of the Puget Sound stations differed from the usual pattern of high counts in winter with the addition of high counts in June or July. Both coastal estuaries showed fecal coliform bacteria counts that were more persistent than those at stations in Puget Sound with high counts. The highest and most persistent counts were in Grays Harbor.

SUMMARY

This report is focused on measurements of water quality in Puget Sound and the Washington coastal estuaries. The indicators of poor water quality addressed here include low dissolved oxygen and fecal coliform contamination. Other indications of poor water quality, such as, chemical contamination (e.g., heavy metals, organics, toxins) and any modifications to the flushing ability of these estuaries are not addressed here.

The data reported here indicate that the water quality of Puget Sound as a whole is good, yet there are individual stations where low dissolved oxygen concentrations and high fecal coliform bacteria counts are observed. These are typically stations near urban areas and where persistent or seasonal stratification of the water column exists. Water-column stratification is a natural phenomenon, and often is maintained by freshwater input from rivers. Rivers or other runoff can also input nutrients that can support more organic production which will, in turn, deplete oxygen concentrations at stations where physical mixing of the water column is low. Fecal coliform bacteria enter marine waters where runoff is high. Thus, areas most sensitive to these water quality problems will be areas with high runoff, low mixing, and anthropogenic inputs of nutrients and sewage. Areas in Puget Sound where stratification is naturally strong and where problems with fecal contamination and low dissolved oxygen concentrations either have been observed or have a high potential are Bellingham Bay, Budd Inlet, Commencement Bay, Elliott Bay, Sinclair Inlet, Possession Sound, Saratoga Passage, and southern Hood Canal. The latter three areas showed persistent stratification and low dissolved oxygen concentrations during Wateryear 1993. High fecal coliform bacteria counts were found in each of these eight areas except Saratoga Passage.

The coastal estuaries show different dynamics from Puget Sound in terms of physical mixing, dissolved oxygen and nutrient concentrations, and fecal contamination. Stratification is strong at times due to high freshwater input but often obscured, presumably by tidal or wind mixing. Low dissolved oxygen concentrations were not observed in either Grays Harbor or Willapa Bay. Chronic high fecal coliform bacteria counts were observed in Grays Harbor and to a much less degree in Willapa Bay.

INTRODUCTION

This data report of the Washington State Department of Ecology (Ecology) Ambient Monitoring Section consists of water quality data for marine waters in Puget Sound, Willapa Bay, and Grays Harbor collected monthly during Wateryear 1993 (WY 1993 = October 1992 through September 1993). These data were collected as a component of Ecology's long-term Marine Water Column Ambient Monitoring Program. Data from the Program's other monitoring efforts (seasonal studies in Budd Inlet and Sequim Bay) during WY 1993 are not included here.

Marine Water Column Ambient Monitoring Program Statement of Purpose

The Marine Water Column Ambient Monitoring Program is designed to measure ambient water quality conditions in Puget Sound and the coastal estuaries (Janzen, 1992a). Long-term ambient monitoring data is required for establishing baseline conditions and can be used to detect effects of contamination and/or habitat degradation resulting from human activities. The long-term database can be used for assessment of ambient water quality conditions, annual patterns, and degree of variability in specific locations, and for the maintenance of regulatory listings of waterbodies. Implementation of marine water quality management activities for Puget Sound and the outer coastal estuaries can be based, in part, on quantitative water quality data such as was gathered by this monitoring program.

Program Objectives

Objectives of Ecology's Marine Water Column Ambient Monitoring Program in Puget Sound, Willapa Bay, and Grays Harbor are to:

1) Characterize spatial and temporal patterns of basic water quality parameters (e.g., temperature, salinity, density, dissolved oxygen, pH, chl *a*, light transmission, nutrients, etc.);

2) Identify significant changes in these parameters that may indicate environmental changes or emerging problems;

3) Collect data that can be used to assess compliance with state and federal water quality regulations and to determine the effectiveness of regulatory actions designed to improve marine water quality;

4) Provide water quality information to support specific programs within Ecology, at the Environmental Protection Agency and other agencies, and those programs identified in the Puget Sound Water Quality Management Plan;

5) Support environmental science research activities through the availability of consistent, scientifically and statistically valid data; and

6) Provide baseline water quality data as a service to the public and any other data requesters.

Program Background

Ecology initiated its statewide Marine Water Column Ambient Monitoring Program in 1967. The original purpose of the program was to determine existing water quality conditions on a regular basis and to identify spatial patterns and temporal trends from the results. Many of the sampling sites were located near municipal and industrial discharges in order to measure the effectiveness of agency regulatory programs. During the program's 26 year history, changes have been made to the original program to meet growing information needs and to incorporate technological advancements in environmental sampling.

In 1986, the Puget Sound Water Quality Authority (PSWQA) appointed an interdisciplinary committee to design the Puget Sound Ambient Monitoring Program (PSAMP) with the objective of coordinating various monitoring efforts within Puget Sound conducted by different government agencies into a comprehensive long-term monitoring program (PSWQA, 1988). Ecology's current Marine Water Column Ambient Monitoring Program in Puget Sound and its coordination with PSAMP directives is described in the Marine Water Column Ambient Monitoring Plan (Janzen, 1992a). This document also describes the design for Ecology's water column monitoring in the coastal estuaries of Willapa Bay and Grays Harbor.

Two components of Ecology's Marine Water Column Ambient Monitoring Program are long-term monitoring and seasonal monitoring. Long-term monitoring consists of visiting numerous selected stations once per month. The goal of this monitoring is to establish and maintain consistent baseline environmental data. Seasonal monitoring entails sampling individual estuaries with better spatial and temporal resolution, allowing specific hypotheses relevant to the environmental status of that specific location to be addressed.

In WY 1993, funding allowed for long-term monitoring in Puget Sound and the coastal estuaries, and two of the three planned seasonal studies in Puget Sound. This report is a summary of the results from long-term monitoring during WY 1993.

METHODS

Wateryear 1993 Long-Term Ambient Monitoring Approach

Ecology's long-term ambient monitoring strategy (Janzen, 1992a) identifies stations as core, rotating, or floating stations. Twenty-two core stations (16 in Puget Sound, 6 in the coastal estuaries) are sampled monthly every wateryear. Rotating stations are sampled monthly for one wateryear on a three-year rotating schedule. There are 30 rotating stations that are incorporated into the rotation schedule. Floating stations are sampled monthly when specific interest arises (e.g., to augment seasonal monitoring).

Twenty-three stations in Puget Sound (Figure 1), five stations in Grays Harbor (Figure 2), and five stations in Willapa Bay (Figure 2) were sampled monthly during WY 1993. Station information and the parameters sampled are listed in Table 1.

Materials and Procedures

Field Procedures

Long-term monitoring was conducted from a DeHavilland Beaver floatplane which allowed a large geographic area to be sampled in a short amount of time. Four surveys were scheduled in separate weeks each month to complete sampling throughout the Puget Sound and coastal station networks. Approximately eight to ten stations were sampled per survey. Sample collection methods were in compliance with the Recommended Guidelines for Measuring Conventional Marine Water Column Variables in Puget Sound (Puget Sound Estuary Program (PSEP), 1991) and are described in detail by Janzen (1992a). Major features are summarized below.

A Sea-Bird Electronics, Inc. Seacat® model SBE-19 conductivity-temperature-depth profiler (CTD) was used for collecting continuous water column profile data. In addition to measuring conductivity (used to compute salinity and density), temperature, and pressure, the CTD was equipped with sensors to measure pH, dissolved oxygen (D.O.), and light transmission. Both the conductivity and D.O. sensors were flushed continuously with sample water by a pump attached to and powered by the CTD. In WY 1993, profiles at each station were conducted from the sea surface to 100 m depth, or the sea bottom when shallower.

Secchi disk depths were used to indicate water clarity and derive the extinction coefficient of incident light penetration through the water column. Secchi depths (to the nearest 0.1 m) were taken at each station using a solid white, 30-cm disk. Surface water conditions (glare and waves) are the main source of inaccuracy in Secchi depth readings. To help reduce sources of error, all field crew were trained to

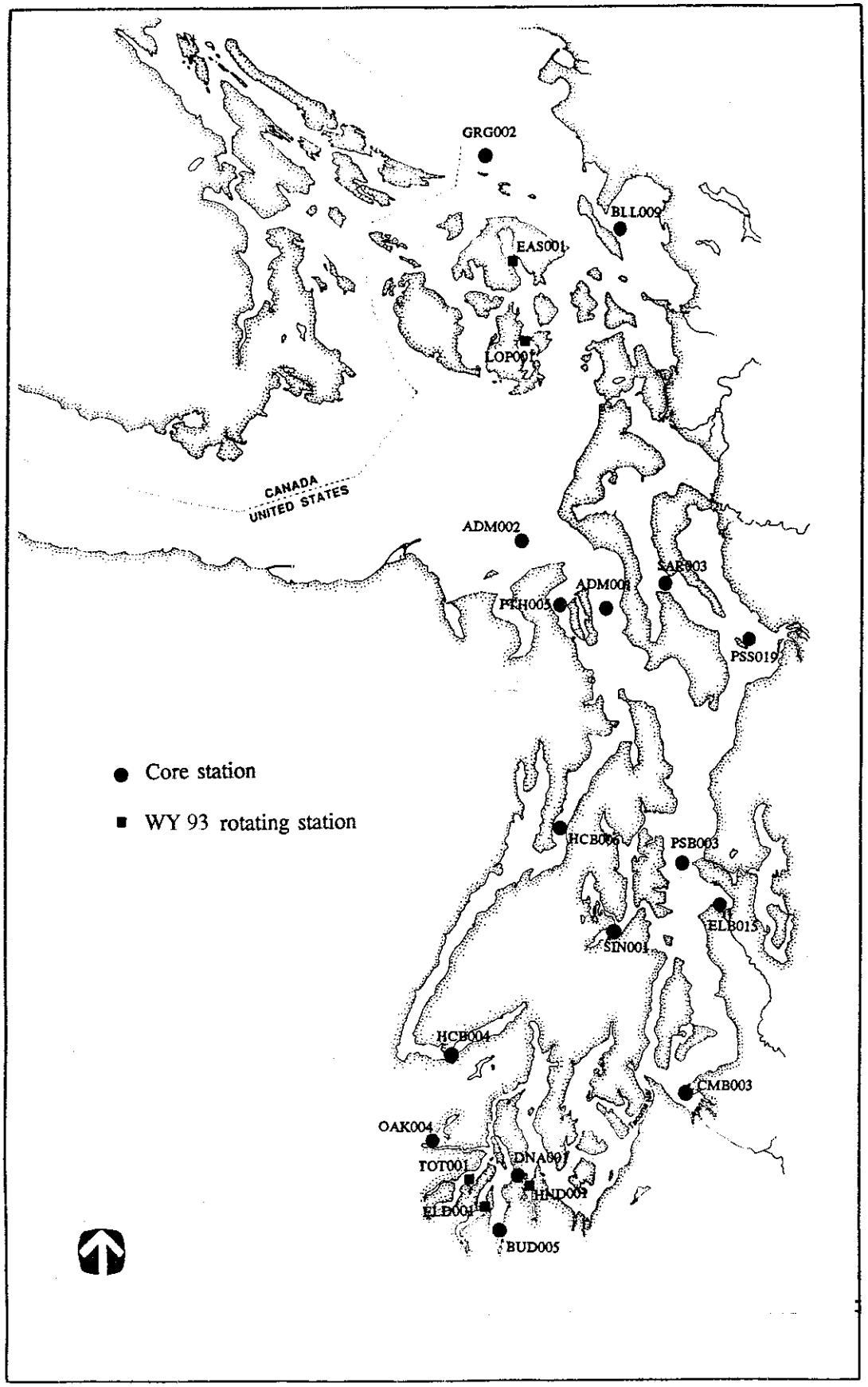


Figure 1. Long-term monitoring stations for WY 1993 in Puget Sound.

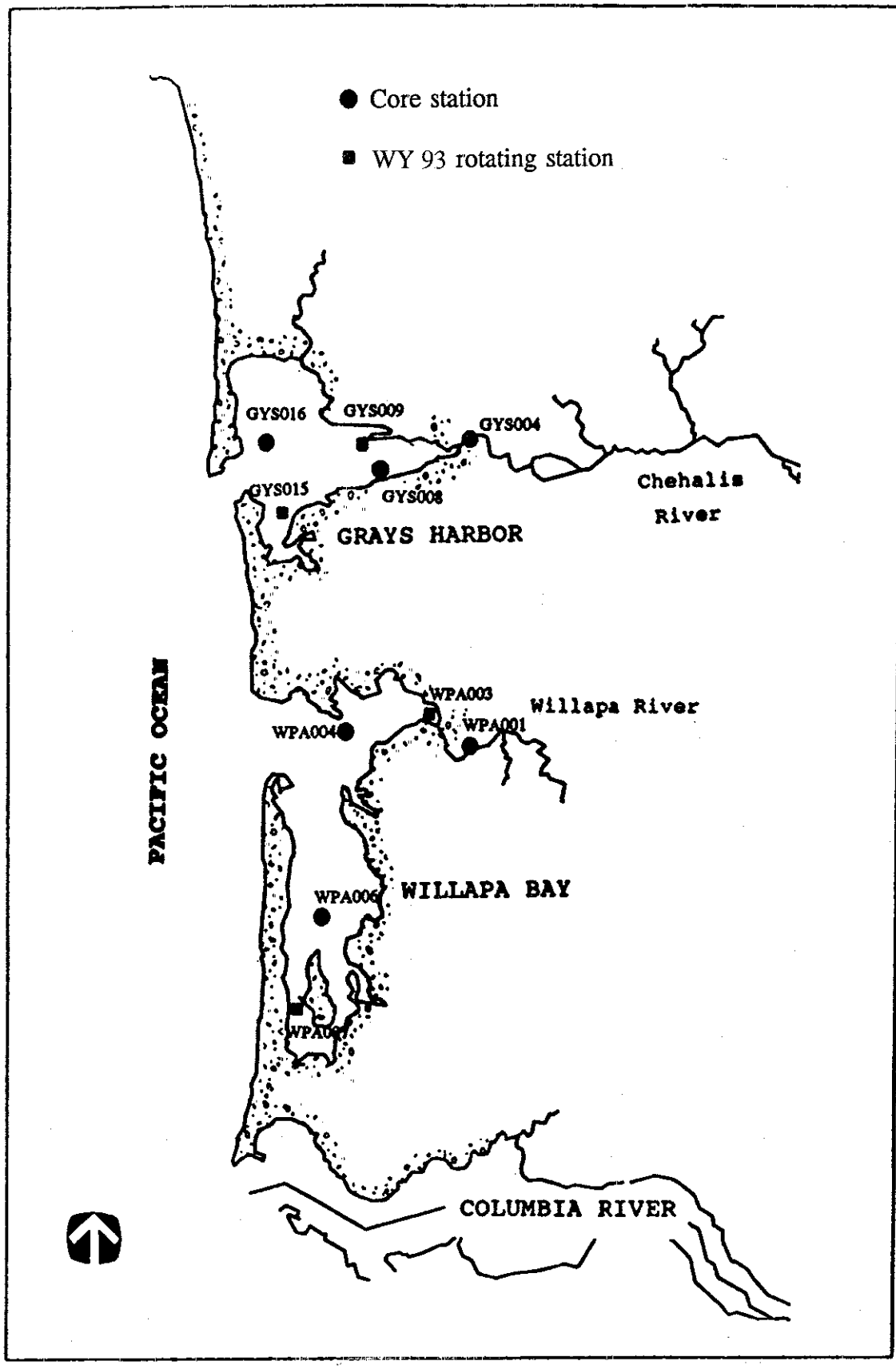


Figure 2. Long-term monitoring stations for WY 1993 in Grays Harbor and Willapa Bay.

Table 1. Long-term monitoring stations sampled during WY 1993. Station type notation is C=core station, R=rotating station, and F=floating station. All samples marked 0 m were taken from 0.5 m, except the fecal coliform bacteria sample which was from 0.1 m.

Station	Type	Basin	Parameters sampled*	Sample depths (m)
Puget Sound				
ADM001	C	Admiralty Inlet	All Parameters	0, 10, 30
ADM002	C	Strait of Juan de Fuca	All Parameters	0, 10, 30
BLL009	C	San Juan Basin	All Parameters	0, 10
BUD005	C	Southern Basin	All Parameters	0, 10
CMB003	C	PS Main Basin	All Parameters	0, 10, 30
CRR001	R	Southern Basin	All Parameters	0, 10, 30
CSE001	R	Southern Basin	All Parameters	0, 10, 30
DNA001	C	Southern Basin	All Parameters	0, 10, 30
EAS001	R	San Juan Basin	CTD and Secchi	0, 10, 30
ELB015	C	PS Main Basin	All Parameters	0, 10, 30
ELD001	R	Southern Basin	All Parameters	0, 10
GRG002	C	Strait of Georgia	All Parameters	0, 10, 30
HCB004	C	Hood Canal Basin	All Parameters	0, 10, 30
HCB006	C	Hood Canal Basin	All Parameters	0, 10, 30
HND001	R	Southern Basin	All Parameters	0, 10
LOP001	R	San Juan Basin	CTD and Secchi	0, 10
OAK004	C	Southern Basin	All Parameters	0, 10
PSB003	C	PS Main Basin	All Parameters	0, 10, 30
PSS019	C	Whidbey Basin	All Parameters	0, 10, 30
PTH005	C	Admiralty Inlet	All Parameters	0, 10, 30
SAR003	C	Whidbey Basin	All Parameters	0, 10, 30
SIN001	C	PS Main Basin	All Parameters	0, 10
TOT001	R	Southern Basin	All Parameters	0, 10
Coastal Estuaries				
GYS004	C	Grays Harbor	All Parameters	0, 10
GYS008	C	Grays Harbor	All Parameters	0, 10
GYS009	R	Grays Harbor	CTD and Secchi	0, 10
GYS015	R	Grays Harbor	CTD and Secchi	0, 10
GYS016	C	Grays Harbor	All Parameters	0, 10
WPA001	C	Willapa Bay	All Parameters	0, 10
WPA003	R	Willapa Bay	CTD and Secchi	0, 10
WPA004	C	Willapa Bay	All Parameters	0, 10
WPA006	C	Willapa Bay	All Parameters	0, 10
WPA007	R	Willapa Bay	CTD and Secchi	0, 10

* All parameters refers to: CTD profile, Secchi depth, dissolved nutrients (see text), chlorophyll *a* (0.5 m, 10 m only), and fecal coliform bacteria (0.1 m only).

conduct Secchi depth readings using the same procedure. If surface conditions were not optimal, the reading was not recorded or was recorded as an estimate.

A 1.2-L Niskin® bottle was used to collect water at 0.5, 10, and 30 m. For stations shallower than either 10 or 30 m, a sample at the near-bottom depth (1 m off sea bed) was taken. Ideally, discrete water-column sampling would be done above and below the pycnocline (the layer of rapidly changing density); however, lack of real-time CTD data display capability from the present sampling platform precluded this. Data for these fixed depths must be interpreted with knowledge of the CTD profile made at the time. Discrete water samples were taken from the Niskin bottle for dissolved nutrients (ammonium-N, nitrite-N, nitrate+nitrite-N, and orthophosphate-P), and pigments (chl *a* and phaeopigment). In May 1992, analysis of nitrite-N was discontinued in all but three urban bay stations (BUD005, CMB003, and BLL009). This was because previous wateryear data indicated that nearly all concentrations were below the reporting limit. Samples for D.O. were drawn periodically for comparison to the *in situ* sensor values. Samples for fecal coliform bacteria were collected just below the surface (0.1-m) using sterile glass sample bottles.

Laboratory Procedures

Analyses for dissolved nutrients, pigments, and fecal coliform bacteria were conducted at the Manchester Environmental Laboratory (MEL) using methods described in Ecology (1992).

All nutrient samples were maintained at 4°C and then filtered through Nalgene® 0.45 μm pore cellulose acetate filters at MEL within 24 hours of collection. Nutrient samples were analyzed for ammonium-N, nitrite-N, nitrate+nitrite-N, and orthophosphate-P using an Alpkem® series 300 autoanalyzer at MEL. If immediate analysis was not possible, samples were frozen after being filtered.

Samples for chl *a* and phaeopigment were filtered through Whatman® GF/F glass fiber filters (0.70 μm nominal pore size) at the end of the sampling day by AMS staff. The filters were stored and frozen in glass centrifuge tubes according to Ecology (1992) procedures for transfer to MEL. Subsequent to WY 1993's field season, the storage of the filter in air was shown by Ambient Monitoring Section (AMS) staff to result in loss of up to 22% of the chl *a* compared with filter storage in 90% acetone (Eisner, 1994). All WY 1993 data were produced using the old method, and therefore are presumably underestimates. Determination of chl *a* and phaeopigment concentrations was made by MEL using fluorometric detection with a Sequoia-Turner model 112 fluorometer and the APHA *et al.* (1989) protocol.

Fecal coliform bacteria samples were stored refrigerated and transferred to MEL within 24 hours of collection. Upon arrival, samples were incubated and analyzed using the membrane filter method (APHA *et al.*, 1989).

The discrete samples for D.O. analysis were analyzed by AMS staff using the azide-modified Winkler method (APHA *et al.*, 1989). Since liquid chemicals were not allowed on the seaplane for safety reasons, powdered forms of the reagents were used. These powdered reagents have the capability to accurately bind oxygen for D.O. concentrations up to 10 mg/L (Hach, 1989). Results from the Winkler D.O. analyses were compared with the *in situ* D.O. results obtained with the CTD's Beckman oxygen sensor to monitor for calibration drift or sensor failure. Only discrete sample results < 10 mg/L were used for comparison with the *in situ* sensor. Discrete analyses were not reported in the database.

Data Management

Results from discrete water sample analyses for all WY 1993 stations were entered into Ecology's AMS database (Dbase 4®). Following quality assurance checks, these data were then uploaded into PC STORET, a PC version of the mainframe STORET, a national environmental database managed by the United States Environmental Protection Agency.

The CTD data files were processed using Sea-Bird Electronics, Inc. SEASOFT® software (either version 4.015 or 4.024). The CTD data, with the proper calibration coefficients applied, were bin-averaged (an interpolation process that averages sub-groups of data) into half-meter bins. Profiles of salinity and density with depth were derived from measured values of temperature, conductivity, and pressure. Further details on WY 1993 CTD processing procedures can be found in the CTD Data Acquisition Software Manual (Sea-Bird Electronics, Inc., 1992; 1993).

All data from the CTD for 0.5, 10, and 30 m depths were entered into the AMS database and uploaded into PC STORET. If the bottom depth was less than 10 or 30 m, the values at 0.5 m from the bottom were used. The complete CTD profiles were archived in hard-copy and on computer diskettes for subsequent data analysis and retrieval.

Quality Assurance/Quality Control Procedures

In-Field Quality Assurance/Quality Control Procedures

During WY 1993, one station per survey was selected for field QA/QC procedures. Replicate surface water samples were collected at these same stations each month. A station was selected from each survey where positive results (above reporting limits) were expected. Field replicate results provide an estimate of the total variability (sampling and analytical) in the results for nutrients, pigments, and fecal coliform bacteria. The procedure entailed the collection of triplicate water samples using three separate surface (0.5-m) bottle casts at each selected QA station. The replicates were sent to the laboratory as blind samples and analyzed for dissolved nutrients and for

pigments. Duplicate surface samples (at 0.1 m) for fecal coliform bacteria analysis were also collected at these pre-selected stations.

Laboratory Sample Analysis

Table 2 lists the WY 1993 QA/QC objectives for Ecology's Marine Water Column Ambient Monitoring Program. These objectives were different from PSAMP QA objectives (PSWQA, 1988) in the following cases:

1) Ecology's reporting limits for nitrite-N were 0.01 milligrams per liter (mg/L) whereas PSAMP requests 0.005 mg/L,
2) Ecology's reporting limits for orthophosphate-P were 0.01 mg/L whereas PSAMP requests 0.002 mg/L, and
3) Ecology's precision (relative standard deviation (RSD)) target for chl *a* and phaeopigment was 20% whereas PSAMP requests precision within 10%.

All other target objectives met or exceeded those listed in the PSAMP document. The QA standards and procedures for MEL are described in Ecology (1988). Nutrient samples were analyzed in batches. Each batch run included analysis of two blanks, five known concentration check standards (analyzed once before the batch run, and once after), and one spiked sample. Select field samples were split at the laboratory for separate analysis of nutrients. A select number of pigment samples were split before filtering and sent to the laboratory as blind samples. Laboratory split results provide an estimate of the analytical variability. Field blanks for pigments were made by filtering distilled water and were sent to the lab as blind samples. Laboratory method blanks for pigments were determined with 90% acetone and fluorometer readings were taken before (pre) and after (post) batch analysis of pigment samples.

Additional quality assurance procedures for other laboratory analyses and equipment calibration are in Ecology (1988) and Janzen (1992a). Data qualifiers for laboratory results are given with the station data reports in Appendix A.

CTD Calibration Procedures

An annual calibration was performed by the Northwest Regional Calibration Center (NRCC) on the CTD's temperature, conductivity and D.O. sensors, and a biennial calibration was done for the CTD's pressure sensor. In-house calibrations were conducted monthly on the D.O. and pH sensors, and on the light transmissometer. Calibration procedures for the CTD followed Sea-Bird Electronics, Inc. (1990) and Janzen (1992a). The most recent calibration coefficients were used in processing data, thus maintaining accuracy by correcting for drift in sensor performance.

Since the discrete Winkler D.O. analyses did not have the same accuracy as the *in situ* D.O. measurements, the Winkler D.O. data could not be used for direct

Table 2. Marine water column quality assurance/quality control objectives.

Analytical parameters	Ecology's reporting units*	Ecology's reporting limit	Relative standard deviation (%RSD)**
laboratory analysis parameters:			
ammonium-N	mg/L	0.01	10%
nitrite-N	mg/L	0.01	10%
nitrate+nitrite-N	mg/L	0.01	10%
orthophosphate-P	mg/L	0.01	10%
chlorophyll a and phaeopigment	ug/L	0.05	20%
fecal coliform bacteria	#/100 mL	1	20%
conductivity	umhos/cm @ 25 C	1	8%
CTD parameters:			
salinity	ppt	0.01	8%
temperature	C	0.1	5%
pH	pH units	0.1	0.1 pH unit
dissolved oxygen	mg/L	0.1	8%
light transmission	% light	0.1	5%

* PSAMP units ug-at/L can be computed with the following equations: ((mg/L*1000)/14.01) for nitrogen; ((mg/L*1000)/30.97) for phosphorus.

** %RSD = (sample standard deviation/sample mean) x 10

corrections of the *in situ* D.O. sensor calibration. Also, bottle casts were conducted following the CTD cast, and so the discrete sample is not a precise replicate. However, the Winkler D.O. data were used to verify that the *in situ* D.O. sensor was performing to the needed precision (+/- 1.0 mg/L). If this precision was not met, the data were flagged as estimated values.

RESULTS

In WY 1993, 43 of the 48 scheduled weekly monitoring surveys were completed. Of these, 34 of 36 were conducted in Puget Sound, and 9 of 12 in Grays Harbor and Willapa Bay. High winds, fog, and low cloud cover were among the reasons for failure to conduct planned surveys.

Station data, presented in Appendix A, include the 0.5, 10, and 30 m values from the CTD profiles for temperature (°C), salinity (parts per thousand), pH (standard units), D.O. (both mg/L and percent saturation), and light transmission (percent transmission). Also shown are the Secchi disk depths (m), and laboratory results of discrete water sample analyses for fecal coliform bacteria at 0.1 m (number per 100 mL), dissolved nutrients (mg/L) at 0.5, 10, and 30 m, and pigments (μg/L) at 0.5, and 10 m. For stations shallower than either 10 or 30 m, the near-bottom depth (1 m off sea bed) is recorded. All appendices in this report, are divided into two sections: 1) data for Puget Sound stations, and 2) data for the coastal estuary stations (Grays Harbor and Willapa Bay).

Climate

During October 1991-April 1992, strong El Niño conditions were observed in the equatorial Pacific Ocean (Kessler and McPhadden, in press, a, b) and effects from this event were evident in the Puget Sound region's climate. The typical influence from El Niño on local climate is less precipitation and warmer air temperatures. Compared to the 30-y record, in WY 1992, air temperatures warmed earlier and precipitation was 21% less at Sea-Tac Airport (NOAA, 1992). A second though much weaker El Niño warming event occurred in the equatorial Pacific in February-June 1993 (Kessler and McPhadden, in press a, b).

In order to detect differences in the air temperature and precipitation data for WY 1993, anomalies were calculated by subtracting WY 1993 monthly mean values from the 30-y monthly means. Both data sets were Sea-Tac Airport data obtained from the National Climate Data Center (NOAA, 1993). These anomalies (Figure 3A) show that WY 1993 was characterized by fall (Oct-Nov 1992) conditions that were warmer and drier, perhaps still in response to effects from the 1991-2 El Niño, winter (Dec 1992-Feb 1993) conditions that were cooler and drier, spring (Mar-Jun 1993) conditions that were warmer and wetter, and summer (Jul-Sep 1993) conditions that

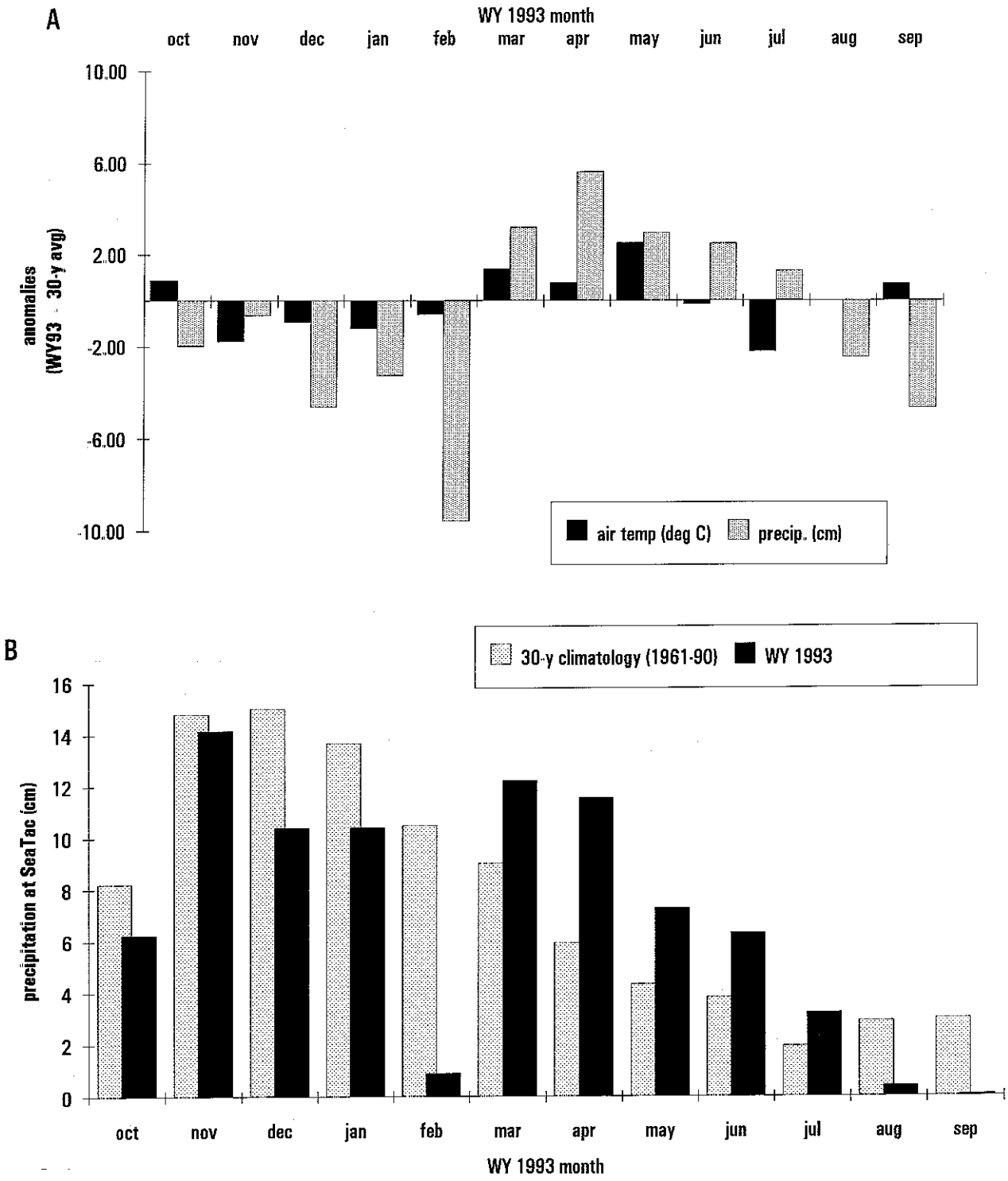


Figure 3. Climate data for WY 1993. (A) Anomalies for WY 1993 air temperatures and precipitation compared to 30-y average. Data obtained from National Climate Data Center (NOAA, 1993) for Sea-Tac Airport. (B) Precipitation at Sea-Tac during WY 1993 and the 30-y average. Same data source.

were warmer and drier overall, with the exception of July, which was cooler and wetter. The return of these warmer and drier conditions in the summer of 1993 may reflect influence from the second warming event.

The heaviest precipitation recorded at Sea-Tac Airport during WY 1993 was in November 1992, March, and April 1993 (Figure 3B). Comparing the WY 1993 mean with the 30-y annual mean, WY 1993 had 11% less precipitation (6.92 versus 7.75 cm), yet as Figure 3B shows, the distribution of the precipitation over the wateryear was atypical.

Fresh water flow during WY 1993 was below normal, as demonstrated by flows 69% of normal runoff from the Chehalis River and 77% of normal runoff by the Skykomish River (USGS, 1993). These two river systems are considered representative of western Washington. These represent slight increases over the WY 1992 data, which showed 62% and 73% of normal runoff for these two rivers, respectively (USGS, 1992).

Temperature, Salinity, and Density

Individual profiles of temperature (°C), salinity (parts per thousand, = ppt), and density (sigma-*t*) with depth (m) obtained from the CTD casts for the Puget Sound stations monitored during WY 1993 are in Appendix B.1; those for Grays Harbor and Willapa Bay are in Appendix B.2. At most stations, profiles were conducted from the sea surface to sea bed, or 100 m whichever came first.

Temperature and Salinity Anomalies

Five stations from Puget Sound and one each from Willapa Bay and Grays Harbor were selected for calculation of sea-surface temperature and salinity anomalies, as well as for comparison of the 0, 10, and 30 m temperature and salinity data with that from WY 1992 (El Niño wateryear) and WY 1991 (non-El Niño wateryear). The selected stations in Puget Sound were: GRG002, in open waters of the Strait of Georgia, but potentially influenced by the plume of the Fraser River; ADM002, in open waters at the entrance to Admiralty Inlet, over the sill, in an often well-mixed regime that is not near riverine influence; PSB003, in open waters of the Puget Sound main basin off West Point where freshwater input from the Lake Washington ship canal and Elliott Bay (Duwamish River) would be evident; DNA001, in Dana Passage, a thoroughly mixed channel in southern Puget Sound where waters from several estuaries communicate with the main basin waters; and BUD005, a representative southern Puget Sound estuary with riverine input (Deschutes River), and relatively low mixing due to density stratification.

The stations selected in Grays Harbor, GYS009, and Willapa Bay, WPA004, are located intermediate in these estuaries, and thus would be influenced by both riverine input and communication with Pacific Ocean waters. Tidal stage is a strong

determinant in the degree of marine versus riverine influence at a given sampling event in these coastal embayments. However, it was not logistically feasible to control for tidal stage in these data.

The WY 1993 anomalies for sea-surface temperature (SST) and salinity must be interpreted with caution, since the long-term monthly means used were only 5-y means (WY 1988 to WY 1992). Adequate data do not exist for calculating monthly means over a longer time period since prior to 1988 monitoring did not occur during winter months.

The SST data for WY 1993 showed strong positive SST anomalies (greater than 3°C) in May at GRG002, PSB003 and BUD005 (Figure 4A). The strong positive anomalies, all in May, follow large positive anomalies in both air temperature and precipitation in April-May (Figure 3A). These stations are all near rivers, whereas Stations ADM002 and DNA001, which are more well-mixed than the others and not strongly influenced by rivers, did not show major anomalies in May.

Negative anomalies greater than 2°C were observed at BUD005 in January, and June through August (Figure 4A). The cause of the lower SST at BUD005 is not apparent. Precipitation was quite low in July and August, and rivers are generally warmer than seawater. The water column at BUD005 stratifies, and a surface layer could have been cooled by surface winds. The air temperature showed a negative anomaly only in July. It is likely that this anomaly was merely the consequence of the majority of the WY 1993 sampling being conducted in the morning, whereas the majority during WY 1991 and 1992 was in the afternoon. SST readings from stratified areas subject to solar heating should be interpreted with caution and attention to time of measurement.

Sea-surface salinity anomalies have been plotted in the same manner (Figure 4B). These show that the negative SST anomalies in BUD005 do not appear to be related to precipitation or runoff activity. The May SST positive anomalies are mirrored by negative salinity anomalies, confirming the conclusion that these show a high runoff event. The strong negative anomaly in November at GRG002 does not show up as a SST anomaly, but may be because the river water was of similar temperature to that station at that time. Evidence of the Fraser River plume often is noticed at Station GRG002 (Appendix A; Thomson, 1994). The drier winter months (December, January, February; Figure 3A) may have influenced the general pattern of positive salinity anomalies in December through April seen at most stations.

Similar plots were made for the coastal estuaries (Figures 5A, B). The drier fall through winter is clearly seen in the higher salinities and the colder temperatures of the sea surface through April. The summer months show fresher salinities and higher temperatures, probably in response to the marked precipitation in the spring and summer of WY 1993. The applicability of Sea-Tac weather data to these coastal sites is uncertain.

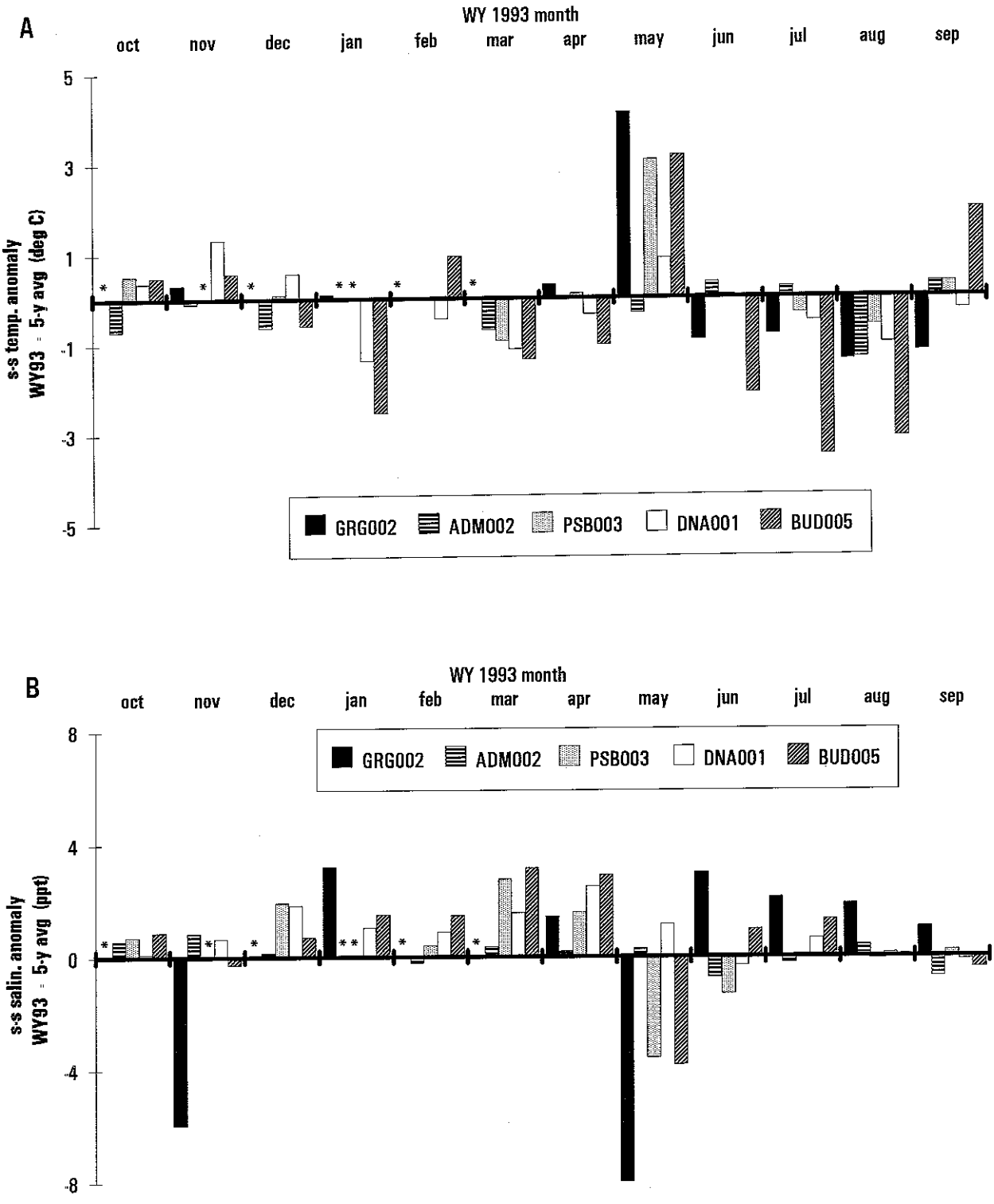


Figure 4. Sea-surface anomalies for (A) temperature and (B) salinity, for several stations in Puget Sound versus Wateryear 1993 month. The * indicates station was not sampled during given month.

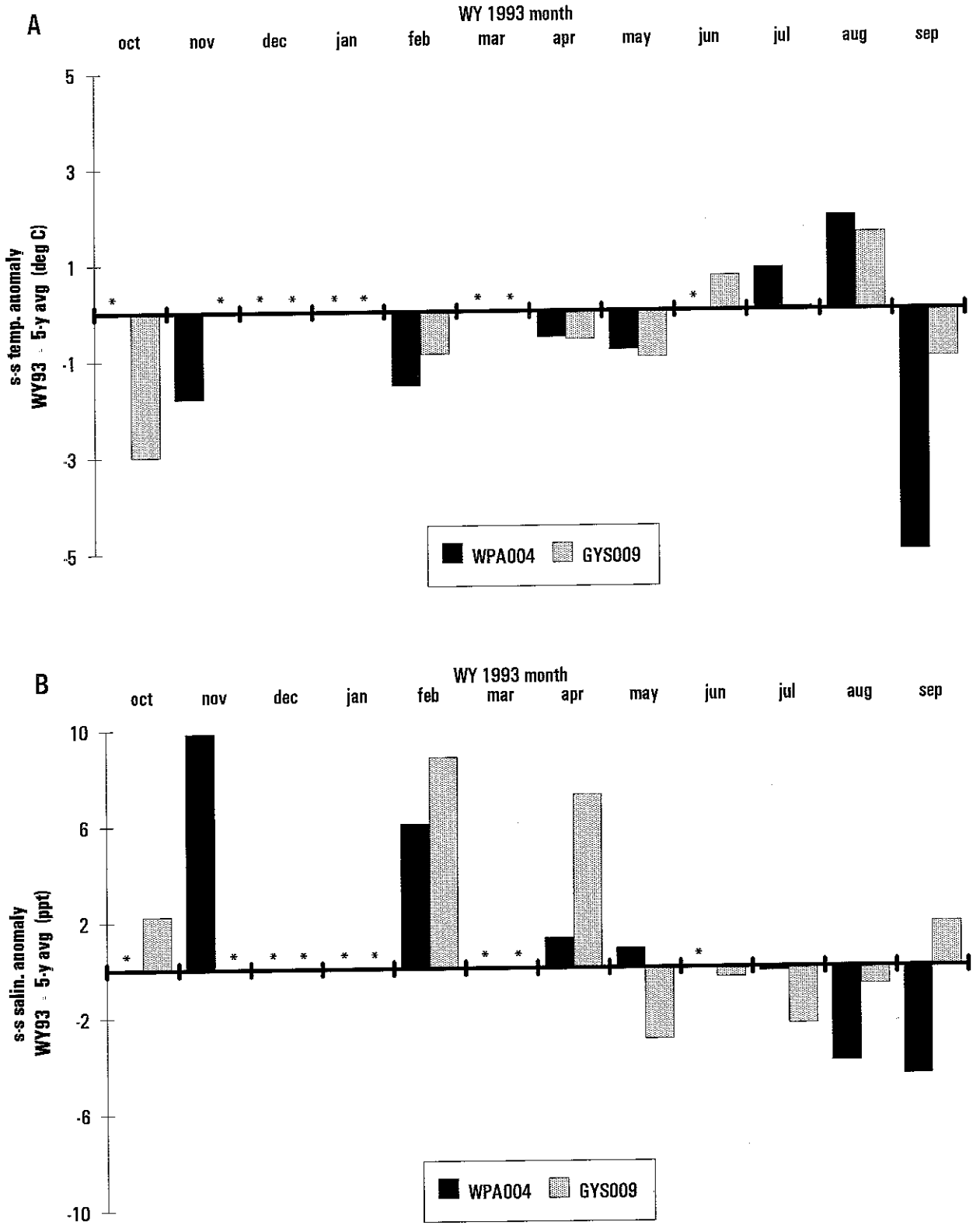


Figure 5. Sea-surface anomalies for (A) temperature and (B) salinity, for one station in each of Willapa Bay and Grays Harbor versus Wateryear 1993 month. The * indicates station was not sampled during given month.

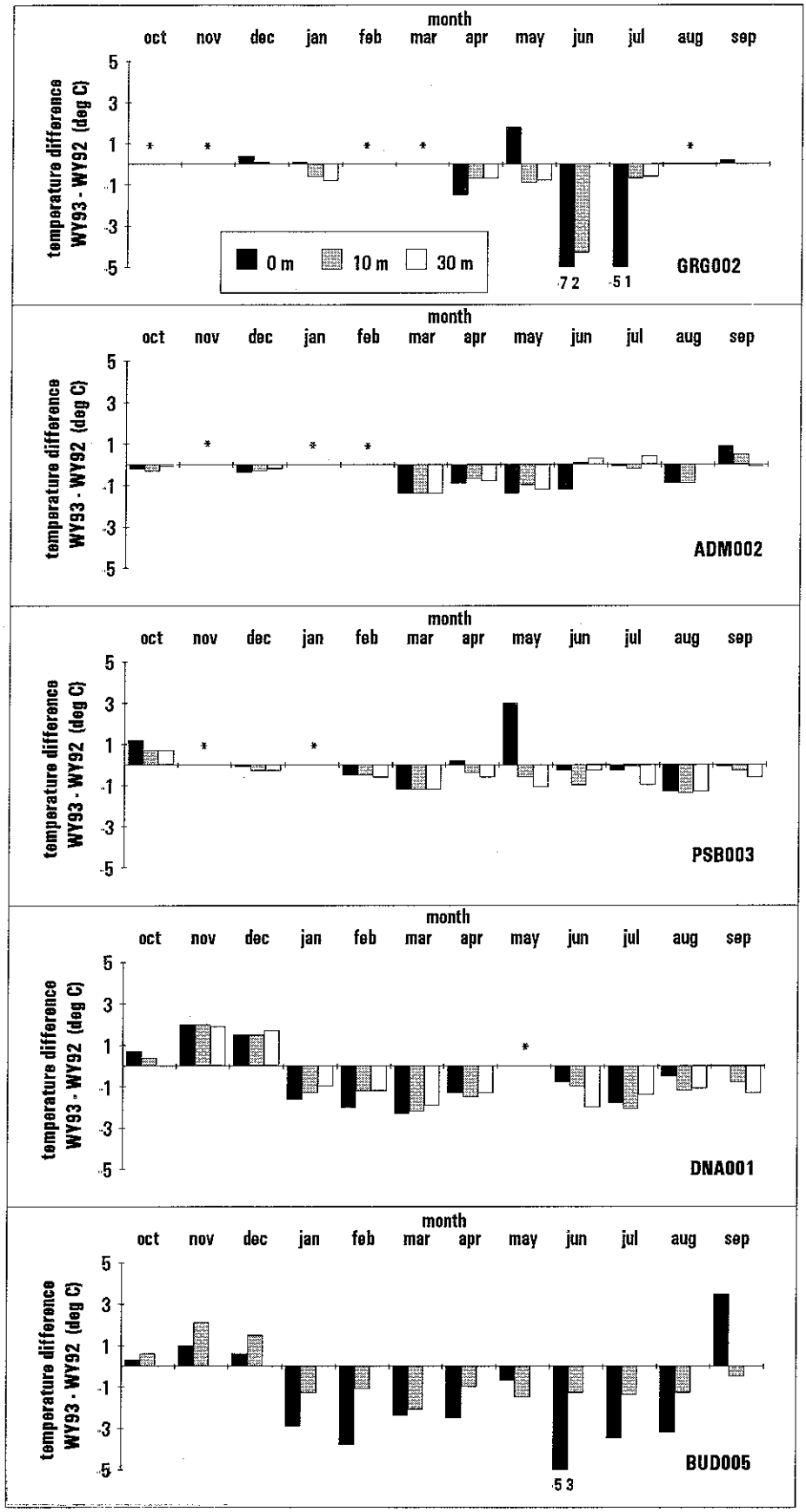
Wateryear Comparisons

The strong El Niño event during WY 1992 affords an opportunity to look at the effects of climate forcing on the temperature and salinity of local marine waters. Data from the last three wateryears represent three different climatological conditions. Wateryear 1991 could be considered "typical" in that it preceded El Niño. Wateryear 1992 was during a strong El Niño event. Reduced precipitation as well as higher air temperatures were most profound during this year, as has been usual for this local area during El Niños. During WY 1993, there was a mild El Niño event; this wateryear had mixed conditions, with a drier fall-winter and wetter spring-summer. Although neither WY 1991 or 1993 had strong El Niño signals, these two wateryears were substantially different from each other in that river runoff was much higher during WY 1991. Runoff was at 111% and 132% of the normal record for the Chehalis and Skykomish rivers during WY 1991 (USGS, 1991). Three significant flood events were recorded in WY 1991, two during November and one in March. In summary: WY 1991 was very wet; WY 1992 was quite dry and warm; and WY 1993 had mixed conditions but was drier than average.

To investigate these climate effects on marine waters, the temperature and salinity data from 0, 10, and 30 m for the same five Puget Sound stations and two coastal estuary stations for WY 1992 were subtracted from those for WY 1993. The same subtraction was made between the WY 1991 and WY 1993 data. Assuming that the WY 1992 data will generally be warmer and saltier, due to the warmer air temperatures, reduced precipitation and runoff during El Niño, then negative temperature differences and negative salinity differences should be found for the WY 1993/1992 comparison. Comparing WY 1991 and WY 1993 should yield a more random pattern, but may show positive salinity differences due to the high runoff in WY 1991 and the less than average runoff in WY 1992 and WY 1993.

The WY 1993/1992 plots do show a preponderance of negative temperature differences (Figure 6) that are most pronounced at 0 m, but clearly evident at 30 m as well. The WY 1993/1991 plots do not show a strong overall temperature difference pattern (Figure 7). Positive temperature differences are seen towards the end of the wateryear, but the pattern is less striking. The wateryear-averaged differences on Figures 6 and 7 show many more negative values in the 1993/1992 comparison (13 out of 14) than in the 1993/1991 comparison (2 out of 14). The large values of the standard deviation indicate the variability in the data.

The companion salinity plots (Figures 8 and 9) show more equivocal results for both comparisons, although positive salinity differences in the 1993/1991 comparison were generally stronger, probably reflecting the high runoff in WY 1991. However, that positive salinity differences in the 1993/1991 comparison (11 out of 14) were observed only slightly more often than in the 1993/1992 comparison (10 out of 14) implies that WY 1993 had the highest salinity values of the three wateryears. This



GRG002	0 m	10 m	30 m
mean:	-1.61	-1.01	-0.41
sd:	3.30	1.50	0.39

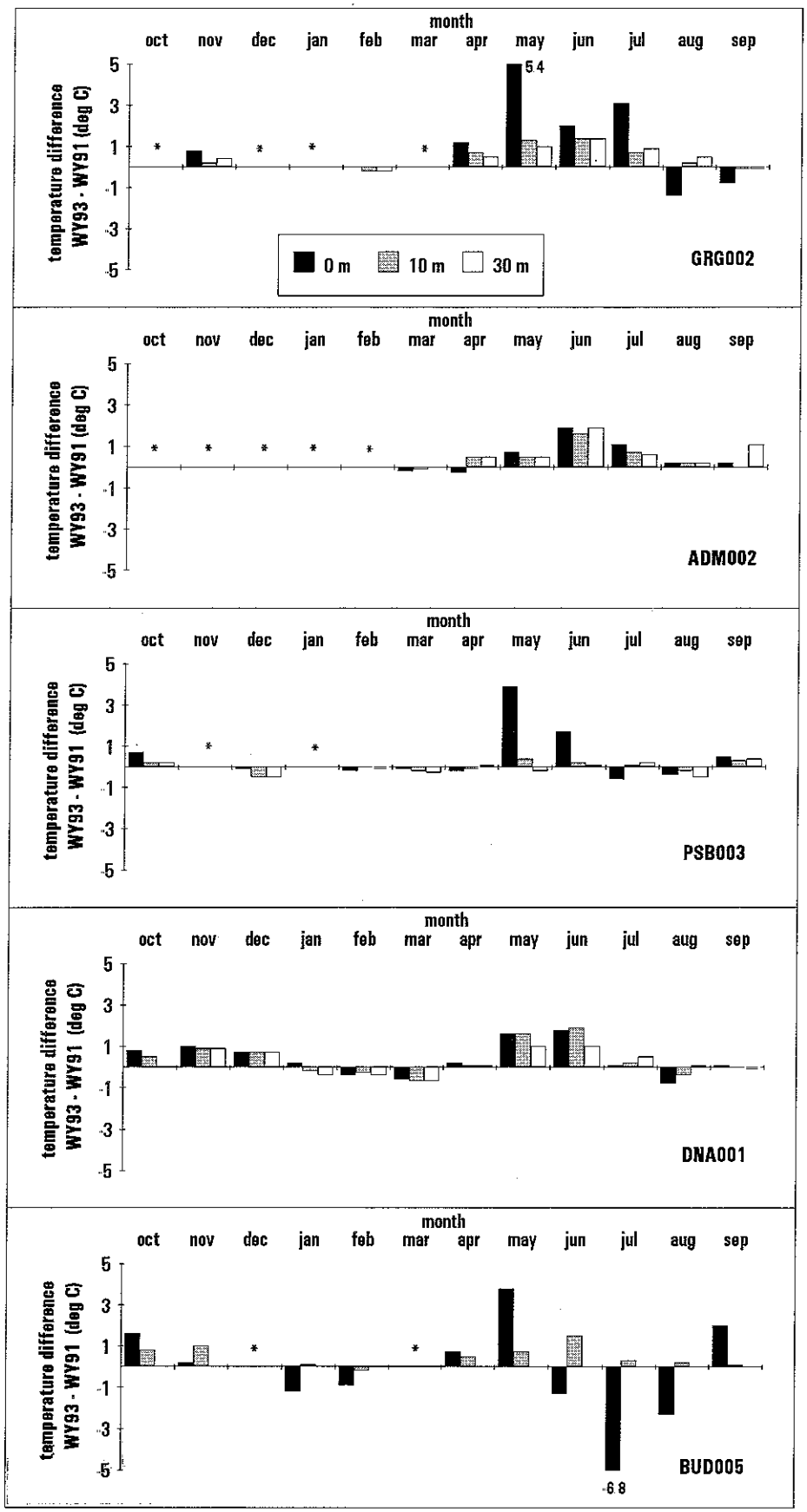
ADM002	0 m	10 m	30 m
mean:	-0.62	-0.47	-0.34
sd:	0.75	0.59	0.64

PSB003	0 m	10 m	30 m
mean:	0.06	-0.51	-0.63
sd:	1.25	0.60	0.59

DNA001	0 m	10 m	30 m
mean:	-0.55	-0.67	-0.69
sd:	1.45	1.38	1.34

BUD005	0 m	10 m	30 m
mean:	-1.58	-0.61	
sd:	2.52	1.30	

Figure 6. Temperature differences for WY 1993 minus WY 1992 for several stations in Puget Sound versus wateryear month. The * indicates station was not sampled during given month.



GRG002	0 m	10 m	30 m
mean:	1.29	0.53	0.55
sd:	2.21	0.60	0.54

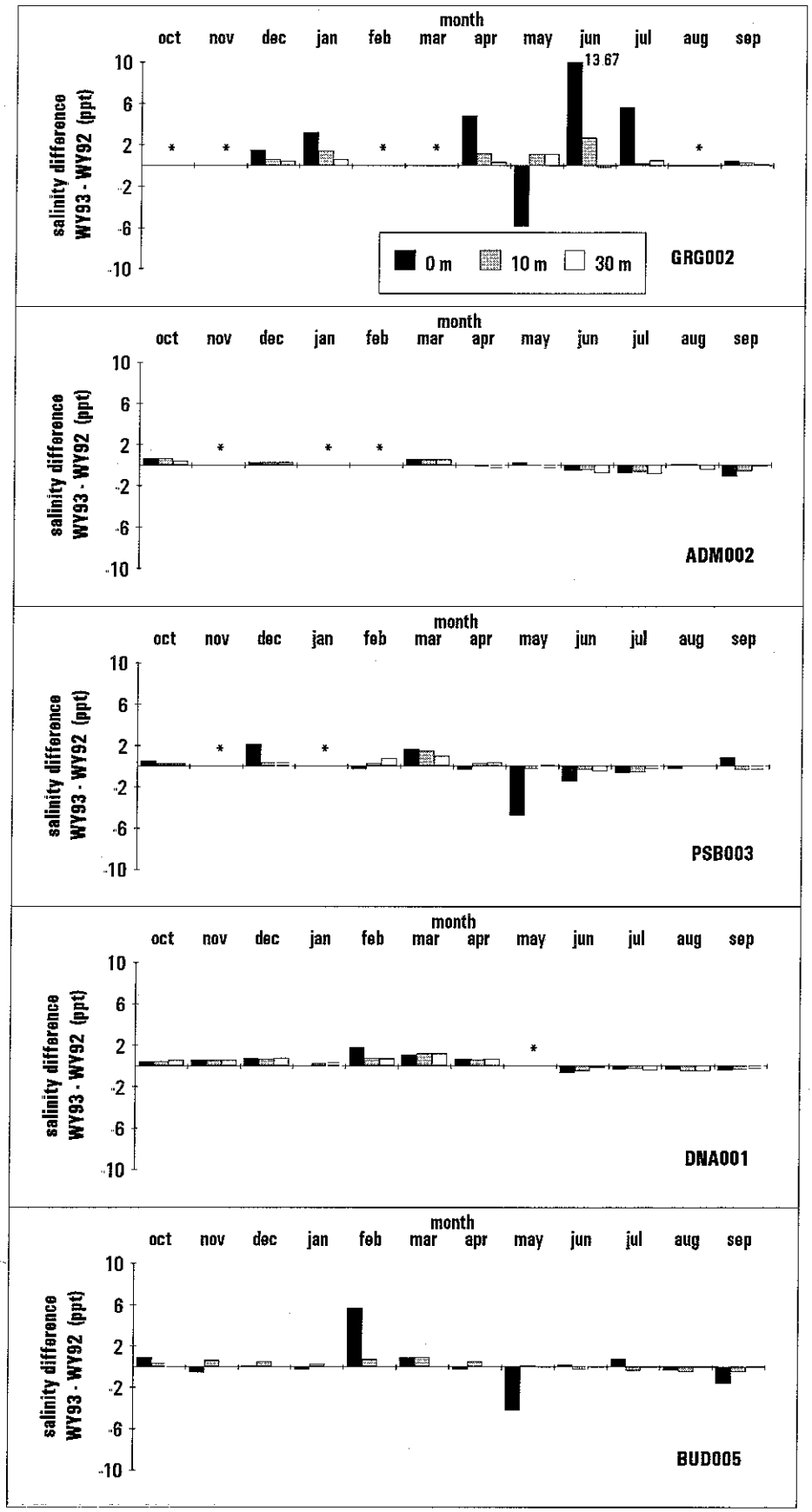
ADM002	0 m	10 m	30 m
mean:	0.51	0.49	0.69
sd:	0.78	0.57	0.64

PSB003	0 m	10 m	30 m
mean:	0.52	0.02	-0.06
sd:	1.36	0.27	0.31

DNA001	0 m	10 m	30 m
mean:	0.39	0.36	0.23
sd:	0.82	0.80	0.59

BUD005	0 m	10 m	30 m
mean:	-0.42	0.50	
sd:	2.89	0.51	

Figure 7. Temperature differences for WY 1993 minus WY 1991 for several stations in Puget Sound versus wateryear month. The * indicates station was not sampled during given month.



	0 m	10 m	30 m
mean:	3.35	1.06	0.42
sd:	5.92	0.85	0.40

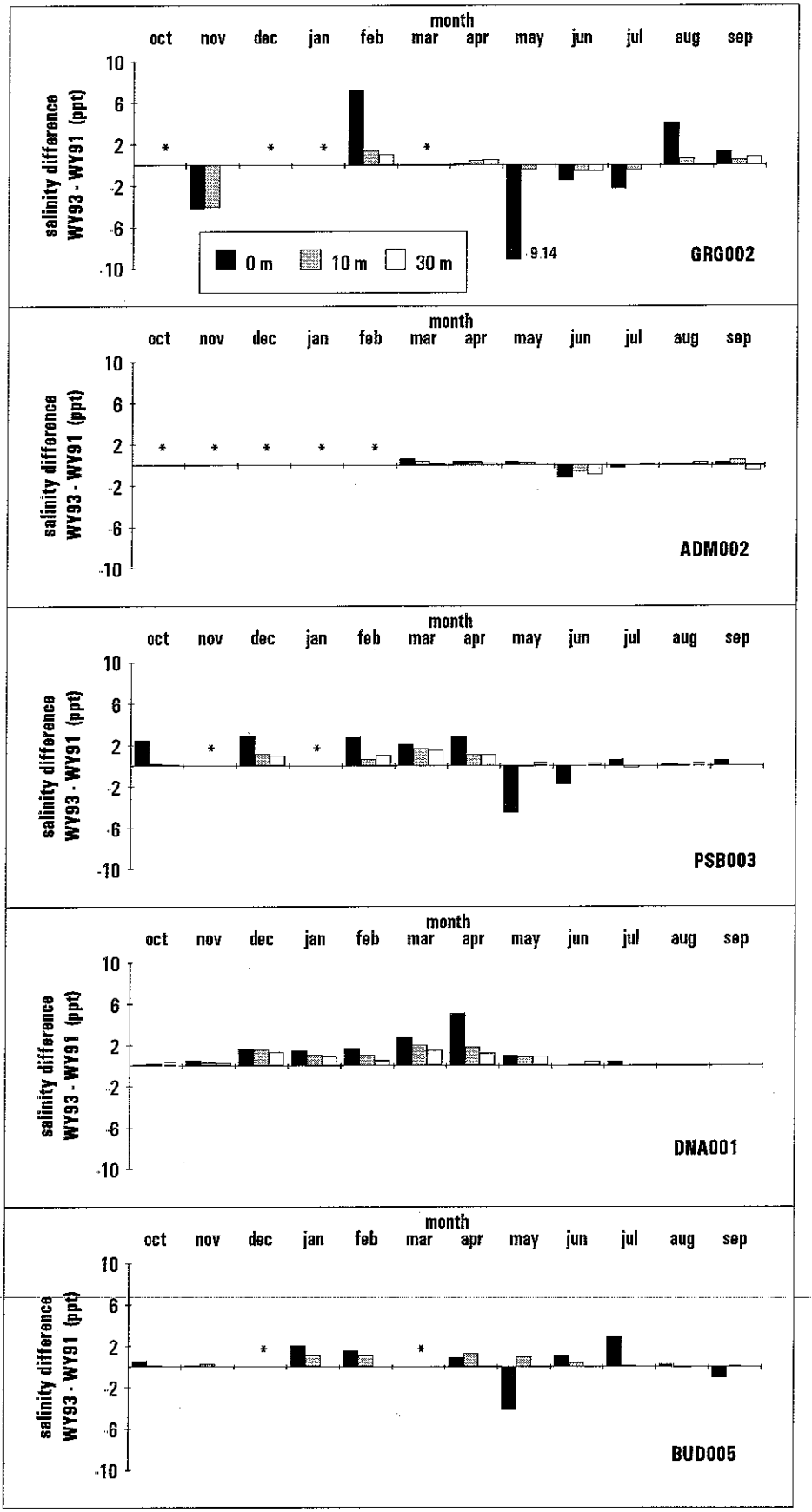
	0 m	10 m	30 m
mean:	-0.06	-0.03	-0.16
sd:	0.61	0.48	0.50

	0 m	10 m	30 m
mean:	-0.27	0.11	0.19
sd:	1.92	0.59	0.47

	0 m	10 m	30 m
mean:	0.32	0.27	0.33
sd:	0.75	0.57	0.55

	0 m	10 m	30 m
mean:	0.09	0.21	
sd:	2.26	0.00	

Figure 8. Salinity differences for WY 1993 minus WY 1992 for several stations in Puget Sound versus wateryear month. The * indicates station was not sampled during given month.



GRG002	0 m	10 m	30 m
mean:	-0.53	-0.30	0.27
sd:	5.04	1.67	0.56

ADM002	0 m	10 m	30 m
mean:	0.04	0.16	-0.06
sd:	0.63	0.39	0.45

PSB003	0 m	10 m	30 m
mean:	0.81	0.46	0.54
sd:	2.41	0.64	0.56

DNA001	0 m	10 m	30 m
mean:	1.21	0.75	0.61
sd:	1.49	0.75	0.53

BUD005	0 m	10 m	30 m
mean:	0.40	0.53	
sd:	1.94	0.51	

Figure 9. Salinity differences for WY 1993 minus WY 1991 for several stations in Puget Sound versus wateryear month. The * indicates station was not sampled during given month.

probably reflects the response from two subsequent years with less than average runoff (USGS, 1991; 1992) and is evidenced by the large number of positive salinity anomalies in Figure 4B.

These comparisons for the coastal estuaries are shown in Figures 10 and 11. The pattern of temperature differences in the two estuaries was very similar (Figure 10), yet for salinity, the two estuaries were rather dissimilar (Figure 11). In Willapa Bay, there were no major salinity differences between the three wateryears. Salinity differences in Gray's Harbor showed both negative and positive differences in March and August, respectively, that appear to be driven by features in the WY 1993 data. The temperature differences also show this pattern of a strong influence from the WY 1993 data (Figure 10). The patchiness of the sampling makes seasonal interpretation difficult, but no strong El Niño signal is evident. It is probable that the river signal dwarfed the oceanic signal at these stations.

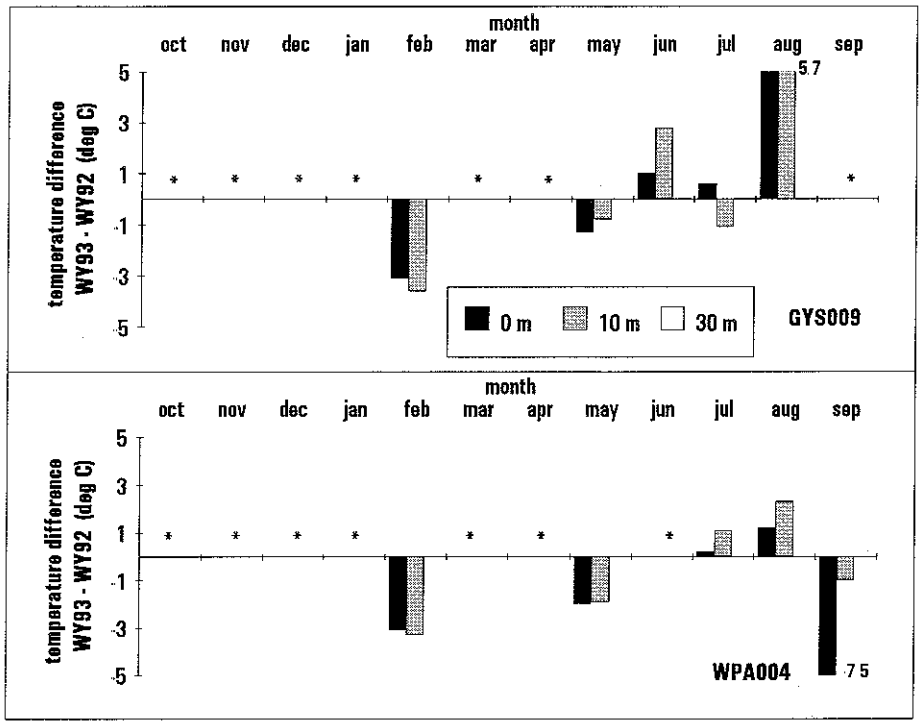
Density Stratification

Stratification refers to the horizontal layering of water masses within the water column due to density differences. Water density is affected by temperature and salinity, increasing with decreasing temperature or with increasing salinity. A change in density of 1 kg m^{-3} can be effected either by a 5°C change in temperature or 1 ppt change in salinity, or a combination of changes in both parameters (Pond and Pickard, 1983).

The vertical profiles of density in Appendix B are plotted in terms of "sigma-*t*", an oceanographic convention used to represent density. Millero and Poisson (1981) has most recently defined sigma-*t* as the density (kg m^{-3}) minus 1000 (kg m^{-3}). Therefore, a density of 1026.95 kg m^{-3} converts to a sigma-*t* of 26.95 (the units are typically left off). Temperature, salinity and pressure each contribute to water density. *In situ* temperature and salinity, and atmospheric pressure are used to derive sigma-*t*. Pressure affects the *in situ* temperature, raising it slightly; however this is not a factor in the shallow inland and coastal marine waters monitored here.

Density gradients within the water column indicate stratification and the layer where density increases rapidly with depth is known as the "pycnocline." Ambient air temperature, solar radiation, fresh water input from both precipitation and river flow, surface winds, internal waves, and tidal circulation are some of the factors that influence stratification in the water column. Any factor that mixes water masses (e.g., winds, tidal circulation) will decrease stratification, and factors that increase density differences (e.g., fresh water input to the surface, high solar radiation) produce or maintain stratification. A typical model of estuarine stratification is of two layers: relatively warm, fresh water overlying colder, more saline water with separation by a distinct pycnocline.

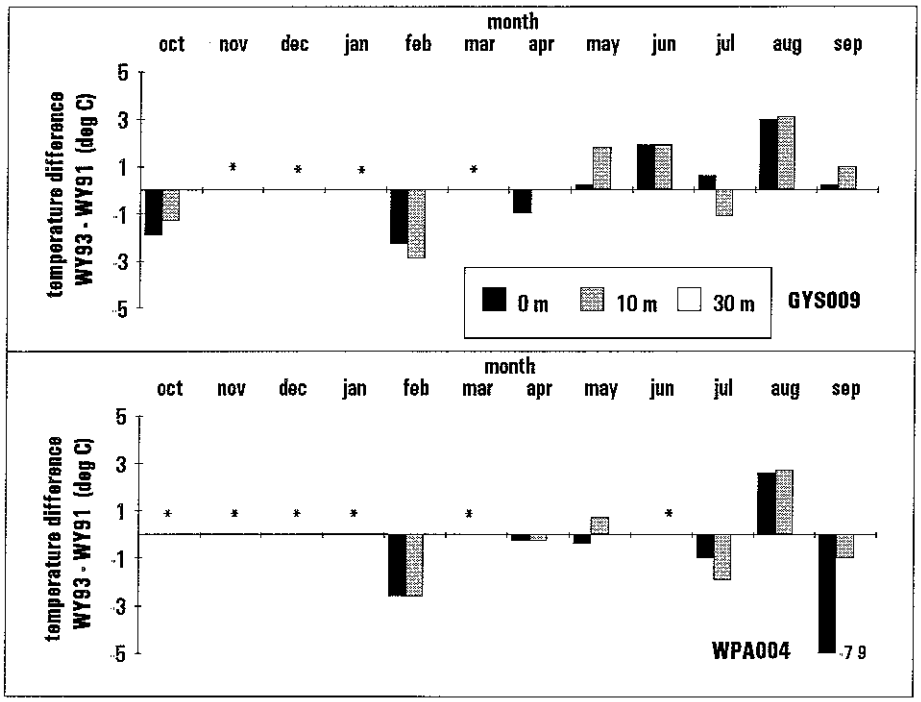
A



	0 m	10 m	30 m
mean:	0.44	0.60	
sd:	3.03	3.65	

	0 m	10 m	30 m
mean:	-2.24	-0.56	
sd:	3.40	2.26	

B

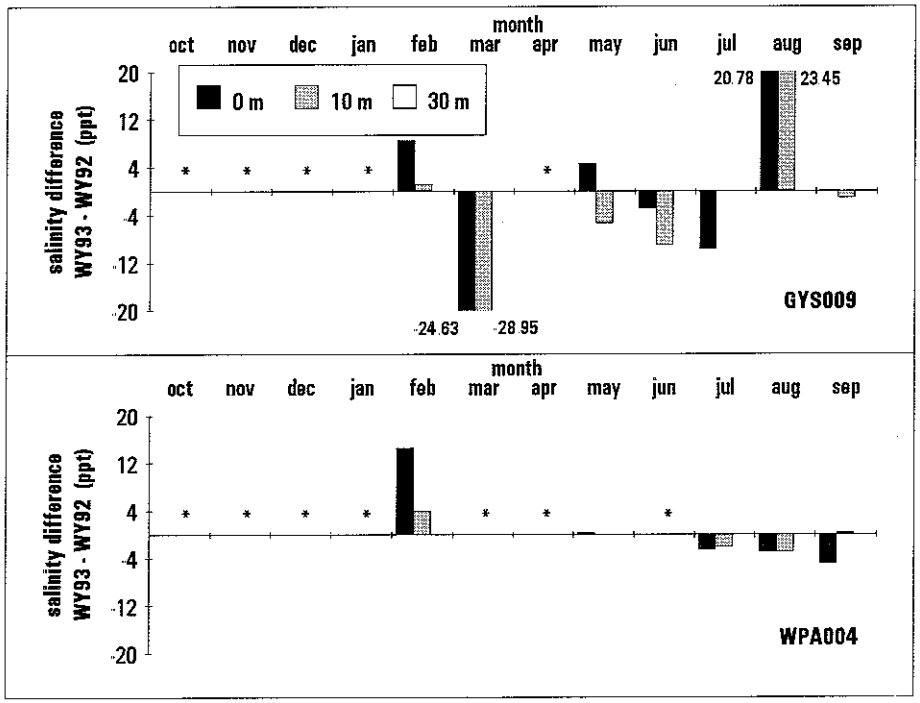


	0 m	10 m	30 m
mean:	0.09	0.31	
sd:	1.81	2.00	

	0 m	10 m	30 m
mean:	-1.60	-0.40	
sd:	3.52	1.91	

Figure 10. Temperature differences for (A) WY 1993 minus WY 1992 and (B) WY 1993 minus WY 1991 for one station in each of Willapa Bay and Grays Harbor versus wateryear month. The * indicates station was not sampled during given month.

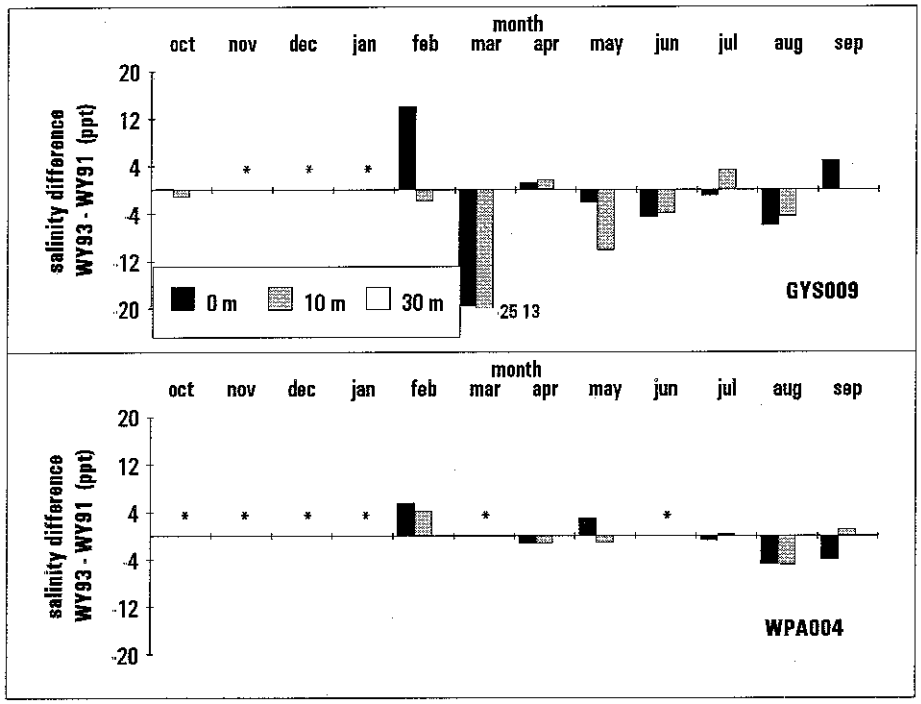
A



	0 m	10 m	30 m
mean:	-0.49	-2.87	
sd:	14.35	15.51	

	0 m	10 m	30 m
mean:	0.80	-0.18	
sd:	7.87	2.73	

B



	0 m	10 m	30 m
mean:	-1.49	-4.66	
sd:	9.05	8.61	

	0 m	10 m	30 m
mean:	-0.42	-0.27	
sd:	4.01	3.04	

Figure 11. Salinity differences for (A) WY 1993 minus WY 1992 and (B) WY 1993 minus WY 1991 for one station in each of Willapa Bay and Grays Harbor versus wateryear month. The * indicates station was not sampled during given month.

In the coastal estuaries and most areas of Puget Sound (e.g., ELB015, BLL009), differences in salinity are a stronger influence on density stratification than differences in temperature (Appendix B). The large variation in salinity is primarily due to the large amount of riverine input to these areas. Thus, salinity-driven stratification is typical of estuarine environments. Another general feature of the Puget Sound data is the lack of a classic "mixed layer" above the pycnocline. Instead, the pycnocline typically extends to the surface. Thus in this situation, the density change with depth is relatively constant from the water surface to the bottom of the pycnocline.

Most stations sampled in Puget Sound during WY 1993 exhibited distinct stratification, shown by a change in sigma-*t* (delta sigma-*t*) over the pycnocline of >2, although intensity and duration of the stratification varied over time (Appendix B.1). Much variation was evident, but general stratification patterns can be identified for the Puget Sound stations visited in WY 1993 (Table 3). Two stratification patterns were most common: "persistent" stratification over the wateryear, and "seasonal" stratification, usually occurring between April and September. This description is a general categorization; for example, seasonal influences can be seen in stations exhibiting persistent stratification, and the gradient (magnitude of delta sigma-*t*) as well as the depth of the pycnocline varied from station to station also. For instance, ADM002, which showed seasonal stratification had a very deep (40-50 m) pycnocline. "Episodic" or isolated stratification events that were weak (delta sigma-*t* ≤ 2) occurred at two stations. The fourth pattern, "weak" stratification, refers to areas where the water column was relatively well-mixed during all observations. The stratification patterns shown in Table 3 were derived from analysis of the WY 1993 data, but are also consistent for data collected during WY 1991 and WY 1992 (Janzen and Eisner, 1993a; b).

Table 3. Classification of Puget Sound stations according to stratification pattern observed.

Persistent	Seasonal	Episodic	Weak
BLL009	ADM001	HND001	DNA001
BUD005	ADM002	OAK004	LOP001
CMB003	CRR001		PTH005
ELB015	CSE001		TOT001
HCB004	EAS001		
HCB006	ELD001		
PSS019	GRG002		
SAR003	PSB003		
SIN001			

Both Grays Harbor and Willapa Bay have significant river inputs; the Chehalis River flows into the head of Grays Harbor and Willapa Bay receives both the Willapa River in the northern section and the Naselle River in the southern section. During WY 1993, the contribution of freshwater into Willapa Bay from these two rivers was 56% and 44% respectively (USGS, 1993). Both estuaries are partially enclosed water bodies resulting in some restriction of water exchange with the Pacific Ocean. Grays Harbor has a bar at the mouth of the harbor extending between two peninsulas that form the western shore of the embayment. Long Beach Peninsula forms a barrier between the Pacific Ocean and the southern waters of Willapa Bay.

Most of the coastal estuary stations sampled during WY 1993 exhibited stratification of highly variable intensity and duration (Appendix B.2). The coastal estuary stations showed a gradient in stratification intensity from the head to mouth of the estuary. This pattern in Grays Harbor and Willapa Bay is suggestive of circulation where a saline layer flows inland under an outflowing fresh water lens. Tidal mixing will break-down this stratification and result in a partially mixed estuary. Circulation and stratification will be dependent on river flow, tides, water depth, and mixing processes in these estuaries.

The gradient was highly variable with respect to month sampled, although not apparently linked to a seasonal pattern. This suggests that tidal stage may have been a strong determinant of the stratification encountered at a station. Variability in tidal stage at the time of sampling was not controlled for due to time constraints on the seaplane flights. Sampling with respect to tidal stage would be necessary to determine the presence of seasonal patterns and to further understand the dynamics of stratification in these areas.

River Stations GYS004 and WPA001 showed the most pronounced stratification (Appendix B.2), as might be expected. With further distance away from the river and its channels, the pycnocline was less-pronounced and shallower. Although data are not available for all months, two stations were consistently well mixed: WPA006 and WPA007, located in the southern portion of Willapa Bay. Tidal mixing at these two relatively shallow stations (10 m or less) is probably responsible for obscuring stratification. Vertical mixing from wind stress may also contribute.

Dissolved Oxygen and Light Transmission

Individual profiles of *in situ* dissolved oxygen concentration (mg/L) and light transmission (percent light transmission) with depth (m) obtained from the CTD casts for the Puget Sound stations monitored during WY 1993 are in Appendix C.1; those for Grays Harbor and Willapa Bay are in Appendix C.2. Profiles were obtained from the sea surface to the sea bed at most stations.

Dissolved Oxygen

The *in situ* dissolved oxygen (D.O.) data collected during March, April, May and June 1993 are coded "J" for "estimate" because the *in situ* D.O. sensor had a faulty manifold and a replacement part was not available until July. The D.O. readings from the faulty sensor varied as much as 0.8 mg/L in a stable water bath; it is unknown what the sensor's performance was in dynamic field conditions.

Depressed levels of D.O. available in the water column can have a serious impact on marine organisms. Effects of D.O. depletion are both organism- and habitat-specific (Harding *et al.*, 1992). The degree of impact is dependent upon the temporal and spatial stability of the depressed D.O. levels. The exact D.O. concentration where deleterious effects occur is species-specific and not well explored for local waters.

Anoxia, where no oxygen is available, is an environment habitable only by anaerobic organisms, primarily bacteria. Hypoxia, meaning low oxygen concentrations, is generally regarded as the level where stress to organisms can occur. Although hypoxia has been commonly defined in the literature as occurring at concentrations between 0.5-3.0 mg/L (e.g., Harding *et al.*, 1992; PSEP, 1988) or between 0.2-2.0 mg/L (e.g., Pihl *et al.*, 1992; Llansó, 1992), there is evidence that the behavior of some organisms (e.g., fish, larvae) can be negatively affected at D.O. concentrations as high as 4-4.5 mg/L (Whitmore, *et al.*, 1960; Kramer, 1987; Breitburg *et al.*, 1994). It also should be considered that D.O. concentrations in the water column may not reflect hypoxic or anoxic conditions experienced by benthic organisms. Jørgensen (1980) found that significant D.O. gradients can exist between 0.5 to 0.05 m above the sediment in a fjord.

In this report, D.O. concentrations between 0.5-3.0 mg/L are referred to as hypoxic. All observations of water column D.O. concentrations < 5 mg/L are reported in this section. The value of 5 mg/L is used as a guideline to indicate where low D.O. problems may occur, and was chosen based on literature review of the upper limit of effects. Depressed levels of D.O. were seen at several Puget Sound stations during WY 1993 (Table 4). Six stations exhibited D.O. concentrations < 5 mg/L; four were located in northern Puget Sound and two in Hood Canal. At two of these stations, EAS001 and HCB004, D.O. concentrations < 3 mg/L were evident during one month. The Washington State marine water quality standards for D.O. vary according to the classification of the waterbody (WAC 173-201, 1991), which is governed by the intended maximum beneficial use of those waters. The state's minimum numeric standards (Table 4) for these six stations are higher than the minimum values observed. Similar results were found in WY 1991 and 1992 (Janzen and Eisner, 1993a; b) for these six stations, as shown in Table 4. All six stations were monitored in each of the three wateryears. The WY 1991 and 1992 reports (Janzen and Eisner, 1993a; b) cite three additional stations with D.O. concentrations

< 5 mg/L: HCB007 (WY 1991-2); HCB003 and PAH008 (WY 1991, no WY 1992 data); however, these stations were not monitored in WY 1993. Dissolved oxygen concentrations < 5 mg/L were not observed at any of the stations in the coastal estuaries during WY 1993.

Table 4. Stations with low D.O. concentrations during WY 1993. A * indicates the same observation for WY 1991; the # indicates the same observation for WY 1992.

Station class	State waterbody class and its minimum D.O. conc. standard	D.O. below 5 mg/L	D.O. below 3 mg/L	D.O. below state minimum standard
ADM002	AA, 7 mg/L	X*#		X*
EAS001	AA, 7 mg/L	X*#	X#	X#
PSS019	A, 6 mg/L	X*#		X*#
SAR003	A, 6 mg/L	X*#		X*#
HCB004	AA, 7 mg/L	X*#	X*#	X*#
HCB006	AA, 7 mg/L	X*#		X#

The state standards are intended to reflect minimum D.O. concentrations for naturally occurring marine waters. Concentrations below these standards are assumed to be resulting from anthropogenic influence. However, data to rigorously establish the pre-anthropogenic D.O. concentrations for local marine waters are not available. Naturally occurring conditions can cause D.O. concentrations to be low. Biological activity (e.g., primary production, respiration, oxidative reactions), input of low-oxygenated fresh or oceanic water, and stratification, as well as circulation patterns and mixing regimes affect ambient levels of D.O. and its distribution both vertically and horizontally. Thus, a site-specific condition, such as sluggish circulation or proximity to oceanic deep water, may cause one station to have lower D.O. concentrations than another station of the same waterbody classification for reasons that are not due to anthropogenic impact. Alternatively, the same anthropogenic impact, such as a certain amount of nutrient input, may have a much more profound impact on the D.O. concentration of one station than that of another within the same waterbody classification. Thus, each case must be evaluated with respect to the natural characteristics of the location.

Low D.O. concentrations were largely constrained to near-bottom depths. Typical causes for this pattern are a source of low-oxygenated deep oceanic water or high biological productivity with subsequent decomposition of the sunken organic material. In addition, stratification will intensify the condition. A well-mixed water column

would have oxygenated surface waters mixed down whereas stratification represents a barrier to this mixing. Each of the six stations where D.O. concentrations fell below 5 mg/L experienced persistent or seasonal stratification (Table 3). A further explanation of the implications of stratification is included in the Discussion. Other factors that may have contributed to low D.O. concentrations at these stations are poor circulation, sediment oxygen demand, and chemical oxidation processes. In the following section, the severity and persistence of the low D.O. concentrations for these six stations (see Appendix C), as well as their physical characteristics (see Appendix B) and potential causes are identified.

North Puget Sound

Station ADM002 is a moderately deep-water (around 70 m) station located in the Strait of Juan de Fuca off the Quimper Peninsula. Seasonal stratification was evident from May through September but was not strongly developed, with delta sigma-*t* around 2. The pycnocline was much deeper than most of the other stations sampled, not starting until 40 m or more, and it was relatively compressed. Concentrations of D.O. below 5 mg/L were observed in July and September, but were limited to the depths below 40 m, which coincided with the pycnocline and a subsurface current (pers. obs., SAB). Dissolved oxygen concentrations were just below 5 mg/L, at approximately 4.9 mg/L. The low D.O. concentrations at this station are likely a result of low-oxygenated oceanic waters flowing east through the Strait of Juan de Fuca and into Puget Sound beneath a less-saline surface layer. Deep oceanic waters typically are not well-oxygenated; deep waters off the Washington shelf at Copalis show D.O. concentrations as low as 3 mg/L (Landry *et al.*, 1989). The deep waters flowing in through the Strait of Juan de Fuca would have low D.O. concentrations. This deep water will shoal when passing over the sill at Admiralty Inlet. Thus, low D.O. concentrations at this station can be explained by non-anthropogenic processes.

ADM002:

WY 1993 month	Minimum D.O. conc. (mg/L) and depth (m)	Depth range (m) of D.O. conc. <5 mg/L	Cast Depth (m)
Jul 93	4.9, 49.5	49.5 only	49.5
Sep 93	4.9, 52.5	51.0 - 53.0	53.0

Station EAS001, located in Orcas Island's East Sound in roughly 30-35 m deep water, was seasonally stratified. A weak pycnocline (delta sigma-$t \leq 2$) developed over the months of May through September, from the surface to typically 10 m or less. Low D.O. concentrations were observed only in June when ambient levels fell below 5 mg/L for depths greater than 25.5 m and were hypoxic at the bottom depth. Factors responsible for this event may include decomposition of organic matter from a spring phytoplankton bloom; however, no data are available to evaluate this. Further investigation would be required to evaluate this condition. Dissolved oxygen

concentrations were not observed below 5 mg/L in WY 1991, but showed minima of 1.7 and 4.9 in July and August 1992, respectively.

EAS001:

WY 1993 month	Minimum D.O. conc. (mg/L) and depth (m)	Depth range (m) of D.O. conc. <5 mg/L	Cast Depth (m)
Jun 93	2.7, 29.0	25.5 - 29.0	29.0

Station PSS019, located off Gedney Island in the deep waters (~105 m) of Possession Sound, was persistently stratified throughout the wateryear. A strong pycnocline (delta sigma-*t* ranged 3 to 10) was common in the upper 10 - 15 m, the result of a major river source nearby (Snohomish River). Ambient D.O. concentrations below 5 mg/L were observed in November, July, and September. In November, the water column below 22 m fluctuated above and below the 5 mg/L concentration. The strong and persistent stratification observed reduces this area's ability for mixing, and therefore increase the potential for a buildup of low D.O. conditions. The high chl *a* concentrations observed in March and April (Appendix A.1) may or may not reflect anthropogenic input of nutrients. Decomposition of this large biomass will decrease D.O. concentrations. Organic material and nutrient input from the river and other sources should be evaluated in order to ascertain the cause of this condition. Activity in Everett Harbor may also be indicated. These WY 1993 results indicate more frequent D.O. depression than in either WY 1991 or 1992, where only one occurrence of D.O. concentrations <5 mg/L were found (5.0 in October 1990 and 4.4 in September 1991). However, CTD casts prior to June 1992 were only conducted to 30 m maximum depth. Therefore, comparison is not valid.

PSS019:

WY 1993 month	Minimum D.O. conc. (mg/L) and depth (m)	Depth range (m) of D.O. conc. <5 mg/L	Cast Depth (m)
Nov 92	4.4, 34.0	22.5 - 25.0 30.0 - 38.5 41.5 - 66.0	98.0
Jul 93	4.8, 101.5	97.5 - 102.0	102.0
Sep 93	4.7, 80.5	76.0 - 101.0	103.5

Station SAR003, a deep-water (~122 m, only ~100 m sampled) station located in Saratoga Passage, was persistently stratified (delta sigma-*t* ranged 3 to 10)) with the pycnocline typically comprising the upper 10 - 20 m. This station is influenced by several rivers. Depressed D.O. concentrations were observed only in September, when the lower 46 m of the water column had D.O. concentrations below 5 mg/L. Although this layer was substantial in thickness, the concentrations were not

drastically lower than 5 mg/L. The D.O. minimum concentration and timing is similar to those observed in WY 1991 and 1992 (4.4 in October 1990 and 5.0 in both October 1991 and September 1992), although data prior to June 1992 is from 30 m or less only. Low D.O. concentration observations consistently occur in the fall, and sometimes coincide with high chl *a* concentrations. Thus, the D.O. depression may reflect a response to fall blooms. Whether phytoplankton blooms were unnaturally high should be evaluated, as well as whether advection of low D.O. waters from PSS019 northward occurs. Waters with D.O. below 5 mg/L were occasionally seen to develop in Possession Sound or in Skagit Bay in the 1950-1960's database of Collias *et al.* (1974) during fall, but were not seen in Saratoga Passage.

SAR003:

WY 1993 month	Minimum D.O. conc. (mg/L) and depth (m)	Depth range (m) of D.O. conc. <5 mg/L	Cast Depth (m)
Sep 93	4.9, 70.0	35.0 only 40.0 - 41.0 42.0 - 88.0	88.0

Hood Canal

Station HCB006, a deep (~100 m) station located in Hood Canal near Bangor, was persistently stratified with a typically weak pycnocline (delta sigma-*t* $\leq$2) in the upper 15 m, that became stronger seasonally (delta sigma-*t* >3 in May-Aug.). Concentrations of D.O. below 5 mg/L were observed in the upper third of the water column in October. This station is the farthest seaward of the stations monitored in the long, narrow Hood Canal. Seasonally occurring low D.O. conditions were recorded in Hood Canal in the 1950's, and appear to originate at the head of the Canal, at Lynch Cove, and spread seaward along the canal (Collias *et al.*, 1974; Curl and Paulson, 1991) along a density surface. The extent of the spread of low D.O. concentrations may be increasing since the 1950's when it rarely was observed past Hoodsport (Collias *et al.*, 1974). This observation of low D.O. concentrations and a similar one in October of WY 1992 (data for top 30 m only prior to June 1992) are consistent with this hypothesis, though interannual variation can be expected to be large for D.O. concentrations, since so many factors are involved. The severity and extent of low D.O. concentrations in Hood Canal cannot be determined without further investigation.

HCB006:

WY 1993 month	Minimum D.O. conc. (mg/L) and depth (m)	Depth range (m) of D.O. conc. <5 mg/L	Cast Depth (m)
Oct 92	4.4, 22.0	12.0 - 28.5	78.5

Station HCB004 is located east of the Great Bend of Hood Canal, just inside the sill located at Sister's Point, in approximately 50 m water depth. This station is persistently stratified, with a strong pycnocline (delta sigma-*t* ranged 4 to 7) typically located in the upper 15 m. Concentrations of D.O. were observed below 5 mg/L in 7 out of 10 months sampled during WY 93. Severely hypoxic conditions were recorded in October, when D.O. concentrations were below 3 mg/L from 6.0 m to the bottom, and below 1 mg/L from 11 to 38 m. These observations are consistent with recent data; D.O. concentrations below 5 mg/L were recorded in 10 out of 10 months sampled in WY 1991, and in 9 out of 12 months for WY 1992. Hypoxic conditions (< 3 mg/L) were recorded in June through October of 1991, 1992 and 1993. (Data for top 30 m only prior to June 1992.) A thorough comparison of the historical data from the 1950's and 60's (Collias *et al.*, 1974) with these recent data should be made in order to evaluate whether a historical trend is evident.

Southern Hood Canal has a naturally high primary production of organic material, due to the water-column stability and nutrient supply afforded by the riverine input and the lack of disruptive mixing due to the sill's protection. The highest chl *a* concentrations recorded in WY 1993 (38 and 54 μg/L) were at this station. Decomposition of this large amount of organic matter, strong and persistent stratification, and sluggish circulation due to the sill, are the optimal conditions for a natural build-up of low D.O. concentrations. However, the influence of anthropogenic input of nutrients (*e.g.*, via rivers, leaking septic tanks, terrestrial runoff) on the phytoplankton production cycle are not established for this area. Over the period of WY 1991 to 1993, extremely high chl *a* concentrations (>30 μg/L) have been observed in the months of November, May, June, July, and August; this is not consistent with the typical pattern of temperate estuarine spring and fall blooms, such as for nearby Dabob Bay (Downs and Lorenzen, 1985). Nutrient limitation of the entire phytoplankton population's growth during summer is not evidenced by these high of chl *a* concentrations in June through August. The depth and physical characteristics of the Dabob Bay station and HCB004 differ; however, anthropogenic input of nutrients could possibly influence the amount of phytoplankton at HCB004. Further study is required to assess the sources responsible for the severity of the low D.O. concentrations here.

HCB004:

WY 1993 month	Minimum D.O. conc. (mg/L) and depth (m)	Depth range (m) of D.O. conc. <5 mg/L	Cast Depth (m)
Oct 92	0.3, 18.5	3.5 - 51.0	51.0
Nov 92	3.1, 5.0	2.5 - 49.0	49.0
Feb 93	4.2, 38.5	28.5 - 51.5	51.5
Jun 93	4.4, 37.0	27.0 - 50.0	50.0
Jul 93	4.3, 28.5	25.5 - 50.0	50.5
Aug 93	3.6, 27.0	8.5 - 50.5	50.5
Sep 93	3.0, 16.0	5.5 - 16.0	16.0

Light Transmission

The profiles in Appendix C show % light transmission (transmissivity) with depth (m), as measured with an *in situ* transmissometer on the CTD. The light transmissometer measures the instantaneous light transmission over a 25-cm path of the ambient water column. The % light transmission decreases in response to increases in turbidity, since particles absorb and deflect light. Suspended sediments and algal blooms are the most common causes of increased turbidity, and are not differentiated by this measurement. The % light transmission at a certain depth indicates the particulate load suspended in that water.

In areas known to have strong bottom currents, low % light transmission values near the bottom are caused by particles suspended from the sea bed. A severe decrease in the % light transmission at the bottom of a profile is an artefact, caused by contact of the CTD with the bottom sediments (*e.g.*, ELB015 in December).

Within the water column, low % light transmission values are harder to interpret, since both phytoplankton blooms and sediment plumes (*e.g.*, associated with river runoff) cause a decrease in light transmission. Profiles of % light transmission can be used as another indicator of stratification, since robust mixing will homogeneously distribute particles. Well-mixed stations, such as DNA001, exhibit few variations of this parameter with depth. Thin layers of reduced light transmission at the surface can indicate particle load from river water, and this conclusion can be confirmed by observation of the companion salinity profile, *e.g.*, GRG002 in May, PSS019 in November, January and March. The dramatic reduction in light transmission in typical river water is shown by river stations GYS004 and WPA001, where light transmission is rarely greater than 20%. Low light transmission also indicates high concentrations of phytoplankton, *i.e.*, blooms. The high phytoplankton concentration at HCB004 during May indicated by the 10 m chl *a* concentration shows up as a distinct minimum in light transmission (30%).

Light transmissometer data are best interpreted in concert with other measured parameters, to confirm observations regarding stratification, river input, bottom currents and phytoplankton concentrations.

Secchi Disk Depths

Light Extinction and the Euphotic Zone Depth

Secchi disk readings (depth of the disk's disappearance) provide an indication of the penetration of incident radiation (sunlight striking the sea surface) into the water column. The readings are used to calculate an estimate of the euphotic zone depth, the portion of the water column where there is sufficient light for photosynthesis. Therefore, a shallow euphotic zone means less of the water column is available for

growing phytoplankton. By convention, the depth of the euphotic zone is defined (e.g., Steemann Nielsen, 1975) as the depth at which 1% of the incident radiation (I_o) is available. Some investigators have used the 0.1% light level as the lower limit; however, in temperate regions, where incident radiation is not strong, the 1% light level is an appropriate delimiter.

Individual Secchi readings, recorded to the nearest 0.1 m, are listed in Appendix A for all stations monitored in WY 1993. These readings were used to calculate estimates of k, the extinction coefficient of light, and of the euphotic zone depth. The extinction coefficient, k, was first determined from the equation:

$$k = 1.6 \,/\, \text{Secchi disk reading (m)} \qquad (1)$$

Equation (1) was originally derived by Poole and Atkins (1929) for the English Channel with a value of 1.7, instead of 1.6. The value of 1.6 used here follows empirical observations for local Puget Sound waters, and the suggestion of Holmes (1970) that this constant is lower in coastal water.

The euphotic zone depth, or 1% I_o depth, is derived using the formula for light extinction in water:

$$I_z/I_o = e^{-kz} \qquad (2),$$

substituting 0.01 (*i.e.*, 1%) for I_z/I_o, and solving for z, the depth (m) at which 1% of I_o is found.

Plots of 1% I_o depths versus month for each station visited during WY 1993 are found in the top panel of Appendix D.1 for Puget Sound and of D.2 for the coastal estuaries. Deep euphotic zones indicate the absence of particles. Shallower euphotic zones reflect suspended particulates, but this can be caused either from sedimentary load or large phytoplankton concentrations. Shown in the second panel of Appendix D are plots of chlorophyll *a* concentrations (chl *a*, μg/L) versus month. Comparisons of the euphotic zone depths with the chl *a* data and salinity profiles (Appendix B) are necessary to aid in the interpretation of shallow euphotic zones. Regardless of their cause, shallow euphotic zones restrict the distribution of phytoplankton production, since adequate light for photosynthesis is available only in the euphotic zone.

Many of the coastal stations are located in rivers or in shallow embayments heavily influenced by riverine inputs with high particle loads. Euphotic zone depths were generally very shallow at the coastal stations.

From late fall through early spring, some of the Puget Sound stations (e.g., BLL009, OAK004, PSS019) experienced a decrease in 1% I_o depth. During these months, shallow euphotic zone depths may be caused by large quantities of suspended

sediment associated with increased river runoff. Many Puget Sound stations (e.g., ADM001, BUD005, PSB003) exhibit shallow euphotic zone depths during the period of time from late spring to early fall. Algal blooms are often observed during this time, and may be the cause of shallow euphotic zones. Many stations exhibit increased chl *a* concentrations corresponding to periods of shallow euphotic zone depths (Appendix D).

Light Extinction Coefficient Versus Surface Chlorophyll *a* Concentration

To identify the source of light extinction for a particular station, regressions of k versus surface (0.5 m) chl *a* concentration were made. The regression results are shown in the bottom panels of Appendix D. If light extinction was only due to phytoplankton and not suspended sedimentary particles, then the regression slope would be positive and the fit (r^2) would be tight (approaching 1.000). An outlier above the regression line (a higher value of k than the regression) would indicate non-chlorophyll containing particles which extinguish light. Lack of a positive slope implies surface chl *a* concentration is not a determinant of the light extinction coefficient.

A shortcoming of this approach is that the surface chl *a* concentration was used, when in fact the integrated value for the whole water-column should be used, since chl *a* may not be homogeneously distributed. If surface chl *a* concentrations are low (e.g., due to nutrient limitation in the surface layer), yet a substantial concentration exists subsurface, then the wrong conclusion could be made for the cause of light extinction. Continuous profiles of chl *a* are not presently measured, therefore integrated values could not be determined. Chlorophyll *a* concentrations at 10 m could be checked for indication of a subsurface population; however without better vertical resolution, light extinction by a subsurface population at a depth other than 10 m can not be ruled out as the cause of outliers.

In spite of this crude treatment, some patterns are found that are informative. A generally positive slope with a good fit indicate that phytoplankton biomass was a strong determinant of the light extinction coefficient. This was observed in BUD005, PTH005 and SIN001. Outliers of high light extinction were evident in May at BUD005 and in September at PTH005. The salinity profiles confirm that both of these stations had their strongest surface fresh water signals in these months. Therefore, the outliers can be interpreted as particulate material from riverine input that caused the stronger light extinction. Outliers of particularly high light extinction were seen most frequently in the high runoff months of November, December, January, March and April (Figure 3B), e.g., see PSS019, SAR003, BLL009.

Generally flat slopes can be observed for two reasons. One cause is that chl *a* concentrations were always low, so that there is no spread in the data (note that axes on the graphs in Appendix D vary), such as was found at ADM002, GRG002, and

TOT001. A second cause is that non-chlorophyll containing particulates (sediments) often determine the light extinction, particularly when chl *a* is low, thus resulting in a consistently high value of k. This is apparent at BLL009 and OAK004, where the minimum k is higher (~0.5) than at other stations (~0.2).

In the coastal estuaries at stations where chl *a* data were collected (GYS008, GYS016, WPA004 and WPA006) the slopes are relatively flat and k is consistently high. Outliers of high light extinction were observed in May at all four stations. Not surprisingly, this demonstrates the profound influence of river water in these estuaries.

Pigments

Chlorophyll *a* and Phaeopigment

The pigment chlorophyll *a* (chl *a*) is common to all organisms capable of photosynthesis. Phaeopigment (phaeo) refers to numerous degradation products of chl *a*, including phaeophorbides and phaeophytins. In marine systems, these degradation pigments are primarily the product of zooplankton herbivory. Chlorophyll *a* can be used as an indicator of phytoplankton biomass, although since the cellular quota of chl *a* varies widely, it can not be converted to cell number or carbon biomass. Phaeo concentrations can indicate how much of the chl *a* has been degraded, either through herbivory or cellular processes.

Phytoplankton blooms (an accumulated high concentration of phytoplankton) require specific conditions conducive to growth in order to occur. Low incident radiation, lack of stratification, high levels of turbidity (light limitation), nutrient limitation, and zooplankton grazing all negatively influence phytoplankton biomass increase and thus can lead to low chl *a* concentrations. It must be recognized that chl *a* concentrations are not a proxy for phytoplankton growth. Any concentration is the net balance of growth and loss processes. Thus, the same concentration could exist with high phytoplankton growth but high loss through grazing or mixing out, as could exist with low growth and low losses. Blooms occur when high growth is sustained in the absence of substantial loss processes (e.g., before grazing zooplankton are numerous, before nutrients or light limit phytoplankton growth, before mixing washes cells out of the euphotic zone).

Results of the MEL fluorometric analyses of extracted chl *a* and phaeo concentrations (μg/L) are tabulated in Appendix A. Appendix A lists "pheophytin" concentrations; however, the fluorometric method does not distinguish phaeophorbide from phaeophytin, and since phaeophorbide is more common in marine waters (Vernet and Lorenzen, 1987), the collective term "phaeopigment" should be used. Plots of the 0.5-m and 10-m chl *a* concentrations (μg/L) versus WY 1993 month sampled are in the second panel of Appendix D. Because of the filter storage procedure (see Methods), chl *a* values may be low by up to 22%.

The plots of chl *a* concentration with time show seasonal patterns (Appendix D) which reflect the balance of growth and loss processes at each station. In general, chl *a* concentrations were higher from late spring through early fall than in winter, e.g., BLL009. In winter, light limitation and strong mixing (from winds or lack of thermal heating) prevent phytoplankton accumulation. High chl *a* concentrations, indicating blooms, tend to occur in spring (April- May) and fall (September-October). Often the summertime chl *a* concentrations are of an intermediate to low value, possibly reflecting nutrient limitation due to stratification. Several stations demonstrate this typical temperate seasonal pattern, e.g., BLL009, CRR001, and SAR003.

Some stations showed elevated chl *a* concentrations and even blooms in summertime, and therefore indicate that nutrients were not limiting. This can be due either to a lack of continuous stratification, such that nutrients are injected into the euphotic zone from depth following mixing events, or an additional supply of nutrients (runoff, septic tanks, agricultural wastes) to the euphotic zone. This pattern was observed in BUD005, CMB003, CSE001, HCB004, OAK004, PSB003, PTH005. In Puget Sound, strong tidal exchange can mix waters, making nutrients available to the euphotic zone. Nutrient and density data should be consulted for interpretations for these stations.

Stations with deep mixed layers (GRG002, ADM002, and DNA001) showed chl *a* concentrations that were low throughout the growing season, reflecting a phytoplankton population with higher loss (mixed out of euphotic zone) than growth.

The chl *a* data for the coastal estuaries in WY 1993 have large gaps that make seasonal pattern interpretations impossible.

Nutrients

Dissolved inorganic nutrients, primarily forms of nitrogen and phosphorus, are an important component of marine ecosystems since nutrients are required for the growth of phytoplankton, the first trophic level of the marine environment. In seawater, several forms of dissolved nutrients exist. Dissolved organic forms (e.g., amino acids, urea) will not be addressed here, although the role of these forms in phytoplankton nutrition is gaining attention (Antia *et al.*, 1991; Paul, 1983). For nitrogen, common inorganic forms in seawater include ammonium (NH_4^+), nitrite (NO_2^-), and nitrate (NO_3^-). The pH range of seawater drives the hydrolyzation reaction of ammonia such that less than 2% of the ammonia-based nitrogen is in the unionized form, NH_3, in seawater (Grasshoff *et al.*, 1983). Therefore, "ammonium-N" is adopted here as the name for ammonia-based nitrogen. Since dissolved ammonia is toxic to fish and other organisms, this distinction is important. Chemical analysis of nitrate-N requires a step to separate nitrate-N from nitrite-N. Since nitrite-N concentrations are usually quite low, this step is often eliminated and both nutrients are typically recorded together as "nitrate+nitrite-N", with the assumption

that nitrite-N is insignificant. However, at times nitrite-N concentrations can be above the reporting limit. Recent Ecology data (Janzen and Eisner, 1993a, b) has directed the analysis of this nutrient to three urban bays only. Phosphorus also exists in organic and inorganic forms, although the primary form in seawater is orthophosphate. Orthophosphate-P is the form that is most easily taken up by phytoplankton.

During WY 1993, 21 of the 23 Puget Sound stations and 6 of the 10 coastal estuary stations were sampled for the dissolved nutrients ammonium-N, nitrate+nitrite-N, and orthophosphate-P. Nitrite-N was sampled at 3 Puget Sound stations, BLL009, BUD005, and CMB003. The results of the nutrient analyses conducted by MEL are tabulated in Appendix A. Plots of the 0.5-m and 10-m nitrate+nitrite-N concentration (mg/L) versus WY 1993 month are in the third panel of Appendix D.

Nutrient "Depletion"

Dissolved inorganic nitrogen is generally considered to be the limiting nutrient in marine systems (e.g., Valiela, 1984). While low ambient nitrogen concentration is sometimes associated with low phytoplankton biomass, the rates of nitrogen uptake by phytoplankton and resupply to phytoplankton, as well as the concentration of nitrogen must be known in order to determine actual nutrient limitation of growth. The nutrient concentration may be undetectable, yet its supply and uptake rates may be linked such that the supply rate is adequate for unlimited growth and the uptake rate is equivalent so no accumulation occurs. Experiments designed to determine nitrogen uptake and recycling rates, combined with greater temporal and spatial sampling frequency would be necessary to determine whether any of the Puget Sound or coastal stations are nutrient-limited during any part of the year. Threshold concentrations for nutrient limitation of phytoplankton growth vary with species, light and temperature conditions (Parsons *et al.*, 1984). Since the species composition in these local waters is highly diverse, this would be an enormous task.

In previous WY reports (Janzen, 1992b; Janzen and Eisner, 1993a; b), nitrate+nitrite-N "depletion" was defined as concentrations below 0.04 mg/L. This concentration cut-off was based on a model derived in a study conducted by URS (1986) in Budd Inlet, and was applied to stations throughout Puget Sound. However, data exist showing significant uptake for coastal species at this concentration (Kokkinakis and Wheeler, 1987; Raymont, 1980; Parsons and Harrison, 1983). There are two distinctions that need addressing: 1) a concentration of 0.04 mg/L nitrate-nitrite-N is not deplete and is unlikely to cause limitation of phytoplankton growth; and 2) nutrient limitation even when nutrients concentrations are below reporting limits can not be assumed since some phytoplankton have such high affinities for dissolved nutrients that uptake occurs at analytically undetectable concentrations (Hecky and Kilham, 1988).

A thorough discussion of nutrient limitation in Puget Sound is found in PSEP (1991), which concludes that the main channels of Puget Sound have not been demonstrated to show nutrient limitation from the few nutrient-addition bioassay studies that have been conducted. Some areas of Puget Sound with restricted water flow show nutrient levels below reporting limit at times; proof that phytoplankton growth is actually limited has not been demonstrated, nor has it been thoroughly studied. Vertically migrating dinoflagellates that can span the nitricline may account for the high chl *a* concentrations seen during times of undetectable nutrients.

Although the range for different species is quite wide, a common cut-off for where nitrate concentrations may be limiting is 0.014 mg/L (1.0 μmol/L) (see Goldman and Glibert, 1983), which is at the MEL reporting limit (0.01 mg/L). Using the range of minimum nitrogen to phosphorus (N:P) molar ratios necessary for algal growth in coastal waters, (determined to be between 5:1 and 15:1 by Ryther and Dunstan (1971) and McCarthy (1980)), the similar cut-off concentration for orthophosphate can be calculated to be from 0.0028 to 0.0009 mg/L. These concentrations fall well below the MEL reporting limit of 0.01 mg/L.

In conclusion, it is inappropriate to discuss either nutrient limitation or nutrient depletion, since these may or may not occur at the concentrations of analytical reporting limit. In fact, there is more suggestion that the latter case is true (PSEP, 1991). For the purpose of this report, nutrient concentrations at or below the reporting limit of MEL are referred to as "undetectable" nutrients. The analytical reporting limit of MEL is 0.01 mg/L for nitrate+nitrite-N, nitrite-N, ammonium-N, and orthophosphate-P. As previously stated, stations with undetectable nutrient concentrations are not necessarily nutrient limited, since nutrient uptake and resupply rates may be sufficient for phytoplankton growth, while low nutrient concentrations are maintained.

Nitrite-N (NO_2^--N)

Historically, a very large percentage of samples from Puget Sound analyzed for nitrite-N have shown concentrations below the reporting limit of 0.01 mg/L (Janzen and Eisner, 1993a; b). In order to adequately assess nitrite-N concentrations, a detection level of 0.005 mg/L must be achieved (PSWQA, 1988). Ecology proposed discontinuing nitrite sample collection at all but a few urban bays, until lower reporting limits were available. The PSAMP steering committee approved the proposal in June 1992.

During WY 1993, Ecology sampled three urban embayments for dissolved nitrite-N. Stations BLL009, BUD005, and CMB003 were chosen because historical data showed some concentrations above the reporting limit of 0.01 mg/L. In 66 of 77 (85.7%) samples analyzed in WY 1993, dissolved nitrite-N concentrations were below the reporting limit. The few times nitrite-N was detected, the values were only slightly above 0.01 mg/L.

Ammonium-N (NH_4^+-N)

Ammonium-N concentrations in Puget Sound and the coastal estuaries were generally lower than nitrate+nitrite-N concentrations. This observation has been consistent in the Ecology data (Janzen, 1992b; Janzen and Eisner, 1993a; b). Ammonium-N is the regenerated form of N and is excreted by zooplankton (Dugdale and Goering, 1967; Valiela, 1984). Most phytoplankton assimilate ammonium-N much more rapidly than other sources of nitrogen since it is the reduced form (Parsons *et al.*, 1984), and so it is rarely observed in substantial quantities in seawater.

Stations with high ammonium-N concentrations could indicate the presence of an ammonia source (e.g., combined sewer overflow). Station BUD005 exhibited the most consistently high concentrations of ammonium-N, with frequent values over 0.10 mg/L and average annual (WY 1993) concentrations of 0.04 and 0.06 mg/L at 0.5 m and 10 m respectively. Likely contributors to these elevated ammonium-N levels are runoff from the Deschutes river, and the LOTT wastewater treatment plant which discharges effluent into Budd Inlet. Stations with ammonium-N concentrations over 0.05 mg/L recorded two or more times during WY 1993 were: BLL009, BUD005, CRR001, CSE001, DNA001, ELD001, GYS004, HND001, OAK004, SIN001, and TOT001. Station BUD005 was the only station with values over 0.10 mg/L.

Nitrate+Nitrite-N ($NO_3^-+NO_2^-$-N)

Of the 682 samples collected for nitrate+nitrite-N analysis, 13% had concentrations below the reporting limit of 0.01 mg/L. The locations of these samples are in Table 5. Temporal and spatial characteristics of these samples show that nitrate+nitrite-N concentrations were undetectable most commonly during the summer months of May through September and at the 0.5 m depth. Undetectable nitrate+nitrite-N concentrations at both 0.5 and 10 m depths were found only in the southern portion of Puget Sound (OAK004, TOT001, BUD005, CSE001, and ELD001) and in both coastal estuaries. Curiously, 7 of the 88 samples with undetectable nitrate+nitrite-N concentrations, had detectable levels of both ammonium-N and orthophosphate-P; the locations for these samples were evenly distributed geographically (Table 5). More typically, in 81 of the 88 samples, ammonium-N was also undetectable, and in 23 of these, both ammonium-N and orthophosphate-P were undetectable.

Detectable nitrate+nitrite-N concentrations were generally observed at all stations from October through March. While removal of nitrate+nitrite-N from the surface waters is from phytoplankton uptake, processes which promote detectable nitrate+nitrite-N concentrations in surface waters are increased river runoff, low phytoplankton concentrations, and reduced water column stratification which allows for greater mixing between nutrient-rich deep waters and surface waters.

Table 5. Stations with undetectable (<0.01 mg/L) nitrate+nitrite-N concentrations during WY 1993.

Station	Month	Sample depth (m)	Station	Month	Sample depth (m)
North Puget Sound					
BLL009	Apr-93	0.5*	SAR003	Mar-93	0.5
	Jun-93	0.5**		Apr-93	0.5*
	Aug-93	0.5*		May-93	0.5**
				Jun-93	0.5**
PSS019	Apr-93	0.5**		Jul-93	0.5
	Jun-93	0.5**		Aug-93	0.5*
	Jul-93	0.5*		Sep-93	0.5*
PTH005	May-93	0.5*			
	Sep-93	0.5**			
Central Puget Sound					
CMB003	May-93	0.5*	PSB003	May-93	0.5**
	Jun-93	0.5*		Jun-93	0.5**
ELB015	May-93	0.5**	SIN001	May-93	0.5**, 10*
				Jun-93	0.5*
				Aug-93	0.5
South Puget Sound					
BUD005	Jul-93	0.5*	CSE001	May-93	0.5**, 10**
	Aug-93	0.5*, 10*		Jun-93	0.5*
	Sep-93	0.5*		Jul-93	0.5*
				Aug-93	0.5*
CRR001	Oct-92	0.5*		Sep-93	0.5*
	May-93	0.5*			
	Jul-93	0.5*	ELD001	May-93	0.5*, 10*
	Aug-93	0.5*		Aug-93	0.5
	Sep-93	0.5**		Sep-93	0.5*

*=Ammonium-N concentration below 0.01 mg/L

**=Ammonium-N and orthophosphate-P concentrations below 0.01 mg/L

Table 5. Continued.

Station	Month	Sample depth (m)	Station	Month	Sample depth (m)
South Puget Sound (continued)					
OAK004	May-93	0.5*, 9*	TOT001	May-93	0.5*
	Jul-93	0.5*		Aug-93	0.5*, 10*
	Aug-93	0.5*, 10*		Sep-93	0.5*, 10*
	Sep-93	0.5*, 8*			
Hood Canal					
HCB004	Oct-92	0.5*	HCB006	May-93	0.5**
	Mar-93	0.5		Jun-93	0.5*
	May-93	0.5**			
	Jun-93	0.5*			
	Jul-93	0.5*			
	Aug-93	0.5*			
	Sep-93	0.5*			
Coastal Embayments					
GYS008	Jul-93	0.5*, 4*	WPA006	Apr-93	0.5*, 8*
				May-93	0.5**, 2**
GYS016	Apr-93	0.5**, 6**		Jul-93	0.5*, 7*
	Jun-93	0.5**, 7**		Aug-93	0.5*, 7*
				Sep-93	0.5, 7*
WPA004	Apr-93	0.5**, 9**			
	Jul-93	0.5*, 10*			
	Aug-93	0.5*, 10*			
	Sep-93	0.5*, 10			

*=Ammonium-N concentration below 0.01 mg/L

**=Ammonium-N and orthophosphate-P concentrations below 0.01 mg/L

Months with low nitrate+nitrite-N concentrations (late spring through early fall) often correspond with increased chl *a* concentrations (Appendix D), indicating nutrient uptake by phytoplankton. Other factors that may contribute to lower nitrate+nitrite-N levels during this time period are decreased river runoff and increased stratification, both of which decrease the supply rate of nutrients to the surface waters. This inverse correlation is typical of marine systems (e.g., PSEP, 1991). A rigorous correlation analysis of these parameters would require integrated values over the euphotic zone; the two to three data points (0.5, 10 and 30 m) in this database are not adequate for statistical purposes to infer nutrient-chlorophyll relations.

Orthophosphate-P (oPO_4^{-3}-P)

Orthophosphate-P concentrations followed the same general pattern as nitrate-nitrite-N, with lower concentrations at 0.5 m than at either 10 or 30 m, and lowest concentrations from late spring to early fall. Only 5.7% of samples collected during WY 1993 had orthophosphate-P concentrations below the reporting limit of 0.01 mg/L. Interestingly, 17 of the 39 samples with orthophosphate-P levels below the reporting limit, had detectable nitrate+nitrite-N concentrations. Eleven of these samples had measurable concentrations of ammonium-N also. All but one of these 17 samples were from either Grays Harbor or Willapa Bay, at stations GYS004, GYS016, WPA001 and WPA004. Nutrient limitation due to N versus P is sometimes variable in estuaries with significant freshwater input. Of the coastal samples, all of which came from between 0.5 and 10 m, the salinities at these sample depths ranged between 0.4 and 24 ppt. The one Puget Sound sample was from PSS019 during May at 0.5 m and a salinity of 15 ppt. Although, this condition of detectable N with undetectable P nutrient concentrations can not be used to draw conclusions regarding nutrient limitation, a difference in the nutrient dynamics (linked to the significance of freshwater input) for Puget Sound phytoplankton versus that for these coastal estuaries is indicated.

Fecal Coliform Bacteria

Coliform bacteria are present in human and animal fecal wastes. Most coliform bacteria are not harmful to humans, however, some very rare strains are pathogenic, causing severe complications and/or death. Even though most fecal coliform bacteria are not harmful themselves, their presence can serve as an indicator for pathogenic bacteria and viruses that also are in feces. Both point (e.g., combined sewer overflows, direct marine discharge) and non-point (e.g., surface water runoff from dairy farms) sources of fecal coliform bacteria enter streams and rivers, and thus fresh water input is a major source of fecal coliform bacteria to the marine environment. Increased river discharge and runoff caused by heavy rains often corresponds with elevated bacterial counts in marine waters.

The fecal coliform bacteria criterion for class A and AA marine waters states that the bacteria count shall not exceed a geometric mean value of 14 organisms/100 mL, with no more than 10 percent of samples exceeding 43 organisms/100 mL (WAC 173-201,

1991). This criterion is better applied to more intensive survey data, where multiple samples are collected over smaller areas, instead of the once per month point sample for each station that is presented here. In this report, the level of 14 organisms/ 100 mL is used as a general guideline of where contamination may be of concern and will be termed a "high" count. These data can not be used to derive "exceedances."

Fecal coliform bacteria samples were collected at 21 of the 23 Puget Sound stations and at 6 of the 10 coastal stations. During WY 1993, samples from 10 stations had high (>14 organisms/100 mL) fecal coliform bacteria (fcb) counts during at least one month (Table 6). Many of the stations with high fcb counts in WY 1993 have also shown high fcb counts in previous wateryears. Samples from PSS019, CMB003, BUD005, OAK004, GYS004, GYS008, and WPA001 have had counts over 14 organisms/100 mL during at least one month in each wateryear from 1990 through 1993.

Figure 12 shows when fcb counts were high for Wateryears 1991 through 1993 for the stations listed in Table 6. In Puget Sound, high counts mostly occurred in November and July during WY 1993 (Figure 12). Wintertime high counts have been common in Puget Sound; however summertime high counts were not observed in WY 1991-1992. Four high counts occurred in July (PSS019, CMB003, ELB015, SIN001) and one in June (OAK004). These may be linked to a freshwater runoff event. A positive precipitation anomaly occurred in July; however the four preceding months also showed positive anomalies (Figure 3A). The salinity profiles for the four stations with July high counts do not show an excessive amount of less saline surface water compared with the June or August data (Appendix B). The proximity of sampling date to the runoff event would have a major impact on whether high fcb counts were recorded or not since the fcb do not typically live for more than 2 d in seawater (Lessard and Sieberth, 1983). High fcb counts have not been observed in summer months at any of the stations monitored during Wateryears 1990 through 1992.

The coastal estuary stations have consistently higher fcb counts in general than are found at the Puget Sound stations (Figure 12). The two stations in Grays Harbor and one in Willapa Bay have commonly showed summertime high counts as well.

The fcb data presented here are useful for identifying areas with chronically high fcb counts: GYS004, GYS008, PSS019, CMB003, WPA001, and to a lesser extent BUD005 and OAK004. It must be stressed however, that since high fcb counts are erratic due to the short lifetime of fcb in seawater (1-2 d; Lessard and Sieburth, 1983) and to the episodic nature of runoff events, these stations are severely under-sampled with respect to establishing interannual trends. The lack of summertime fcb count exceedances in Puget Sound in all data from WY 1990-1992 and its presence in five stations during WY 1993 is, however, a notable difference, although it may have been linked to a rare storm event. Continued monitoring is required to assess this.

Table 6. Stations with a high fecal coliform bacteria count of > 14 org/100 mL during WY 1993.

Station	Month	# organisms/100 mL
North Puget Sound		
BLL009	January	22
PSS019	November	80
	January	22
	July	91
Central Puget Sound		
CMB003	October	15
	November	130
	July	35
ELB015	November	43
	July	38
SIN001	July	18
South Puget Sound		
BUD005	November	37
	December	27
OAK004	November	30
	June	25
Coastal Estuaries		
GYS004	October	64
	April	33
	May	53
	June	150
	August	41
	September	52
GYS008	October	43
	April	33
	May	33
WPA001	April	15
	May	27
	June	100

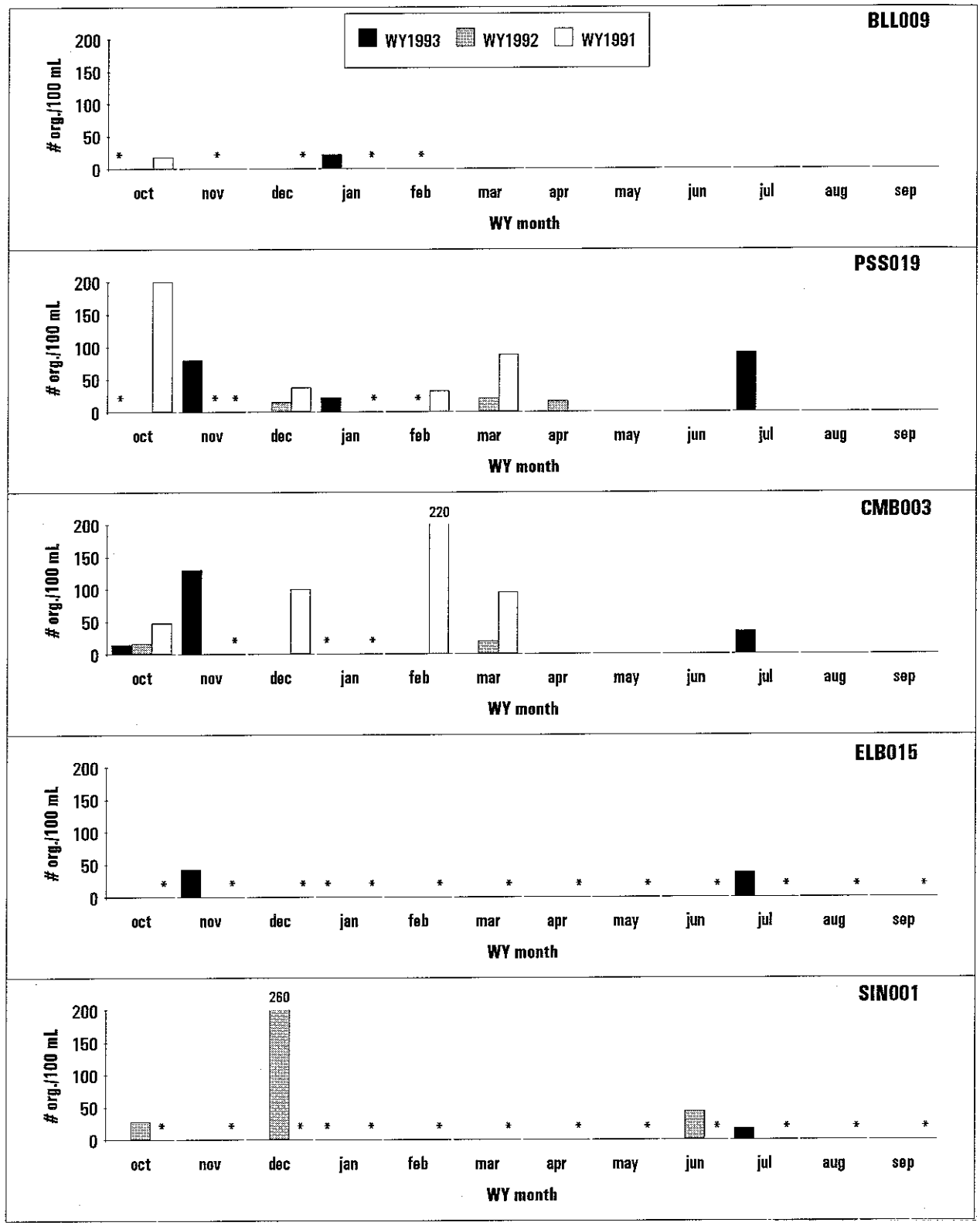


Figure 12. Fecal coliform bacteria counts versus Wateryear month WY 1991, 1992, 1993 data for stations with high counts (> 14 organisms/100 mL) during WY 1993. The * indicates sample was not obtained.

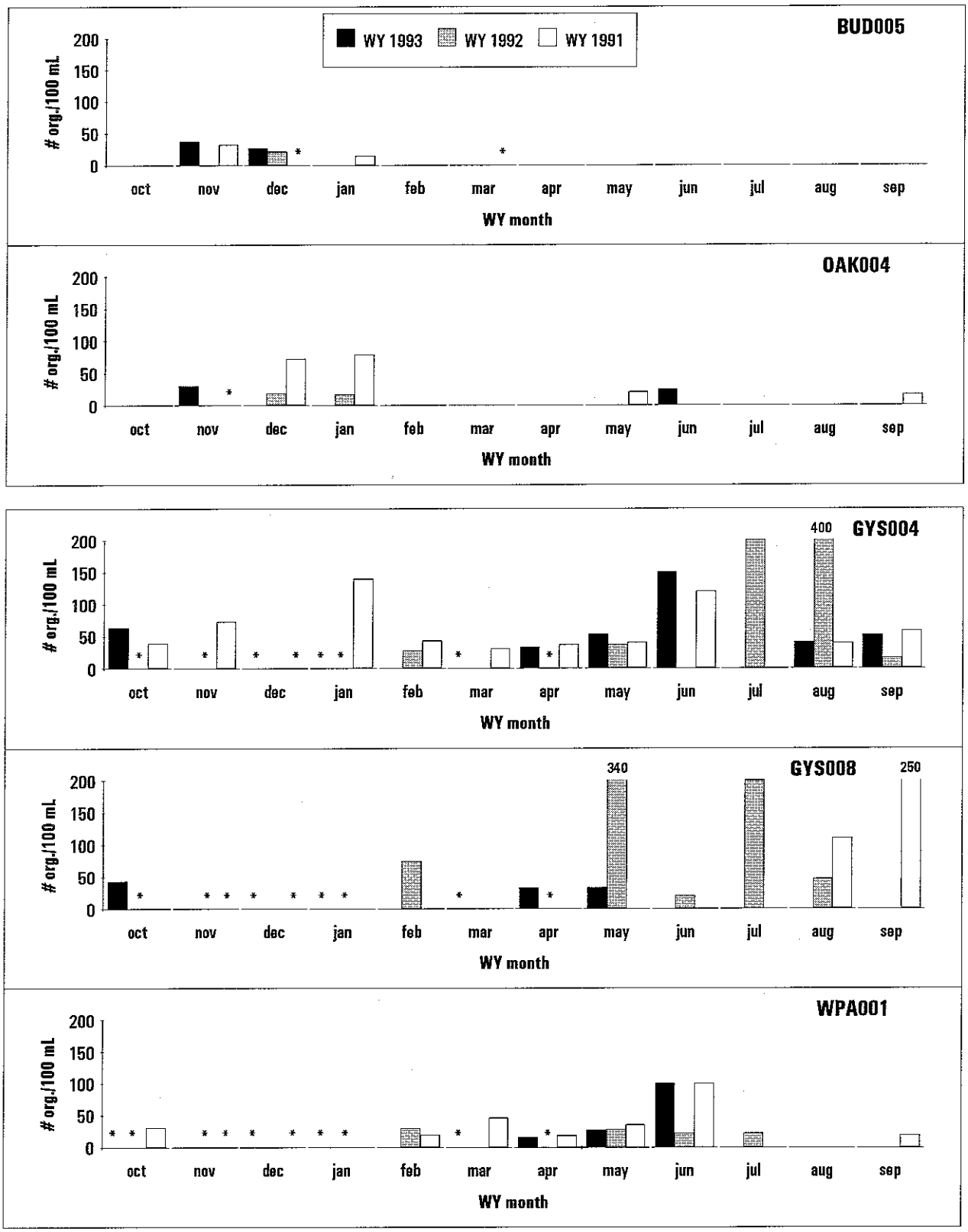


Figure 12.. Continued.

Quality Control

Quality control results for WY 1993 are presented in Appendix E. The precision, as estimated by the relative standard deviation of replicates, was within the target range for better than 75% of the data for most parameters, except ammonium-N, chl *a*, and phaeo. The mean of the check standard results were within 5% of the true value for all nutrients, but showed many values over 10% (Appendix E). Check standards were not in the concentration range of the bulk of the marine data presented here.

DISCUSSION

The data presented within this report can by no means be consolidated to a general conclusion. One impression that the user of this report will hopefully have obtained is the complexity and interconnectedness of the data. Stratification, chlorophyll, nutrients, light penetration, and dissolved oxygen data are all interrelated.

This discussion will focus on stratification and its implications for water quality in Puget Sound and the coastal estuaries. The classification of stations according to their physical stratification will be revisited and how these are reflected by the other data, particularly dissolved oxygen, presented here.

Implications of Stratification

The development of stratification within the water column is significant because of the physical barrier it presents with respect to vertical water movement. Turbulent eddies, driven by winds and tides, cause vertical mixing of phytoplankton, D.O., nutrients, etc. If, however, the water is stratified, that is, its density increases significantly with depth, then the ability of turbulent eddies to accomplish vertical mixing may be greatly decreased. This is particularly true at the pycnocline, the region of greatest density increase, which is often observed in the top few meters of the water column. Thus, stratification may effectively isolate the surface water from the deep water. When stratification is intense, two environmental conditions can be affected: surface waters can become depleted of nutrients (nitrogen and phosphorus compounds) and bottom waters can become depleted of oxygen. This is due to phytoplankton growth in the surface water that will deplete ambient nutrients, with no resupply from nutrient-rich deep waters, and to the decomposition of the organic material in the bottom water that will consume oxygen, with no resupply from oxygen-rich surface water.

The concentration of dissolved oxygen present in water is determined by the net result of input and uptake. Examples of inputs are photosynthetic production, diffusion of oxygen from the atmosphere through the water column, and advection of surface waters saturated with dissolved oxygen into undersaturated bottom waters.

Concentrations of dissolved oxygen can be diminished by any biological or chemical process exerting an oxygen demand. Examples of biological oxygen demand are respiration and bacterial decay of organic matter. Chemical oxygen demand occurs wherever oxidation-reduction processes occur such as the oxidation of metals (e.g., rusting of iron) or sulfides.

Phytoplankton cells provide decaying organic matter when they die, sink through the water column, and decompose in the bottom waters. The decomposition process uses oxygen which cannot be replenished from surface water advection in the presence of a strong pycnocline. If phytoplankton growth is significant, the bottom waters can become depleted of oxygen to the extent that other biological life is affected.

As with concentrations of dissolved oxygen, nutrients available in the water column are a result of the dynamic process of inputs and uptake. Some of the sources of nutrients in marine waters are dissolved and particulate matter carried by rivers, effluents from sewage treatment plants, agricultural runoff, and failing septic tanks. Examples of nutrient sinks are the binding of nutrients to particulate matter that eventually settles out, and consumption by phytoplankton.

When the pycnocline depth is shallower than the euphotic zone, sufficient light is present, and nutrients are available, conditions for phytoplankton growth are favored. The phytoplankton cells become concentrated in the upper layer of water where temperature and ambient light conditions provide an ideal environment for growth to occur. Nutrients are consumed from this upper water layer as phytoplankton growth occurs. Without a replenishing source, nutrient depletion can occur and thus limit phytoplankton growth.

However, where nutrient sources to the surface water exist, oxygen depletion of bottom waters can become exacerbated during the growing season. Eutrophic conditions can develop with large algal blooms resulting in correspondingly large die-offs and oxidation of this organic matter in bottom waters. The factors that influence the development of eutrophic conditions are the initial presence of phytoplankton cells, an abundant source of nutrients, and a strong pycnocline. Large algal blooms can result in bottom water hypoxia or anoxia.

Depletion of D.O. in the water column can have a serious impact on marine ecosystems. The degree of impact upon any given ecosystem may be dependent upon the intensity of the D.O. depletion as well as the temporal and spatial stability/persistence of the depressed D.O. levels (Llansò, 1992). In addition, the effects of D.O. depletion are both organism- and habitat-specific (Harding *et al.*, 1992). Certain species of fish are stressed by environmental conditions of D.O. concentrations just under 5 mg/L (Kramer, 1987; Whitmore *et al.*, 1960). Other species may not exhibit stress at 2.0 mg/L (Pihl *et al.*, 1992). Benthic infauna and, particularly, molluscs are more resistant to hypoxia (Theede *et al.*, 1969).

Hypoxic conditions can exert considerable stress on many marine organisms and, if persistent, can kill organisms such as fish. Fish may move away from the depleted area, or have higher susceptibility to disease (Smith *et al.*, 1992). Continual, or even intermittent hypoxic events, may result in a shift in species composition. Motile species that are affected will attempt to leave the hypoxic area. Sedentary species may be killed outright, or exhibit significant changes in reproductive rates and larval recruitment (Llansò, 1992). The species composition of a given area may also shift in response to changes in predator-prey relationships. Hypoxic conditions can initiate behavioral changes and physiological stresses (Roman *et al.*, 1993). The diel pattern of vertical migration exhibited by some zooplankton to avoid predation can be interrupted. Copepods have been found to remain in the pycnocline in an attempt to avoid a bottom layer of low-oxygenated water (Olson, 1989). Hypoxia may also inhibit the hatching of zooplankton eggs, thereby reducing larval recruitment, and suppress metabolic rates (Roman *et al.*, 1993).

Anoxic conditions, where no oxygen is available, create an environment habitable by anaerobic organisms only, primarily bacteria. Aerobic organisms that are motile will attempt to avoid or flee from anoxic waters. Most benthic organisms are killed by anoxic conditions.

The net effect of oxygen depletion in marine waters may be a shift in species composition, a decrease in population numbers and species diversity with a resulting decrease in amount and type of biomass, a disruption of the usual predator-prey interaction, and a shift in the expected trophic pathways. These combined effects can result in reduced availability and subsequent harvest of marine resources.

Influence of Stratification on Puget Sound and Coastal Estuary Stations

Of the Puget Sound stations where low D.O. concentrations were observed, ADM002, EAS001, PSS019, SAR003, HCB004, and HCB006, the latter four are stations with persistent stratification. Station ADM002 is not regarded as having a D.O. problem, since the cause for the low D.O. concentrations is a subsurface flow of low-oxygenated deep oceanic water. Station EAS001 is only seasonally stratified, and not particularly strongly so. Further investigation of the nutrient and pigment concentrations at this station are recommended, as currently it is sampled for CTD parameters only. The other four stations point to two regions in Puget Sound that may be sensitive to nutrient input: the waters adjacent to Everett Harbor, and Hood Canal.

The other stations where persistent stratification was observed, BLL009, BUD005, CMB003, ELB015, and SIN001, should be regarded as areas where significant nutrient loading could present low D.O. problems. Most of these stations are bays near urban areas. It must be stressed that these stations represent one isolated area in

these bays, and that conditions within the bay could be quite variable. For instance, Ecology has monitored Budd Inlet during its seasonal studies (Eisner *et al.*, 1994), and D.O. concentrations well below 5 mg/L were found in the inner bay that are never seen at Station BUD005. Therefore, the physical stratification characteristics of these areas should be regarded as indicators of their sensitivity.

Stations BLL009, BUD005, CMB003, ELB015, HCB004, HCB006, PSS019, SAR003, and SIN001, all of which had persistent stratification, showed undetectable nutrients during part of WY 1993, and all but SAR003 and the HCB stations showed high fcb counts.

The lack of low D.O. concentrations in the coastal estuaries was significant, especially since the river input maintains intense stratification at times. However, tidal action in these estuaries is strong and highly influences the data collected at a given time. It is possible that tidal flushing keeps D.O. concentrations from going low. Also, episodic wind mixing would be more effective in these relatively shallow estuaries. Interestingly, the high fcb counts in these estuaries, which far exceed those seen in Puget Sound, suggests that flushing is not complete throughout the water column. However, an alternative is that the input of fcb in the coastal estuaries is quite large and thus not sufficiently affected by flushing.

RECOMMENDATIONS

- Continue to monitor physical parameters (temperature and salinity) that allow assessment of physical influence of climate patterns on marine waters.
- Expand monitoring in the low D.O.-sensitive areas of Hood Canal and off Everett Harbor and assess whether these conditions are changing with time.
- Take pigment and nutrient samples at EAS001 in order to help evaluate the low D.O. concentrations observed there.
- Make a thorough comparison of the Collias *et al.* (1974) database with Ecology's data for D.O. to establish any changing trends.
- In order to follow nutrient dynamics, and particularly the depletion of N versus P concentrations, lower reporting limits for ammonium-N and orthophosphate-P are required. Also, nutrient addition assays are necessary in order to demonstrate nutrient limitation effects.
- Increase the resolution of chl *a* measurements (*in situ* detection) so that integrated values of chl *a* over the euphotic zone are determined that can then be used along with the extinction coefficient to follow particle load versus phytoplankton in extinguishing downwelling light.
- Continue monitoring of Puget Sound stations for fcb to see if summertime exceedance pattern seen in WY 1993, but not before, persists.
- Two stations (GYS004 and GYS008) in Grays Harbor show chronic fecal coliform contamination. These results are consistent with Department of Health's classification of "prohibited" status for shellfish growing areas in the west half of Grays Harbor (Health, 1993). This area includes numerous industrial and sewer outfalls. Further study should be made to determine the source(s) of contamination.
- Several water quality problems observed in Budd Inlet may be due to nutrient loading. The LOTT WWTP has begun removing up to 90% of the nitrogenous compounds in their effluent, as of spring 1994. The Inlet should be monitored to observe whether this change results in improved water quality.

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APPENDIX A

Water quality data from WY 1993 for:

1) Puget Sound stations
2) Grays Harbor and Willapa Bay stations

Data remark codes used during Wateryear 1993:

Remark Code	Definition
J	Estimated value; compound was positively identified, but numerical result is an estimate.
U or K	Compound was analyzed for but not detected at or above the report value. The number reported is reporting limit.
S	High background of non-coliform growth: motile, spreading colony which may overlap and mask E. coli colonies.
X	High background of non-coliform growth: non-motile, discrete colonies that may overlap and mask E. coli colonies.

PUGET SOUND STATIONS

ADM001
ADMIRALTY INLET S END WHIDBEY IS
48 01 48.0 122 37 00.0 2F 0 Elev= 0 ft
53029 Washington Island Co. PACIFIC NORTHWEST
PUGET SOUND (Island-06) 131106
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/26	1335	000	11.6	6.2	70.0	7.7	84.5	1K	11.5	30.80	0.224	
	1340	010	11.5	6.2	70.1	7.7	84.4			30.81	0.189	
	1345	030	11.5	6.2	69.7	7.7	84.5			30.81	0.283	
92/12/21	1105	000	9.1	7.9	83.5	7.7	83.7	1K	11.5	30.37	0.341	
	1115	010	9.1	7.8	83.2	7.7	84.1			30.38	0.339	
	1125	030	9.1	7.8	82.7	7.7	84.0			30.40	0.364	
93/02/01	1210	000	8.0	8.9	91.1	7.7	80.4	1K	9.0	29.03	0.361	
	1220	010	8.0	8.6	88.4	7.7	81.5			29.58	0.373	
	1230	030	8.0	8.5	87.5	7.7	82.1			30.00	0.386	
93/03/09	1135	000	8.0	10.1J	104.0J	7.7	67.8	1K	9.0	29.63	0.350	
	1145	010	7.8	9.7J	99.5J	7.7	82.5			30.11	0.349	
	1155	030	7.8	9.6J	98.4J	7.7	82.1			30.28	0.347	
93/04/19	1210	000	9.7	10.0J	105.8J	8.0	77.7	1K	8.8	28.22	0.201	
	1215	010	9.0	9.5J	100.0J	8.0	80.2			29.39	0.220	
	1225	030	8.9	9.2J	96.9J	8.0	81.9			29.85	0.212	
93/05/18	1140	000	12.7	8.4J	93.7J	8.0	50.3		4.7	26.14	0.040	
	1145	010	10.3	10.6J	114.2J	7.8	68.1			28.72	0.150	
	1150	030	10.3	10.3J	110.8J	7.8	68.8			28.96	0.174	
93/06/14	1130	000	12.0	10.5J	117.3J	8.1	68.2	1K	5.6	28.26	0.153	
	1140	010	11.7	10.0J	111.1J	8.0	72.9			28.79	0.187	
	1150	030	11.1	8.3J	91.4J	7.9	81.7			29.53	0.197	
93/07/19	1055	000	9.5	16.7	172.7	8.1	66.8	1K	5.1	25.03	0.092	
	1100	010	12.6	8.6	97.7	8.0	74.1			28.93	0.132	
	1105	023	12.1	8.3	93.3	7.9	74.6			29.34	0.193	
93/08/18	1230	000	12.4	7.8	88.8	7.9	83.2	1K	3.0	29.78	0.243	
	1235	010	11.9	7.4	83.2	7.8	82.9			30.22	0.241	
	1250	030	12.0	7.7	86.5	7.8	82.9			30.08	0.253	
93/09/08	1230	000	13.1	8.7	100.5	8.0	63.9	1K	7.1	29.87	0.163	
	1235	010	12.4	7.9	90.2	7.9	81.7			30.15	0.200	
	1245	030	12.2	7.5	84.6	7.9	83.4			30.27	0.251	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/26	1335	000	0.010K	0.050	446335	0.40J	0.18J
	1340	010	0.010K	0.040	446336	0.42J	0.27J
	1345	030	0.010K	0.063	446337		
92/12/21	1105	000	0.010K	0.075	526335	0.33J	0.19J
	1115	010	0.010K	0.076	526336	0.26J	0.20J
	1125	030	0.010K	0.075	526337		
93/02/01	1210	000	0.010K	0.071	66335	0.27J	0.27J
	1220	010	0.010K	0.071	66336	0.30J	0.21J
	1230	030	0.010K	0.070	66337		
93/03/09	1135	000	0.016	0.066	116335	1.00	0.29
	1145	010	0.013	0.066	116336	0.91	0.44
	1155	030	0.016	0.067	116337		
93/04/19	1210	000	0.012	0.043	176335	4.90	1.20
	1215	010	0.015	0.047	176336	3.10	0.58
	1225	030	0.021	0.044	176337		
93/05/18	1140	000	0.010K	0.016		6.00	2.90
	1145	010	0.010K	0.032		6.00	2.50
	1150	030	0.022	0.038			
93/06/14	1130	000	0.010K	0.036	256335	4.70	1.60
	1140	010	0.010	0.042	256336	2.30	1.30
	1150	030	0.015	0.044	256337		
93/07/19	1055	000	0.010K	0.030	306335	8.20	2.20
	1100	010	0.010K	0.035	306336	6.10	3.20
	1105	023	0.015	0.047	306337		
93/08/18	1230	000	0.011	0.052	346335	1.20	1.10
	1235	010	0.011	0.050	346336	1.30	1.10
	1250	030	0.011	0.050	346337		
93/09/08	1230	000	0.010K	0.033	376335	5.10J	2.10J
	1235	010	0.012	0.036	376336	4.90J	1.60J
	1245	030	0.019	0.061	376337		

ADM002
ADMIRALTY INLET NEAR PROTECTION ISLAND
48 11 15.0 122 50 30.0 2F000 Elev= 0 ft
53031 Washington Jefferson Co. PACIFIC NORTHWEST
PUGET SOUND (Quilcene/Snow-17) 131117
21540000 Reach=17110019 0.000 Drg= 0 sqmi
AMBNT/OCEAN/RMP

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/26	1450	000	10.3	5.9	64.7	7.7	82.9	1K	10.5	31.47	0.312	
	1455	010	10.1	5.7	61.8	7.7	82.9			31.59	0.112	
	1500	030	9.7	5.3	57.5	7.7	84.0			31.88	0.197	
92/11/18	1025	000	9.5	6.8	73.1	7.7	82.3	1K	10.0	31.11	0.374	
	1030	010	9.5	6.6	70.6	7.7	81.5			31.19	0.377	
	1035	030	9.3	5.9	63.6	7.7	81.8			31.61	0.383	
92/12/21	1015	000	8.5	8.4	87.9	7.7	81.5	1K	9.0	30.72	0.357	
	1025	010	8.5	8.3	87.0	7.7	81.5			30.75	0.359	
	1035	030	8.4	8.0	83.6	7.7	82.1			31.20	0.336	
93/02/01	1045	000	7.5	8.9	91.3	7.7	83.1	1K	10.0	31.01	0.356	
	1055	010	7.4	8.7	89.5	7.7	83.1			31.07	0.355	
	1105	030	7.3	8.6	87.8	7.7	83.4			31.15	0.356	
93/03/09	1020	000	7.7	9.5J	97.8J	7.7	76.2	1K	7.9	31.03	0.341	
	1030	010	7.7	9.5J	97.8J	7.7	79.4			31.03	0.339	
	1040	030	7.7	9.4J	96.7J	7.7	79.4			31.03	0.340	
93/04/19	1135	000	8.9	8.9J	93.7J	7.9	82.7	1K	13.0	30.61	0.232	
	1140	010	8.9	9.0J	94.5J	7.9	82.5			30.62	0.235	
	1145	030	8.8	8.9J	94.4J	7.9	82.7			30.62	0.233	
93/05/18	1020	000	9.9	9.2J	99.7J	7.6	75.7		6.4	30.53	0.195	
	1025	010	9.7	8.8J	94.9J	7.6	75.5			30.56	0.204	
	1030	030	9.6	8.9J	95.9J	7.6	77.7			30.60	0.225	
93/06/14	1010	000	11.3	8.9J	98.1J	7.9	62.5	1K	7.9	29.50	0.174	
	1020	010	10.9	8.3J	91.6J	7.9	81.7			30.12	0.211	
	1030	030	10.4	7.4J	81.2J	7.8	81.4			30.76	0.220	
93/07/21	1520	000	11.0	7.1	78.9	7.8	81.2	1K	7.4	30.41	0.241	
	1525	010	10.6	6.7	73.9	7.7	81.1			30.65	0.279	
	1530	030	10.5	6.5	70.7	7.7	77.7			30.89	0.267	
93/08/18	1115	000	10.7	6.5	72.1	7.7	80.7	1K	8.0	31.06	0.304	
	1120	010	10.6	6.5	71.7	7.7	80.8			31.08	0.317	
	1130	030	10.6	6.4	70.8	7.7	80.7			31.15	0.333	
93/09/08	1140	000	11.7	6.8	76.4	7.8	59.6	1K	14.6	30.34	0.271	
	1145	010	11.1	6.9	76.2	7.8	85.1			30.96	0.263	
	1200	030	10.2	6.1	66.2	7.7	85.9			31.60	0.315	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/26	1450	000	0.010K	0.064	446330	0.21J	0.15J
	1455	010	0.010K	0.018	446331	0.36J	0.39J
	1500	030	0.010K	0.037	446332		
92/11/18	1025	000	0.012	0.076	476330	0.15J	0.19J
	1030	010	0.011	0.076	476331	0.14J	0.19J
	1035	030	0.013	0.079	476332		
92/12/21	1015	000	0.010K	0.072	526330	0.32J	0.26J
	1025	010	0.010K	0.073	526331	0.21J	0.29J
	1035	030	0.010K	0.072	526332		
93/02/01	1045	000	0.011	0.064	66330	0.16J	0.13J
	1055	010	0.010K	0.061	66331	0.20J	0.21J
	1105	030	0.010K	0.064	66332		
93/03/09	1020	000	0.014	0.060	116330	0.61	0.29
	1030	010	0.013	0.062	116331	0.36	0.29
	1040	030	0.012	0.064	116332		
93/04/19	1135	000	0.014	0.048	176330	1.40	1.10
	1140	010	0.014	0.048	176331	1.20	1.10
	1145	030	0.014	0.049	176332		
93/05/18	1020	000	0.010K	0.039		2.80	1.80
	1025	010	0.010	0.040		2.30	1.70
	1030	030	0.012	0.042			
93/06/14	1010	000	0.011	0.040	256330	3.10	1.70
	1020	010	0.011	0.046	256331	1.30	1.00
	1030	030	0.010K	0.048	256332		
93/07/21	1520	000	0.010K	0.052	306330	1.90	1.20
	1525	010	0.010K	0.055	306331	1.10	0.70
	1530	030	0.010K	0.055	306332		
93/08/18	1115	000	0.010	0.053	346330	0.94	0.75
	1120	010	0.010K	0.053	346331	0.93	0.89
	1130	030	0.010K	0.057	346332		
93/09/08	1140	000	0.016	0.044	376330	0.86J	0.37J
	1145	010	0.018	0.047	376331	2.00J	0.94J
	1200	030	0.017	0.052	376332		

BLL009
BELLINGHAM BAY NR POINT FRANCES
48 41 10.0 122 35 54.0 1F 0 Elev= 0 ft
53073 Washington Whatcom Co. PACIFIC NORTHWEST
PUGET SOUND (Nooksack-01) 131101
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/11/09	1410	000	9.5	9.4	96.2	7.8	41.5	13	1.8	23.84	0.325	0.011
	1415	010	10.0	7.2	78.0	7.7	72.8			29.89	0.354	0.010K
92/12/15	1135	000	7.6	8.9	90.9	7.7	66.5	1K	4.1	29.38	0.314	0.010K
	1145	010	8.5	7.7	80.4	7.7	74.2			30.36	0.355	0.010K
93/01/26	1245	000	5.7	11.2	103.5	7.8	17.4	22S	1.0	21.42	0.612	0.010K
	1250	010	6.8	9.0	90.4	7.7	66.3			30.24	0.527	0.010K
93/02/17	1510	000	5.7	10.4	100.5	7.8	49.6	1K	2.5	28.98	0.383	0.010K
	1515	010	6.6	10.4	103.8	7.7	66.3			29.87	0.387	0.010K
93/03/16	1440	000	8.0	10.0J	101.3J	7.8	53.1	2	3.0	27.37	0.348	0.010K
	1445	010	7.6	9.1J	93.5J	7.7	74.1			30.09	0.364	0.010K
93/04/27	1510	000	10.5	12.8J	139.1J	8.5	54.2	1K	2.9	29.28	0.010K	0.010K
	1520	010	9.6	11.2J	119.7J	8.3	62.8			29.49	0.064	0.010K
93/05/26	1405	000	15.3	10.2J	120.4J	8.2	65.0		4.9	27.12	0.030	
	1410	004	12.6	9.6J	108.7J	8.0	74.1			28.73	0.112	
93/06/30	1420	000	16.4	11.6J	140.4J	8.4	48.3	1K	3.5	27.21	0.010K	0.010K
	1425	010	11.3	8.2J	90.3J	7.9	68.2			29.60	0.139	0.010K
93/07/21	1150	000	15.3	8.3	97.8	8.1	62.4	1	3.4	26.75	0.035	0.010K
	1200	009	12.7	7.4	84.0	7.9	77.0			28.79	0.204	0.010K
93/08/24	1435	000	13.9	11.7	136.9	8.3	47.1	1K	3.6	29.39	0.010K	0.010K
	1440	007	12.9	9.3	106.5	8.1	55.7			29.53	0.242	0.010K
93/09/20	1410	000	12.1	7.7	86.6	7.9	75.6	1K	6.1	29.75	0.200J	0.010U
	1415	010	11.4	6.8	76.3	7.9	80.0			30.13	0.240J	0.014J

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/11/09	1410	000	0.047	0.056	466259	0.88J	0.19J
	1415	010	0.021	0.068	466260	0.22J	0.40J
92/12/15	1135	000	0.025	0.058	516259	0.44J	0.36J
	1145	010	0.010K	0.069	516260	0.15J	0.17J
93/01/26	1245	000	0.043	0.051	56259	1.23J	0.55J
	1250	010	0.022	0.069	56260	0.37J	0.29J
93/02/17	1510	000	0.015	0.070	86259	0.21J	0.24J
	1515	010	0.010K	0.072	86260	0.31J	0.32J
93/03/16	1440	000	0.029	0.057	126259	1.20	0.61

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
93/03/16	1445	010	0.037	0.065	126260	0.89	0.54
93/04/27	1510	000	0.010K	0.011	186259	23.30	6.30
	1520	010	0.022	0.019	186260	16.90	6.20
93/05/26	1405	000	0.021	0.020		7.40	1.60
	1410	004	0.052	0.041		2.30	0.87
93/06/30	1420	000	0.010K	0.010K	276259	6.40	0.74
	1425	010	0.034	0.044	276260	5.30	1.30
93/07/21	1150	000	0.019	0.027		4.60	1.30
	1200	009	0.052	0.052		1.40	0.71
93/08/24	1435	000	0.010K	0.017	356259	16.10	3.30
	1440	007	0.010K	0.048	356260	7.80	3.00
93/09/20	1410	000	0.025J	0.055J	396259	2.80	0.72
	1415	010	0.028J	0.057J	396260	1.40	0.72

BUD005
BUDD INLET-OLYMPIA SHOAL AT HORN
47 05 32.0 122 55 01.0 2F 0 Elev= 0 ft
53067 Washington Thurston Co. PACIFIC NORTHWEST
PUGET SOUND (Deschutes-13) 131113
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/05	1615	000	15.3	10.3	124.5	8.2	77.4	1K		29.54	0.109	0.012
	1625	010	14.7	6.6	78.1	7.9	80.8			29.92	0.176	0.010K
92/11/03	1100	000	11.8	7.9	87.6	7.7	74.1	37	9.0	27.71	0.234	0.012
	1105	010	12.9	6.6	76.2	7.7	75.9			30.01	0.246	0.010K
92/12/01	0920	000	9.3	8.6	89.8	7.6	68.9	27	6.4	27.68	0.297	0.012
	0925	010	10.8	7.9	86.4	7.7	74.8			29.72	0.296	0.010K
93/01/11	1015	000	5.4	10.1	96.6	7.6	73.7	8	5.8	28.31	0.317	0.013
	1025	010	7.3	8.9	90.2	7.6	72.5			29.38	0.315	0.010K
93/02/08	0935	000	7.3	10.2	100.7	7.7	82.0	2	9.1	26.41	0.346	0.011
	0940	010	7.6	8.8	89.5	7.7	76.4			28.97	0.330	0.011
93/03/03	1030	000	7.4	12.0J	121.0J	7.7	81.1	1K	5.0	28.84	0.292	0.010K
	1040	010	7.1	11.0J	110.7J	7.7	77.2			29.19	0.296	0.010K
93/04/12	1015	000	9.5	8.7J	91.0J	7.8	63.3	11	6.5	27.10	0.266	0.010K
	1020	008	9.0	9.9J	103.7J	7.8	77.1			28.92	0.276	0.010K
93/05/17	0950	000	16.4	14.7J	173.2J	8.0	39.5	10	2.1	22.31	0.018	0.010K
	1000	009	10.3	9.1J	98.0J	7.6	60.5			28.70	0.143	0.010K
93/06/07	1000	000	13.0	11.0J	125.2J	8.0	70.9	1U	5.1	28.53	0.044	0.010K
	1005	010	12.2	9.4J	105.3J	7.9	72.2			28.66	0.082	0.010K
93/07/12	0950	000	14.3	9.6	113.1	8.1	55.8	1K	2.9	28.64	0.010K	0.010K
	0955	010	13.3	7.1	81.9	7.8	57.8			28.80	0.102	0.010K
93/08/09	0925	000	15.9	12.2	147.0	8.2	55.5	6	2.6	28.33	0.010K	0.010K
	0930	010	14.2	6.8	80.1	7.8	52.8			28.99	0.010K	0.010K
93/09/07	1000	000	19.1	12.7	163.8	8.7	54.4	4	2.3	27.91	0.010K	0.010K
	1005	010	14.6	6.6	78.0	7.9	66.2			29.37	0.094	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/05	1615	000	0.017	0.078	416300	4.95J	0.94J
	1625	010	0.065	0.092	416301	3.09J	0.93J
92/11/03	1100	000	0.100	0.081	456300	1.11J	0.38J
	1105	010	0.069	0.079	456301	4.13J	0.53J
92/12/01	0920	000	0.075	0.079	496300	3.38J	0.19J
	0925	010	0.023	0.075	496301	5.18J	0.86J
93/01/11	1015	000	0.046	0.076	36300	3.26J	0.29J

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
93/01/11	1025	010	0.020	0.072	36301	3.06J	0.45J
93/02/08	0935	000	0.064	0.053	76300	1.05J	0.47J
	0940	010	0.037	0.063	76301	5.14J	1.12J
93/03/03	1030	000	0.018	0.067	106300	1.75J	0.51J
	1040	010	0.016	0.067	106301	3.02J	0.44J
93/04/12	1015	000	0.078	0.046	166300	1.60	0.51
	1020	008	0.055	0.056	166301	4.60	0.90
93/05/17	0950	000	0.010K	0.011	216300	7.10	2.40
	1000	009	0.148	0.099	216301	14.50	5.60
93/06/07	1000	000	0.048	0.042	246300	3.60	1.60
	1005	010	0.111	0.061	246301	2.80	1.70
93/07/12	0950	000	0.010K	0.037	296300	13.40	1.20
	0955	010	0.053	0.057	296301	1.50	1.10
93/08/09	0925	000	0.010K	0.041	336300	14.50	1.00
	0930	010	0.010K	0.065	336301	25.70	3.60
93/09/07	1000	000	0.010K	0.021	376300	14.30	2.10
	1005	010	0.061	0.042	376301	1.90	0.81

CMB003
COMMENCEMENT BAY
47 17 26.0 122 26 56.0 2F 0 Elev= 0 ft
53053 Washington Pierce Co. PACIFIC NORTHWEST
PUGET SOUND (Puyallup/White-10) 131110
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/26	1025	000	12.4	6.3	71.7	7.7	62.2	15X	6.5	29.19	0.101	0.010K
	1030	010	12.4	6.3	72.3	7.7	83.5			30.45	0.303	0.010K
	1035	030	12.3	6.0	68.1	7.7	80.9			30.58	0.176	0.010K
92/11/18	1415	000	11.3	7.4	80.5	7.7	67.5	130	4.0	26.49	0.345	0.010K
	1420	010	11.7	6.4	71.3	7.7	84.6			30.43	0.353	0.010K
	1435	030	11.6	6.3	71.1	7.7	86.2			30.55	0.358	0.010K
92/12/21	1400	000	9.7	7.7	82.3	7.7	78.3	8	7.5	29.28	0.351	0.010K
	1410	010	9.9	7.3	79.0	7.7	83.9			30.17	0.338	0.010K
	1420	030	10.0	7.1	76.6	7.7	81.6			30.33	0.335	0.010K
93/02/01	1605	000	8.1	8.6	87.2	7.6	45.1		4.1	27.62	0.482	0.010K
	1615	010	8.1	8.3	86.0	7.7	79.5			30.00	0.467	0.010K
	1625	030	8.2	8.1	83.8	7.7	80.9			30.21		0.010K
93/03/09	1500	000	8.0	10.1J	104.3J	7.7	85.1	1	11.0	29.59	0.348	0.010K
	1510	010	8.0	10.2J	104.7J	7.7	85.3			29.59	0.352	0.010K
	1520	030	7.7	9.4J	96.7J	7.7	85.6			29.96		
93/04/19	1410	000	9.8	10.6J	112.5J	8.0	71.9	1K	7.4	27.59	0.298	0.010K
	1415	010	8.4	9.3J	96.9J	7.9	81.1			29.57	0.311	0.010K
	1425	030	8.2	8.7J	90.3J	7.8	83.5			29.71		0.010K
93/05/18	1510	000	13.4	15.4J	174.7J	8.3	41.7		3.6	26.72	0.010K	0.010K
	1515	010	10.1	11.2J	120.1J	7.8	72.3			28.87	0.173	0.010K
	1520	030	9.6	10.1J	107.6J	7.7	79.6			29.19		0.010K
93/06/14	1435	000	12.5	14.7J	164.3J	8.3	42.5	1K	2.6	27.10	0.010K	0.010K
	1445	010	10.9	10.5J	114.2J	8.0	74.5			28.84	0.193	0.010K
	1455	030	10.4	9.3J	100.9J	7.9	83.9			29.14		0.010K
93/07/19	1400	000	14.2	13.1	147.8	8.2	33.0	35	1.1	22.14	0.090	0.010K
	1405	010	11.9	9.0	101.0	7.9	74.6			29.15	0.154	0.010K
	1420	030	11.6	7.8	86.7	7.8	84.0			29.29		0.010K
93/08/18	1530	000	16.0	10.8	126.6	7.8	29.4	4	1.9	22.46	0.184	0.011
	1535	010	12.3	7.4	83.7	7.8	85.6			29.62	0.223	0.010K
	1550	030	12.2	7.4	83.2	7.8	86.7			29.76		0.010
93/09/08	1515	000	14.5	10.7	125.8	8.1	60.2	1K	3.0	28.91	0.056	0.010K
	1520	010	12.6	7.1	81.2	7.9	85.2			29.87	0.237	0.010K
	1530	030	12.1	6.4	71.8	7.8	77.5			30.04		0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/26	1025	000	0.016	0.022	446345	1.33J	0.28J
	1030	010	0.010K	0.071	446346	0.46J	0.14J
	1035	030	0.010K	0.039	446347		
92/11/18	1415	000	0.049	0.077	476345	0.37J	0.28J
	1420	010	0.010K	0.080	476346	0.38J	0.22J
	1435	030	0.010K	0.081	476347		
92/12/21	1400	000	0.131	0.081	526345	0.26J	0.15J
	1410	010	0.019	0.079	526346	0.18J	0.12J
	1420	030	0.010K	0.079	526347		
93/02/01	1605	000	0.038	0.078	66345	0.19J	0.22J
	1615	010	0.032	0.082	66346	0.20J	0.10J
93/03/09	1500	000	0.029	0.068	116345	4.50	0.46
	1510	010	0.026	0.069	116346	2.10	0.42
93/04/19	1410	000	0.014	0.052	176345	4.60	3.00
	1415	010	0.015	0.063	176346	3.20	0.40
93/05/18	1510	000	0.010K	0.012		6.20	3.20
	1515	010	0.024	0.041		6.60	2.30
93/06/14	1435	000	0.010K	0.014	256345	16.60	7.00
	1445	010	0.021	0.048	256346	2.30	1.90
	1455	030			256347		
93/07/19	1400	000	0.010K	0.013	306345	9.30	2.00
	1405	010	0.010K	0.039	306346	9.70	2.60
	1420	030			306347		
93/08/18	1530	000	0.026	0.042	346345	1.40	0.38
	1535	010	0.010	0.050	346346	1.40	0.59
	1550	030			346347		
93/09/08	1515	000	0.010K	0.020	376345	9.60J	4.60J
	1520	010	0.029	0.039	376346	0.81J	0.59J

CRR001
CARR INLET OFF GREEN POINT
47 16 36.0 122 42 30.0 2F 0 Elev= 0 ft
53053 Washington Pierce Co. PACIFIC NORTHWEST
PUGET SOUND (Kitsap-15) 131115
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/05	1310	000	14.7	11.7	139.2	8.3	61.5	1K	3.6	29.96	0.010K	
	1320	010	13.7	8.0	93.6	8.0	74.1			30.16	0.107	
	1330	030	13.5	6.3	73.3	7.8	88.4			30.27	0.209	
92/11/03	1235	000	12.6	7.0	79.7	7.8	86.0	1K	14.0	30.27	0.278	
	1240	010	12.6	6.7	76.9	7.8	86.0			30.30	0.265	
	1250	030	12.7	5.9	68.1	7.7	85.6			30.40	0.285	
92/12/01	1040	000	11.3	6.9	76.8	7.7	82.8	1K	11.1	30.35	0.312	
	1045	010	11.3	6.9	76.5	7.7	82.8			30.34	0.313	
	1050	030	11.3	6.8	75.8	7.7	82.8			30.34	0.338	
93/01/11	1200	000	8.5	8.4	87.1	7.7	81.1	3	9.5	30.04	0.333	
	1210	010	8.5	8.4	87.1	7.7	81.4			30.04	0.346	
	1220	030	8.4	8.4	87.4	7.7	82.3			30.05	0.349	
93/02/08	1055	000	7.9	9.1	93.5	7.7	82.7	1K	11.0	29.71	0.347	
	1100	010	7.9	9.1	93.2	7.7	82.8			29.71	0.379	
	1105	030	7.9	8.6	88.3	7.7	81.9			29.80	0.392	
93/03/03	1215	000	7.7	10.5J	107.3J	7.7	82.5	1K	7.4	29.65	0.364	
	1220	010	7.5	10.2J	103.5J	7.6	84.1			29.71	0.372	
	1225	030	7.4	10.1J	102.6J	7.6	84.3			29.72	0.382	
93/04/12	1155	000	9.7	8.3J	88.1J	7.9	86.5	1K	13.1	29.29	0.313	
	1200	010	8.6	9.7J	101.0J	7.8	82.4			29.48	0.360	
	1205	030	8.4	9.4J	97.0J	7.8	83.7			29.53	0.344	
93/05/17	1210	000	14.3	14.8J	174.4J	8.2	66.2	1	4.6	29.05	0.010K	
	1215	010	10.5	13.4J	145.7J	7.9	69.4			29.01	0.093	
	1230	030	9.8	10.6J	112.8J	7.7	81.6			29.15	0.192	
93/06/07	1140	000	11.9	10.7J	119.4J	8.0	81.1	1U	11.3	29.01	0.087	
	1145	010	11.3	10.4J	114.2J	8.0	84.4			29.03	0.103	
	1150	030	10.7	9.9J	108.3J	7.9	83.9			29.08	0.145	
93/07/12	1115	000	15.9	10.9	132.6	8.3	75.0	1K	4.6	28.86	0.010K	
	1120	010	12.6	9.4	106.2	8.0	80.8			29.00	0.107	
	1130	030	12.1	8.4	94.6	7.9	86.8			29.05	0.165	
93/08/09	1055	000	15.7	11.3	136.4	8.2	89.4	1K	14.5	29.09	0.010K	
	1100	010	13.2	8.9	102.1	8.0	87.0			29.30	0.162	
	1110	030	12.6	7.8	88.5	7.9	88.6			29.31	0.240	
93/09/07	1145	000	16.9	13.5	167.8	8.5	68.6	1K	8.4	29.33	0.010K	
	1150	010	13.3	8.3	96.1	8.0	71.9			29.60	0.138	
	1155	030	13.2	7.3	84.5	7.9	86.9			29.72	0.206	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/05	1310	000	0.010K	0.035	416307	20.80J	1.55J
	1320	010	0.010K	0.048	416308	18.35J	0.33J
	1330	030	0.017	0.063	416309		
92/11/03	1235	000	0.030	0.072	456307	0.49J	0.32J
	1240	010	0.031	0.073	456308	0.39J	0.34J
	1250	030	0.033	0.076	456309		
92/12/01	1040	000	0.010K	0.078	496307	2.19J	0.36J
	1045	010	0.010K	0.078	496308	1.94J	0.60J
	1050	030	0.010K	0.080	496309		
93/01/11	1200	000	0.010K	0.079	36307	0.43J	0.20J
	1210	010	0.010K	0.078	36308	0.50J	0.25J
	1220	030	0.010K	0.077	36309		
93/02/08	1055	000	0.019	0.065	76307	0.98J	0.39J
	1100	010	0.019	0.066	76308	0.73J	0.24J
	1105	030	0.021	0.073	76309		
93/03/03	1215	000	0.010K	0.076	106307	1.00J	0.48J
	1220	010	0.010K	0.077	106308	0.83J	0.19J
	1225	030	0.010K	0.077	106309		
93/04/12	1155	000	0.047	0.060	166307	0.82	0.08
	1200	010	0.052	0.063	166308	0.80	0.26
	1205	030	0.046	0.065	166309		
93/05/17	1210	000	0.010K	0.013	216307	4.60	2.20
	1215	010	0.010K	0.030	216308	12.70	5.90
	1230	030	0.031	0.049	216309		
93/06/07	1140	000	0.052	0.040	246307	2.20	0.95
	1145	010	0.045	0.046	246308	0.78	0.63
	1150	030	0.044	0.053	246309		
93/07/12	1115	000	0.010K	0.018	296307	1.40	0.66
	1120	010	0.014	0.039	296308		
	1130	030	0.023	0.048	296309		
93/08/09	1055	000	0.010K	0.025	336307	2.30	0.34
	1100	010	0.018	0.050	336308	1.80	1.00
	1110	030	0.010K	0.059	336309		
93/09/07	1145	000	0.010K	0.010K	376307	0.57	0.39
	1150	010	0.010K	0.032	376308	9.50	6.10
	1155	030	0.017	0.037	376309		

CSE001
CASE INLET OFF SOUTHERN HERON IS
47 15 53.0 122 50 35.0 2F 0 Elev= 0 ft
53053 Washington Pierce Co. PACIFIC NORTHWEST
PUGET SOUND (Kitsap-15) 131115
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/05	1340	000	15.6	8.8	106.5	8.1	78.0	1K	6.0	29.84	0.104	
	1350	010	14.3	6.6	78.5	7.9	83.7			30.07	0.163	
	1400	030	13.9	6.4	75.1	7.9	82.8			30.16	0.181	
92/11/03	1310	000	12.9	7.2	82.2	7.8	82.1	1K	10.0	29.96	0.189	
	1315	010	12.9	6.7	77.1	7.8	82.3			30.05	0.246	
	1320	030	12.7	6.3	72.1	7.8	78.7			30.28	0.280	
92/12/01	1125	000	10.9	7.8	85.4	7.8	78.4	1K	9.0	29.97	0.290	
	1130	010	10.9	7.7	85.0	7.8	78.3			29.97	0.284	
	1135	030	10.9	7.5	83.1	7.8	77.8			29.99	0.286	
93/01/11	1340	000	7.5	9.3	94.2	7.8	78.2	1K	7.5	29.63	0.317	
	1350	010	7.6	9.0	91.7	7.8	78.2			29.66	0.320	
	1400	030	7.7	8.8	90.0	7.7	77.5			29.68	0.329	
93/02/08	1135	000	7.4	10.1	102.2	7.8	81.9	1	11.0	29.13	0.295	
	1140	010	7.3	10.1	102.0	7.8	81.7			29.12	0.314	
	1145	030	7.6	9.2	93.9	7.8	79.6			29.35	0.329	
93/03/03	1245	000	7.3	11.5J	116.2J	7.7	86.0	1K	12.0	29.34	0.308	
	1250	010	7.2	11.1J	111.5J	7.7	85.6			29.35	0.315	
	1255	011	7.2	11.0J	110.9J	7.7	85.2			29.35	0.353	
93/04/12	1230	000	9.6	8.6J	91.6J	8.0	87.3	1K		28.85	0.198	
	1235	010	8.6	10.4J	108.0J	7.9	84.8			29.19	0.254	
	1240	030	8.4	9.2J	95.2J	7.8	78.5			29.38		
93/05/17	1130	000	16.2	14.2J	173.1J	8.3	67.7	1K	4.3	28.32	0.010K	
	1135	010	10.7	11.8J	128.7J	8.0	71.3			28.66	0.012	
	1140	030	9.5	9.6J	102.2J	7.6	80.4			29.11	0.238	
93/06/14	1620	000	14.7	13.9J	164.5J	8.4	57.2	1K	3.6	28.42	0.010K	
	1630	010	12.1	10.6J	119.0J	8.1	72.7			28.80	0.106	
	1640	030	11.2	9.4J	102.8J	7.9	77.4			28.98	0.184	
93/07/12	1155	000	15.6	11.2	135.0	8.3	63.6	1	4.5	28.62	0.010K	
	1200	010	13.1	8.3	95.2	7.9	77.7			28.84	0.109	
	1205	030	12.2	7.9	89.2	7.9	72.9			28.99	0.166	
93/08/09	1240	000	16.0	12.2	147.8	8.3	72.7	1	5.9	28.91	0.010K	
	1245	010	14.2	9.1	106.8	8.1	78.9			29.00	0.079	
	1250	030	13.1	7.8	90.0	7.9	82.5			29.19	0.162	
93/09/07	1340	000	16.8	11.6	144.0	8.3	70.3	1K	5.6	29.12	0.010K	
	1345	010	14.5	8.2	96.9	8.1	75.7			29.36	0.078	
	1350	030	13.8	7.3	85.4	7.9	81.8			29.53	0.155	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/05	1340	000	0.010K	0.057	416310	4.80J	1.18J
	1350	010	0.030	0.061	416311	4.52J	-0.03J
	1400	030	0.021	0.060	416312		
92/11/03	1310	000	0.048	0.062	456310	3.29J	0.82J
	1315	010	0.054	0.077	456311	1.85J	0.38J
	1320	030	0.035	0.075	456312		
92/12/01	1125	000	0.013	0.077	496310	5.30J	0.89J
	1130	010	0.013	0.077	496311	4.34J	0.97J
	1135	030	0.013	0.077	496312		
93/01/11	1340	000	0.011	0.075	36310	4.17J	0.61J
	1350	010	0.011	0.075	36311	2.81J	0.44J
	1400	030	0.010K	0.075	36312		
93/02/08	1135	000	0.025	0.059	76310	5.49J	0.77J
	1140	010	0.023	0.062	76311	5.14J	0.79J
	1145	030	0.022	0.063	76312		
93/03/03	1245	000	0.010K	0.070	106310	1.40J	0.31J
	1250	010	0.010K	0.070	106311	0.91J	0.51J
	1255	011	0.010K	0.074	106312		
93/04/12	1230	000	0.044	0.045	166310	0.44	0.17
	1235	010	0.055	0.055	166311	1.60	0.39
93/05/17	1130	000	0.010K	0.010K	216310	1.50	0.98
	1135	010	0.010K	0.020	216311	23.50	6.80
	1140	030	0.053	0.059	216312		
93/06/14	1620	000	0.010K	0.017		8.40	3.10
	1630	010	0.017	0.039		6.30	2.00
	1640	030	0.046	0.055			
93/07/12	1155	000	0.010K	0.022	296310	5.30	1.20
	1200	010	0.074	0.057	296311	10.10	1.50
	1205	030	0.049	0.057	296312		
93/08/09	1240	000	0.010K	0.029	336310	4.80	1.30
	1245	010	0.034	0.049	336311	5.30	2.00
	1250	030	0.054	0.060	336312		
93/09/07	1340	000	0.010K	0.015	376310	4.30	2.60
	1345	010	0.018	0.028	376311	8.20	2.10
	1350	030	0.041	0.039	376312		

DNA001
DANA PASSAGE NEAR BRISCO POINT
47 09 42.0 122 52 14.0 1F 0 Elev= 0 ft
53067 Washington Thurston Co. PACIFIC NORTHWEST
PUGET SOUND (Deschutes-13) 131113
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/05	1435	000	14.6	7.8	93.0	8.0	78.7	1K		29.99	0.145	
	1445	010	14.3	7.2	85.3	7.9	78.3			30.06	0.154	
	1455	030	13.8	6.4	74.9	7.9	78.4			30.18	0.165	
92/11/03	1130	000	12.8	7.0	80.0	7.8	82.5	1K	10.5	30.09	0.159	
	1135	010	12.8	6.9	79.6	7.8	82.5			30.08	0.177	
	1140	030	12.7	6.5	74.5	7.8	80.3			30.19	0.194	
92/12/01	0945	000	10.8	7.5	82.5	7.7	77.3	1	8.0	29.91	0.316	
	0950	010	10.9	7.4	81.0	7.7	78.2			29.96	0.309	
	0955	030	11.1	7.0	77.8	7.7	77.2			30.09	0.301	
93/01/11	1050	000	7.0	9.0	90.5	7.7	74.6	6	5.5	29.18	0.315	
	1100	010	7.4	8.8	89.6	7.7	74.0			29.47	0.316	
	1110	030	7.6	8.7	88.6	7.7	74.3			29.55	0.318	
93/02/08	1000	000	7.6	9.1	92.4	7.7	77.0	1	7.4	29.04	0.361	
	1005	010	7.6	9.1	92.0	7.7	76.1			29.09	0.317	
	1010	030	7.6	9.0	91.4	7.7	76.5			29.15	0.363	
93/03/03	1105	000	7.2	10.9J	109.7J	7.7	83.2	1K	7.7	29.23	0.333	
	1110	010	7.2	10.6J	106.8J	7.6	83.4			29.34	0.340	
	1115	030	7.3	10.1J	101.9J	7.6	82.0			29.56	0.358	
93/04/12	1045	000	8.9	7.6J	79.0J	7.8	79.4	1K	10.2	29.03	0.293	
	1050	010	8.6	9.7J	101.0J	7.8	82.6			29.13	0.303	
	1055	030	8.4	9.4J	97.1J	7.8	81.7			29.36	0.317	
93/05/17	1020	000	12.1	12.9J	143.9J	7.9	66.1	1	4.5	28.38	0.052	
	1025	010	11.5	12.2J	134.5J	7.8	67.8			28.56	0.103	
	1030	030	10.4	10.8J	116.4J	7.7	73.2			28.91	0.151	
93/06/07	1025	000	13.0	10.4J	118.2J	8.0	71.8	1	4.1	28.19	0.098	
	1030	010	12.7	10.1J	114.4J	8.0	69.5			28.44	0.104	
	1045	030	11.7	10.0J	110.9J	7.9	64.4			28.79	0.100	
93/07/12	1020	000	13.8	8.9	103.8	8.0	71.2	1K	4.6	28.74	0.097	
	1025	010	13.0	8.7	99.5	7.9	73.9			28.88	0.095	
	1030	030	12.5	8.1	91.8	7.9	73.3			28.93		
93/08/09	0955	000	14.5	9.8	115.2	8.1	73.5	1K	7.1	29.02	0.091	
	1000	010	13.8	8.8	102.2	8.0	79.8			29.06	0.105	
	1005	030	13.1	8.1	92.6	7.9	77.3			29.25	0.169	
93/09/07	1030	000	14.9	9.0	107.8	8.0	75.9	1K	6.9	29.39	0.075	
	1035	010	14.1	7.9	93.2	8.0	78.9			29.51	0.130	
	1040	030	13.6	7.3	85.0	7.9	78.9			29.61	0.160	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/05	1435	000	0.010	0.060	416302	5.49J	1.30J
	1445	010	0.013	0.054	416303	3.31J	0.58J
	1455	030	0.015	0.054	416304		
92/11/03	1130	000	0.037	0.050	456302	1.56J	0.30J
	1135	010	0.038	0.054	456303	1.74J	0.47J
	1140	030	0.036	0.057	456304		
92/12/01	0945	000	0.016	0.078	496302	3.65J	0.87J
	0950	010	0.015	0.080	496303	3.63J	0.61J
	0955	030	0.016	0.079	496304		
93/01/11	1050	000	0.015	0.077	36302	2.17J	0.57J
	1100	010	0.012	0.076	36303	1.16J	0.63J
	1110	030	0.011	0.075	36304		
93/02/08	1000	000	0.028	0.065	76302	2.16J	0.68J
	1005	010	0.023	0.062	76303	2.08J	0.65J
	1010	030	0.026	0.068	76304		
93/03/03	1105	000	0.015	0.074	106302	1.31J	0.39J
	1110	010	0.011	0.074	106303	1.59J	0.48J
	1115	030	0.010K	0.076	106304		
93/04/12	1045	000	0.073	0.058	166302	0.30	0.20
	1050	010	0.064	0.059	166303	0.89	0.42
	1055	030	0.058	0.060	166304		
93/05/17	1020	000	0.012	0.026	216302	12.10	4.10
	1025	010	0.020	0.033	216303	3.80	1.20
	1030	030	0.033	0.043	216304		
93/06/07	1025	000	0.037	0.044	246302	4.60	1.40
	1030	010	0.042	0.046	246303	3.20	2.10
	1045	030	0.039	0.045	246304		
93/07/12	1020	000	0.028	0.047	296302	4.60	1.60
	1025	010	0.027	0.044	296303	6.60	2.10
93/08/09	0955	000	0.017	0.052	336302	8.10	1.60
	1000	010	0.025	0.049	336303	5.70	1.70
	1005	030	0.044	0.057	336304		
93/09/07	1030	000	0.010K	0.033	376302	8.50	2.20
	1035	010	0.021	0.034	376303	5.10	1.40
	1040	030	0.031	0.038	376304		

EAS001
EAST SOUND AT ROSARIO POINT
48 38 35.0 122 52 56.0 2F000 Elev= 0 ft
53055 Washington San Juan Co. PACIFIC NORTHWEST
PUGET SOUND (San Juan-02) 131102
21540000 Reach=17110003000 0.000 Drg= 0 sqmi
AMBNT/OCEAN

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/11/09	1300	000	10.1	8.3	89.9	7.8	82.8		11.9	30.63		
	1305	010	10.1	8.1	88.4	7.8	82.3			30.64		
	1310	030	9.9	6.5	70.9	7.7	68.6			30.74		
93/03/16	1355	000	8.3	15.5J	161.6J	8.3	52.1		4.3	30.35		
	1400	010	7.1	14.2J	143.5J	8.1	55.5			30.37		
	1405	030	7.2	9.4J	95.3J	7.7	60.2			30.53		
93/04/27	1400	000	10.4	12.3J	134.6J	8.4	64.0		4.5	30.39		
	1410	010	9.7	11.7J	125.6J	8.3	59.2			30.41		
	1420	029	8.9	8.2J	85.6J	8.0	66.2			30.44		
93/05/26	1255	000	12.5	13.7J	156.2J	8.2	59.6		5.0	30.05		
	1300	010	11.4	11.4J	127.1J	8.1	72.1			30.07		
	1305	030	10.3	6.2J	67.5J	7.7	69.5			30.31		
93/06/30	1140	000	15.4	10.3J	124.5J	8.2	83.9		8.5	29.77		
	1145	010	11.5	8.3J	92.6J	7.9	80.1			29.90		
	1150	029	11.2	2.7J	30.0J	7.5	70.4			30.02		
93/07/21	1330	000	15.1	9.6	114.7	8.2	77.6		7.6	29.14		
	1335	010	11.3	6.5	72.0	7.7	82.0			30.06		
	1340	029	10.9	6.0	66.0	7.7	63.6			30.36		
93/08/24	1205	000	13.4	8.7	100.9	8.0	65.6		6.0	30.21		
	1210	010	12.0	6.2	70.5	7.8	77.1			30.24		
	1215	030	11.2	5.4	59.8	7.8	70.0			30.48		
93/09/20	1440	000	13.1	12.8	148.0	8.3	60.3		3.1	30.09		
	1445	010	11.5	5.1	56.5	7.8	82.0			30.34		
	1450	030	11.2	6.7	74.3	7.9	69.4			30.49		

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L

ELB015
ELLIOTT BAY EAST OF DUWAMISH HEAD
47 34 48.0 122 22 06.0 2F000 Elev= 0 ft
53033 Washington King Co. PACIFIC NORTHWEST
PUGET SOUND (Duwamish/Green-09) 131109
21540000 Reach=17110019000 0.000 Drg= 0 sqmi
AMBNT/OCEAN

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/26	1115	000	12.7	6.3	71.9	7.7	84.9	1	14.0	29.94	0.294	
	1120	010	12.4	6.1	70.0	7.7	86.3			30.56	0.291	
	1130	030	12.3	6.1	69.7	7.7	84.0			30.57		
92/11/18	1225	000	11.3	7.2	78.4	7.7	78.8	43	11.0	26.91	0.345	
	1235	010	11.6	6.6	74.3	7.7	84.7			30.50	0.348	
	1240	030	11.6	6.4	72.1	7.7	84.8			30.53		
92/12/21	1300	000	9.5	7.7	81.6	7.7	78.6	10	10.7	28.17	0.330	
	1310	010	9.9	7.4	79.4	7.7	83.9			30.31	0.329	
	1320	030	9.8	7.4	79.6	7.7	83.3			30.31		
93/02/01	1450	000	7.9	9.1	90.8	7.7	68.4	1	9.1	24.83	0.385	
	1500	010	8.1	8.5	88.0	7.7	82.1			30.01	0.374	
	1510	030	8.1	8.4	86.7	7.7	80.5			30.12		
93/03/09	1345	000	8.4	10.3J	104.2J	7.7	81.6	1	9.0	26.26	0.393	
	1355	010	7.8	9.6J	98.3J	7.6	85.7			29.94	0.389	
	1405	030	7.7	9.4J	96.1J	7.6	85.0			29.97		
93/04/19	1335	000	9.7	13.9J	147.9J	8.2	62.2	1K	5.1	29.14	0.083	
	1345	010	8.9	12.2J	128.1J	8.1	69.6			29.46	0.199	
	1355	030	8.4	9.6J	99.8J	7.9	84.6			29.68		
93/05/18	1320	000	13.3	15.4J	171.0J	8.3	43.0		3.4	23.28	0.010K	
	1325	010	10.9	13.4J	146.2J	8.0	55.2			28.42	0.056	
	1330	030	9.8	10.4J	110.9J	7.7	82.0			29.09		
93/06/14	1330	000	13.2	13.3J	148.7J	8.2	53.8	1	3.2	25.12	0.062	
	1340	010	11.0	10.6J	115.6J	8.0	78.7			29.03	0.151	
	1350	030	10.6	9.5J	103.7J	7.9	85.8			29.20		
93/07/19	1230	000	13.0	10.2	114.9	7.9	64.1	38	3.8	26.58	0.201	
	1240	010	11.7	7.7	85.8	7.8	85.4			29.17	0.231	
	1250	030	11.3	7.1	78.1	7.7	87.6			29.33		
93/08/18	1450	000	14.6	8.2	96.3	7.9	58.6	3	6.4	27.16	0.204	
	1500	010	12.6	8.3	94.4	7.9	82.9			29.64	0.196	
	1505	030	12.4	7.6	86.2	7.8	85.4			29.72		
93/09/08	1435	000	15.3	10.6	125.9	7.9	69.1	1K	6.0	27.49	0.145	
	1445	010	12.5	7.0	79.4	7.8	87.2			29.98	0.242	
	1450	030	12.4	6.9	77.9	7.8	87.1			30.07		

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/26	1115	000	0.010K	0.070	446341	0.21J	0.05J
	1120	010	0.010K	0.071	446342	0.33J	0.09J
92/11/18	1225	000	0.012	0.075	476341	0.34J	0.19J
	1235	010	0.010K	0.080	476342	0.46J	0.13J
92/12/21	1300	000	0.010K	0.077	526341	0.26J	0.17J
	1310	010	0.049	0.083	526342	0.26J	0.17J
93/02/01	1450	000	0.015	0.063	66341	0.27J	0.23J
	1500	010	0.010K	0.067	66342	0.42J	0.21J
93/03/09	1345	000	0.038	0.057	116341	0.35	0.36
	1355	010	0.018	0.073	116342	0.23	0.12
93/04/19	1335	000	0.010K	0.031	176341	24.10	4.90
	1345	010	0.010K	0.045	176342		
93/05/18	1320	000	0.010K	0.010K		3.60	2.50
	1325	010	0.010K	0.019		8.00	2.20
93/06/14	1330	000	0.010K	0.021	256341	10.30	6.70
	1340	010	0.010K	0.041	256342	7.00	4.00
93/07/19	1230	000	0.010K	0.045	306341	3.30	1.90
	1240	010	0.010K	0.053	306342	1.00	1.70
93/08/18	1450	000	0.017	0.044	346341	0.83	0.24
	1500	010	0.010K	0.045	346342	4.40	1.40
93/09/08	1435	000	0.010K	0.023	376341	6.90J	3.00J
	1445	010	0.011	0.039	376342	0.68J	0.65J

ELD001
ELD INLET NEAR FLAPJACK POINT
47 06 23.0 122 56 55.0 2F 0 Elev= 0 ft
53067 Washington Thurston Co. PACIFIC NORTHWEST
PUGET SOUND (Deschutes-13) 131113
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/05	1555	000	15.8	10.5	127.5	8.2	66.5	1K		29.77	0.060	
	1605	010	14.9	8.3	99.0	8.0	72.4			29.83	0.090	
92/11/03	1450	000	12.3	7.5	84.9	7.8	71.7	1K	5.5	29.60	0.163	
	1455	010	12.7	6.9	78.4	7.8	77.8			29.85	0.163	
92/12/01	1240	000	9.8	8.5	91.2	7.8	68.2	2	5.0	29.26	0.289	
	1245	010	10.3	8.0	86.2	7.7	74.7			29.53	0.287	
93/01/11	1520	000	5.2	10.3	98.0	7.8	71.5	1K	4.7	28.58		
	1525	010	6.5	9.3	91.9	7.7	72.2			29.16	0.299	
93/02/08	1310	000	7.6	9.6	97.0	7.8	75.4		7.0	28.03	0.337	
	1315	010	7.6	9.1	92.5	7.7	75.9	1K		28.71	0.366	
93/03/03	1410	000	7.3	12.1J	122.1J	7.8	85.7	1K	9.9	28.72	0.258	
	1415	010	6.9	11.2J	111.7J	7.7	84.5			29.03	0.306	
93/04/12	1405	000	9.7	8.0J	84.6J	8.0	73.6	1K	5.4	28.12	0.175	
	1410	010	9.3	10.2J	107.7J	7.9	76.1			28.68	0.247	
93/05/17	1535	000	17.9	11.4J	142.7J	8.1	69.2	1K	4.9	27.72	0.010K	
	1540	010	11.8	14.8J	164.5J	8.1	68.2			28.48	0.010K	
93/06/14	1750	000	15.4	9.4J	113.0J	8.0	75.6	8	6.0	28.27	0.084	
	1800	010	13.0	8.9J	101.7J	8.0	76.7			28.56	0.076	
93/07/12	1315	000	15.1	9.6	114.9	8.1	75.8	1K	4.5	28.64	0.058	
	1320	010	14.2	8.4	98.2	8.0	69.9			28.70	0.080	
93/08/09	1415	000	16.8	12.4	153.0	8.2	73.7	1K	1.6	28.75	0.010K	
	1420	009	14.8	8.0	95.0	8.0	67.9			28.93	0.033	
93/09/07	1315	000	18.4	13.5	171.6	8.4	65.4	1K	2.5	28.83	0.010K	
	1320	010	15.1	7.3	87.4	8.0	57.5			29.33	0.051	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/05	1555	000	0.010K	0.045	416317	16.78J	1.65J
	1605	010	0.012	0.052	416318	11.18J	2.46J
92/11/03	1450	000	0.094	0.062	456317	3.03J	0.64J
	1455	010	0.066	0.056	456318	2.97J	0.54J
92/12/01	1240	000	0.046	0.073	496317	7.06J	1.40J
	1245	010	0.036	0.076		3.65J	0.92J
93/01/11	1520	000			36317	0.74J	0.23J

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
93/01/11	1525	010	0.021	0.072	36318	4.22J	1.03J
93/02/08	1310	000	0.043	0.060		1.44J	0.46J
	1315	010	0.034	0.069	76318	2.80J	0.33J
93/03/03	1410	000	0.017	0.063	106317	1.79J	0.35J
	1415	010	0.019	0.069	106318	3.53J	0.84J
93/04/12	1405	000	0.068	0.044	166317	1.30	0.59
	1410	010	0.075	0.053	166318	3.50	0.89
93/05/17	1535	000	0.010K	0.021	216317	1.20	0.35
	1540	010	0.010K	0.021	216318	8.50	1.90
93/06/14	1750	000	0.051	0.045		2.80	1.30
	1800	010	0.048	0.044		2.50	0.85
93/07/12	1315	000	0.020	0.044	296317	1.10	0.48
	1320	010	0.061	0.051	296318	4.00	1.00
93/08/09	1415	000	0.010	0.045	336317	23.50	2.40
	1420	009	0.033	0.050	336318	2.60	0.81
93/09/07	1315	000	0.010K	0.022	376317	4.70	0.88
	1320	010	0.050	0.037	376318	4.50	0.91

GRG002
STRAIT OF GEORGIA NEAR PATOS ISLAND
48 48 30.0 122 57 10.0 2F000 Elev= 0 ft
53055 Washington San Juan Co. PACIFIC NORTHWEST
PUGET SOUND (San Juan-02) 131102
21540000 Reach=17110003 0.000 Drg= 0 sqmi
AMBNT/OCEAN/RMP

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/11/09	1330	000	9.7	9.5	97.7	7.8	70.3	1	5.7	23.13	0.266	
	1335	010	9.9	8.4	87.7	7.7	83.3			25.63	0.282	
	1340	030	10.0	5.8	62.4	7.6	86.5				0.332	
92/12/15	1050	000	8.6	8.0	83.8	7.6	81.4	1K	8.5	29.57	0.304	
	1100	010	9.0	7.2	76.4	7.6	84.3			29.88	0.315	
	1110	023	8.9	7.2	75.8	7.6	82.8			30.08	0.373	
93/01/26	1330	000	7.2	8.6	86.8	7.7	83.4	1K	10.8	30.05	0.506	
	1335	010	7.2	8.4	84.8	7.7	82.4			30.23	0.513	
	1340	030	7.2	8.3	83.8	7.7	81.8			30.30	0.515	
93/02/17	1420	000	7.3	8.7	88.3	7.7	82.2	1K	9.4	30.21	0.387	
	1425	010	7.3	8.6	87.6	7.7	82.4			30.22	0.361	
	1430	030	7.3	8.6	87.2	7.7	82.5			30.27	0.372	
93/04/27	1425	000	9.3	9.4J	99.8J	8.0	79.9	1K	8.6	29.88	0.261	
	1430	010	8.8	8.9J	93.1J	8.0	79.6			30.19	0.282	
	1440	030	8.6	8.5J	88.6J	7.9	80.4			30.28	0.308	
93/05/26	1315	000	14.9	9.3J	104.0J	8.1	57.4		3.5	19.29	0.097	
	1320	010	10.0	9.0J	97.3J	7.9	81.3			29.47	0.197	
	1330	030	9.7	8.7J	93.3J	7.9	81.1			29.94	0.220	
93/06/30	1330	000	12.1	9.1J	101.3J	8.0	76.3	1K	7.4	27.38	0.136	
	1335	010	11.2	8.2J	90.5J	7.9	79.2			28.67	0.191	
	1345	030	11.0	7.7J	84.0J	7.9	79.3			28.91	0.205	
93/07/21	1235	000	13.4	8.9	101.2	8.0	75.2	1K	5.8	27.60	0.109	
	1240	010	10.9	6.6	73.0	7.7	84.6			29.40	0.215	
	1250	030	10.9	6.4	70.3	7.7	81.8			29.94	0.282	
93/08/24	1345	000	12.6	7.6	86.5	8.0	79.3	1K	9.8	28.82	0.257	
	1350	010	11.4	6.8	75.4	7.9	82.2			29.57	0.269	
	1400	030	11.1	6.3	69.8	7.8	83.7			29.81	0.314	
93/09/20	1525	000	12.0	7.5	84.0	7.9	77.0	1K	9.9	28.76	0.228J	
	1535	010	11.1	6.5	71.5	7.8	83.4			29.90	0.248J	
	1540	030	10.7	6.0	65.8	7.8	83.1			30.39	0.301J	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/11/09	1330	000	0.012	0.047	466256	1.02J	0.39J
	1335	010	0.010	0.051	466257	0.38J	0.26J
	1340	030	0.010K	0.065	466258		
92/12/15	1050	000	0.010K	0.059	516256	0.17J	0.13J
	1100	010	0.010K	0.061	516257	0.23J	0.16J
	1110	023	0.010K	0.080	516258		
93/01/26	1330	000	0.010K	0.056	56256	0.33J	0.20J
	1335	010	0.010K	0.069	56257	0.24J	0.23J
	1340	030	0.010K	0.069	56258		
93/02/17	1420	000	0.010K	0.058	86256	0.19J	0.17J
	1425	010	0.010K	0.068	86257	0.22J	0.22J
	1430	030	0.010K	0.069	86258		
93/04/27	1425	000	0.010K	0.055	186256	2.20	0.78
	1430	010	0.013	0.058	186257	0.81	0.55
	1440	030	0.016	0.061	186258		
93/05/26	1315	000	0.015	0.018		1.10	0.28
	1320	010	0.016	0.044		2.30	1.10
	1330	030	0.021	0.052			
93/06/30	1330	000	0.010K	0.031	276256	2.70	0.84
	1335	010	0.010K	0.041	276257	1.80	1.10
	1345	030	0.011	0.045	276258		
93/07/21	1235	000	0.010K	0.032		5.60	0.52
	1240	010	0.010K	0.048		1.90	0.75
	1250	030	0.010K	0.057			
93/08/24	1345	000	0.010K	0.037	356256	3.00	0.81
	1350	010	0.010K	0.046	356257	1.60	0.58
	1400	030	0.010K	0.055	356258		
93/09/20	1525	000	0.016J	0.051J	396256	2.30	0.63
	1535	010	0.013J	0.054J	396257	2.30	0.90
	1540	030	0.017J	0.063J			

HCB004
HOOD CANAL AT SISTERS POINT
47 21 23.0 123 01 25.0 2F 0 Elev= 0 ft
53045 Washington Mason Co. PACIFIC NORTHWEST
PUGET SOUND (Kitsap-15) 131115
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/05	1155	000	14.5	10.7	123.5	8.1	58.8	1	3.4	24.81	0.010K	
	1205	010	10.3	1.4	14.7	7.3	78.7			29.68	0.349	
	1210	030	10.0	0.5	5.5	7.2	73.4			29.99	0.371	
92/11/09	0945	000	8.9	10.0	100.1	8.0	46.8	1	2.9	22.17	0.040	
	0950	010	11.4	3.6	40.3	7.4	74.6			30.51	0.354	
	0955	030	11.5	4.1	45.5	7.5	68.6			30.64	0.346	
93/02/17	1025	000	7.2	11.9	117.4	8.2	70.0	1K	6.0	26.26	0.058	
	1030	010	7.7	10.9	109.8	8.0	77.3			26.90	0.114	
	1035	030	9.8	4.7	50.7	7.5	84.2			30.23	0.332	
93/03/16	1040	000	9.6	12.5J	129.4J	8.2	74.3	1K	5.6	24.53	0.010K	
	1045	010	9.0	6.2J	65.8J	7.4	79.9			30.11	0.348	
	1050	030	8.7	6.4J	66.7J	7.5	77.2			30.32	0.389	
93/04/27	1025	000	10.2	10.6J	111.1J	7.9	61.1	1	4.2	25.07	0.129	
	1035	010	8.8	6.3J	65.8J	7.5	82.1			30.06	0.362	
	1045	030	8.7	6.0J	62.9J	7.6	70.1			30.18	0.404	
93/05/26	0945	000	16.0	11.0J	129.1J	8.3	61.6	1K	4.5	22.88	0.010K	
	0955	010	10.8	9.0J	97.9J	8.0	30.5			28.42	0.032	
	1000	030	8.9	6.1J	63.9J	7.6	75.7			29.80	0.291	
93/06/30	0935	000	17.4	9.1J	110.2J	8.2	73.5	1	6.9	23.37	0.010K	
	0945	010	11.9	9.3J	103.7J	8.0	81.9			28.49	0.029	
	0955	030	9.7	4.6J	49.5J	7.4	77.9			29.37	0.233	
93/07/21	1655	000	16.2	9.9	117.4	8.2	71.3	3	4.5	24.18	0.010K	
	1705	010	12.1	9.0	100.2	8.0	73.4			28.77	0.032	
	1710	030	9.7	4.5	47.7	7.4	69.4			29.45	0.330	
93/08/24	1005	000	17.0	10.1	123.1	8.3	38.9	1K	2.2	26.40	0.010K	
	1015	010	10.4	4.8	52.6	7.6	77.8			29.38	0.266	
	1025	030	9.5	3.7	39.5	7.4	67.1			29.62	0.385	
93/09/20	0955	000	16.2	9.2	109.5	8.3	62.4	1	3.3	25.53	0.010K	
	1000	010	9.9	3.7	39.3	7.5	78.7			29.55	0.387J	
	1005	015	9.6	3.0	32.0	7.4	77.4			29.66	0.454J	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/05	1155	000	0.010K	0.026	416319	1.31J	1.03J
	1205	010	0.010K	0.087	416320	2.53J	0.88J
	1210	030	0.010K	0.097	416321		
92/11/09	0945	000	0.011	0.052	466319	37.89J	2.82J
	0950	010	0.010K	0.093	466320	0.31J	0.35J
	0955	030	0.010K	0.086	466321		
93/02/17	1025	000	0.010K	0.032	86319	6.98J	1.37J
	1030	010	0.010K	0.042	86320	4.84J	1.15J
	1035	030	0.033	0.090	86321		
93/03/16	1040	000	0.021	0.015	126319	3.20	1.10
	1045	010	0.037	0.082	126320	3.80	1.20
	1050	030	0.023	0.085	126321		
93/04/27	1025	000	0.010K	0.029	186319	3.70	1.10
	1035	010	0.010K	0.083	186320	0.73	0.37
	1045	030	0.010K	0.086	186321		
93/05/26	0945	000	0.010K	0.010K	226319	3.20	0.45
	0955	010	0.010K	0.036	226320	53.70	12.00
	1000	030	0.010K	0.079	226321		
93/06/30	0935	000	0.010K	0.013	276319	0.61	0.19
	0945	010	0.010K	0.033	276320	3.80	1.10
	0955	030	0.055	0.082	276321		
93/07/21	1655	000	0.010K	0.021	306319	0.97	0.46
	1705	010	0.010K	0.037	306320	5.80	1.80
	1710	030	0.010K	0.080	306321		
93/08/24	1005	000	0.010K	0.011	356319	9.90	1.40
	1015	010	0.010K	0.069	356320	1.50	0.75
	1025	030	0.010K	0.081	356321		
93/09/20	0955	000	0.010K	0.016J	396319	4.00	1.10
	1000	010	0.010K	0.092J	396320	2.00	0.85
	1005	015	0.010K	0.101J			

HCB006
HOOD CANAL NEAR KING SPIT
47 44 52.0 122 43 49.0 2F 0 Elev= 0 ft
53035 Washington Kitsap Co. PACIFIC NORTHWEST
PUGET SOUND (Kitsap-15) 131115
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/STREAM

INDEX
MILES . . . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/05	1100	000	12.9	8.3	95.0	7.9	74.5	1K	5.9	29.12	0.140	
	1110	010	11.8	5.1	56.7	7.6	83.9			30.18	0.230	
	1120	030	11.7	5.1	57.8	7.7	81.9			30.60	0.274	
92/11/09	1035	000	10.9	6.2	68.2	7.6	79.1	1K	8.5	28.95	0.334	
	1040	010	11.2	5.5	60.7	7.6	83.3			30.04	0.340	
	1045	030	11.2	5.2	58.0	7.6	82.9			30.64	0.344	
92/12/15	1425	000	9.1	7.7	81.5	7.7	82.8	1K	10.5	29.28	0.342	
	1435	010	9.6	7.0	74.6	7.7	81.0			30.17	0.351	
	1445	030	9.5	7.1	75.5	7.7	80.4			30.25	0.340	
93/01/26	1510	000	8.9	8.4	87.4	7.7	76.1	1K	4.7	28.61	0.459	
	1515	010	8.6	7.8	81.2	7.7	82.1			29.92	0.470	
	1520	030	8.2	8.0	83.0	7.7	79.9			30.23	0.507	
93/02/17	1120	000	7.9	8.4	85.9	7.7	75.6	1K	9.5	30.14	0.378	
	1125	010	7.8	8.4	86.3	7.7	81.6			30.15	0.380	
	1130	030	7.8	8.3	85.4	7.7	81.7			30.13	0.371	
93/03/16	1130	000	8.9	12.5J	129.6J	8.0	65.3	1K	5.1	28.08	0.087	
	1135	010	8.2	9.5J	98.4J	7.7	79.3			29.80	0.304	
	1140	030	7.9	8.9J	91.3J	7.7	81.1			30.22	0.332	
93/04/27	1115	000	10.0	10.2J	107.6J	8.1	78.1	1K	6.6	27.09	0.128	
	1125	010	9.3	9.3J	98.3J	8.0	76.7			29.42	0.153	
	1135	030	8.9	8.6J	90.5J	7.9	75.1			29.94	0.252	
93/05/26	1030	000	14.5	13.1J	152.2J	8.4	46.8	1	3.5	26.51	0.010K	
	1035	010	11.3	10.9J	120.4J	8.1	60.8			28.97	0.129	
	1040	030	9.6	8.2J	87.1J	7.8	74.1			29.78	0.235	
93/06/30	1025	000	16.1	9.8J	117.9J	8.2	70.9	1K	8.1	26.82	0.012	
	1030	010	11.7	8.5J	94.4J	7.9	79.1			29.10	0.179	
	1035	030	10.6	6.9J	75.7J	7.7	78.1			29.66		
93/07/21	1605	000	14.2	9.0	104.7	8.0	70.9	1	4.7	28.28	0.115	
	1610	010	11.5	6.9	76.9	7.8	78.8			29.32	0.208	
	1620	030	11.2	6.5	72.2	7.7	76.9			29.89	0.220	
93/08/24	1050	000	14.2	8.7	101.6	8.1	70.0	1K	5.7	28.76	0.125	
	1055	010	13.0	7.6	87.7	8.0	73.7			29.52	0.230	
	1105	030	11.9	6.7	75.1	7.9	74.1			30.23	0.247	
93/09/20	1055	000	13.6	8.1	94.5	8.0	79.5	1K	7.9	29.33	0.113J	
	1105	010	12.4	7.2	81.7	7.9	80.7			29.97	0.216J	
	1110	030	11.8	6.6	74.0	7.8	78.6			30.33	0.218J	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/05	1100	000	0.010K	0.044	416322	3.03J	0.66J
	1110	010	0.010K	0.056	416323	0.78J	0.85J
	1120	030	0.010K	0.062	416324		
92/11/09	1035	000	0.010K	0.074	466322	0.91J	0.61J
	1040	010	0.010K	0.076	466323	0.76J	0.56J
	1045	030	0.010K	0.077	466324		
92/12/15	1425	000	0.010K	0.078	516322	0.71J	0.22J
	1435	010	0.010K	0.078	516323	0.58J	0.28J
	1445	030	0.010K	0.080	516324		
93/01/26	1510	000	0.010K	0.072	56322	0.71J	0.27J
	1515	010	0.010K	0.073	56323	0.62J	0.29J
	1520	030	0.010K	0.076	56324		
93/02/17	1120	000	0.010K	0.078	86322	0.71J	0.24J
	1125	010	0.010K	0.078	86323	0.32J	0.23J
	1130	030	0.010K	0.078	86324		
93/03/16	1130	000	0.019	0.034	126322	11.70	2.60
	1135	010	0.024	0.065	126323		
	1140	030	0.025	0.069	126324		
93/04/27	1115	000	0.016	0.033	186322	0.95	0.32
	1125	010	0.020	0.039	186323	2.00	0.69
	1135	030	0.028	0.057	186324		
93/05/26	1030	000	0.010K	0.010K	226322	3.80	3.90
	1035	010	0.012	0.039	226323	8.00	2.20
	1040	030	0.016	0.060	226324		
93/06/30	1025	000	0.010K	0.015	276322	1.10	0.34
	1030	010	0.010K	0.047	276323	2.20	0.69
	1035	030	0.010K	0.057			
93/07/21	1605	000	0.010K	0.035	306322	4.20	1.30
	1610	010	0.010K	0.052	306323	2.50	0.58
	1620	030	0.012	0.055	306324		
93/08/24	1050	000	0.010K	0.042	356322	2.30	0.68
	1055	010	0.010	0.052	356323	1.20	0.73
	1105	030	0.018	0.056	356324		
93/09/20	1055	000	0.010K	0.037J	396322	0.87	0.55
	1105	010	0.019J	0.053J	396323	1.10	0.57
	1110	030	0.019J	0.054J			

HCB007
HOOD CANAL AT INNER LYNCH COVE
47 23 54.0 122 55 42.0 2F000 Elev= 0 ft
53045 Washington Mason Co. PACIFIC NORTHWEST
PUGET SOUND (Kitsap-15) 131115
21540000 Reach=17110018000 0.000 Drg= 0 sqmi
AMBNT/OCEAN

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
93/05/26	0930	000	16.2	11.5J	136.3J	8.4	62.8		5.0	23.99		
	0935	010	11.3	10.7J	117.4J	8.2	30.0			28.13		
	0940	017	9.2	5.6J	97.2J	7.5	72.8			29.52		

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L

HND001
HENDERSON INLET AT CLIFF POINT
47 09 05.0 122 49 59.0 2F000 Elev= 0 ft
53067 Washington Thurston Co. PACIFIC NORTHWEST
PUGET SOUND (Deschutes-13) 131113
21540000 Reach=17110019 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/05	1415	000	14.8	8.7	103.6	8.0	69.0	1K		29.81	0.097	
	1425	010	14.4	7.6	89.8	8.0	68.4			29.96	0.122	
92/11/03	1200	000	12.3	7.1	80.5	7.8	76.6	1K	7.6	29.79	0.166	
	1210	010	12.7	6.9	79.1	7.8	77.0			29.99	0.178	
92/12/01	1015	000	9.7	8.3	88.8	7.7	68.4	2	6.0	29.44	0.290	
	1020	010	10.6	7.6	83.2	7.7	72.2			29.76	0.290	
93/01/11	1130	000	6.4	9.4	93.2	7.7	72.9	1K	5.2	29.18	0.309	
	1140	010	6.9	9.1	90.6	7.7	70.6			29.34	0.312	
93/02/08	1030	000	7.6	9.1	92.8	7.7	72.3	1K	6.9	28.92	0.328	
	1035	010	7.6	8.9	90.9	7.7	72.8			29.09	0.369	
93/03/03	1145	000	7.3	11.1J	112.3J	7.7	79.6	1	5.4	29.13	0.317	
	1150	010	7.2	10.6J	106.8J	7.7	81.6			29.30	0.346	
93/04/12	1125	000	9.4	8.3J	87.9J	7.9	77.1	1K	7.5	28.63	0.271	
	1130	010	8.7	9.8J	102.4J	7.8	79.3			28.99	0.299	
93/05/17	1100	000	16.1	13.1J	158.4J	8.0	51.9	1	3.5	27.57	0.018	
	1105	008	10.8	10.9J	118.8J	7.8	53.3			28.78	0.021	
93/06/07	1110	000	12.7	10.3J	117.1J	8.0	67.7	2	3.0	28.67	0.078	
	1120	010	12.3	10.2J	114.2J	8.0	64.5			28.71	0.076	
93/07/12	1050	000	14.3	9.0	105.6	8.0	68.4	1	4.0	28.65	0.075	
	1055	010	13.5	8.4	96.4	7.9	65.7			28.79	0.111	
93/08/09	1030	000	15.0	10.7	128.1	8.2	77.5	1K	4.9	28.94	0.042	
	1035	010	14.3	9.1	106.6	8.0	67.0			29.05	0.078	
93/09/07	1115	000	16.9	9.1	112.5	8.0	62.3	3	4.1	28.69	0.062	
	1120	010	14.7	8.4	100.1	8.0	64.3			29.43	0.099	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/05	1415	000	0.010K	0.047	416305	3.60J	0.87J
	1425	010	0.013	0.048	416306	6.45J	1.42J
92/11/03	1200	000	0.049	0.050	456305	2.19J	0.54J
	1210	010	0.046	0.052	456306	1.65J	0.51J
92/12/01	1015	000	0.027	0.079	496305	3.65J	1.13J
	1020	010	0.026	0.078	496306	2.70J	0.74J
93/01/11	1130	000	0.016	0.075	36305	2.06J	0.49J

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
93/01/11	1140	010	0.018	0.075	36306	3.23J	0.68J
93/02/08	1030	000	0.029	0.062	76305	2.49J	0.51J
	1035	010	0.031	0.069	76306	2.48J	0.53J
93/03/03	1145	000	0.013	0.071	106305	1.57J	0.61J
	1150	010	0.012	0.074	106306	1.05J	0.30J
93/04/12	1125	000	0.059	0.056	166305	0.61	0.33
	1130	010	0.055	0.058	166306	2.10	0.58
93/05/17	1100	000	0.012	0.024	216305	1.60	0.72
	1105	008	0.020	0.025	216306	15.60	4.70
93/06/07	1110	000	0.025	0.038	246305	5.20	2.00
	1120	010	0.033	0.041	246306	6.80	2.30
93/07/12	1050	000	0.034	0.044	296305	1.30	0.63
	1055	010	0.051	0.051	296306	5.80	2.30
93/08/09	1030	000	0.010K	0.042	336305	3.30	0.76
	1035	010	0.017	0.053	336306	13.00	1.50
93/09/07	1115	000	0.034	0.040	376305	1.80	0.66
	1120	010	0.017	0.035	376306	6.60	1.90

LOP001
LOPEZ ISLAND AT DECATUR ISLAND
48 38 35.0 122 52 56.0 2F000 Elev= 0 ft
53055 Washington San Juan Co. PACIFIC NORTHWEST
PUGET SOUND (San Juan-02) 131102
21540000 Reach=17110003000 0.000 Drg= 0 sqmi
AMBNT/OCEAN

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/11/09	1230	000	9.9	7.0	75.3	7.7	79.6		7.7	30.26		
	1235	010	9.9	6.9	75.0	7.7	76.2			30.52		
93/02/17	1300	000	7.2	9.2	93.5	7.7	77.3		6.5	30.25		
	1305	010	6.7	9.4	94.4	7.8	73.0			30.27		
93/03/16	1320	000	7.8	9.4J	97.1J	7.7	77.4		7.5	30.39		
	1325	009	7.7	9.4J	96.9J	7.7	76.8			30.38		
93/04/27	1345	000	9.7	9.3J	100.2J	8.0	74.2		6.0	30.31		
	1355	010	9.1	9.3J	99.0J	8.0	68.6			30.33		
93/05/26	1140	000	11.6	11.0J	122.9J	8.1	71.8		6.5	29.98		
	1145	010	10.4	9.6J	104.7J	8.0	70.5			29.97		
93/06/30	1125	000	12.2	9.0J	102.3J	7.9	74.5		7.5	29.86		
	1130	009	11.3	8.3J	92.1J	7.9	69.8			29.96		
93/07/21	1455	000	11.6	7.6	85.4	7.9	70.7		5.2	30.23		
	1500	006	11.1	7.0	77.5	7.8	76.5			30.25		
93/08/24	1155	000	11.5	7.5	84.2	7.9	76.6		7.5	30.29		
	1200	010	11.3	7.0	78.3	7.8	76.4			30.31		
93/09/20	1310	000	11.2	6.8	75.3	7.8	79.6		7.8	30.40		
	1320	010	11.0	6.6	73.1	7.8	76.9			30.41		

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L

OAK004
OAKLAND BAY NEAR EAGLE POINT
47 12 49.0 123 04 35.0 2F 0 Elev= 0 ft
53045 Washington Mason Co. PACIFIC NORTHWEST
PUGET SOUND (Kennedy/Goldsboro-14) 131114
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/05	1510	000	15.9	8.2	99.2	8.0	69.0	1K		28.55	0.063	
	1520	010	15.5	8.2	98.3	8.0	72.4			29.17	0.069	
92/11/03	1350	000	12.2	6.9	76.7	7.7	67.6	30	3.5	27.38	0.187	
	1355	009	12.4	6.9	77.5	7.7	72.5			28.59	0.145	
92/12/01	1155	000	9.1	8.4	86.8	7.7	66.5	4	4.4	26.47	0.291	
	1200	010	9.7	8.0	85.1	7.7	69.0			28.22	0.290	
93/01/11	1420	000	4.8	10.0	93.1	7.7	61.1	1K	3.7	26.58	0.329	
	1430	007	5.4	9.7	92.3	7.7	62.7			27.61	0.332	
93/02/08	1205	000	7.2	9.7	94.9	7.7	73.7	1K	5.5	24.59	0.307	
	1210	010	7.1	9.5	93.2	7.7	67.1			26.01	0.357	
93/03/03	1315	000	7.5	12.5J	121.8J	7.8	71.5	6	6.2	23.44	0.235	
	1320	010	6.7	11.9J	117.6J	7.8	80.4			27.46	0.254	
93/04/12	1315	000	11.3	7.9J	83.0J	8.0	63.8	1K	4.4	22.29	0.169	
	1320	010	10.0	10.5J	110.2J	8.0	72.7			25.68	0.203	
93/05/17	1435	000	15.4	12.4J	145.3J	8.1	59.7	1K	3.4	24.79	0.010K	
	1440	009	14.9	18.2J	211.6J	8.0	54.0			25.13	0.010K	
93/06/14	1655	000	16.2	9.7J	115.2J	8.0	65.7	25	3.9	24.52	0.044	
	1705	010	15.7	9.4J	111.0J	8.0	67.1			25.99	0.062	
93/07/12	1230	000	16.9	9.0	110.5	8.0	61.6	1	3.1	26.99	0.011	
	1235	007	16.6	8.5	103.7	8.0	60.9			27.36	0.021	
93/08/09	1320	000	18.6	10.5	133.4	8.2	65.1	1	4.0	27.30	0.010K	
	1325	010	17.9	9.3	116.0	8.1	68.1			27.59	0.010K	
93/09/07	1420	000	18.7	8.9	112.9	8.1	66.5	4	3.5	27.97	0.010K	
	1430	008	17.8	8.5	106.5	8.1	69.0			28.20	0.011	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/05	1510	000	0.019	0.053	416313	6.45J	2.36J
	1520	010	0.012	0.046	416314	6.64J	1.99J
92/11/03	1350	000	0.098	0.063	456313	2.08J	0.91J
	1355	009	0.072	0.050	456314	0.91J	0.84J
92/12/01	1155	000	0.064	0.079	496313	1.39J	0.60J
	1200	010	0.053	0.078	496314	2.76J	1.41J
93/01/11	1420	000	0.032	0.073	36313	0.92J	0.54J

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
93/01/11	1430	007	0.026	0.073	36314	2.04J	0.90J
93/02/08	1205	000	0.041	0.054	76313	0.57J	0.28J
	1210	010	0.043	0.064	76314	1.23J	0.74J
93/03/03	1315	000	0.019	0.059	106313	0.82J	0.26J
	1320	010	0.021	0.064	106314	0.44J	0.19J
93/04/12	1315	000	0.069	0.038	166313	3.40	1.30
	1320	010	0.059	0.045	166314	2.20	0.88
93/05/17	1435	000	0.010K	0.019	216313	10.00	4.30
	1440	009	0.010K	0.020	216314	11.40	5.60
93/06/14	1655	000	0.010K	0.037		8.90	1.70
	1705	010	0.019	0.042		9.30	3.40
93/07/12	1230	000	0.010K	0.058	296313	10.70	1.80
	1235	007	0.010K	0.046	296314	8.00	2.60
93/08/09	1320	000	0.010K	0.059	336313	21.10	2.30
	1325	010	0.010K	0.055	336314	13.80	2.10
93/09/07	1420	000	0.010K	0.033	376313	7.10	1.60
	1430	008	0.010K	0.032	376314	5.30	1.70

PSB003
PUGET SOUND AT WEST POINT
47 39 36.0 122 26 30.0 2F 0 Elev= 0 ft
53033 Washington King Co. PACIFIC NORTHWEST
Puget Sound 131191
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/26	1140	000	12.3	6.3	71.3	7.7	84.0	1K	11.5	30.47	0.305	
	1145	010	12.3	6.1	69.6	7.7	83.9			30.58	0.313	
	1150	030	12.3	6.1	69.3	7.7	83.9			30.59	0.300	
92/12/21	1150	000	9.6	7.7	82.7	7.7	80.0	3	9.5	29.93	0.341	
	1200	010	9.8	7.4	80.0	7.7	82.4			30.29	0.341	
	1210	027	9.8	7.4	79.6	7.7	82.5			30.32	0.338	
93/02/01	1400	000	8.2	9.0	92.5	7.7	79.8	1	8.5	28.93	0.413	
	1410	010	8.1	8.7	90.0	7.7	80.5			29.55	0.358	
	1420	030	8.0	8.4	87.1	7.7	81.6			30.06	0.373	
93/03/09	1310	000	7.9	9.9J	102.0J	7.7	83.6	1K	10.0	29.71	0.362	
	1320	010	7.8	9.8J	100.0J	7.6	83.7			29.86	0.368	
	1330	030	7.7	9.5J	97.7J	7.6	83.5			29.97	0.391	
93/04/19	1255	000	9.7	10.9J	116.2J	8.1	70.7	1K	7.5	28.76	0.219	
	1300	010	8.8	9.8J	102.8J	7.9	78.4			29.50	0.278	
	1305	016	8.6	9.8J	102.2J	7.9	79.9			29.65	0.302	
93/05/18	1240	000	14.2	11.8J	134.0J	8.4	42.4		3.2	24.17	0.010K	
	1245	010	10.2	11.6J	124.4J	7.9	70.4			28.82	0.197	
	1250	017	9.5	10.1J	107.3J	7.7	78.8			29.28	0.235	
93/06/14	1230	000	12.9	14.0J	157.3J	8.4	47.4	1K	2.6	27.00	0.010K	
	1240	010	10.7	9.5J	103.9J	7.9	79.8			29.12	0.209	
	1250	030	10.4	8.9J	96.6J	7.8	82.4			29.26	0.211	
93/07/19	1300	000	12.6	11.1	126.3	8.1	59.5	1	4.6	28.92	0.037	
	1310	010	12.4	10.1	113.8	8.0	65.2			29.08	0.126	
	1315	030	11.5	7.4	82.4	7.8	80.6			29.45	0.118	
93/08/18	1325	000	13.0	8.3	95.6	7.9	80.5	1K	7.9	29.50	0.183	
	1330	010	12.2	7.3	82.0	7.8	82.3			29.81	0.198	
	1340	030	11.7	6.6	73.5	7.7	81.0			30.03	0.208	
93/09/08	1320	000	13.6	9.6	111.5	8.0	71.3	1	7.2	29.91	0.107	
	1325	010	13.0	8.6	99.0	8.0	77.7			29.98	0.194	
	1330	030	12.5	7.3	83.1	7.9	82.8			30.08	0.210	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/26	1140	000	0.010K	0.070	446338	0.28J	0.18J
	1145	010	0.010K	0.071	446339	0.27J	0.21J
	1150	030	0.010K	0.071	446340		
92/12/21	1150	000	0.010K	0.077	526338	0.38J	0.20J
	1200	010	0.010K	0.077	526339	0.19J	0.15J
	1210	027	0.010K	0.076	526340		
93/02/01	1400	000	0.010K	0.071	66338	0.79J	0.14J
	1410	010	0.010K	0.071	66339	0.26J	0.15J
	1420	030	0.012	0.070	66340		
93/03/09	1310	000	0.020	0.070	116338	0.36	0.25
	1320	010	0.017	0.071	116339	0.49	0.31
	1330	030	0.021	0.071	116340		
93/04/19	1255	000	0.010K	0.048	176338	10.10	1.10
	1300	010	0.011	0.058	176339	6.30	0.73
	1305	016	0.018	0.063	176340		
93/05/18	1240	000	0.010K	0.010K		4.10	2.30
	1245	010	0.032	0.044		4.80	2.50
	1250	017	0.033	0.053			
93/06/14	1230	000	0.010K	0.010K	256338	11.30	7.70
	1240	010	0.029	0.050	256339	2.90	1.60
	1250	030	0.018	0.051	256340		
93/07/19	1300	000	0.010K	0.020	306338	12.00	4.80
	1310	010	0.010K	0.032	306339	8.30	1.90
	1315	030	0.010K	0.032	306340		
93/08/18	1325	000	0.010K	0.042	346338	4.10	1.00
	1330	010	0.010K	0.045	346339	2.70	0.51
	1340	030	0.010K	0.047	346340	2.70	0.79
93/09/08	1320	000	0.010K	0.026	376338	5.90J	3.40J
	1325	010	0.010K	0.034	376339	4.60J	2.70J
	1330	030	0.011	0.035	376340		

PSS019
POSSESSION SOUND OFF EAST GEDNEY ISLAND
48 00 40.0 122 18 00.0 2F 0 Elev= 0 ft
53061 Washington Snohomish Co. PACIFIC NORTHWEST
PUGET SOUND (Snohomish-07) 131107
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/11/09	1125	000	9.4	10.0	95.8	7.6	21.0	80	1.3	12.87	0.295	
	1130	010	11.8	6.1	68.2	7.7	85.8			29.62	0.315	
	1135	030	12.1	4.9	55.4	7.7	86.3			30.56	0.344	
92/12/15	1340	000	8.8	8.6	88.5	7.7	78.3	2	9.0	27.37	0.318	
	1350	010	9.8	7.4	79.0	7.7	84.1			28.95	0.319	
	1400	030	11.0	6.1	67.7	7.7	84.9			30.42	0.325	
93/01/26	1045	000	6.5	11.3	102.5	7.6	8.7	22S	0.9	15.46	0.494	
	1050	010	8.6	8.4	88.0	7.6	73.4			29.72	0.531	
	1055	030	8.8	8.1	85.3	7.6	80.0			30.06	0.518	
93/02/17	1550	000	6.2	10.5	100.2	7.8	77.7	1K	7.5	25.08	0.331	
	1555	010	8.1	8.7	90.1	7.7	85.0			29.85	0.394	
	1600	030	8.2	8.1	83.9	7.7	85.0			30.05	0.376	
93/03/16	1210	000	8.3	13.8J	134.7J	8.3	13.8	7	0.8	20.65	0.023	
	1215	010	8.3	10.2J	105.7J	7.8	77.7			29.09	0.232	
	1220	030	8.0	8.3J	85.5J	7.6	83.2			30.00	0.368	
93/04/27	1640	000	10.8	12.1J	121.1J	8.3	46.1		2.4	15.62	0.010K	
	1650	010	9.5	10.8J	113.3J	8.2	74.4			27.93	0.114	
	1700	030	8.9	10.1J	105.9J	8.1	77.5			29.47	0.188	
93/05/26	1525	000	16.5	9.9J	112.2J	8.3	68.9		11.2	15.30	0.038	
	1530	010	11.2	10.0J	108.9J	8.1	86.9			27.91	0.110	
	1540	030	9.6	9.2J	97.5J	7.9	86.1			29.21	0.197	
93/06/30	1535	000	15.8	11.5J	134.9J	8.4	67.9	1K	6.4	24.34	0.010K	
	1540	010	11.7	9.6J	106.1J	8.0	86.4			28.47	0.135	
	1545	030	10.7	7.8J	85.5J	7.8	86.2			29.15	0.215	
93/07/21	1015	000	15.2	9.7	109.3	8.0	70.3	91	9.2	18.80	0.010K	
	1020	010	12.0	8.0	88.8	7.8	87.1			28.60	0.171	
	1030	030	10.5	6.9	74.6	7.7	88.5			29.26	0.294	
93/08/24	1545	000	13.8	9.0	104.5	8.1	80.6	1K	9.3	27.82	0.127	
	1550	010	12.6	7.6	85.8	7.9	83.4			28.61	0.234	
	1555	030	11.3	6.3	69.6	7.8	86.4			29.67	0.314	
93/09/20	1150	000	12.9	8.3	94.6	7.9	80.7	1	11.2	28.00	0.146J	
	1155	010	11.8	5.8	65.3	7.7	87.6			29.77	0.309J	
	1205	030	11.6	5.5	62.0	7.7	86.2			29.98	0.326J	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/11/09	1125	000	0.057	0.036	466264	1.01J	0.86J
	1130	010	0.010K	0.075	466265	0.25J	0.16J
	1135	030	0.010K	0.078	466266		
92/12/15	1340	000	0.010K	0.074	516264	0.48J	0.20J
	1350	010	0.010K	0.076	516265	0.38J	0.26J
	1400	030	0.010K	0.078	516266		
93/01/26	1045	000	0.033	0.037	56264	1.06J	0.42J
	1050	010	0.010K	0.073	56265	0.31J	0.17J
	1055	030	0.010K	0.075	56266		
93/02/17	1550	000	0.010K	0.062	86264	0.76J	0.29J
	1555	010	0.010K	0.075	86265	0.42J	0.25J
	1600	030	0.010K	0.077	86266		
93/03/16	1210	000	0.018	0.018	126264	13.20	2.40
	1215	010	0.018	0.050	126265	11.20	0.31
	1220	030	0.024	0.073	126266		
93/04/27	1640	000	0.010K	0.010K	186264	17.10	2.40
	1650	010	0.026	0.036	186265	10.60	1.00
	1700	030	0.040	0.046	186266		
93/05/26	1525	000	0.021	0.010K		0.83	0.20
	1530	010	0.035	0.034		0.32	0.44
	1540	030	0.043	0.056			
93/06/30	1535	000	0.010K	0.010K	276264	1.70	0.73
	1540	010	0.010K	0.035	276265	1.20	0.72
	1545	030	0.010K	0.050	276266		
93/07/21	1015	000	0.010K	0.014		1.80	0.66
	1020	010	0.010K	0.042		1.20	0.51
	1030	030	0.010K	0.061			
93/08/24	1545	000	0.010K	0.038	356264	2.00	0.71
	1550	010	0.010K	0.051	356265	1.30	0.56
	1555	030	0.010K	0.061	356266		
93/09/20	1150	000	0.010K	0.045J	396264	1.50	0.79
	1155	010	0.010K	0.071J	396265	0.05K	0.67
	1205	030	0.010K	0.072J			

PTH005
PORT TOWNSEND HARBOR NR WALAN PT
48 05 00.0 122 45 48.0 2F 0 Elev= 0 ft
53031 Washington Jefferson Co. PACIFIC NORTHWEST
PUGET SOUND (Quilcene/Snow-17) 131117
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/STREAM

INDEX
MILES

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/26	1400	000	11.0	6.7	74.2	7.7	80.2	1K	8.0	31.25	0.323	
	1415	010	10.5	6.5	71.7	7.7	79.5			31.45	0.321	
	1425	024	10.2	5.7	62.7	7.7	79.0			31.57		
92/11/18	1100	000	10.0	7.1	76.6	7.7	82.4	1	9.5	30.93	0.359	
	1105	010	10.0	6.7	72.4	7.7	82.4			30.99	0.386	
	1110	020	9.8	6.4	69.2	7.7	83.0			31.08		
92/12/21	1045	000	7.8	8.7	90.0	7.7	78.8	9	7.0	30.82	0.344	
	1055	010	7.8	8.6	89.3	7.7	78.9			30.83	0.340	
	1100	023	8.2	8.1	85.0	7.7	80.1			30.98		
93/02/01	1135	000	7.5	9.0	91.9	7.7	78.5	1K	7.9	30.60	0.353	
	1145	010	7.6	8.8	90.6	7.7	81.6			30.84	0.303	
	1155	024	7.5	8.4	86.2	7.7	70.8			31.00		
93/03/09	1105	000	7.9	10.1J	104.1J	7.7	77.1	1K	9.8	30.91	0.329	
	1115	010	7.8	9.9J	102.0J	7.7	80.1			30.95	0.329	
	1125	020	7.8	9.3J	96.2J	7.7	79.3			31.12		
93/04/19	1110	000	9.7	12.2J	131.2J	8.1	64.5	1K	5.3	30.42	0.094	
	1115	010	9.2	10.7J	113.7J	8.0	69.4			30.51	0.161	
	1120	019	9.0	9.8J	103.8J	8.0	75.1			30.60		
93/05/18	1110	000	13.1	11.7J	134.0J	8.2	56.2		3.6	29.07	0.010K	
	1115	010	10.8	11.2J	123.3J	7.8	59.2			30.13	0.114	
	1120	018	9.8	9.0J	97.0J	7.7	54.9			30.46		
93/06/14	1100	000	12.1	10.9J	123.2J	8.1	63.9	1K	3.7	29.68	0.056	
	1110	010	11.6	9.3J	104.1J	7.9	70.2			30.09	0.130	
	1120	023	10.7	7.2J	78.9J	7.8	60.2			30.45		
93/07/19	1015	000	12.5	9.0	103.1	8.0	70.2	1K	4.8	30.33	0.079	
	1025	010	11.5	7.3	81.5	7.8	74.6			30.67	0.188	
	1035	016	11.1	7.1	78.8	7.8	77.9			30.72		
93/08/18	1200	000	12.8	7.8	89.9	7.9	74.9	1K	6.5	30.69	0.195	
	1205	010	11.5	7.2	81.2	7.8	77.7			30.90	0.233	
	1210	019	10.7	6.2	68.4	7.7	72.8			31.12		
93/09/08	1115	000	14.1	15.6	184.6	8.4	42.5	1K	2.5	30.73	0.010K	
	1120	010	11.4	7.8	87.5	7.9	77.9			31.04	0.226	
	1125	022	10.8	6.6	73.1	7.8	78.7			31.23		

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/26	1400	000	0.010K	0.069	446333	0.77J	0.23J
	1415	010	0.010K	0.070	446334	1.37J	0.38J
92/11/18	1100	000	0.021	0.078	476333	0.50J	0.34J
	1105	010	0.015	0.078	476334	0.25J	0.26J
92/12/21	1045	000	0.010K	0.075	526333	0.46J	0.32J
	1055	010	0.010K	0.074	526334	0.38J	0.24J
93/02/01	1135	000	0.014	0.068	66333	0.91J	0.30J
	1145	010	0.010K	0.069	66334	0.19J	0.18J
93/03/09	1105	000	0.014	0.060	116333	2.20	0.67
	1115	010	0.016	0.061	116334	1.30	0.62
93/04/19	1110	000	0.010K	0.029	176333	15.30	2.40
	1115	010	0.011	0.038	176334	10.50	1.50
93/05/18	1110	000	0.010K	0.011		8.70	3.20
	1115	010	0.010K	0.026		15.60	4.70
93/06/14	1100	000	0.010K	0.022	256333	11.00	2.40
	1110	010	0.010K	0.034	256334	6.90	2.80
93/07/19	1015	000	0.010K	0.028	306333	11.20	1.50
	1025	010	0.025	0.048	306334	3.80	2.20
93/08/18	1200	000	0.014	0.046	346333	3.20	1.00
	1205	010	0.014	0.050	346334	3.00	1.50
93/09/08	1115	000	0.010K	0.010K	376333	10.30J	5.60J
	1120	010	0.015	0.037	376334	5.90J	2.20J

SAR003
SARATOGA PASSAGE OFF EAST POINT
48 06 28.0 122 29 25.0 2F 0 Elev= 0 ft
53029 Washington Island Co. PACIFIC NORTHWEST
PUGET SOUND (Island-06) 131106
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/STREAM

INDEX
MILES . . . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/11/09	1200	000	11.0	8.5	91.5	7.8	85.2	1K	12.0	26.61	0.263	
	1205	010	11.4	7.6	83.6	7.7	86.2			27.98	0.278	
	1210	030	12.0	5.2	59.1	7.7	81.6			30.57	0.318	
92/12/15	1310	000	8.5	8.9	90.7	7.7	79.2	1K	8.5	27.08	0.259	
	1320	010	8.8	8.4	87.2	7.7	84.0			27.63	0.282	
	1330	015	9.9	6.9	73.9	7.6	82.7			29.11	0.279	
93/01/26	1140	000	7.8	9.7	95.8	7.7	43.1	6	1.8	24.85	0.514	
	1145	010	8.6	8.1	84.9	7.6	83.2			29.64	0.499	
	1150	030	8.9	7.7	80.7	7.6	80.7			29.94	0.529	
93/03/16	1240	000	8.7	14.4J	149.4J	8.2	64.2	1K	4.6	27.80	0.010K	
	1245	010	8.4	10.3J	106.5J	7.9	76.5			28.95	0.267	
	1250	029	8.1	8.2J	84.8J	7.6	84.0			30.02	0.373	
93/04/27	1555	000	11.6	10.9J	118.5J	8.4	76.8	1K	6.5	25.42	0.010K	
	1605	010	10.3	10.8J	114.0J	8.3	73.9			26.01	0.027	
	1615	030	8.5	8.7J	90.9J	7.9	84.4			29.49	0.305	
93/05/26	1450	000	17.0	10.0J	117.3J	8.5	80.1		16.0	19.22	0.010K	
	1455	010	10.1	9.4J	100.5J	8.0	89.6			28.15	0.161	
	1505	030	9.3	8.6J	90.7J	7.8	88.3			29.26	0.230	
93/06/30	1500	000	16.2	11.5J	137.5J	8.5	67.5	1K	5.4	24.89	0.010K	
	1505	010	11.5	9.2J	101.1J	8.0	86.6			28.37	0.160	
	1515	030	10.6	7.6J	82.7J	7.8	87.2			29.13	0.223	
93/07/21	1055	000	15.1	10.1	118.5	8.2	69.1	1K	6.1	25.06	0.010K	
	1100	010	12.7	7.9	89.1	7.9	87.5			27.69	0.234	
	1110	030	10.3	6.1	65.7	7.6	83.1			29.27	0.278	
93/08/24	1515	000	15.5	12.5	148.8	8.4	46.4	1K	3.0	26.93	0.010K	
	1520	010	11.9	6.3	69.9	7.9	83.9			28.80	0.279	
	1530	030	11.0	5.7	62.9	7.7	85.3			29.54	0.316	
93/09/20	1235	000	13.0	10.2	116.2	8.2	73.7	1K	7.0	27.73	0.011J	
	1240	010	11.8	5.8	65.3	7.8	85.0			29.48	0.218J	
	1245	030	11.5	5.2	57.8	7.7	85.6			29.80	0.329J	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/11/09	1200	000	0.023	0.070	466261	0.80J	0.17J
	1205	010	0.014	0.074	466262	0.48J	0.31J
	1210	030	0.010K	0.074	466263		
92/12/15	1310	000	0.010K	0.063	516261	0.88J	0.26J
	1320	010	0.010K	0.064	516262	0.83J	0.27J
	1330	015	0.010K	0.063	516263		
93/01/26	1140	000	0.017	0.062	56261	1.18J	0.35J
	1145	010	0.010K	0.073	56262	0.62J	0.22J
	1150	030	0.010K	0.072	56263		
93/03/16	1240	000	0.020	0.020	126261	22.00	3.30
	1245	010	0.021	0.056	126262	5.60	1.60
	1250	029	0.019	0.074	126263		
93/04/27	1555	000	0.010K	0.013	186261	2.90	0.46
	1605	010	0.018	0.022	186262	10.40	2.40
	1615	030	0.027	0.066	186263		
93/05/26	1450	000	0.010K	0.010K		0.12	0.07
	1455	010	0.036	0.044		0.13	0.19
	1505	030	0.030	0.057			
93/06/30	1500	000	0.010K	0.010K	276261	2.00	0.93
	1505	010	0.010K	0.039	276262	1.10	0.73
	1515	030	0.010K	0.050	276263		
93/07/21	1055	000	0.012	0.013		2.00	0.70
	1100	010	0.011	0.057		0.74	0.32
	1110	030	0.010K	0.063			
93/08/24	1515	000	0.010K	0.016	356261	15.00	3.00
	1520	010	0.010K	0.060	356262	1.50	0.69
	1530	030	0.010K	0.065	356263		
93/09/20	1235	000	0.010K	0.027J	396261	9.10	1.30
	1240	010	0.010J	0.058J	396262	3.50	1.60
	1245	030	0.010K	0.074J			

SIN001
SINCLAIR INLET AT NAVAL SHPYARDS
47 32 58.0 122 38 32.0 2F 0 Elev= 0 ft
53035 Washington Kitsap Co. PACIFIC NORTHWEST
PUGET SOUND (Kitsap-15) 131115
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/26	1215	000	13.0	7.9	91.2	7.9	79.9	1K	9.5	29.94	0.199	
	1220	010	12.8	6.7	76.5	7.8	80.6			30.33	0.238	
92/11/18	1155	000	11.4	7.2	79.9	7.7	81.1	5	8.0	30.03	0.304	
	1200	010	11.5	6.6	73.3	7.7	76.0			30.33	0.317	
92/12/21	1330	000	8.6	8.0	83.4	7.7	80.3	4	8.9	29.74	0.327	
	1340	010	8.9	7.6	80.3	7.7	80.5			30.02	0.360	
93/02/01	1530	000	8.0	9.0	92.3	7.7	78.0	1K	8.5	29.34	0.367	
	1540	010	7.8	8.5	87.2	7.7	80.9			29.81	0.397	
93/03/09	1420	000	8.4	10.4J	107.3J	7.7	76.4	1K	6.9	29.42	0.340	
	1430	010	7.8	10.0J	102.4J	7.7	77.9			29.66	0.325	
93/04/19	1000	000	9.4	14.0J	147.7J	8.1	65.0	1	4.0	29.13	0.073	
	1005	010	8.9	9.7J	101.6J	7.8	68.1			29.49	0.241	
93/05/18	1435	000	16.7	14.6J	178.9J	8.4	58.4		4.6	28.18	0.010K	
	1440	010	12.5	14.4J	162.7J	8.1	57.6			28.81	0.010K	
93/06/14	1405	000	16.2	16.8J	204.9J	8.5	21.9	1K	2.4	28.30	0.010K	
	1415	010	12.5	9.4J	106.2J	8.0	64.6			28.87	0.097	
93/07/19	0935	000	15.9	10.5	127.1	8.2	66.9	18	3.9	28.62	0.017	
	0940	010	12.9	7.5	86.1	7.8	64.9			29.12	0.160	
93/08/18	1025	000	15.7	10.2	123.3	8.3	66.8	3	5.5	28.90	0.012	
	1030	010	13.7	7.9	91.6	7.9	69.9			29.53	0.145	
93/09/08	1030	000	15.9	10.9	133.1	8.2	65.3	1	4.5	29.40	0.036	
	1035	010	14.4	8.3	98.7	8.0	70.7			29.78	0.106	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/26	1215	000	0.069	0.077	446343	2.05J	0.87J
	1220	010	0.029	0.073	446344	1.35J	0.51J
92/11/18	1155	000	0.073	0.086	476343	1.07J	0.27J
	1200	010	0.042	0.085	476344	0.89J	0.40J
92/12/21	1330	000	0.025	0.080	526343	1.01J	3.30J
	1340	010	0.030	0.078	526344	0.48J	0.36J
93/02/01	1530	000	0.089	0.070	66343	0.80J	0.23J
	1540	010	0.018	0.064	66344	0.93J	0.39J
93/03/09	1420	000	0.050	0.070	116343	0.98	0.46

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
93/03/09	1430	010	0.040	0.070	116344	1.60	0.86
93/04/19	1000	000	0.010K	0.026	176343	17.50	5.90
	1005	010	0.044	0.058	176344	8.30	1.90
93/05/18	1435	000	0.010K	0.010K		2.40	1.20
	1440	010	0.010K	0.018		4.80	2.30
93/06/14	1405	000	0.010K	0.011	256343	15.60	1.80
	1415	010	0.054	0.044	256344	11.50	2.60
93/07/19	0935	000	0.010K	0.038	306343	5.60	0.97
	0940	010	0.049	0.059	306344	1.50	1.30
93/08/18	1025	000	0.036	0.042	346343	2.00	0.65
	1030	010	0.030	0.050	346344	1.30	1.10
93/09/08	1030	000	0.010K	0.025	376343	10.00J	0.84J
	1035	010	0.027	0.033	376344	5.60J	2.30J

TOT001
TOTTEN INLET NEAR WINDY POINT
47 09 52.0 122 57 48.0 2F 0 Elev= 0 ft
53045 Washington Mason Co. PACIFIC NORTHWEST
PUGET SOUND (Kennedy/Goldsboro-14) 131114
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/05	1540	000	15.3	8.6	103.1	8.1	74.3	1K		29.72	0.086	
	1550	010	15.2	8.4	101.5	8.0	75.0			29.74	0.088	
92/11/03	1415	000	12.6	7.2	82.2	7.8	76.6	1	7.1	29.58	0.159	
	1425	010	12.6	7.2	81.5	7.8	77.9			29.62	0.158	
92/12/01	1215	000	10.0	8.1	86.9	7.7	72.6	1K	5.8	29.04	0.286	
	1220	010	10.0	8.1	86.7	7.7	73.0			29.07	0.305	
93/01/11	1445	000	5.1	9.9	94.3	7.7	69.4	1	4.6	27.91	0.304	
	1455	010	6.2	9.3	91.3	7.7	71.5			28.70	0.307	
93/02/08	1235	000	7.6	9.3	93.6	7.7	74.0	1	6.4	27.45	0.342	
	1240	010	7.4	9.2	92.3	7.7	74.5			27.93	0.340	
93/03/03	1340	000	7.1	12.0J	119.6J	7.8	79.9	1	6.6	28.40	0.272	
	1345	010	6.9	11.8J	117.8J	7.8	80.8			28.50	0.295	
93/04/12	1340	000	9.9	8.7J	92.4J	8.0	73.3	1K	5.5	27.64	0.183	
	1345	010	9.7	11.1J	116.9J	8.0	73.3			27.66	0.193	
93/05/17	1505	000	13.4	11.2J	128.4J	8.0	61.7	1K	4.2	28.08	0.010K	
	1515	010	12.5	13.3J	150.4J	8.0	61.8			28.18	0.044	
93/06/14	1730	000	15.5	10.2J	122.0J	8.1	76.1	1	6.9	27.83	0.053	
	1740	010	13.9	9.7J	112.8J	8.0	77.3			28.23	0.090	
93/07/12	1250	000	15.6	9.1	110.0	8.1	79.1	1K	6.6	28.48	0.034	
	1255	010	15.1	9.0	107.4	8.1	77.8			28.53	0.055	
93/08/09	1345	000	16.9	10.9	134.3	8.3	66.9	1K	4.1	28.62	0.010K	
	1350	010	16.1	10.3	124.8	8.2	73.0			28.74	0.010K	
93/09/07	1450	000	18.0	12.5	157.9	8.3	69.9	1	3.7	29.01	0.010K	
	1455	010	16.3	10.7	130.7	8.2	65.1			29.16	0.010K	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/05	1540	000	0.013	0.056	416315	4.34J	1.30J
	1550	010	0.012	0.045	416316	8.16J	2.23J
92/11/03	1415	000	0.081	0.064	456315	2.99J	0.49J
	1425	010	0.067	0.059	456316	1.15J	0.53J
92/12/01	1215	000	0.046	0.077	496315	3.25J	0.37J
	1220	010	0.040	0.078	496316	2.00J	0.83J
93/01/11	1445	000	0.037	0.074	36315	1.68J	0.39J

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
93/01/11	1455	010	0.026	0.074	36316	2.19J	0.69J
93/02/08	1235	000	0.040	0.065	76315	2.14J	0.46J
	1240	010	0.038	0.065	76316	2.28J	0.64J
93/03/03	1340	000	0.018	0.066	106315	1.02J	0.31J
	1345	010	0.016	0.068	106316	1.91J	0.62J
93/04/12	1340	000	0.064	0.042	166315	0.97	0.41
	1345	010	0.052	0.046	166316	4.70	0.94
93/05/17	1505	000	0.010K	0.016	216315	3.60	1.60
	1515	010	0.014	0.023	216316	10.40	4.60
93/06/14	1730	000	0.040	0.041		3.40	1.60
	1740	010	0.040	0.043		4.60	1.30
93/07/12	1250	000	0.020	0.041	296315	2.60	0.47
	1255	010	0.026	0.047	296316	0.87	0.39
93/08/09	1345	000	0.010K	0.045	336315	2.90	0.43
	1350	010	0.010K	0.048	336316	12.70	1.30
93/09/07	1450	000	0.010K	0.033	376315	4.60	0.81
	1455	010	0.010K	0.027	376316	3.20	0.48

GRAYS HARBOR AND WILLAPA BAY STATIONS

GYS004
GRAYS HBR-CHEHALIS R AT STRD OIL
46 58 41.0 123 47 00.0 2F 0 Elev= 0 ft
53027 Washington Grays Harbor Co. PACIFIC NORTHWEST
COASTAL (Lower Chehalis-22) 131222
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/STREAM

INDEX 1312099
MILES 0001.40 " " " " " " " " " " "

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/28	1010	000	12.4	9.1	88.1	7.1	20.4	64X	1.3	4.17	0.356	
	1015	009	12.7	8.3	86.4	7.4	0.0			13.74	0.319	
92/11/24	1115	000	7.5	11.8	99.9	6.9	9.6		1.0	1.64	0.781	
	1120	010	9.2	10.2	99.8	7.8	0.3			17.86	0.334	
93/02/22	1020	000	4.0	14.1	111.3	4.4	17.4	4	1.5	3.91	0.509	
	1025	009	5.0	11.0	96.2	7.5	3.7			15.72	0.343	
93/04/05	1005	000	9.9	11.4J	101.4J	6.9	7.1	33S	0.8	0.38	0.476	
	1010	009	9.9	11.3J	101.2J	6.9	4.4			0.98	0.447	
93/05/05	1015	000	11.1			6.9	15.8	53	0.7		0.377	
	1020	010	11.0			6.9	14.5				0.373	
93/06/01	0955	000	16.4	9.4J	97.6J	7.1	36.9	150S	1.6	1.81	0.314	
	1000	009	16.4	9.0J	96.4J	7.3	16.3			6.66	0.248	
93/07/13	0945	000	17.3	8.9	98.9	8.0	26.4		2.1	8.92	0.126	
	0950	010	15.5	6.6	77.6	7.8	27.5	0		25.71	0.079	
93/08/02	0950	000	18.7	8.9	97.3	7.3	11.3	41	1.6	2.63	0.284	
	0955	008	18.5	8.5	93.9	7.3	0.0			3.80	0.262	
93/09/13	1010	000	17.4	7.3	85.4	7.7	30.9	52	1.7	17.34	0.144	
	1015	010	17.1	7.0	82.7	7.7	7.2			20.78	0.124	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/28	1010	000	0.033	0.012	446210		
	1015	009	0.053	0.020	446211		
92/11/24	1115	000	0.027	0.010K	486210		
	1120	010	0.046	0.024	486211		
93/02/22	1020	000	0.030	0.010K	96210		
	1025	009	0.041	0.022	96211		
93/04/05	1005	000	0.017	0.010K	156210		
	1010	009	0.015	0.010K	156211		
93/05/05	1015	000	0.013	0.010K	196210		
	1020	010	0.013	0.010K	196211		
93/06/01	0955	000	0.019	0.012	236210	0.74	1.10
	1000	009	0.029	0.012	236211	1.20	2.40
93/07/13	0945	000	0.010K	0.024	296210		

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
93/07/13	0950	010	0.024	0.015	296211		
93/08/02	0950	000	0.010K	0.010K	326210		
	0955	008	0.010K	0.010K	326211		
93/09/13	1010	000	0.047	0.020	386210		
	1015	010	0.060	0.025	386211		

GYS008
GRAYS HARBOR AT MID SOUTH CHAN
46 56 15.0 123 54 43.0 2F 0 Elev= 0 ft
53027 Washington Grays Harbor Co. PACIFIC NORTHWEST
COASTAL (Lower Chehalis-22) 131222
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/28	1030	000	12.3	8.0	87.7	7.8	7.7	43X	1.1	24.31	0.198	
	1035	004	12.3	8.2	89.8	7.8	3.6			24.41	0.199	
92/11/24	1130	000	8.5	10.5	102.7	7.9	28.6		1.5	19.36	0.279	
	1135	006	9.2	10.0	100.8	7.9	12.2			22.52	0.190	
93/02/22	1050	000	5.5	10.4	96.1	7.8	4.4	1K	0.6	22.59	0.233	
	1100	004	5.4	10.3	94.5	7.8	2.6			23.00	0.222	
93/04/05	1025	000	10.6	9.5J	94.4J	7.7	3.6	33X	1.0	15.11	0.283	
	1035	006	10.6	9.7J	96.6J	7.8	2.7			15.29		
93/05/05	1035	000	12.4	7.9J	79.2J	7.8	3.5	33	0.5	10.61J	0.295	
	1040	003	12.4	9.1J	99.0J	7.8	0.3			10.75J	0.304	
93/06/01	1020	000	17.0	8.6J	100.2J	8.1	35.3	7	1.8	18.25	0.064	
	1040	006	16.9	8.6J	100.2J	8.1	22.2			18.28	0.066	
93/07/13	1005	000	17.8	8.1	96.3	8.1	33.5	2	2.0	19.41	0.010K	
	1010	004	17.3	8.0	96.5	8.0	43.8			23.17	0.010K	
93/08/02	1010	000	20.0	7.3	90.9	7.8	10.4	3	1.0	20.30	0.105	
	1015	002	19.9	7.3	91.2	7.8	9.1			20.47	0.097	
93/09/13	1030	000	16.1	7.6	90.8	8.0	21.7	2	1.5	26.48	0.044	
	1035	005	16.0	7.6	90.9	8.0	22.9			26.93	0.047	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/28	1030	000	0.043	0.031	446212	3.45J	3.36J
	1035	004	0.044	0.032	446213	2.96J	5.18J
92/11/24	1130	000	0.041	0.027	486212	1.51J	1.52J
	1135	006	0.035	0.028	486213	1.40J	2.03J
93/02/22	1050	000	0.027	0.028	96212	0.83J	2.66J
	1100	004	0.022	0.027	96213	2.80J	4.18J
93/04/05	1025	000	0.025	0.017	156212	2.80	3.80
93/05/05	1035	000	0.036	0.014	196212	2.00	2.00
	1040	003	0.028	0.012	196213		
93/06/01	1020	000	0.010K	0.015	236212	4.00	1.70
	1040	006	0.010K	0.014	236213	3.90	2.70
93/07/13	1005	000	0.010K	0.014	296212	3.20	1.70
	1010	004	0.010K	0.018	296213	4.10	2.50

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
93/08/02	1010	000	0.026	0.026	326212	7.30	2.90
	1015	002	0.022	0.025	326213	5.40	3.10
93/09/13	1030	000	0.022	0.025	386212	2.40	1.10
	1035	005	0.021	0.024	386213	2.70	2.60

GYS009
GRAYS HARBOR AT MOON IS REACH
46 57 53.0 123 56 54.0 2F 0 Elev= 0 ft
53027 Washington Grays Harbor Co. PACIFIC NORTHWEST
COASTAL (Lower Chehalis-22) 131222
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/28	1100	000	12.2	8.5	93.2	7.9	24.4		1.5	25.74		
	1105	010	12.3	8.3	92.5	7.9	10.7			27.76		
93/02/22	1125	000	5.6	10.4	98.2	7.9	32.1		1.5	24.75		
	1130	010	5.8	10.2	97.6	7.9	25.8			26.10		
93/04/05	1050	000	10.7	10.2J	103.2J	7.9	17.1		1.4	18.27		
	1055	010	10.5	9.8J	100.1J	8.0	5.2			20.02		
93/05/05	1105	000	12.6	7.3J	75.7J	8.0	16.3		1.0	13.75J		
	1110	010	12.6	9.5J	99.5J	8.1	1.3			16.89J		
93/06/01	1055	000	16.9	8.6J	100.4J	8.1	39.8		1.9	19.07		
	1100	010	16.8	8.4J	98.5J	8.1	13.0			20.06		
93/07/13	1030	000	17.5	10.2	119.2	8.4	40.4		2.4	18.07		
	1035	010	14.7	7.4	87.8	8.0	55.0			28.80		
93/08/02	1030	000	19.7	8.0	99.1	8.0	33.8		2.0	20.78		
	1035	010	19.2	7.9	98.5	8.0	23.1			23.45		
93/09/13	1050	000	15.3	7.5	90.1	8.0	49.5		2.5	28.81		
	1055	010	15.0	7.3	86.7	8.0	38.2			29.17		

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L

GYS015
GRAYS HARBOR NR N WHITCOMB FLATS
46 55 23.0 124 04 32.0 1F 0 Elev= 0 ft
53027 Washington Grays Harbor Co. PACIFIC NORTHWEST
Columbia River below Yakima River 131022
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/ESTURY

INDEX
MILES

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
93/05/05	1205	000	12.3	7.4J	82.6J	8.3	45.6		2.3	26.91J		
	1210	009	12.3	10.2J	113.3J	8.3	43.5			26.92J		
93/06/01	1130	000	16.1	11.1J	127.8J	8.5	46.7		2.4	19.14		
	1140	010	16.2	10.0J	115.3J	8.4	52.1			20.02		
93/07/13	1120	000	16.5	8.9	107.5	8.1	58.1		4.0	25.46		
	1125	009	14.3	8.8	104.5	8.1	73.0			30.51		
93/08/02	1100	000	16.5	8.1	98.8	8.1	53.8		3.0	28.14		
	1105	007	16.3	8.2	99.8	8.1	56.1			28.40		
93/09/13	1115	000	11.7	8.2	93.1	8.1	59.3		3.5	32.45		
	1120	010	11.0	7.0	78.7	8.0	59.4			32.58		

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L

GYS016
GRAYS HARBOR NEAR DAMON POINT
46 57 13.0 124 05 30.0 1F 0 Elev= 0 ft
53027 Washington Grays Harbor Co. PACIFIC NORTHWEST
Columbia River below Yakima River 131022
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/ESTURY

INDEX
MILES

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/10/28	1115	000	12.1	8.5	96.7	8.0	42.5	2	2.0	30.55	0.089	
	1120	010	12.1	8.3	94.5	8.0	36.9			30.51	0.075	
93/02/22	1145	000	6.6	10.3	102.0	8.0	56.3	1	2.4	29.36	0.067	
	1155	007	6.6	10.3	101.9	8.0	54.4			29.35	0.075	
93/04/05	1105	000	10.8	10.9J	115.5J	8.2	50.0	1K	2.6	24.79	0.010K	
	1110	006	10.7	10.7J	113.2J	8.2	47.2			24.77	0.010K	
93/05/05	1140	000	12.7	7.7J	84.6J	8.3	31.4	1	1.4	24.14J	0.061	
	1145	002	12.6	8.5J	94.0J	8.3	25.3			24.81J		
93/06/01	1105	000	15.9	10.7J	123.0J	8.5	43.6	4	2.5	19.10	0.010K	
	1110	007	15.9	10.9J	124.7J	8.5	42.5			19.11	0.010K	
93/07/13	1040	000	16.2	8.2	99.4	8.0	67.0	1K	4.8	28.02	0.021	
	1045	007	14.4	8.3	98.5	8.1	69.4			30.16	0.032	
93/08/02	1045	000	18.2	7.9	98.9	8.1	44.3	1K	2.5	26.31	0.032	
	1050	004	18.1	8.0	99.9	8.1	42.1			26.33	0.033	
93/09/13	1100	000	12.0	8.2	93.5	8.1	60.2	1K	3.6	32.31	0.082	
	1105	004	12.0	8.1	92.2	8.1	60.2			32.31	0.086	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/10/28	1115	000	0.019	0.029	446214	1.54J	1.72J
	1120	010	0.018	0.024	446215	1.50J	1.75J
93/02/22	1145	000	0.010K	0.022	96214	4.84J	2.27J
	1155	007	0.010K	0.022	96215	4.76J	2.25J
93/04/05	1105	000	0.010K	0.010K	156214	4.00	1.60
	1110	006	0.010K	0.010K	156215	3.50	2.10
93/05/05	1140	000	0.010K	0.010K	196214	5.10	2.20
93/06/01	1105	000	0.010K	0.010K	236214	9.70	1.40
	1110	007	0.010K	0.010K	236215	10.40	1.90
93/07/13	1040	000	0.010K	0.023	296214	1.70	0.91
	1045	007	0.025	0.028	296215	2.80	4.50
93/08/02	1045	000	0.010K	0.023	326214	2.60	1.70
	1050	004	0.010K	0.022	326215	1.00	0.73
93/09/13	1100	000	0.010K	0.029	386214	16.80	3.20
	1105	004	0.010K	0.028	386215	16.70	3.40

WPA001
WILLAPA RIVER AT RAYMOND
46 41 15.0 123 44 55.0 2F 0 Elev= 0 ft
53049 Washington Pacific Co. PACIFIC NORTHWEST
COASTAL (Willapa-24) 131224
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/STREAM

INDEX 1312137
MILES 0006.40 " " " " " " " " " " "

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/11/24	1310	000	8.1	10.8	96.1	7.4	19.8		1.3	6.86	0.936	
	1315	010	8.8	9.9	96.5	7.8	8.2			18.59	0.354	
93/02/22	1555	000	4.6	11.2	97.8	7.8	31.4	7	1.5	16.63	0.242	
	1605	008	4.6	11.1	97.3	7.8	24.2			17.62	0.230	
93/04/05	1430	000	11.1	10.0J	96.6J	7.5	23.3	15	1.8	8.71	0.438	
	1435	008	10.7	9.7J	95.6J	7.7	9.9			13.21	0.301	
93/05/05	1435	000	13.0	9.7J	96.6J	7.6	19.5	27	1.0	6.54J	0.345	
	1440	007	13.0	9.6J	98.4J	7.7	9.9			10.96J	0.248	
93/06/01	1400	000	17.9	8.3J	92.2J	7.4	22.1	100	1.3	7.85	0.162	
	1405	006	18.0	7.5J	84.8J	7.4	14.5			10.16	0.139	
93/07/13	1350	000	19.1	7.2	84.1	7.5	42.1	11	2.3	11.68	0.092	
	1355	007	18.0	6.4	77.4	7.6	16.2			20.14	0.039	
93/08/02	1355	000	21.4	7.3	91.6	7.6	11.5	8	1.3	16.06	0.061	
	1400	008	20.7	6.9	86.7	7.6	1.4			18.32	0.042	
93/09/13	1405	000	19.2	6.6	82.0	7.7	18.0	8	1.3	23.21	0.062	
	1410	008	18.7	6.3	78.7	7.7	4.7			23.98	0.057	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/11/24	1310	000	0.045	0.012	486220		
	1315	010	0.043	0.024	486221		
93/02/22	1555	000	0.028	0.017	96220		
	1605	008	0.025	0.017	96221		
93/04/05	1430	000	0.041	0.010K	156220		
	1435	008	0.039	0.011	156221		
93/05/05	1435	000	0.042	0.010K	196220		
	1440	007	0.045	0.010K	196221		
93/06/01	1400	000	0.010K	0.010K	236220		
	1405	006	0.010	0.010K	236221		
93/07/13	1350	000	0.016	0.012	296220		
	1355	007	0.041	0.023	296221		
93/08/02	1355	000	0.014	0.014	326220		
	1400	008	0.023	0.017	326221		
93/09/13	1405	000	0.032	0.025	386220		

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
93/09/13	1410	008	0.037	0.025	386221		

WPA003
WILLAPA RIVER AT JOHNSON SLOUGH
46 42 15.0 123 50 10.0 2F 0 Elev= 0 ft
53049 Washington Pacific Co. PACIFIC NORTHWEST
Washington Coast 131291
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/STREAM

INDEX 1312137
MILES 0000.40

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/11/24	1255	000	8.5	10.4	102.3	7.9	37.7		2.0	20.57		
	1300	007	9.3	9.8	101.2	8.0	42.1			25.61		
93/02/22	1535	000	5.2	10.9	101.0	7.9	51.4		2.0	23.43		
	1545	006	4.9	10.8	100.6	8.0	50.6			25.70		
93/04/05	1415	000	11.7	10.0J	104.2J	8.1	34.2		1.9	19.06		
	1420	008	11.1	9.8J	102.4J	8.1	42.0			21.05		
93/05/05	1425	000	13.7	10.0J	108.6J	8.2	17.2		1.0	18.20J		
	1430	010	13.4	10.0J	109.2J	8.2	20.4			19.63J		
93/06/01	1345	000	18.3	8.2J	96.8J	7.9	14.1		1.0	16.34		
	1350	007	17.9	7.8J	91.9J	8.0	13.5			18.19		
93/07/13	1340	000	19.0	7.6	91.5	7.8	30.7		1.9	17.95		
	1345	004	17.9	7.2	88.2	7.9	38.1			23.88		
93/08/02	1340	000	21.2	7.3	94.9	8.0	33.0		2.0	23.94		
	1345	005	20.6	7.4	96.1	8.1	21.6			24.21		
93/09/13	1355	000	18.6	7.2	91.2	8.0	32.8		2.0	27.28		
	1400	008	17.3	7.1	88.6	8.0	40.9			28.84		

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L

WPA004
WILLAPA BAY AT TOKE POINT
46 41 13.0 123 58 20.0 2F 0 Elev= 0 ft
53049 Washington Pacific Co. PACIFIC NORTHWEST
COASTAL (Willapa-24) 131224
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/11/24	1210	000	10.3	9.6	104.5	8.0	57.9		3.1	29.84	0.074	
	1215	006	10.4	9.5	103.4	8.0	56.7			29.97	0.072	
93/02/22	1415	000	6.3	11.1	108.4	8.1	59.2	1K	3.1	28.10	0.062	
	1425	006	6.2	11.0	107.5	8.1	60.9			28.28	0.065	
93/04/05	1250	000	10.8	10.9J	114.7J	8.3	63.0	1K	4.5	23.59	0.010K	
	1255	009	10.6	10.8J	113.6J	8.3	62.0			23.82	0.010K	
93/05/05	1300	000	12.8	10.7J	117.9J	8.3	48.4	1	2.3	24.06J	0.037	
	1305	007	12.7	10.6J	117.1J	8.3	51.3			24.37J	0.042	
93/07/13	1230	000	17.5	8.1	100.6	8.1	63.4	1K	4.0	27.11	0.010K	
	1235	010	16.4	8.4	102.2	8.1	69.2			28.46	0.010K	
93/08/02	1215	000	18.2	8.3	103.8	8.2	59.9	1K	3.6	26.04	0.010K	
	1220	010	18.3	8.4	105.2	8.2	59.5			25.96	0.010K	
93/09/13	1235	000	7.5	18.3	182.6	8.2	60.6	1K	3.9	26.50	0.010K	
	1240	010	13.5	9.2	108.0	8.2	58.1			31.83	0.010K	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
92/11/24	1210	000	0.024	0.028	486216	1.50J	1.31J
	1215	006	0.025	0.027	486217	1.92J	1.39J
93/02/22	1415	000	0.010K	0.019	96216	4.38J	1.31J
	1425	006	0.010K	0.021	96217	5.26J	1.85J
93/04/05	1250	000	0.010K	0.010K	156216	5.10	1.50
	1255	009	0.010K	0.010K	156217	6.00	2.40
93/05/05	1300	000	0.010K	0.010K	196216	6.10	2.10
	1305	007	0.010K	0.010K	196217	6.90	2.70
93/07/13	1230	000	0.010K	0.022	296216	1.80	0.71
	1235	010	0.010K	0.020	296217	3.20	1.70
93/08/02	1215	000	0.010K	0.022	326216	4.30	1.50
	1220	010	0.010K	0.020	326217	4.70	1.80
93/09/13	1235	000	0.010K	0.020	386216	10.90	3.10
	1240	010	0.010	0.019	386217	19.20	6.20

WPA006
WILLAPA BAY AT NAHCOTTA CHANNEL
46 32 44.0 123 58 44.0 2F000 Elev= 0 ft
53049 Washington Pacific Co. PACIFIC NORTHWEST
COASTAL (Willapa-24) 131224
21540000 Reach=17100106000 0.000 Drg= 0 sqmi
AMBNT/OCEAN

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
93/02/22	1445	000	5.6	10.9	104.1	8.0	68.6	1K	4.1	26.50	0.070	
	1455	010	5.6	10.9	103.8	8.0	63.5			27.05	0.069	
93/04/05	1345	000	11.2	9.9J	104.5J	8.1	61.3	1K	3.5	22.92	0.010K	
	1355	008	11.2	9.4J	99.7J	8.1	58.6			23.08	0.010K	
93/05/05	1335	000	13.5	10.3J	113.6J	8.3	55.8	1	2.5	21.40J	0.010K	
	1340	002	13.4	10.4J	114.7J	8.3	56.0			21.59J	0.010K	
93/07/13	1255	000	18.6	8.1	100.2	8.0	63.1	1K	4.0	23.78	0.010K	
	1300	007	17.5	8.0	98.8	8.1	69.3			25.92	0.010K	
93/08/02	1250	000	19.7	7.7	98.3	8.1	48.9	1K	2.6	25.78	0.010K	
	1255	007	19.7	7.7	98.8	8.1	32.5			25.77	0.010K	
93/09/13	1325	000	17.2	8.0	99.9	8.1	69.7	1K	4.5	29.68	0.010K	
	1330	007	16.8	7.7	96.0	8.1	66.3			29.84	0.010K	

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
93/02/22	1445	000	0.010K	0.022	96218	2.92J	1.10J
	1455	010	0.010K	0.020	96219	4.11J	1.46J
93/04/05	1345	000	0.010K	0.012	156218	4.30	1.60
	1355	008	0.010K	0.011	156219	5.20	2.50
93/05/05	1335	000	0.010K	0.010K	196218	4.60	1.40
	1340	002	0.010K	0.010K	196219	4.70	2.10
93/07/13	1255	000	0.010K	0.029	296218	1.70	0.75
	1300	007	0.010K	0.028	296219	2.70	1.10
93/08/02	1250	000	0.010K	0.034	326218	2.70	1.70
	1255	007	0.010K	0.033	326219	2.40	1.50
93/09/13	1325	000	0.011	0.028	386218	4.00	1.50
	1330	007	0.010K	0.029	386219	4.60	3.30

WPA007
WILLAPA BAY NEAR LONG ISLAND
46 27 12.0 124 00 30.0 2F000 Elev= 0 ft
53049 Washington Pacific Co. PACIFIC NORTHWEST
COASTAL (Willapa-24) 131224
21540000 Reach=17100106000 0.000 Drg= 0 sqmi
AMBNT/OCEAN

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
92/11/24	1235	000	7.8	10.6	104.2	7.9	31.6		1.5	23.35		
	1240	003	7.9	10.4	102.5	7.9	11.6			23.34		
93/02/22	1510	000	5.0	12.2	111.9	8.1	70.4		2.4	22.77		
	1515	001	5.0	12.2	112.8	8.1	70.5			22.78		
93/04/05	1330	000	12.1	9.9J	106.0J	8.1	64.8		3.5	21.39		
	1335	002	12.0	10.0J	106.8J	8.1	64.7			21.42		
93/05/05	1405	000	13.5	10.1J	110.7J	8.2	45.2		2.0	20.03J		
	1410	001	13.5	10.0J	109.4J	8.2	45.4			20.02J		
93/07/13	1320	000	18.6	8.2	101.8	8.1	62.6		3.5	23.22		
	1325	010	18.2	8.0	98.9	8.1	65.3			23.52		
93/08/02	1310	000	20.5	7.7	99.5	8.2	54.4		2.7	25.40		
	1315	009	20.3	7.7	100.3	8.2	12.4			25.41		
93/09/13	1315	000	18.1	7.5	95.2	8.0	66.2		3.5	28.58		
	1320	005	18.0	7.4	93.8	8.0	68.8			28.66		

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L

APPENDIX B

Profiles of temperature, salinity, and density data from WY 1993 for:

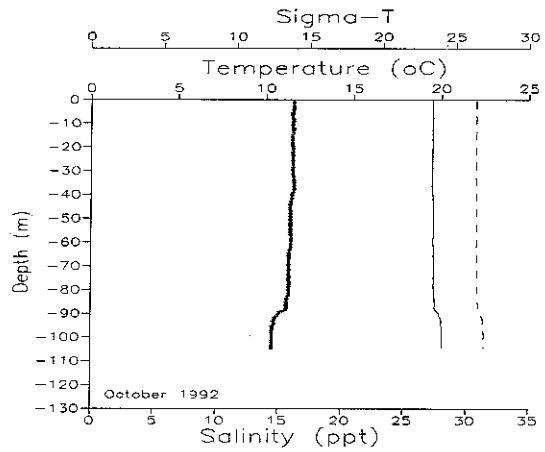
1) Puget Sound stations
2) Grays Harbor and Willapa Bay stations

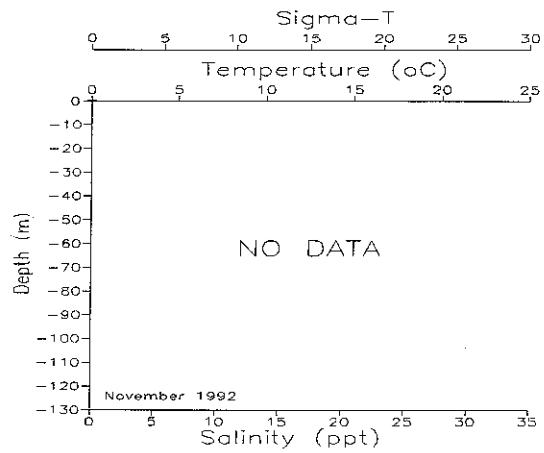
PUGET SOUND STATIONS

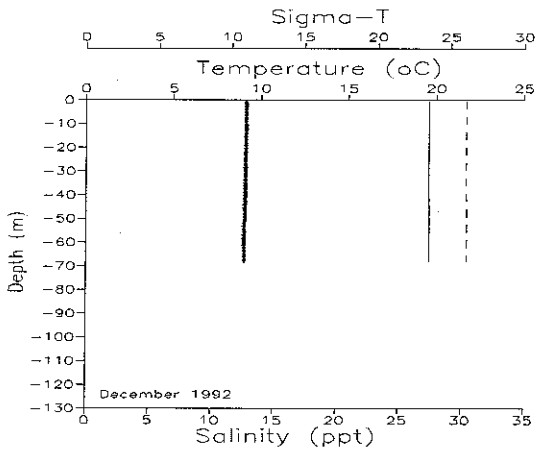
WATERYEAR 1993

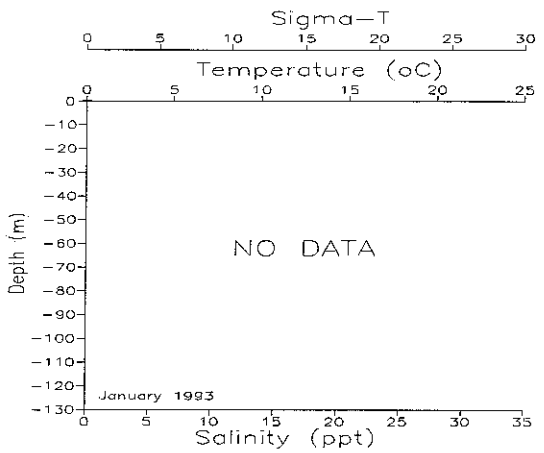
Part 1 of 2

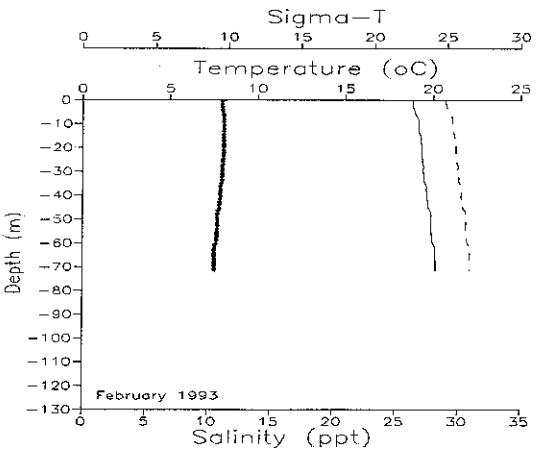
Admiralty Inlet - Bush Point (Station ADM001)

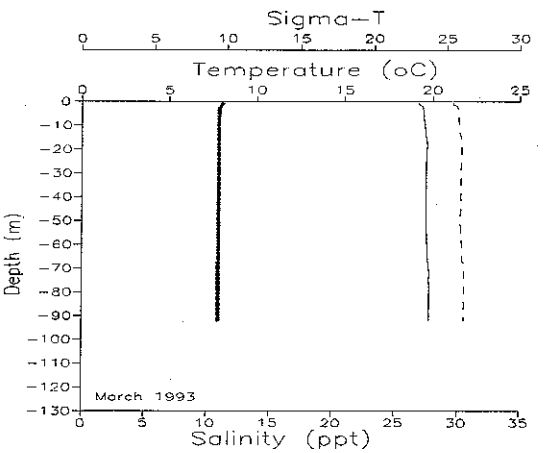










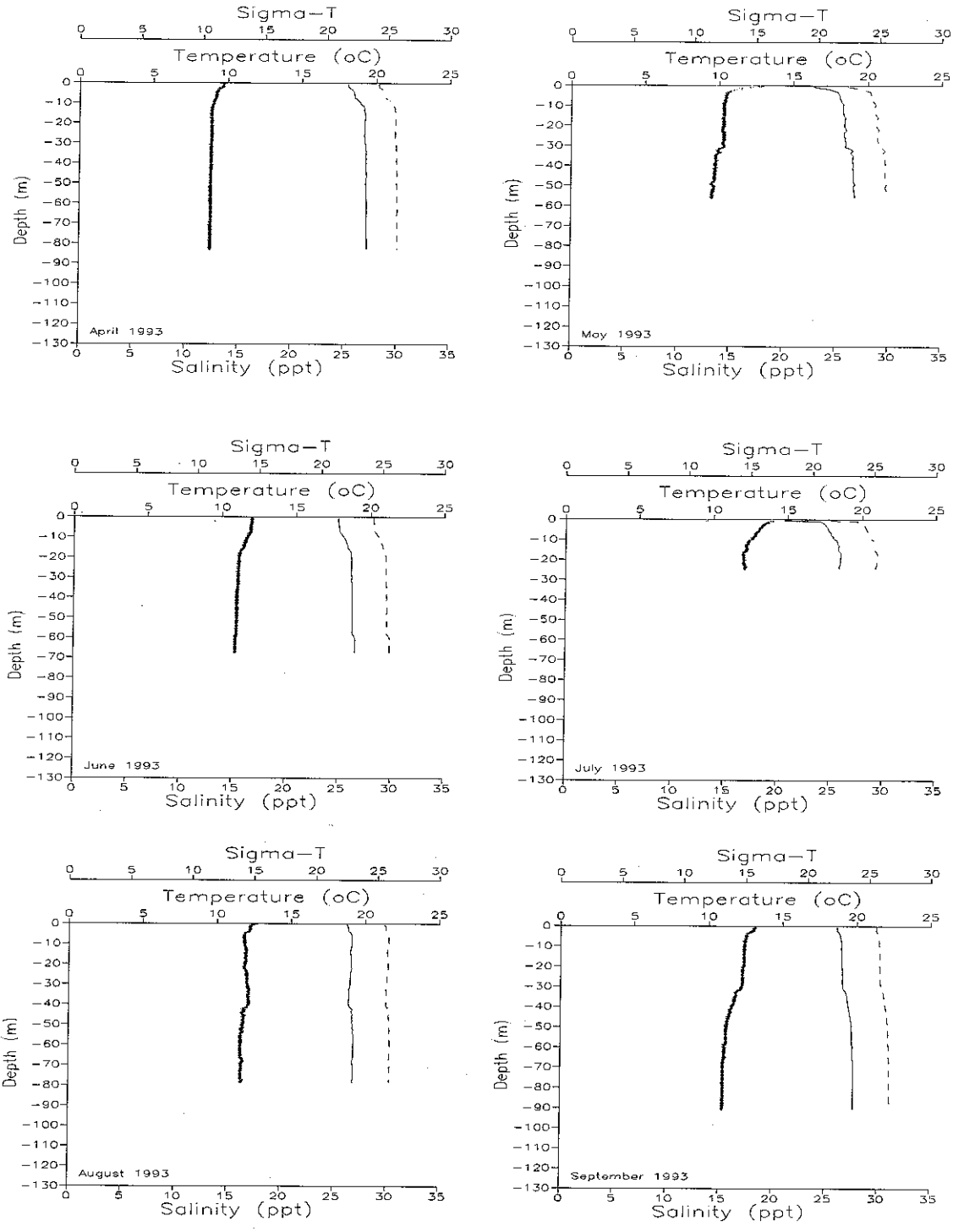


Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

WATERYEAR 1993

Part 2 of 2

Admiralty Inlet - Bush Point (Station ADM001)

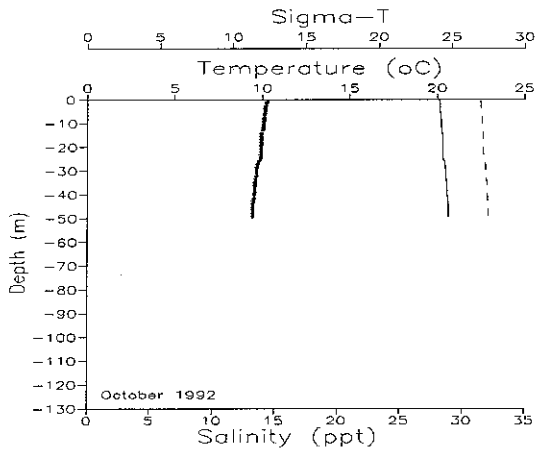


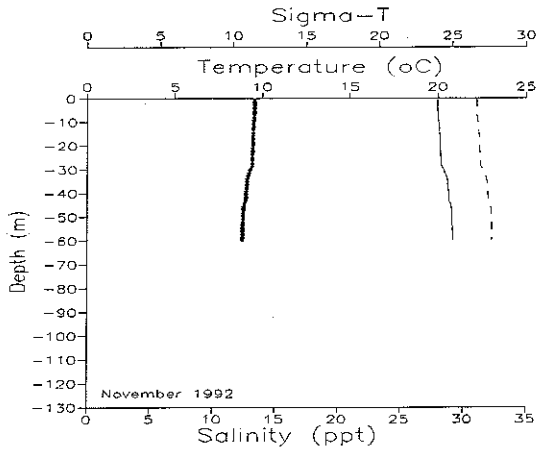
Key: **Temperature = Bold Line** **Salinity = Dashed Line** **Sigma-t = Solid Line**

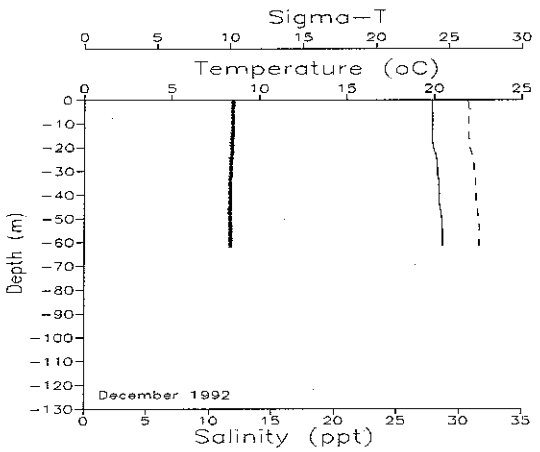
WATERYEAR 1993

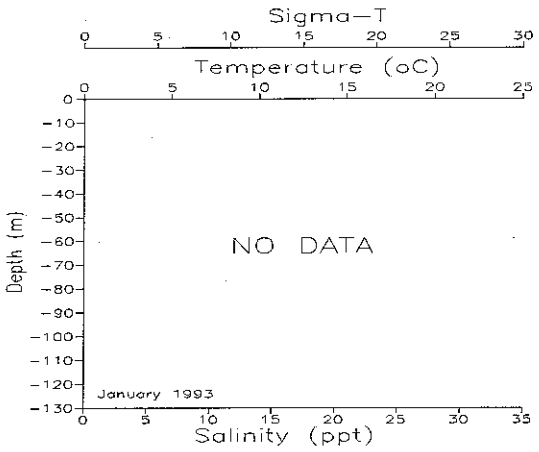
Part 1 of 2

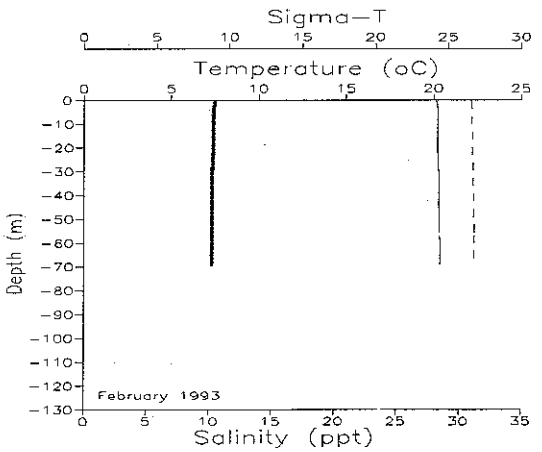
Straits of Juan de Fuca (Station ADM002)

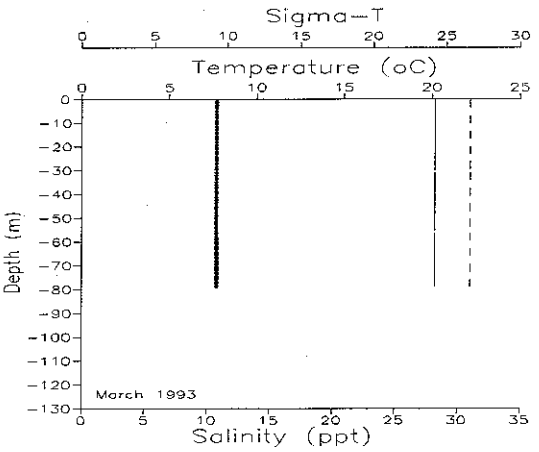










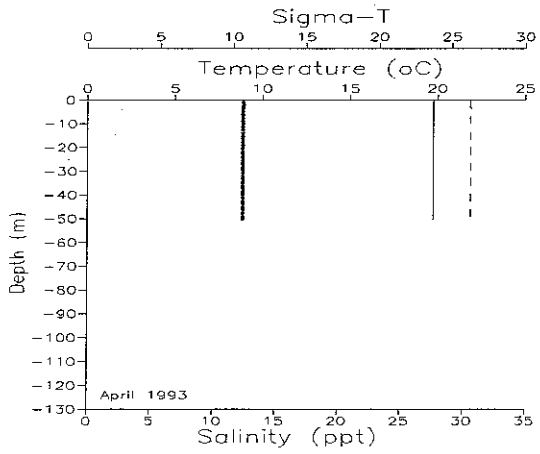


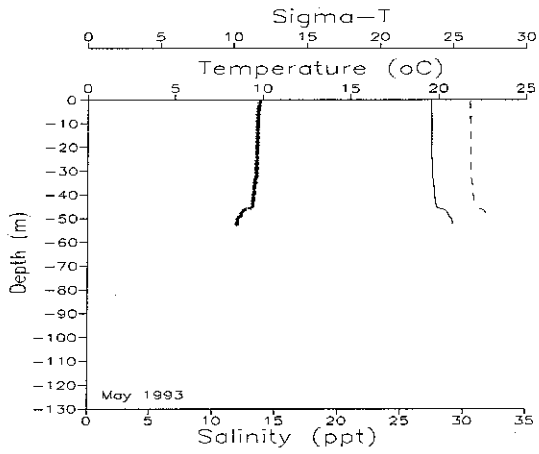
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

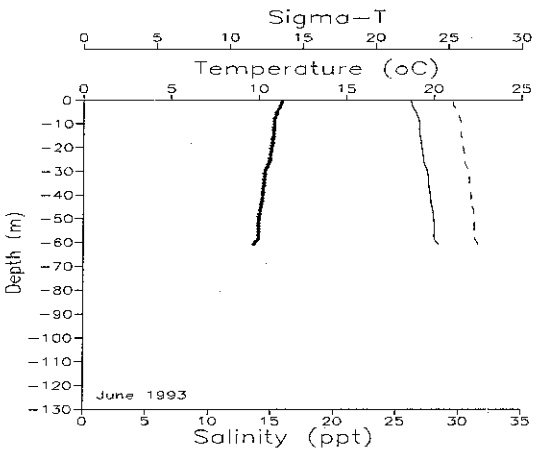
WATERYEAR 1993

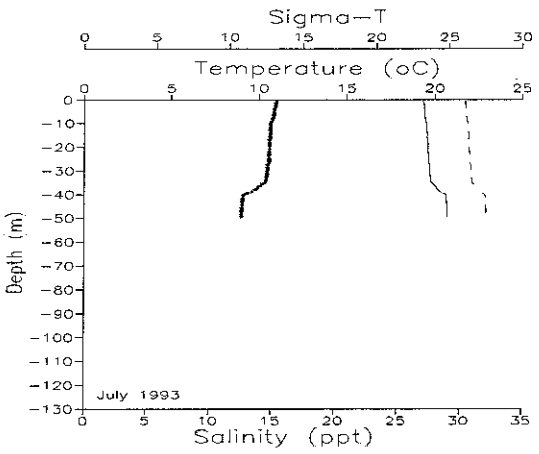
Part 2 of 2

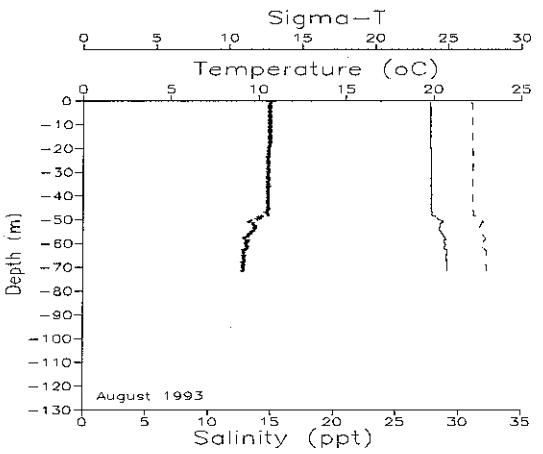
Straits of Juan de Fuca (Station ADM002)

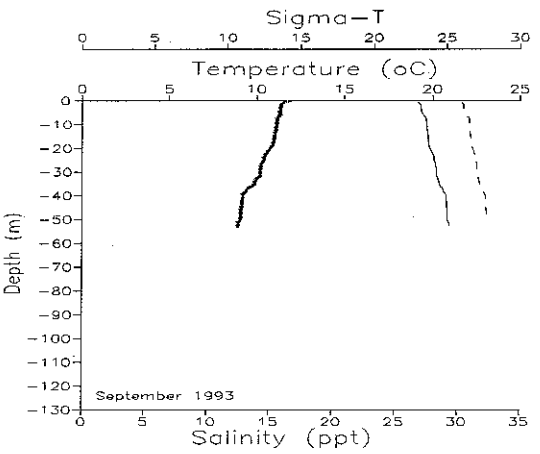








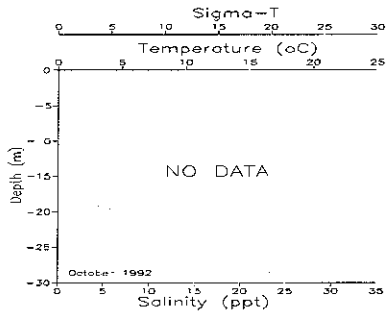


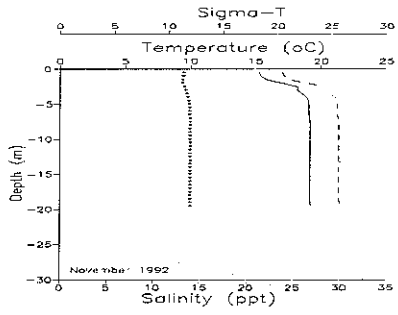


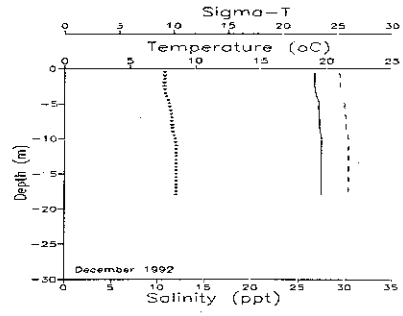
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

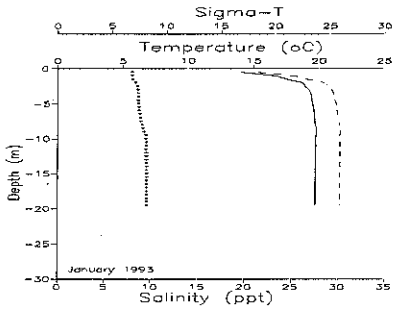
WATERYEAR 1993

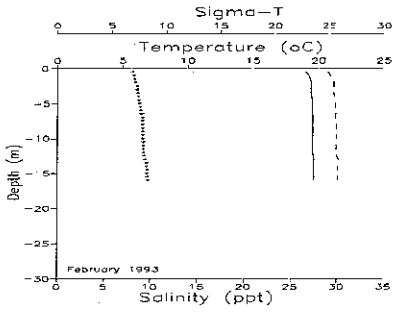
Bellingham Bay (Station BLL009)

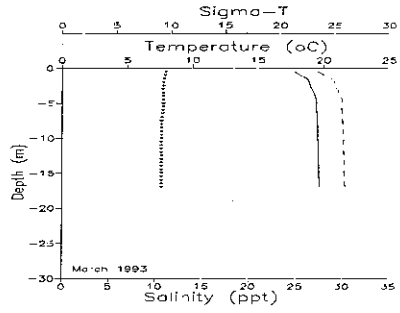


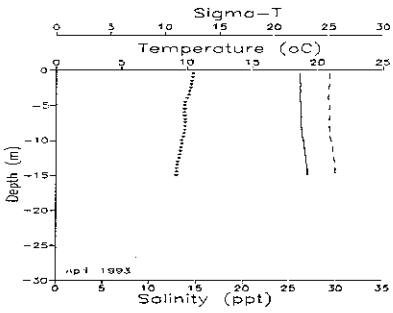


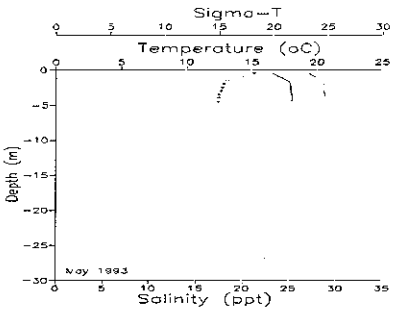


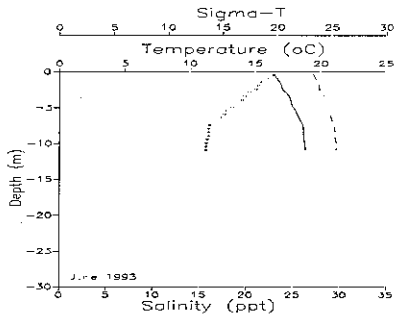


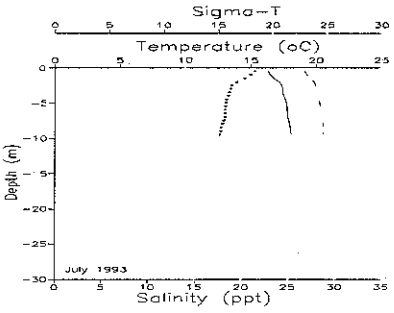


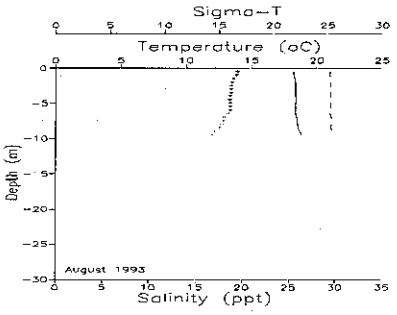


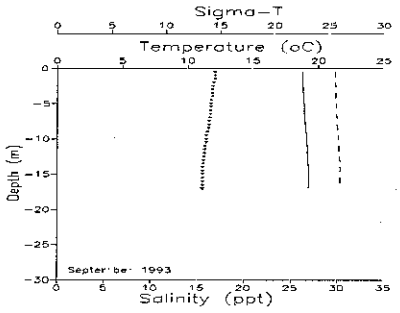








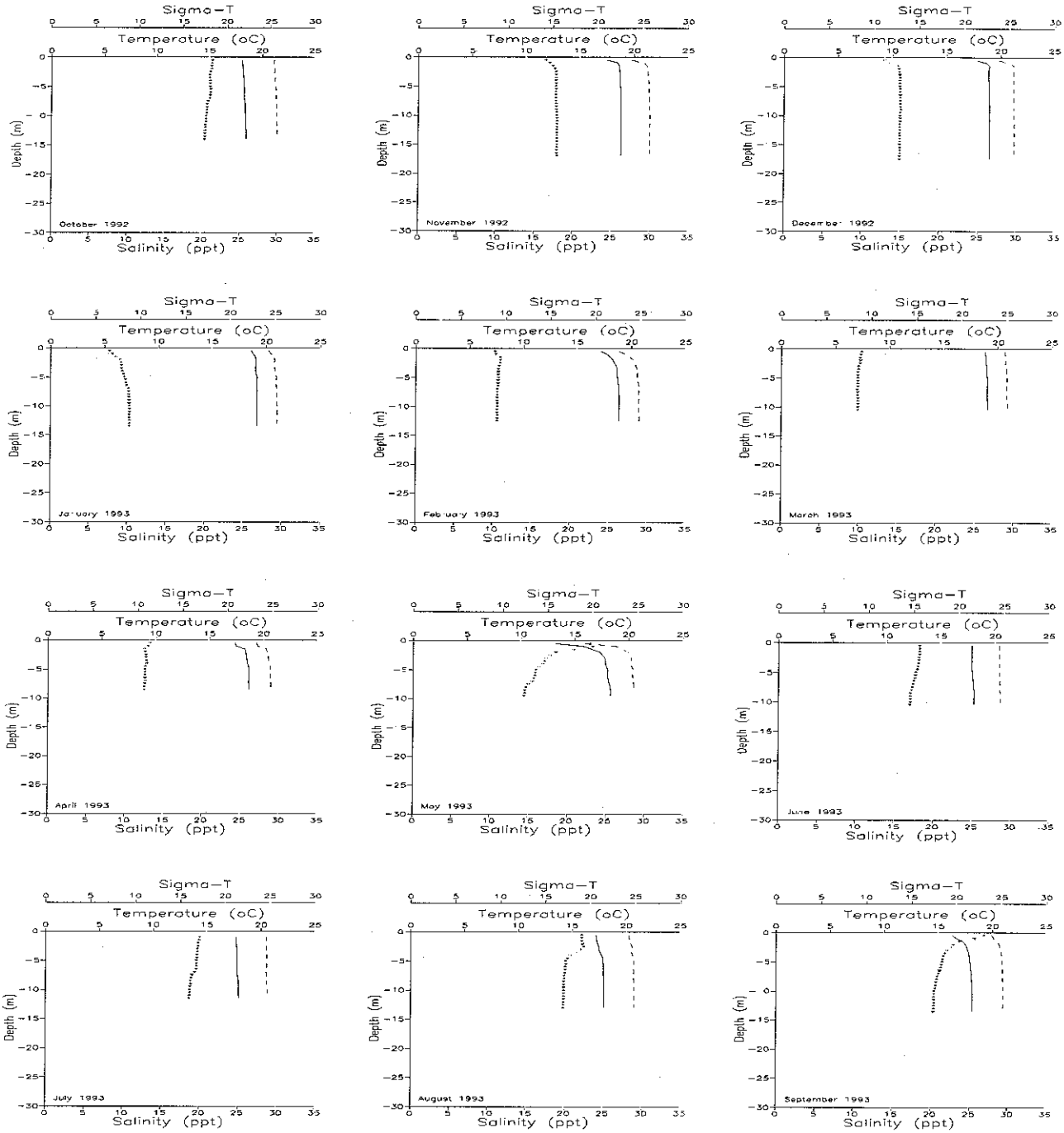




Key: Temperature = Dotted Line Salinity = Dashed Line Sigma-t = Solid Line

WATERYEAR 1993

Budd Inlet (Station BUD005)

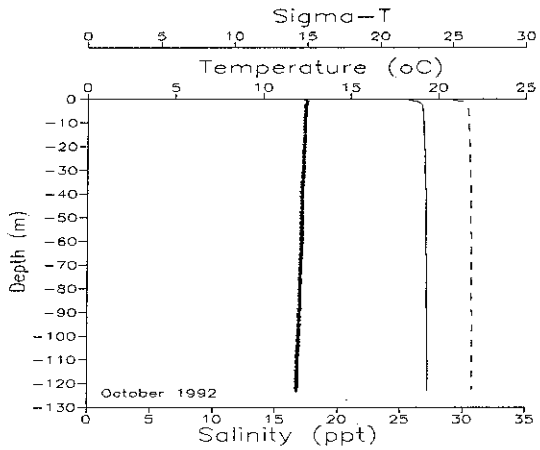


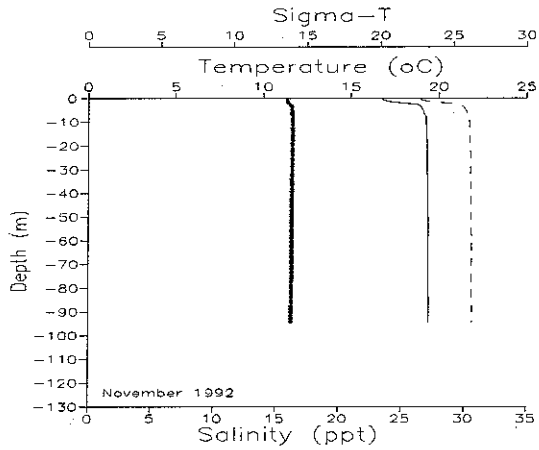
Key: Temperature = Dotted Line Salinity = Dashed Line Sigma-t = Solid Line

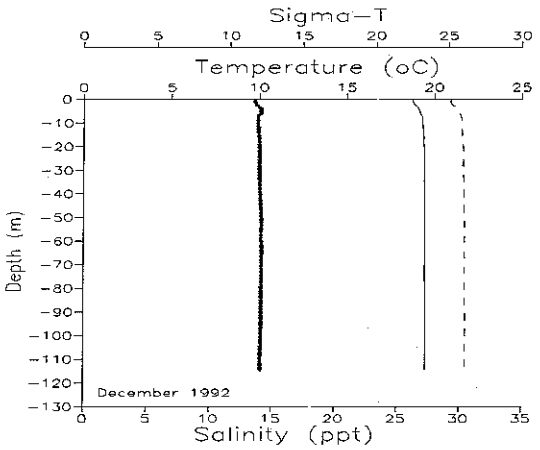
WATERYEAR 1993

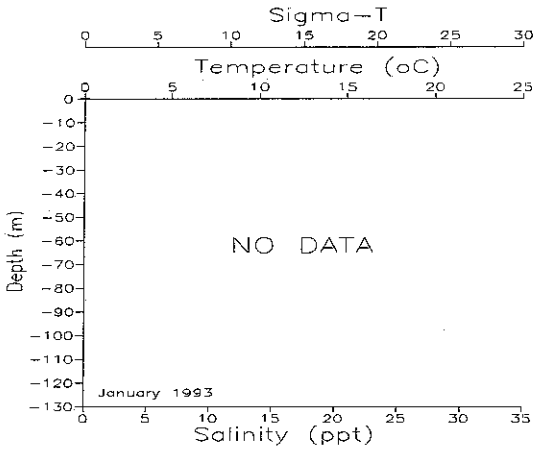
Part 1 of 2

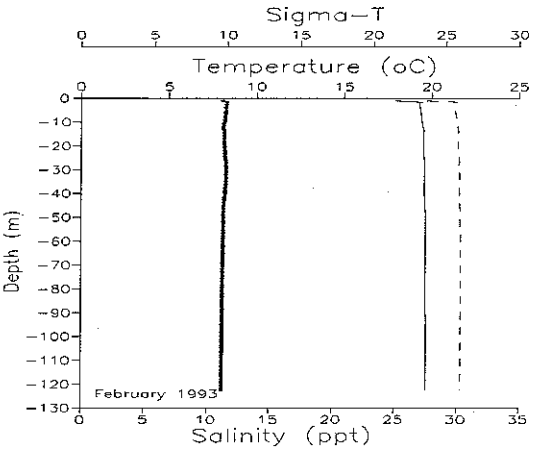
Commencement Bay - Browns Point (Station CMB003)

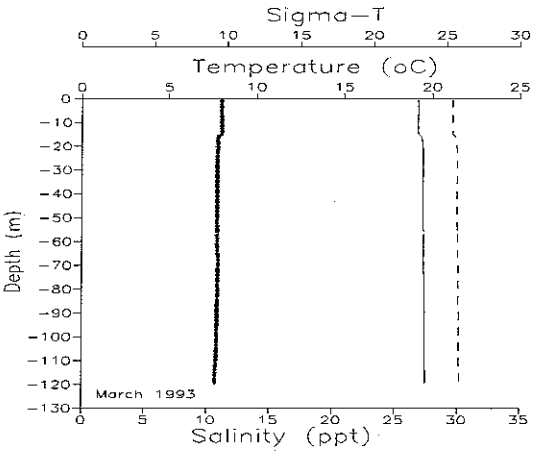










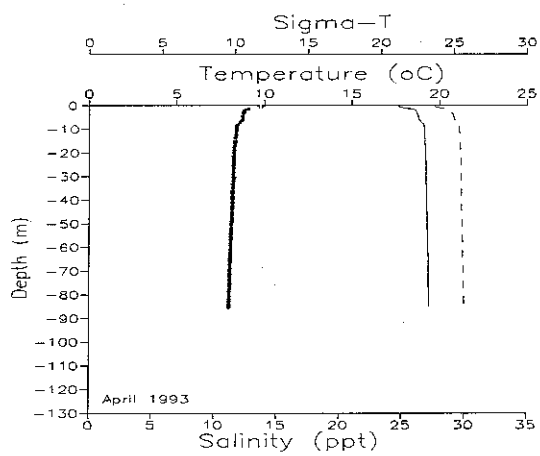


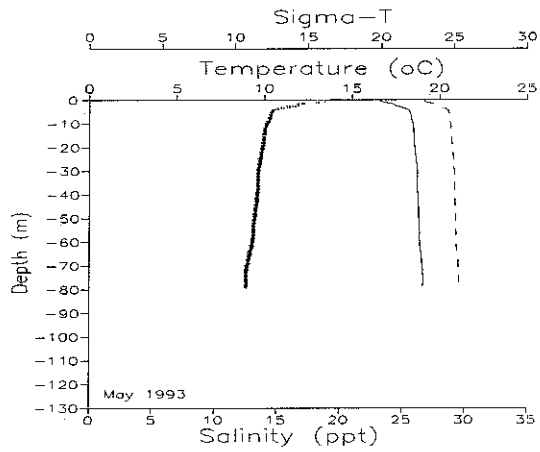
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

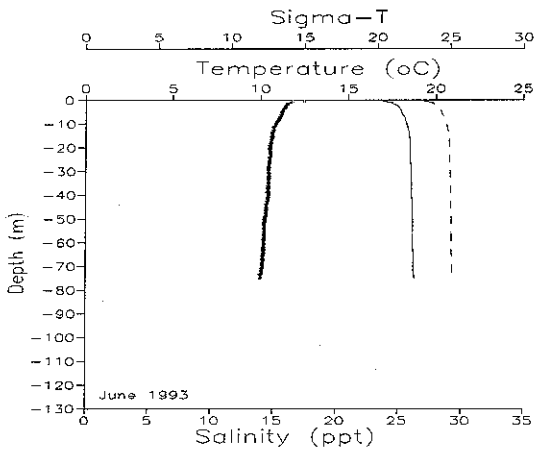
WATERYEAR 1993

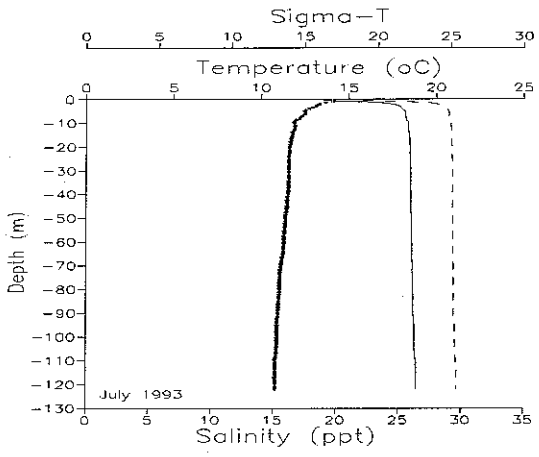
Part 2 of 2

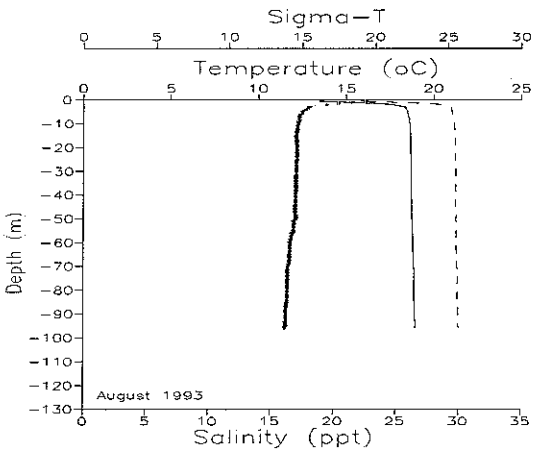
Commencement Bay - Browns Point (Station CMB003)

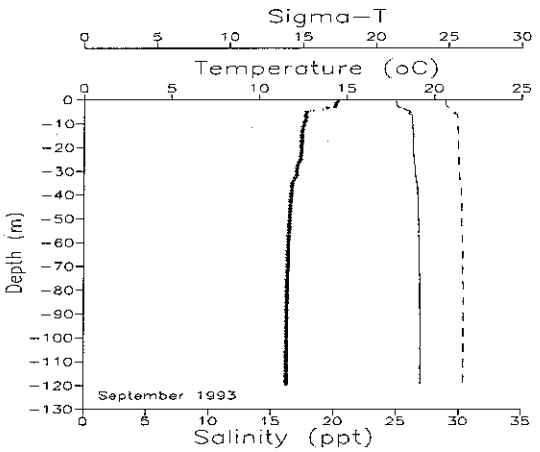










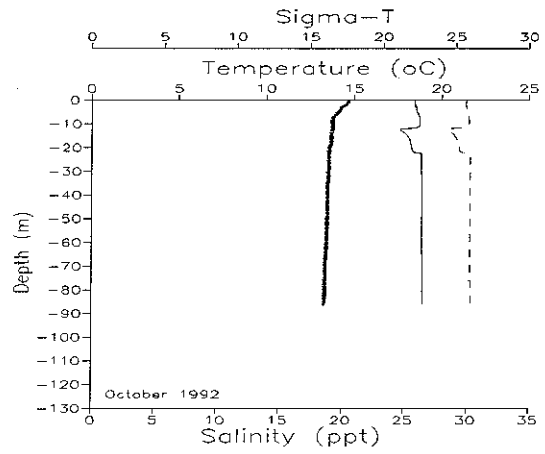


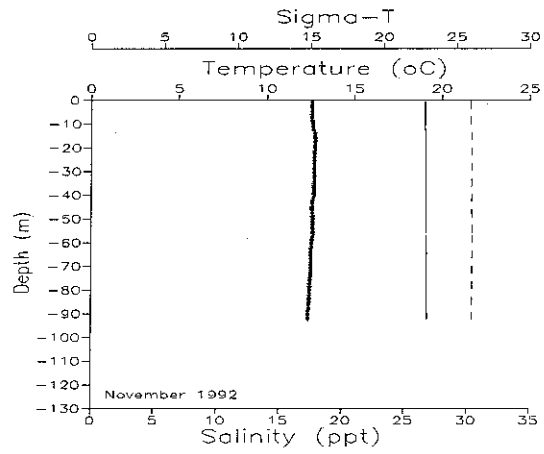
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

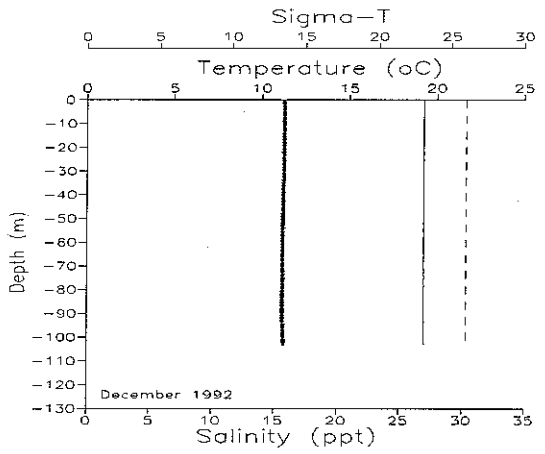
WATERYEAR 1993

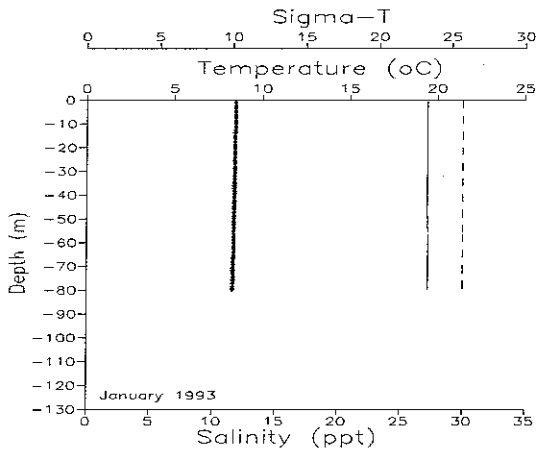
Part 1 of 2

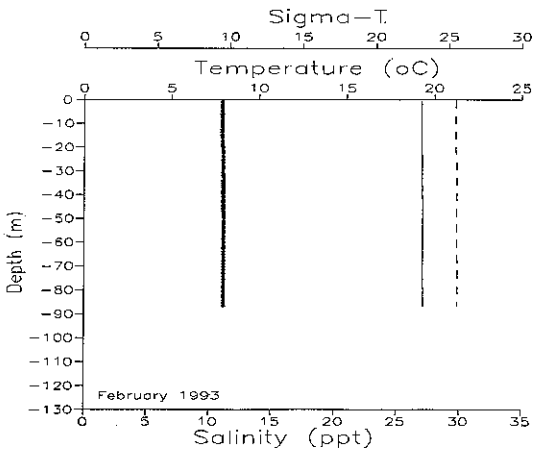
Carr Inlet - Green Point (Station CRR001)

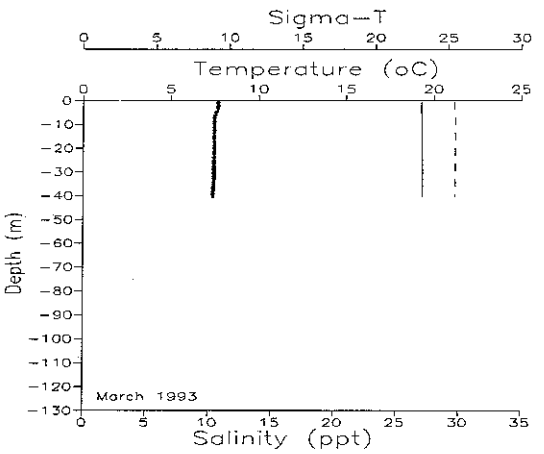










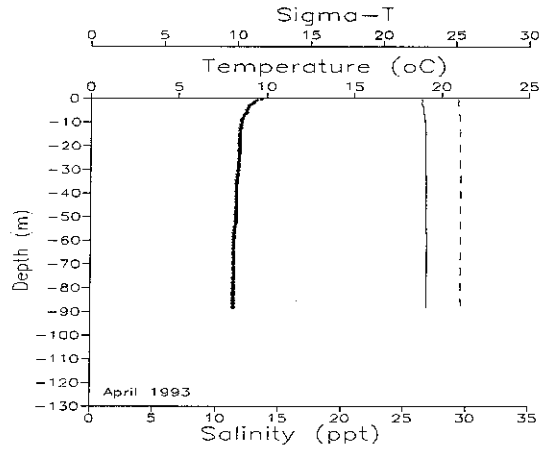


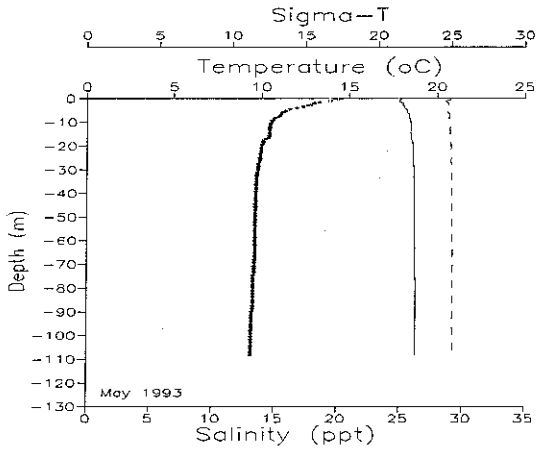
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

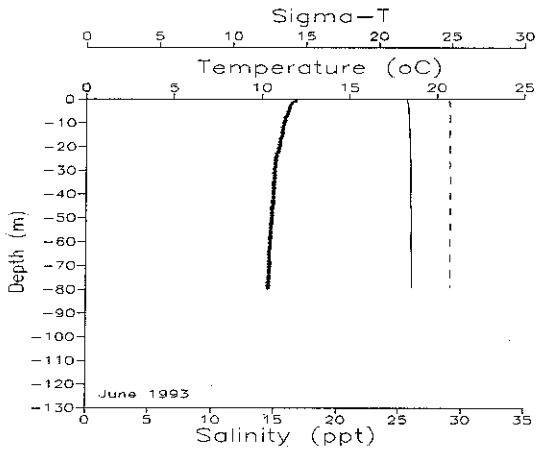
WATERYEAR 1993

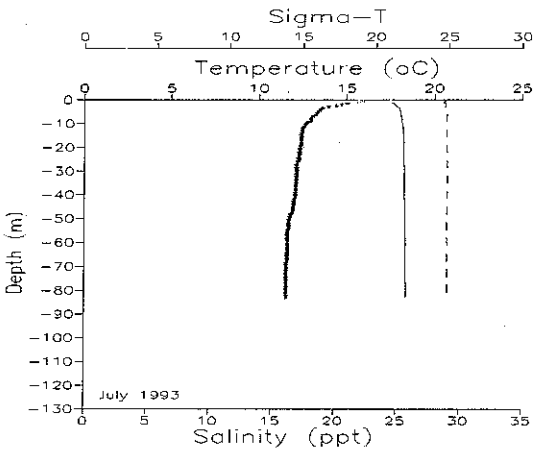
Part 2 of 2

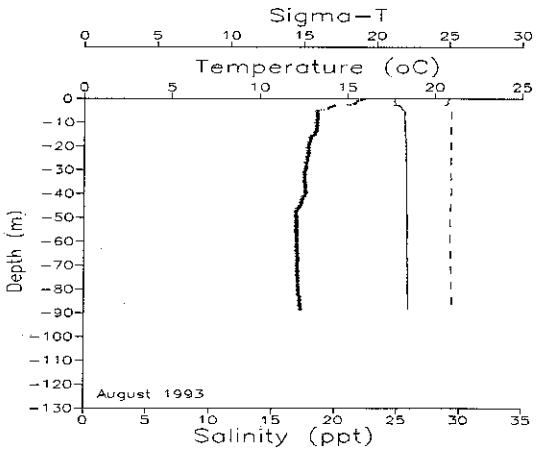
Carr Inlet - Green Point (Station CRR001)

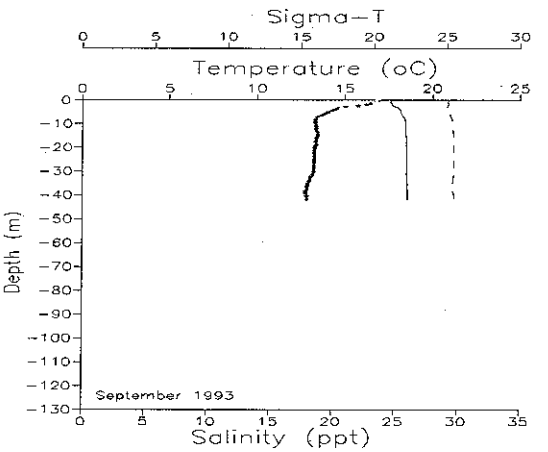










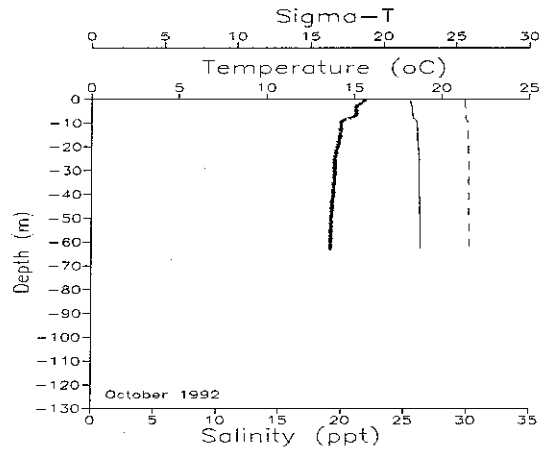


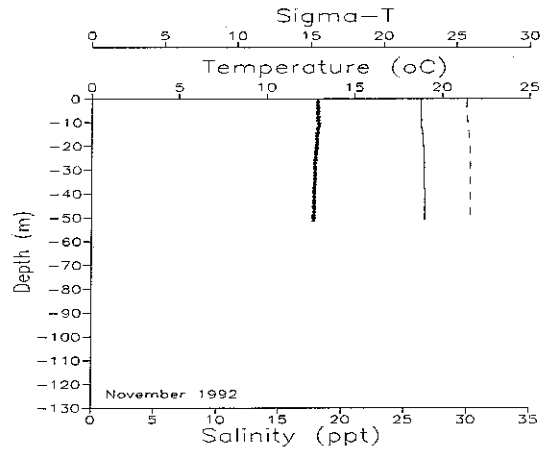
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

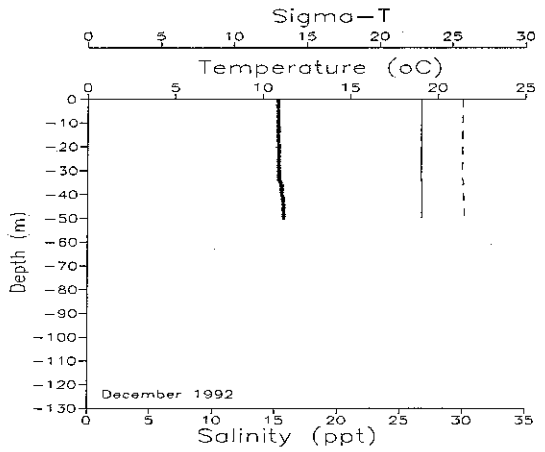
WATERYEAR 1993

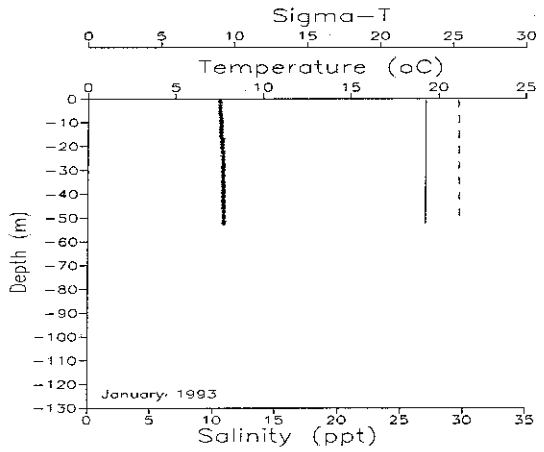
Part 1 of 2

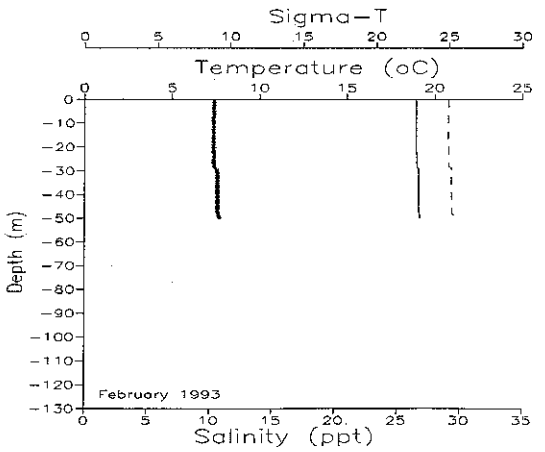
Case Inlet - Heron Island (Station CSE001)

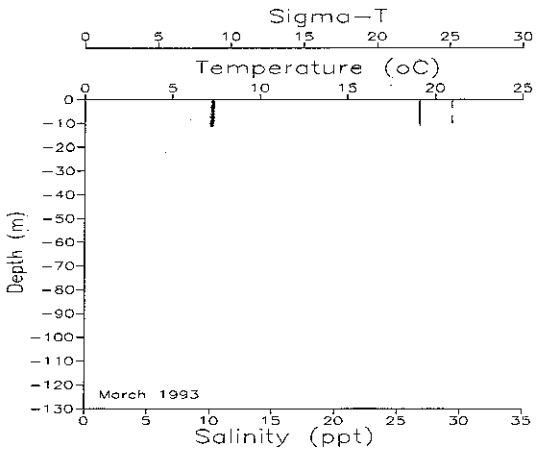










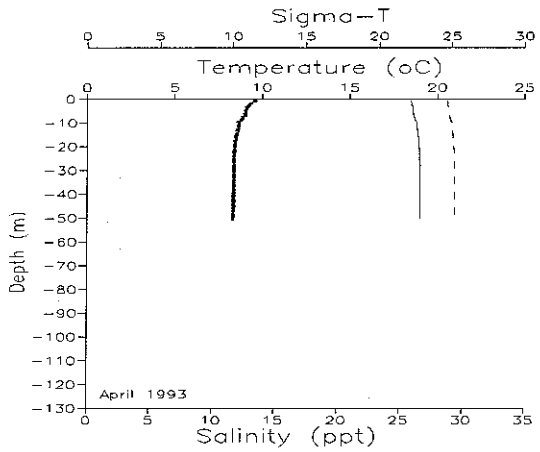


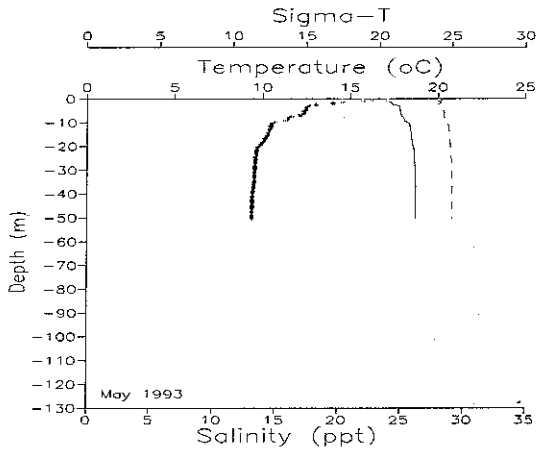
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

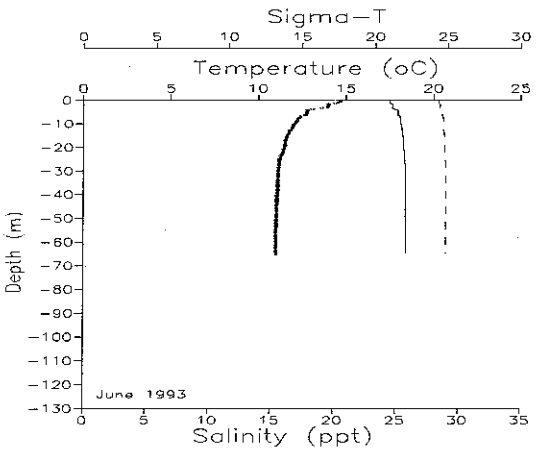
WATERYEAR 1993

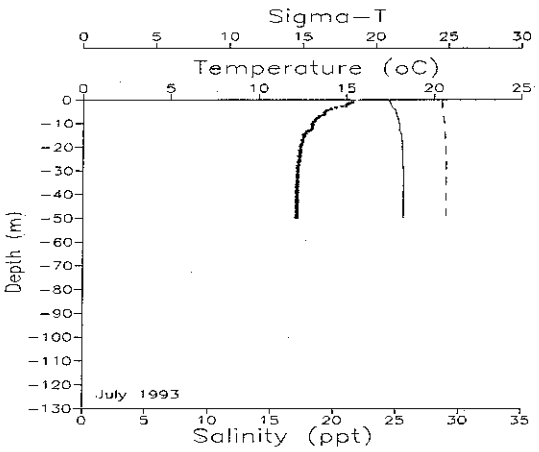
Part 2 of 2

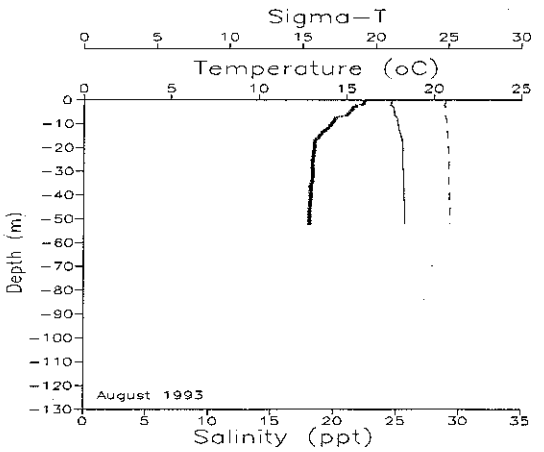
Case Inlet - Heron Island (Station CSE001)

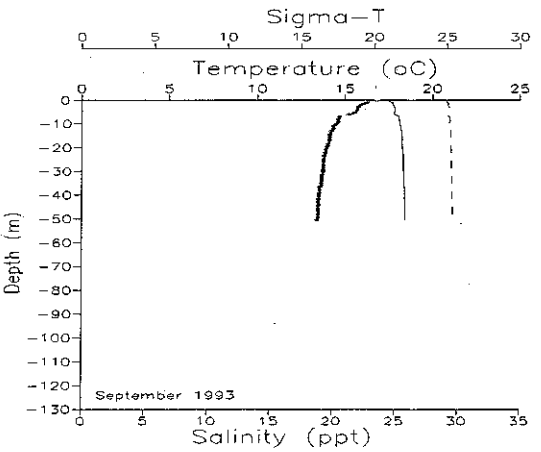










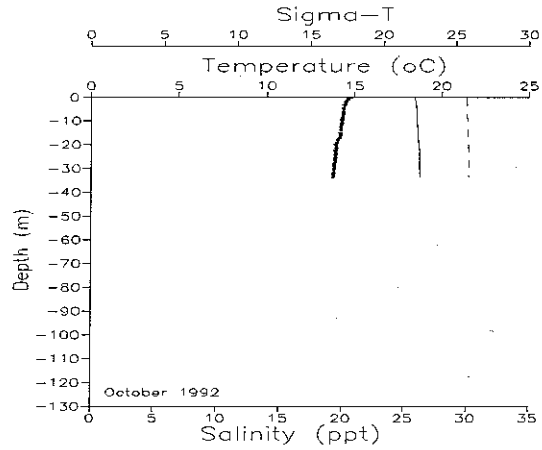


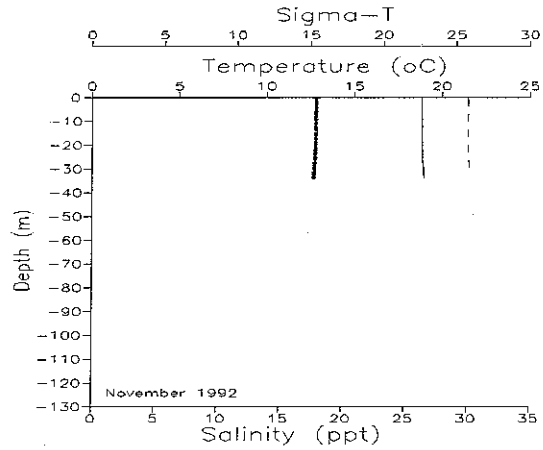
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

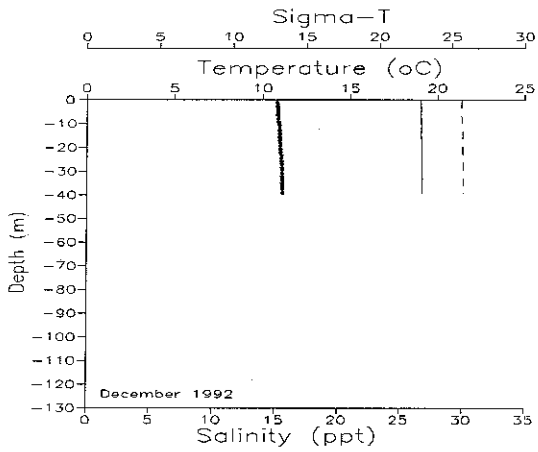
WATERYEAR 1993

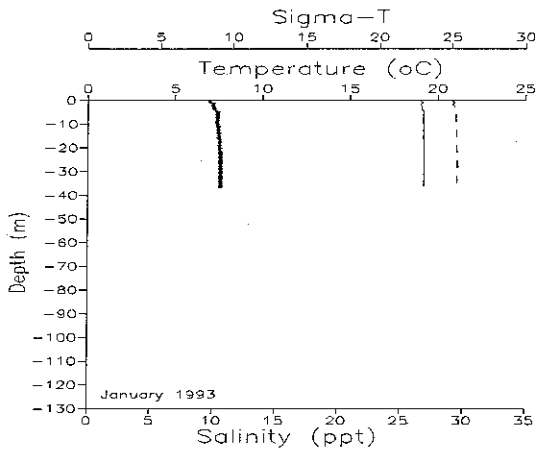
Part 1 of 2

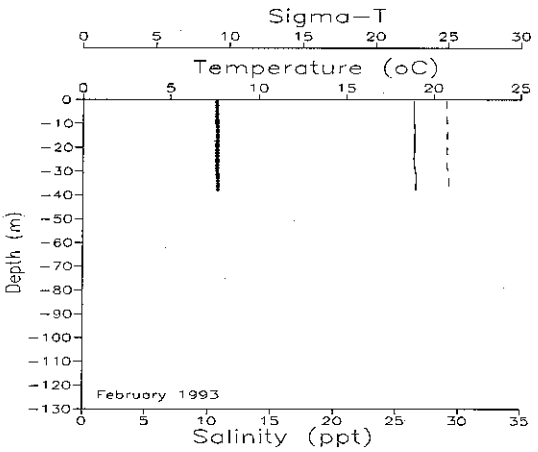
Dana Passage (Station DNA001)

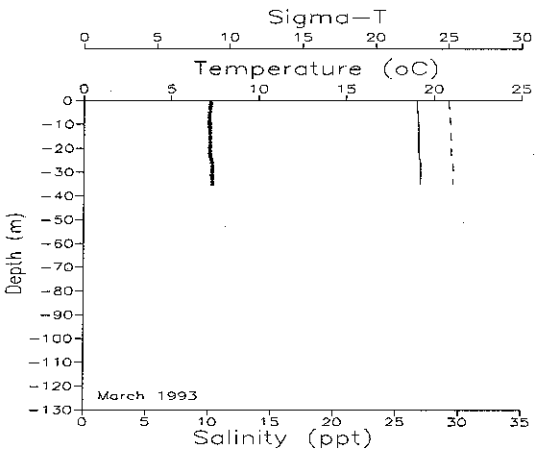










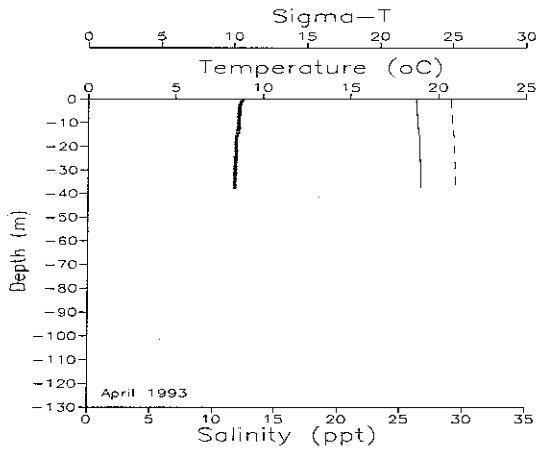


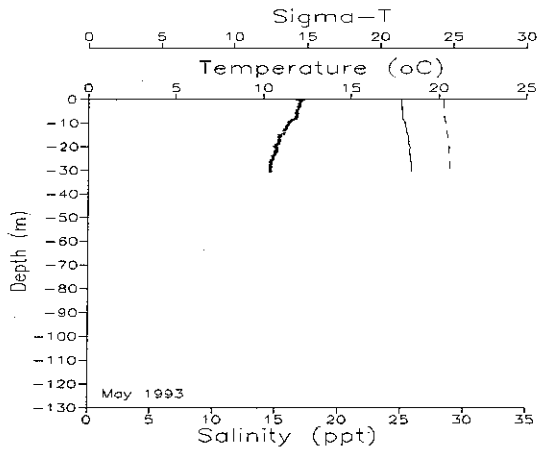
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

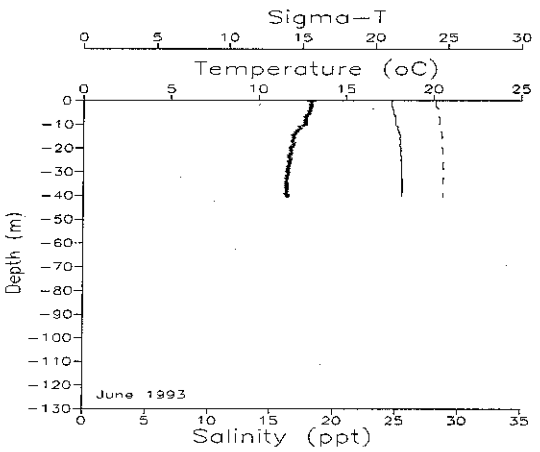
WATERYEAR 1993

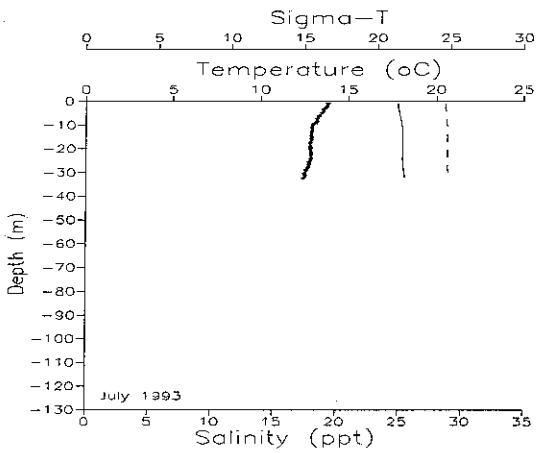
Part 2 of 2

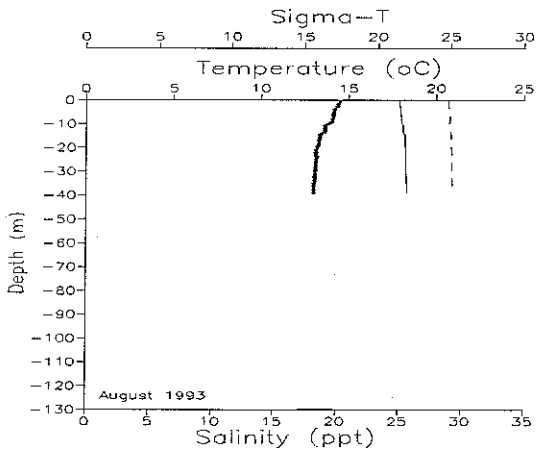
Dana Passage (Station DNA001)

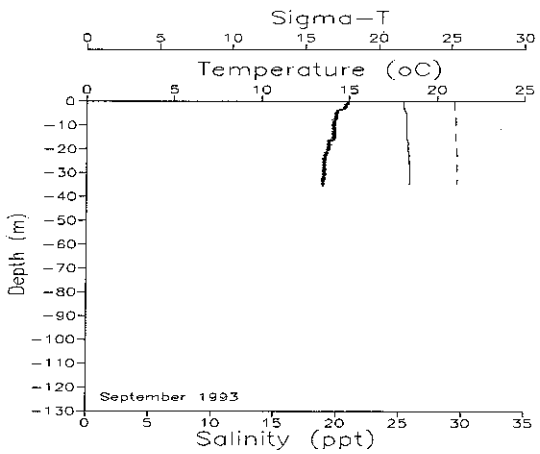










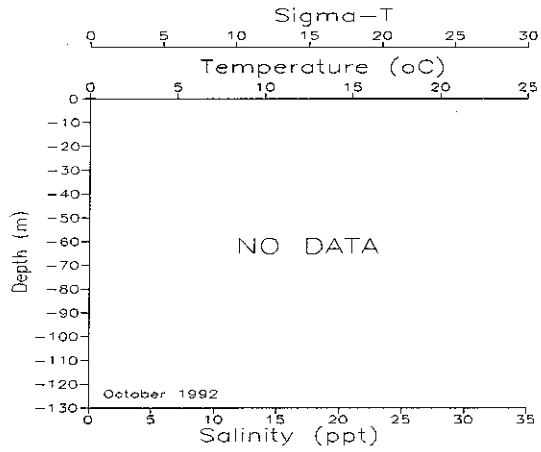


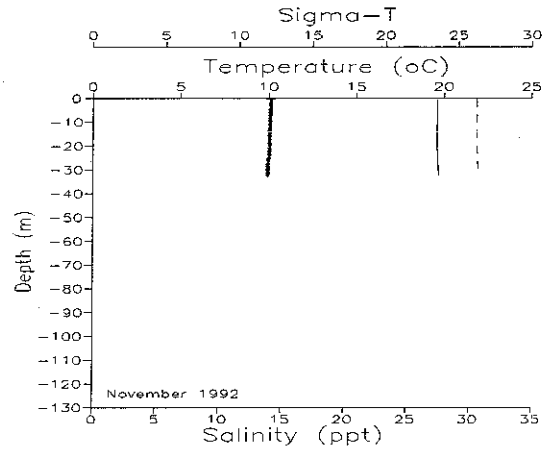
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

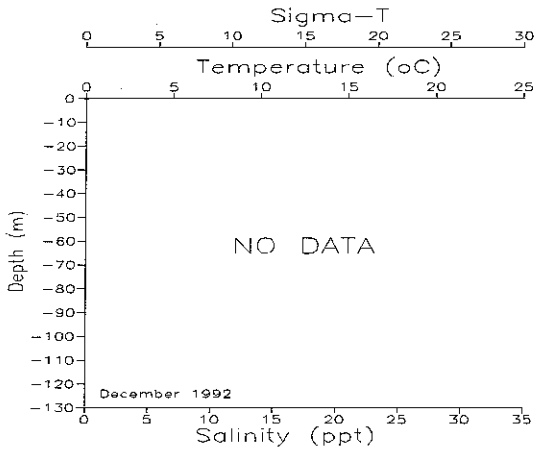
WATERYEAR 1993

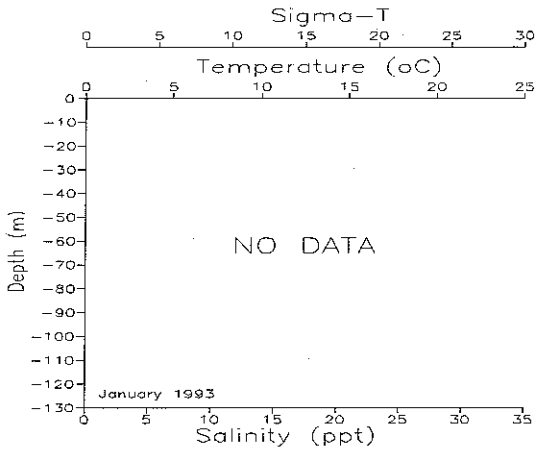
Part 1 of 2

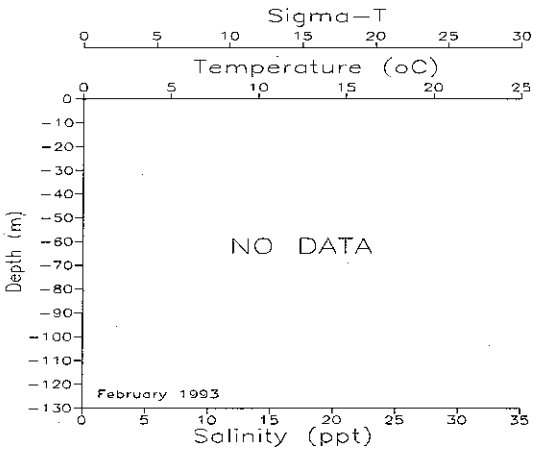
East Sound - Orcas Island (Station EAS001)

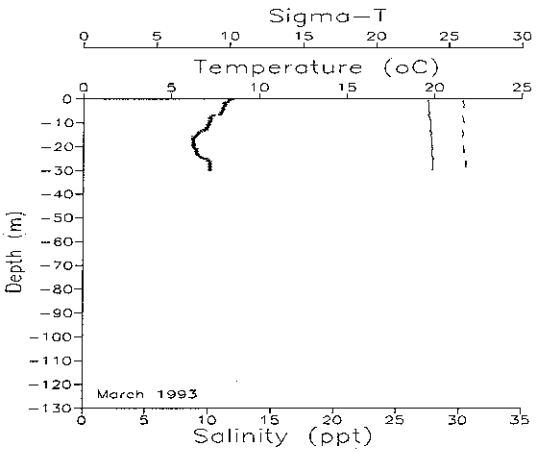










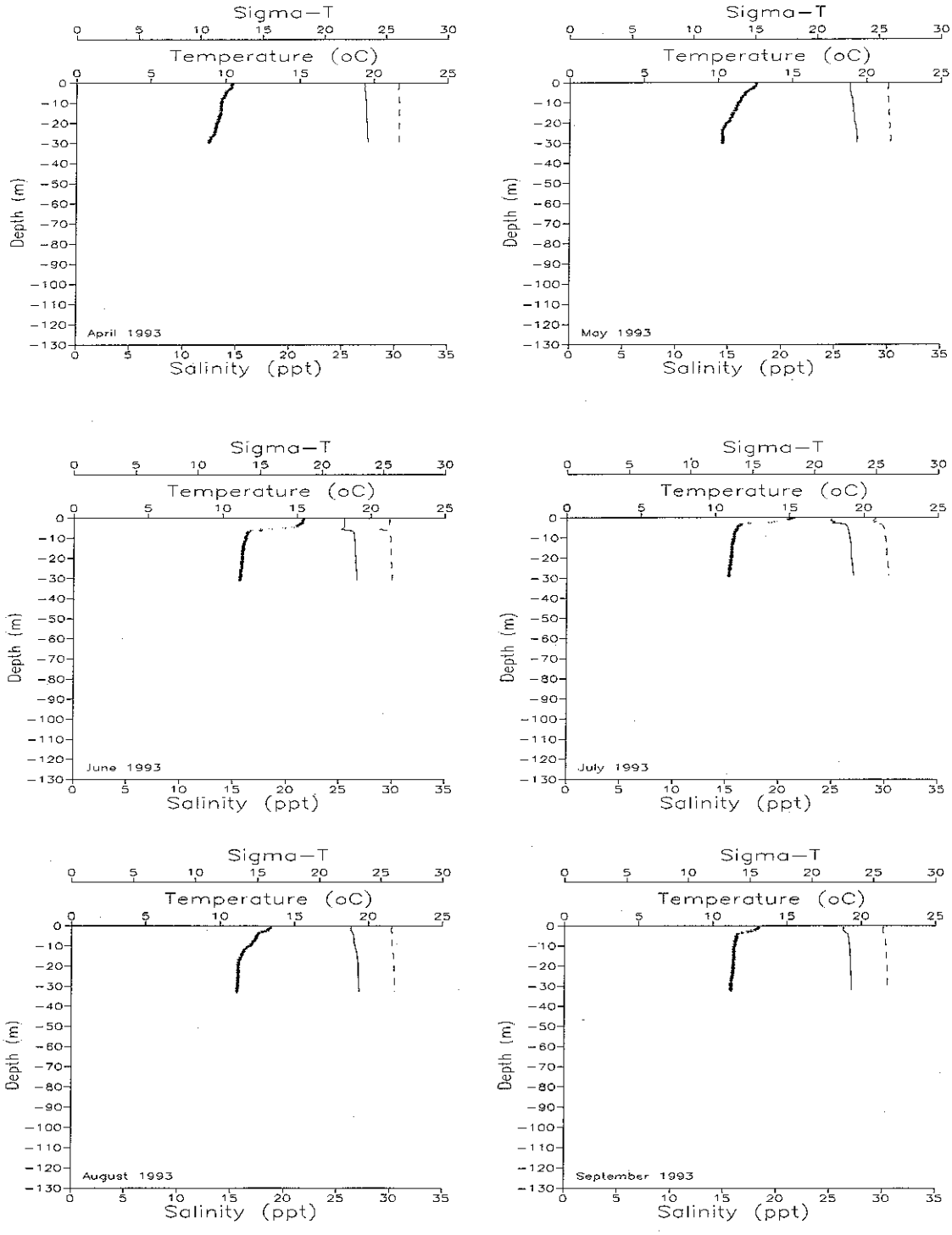


Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

WATERYEAR 1993

Part 2 of 2

East Sound - Orcas Island (Station EAS001)

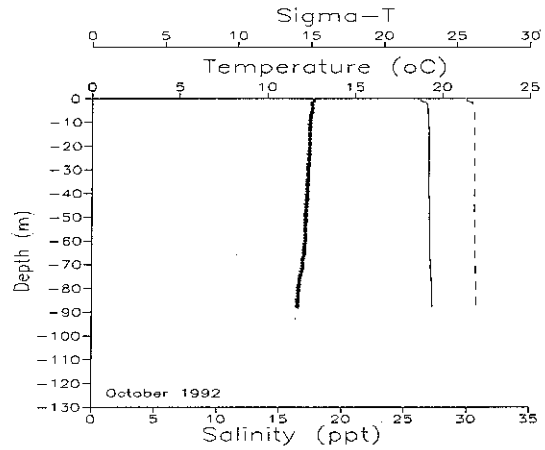


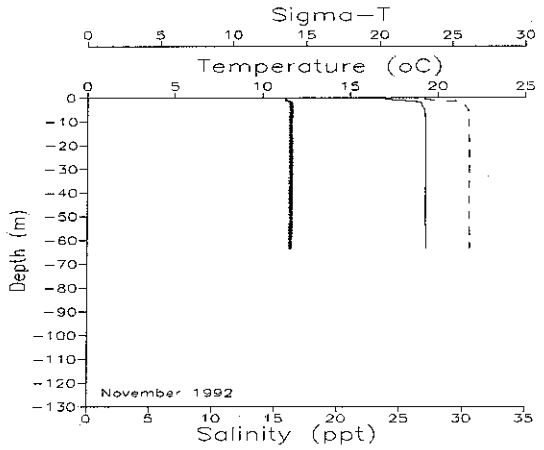
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

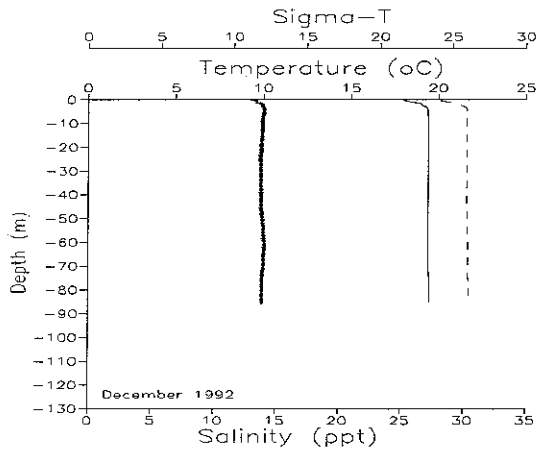
WATERYEAR 1993

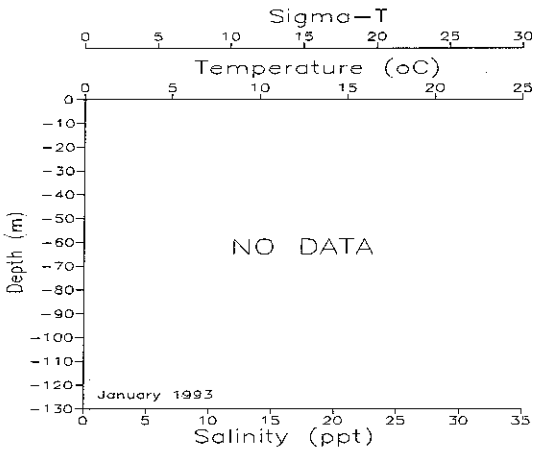
Part 1 of 2

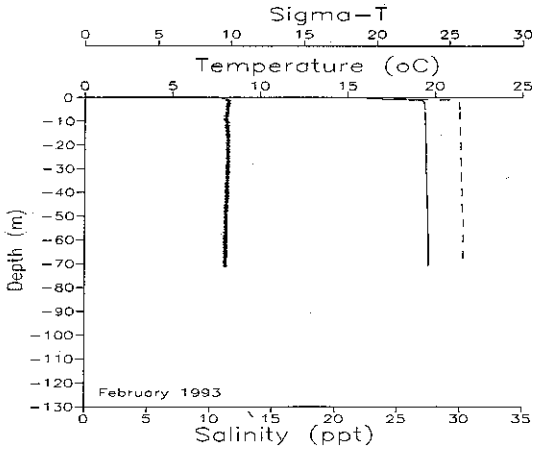
Elliott Bay - East Duwamish Head (Station ELB015)

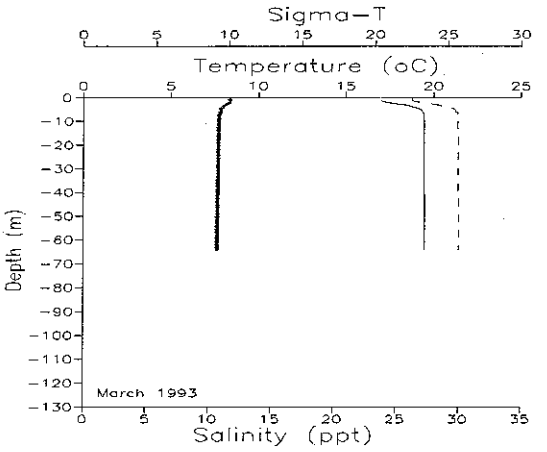










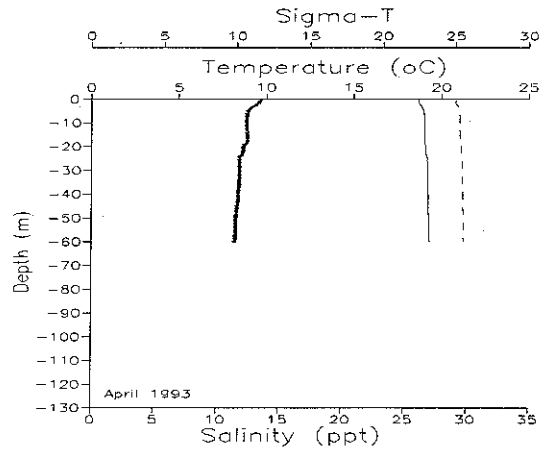


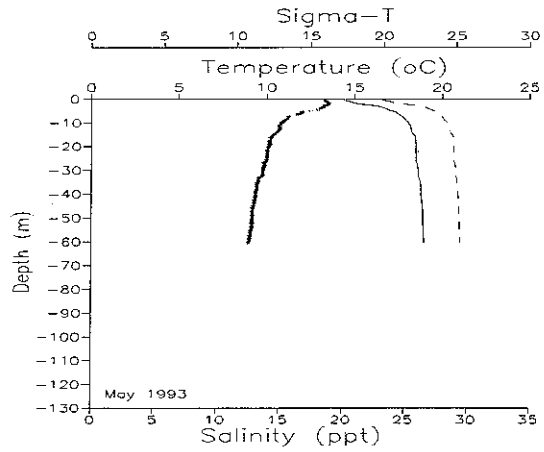
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

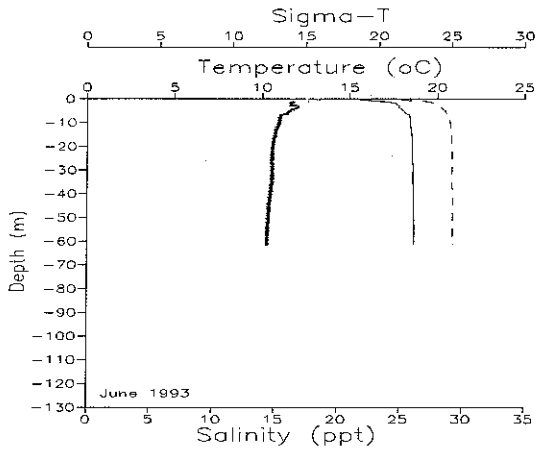
WATERYEAR 1993

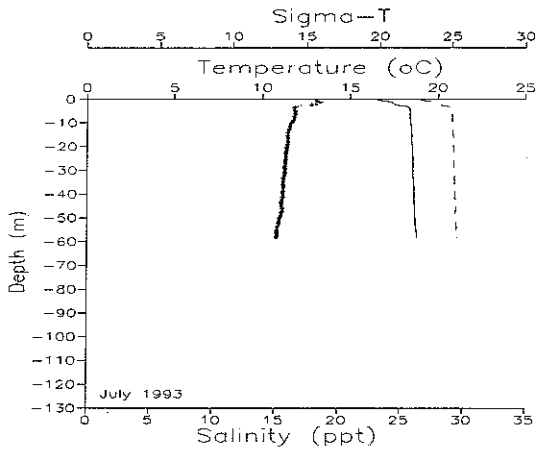
Part 2 of 2

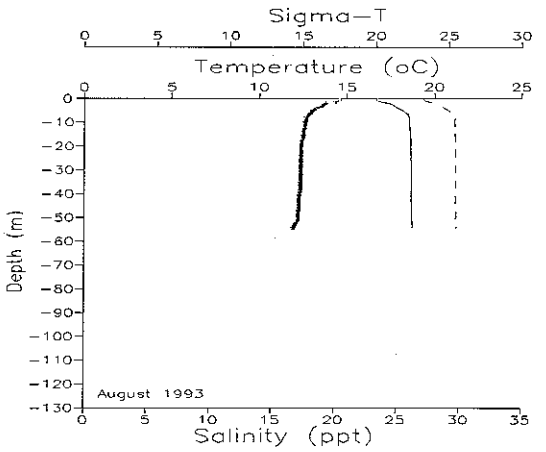
Elliott Bay - East Duwamish Head (Station ELB015)

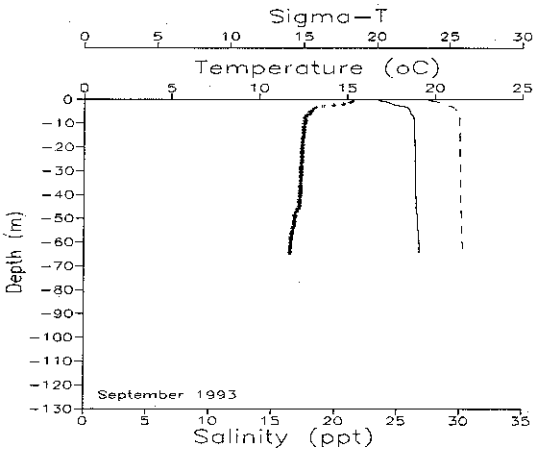








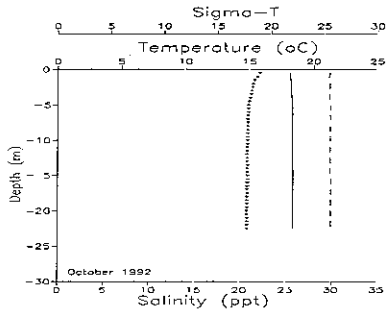


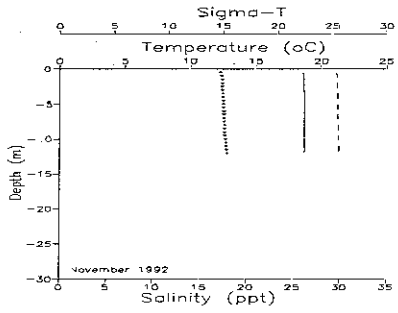


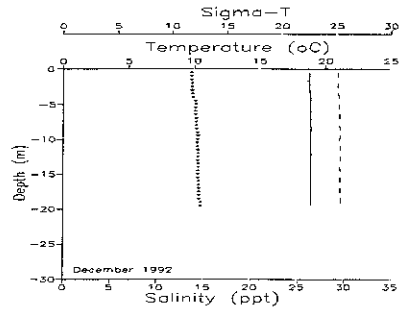
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

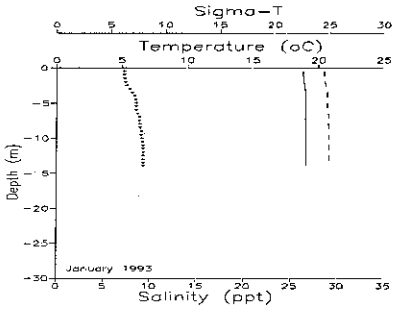
WATERYEAR 1993

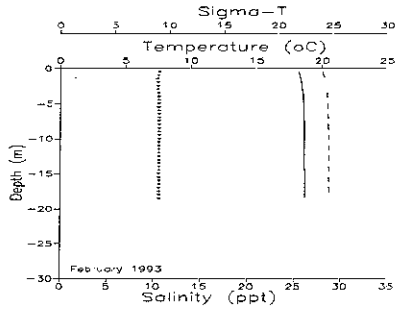
Eld Inlet (Station ELD001)

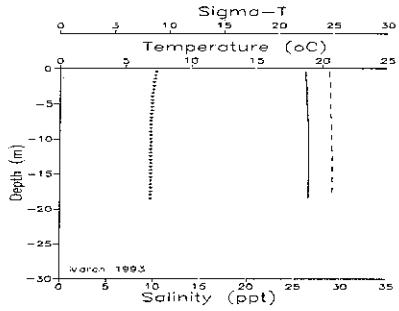


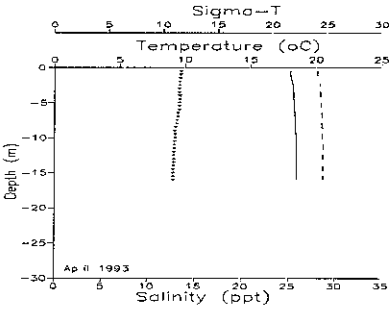


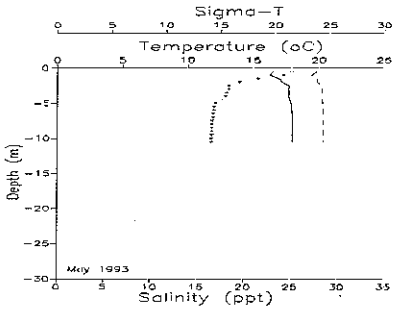


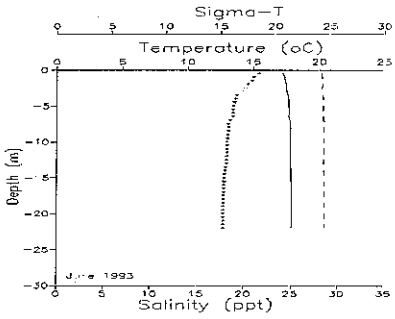


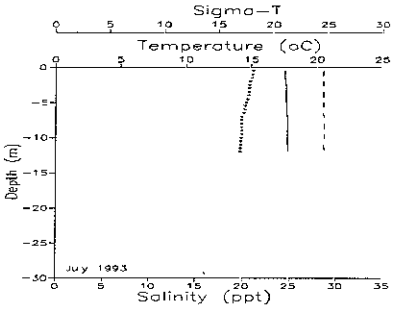


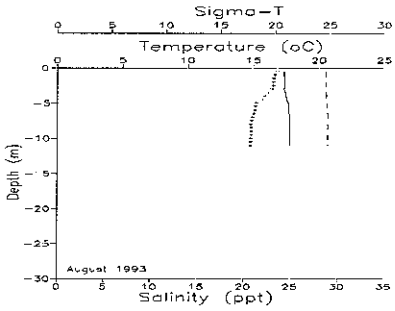


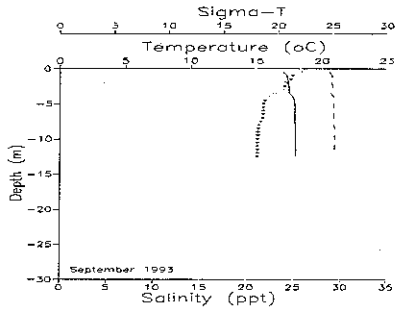










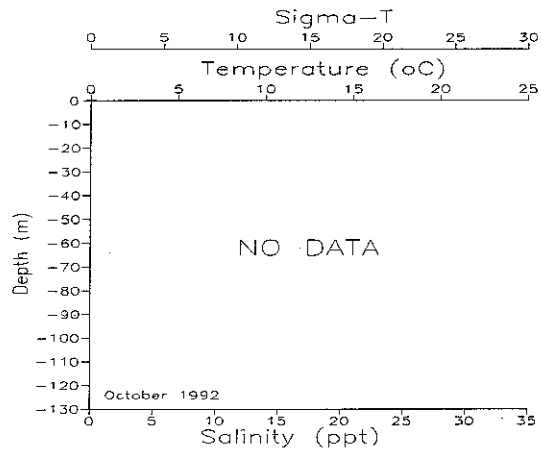


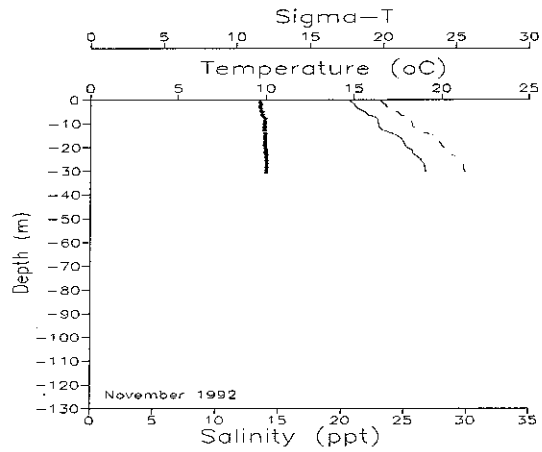
Key: Temperature = Dotted Line Salinity = Dashed Line Sigma-t = Solid Line

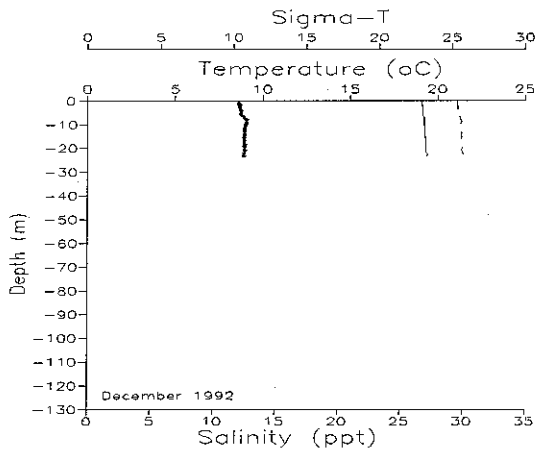
WATERYEAR 1993

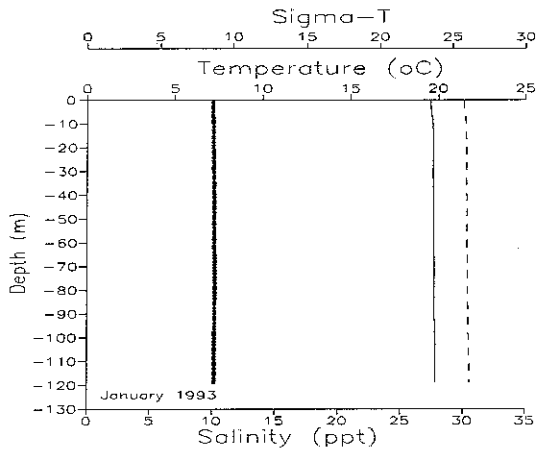
Part 1 of 2

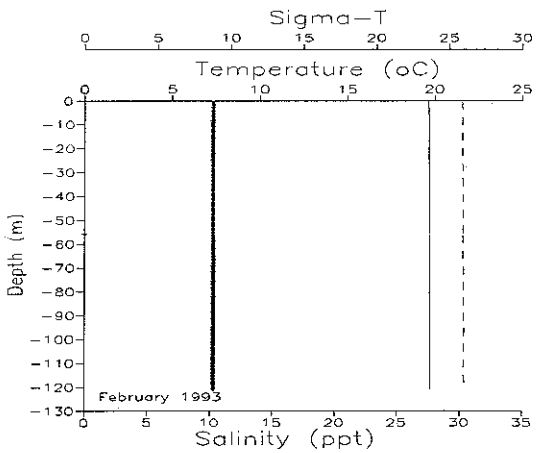
Georgia Strait - North of Patos Is. (Station GRG002)

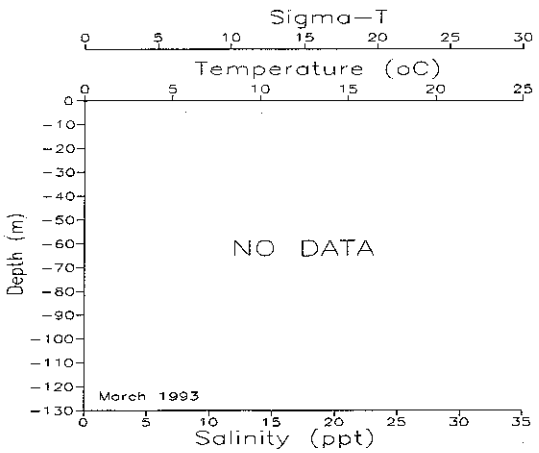










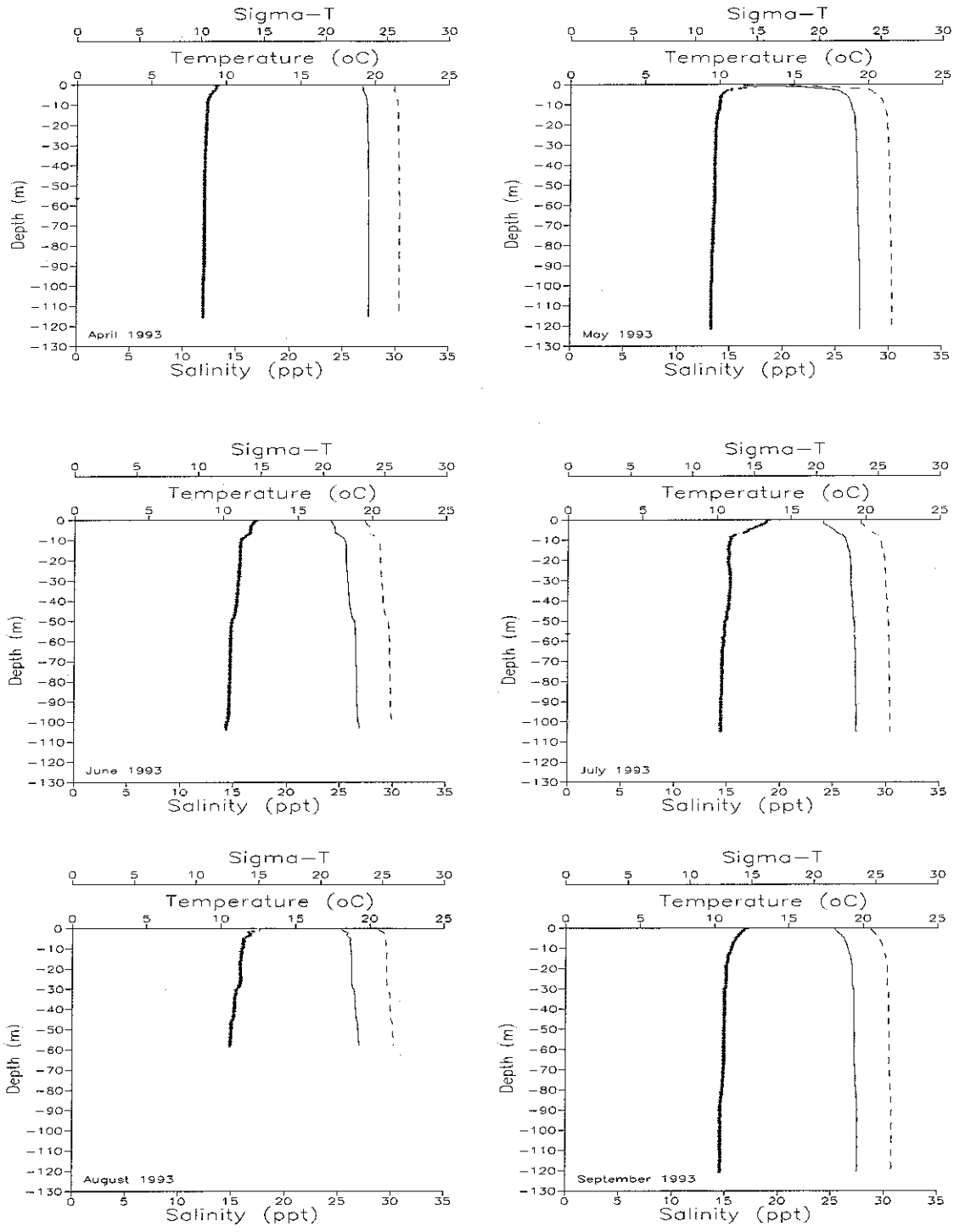


Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

WATERYEAR 1993

Part 2 of 2

Georgia Strait - North of Patos Is. (Station GRG002)

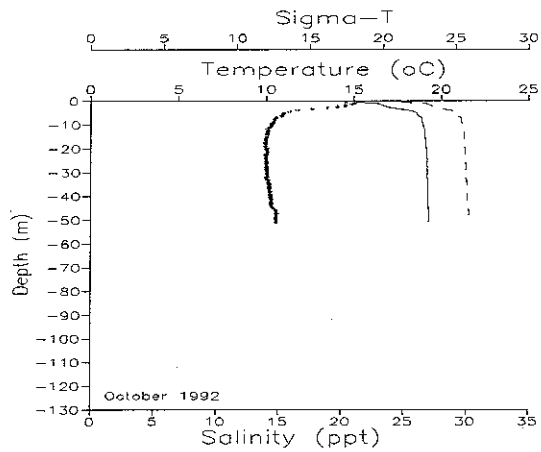


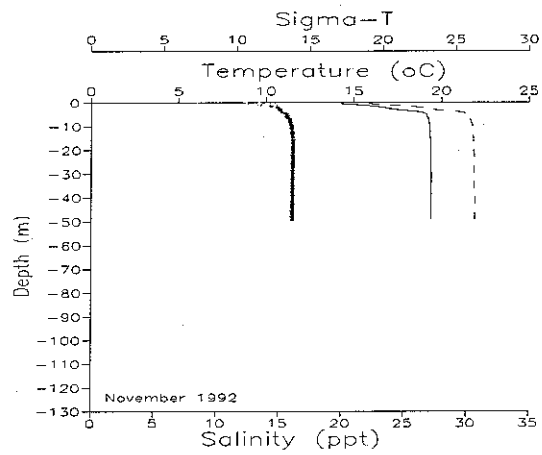
Key: **Temperature = Bold Line** **Salinity = Dashed Line** **Sigma-t = Solid Line**

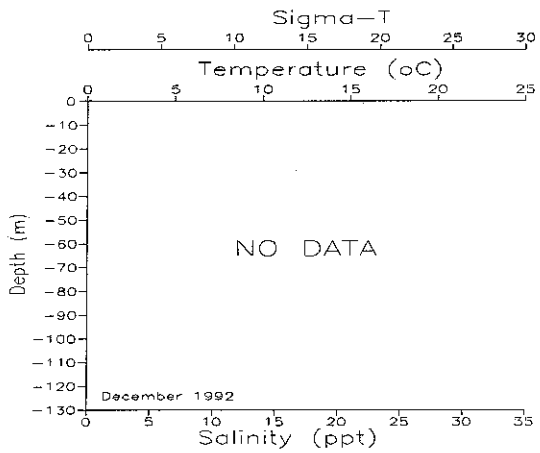
WATERYEAR 1993

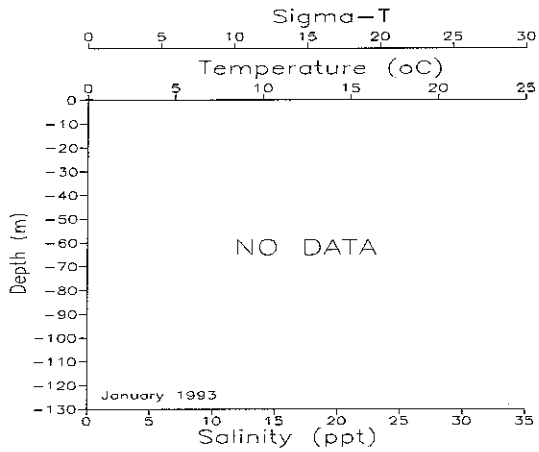
Part 1 of 2

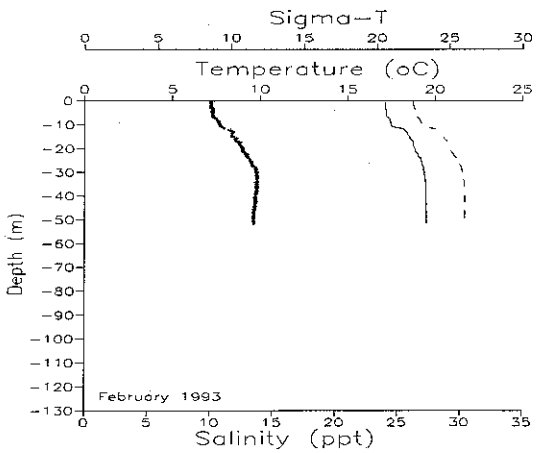
South Hood Canal at Sister's Point (Station HCB004)

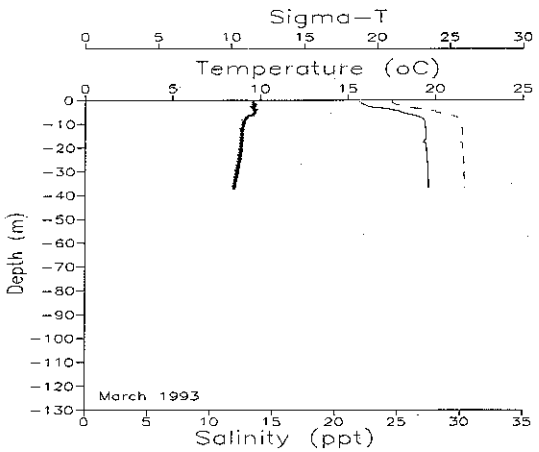










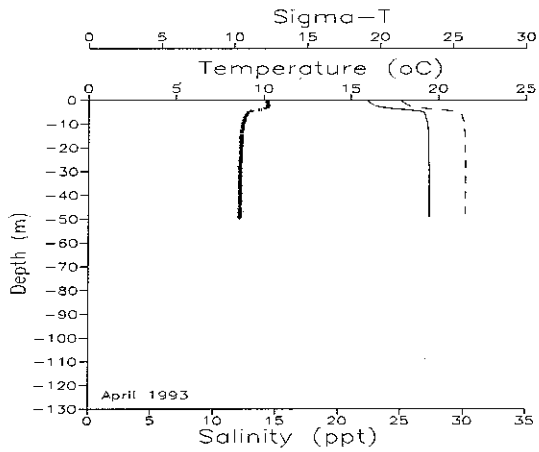


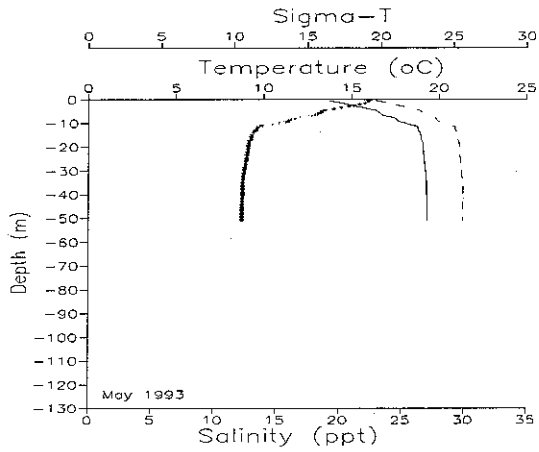
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

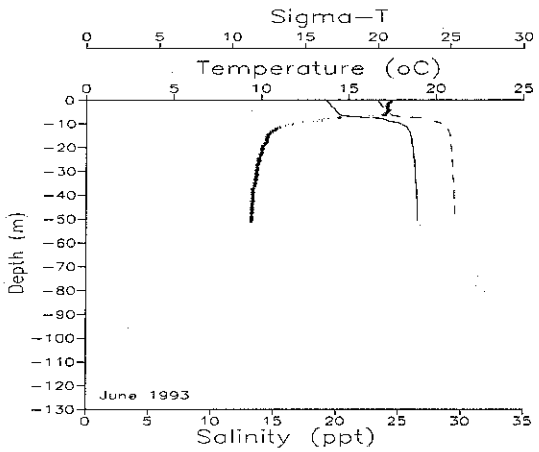
WATERYEAR 1993

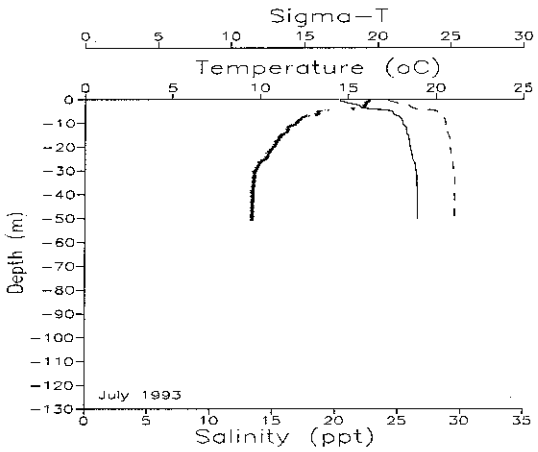
Part 2 of 2

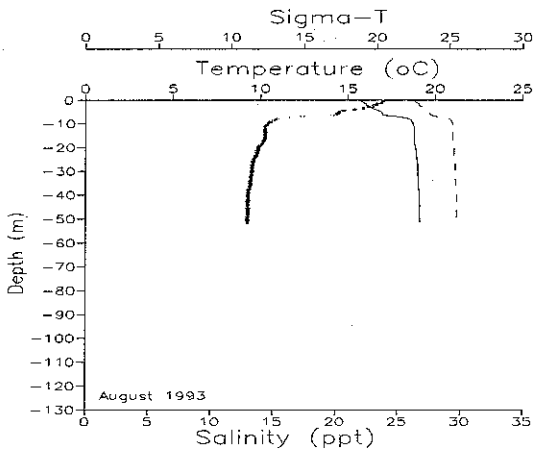
South Hood Canal at Sister's Point (Station HCB004)

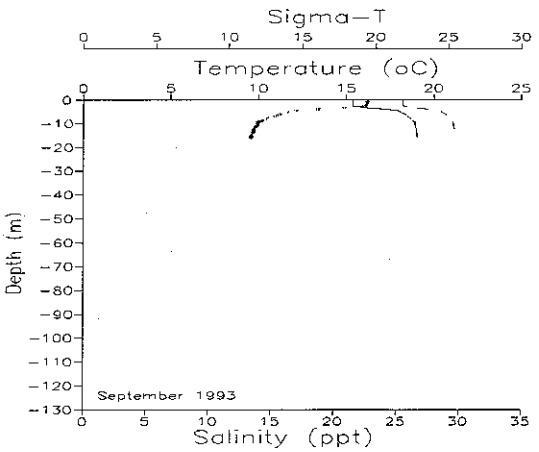










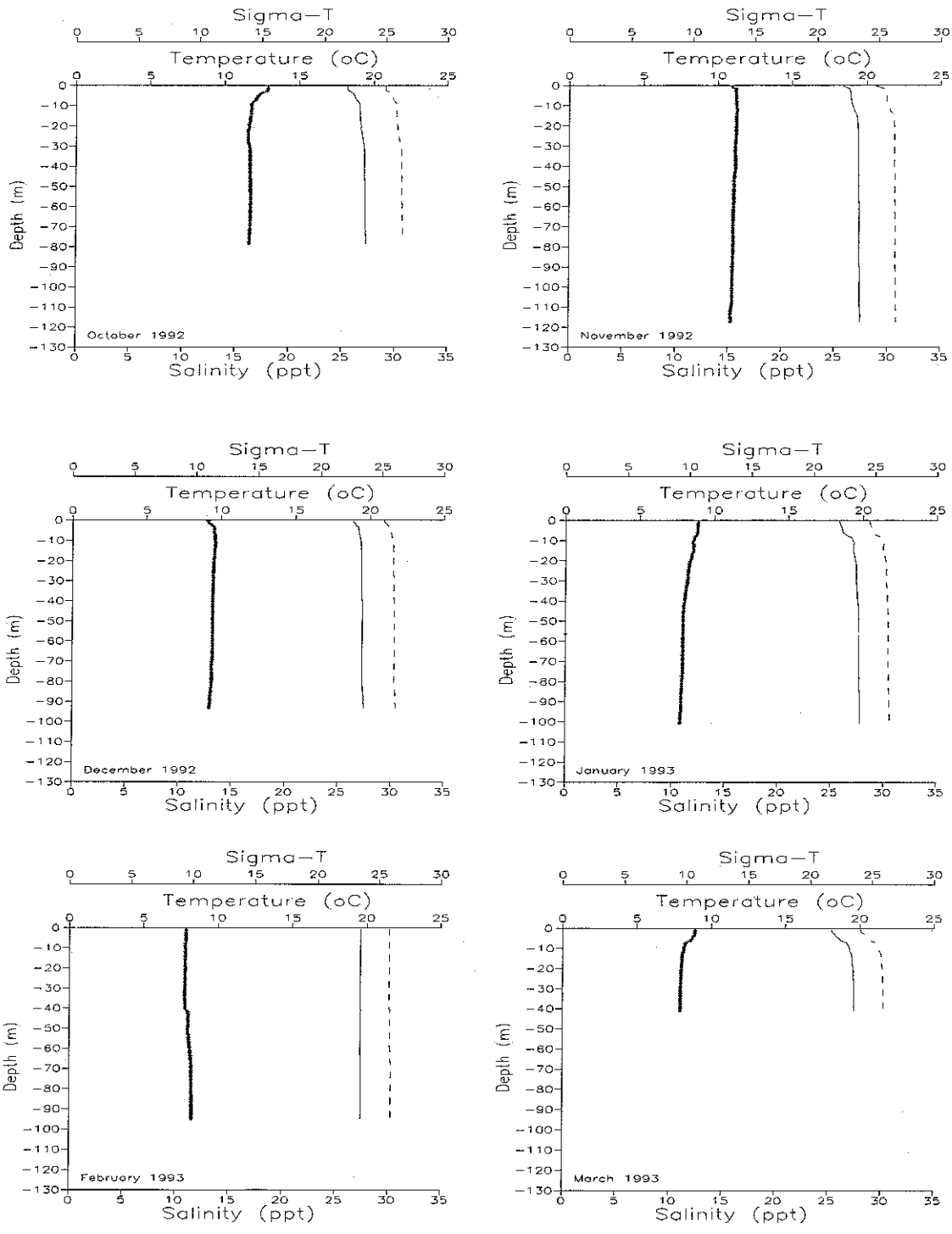


Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

WATERYEAR 1993

Part 1 of 2

North Hood Canal - Bangor (Station HCB006)

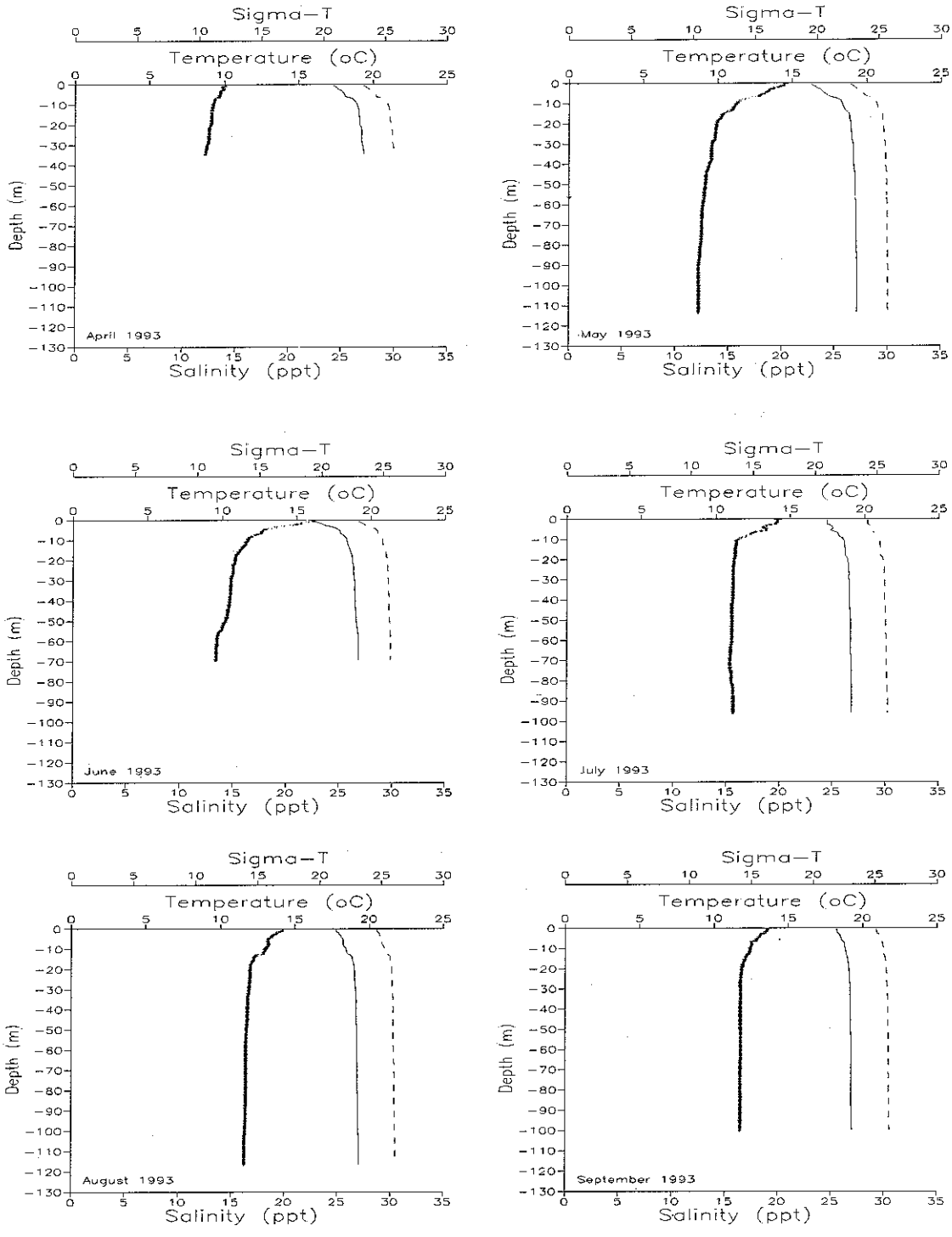


Key: **Temperature = Bold Line** **Salinity = Dashed Line** **Sigma-t = Solid Line**

WATERYEAR 1993

Part 2 of 2

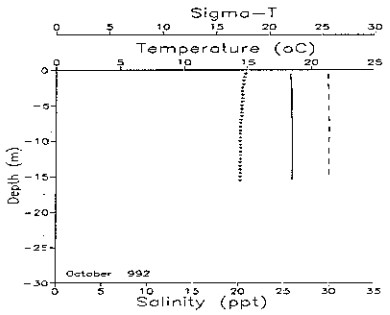
North Hood Canal - Bangor (Station HCB006)

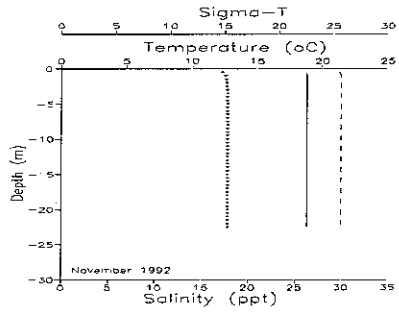


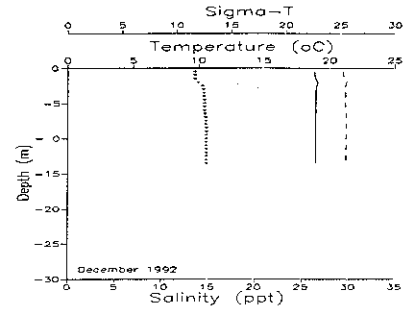
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

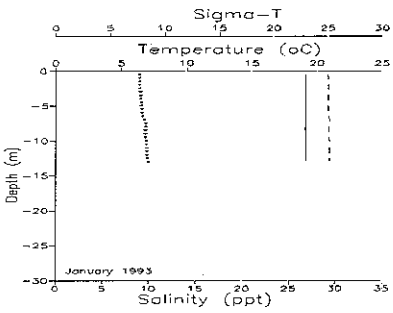
WATERYEAR 1993

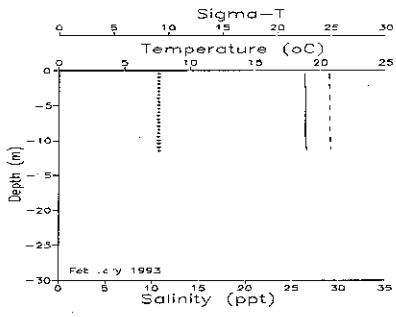
Henderson Inlet (Station HND001)

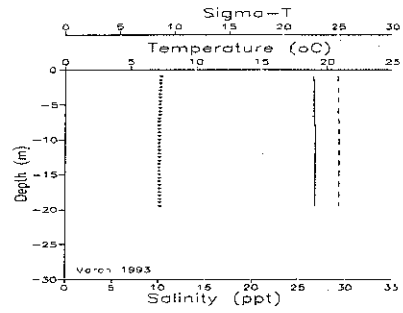


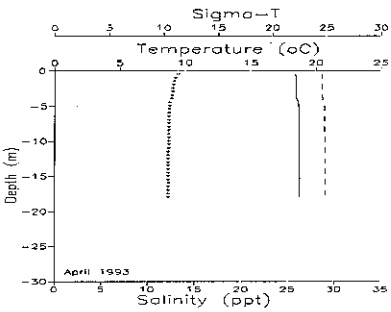


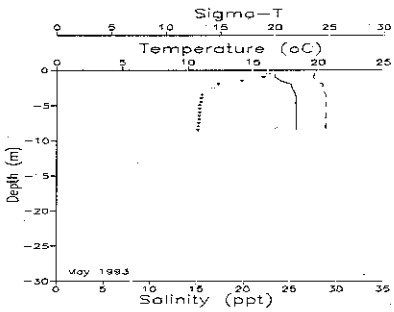


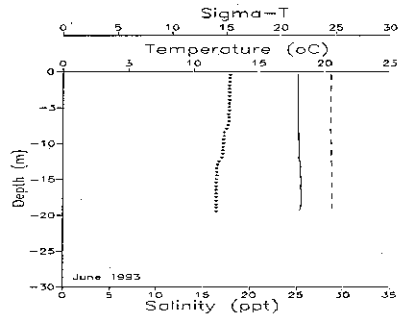


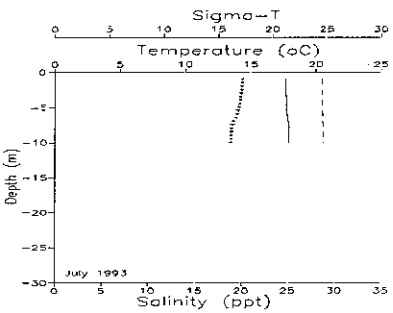


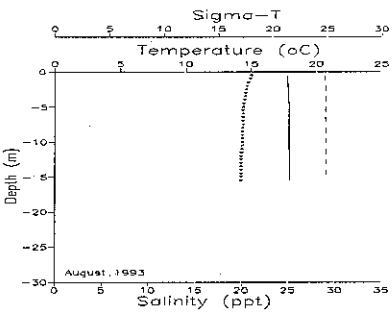


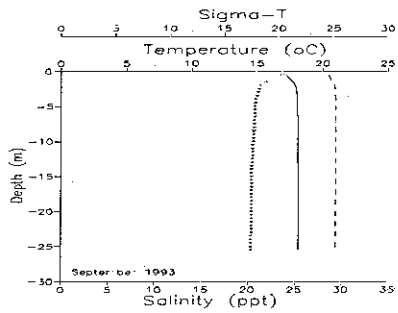








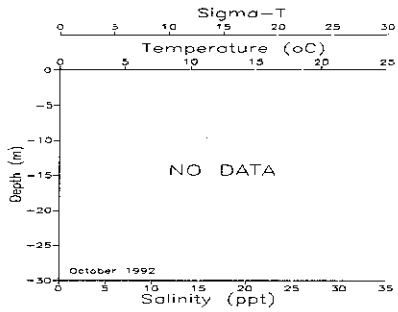


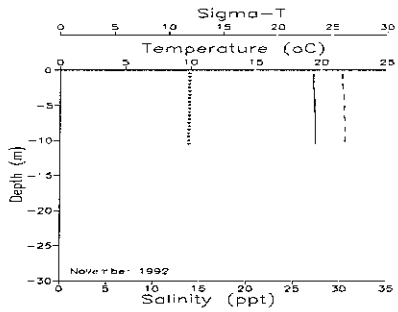


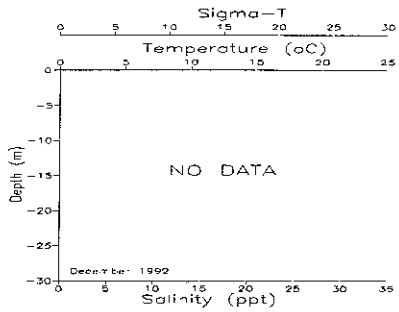
Key: **Temperature = Dotted Line** **Salinity = Dashed Line** **Sigma-t = Solid Line**

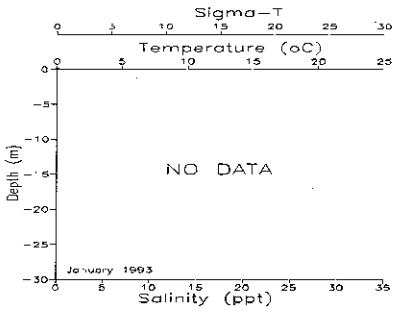
WATERYEAR 1993

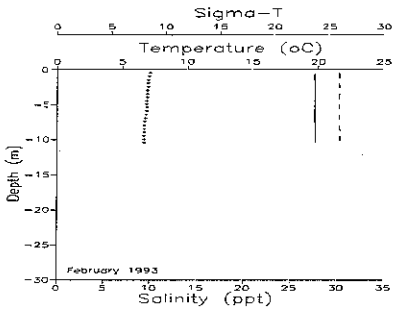
Lopez Sound - Lopez Island (Station LOP001)

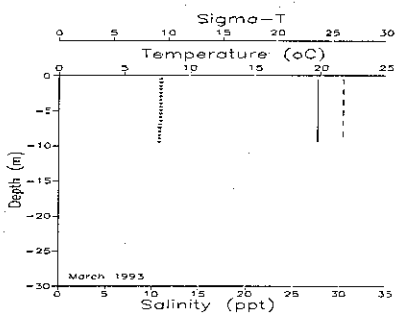


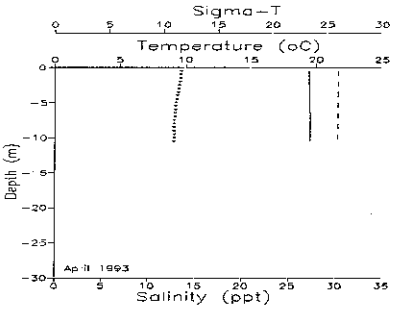


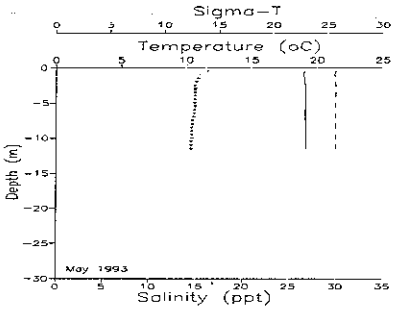


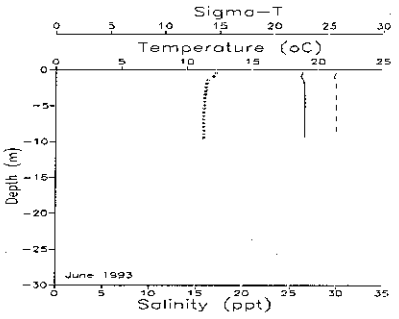


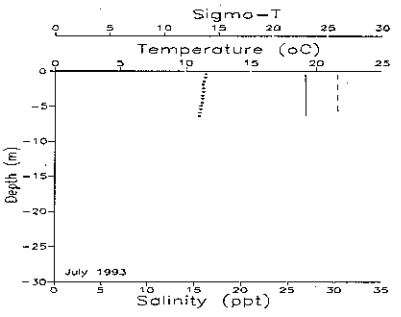


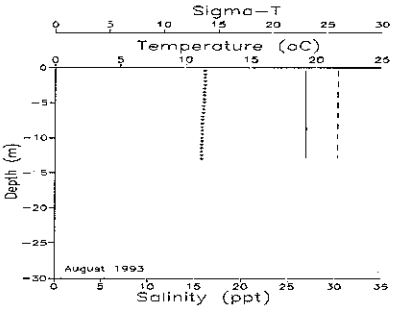


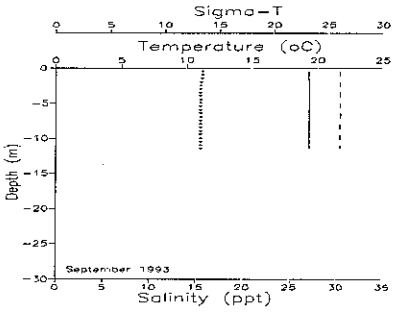








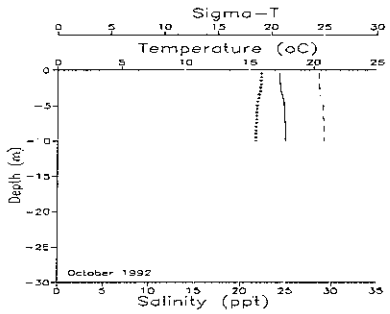


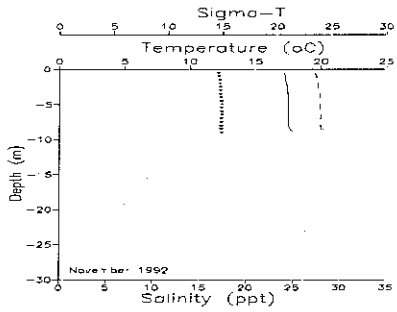


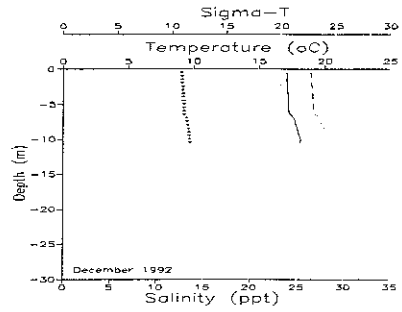
Key: Temperature = Dotted Line Salinity = Dashed Line Sigma-t = Solid Line

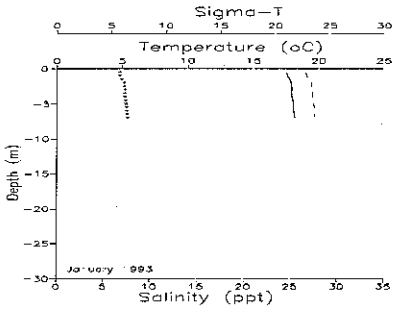
WATERYEAR 1993

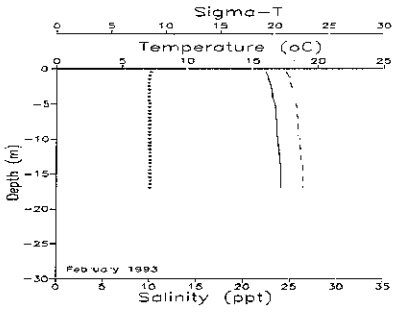
Oakland Bay (Station OAK004)

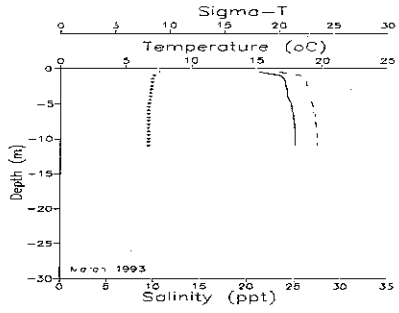


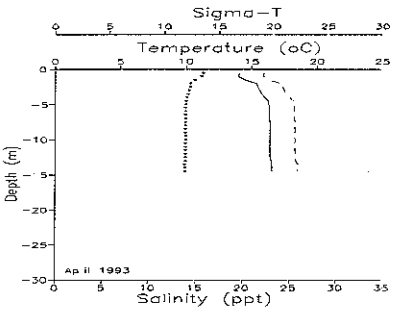


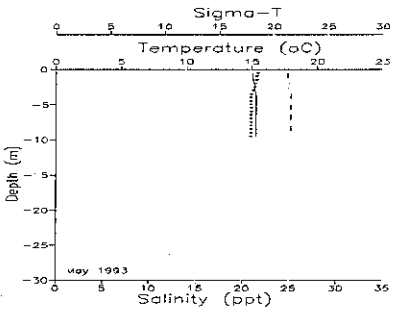


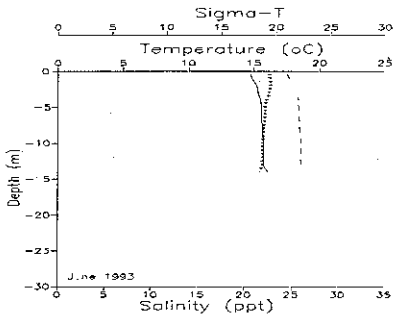


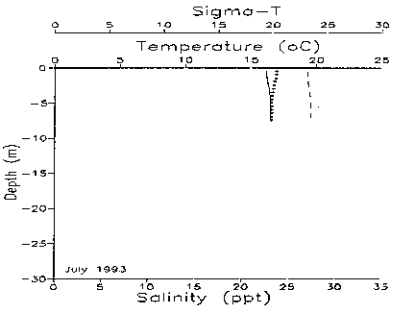


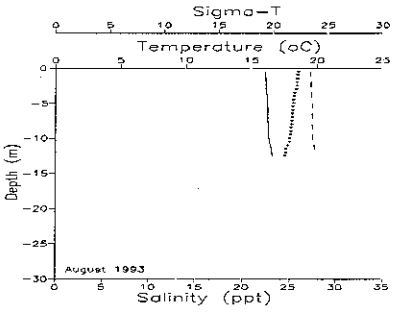


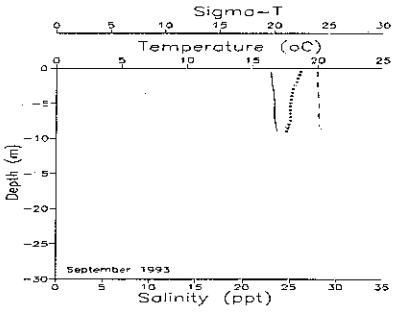










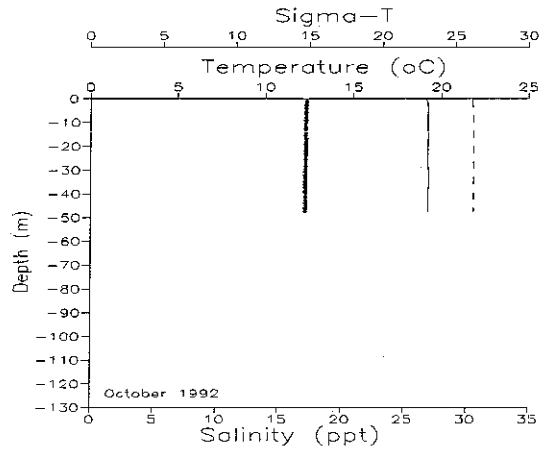


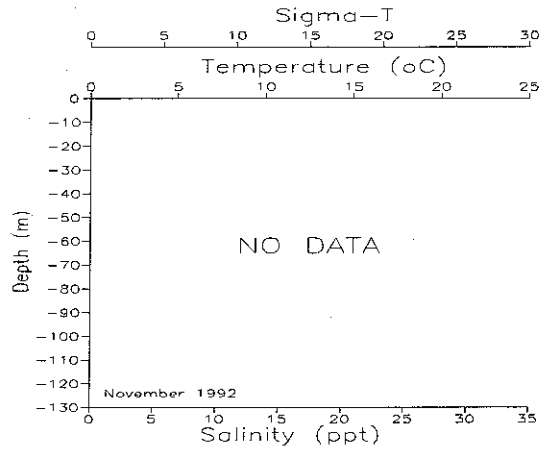
Key: Temperature = Dotted Line Salinity = Dashed Line Sigma-t = Solid Line

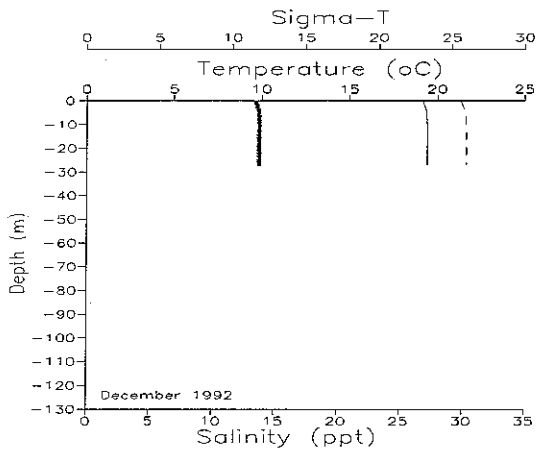
WATERYEAR 1993

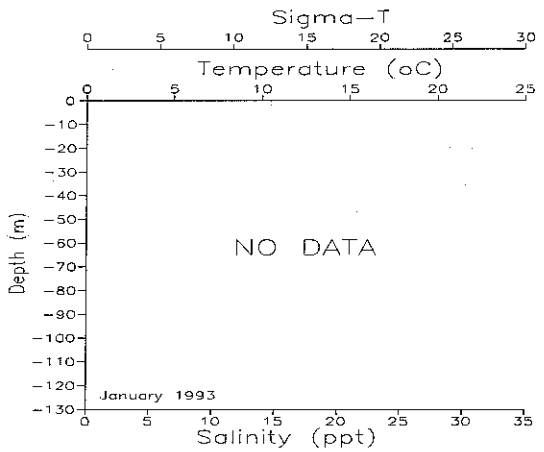
Part 1 of 2

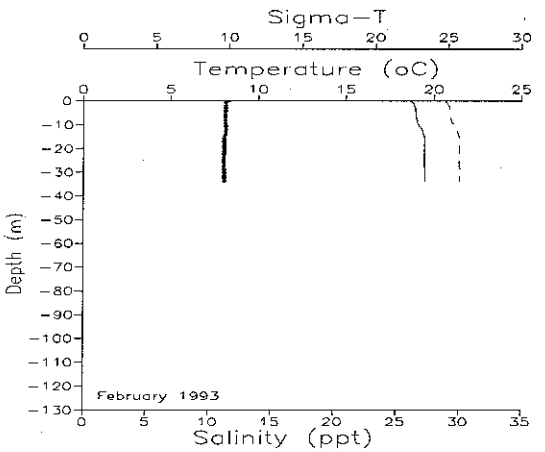
Puget Sound Main Basin - West Point (Station PSB003)

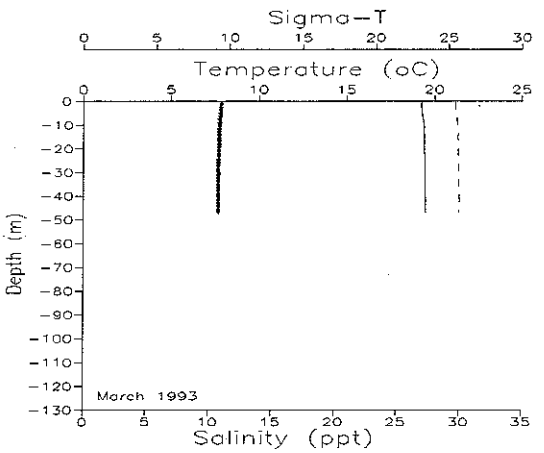










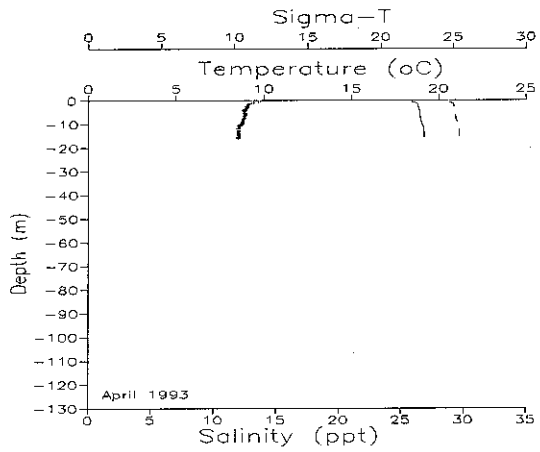


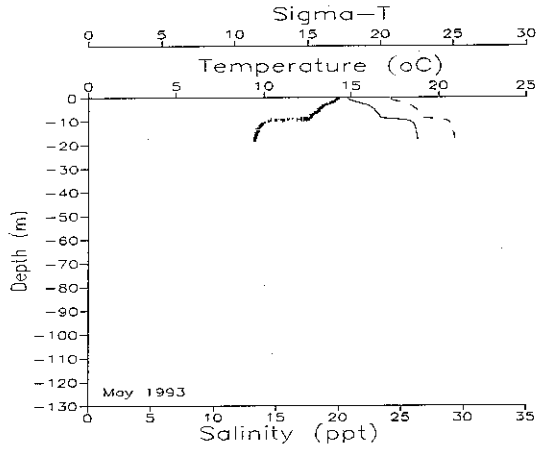
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

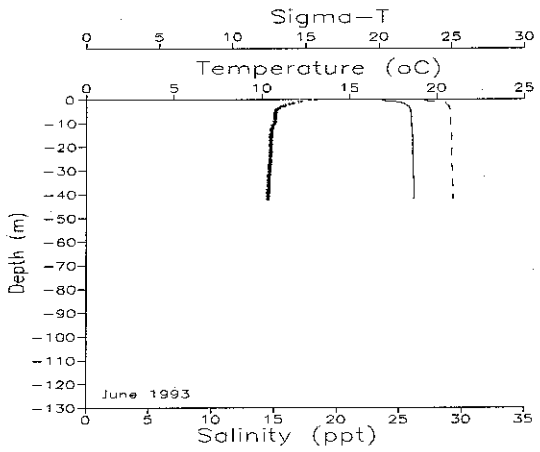
WATERYEAR 1993

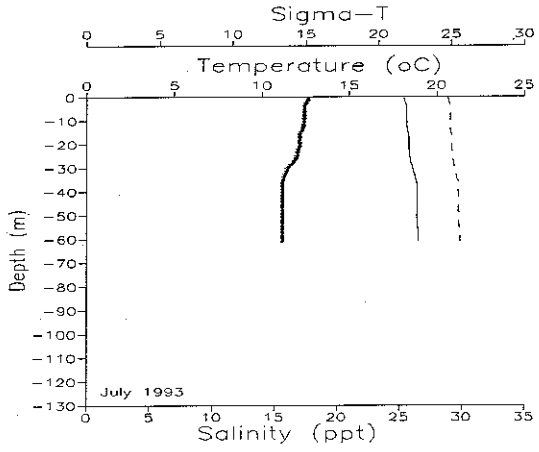
Part 2 of 2

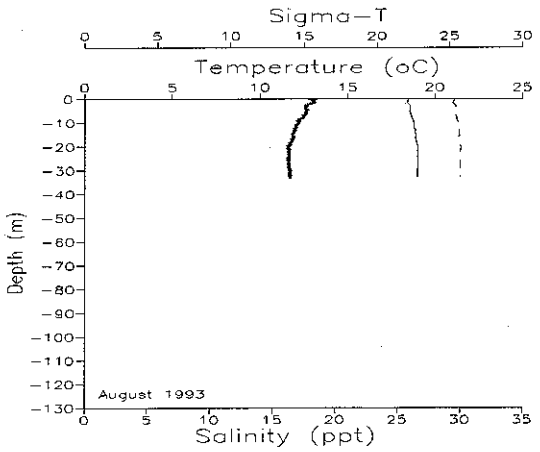
Puget Sound Main Basin - West Point (Station PSB003)

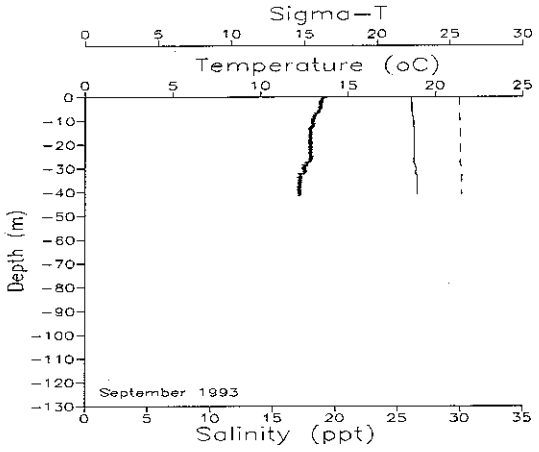










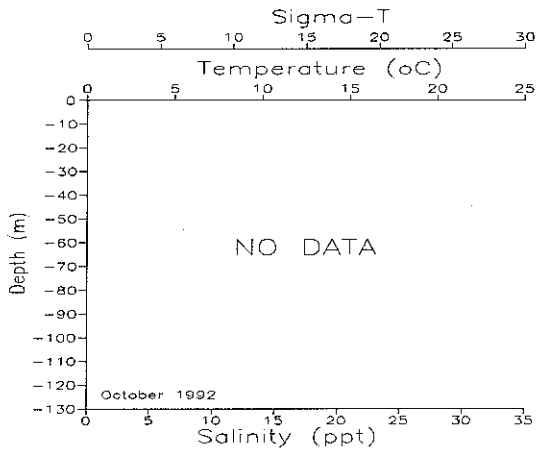


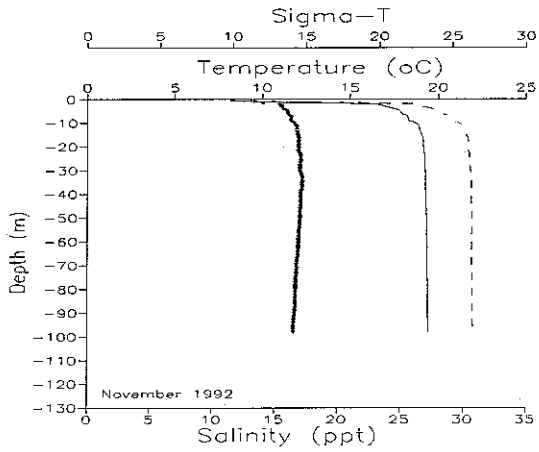
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

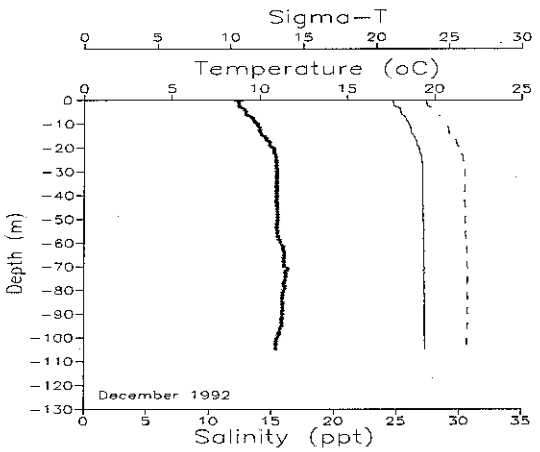
WATERYEAR 1993

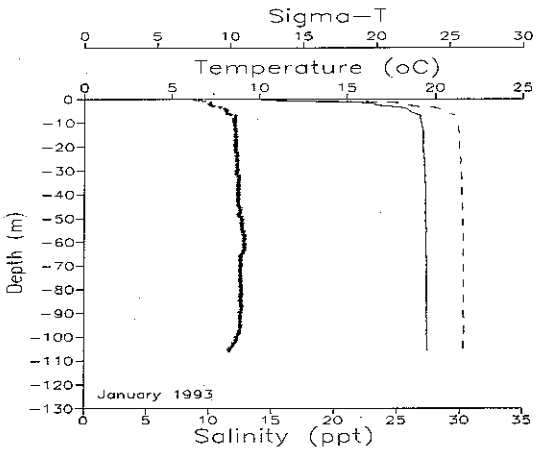
Part 1 of 2

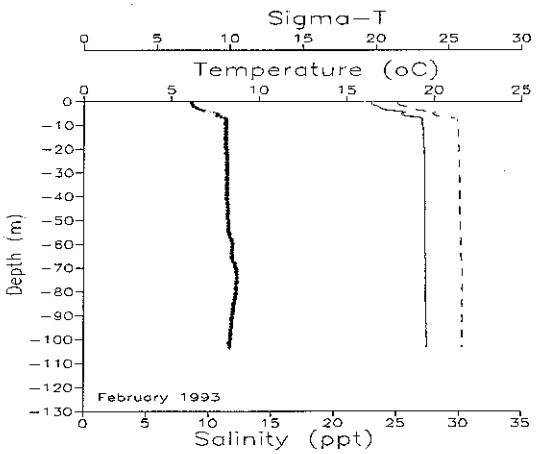
Possession Sound - Gedney Island (Station PSS019)

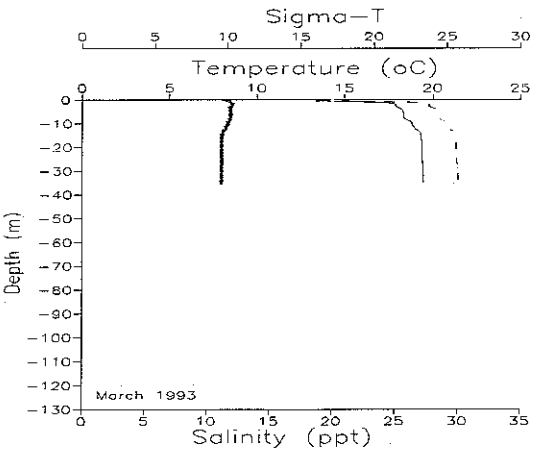










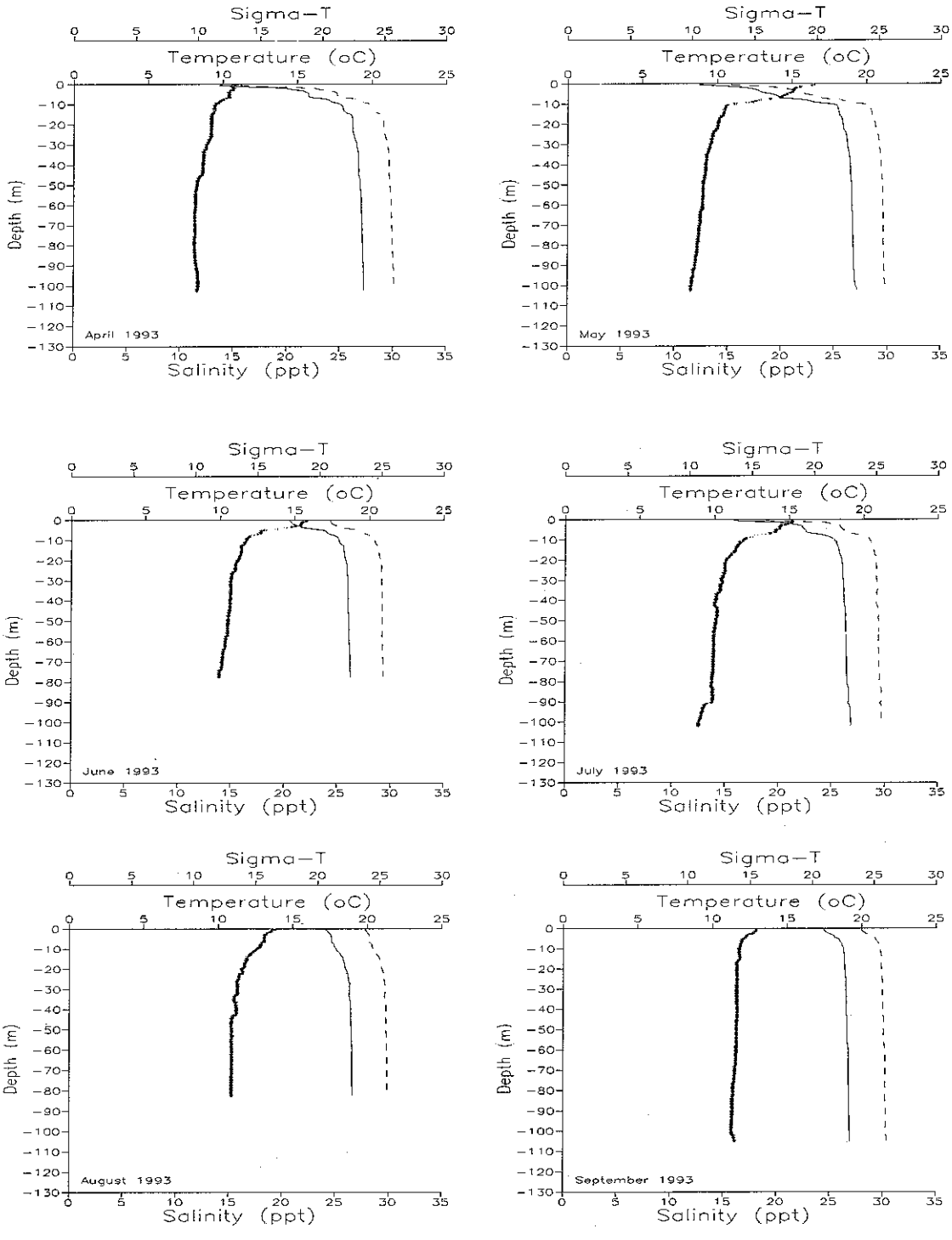


Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

WATERYEAR 1993

Part 2 of 2

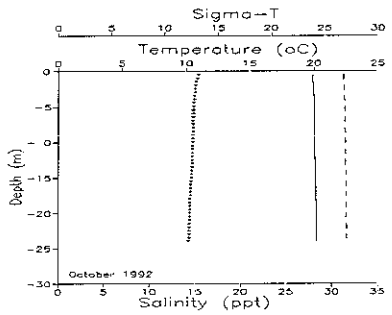
Possession Sound - Gedney Island (Station PSS019)

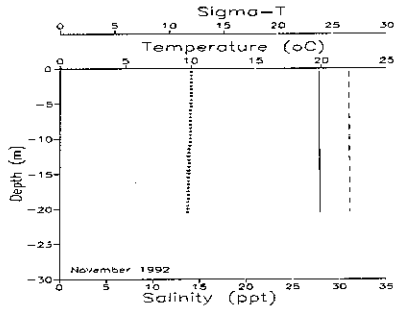


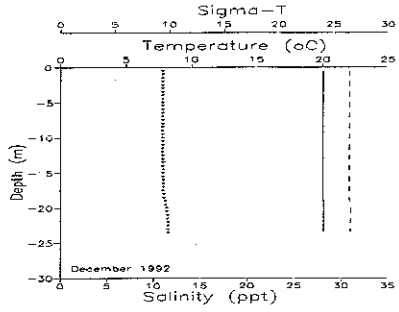
Key: **Temperature = Bold Line** **Salinity = Dashed Line** **Sigma-t = Solid Line**

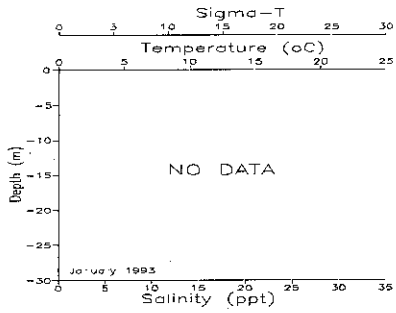
WATERYEAR 1993

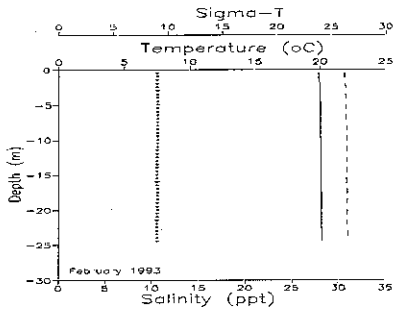
Port Townsend Harbor - Walan Pt. (Station PTH005)

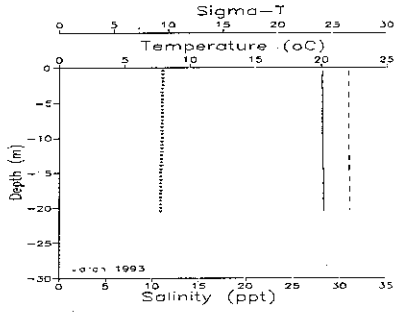


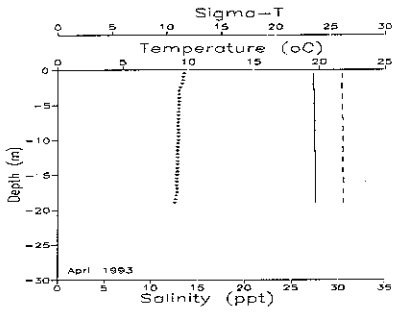


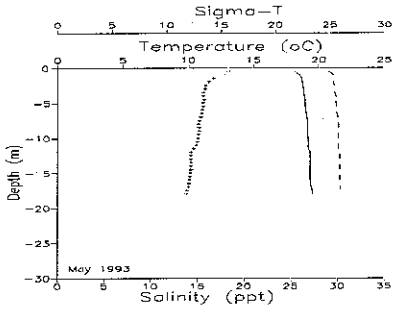


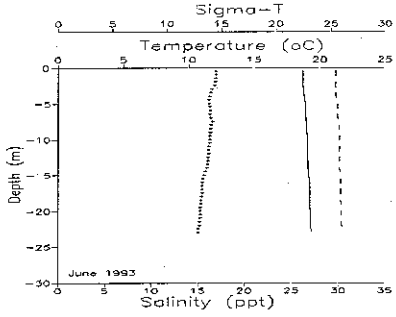


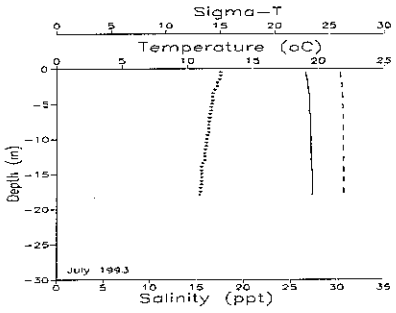


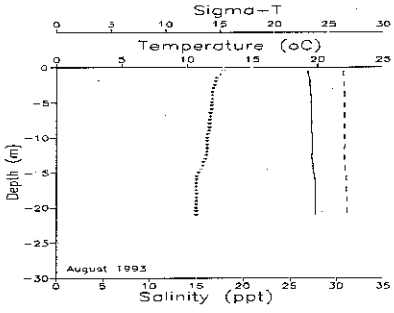


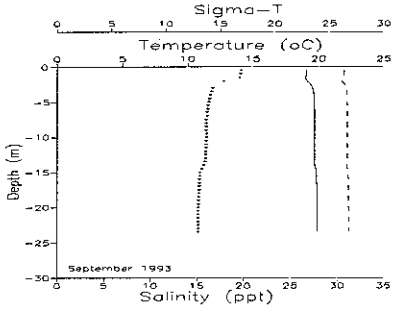










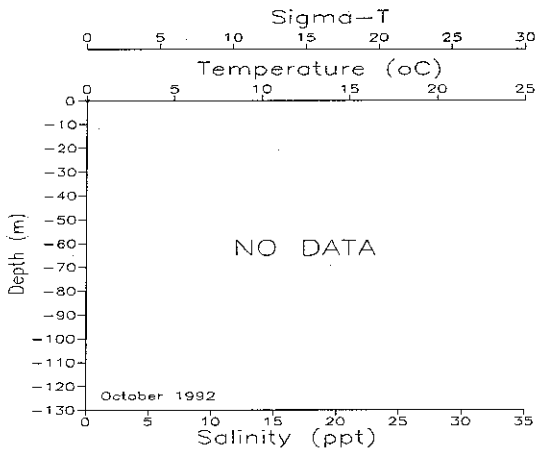


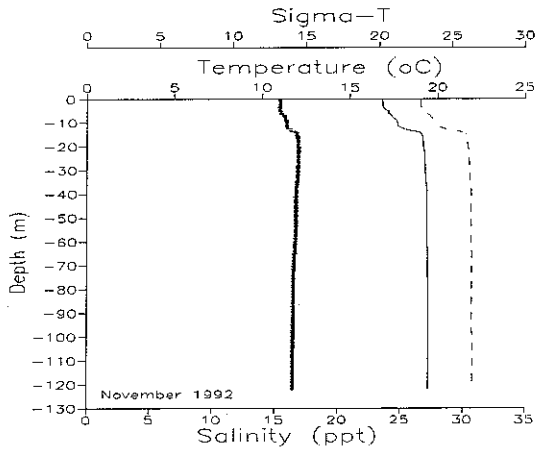
Key: Temperature = Dotted Line Salinity = Dashed Line Sigma-t = Solid Line

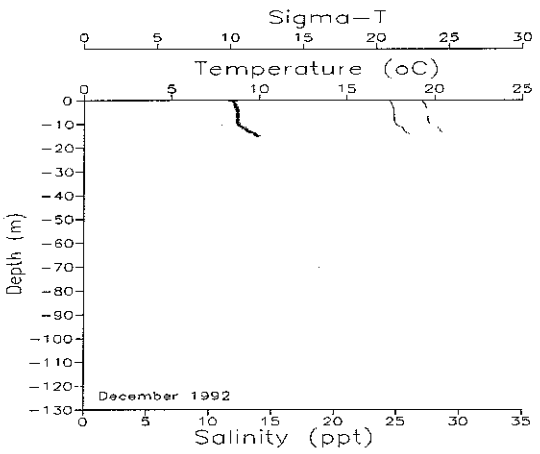
WATERYEAR 1993

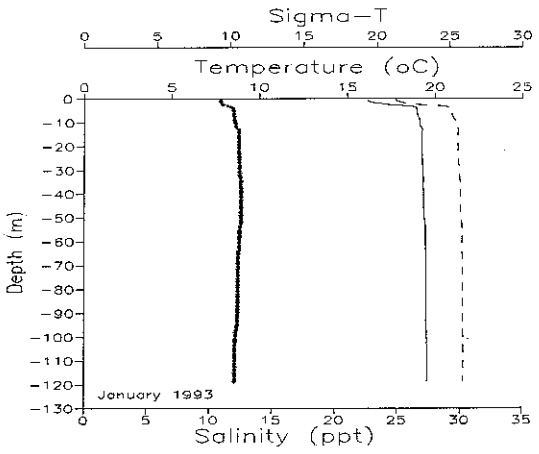
Part 1 of 2

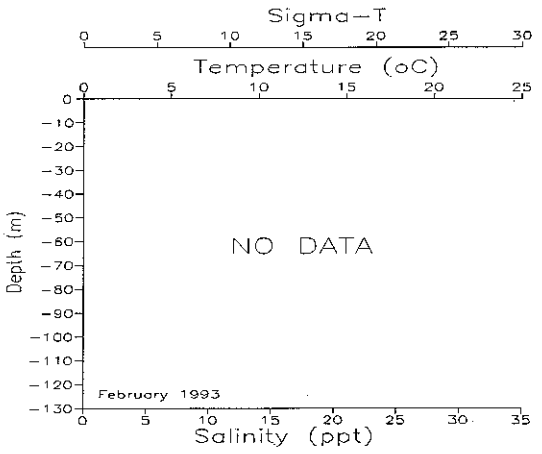
Saratoga Passage - East Point (Station SAR003)

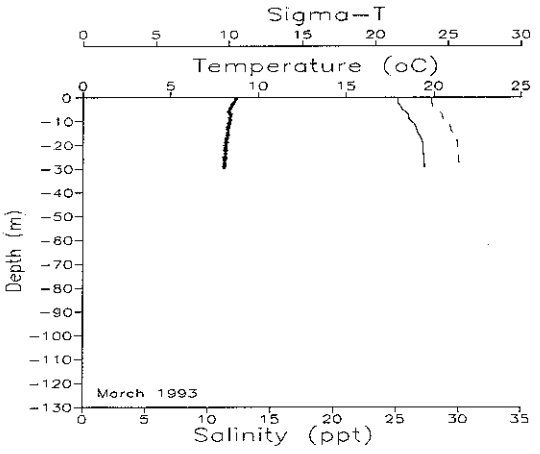










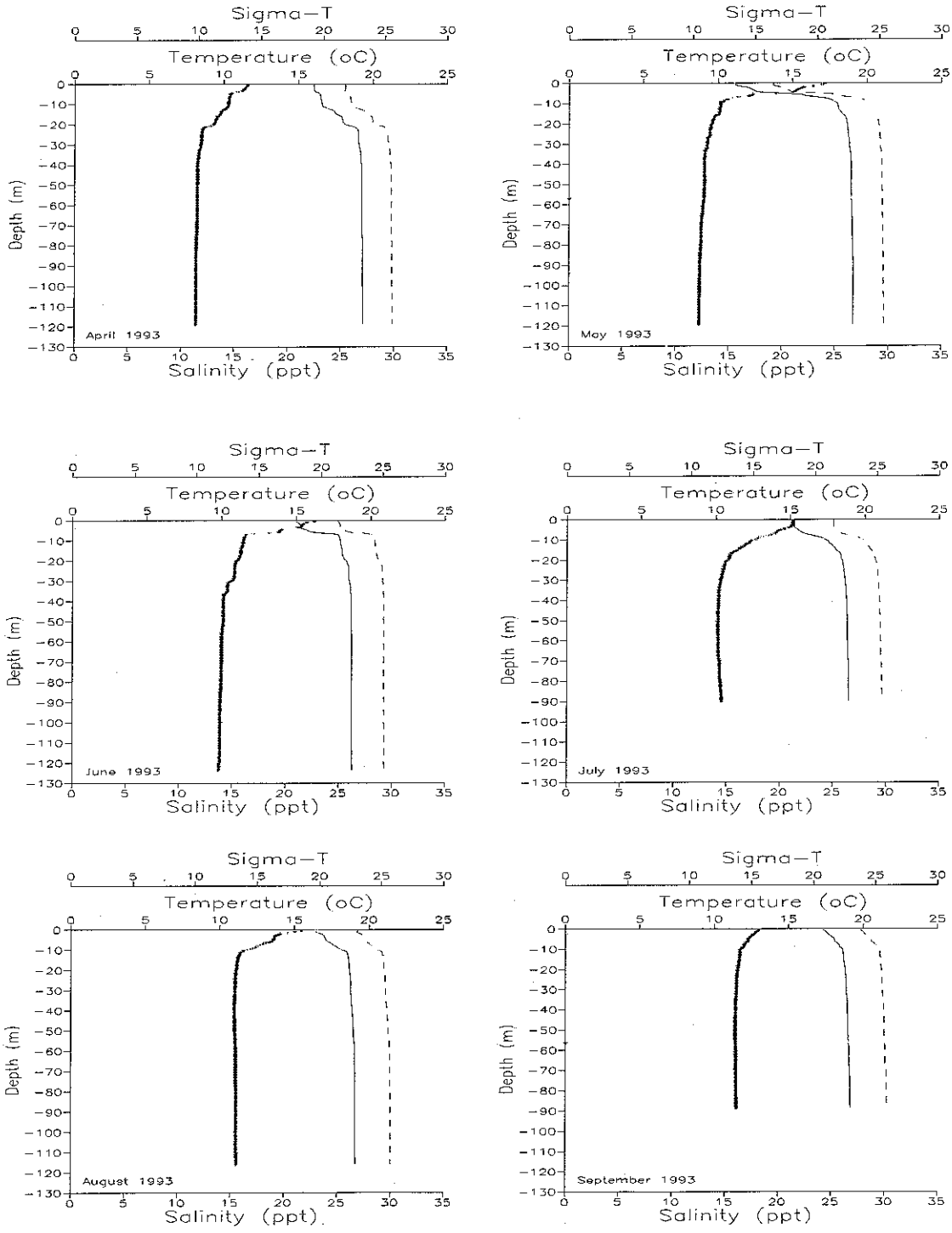


Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

WATERYEAR 1993

Part 2 of 2

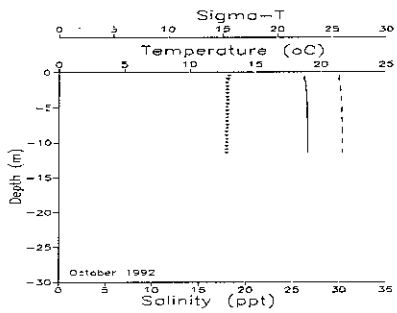
Saratoga Passage - East Point (Station SAR003)

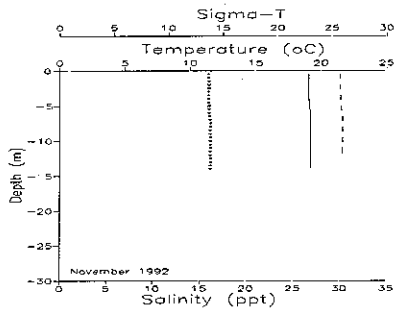


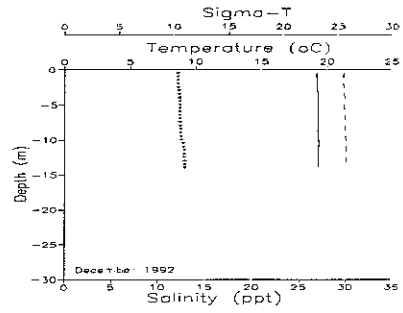
Key: Temperature = Bold Line Salinity = Dashed Line Sigma-t = Solid Line

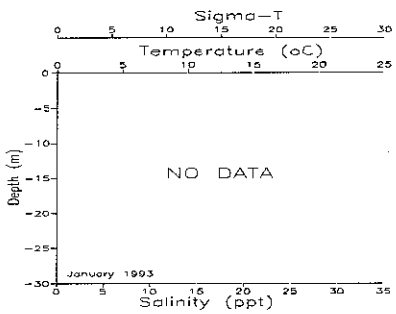
WATERYEAR 1993

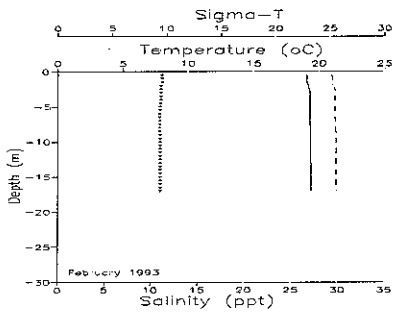
Sinclair Inlet (Station SIN001)

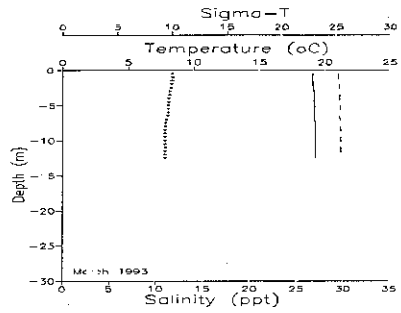


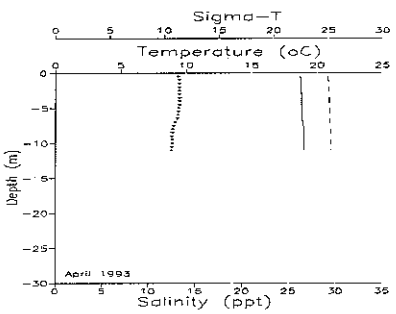


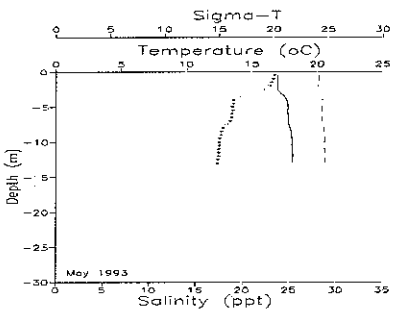


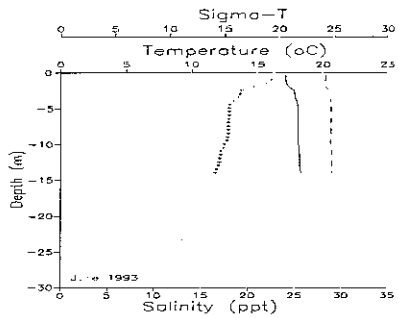


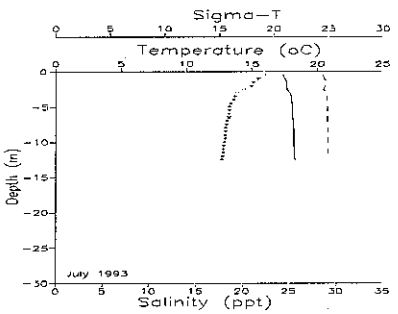


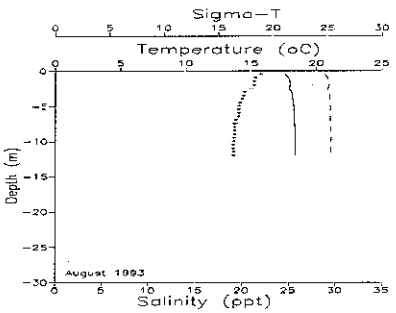


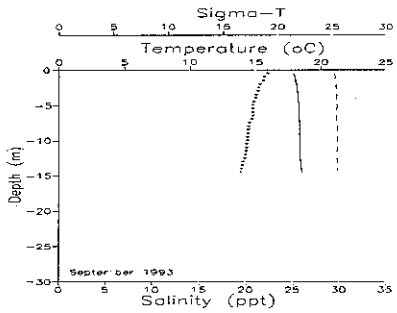








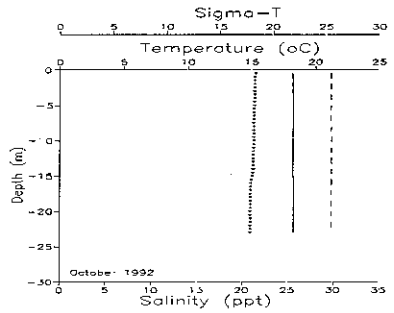


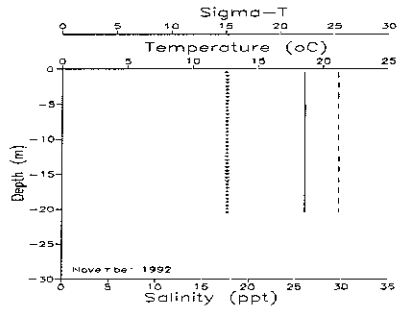


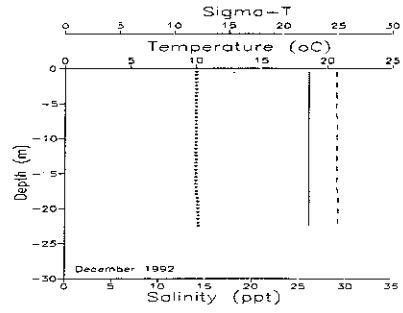
Key: Temperature = Dotted Line Salinity = Dashed Line Sigma-t = Solid Line

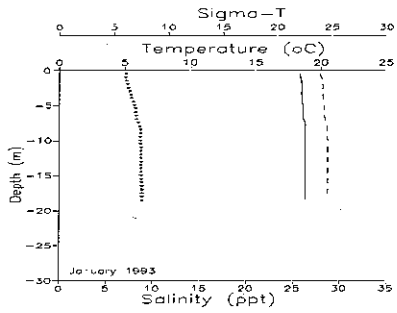
WATERYEAR 1993

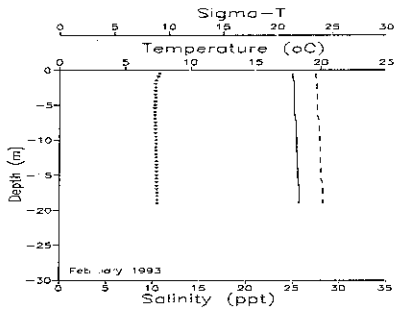
Totten Inlet (Station TOT001)

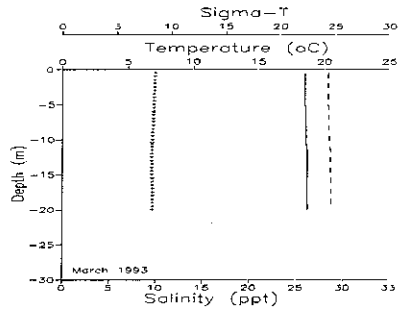


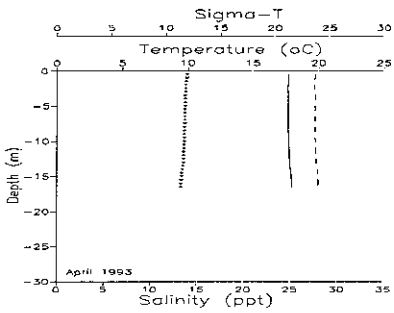


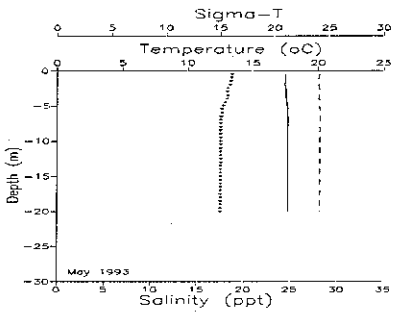


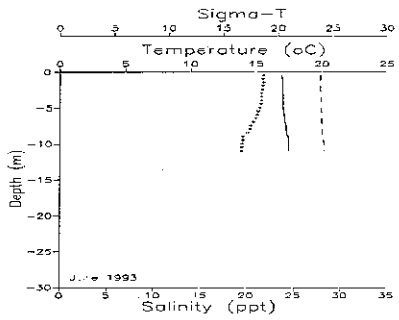


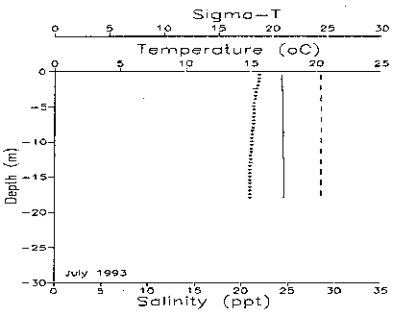


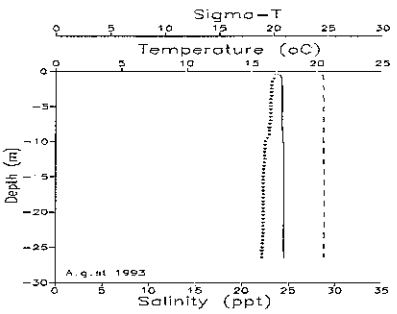


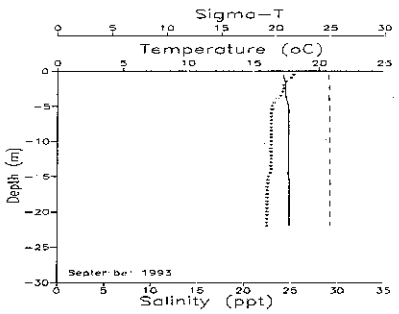










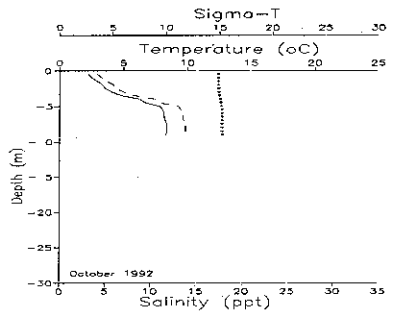


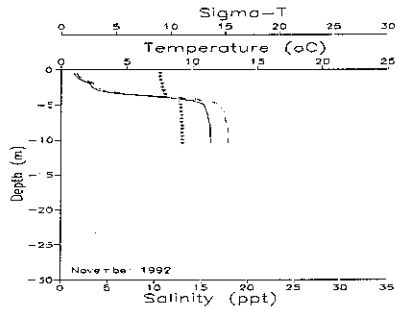
Key: Temperature = Dotted Line Salinity = Dashed Line Sigma-t = Solid Line

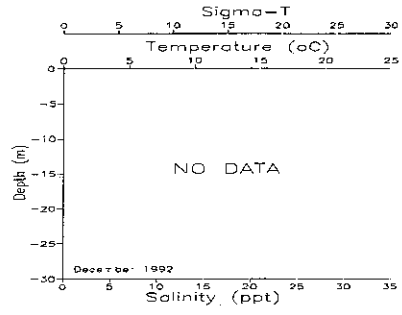
GRAYS HARBOR AND WILLAPA BAY STATIONS

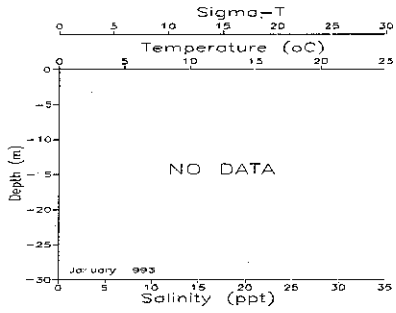
WATERYEAR 1993

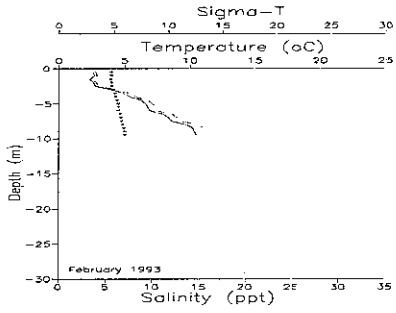
Gray's Harbor - Chehalis (Station GYS004)

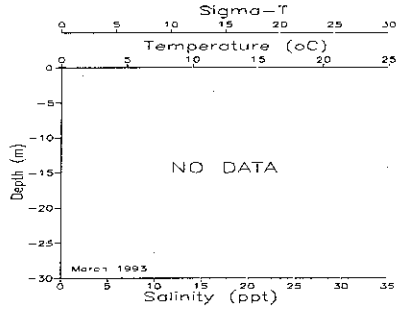


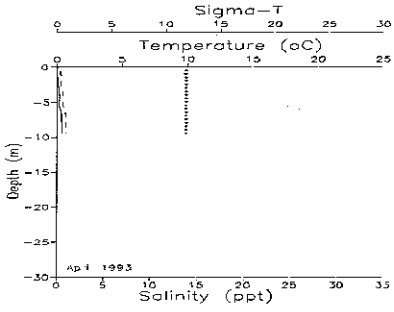


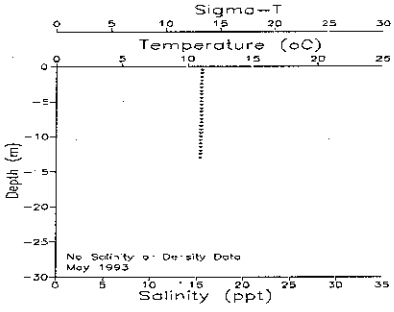


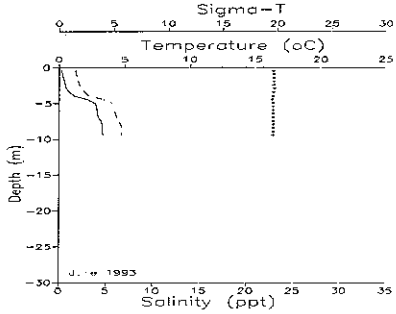


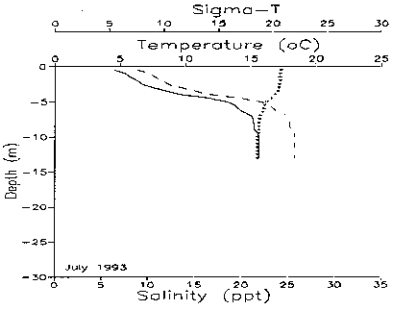


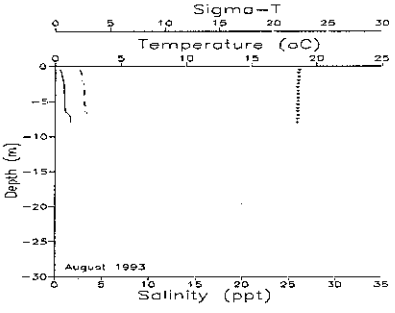


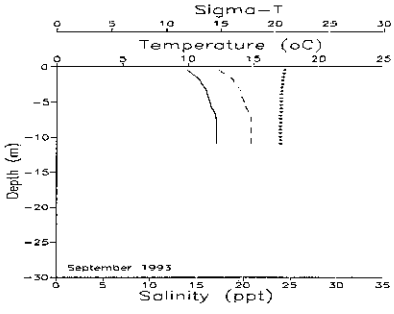








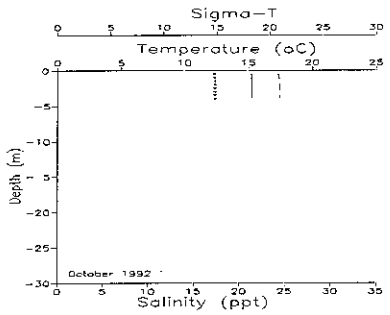


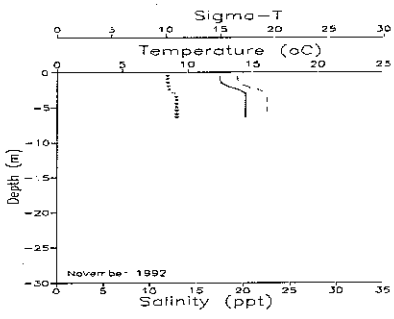


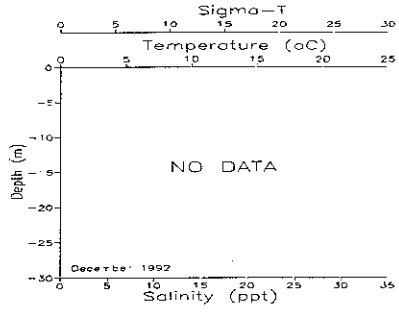
Key: Temperature = Dotted Line Salinity = Dashed Line Sigma-t = Solid Line

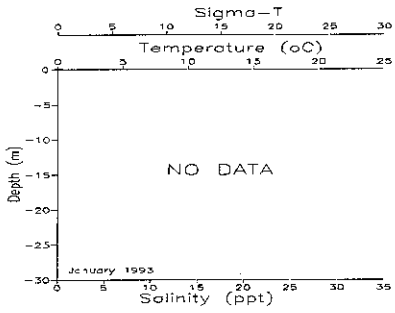
WATERYEAR 1993

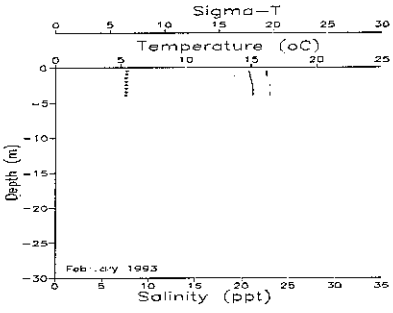
Gray's Harbor - South Channel (Station GYS008)

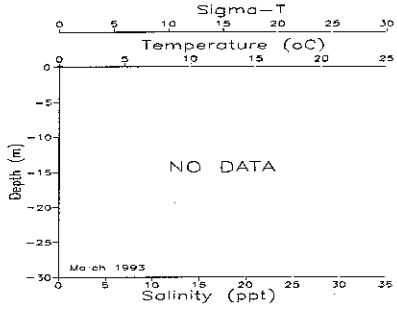


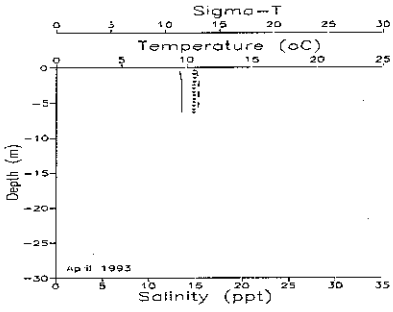


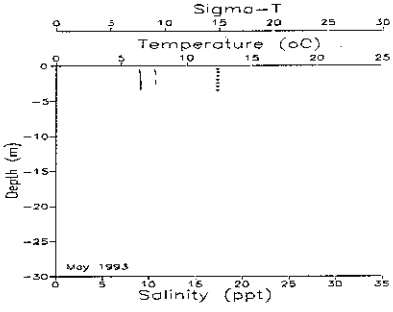


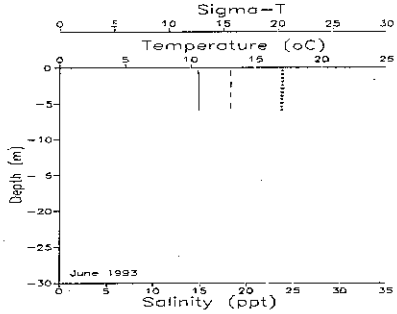


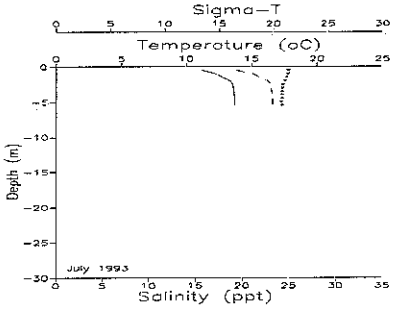


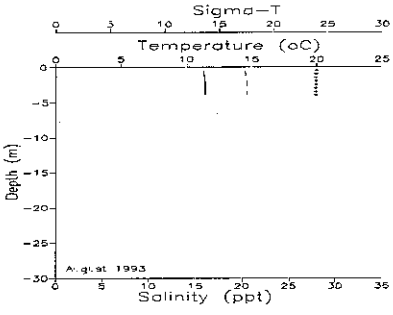


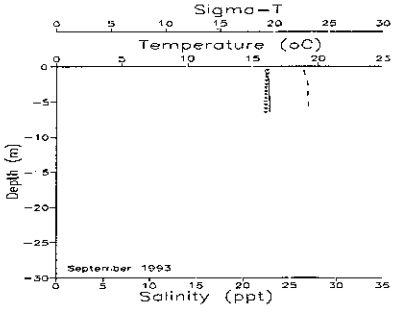








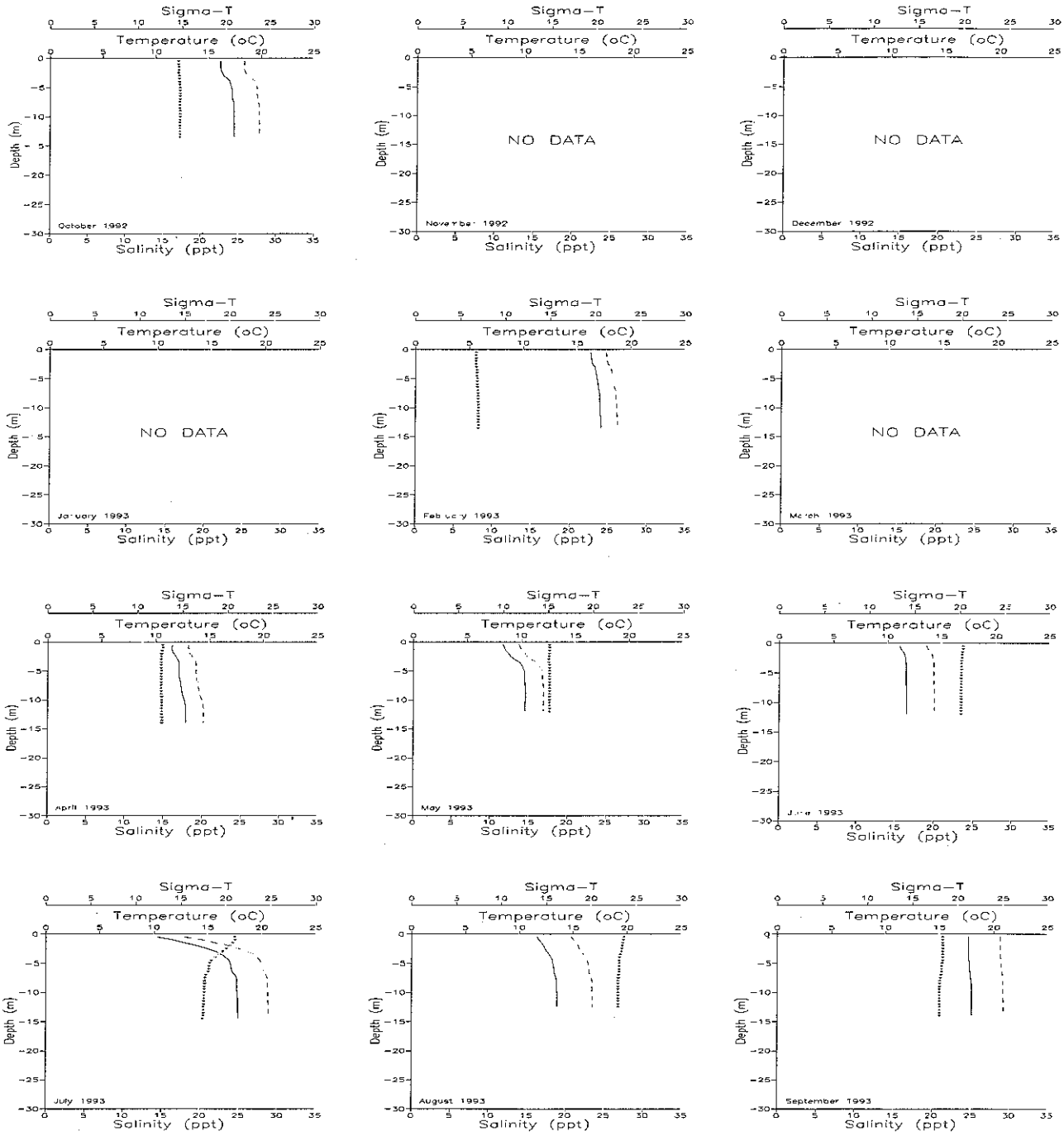




Key: **Temperature = Dotted Line** **Salinity = Dashed Line** **Sigma-t = Solid Line**

WATERYEAR 1993

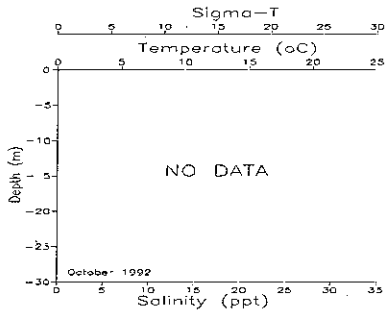
Gray's Harbor North Channel - (Station GYS009)

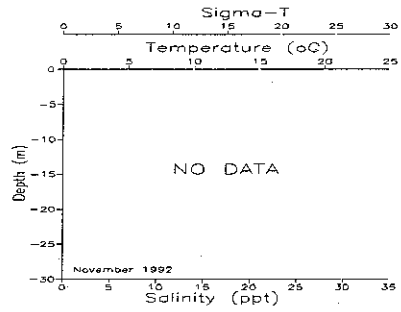


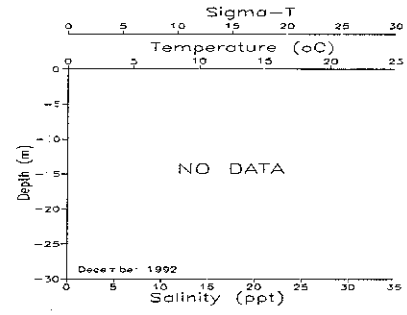
Key: **Temperature = Dotted Line** **Salinity = Dashed Line** **Sigma-t = Solid Line**

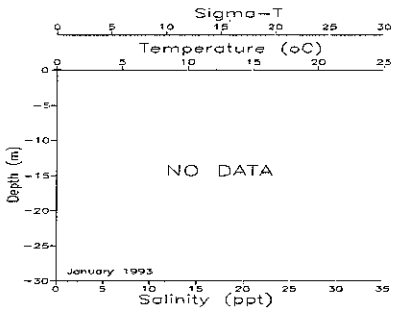
WATERYEAR 1993

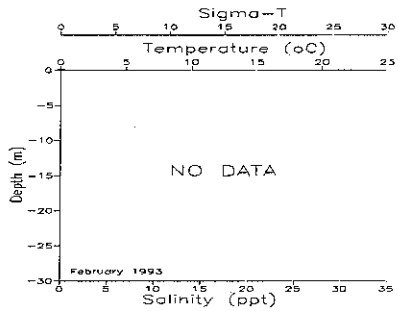
Gray's Harbor - N. Whitcomb Flats (Station GYS015)

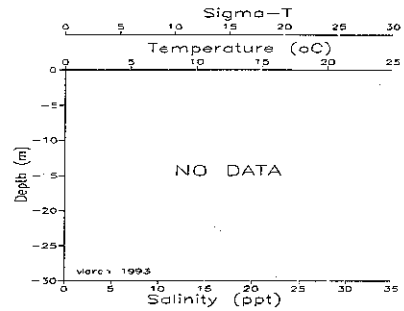


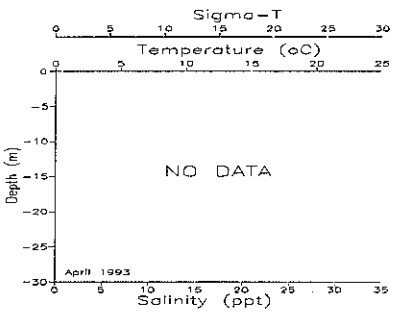


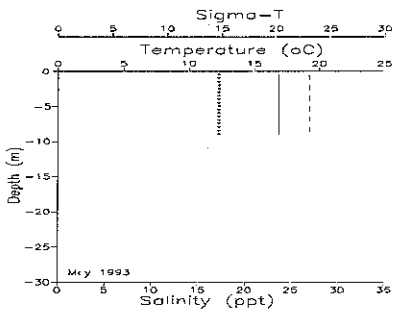


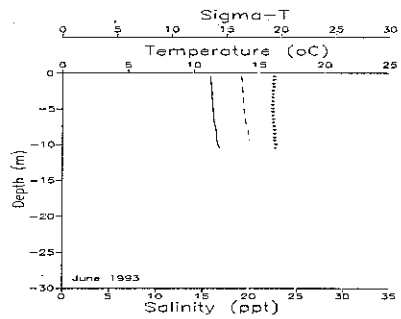


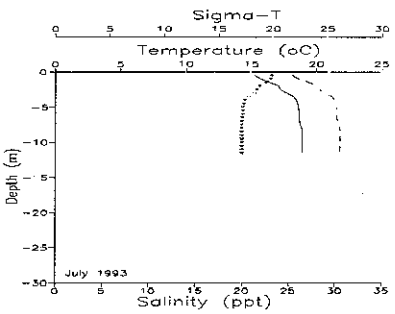


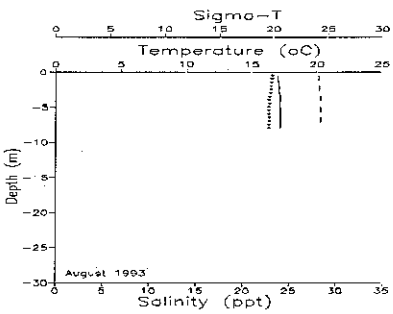


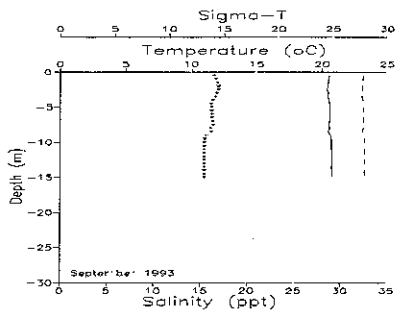








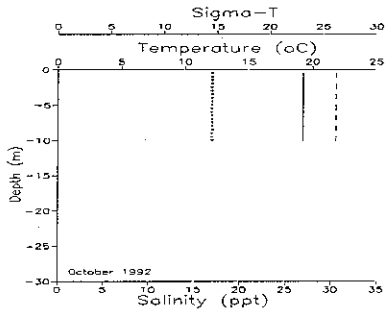


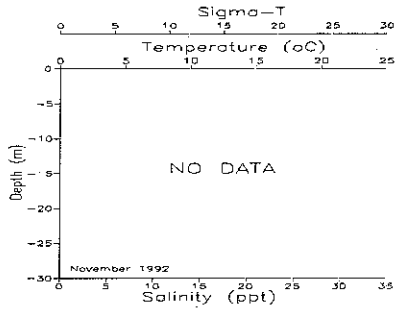


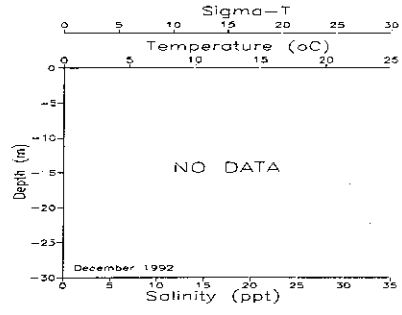
Key: Temperature = Dotted Line Salinity = Dashed Line Sigma-t = Solid Line

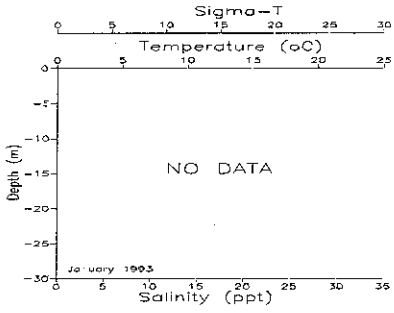
WATERYEAR 1993

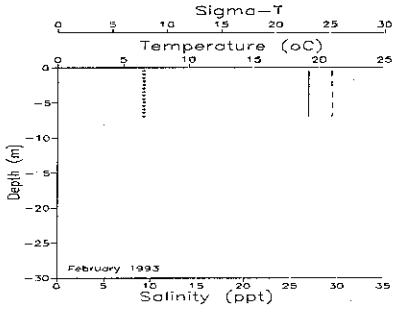
Gray's Harbor - Damon Point (Station GYS016)

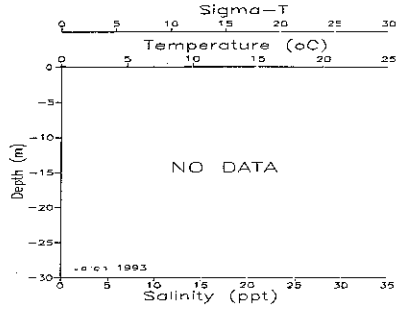


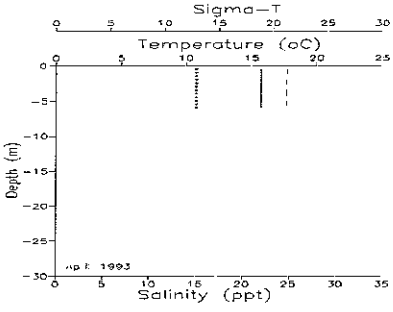


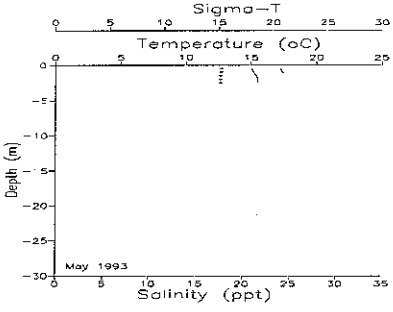


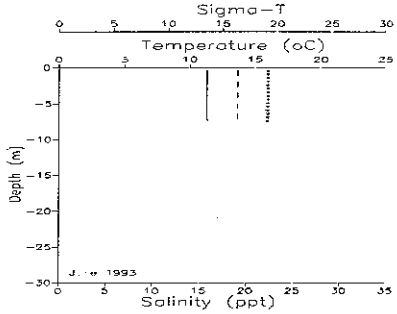


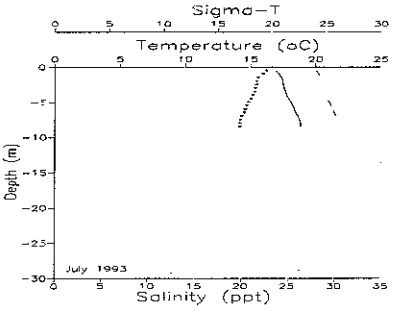


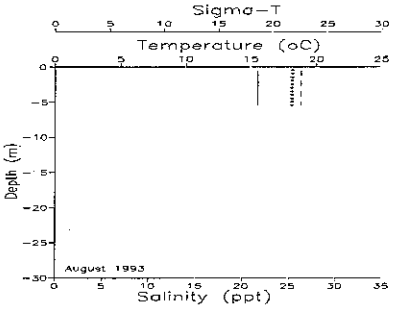


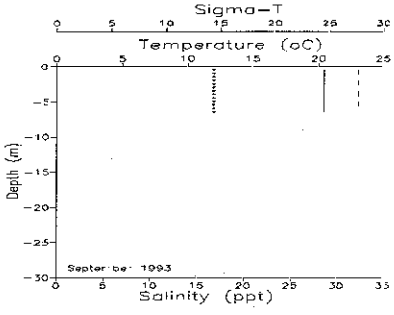








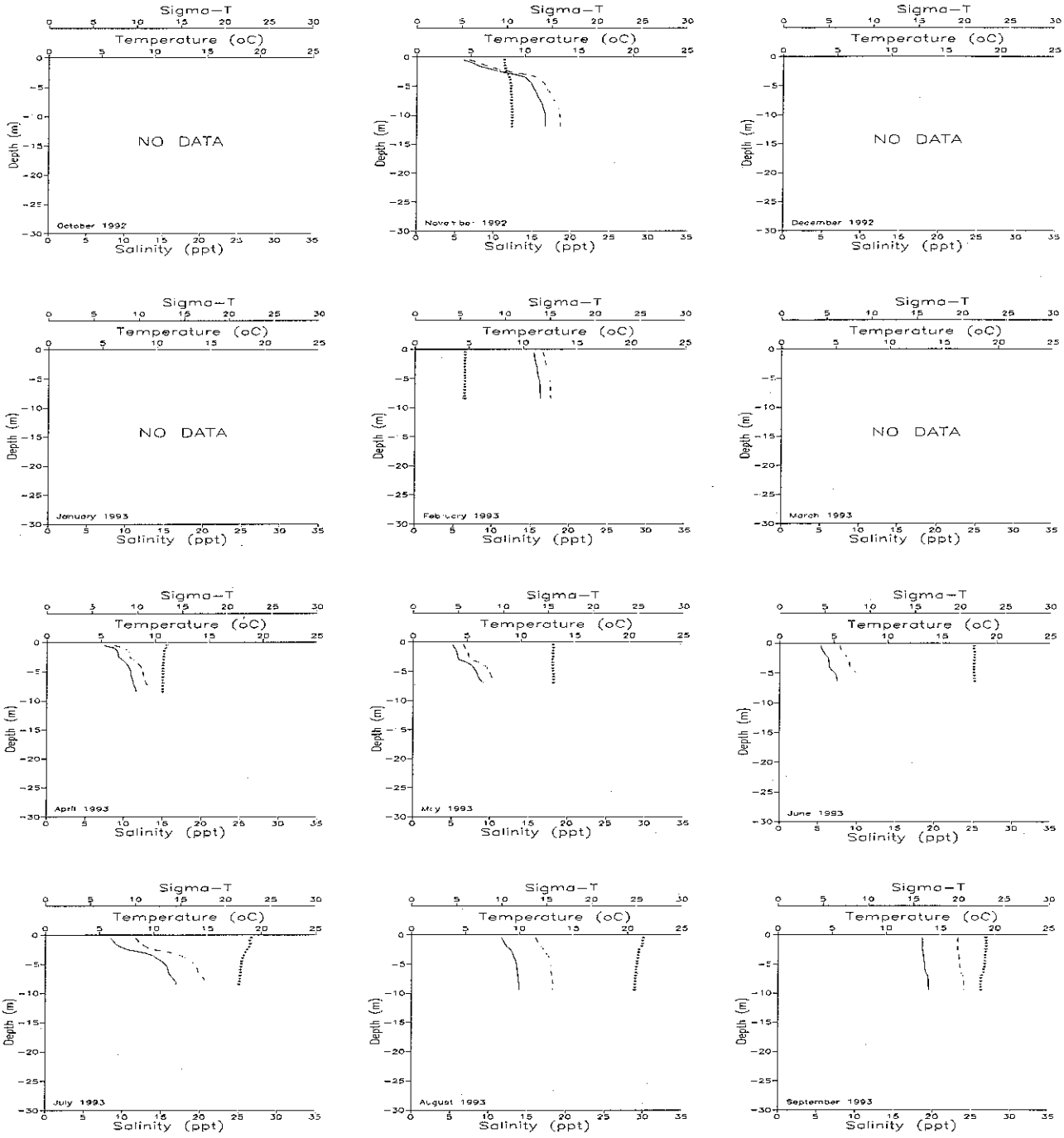




Key: Temperature = Dotted Line Salinity = Dashed Line Sigma-t = Solid Line

WATERYEAR 1993

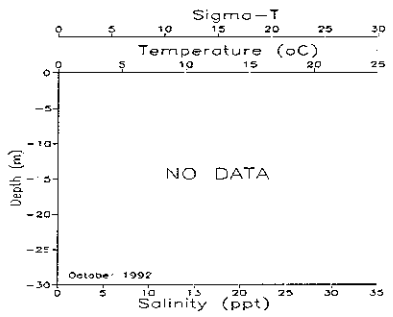
Willapa Bay - Willapa River (Station WPA001)

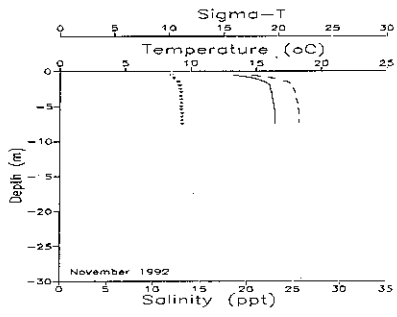


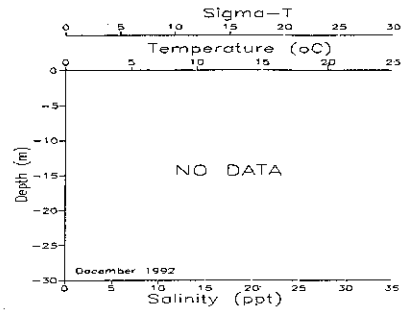
Key: **Temperature = Dotted Line** **Salinity = Dashed Line** **Sigma-t = Solid Line**

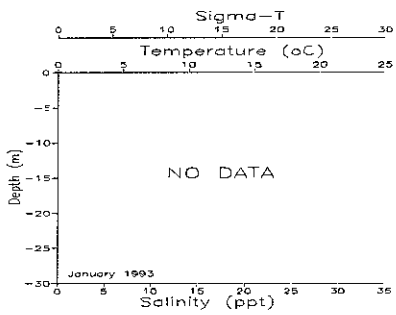
WATERYEAR 1993

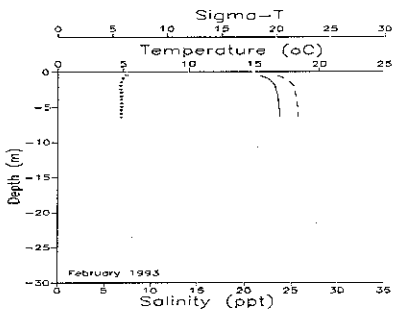
Willapa Bay - Johnson Slough (Station WPA003)

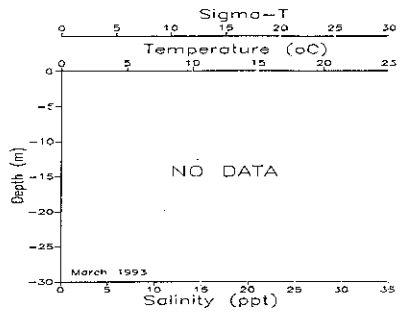


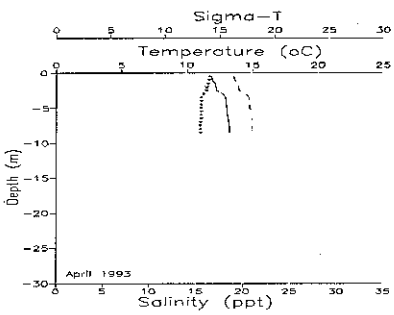


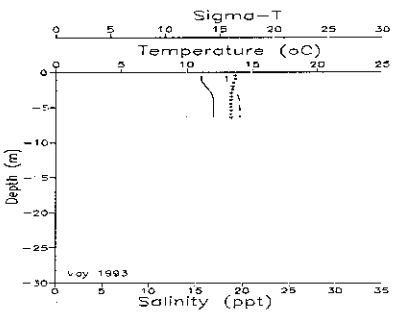


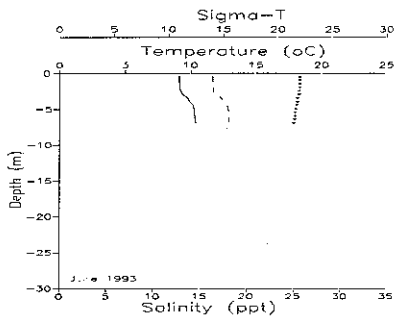


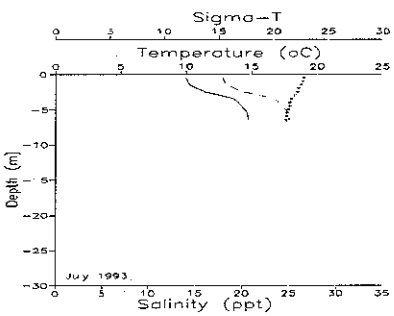


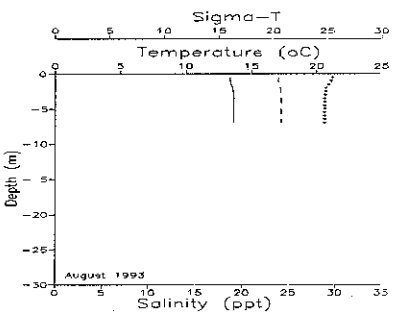


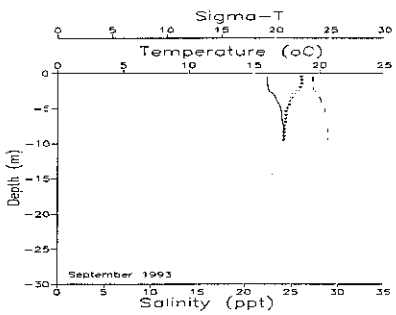








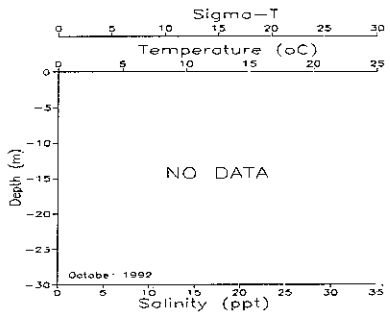


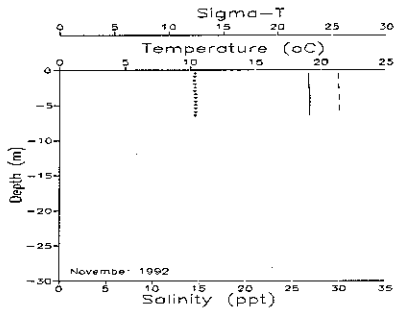


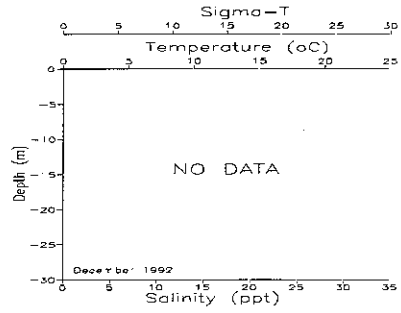
Key: Temperature = Dotted Line Salinity = Dashed Line Sigma-t = Solid Line

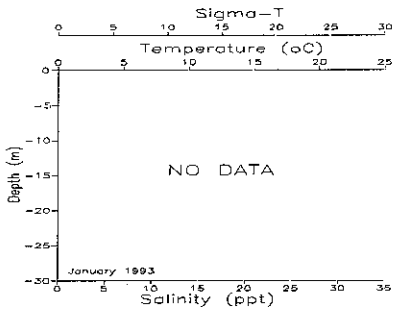
WATERYEAR 1993

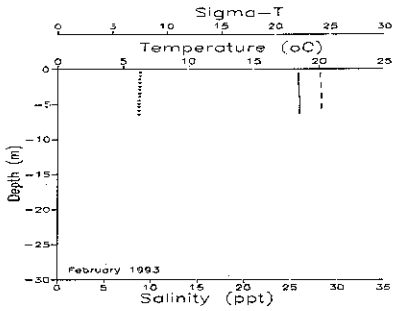
North Willapa Bay (Station WPA004)

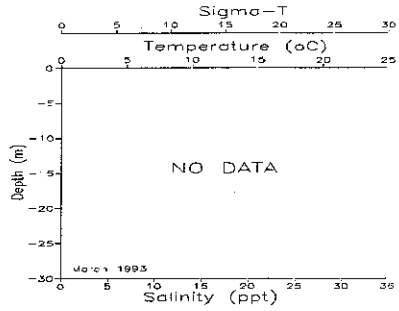


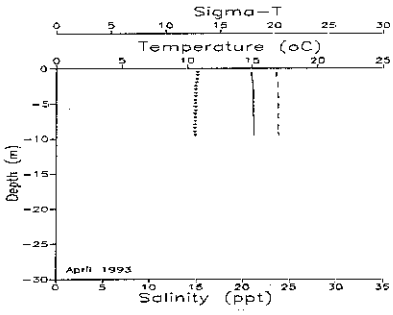


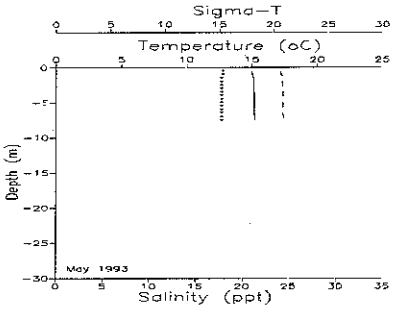


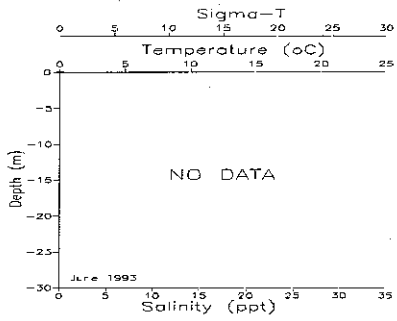


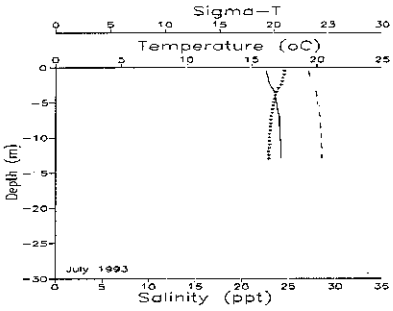


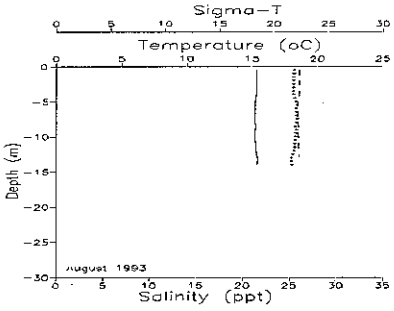


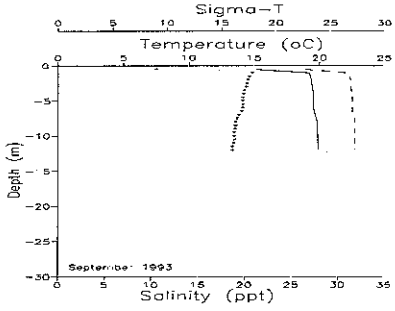








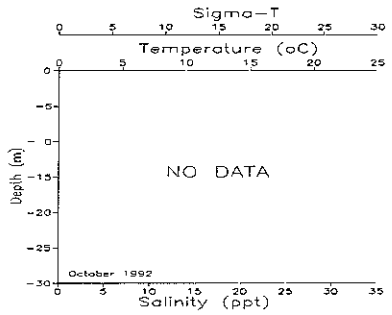


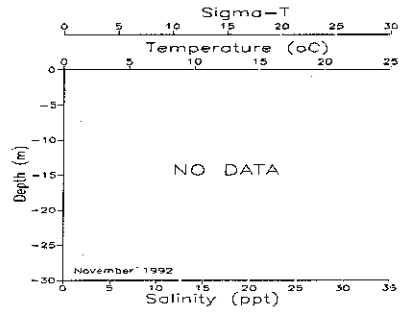


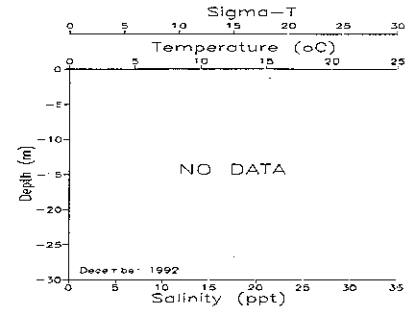
Key: Temperature = Dotted Line Salinity = Dashed Line Sigma-t = Solid Line

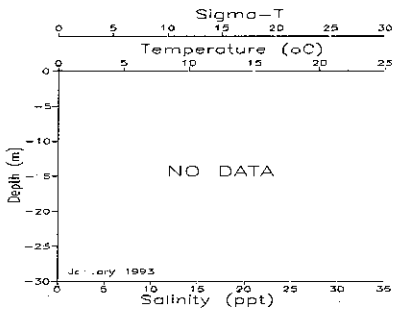
WATERYEAR 1993

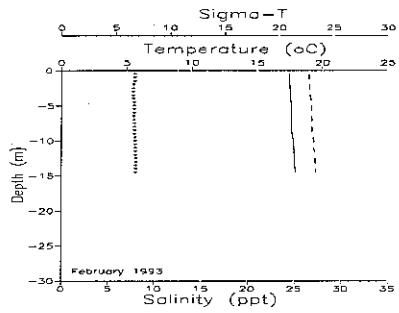
Willapa Bay - Nahcotta Channel (Station WPA006)

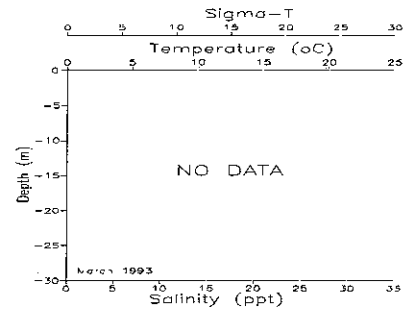


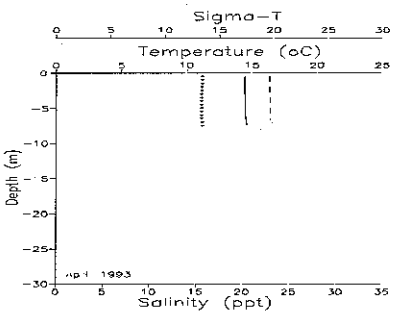


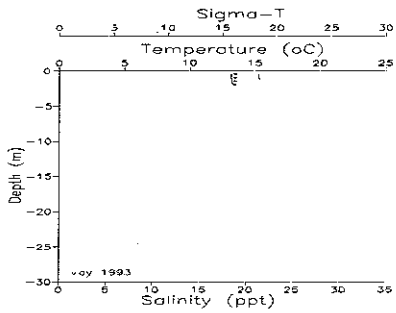


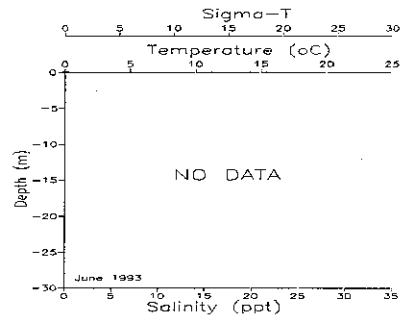


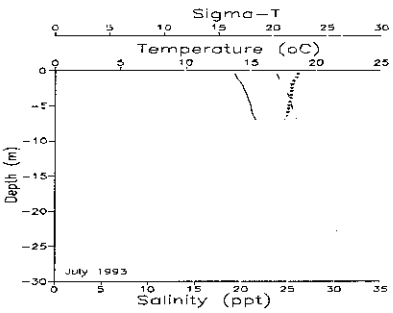


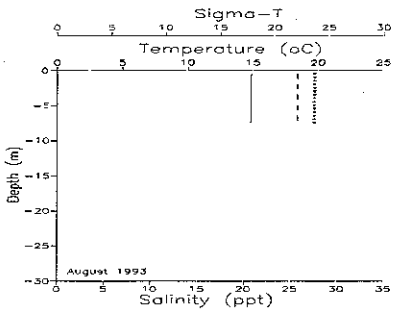


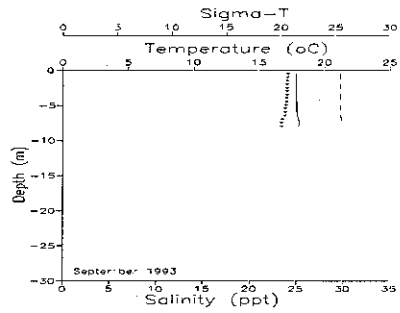








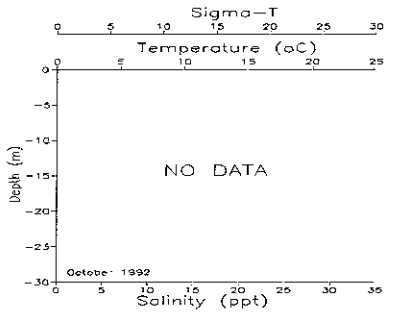


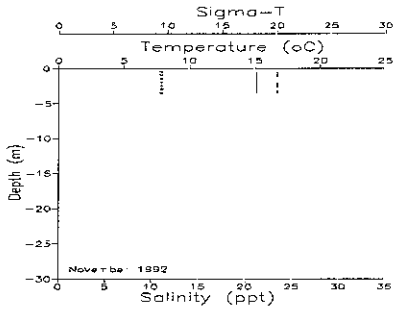


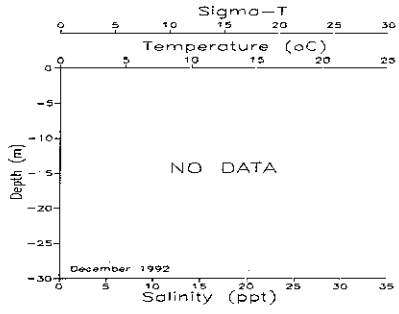
Key: Temperature = Dotted Line Salinity = Dashed Line Sigma-t = Solid Line

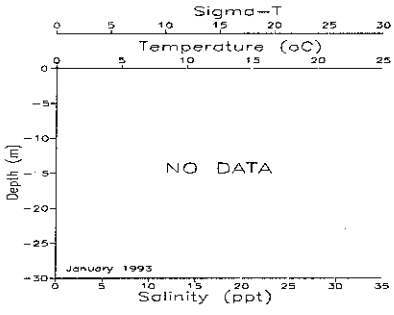
WATERYEAR 1993

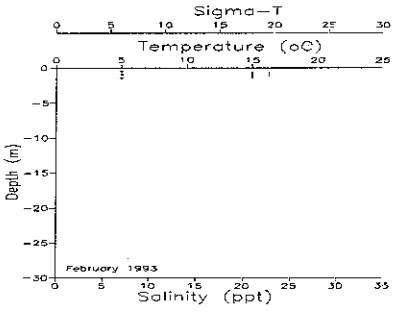
Willapa Bay - S. Jensen Pt. LI (Station WPA007)

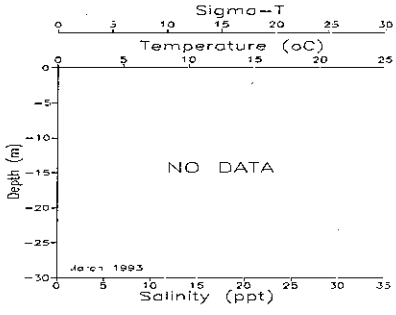


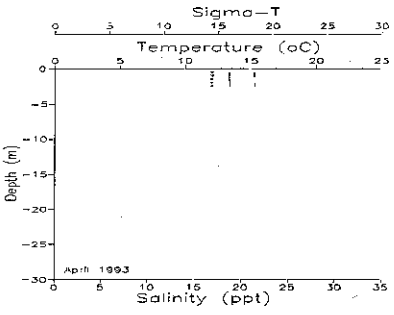


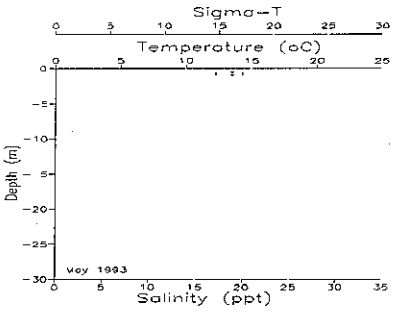


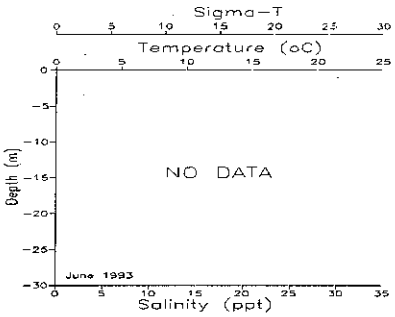


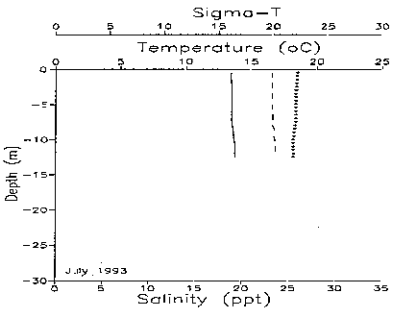


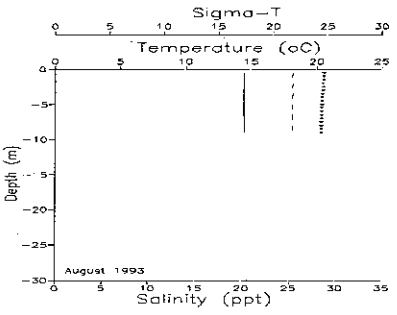


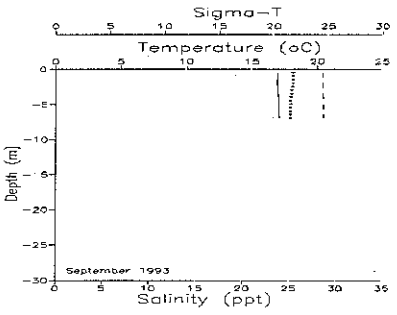












Key: Temperature = Dotted Line Salinity = Dashed Line Sigma-t = Solid Line

APPENDIX C

Profiles of dissolved oxygen and light transmission data from WY 1993 for:

1) Puget Sound stations

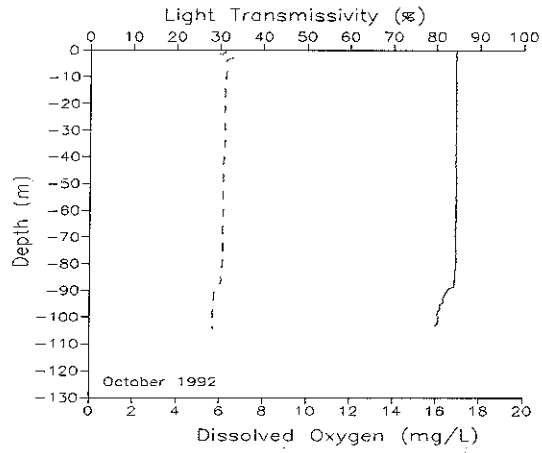
2) Grays Harbor and Willapa Bay stations

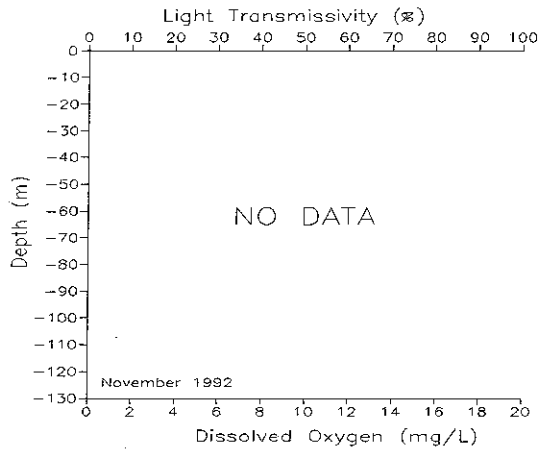
PUGET SOUND STATIONS

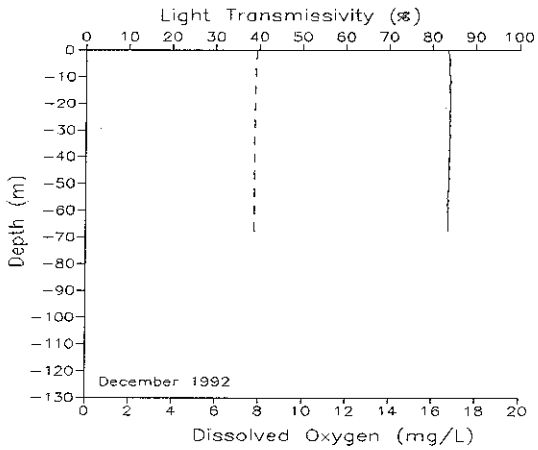
WATERYEAR 1993

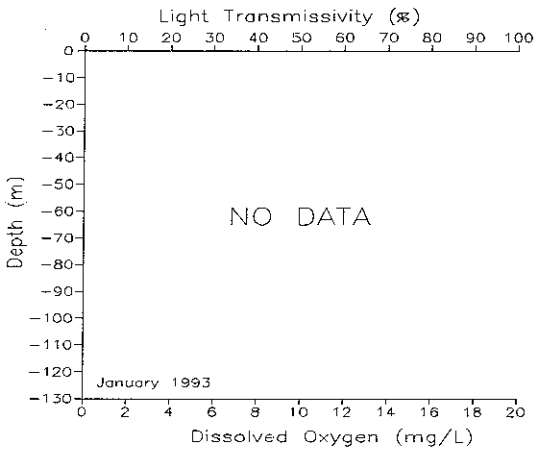
Part 1 of 2

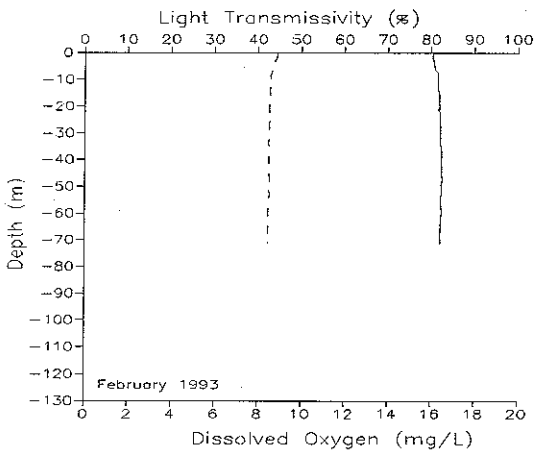
Admiralty Inlet - Bush Point (Station ADM001)

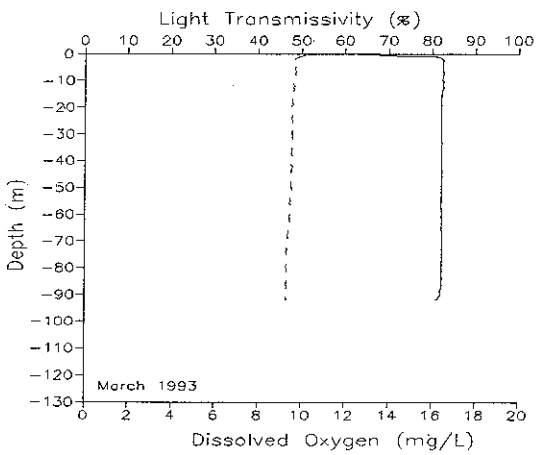










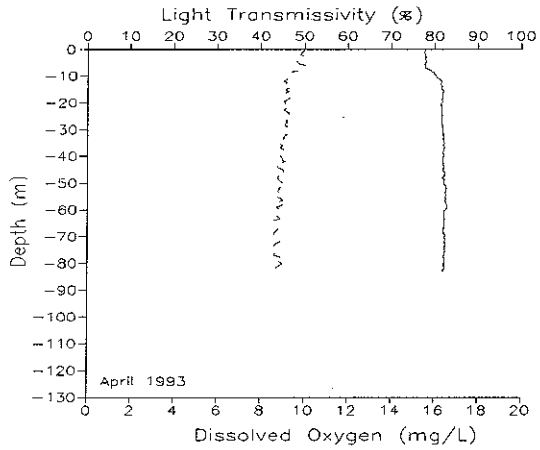


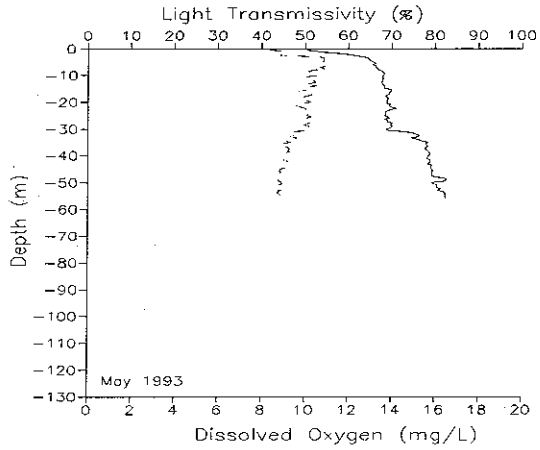
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

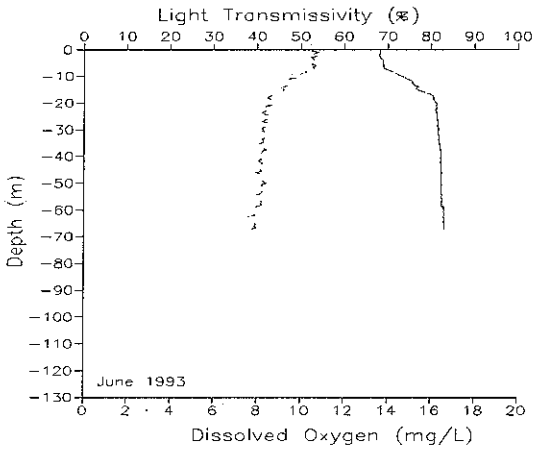
WATERYEAR 1993

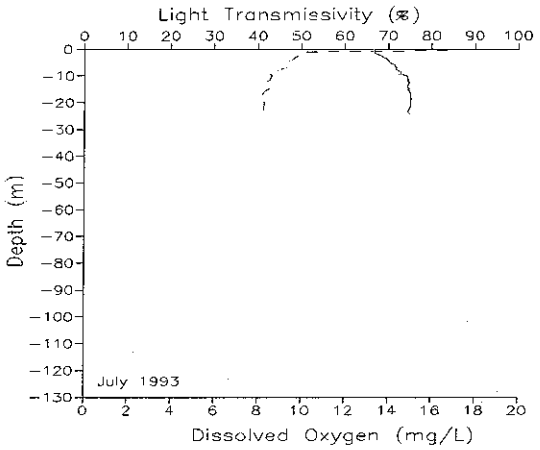
Part 2 of 2

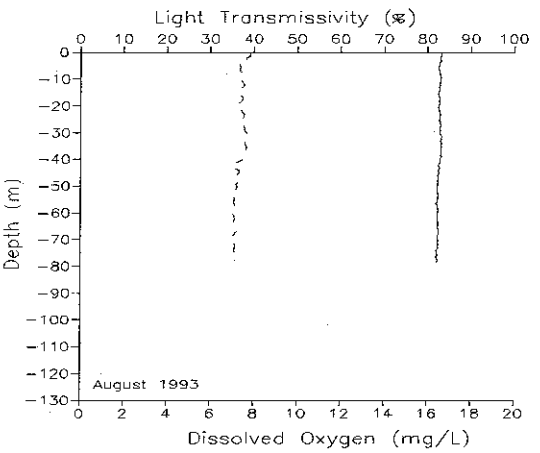
Admiralty Inlet - Bush Point (Station ADM001)

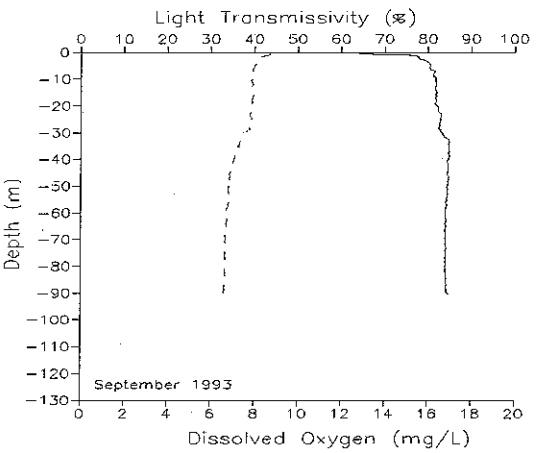










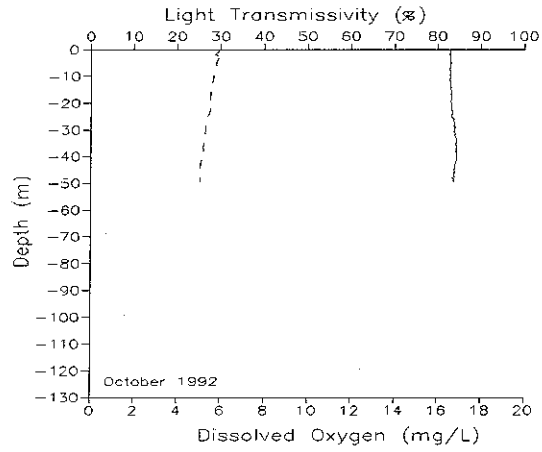


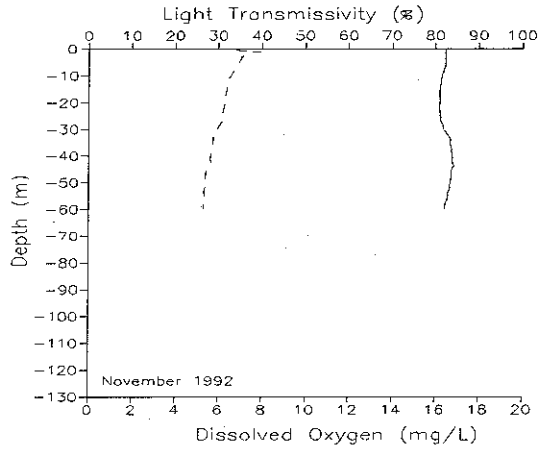
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

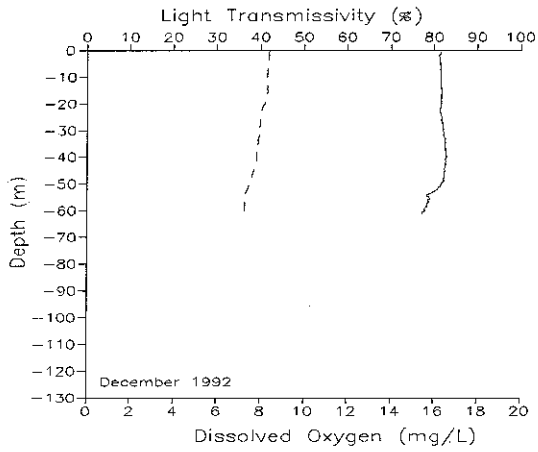
WATERYEAR 1993

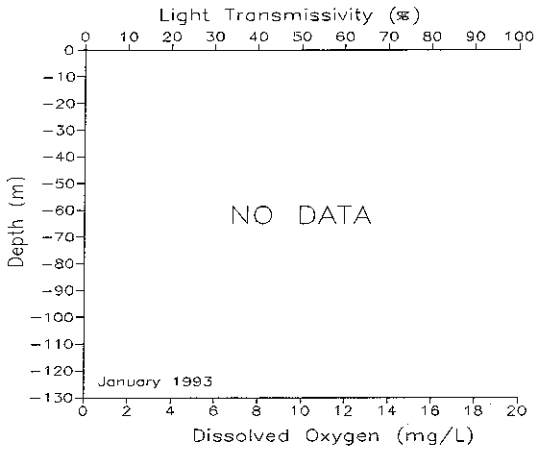
Part 1 of 2

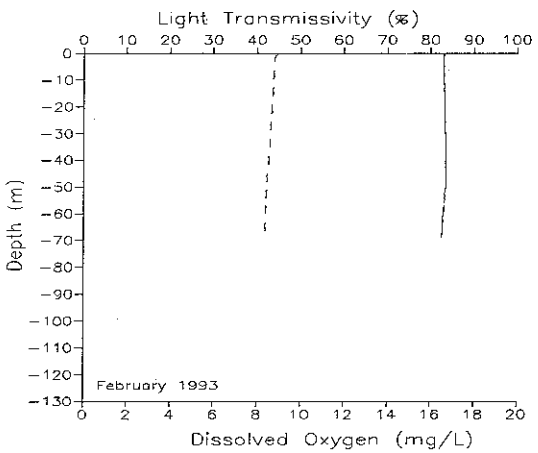
Straits of Juan de Fuca (Station ADM002)

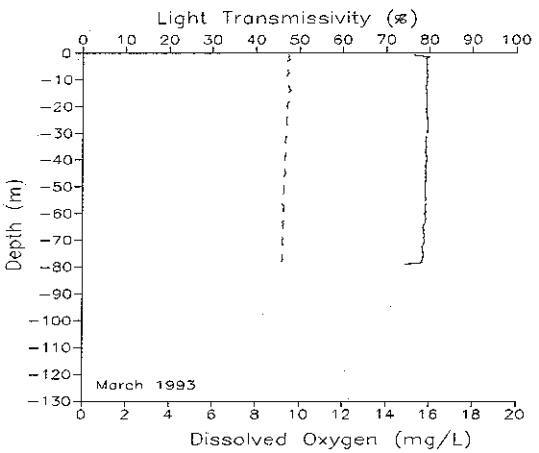










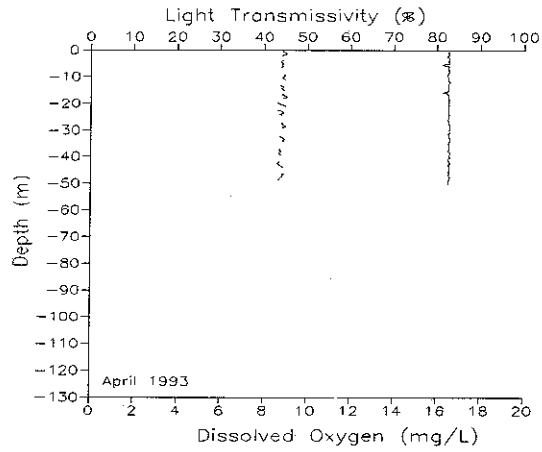


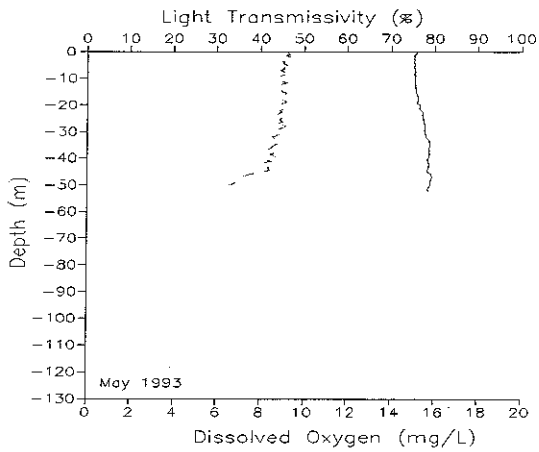
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

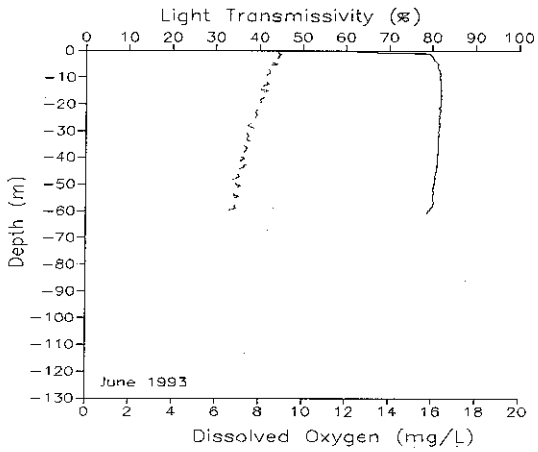
WATERYEAR 1993

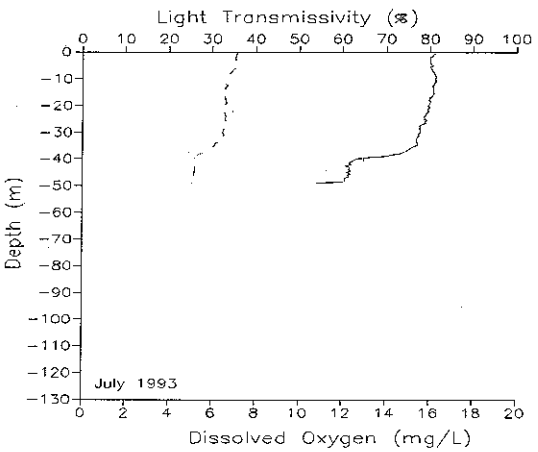
Part 2 of 2

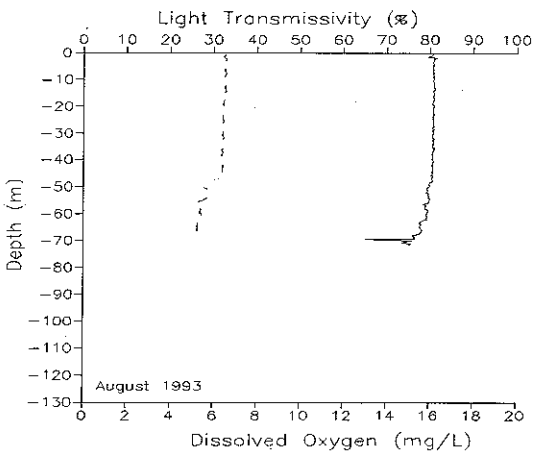
Straits of Juan de Fuca (Station ADM002)

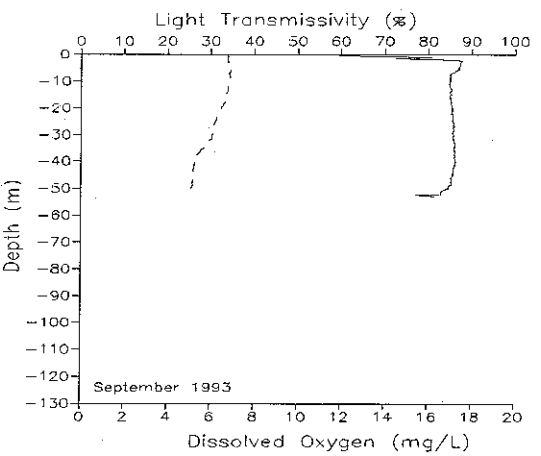








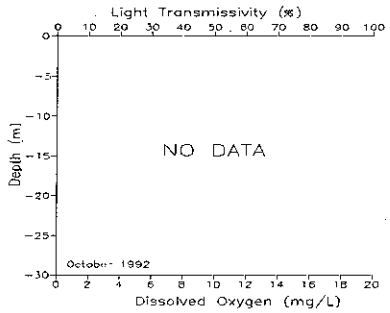


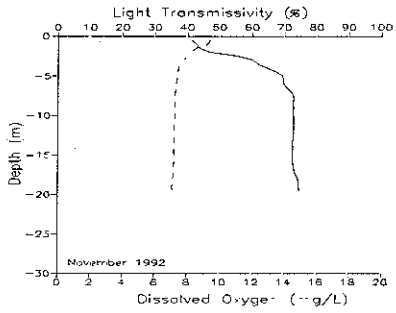


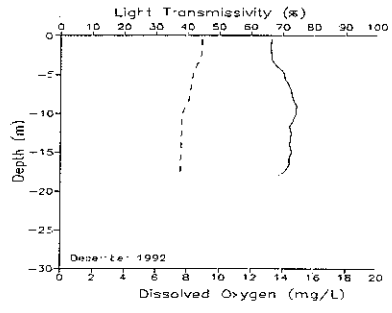
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

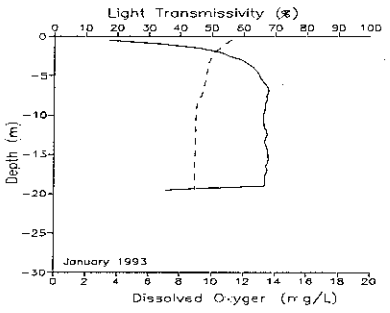
WATERYEAR 1993

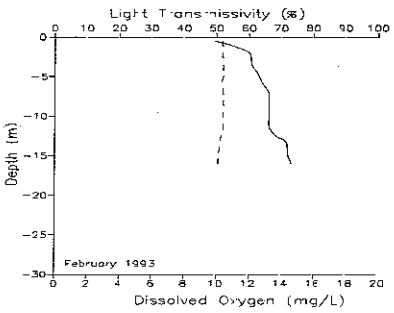
Bellingham Bay (Station BLL009)

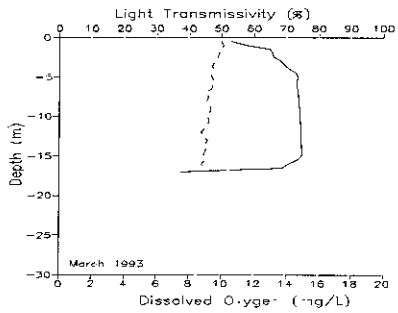


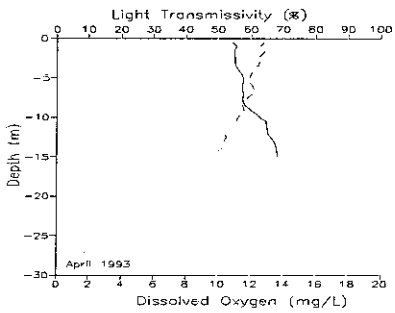


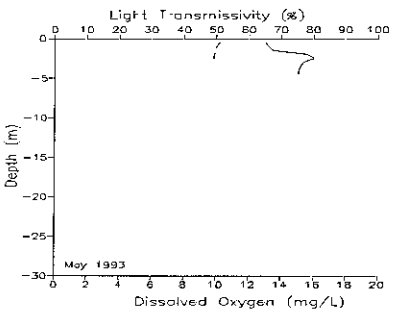


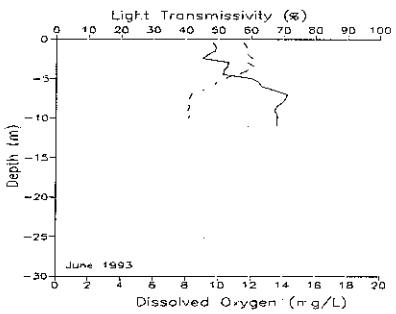


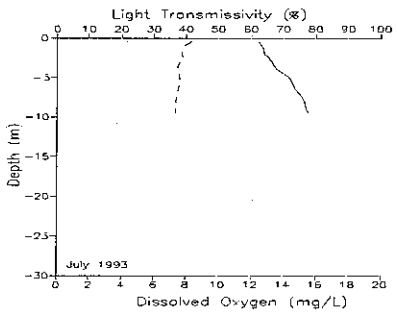


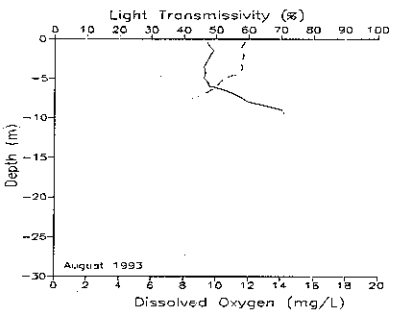


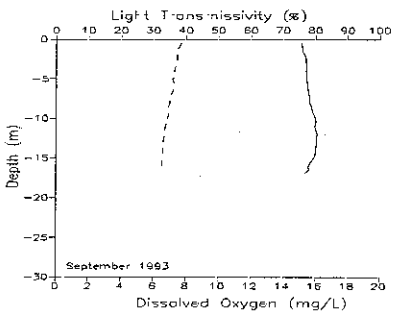








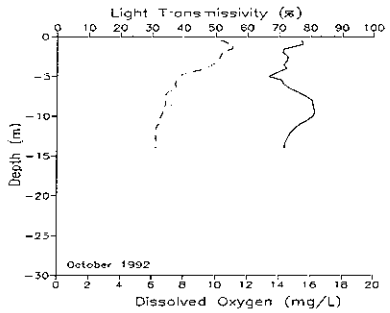


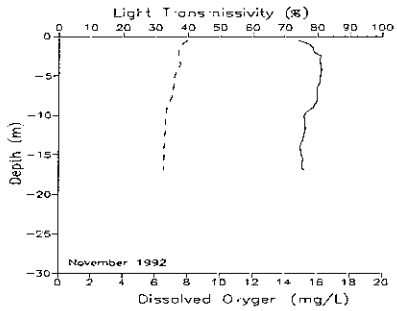


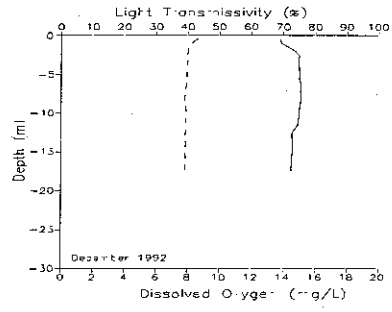
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

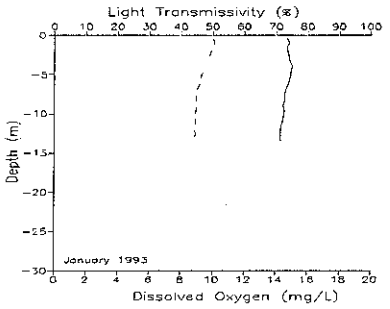
WATERYEAR 1993

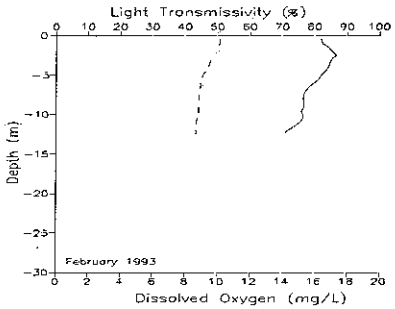
Budd Inlet (Station BUD005)

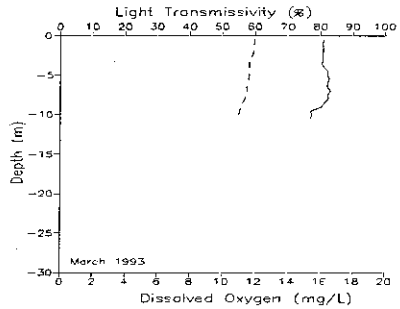


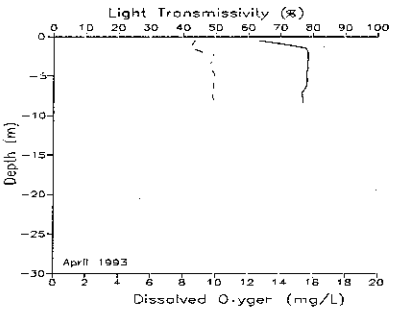


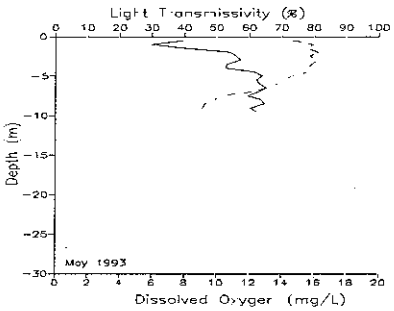


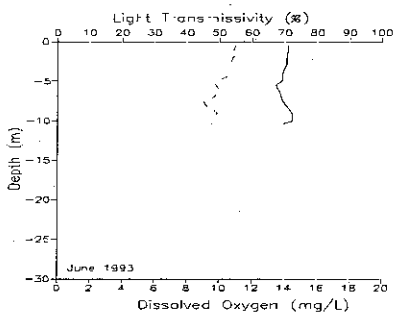


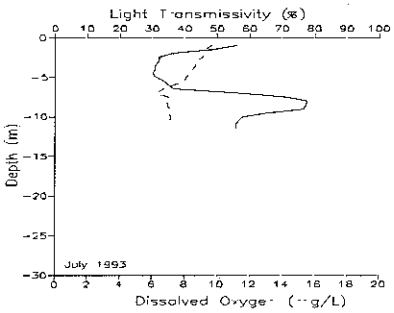


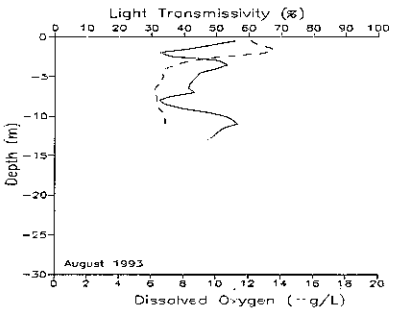


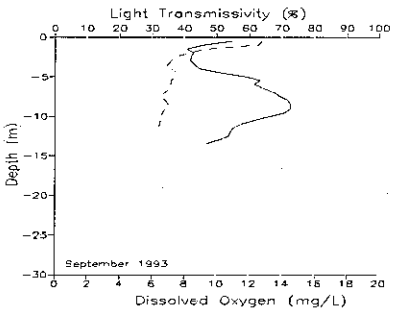










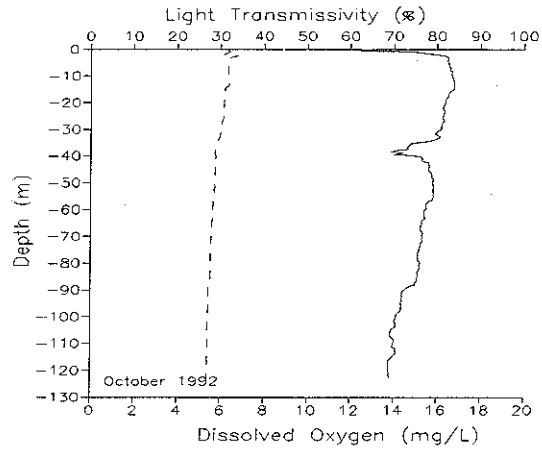


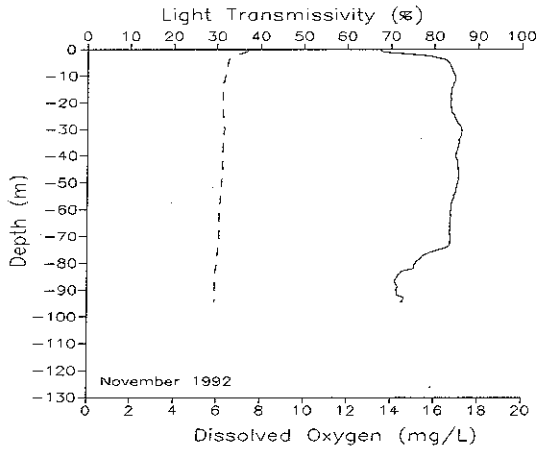
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

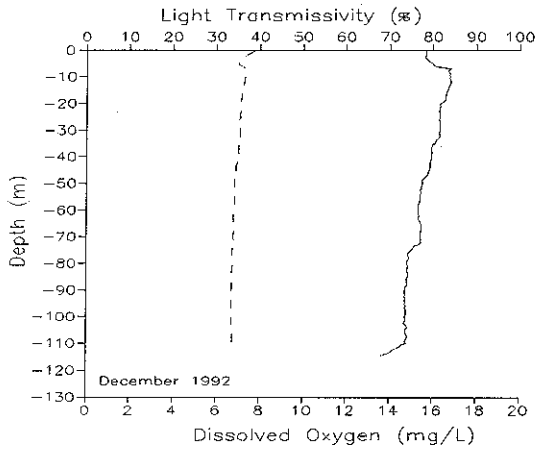
WATERYEAR 1993

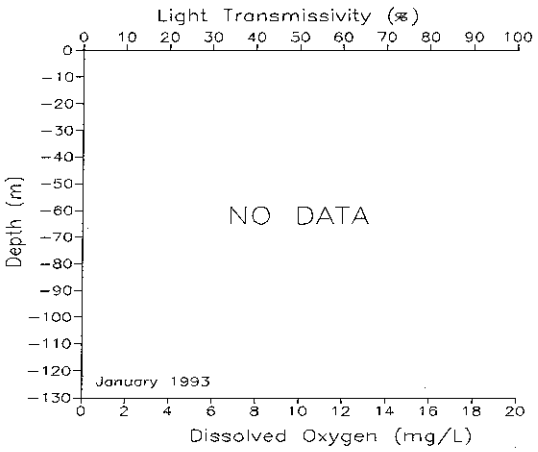
Part 1 of 2

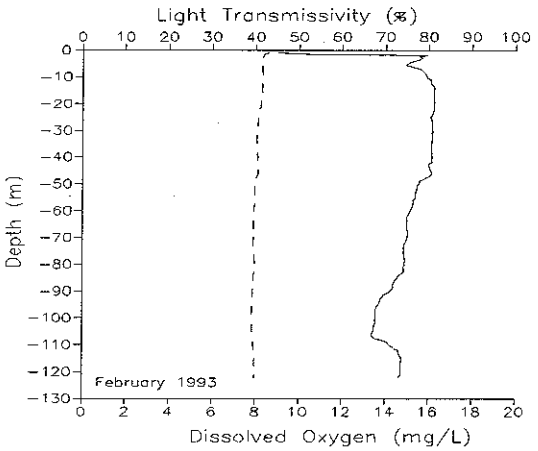
Commencement Bay - Browns Point (Station CMB003)

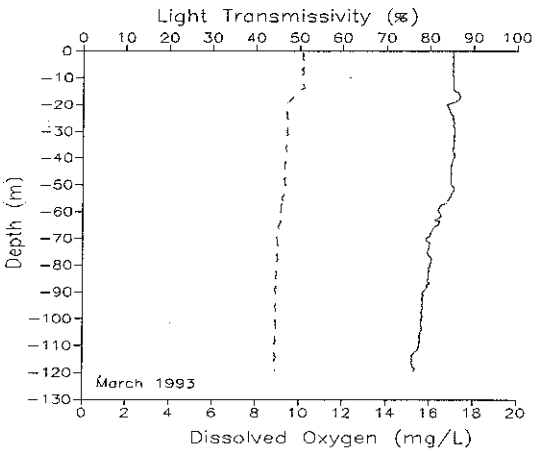










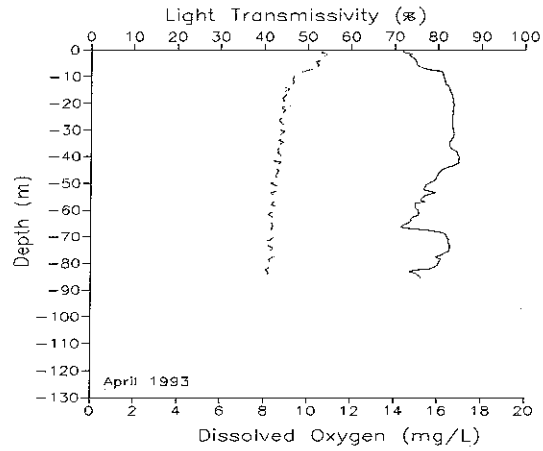


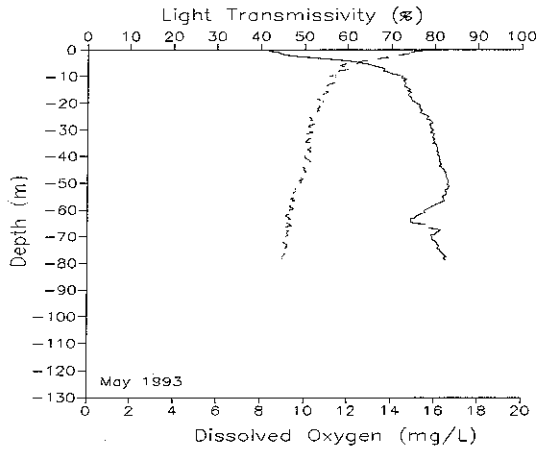
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

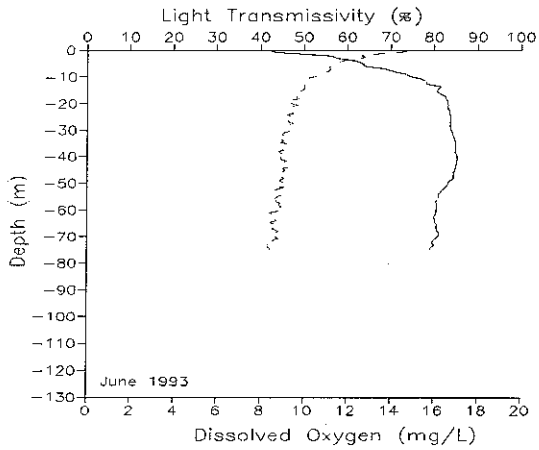
WATERYEAR 1993

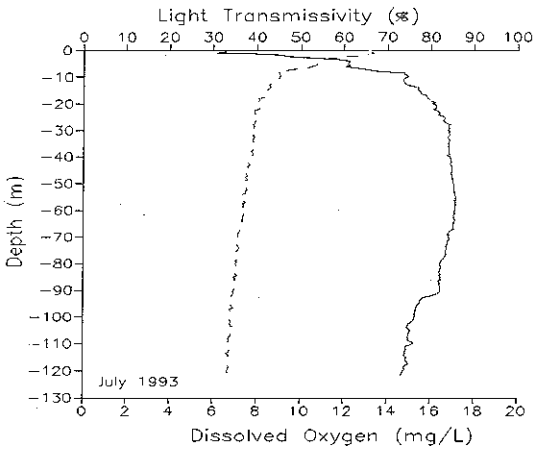
Part 2 of 2

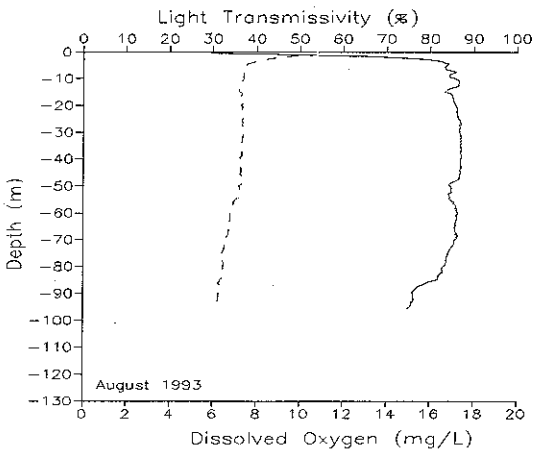
Commencement Bay - Browns Point (Station CMB003)

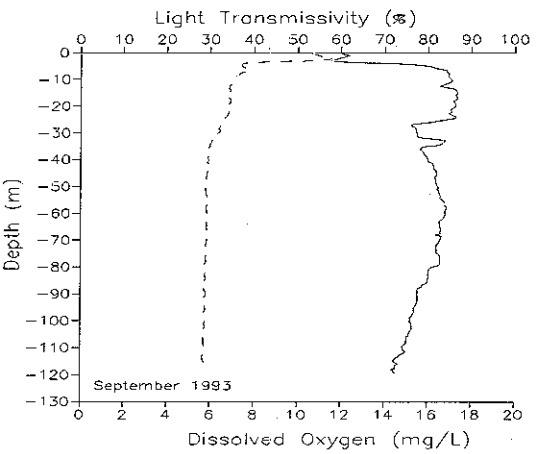










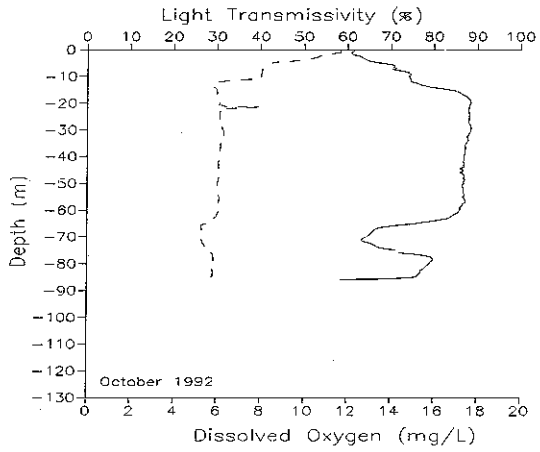


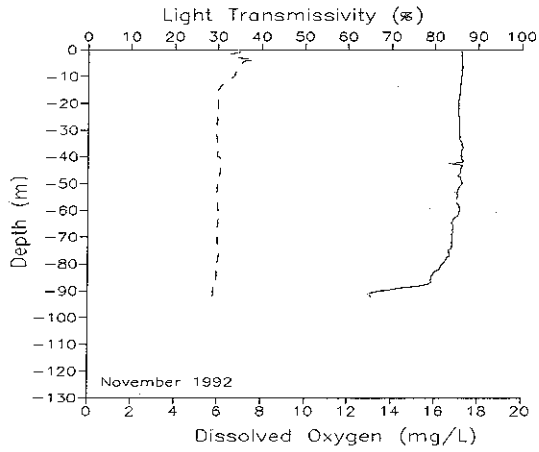
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

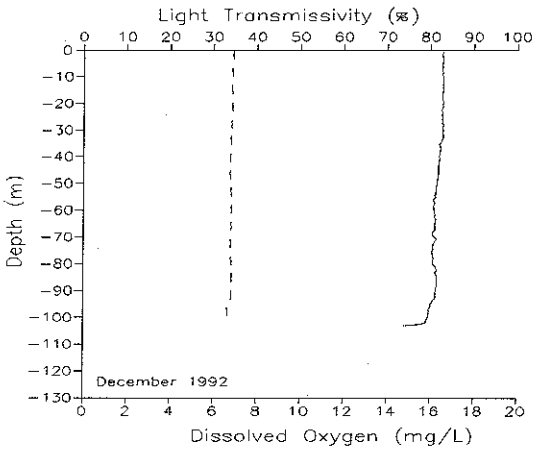
WATERYEAR 1993

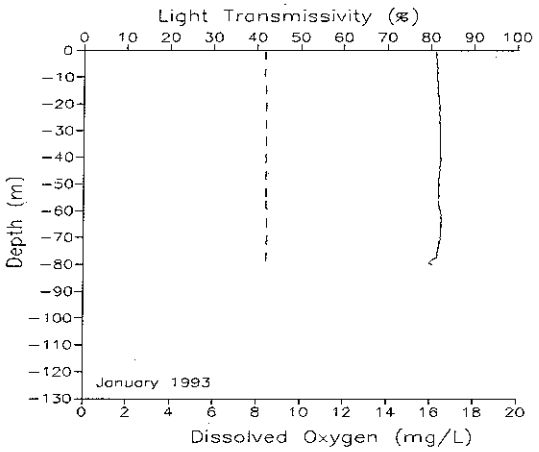
Part 1 of 2

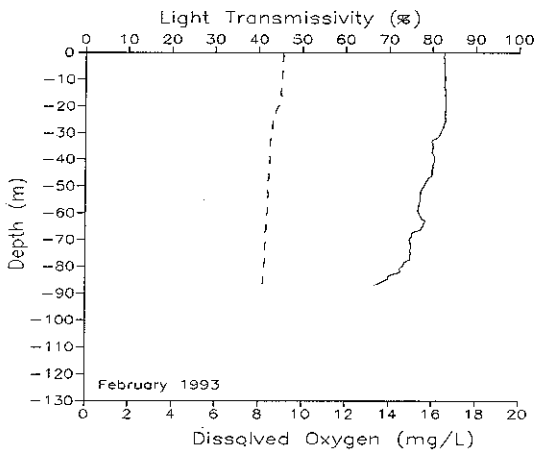
Carr Inlet - Green Point (Station CRR001)

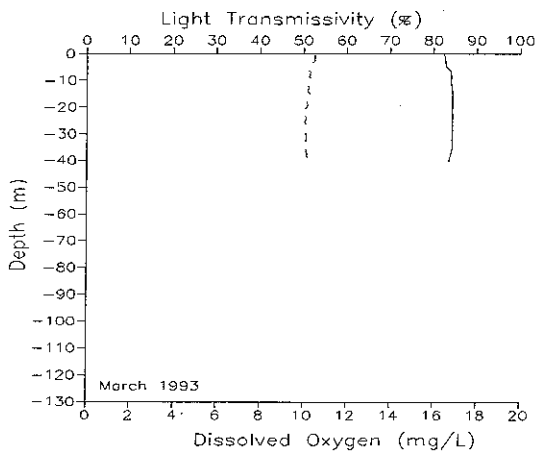










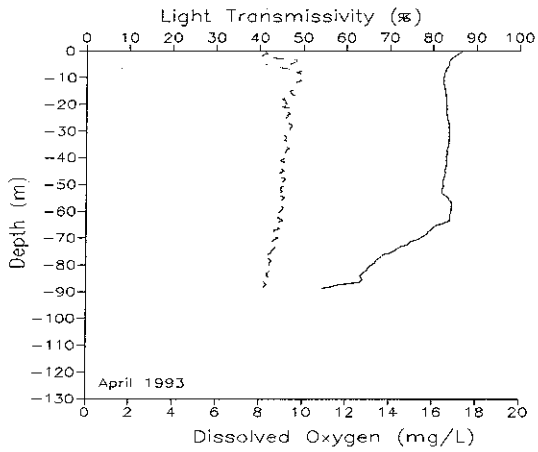


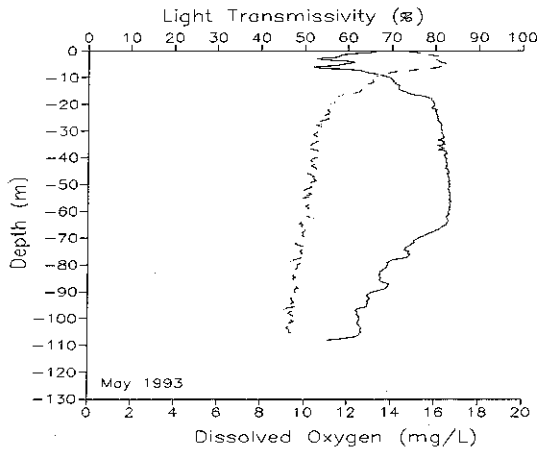
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

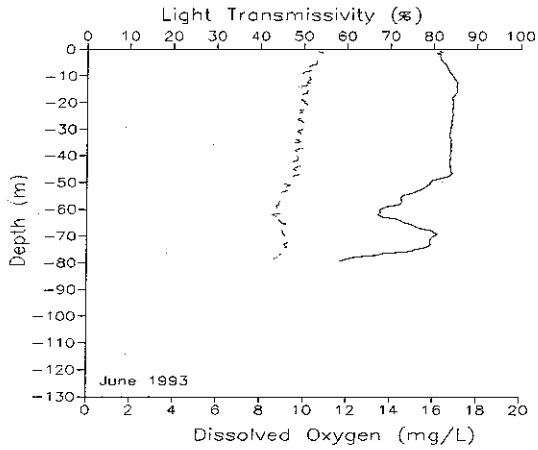
WATERYEAR 1993

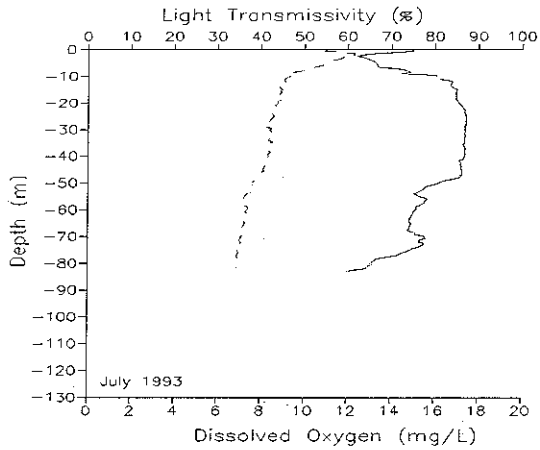
Part 2 of 2

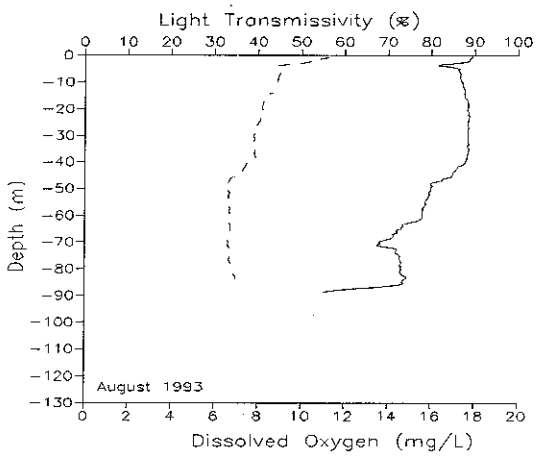
Carr Inlet - Green Point (Station CRR001)

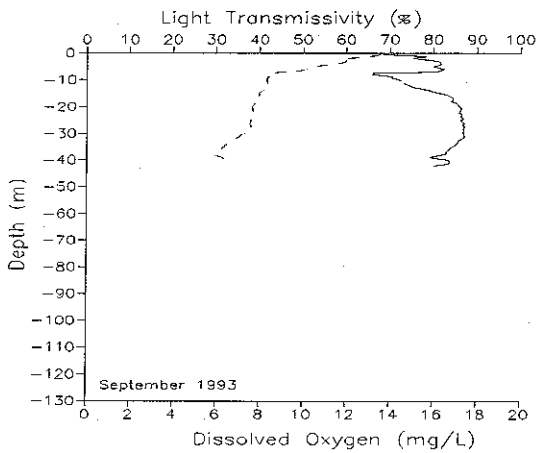










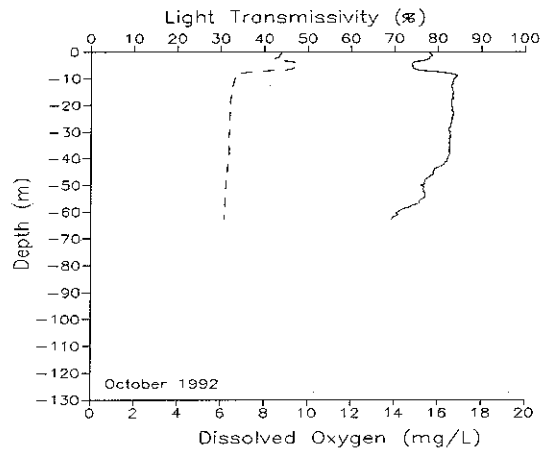


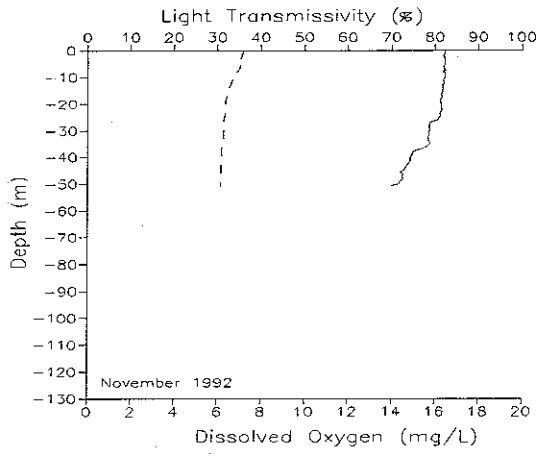
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

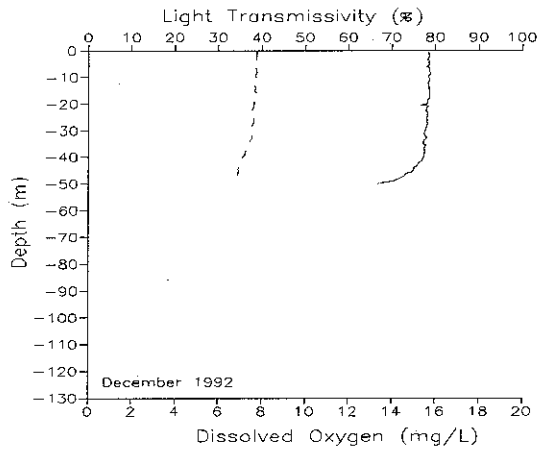
WATERYEAR 1993

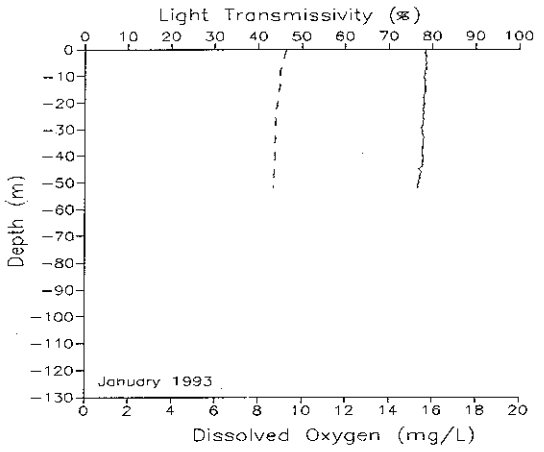
Part 1 of 2

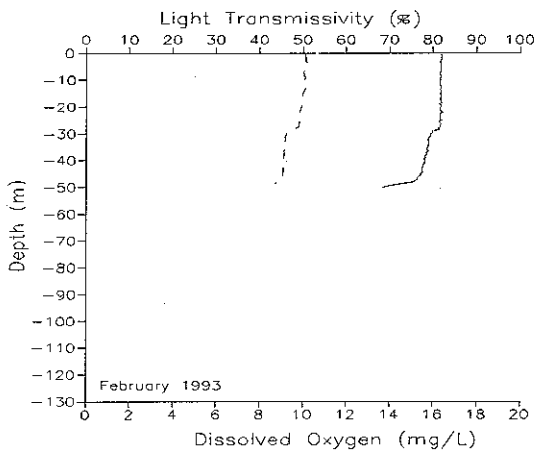
Case Inlet - Heron Island (Station CSE001)

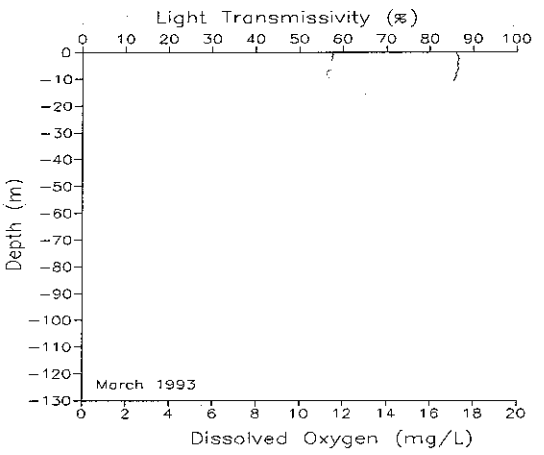










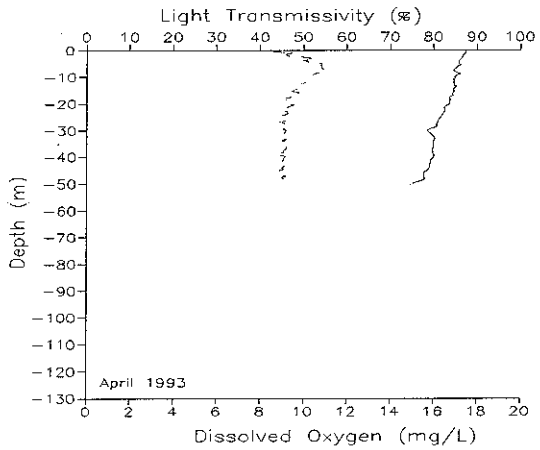


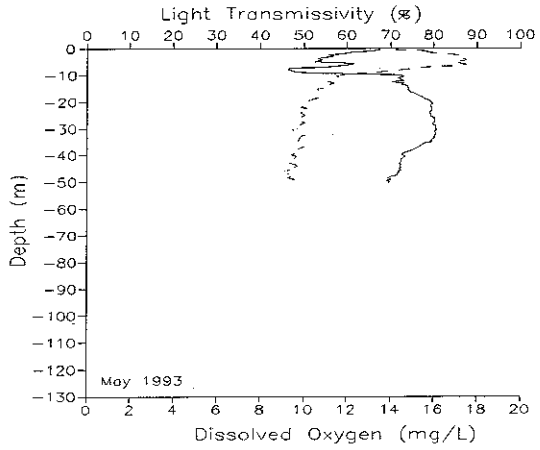
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

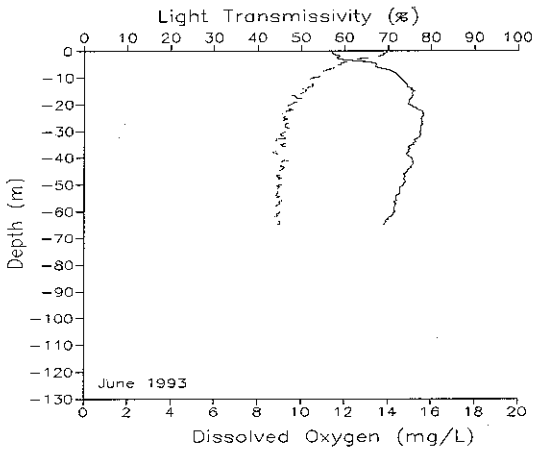
WATERYEAR 1993

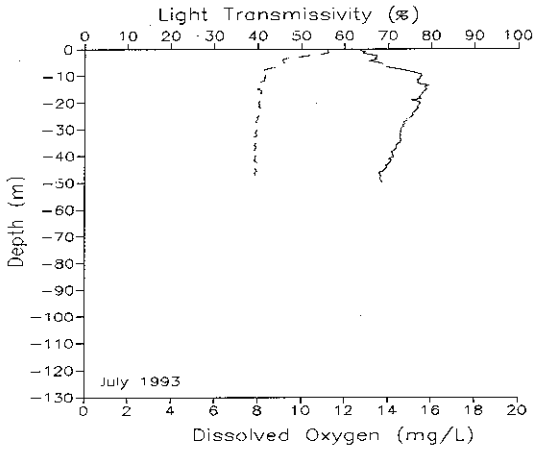
Part 2 of 2

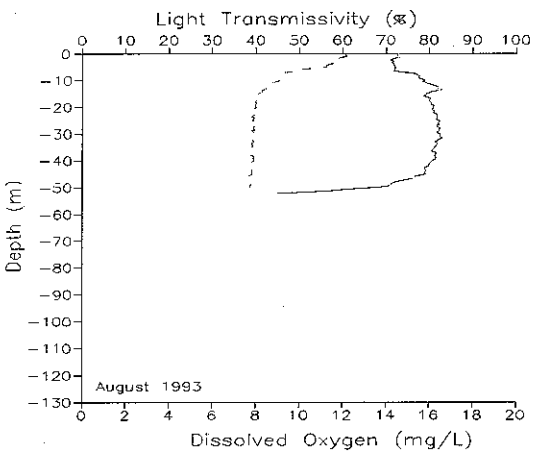
Case Inlet- Heron Island (Station CSE001)

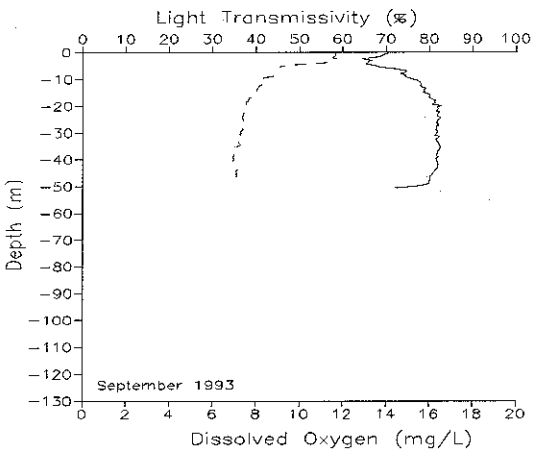










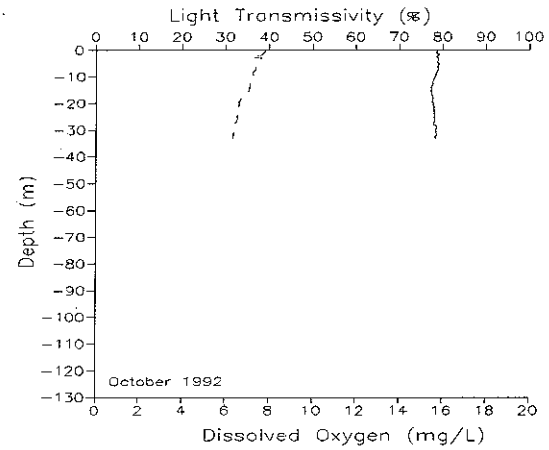


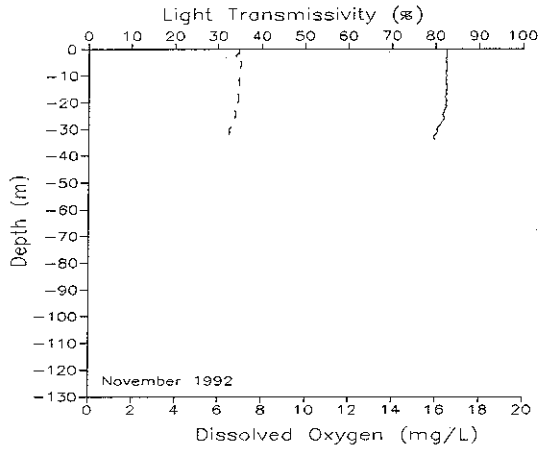
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

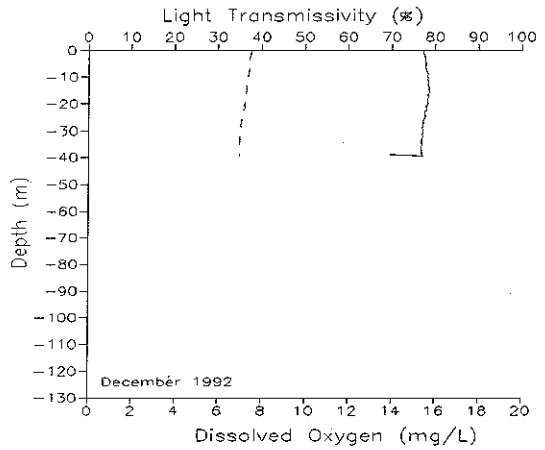
WATERYEAR 1993

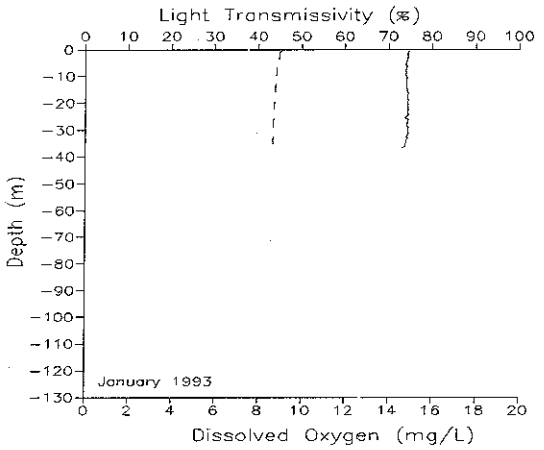
Part 1 of 2

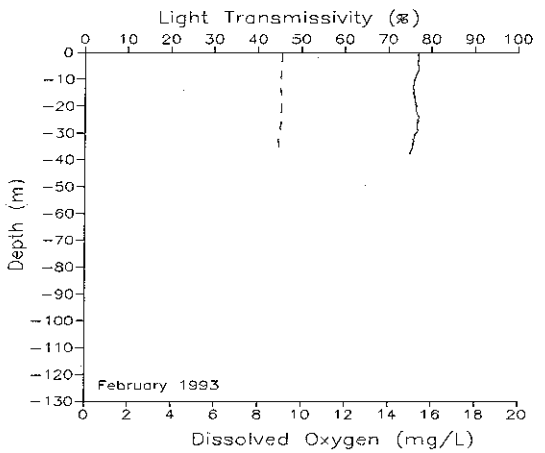
Dana Passage (Station DNA001)

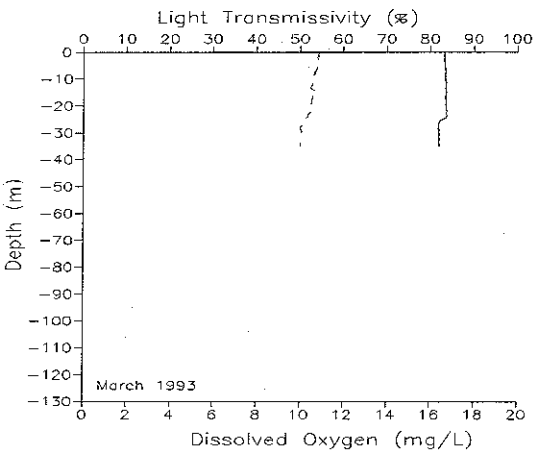










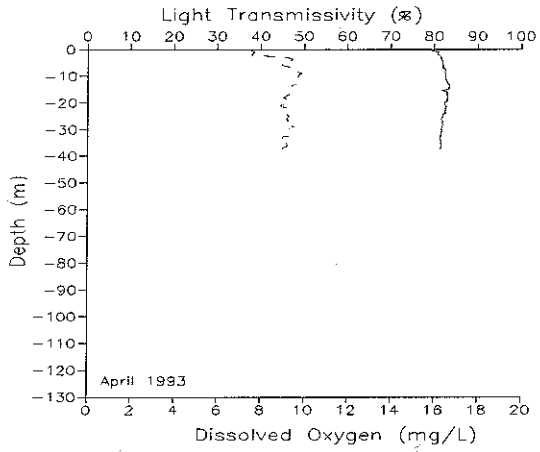


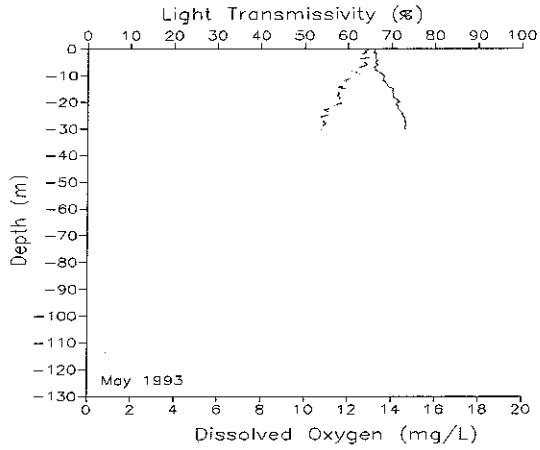
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

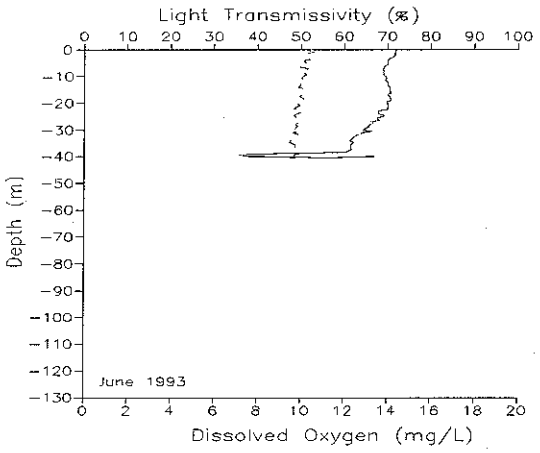
WATERYEAR 1993

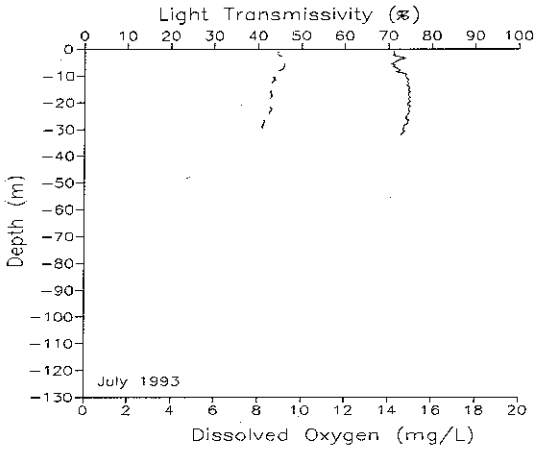
Part 2 of 2

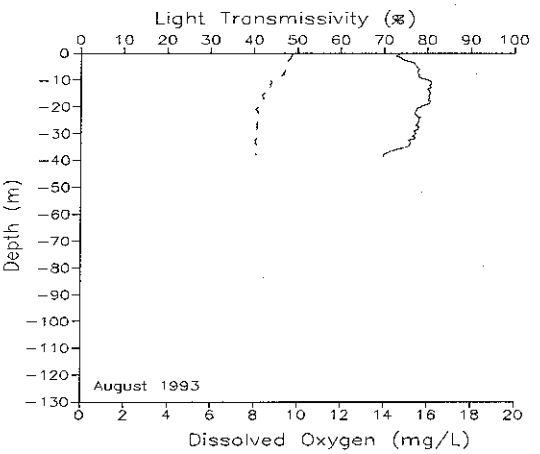
Dana Passage (Station DNA001)

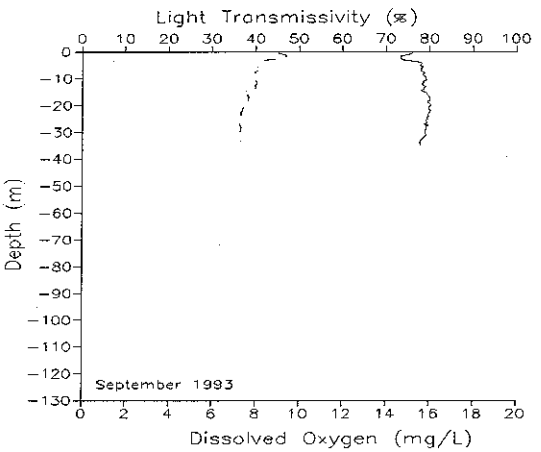










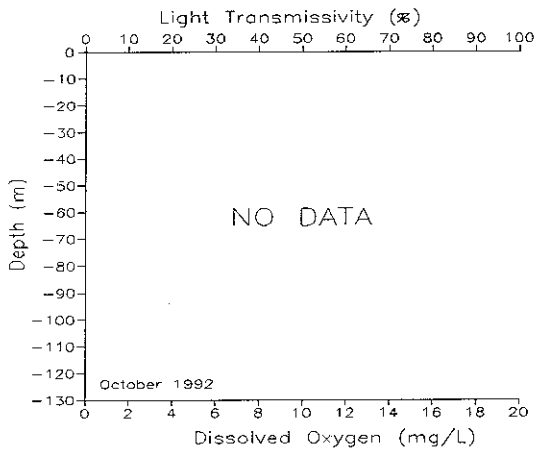


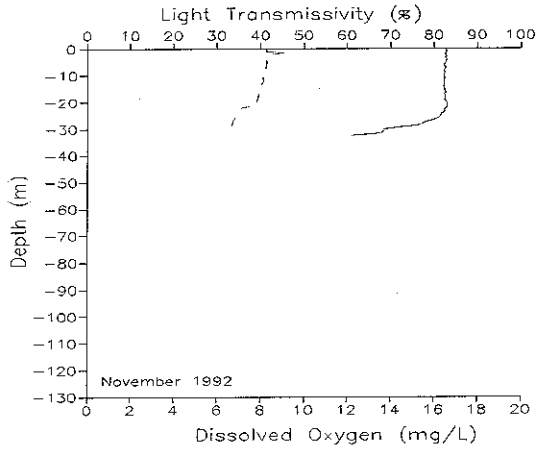
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

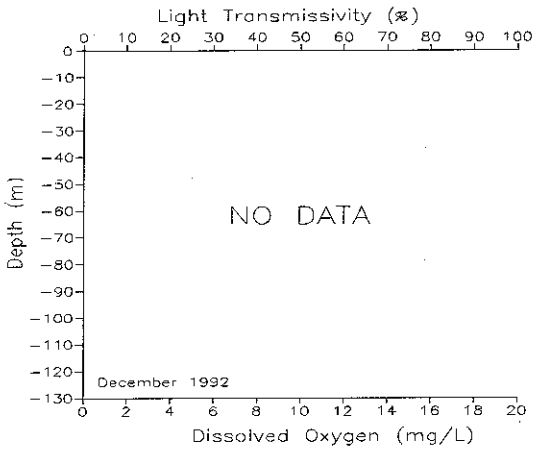
WATERYEAR 1993

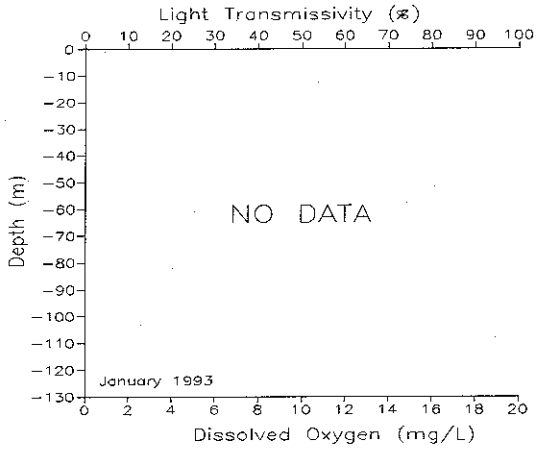
Part 1 of 2

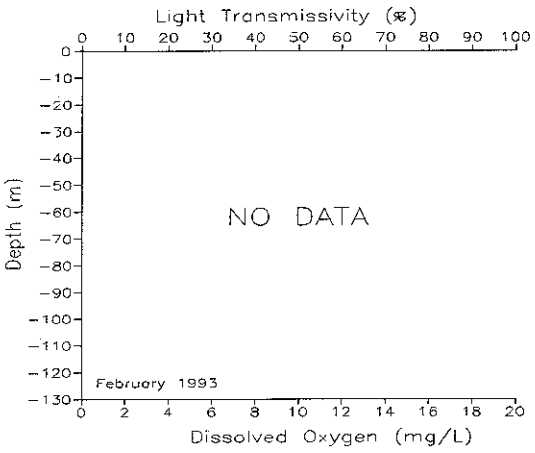
East Sound - Orcas Island (Station EAS001)

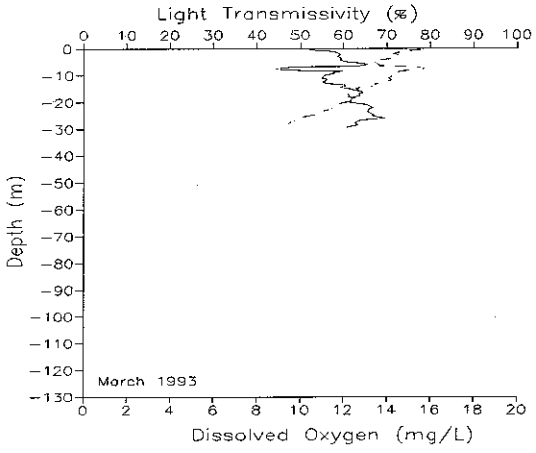










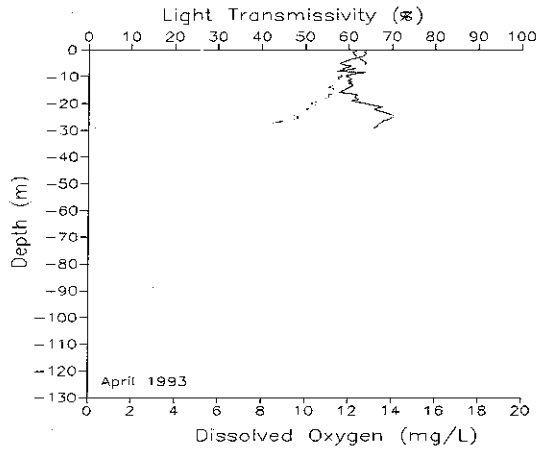


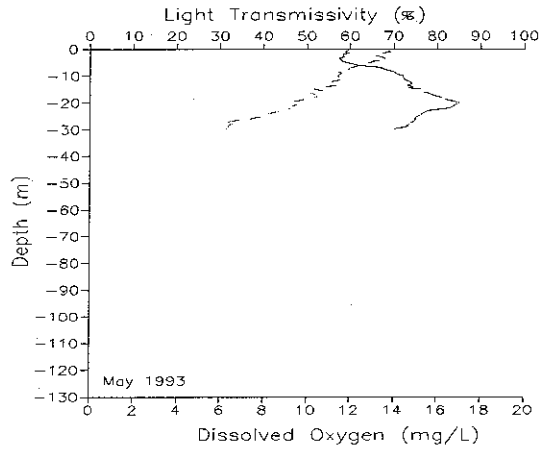
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

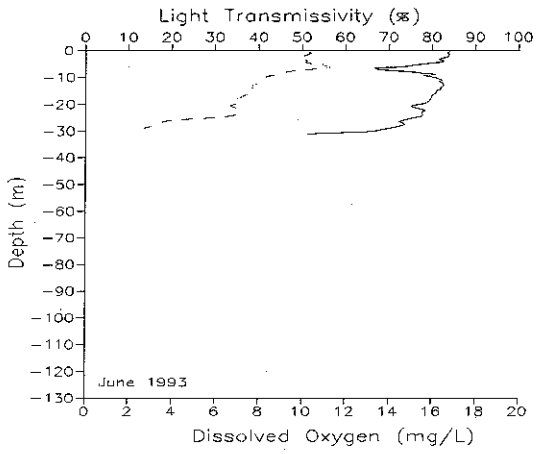
WATERYEAR 1993

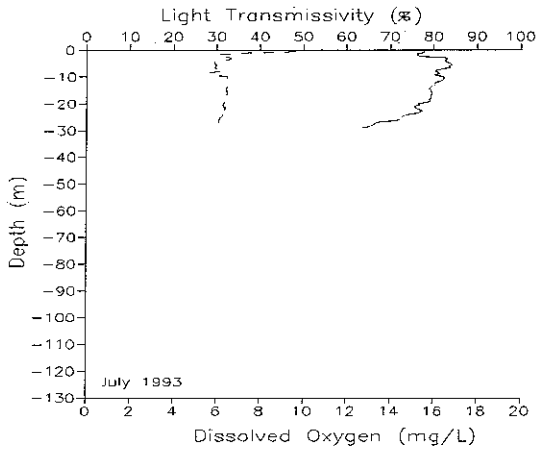
Part 2 of 2

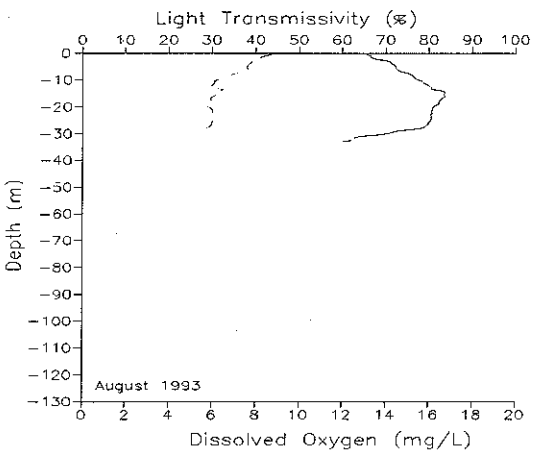
East Sound - Orcas Island (Station EAS001)

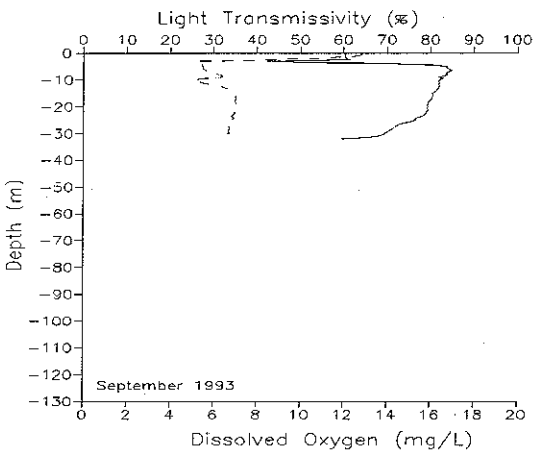










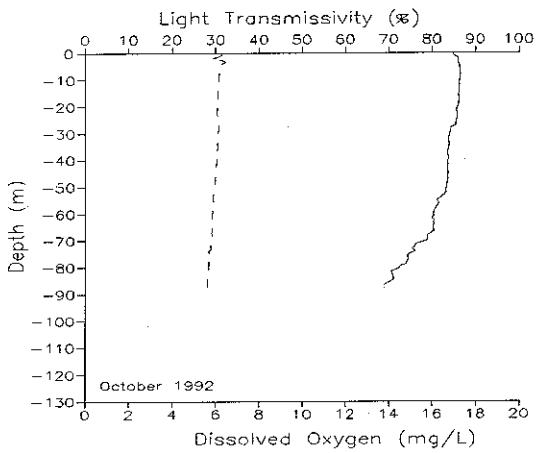


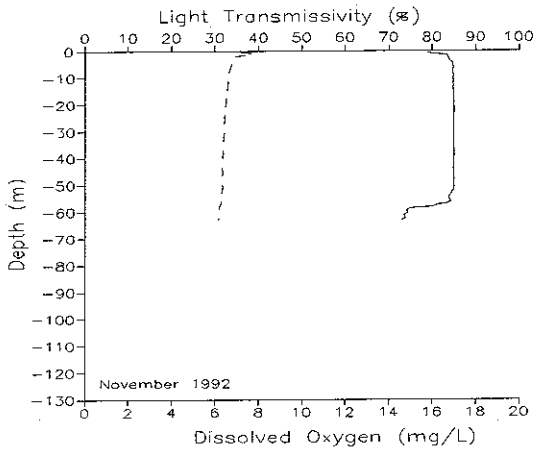
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

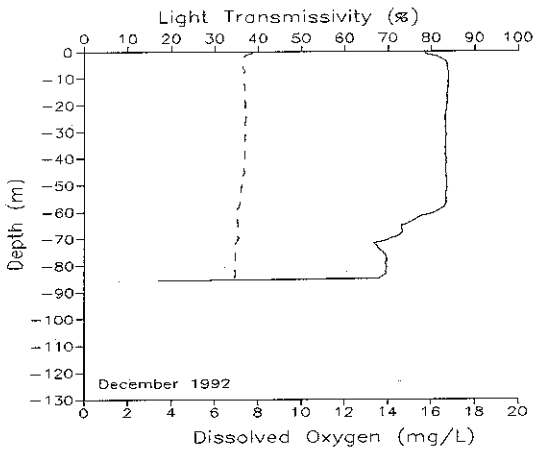
WATERYEAR 1993

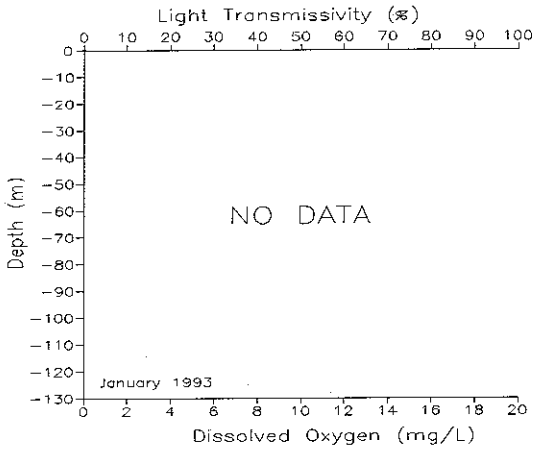
Part 1 of 2

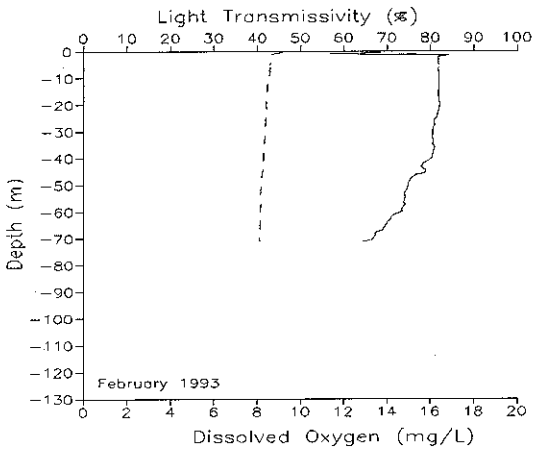
Elliott Bay - East Duwamish Head (Station ELB015)

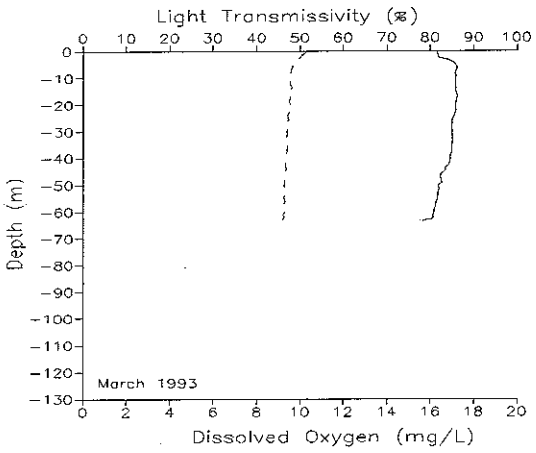










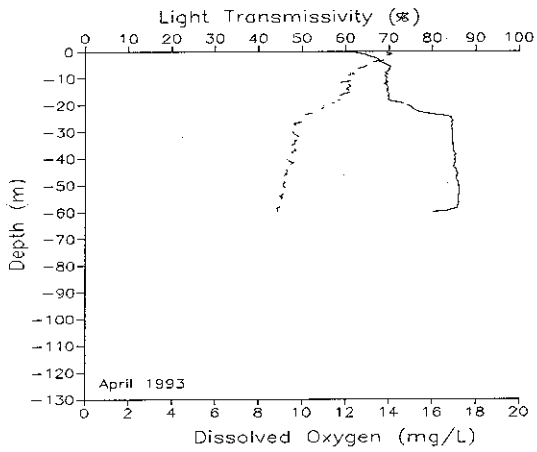


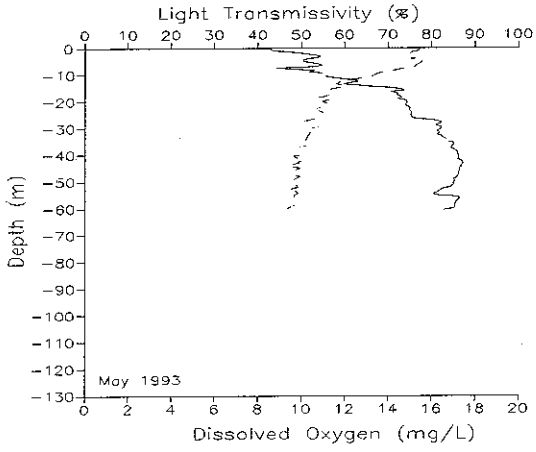
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

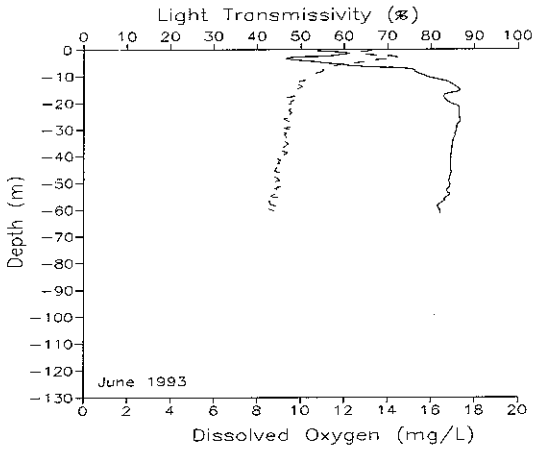
WATERYEAR 1993

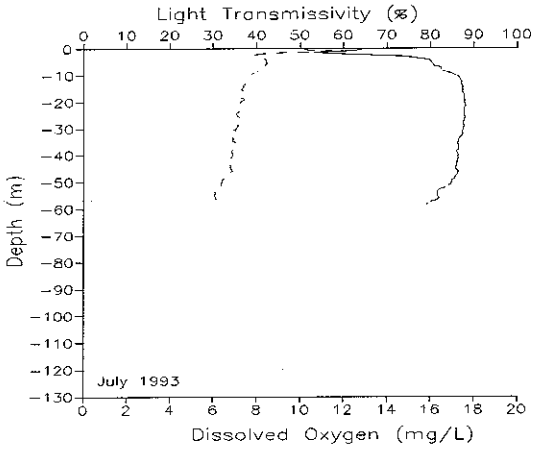
Part 2 of 2

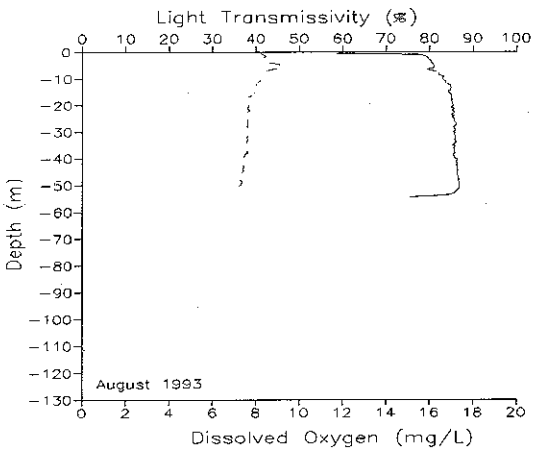
Elliott Bay - East Duwamish Head (Station ELB015)

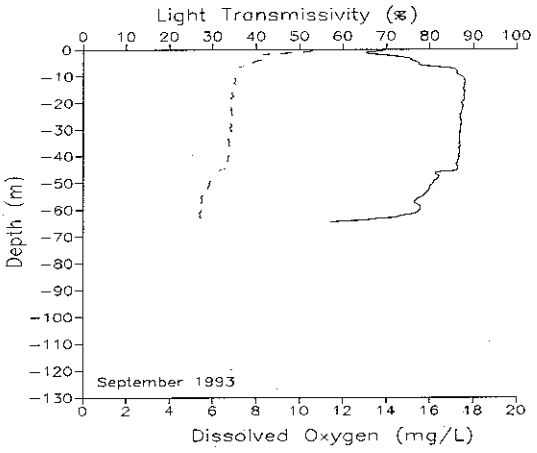








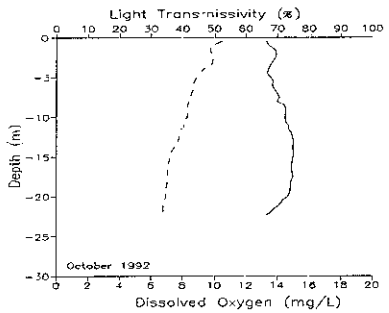


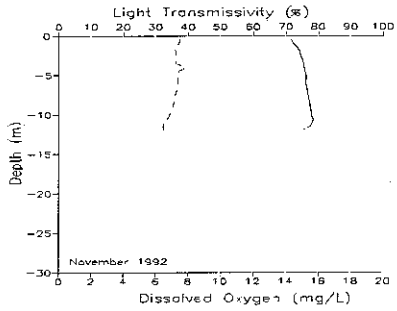


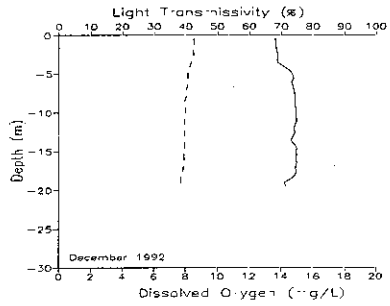
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

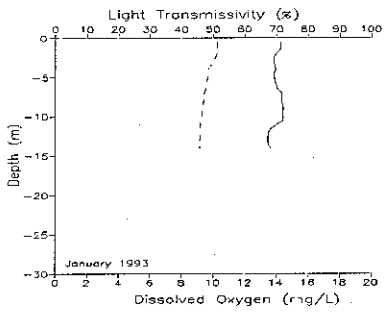
WATERYEAR 1993

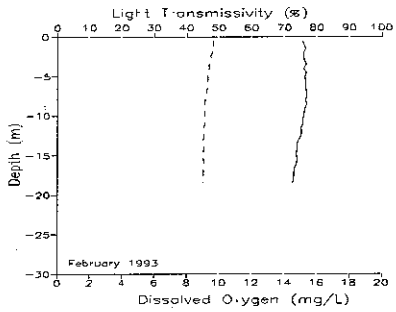
Eld Inlet (Station ELD001)

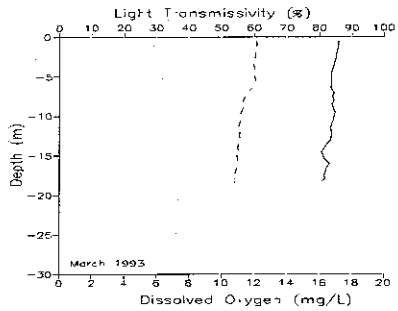


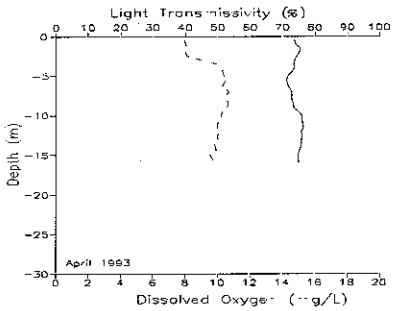


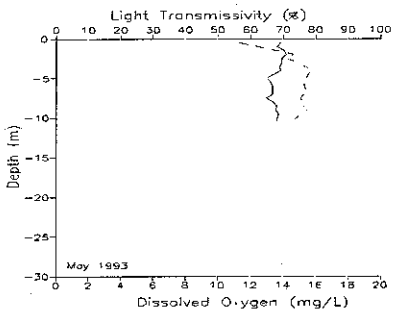


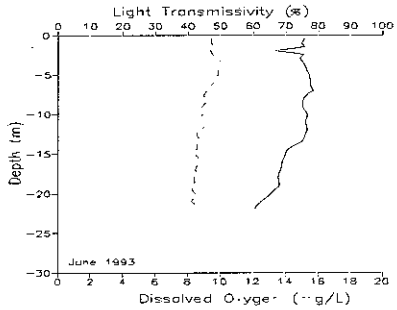


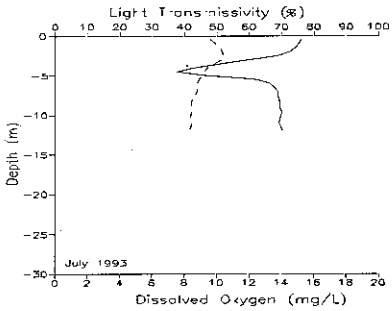


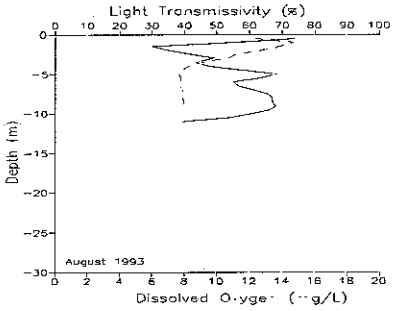


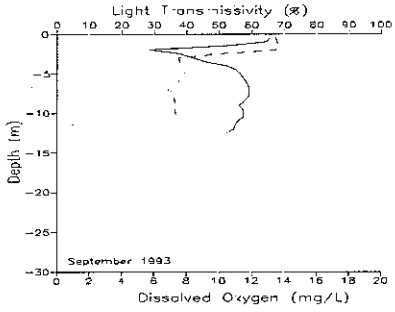










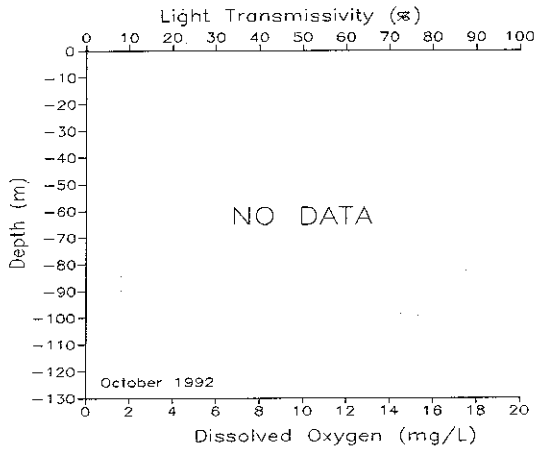


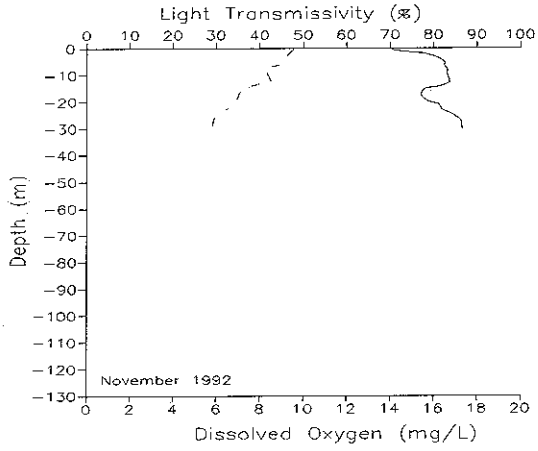
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

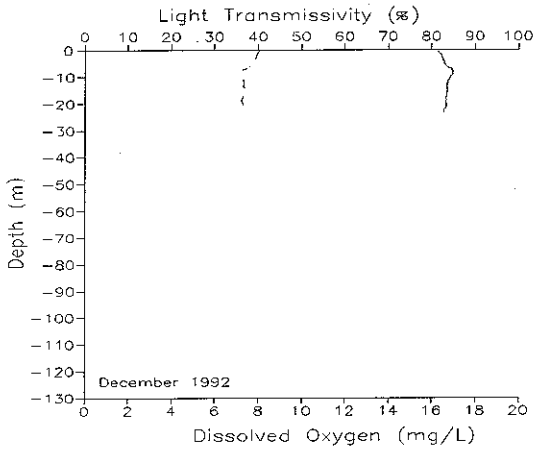
WATERYEAR 1993

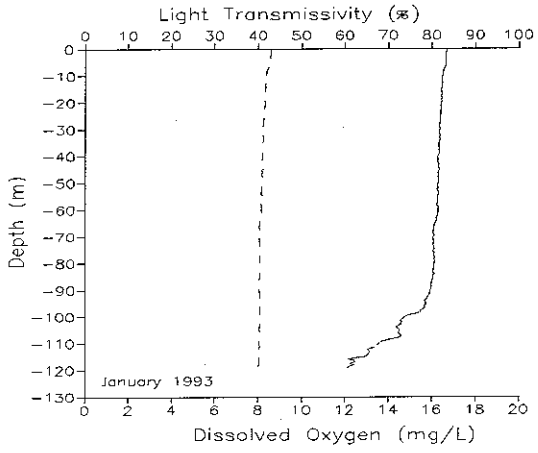
Part 1 of 2

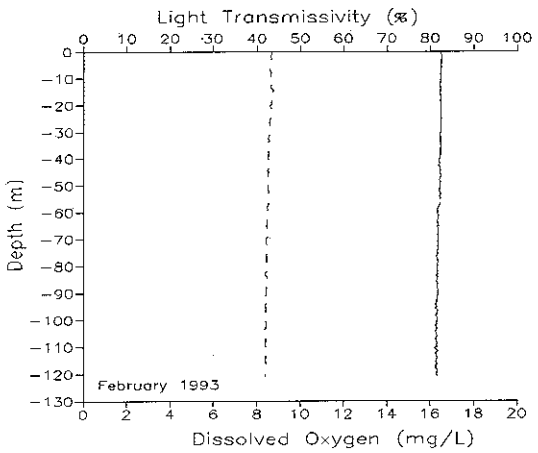
Georgia Strait - North of Patos Is. (Station GRG002)

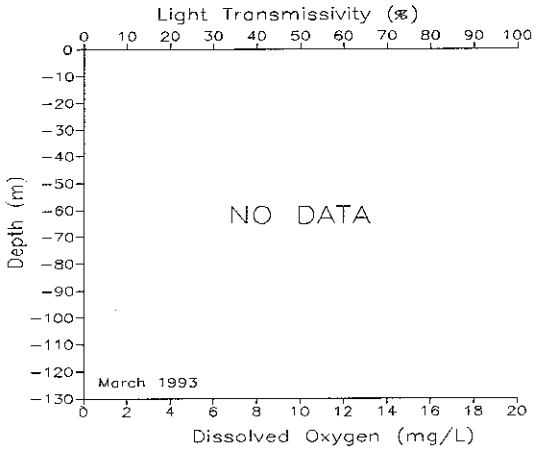










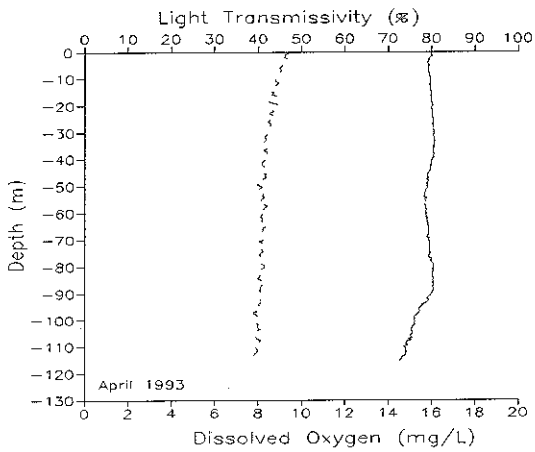


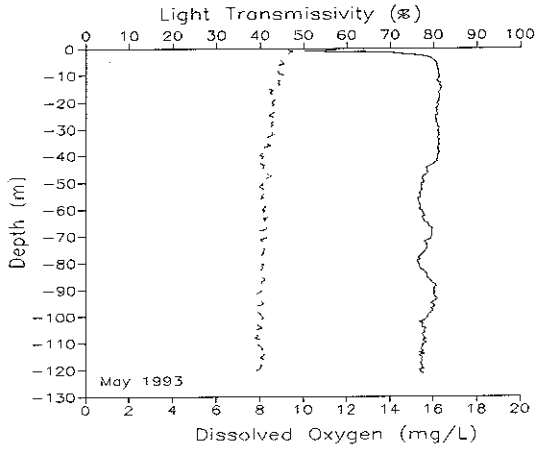
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

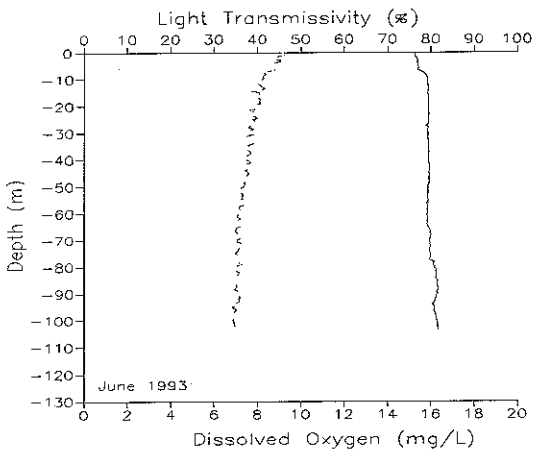
WATERYEAR 1993

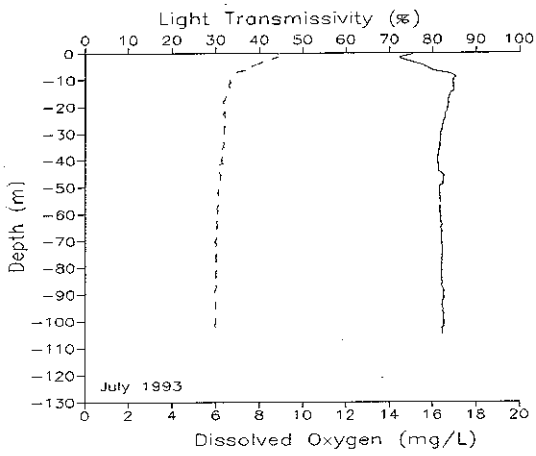
Part 2 of 2

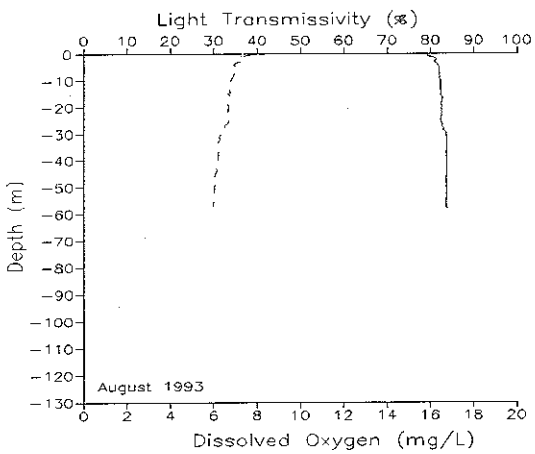
Georgia Strait - North of Patos Is. (Station GRG002)

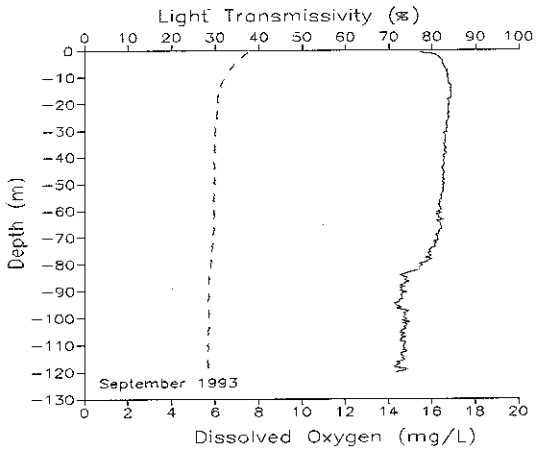










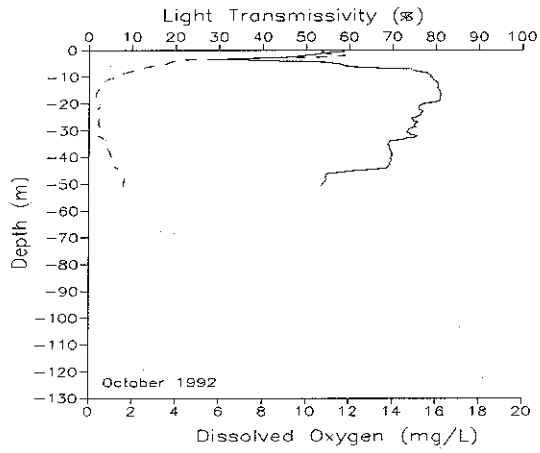


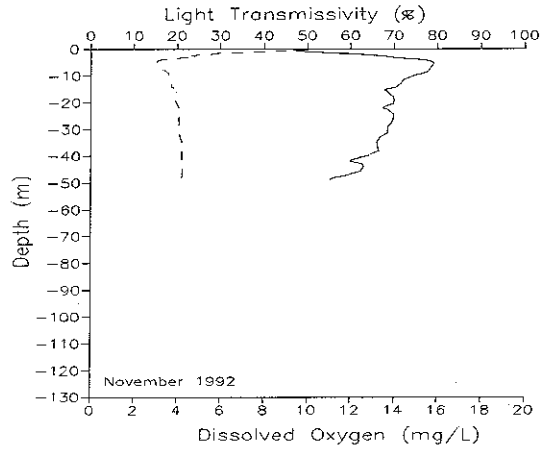
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

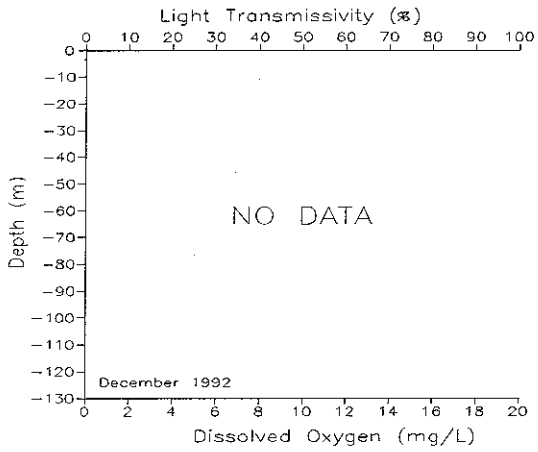
WATERYEAR 1993

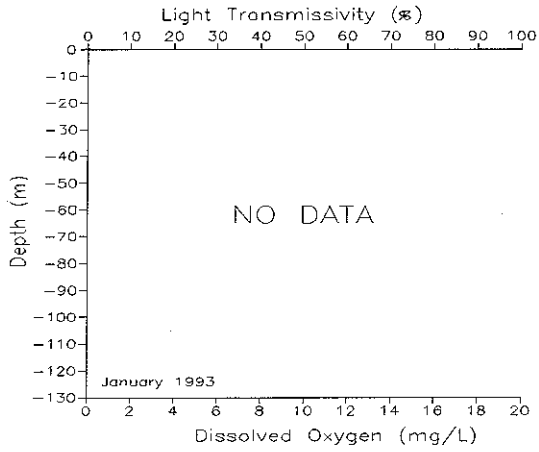
Part 1 of 2

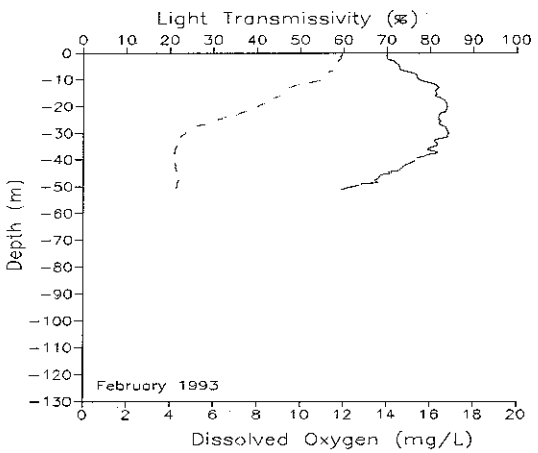
South Hood Canal at Sister's Point (Station HCB004)

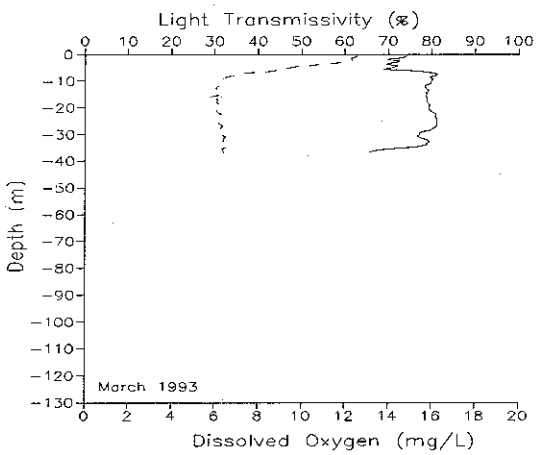










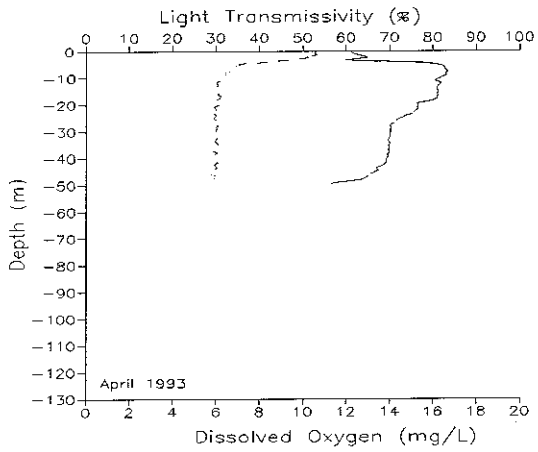


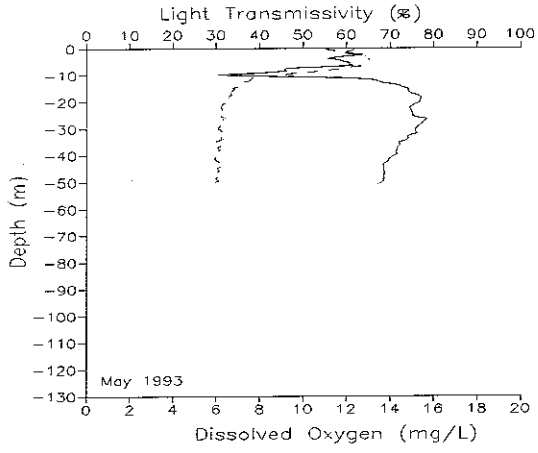
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

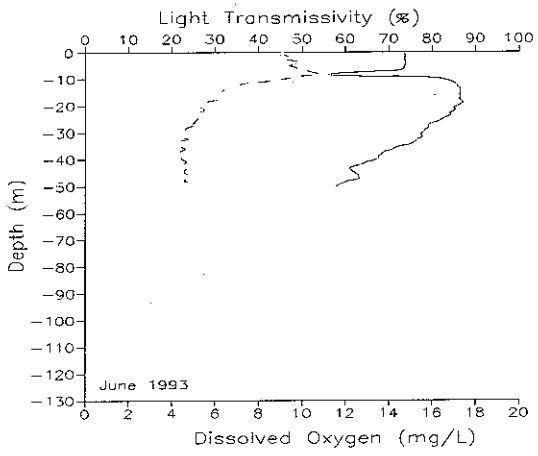
WATERYEAR 1993

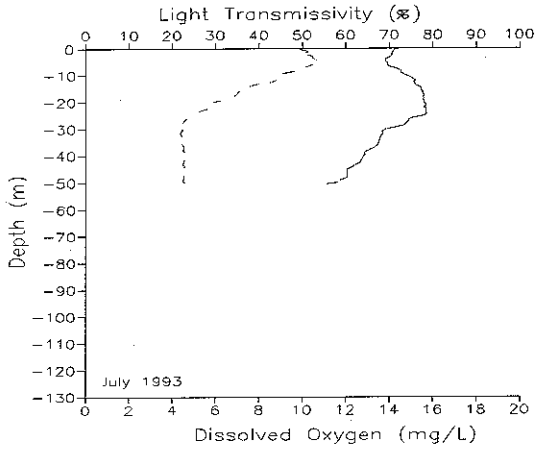
Part 2 of 2

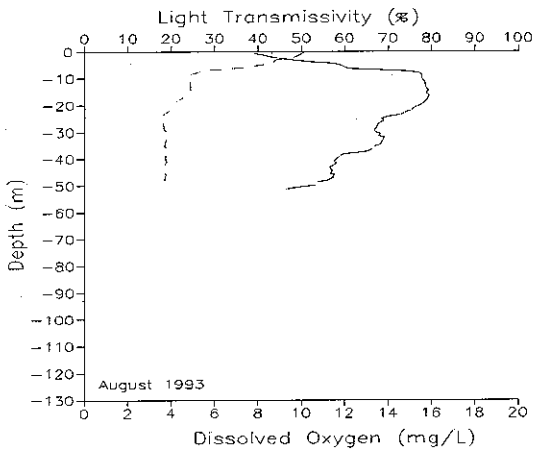
South Hood Canal at Sister's Point (Station HCB004)

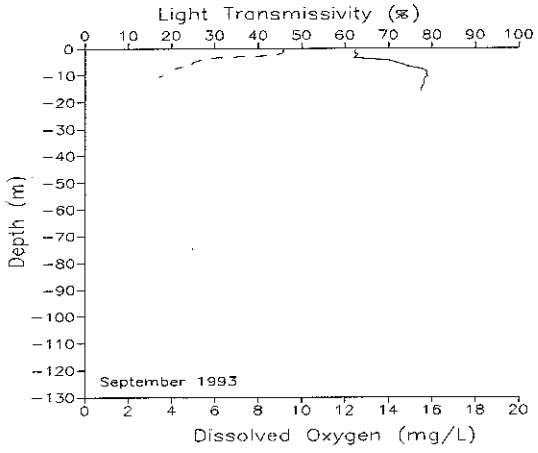










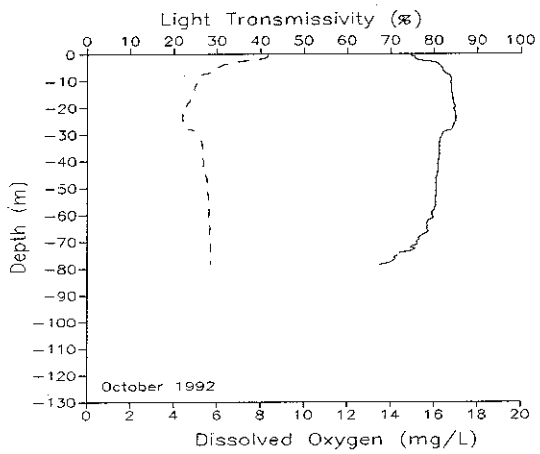


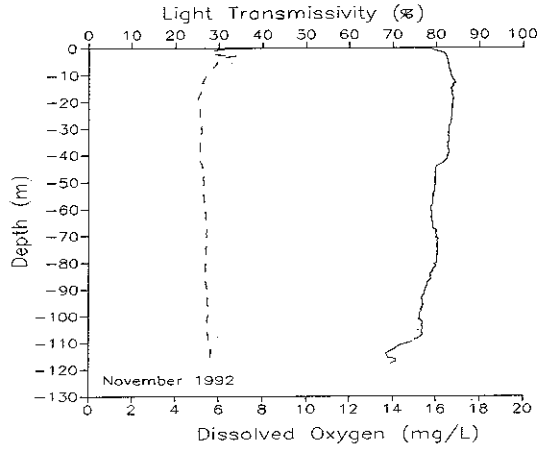
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

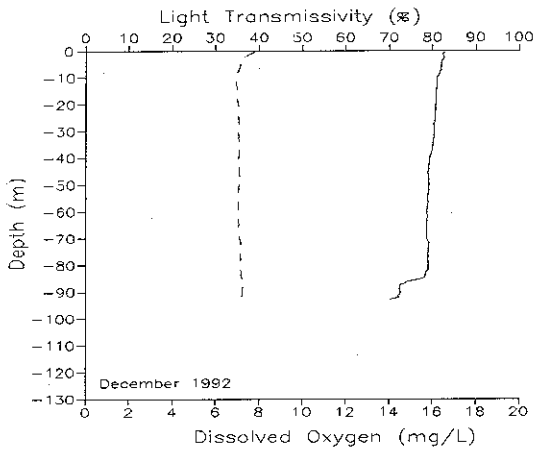
WATERYEAR 1993

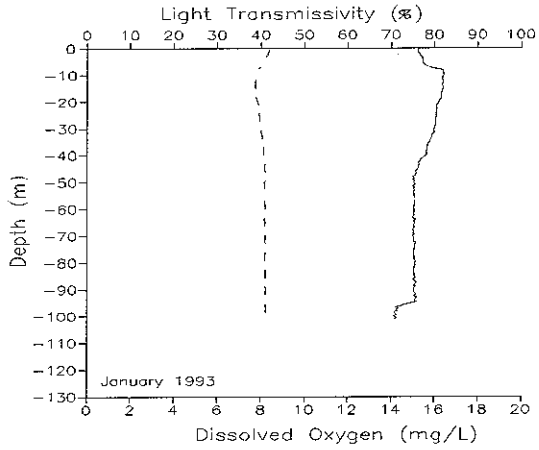
Part 1 of 2

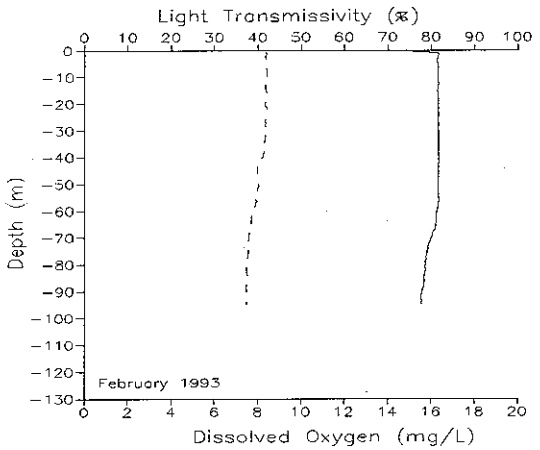
North Hood Canal - Bangor (Station HCB006)

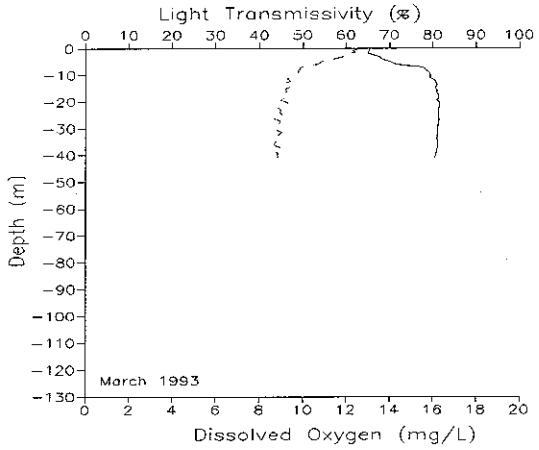










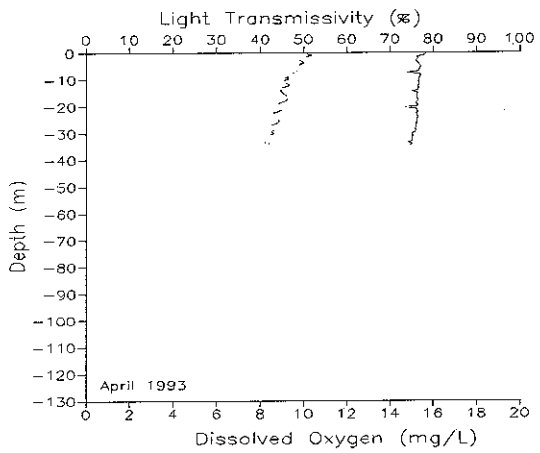


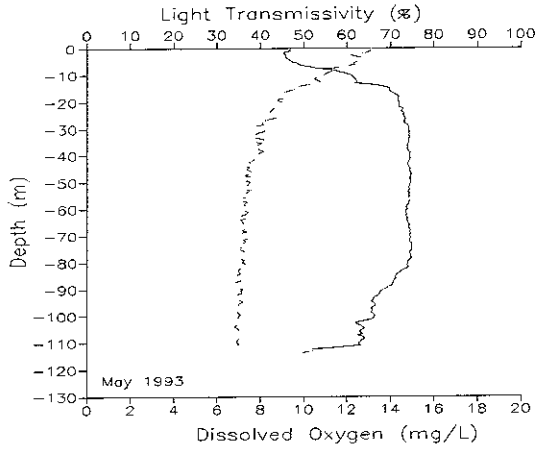
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

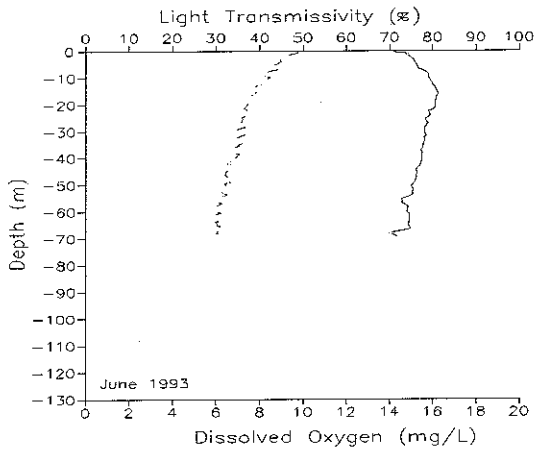
WATERYEAR 1993

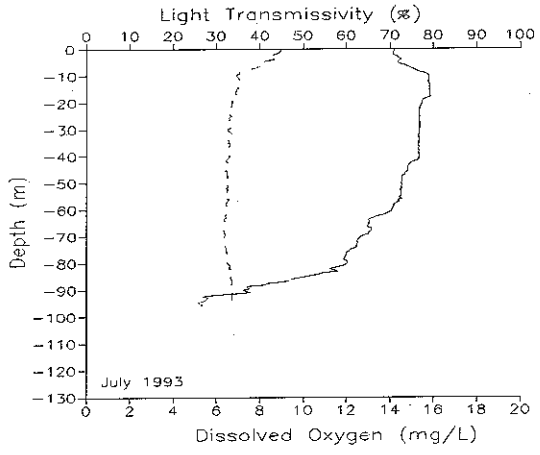
Part 2 of 2

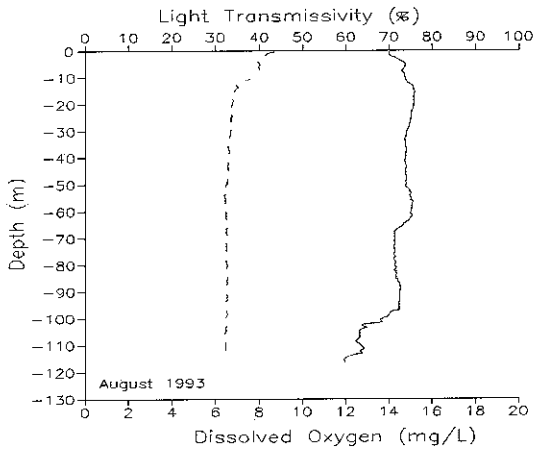
North Hood Canal - Bangor (Station HCB006)

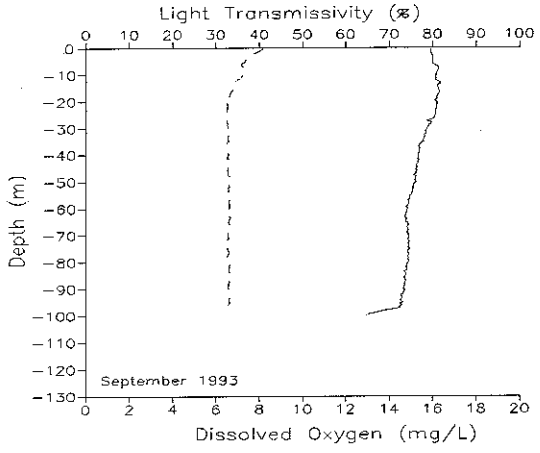








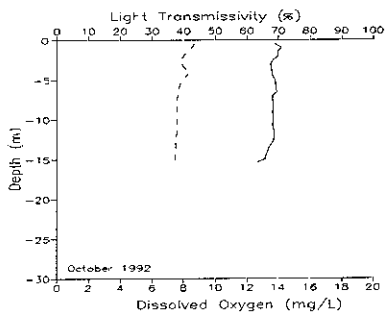


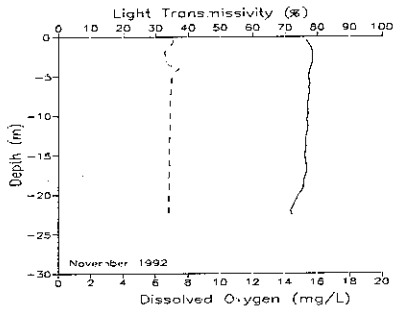


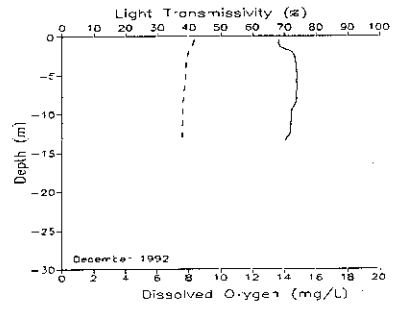
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

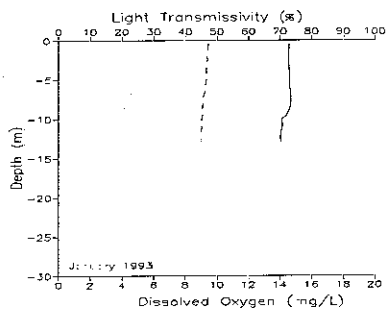
WATERYEAR 1993

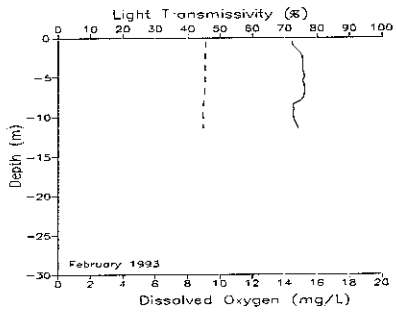
Henderson Inlet (Station HND001)

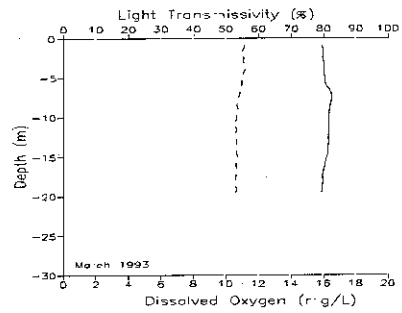


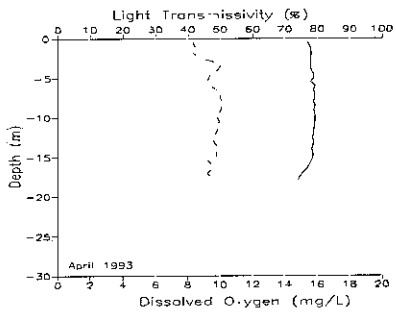


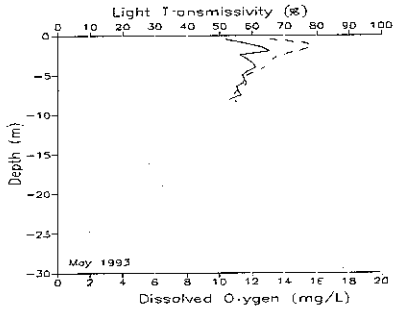


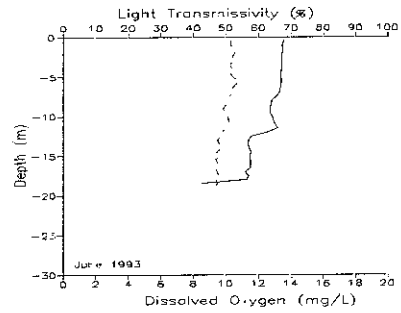


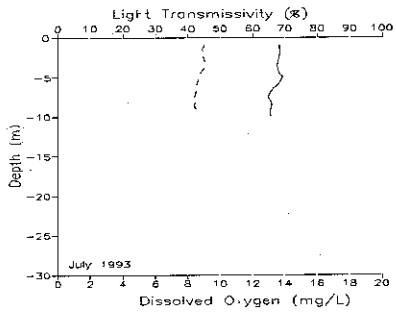


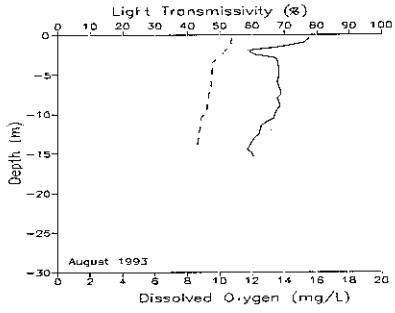


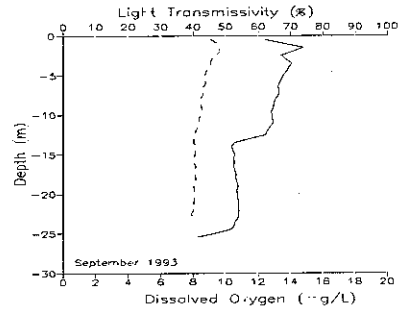








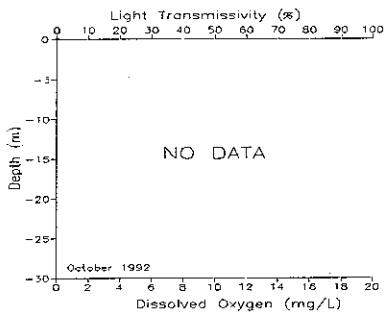


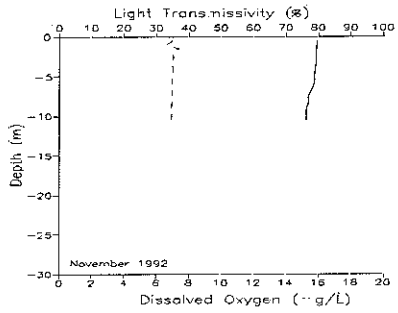


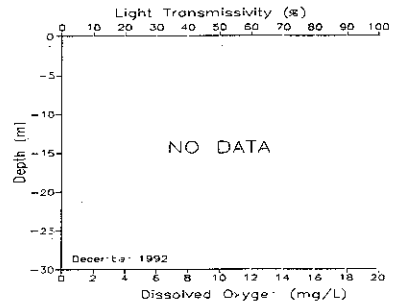
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

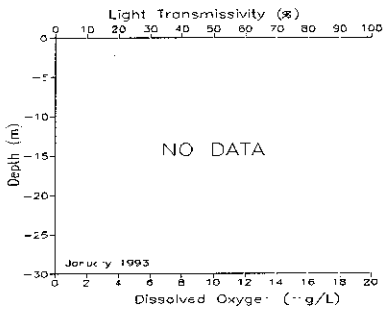
WATERYEAR 1993

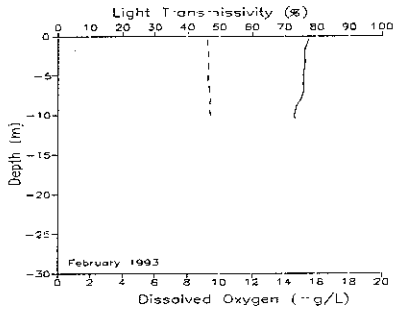
Lopez Sound - Lopez Island (Station LOP001)

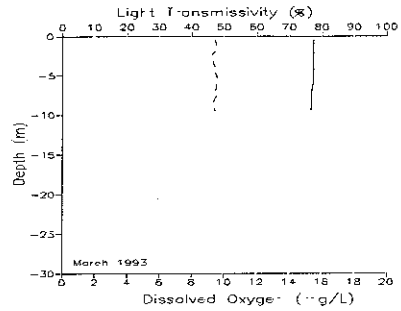


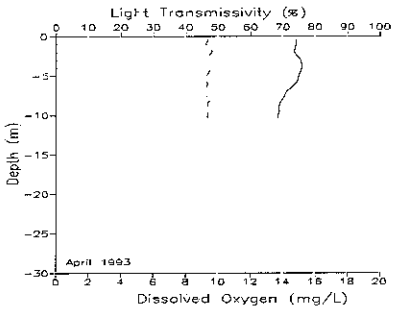


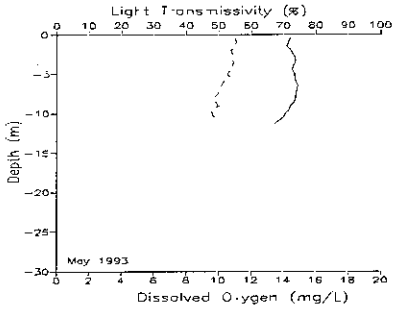


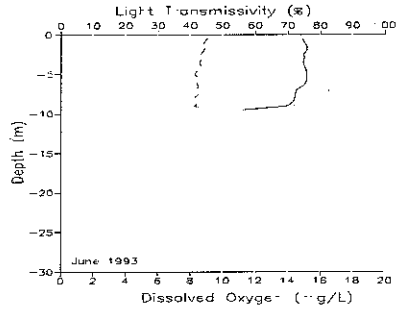


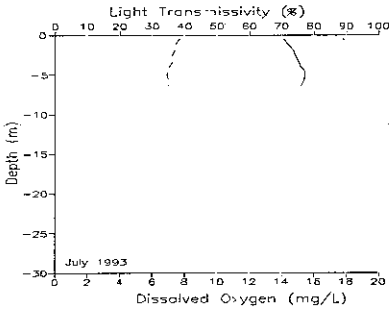


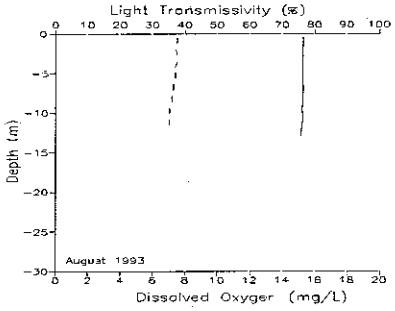


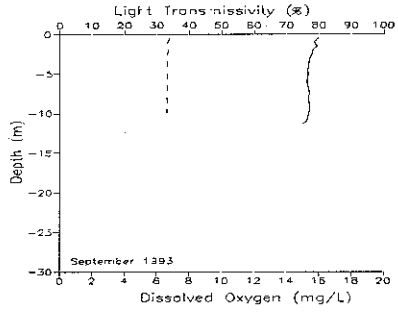








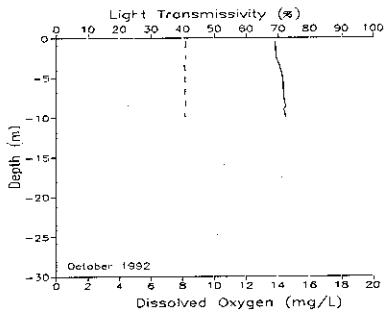


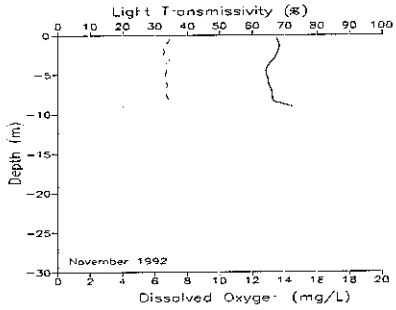


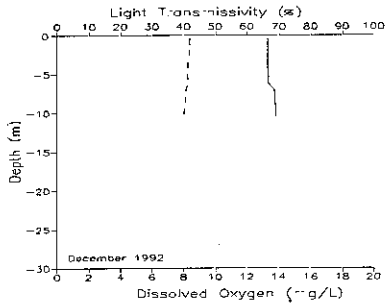
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

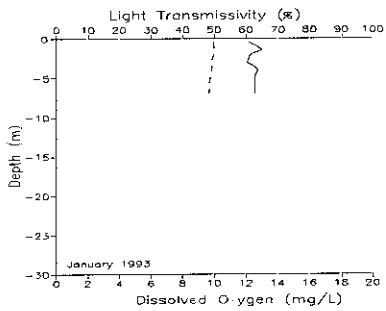
WATERYEAR 1993

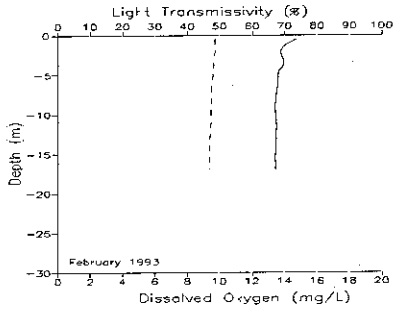
Oakland Bay (Station OAK004)

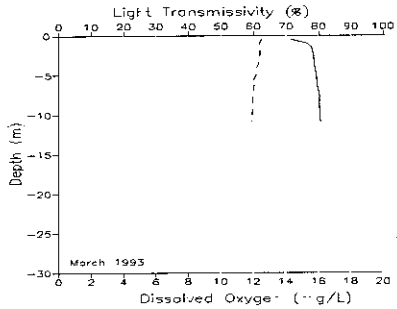


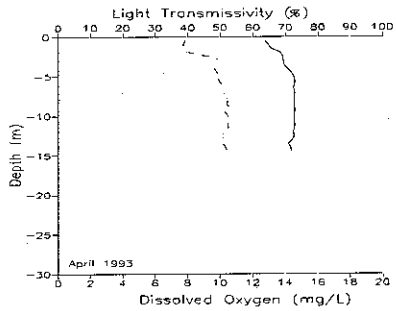


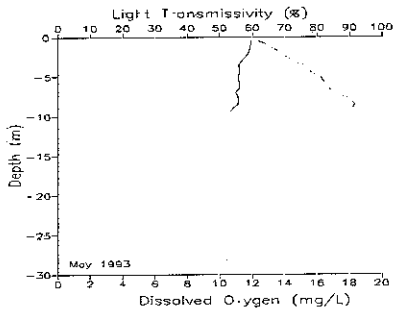


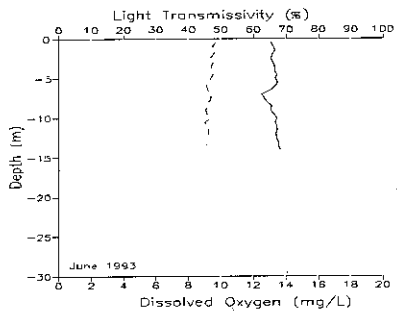


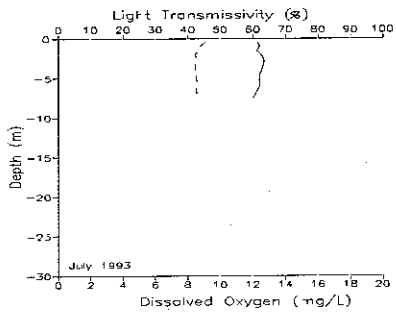


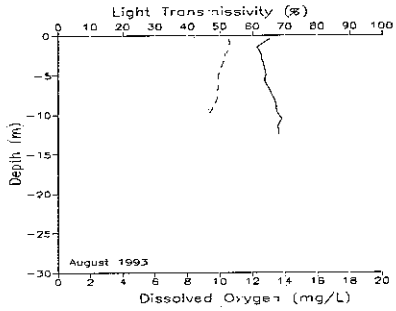


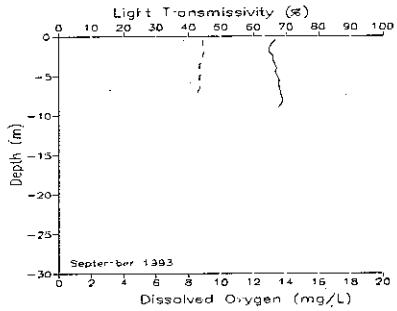










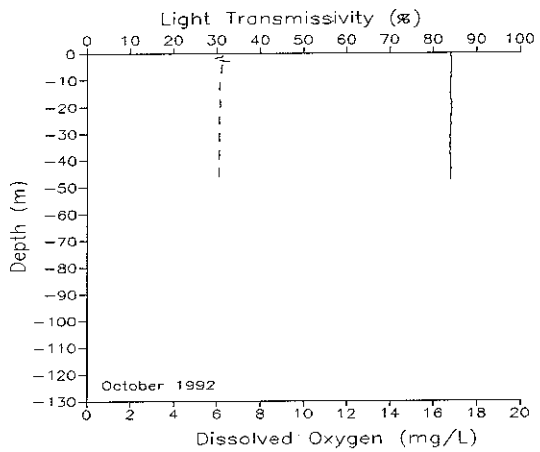


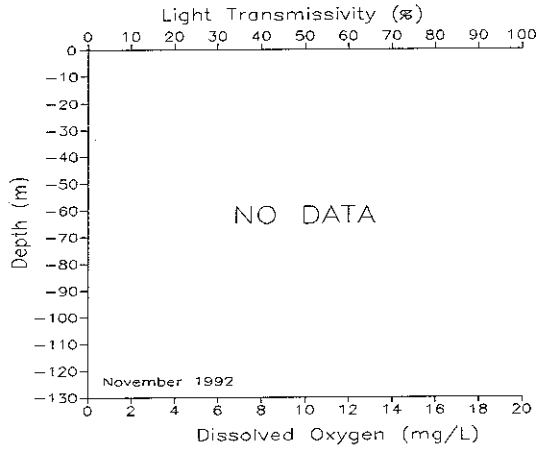
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

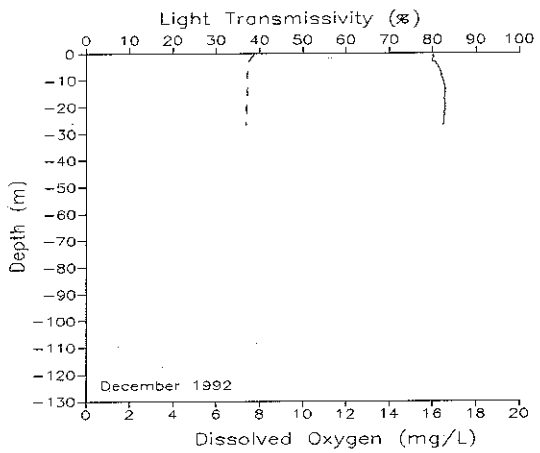
WATERYEAR 1993

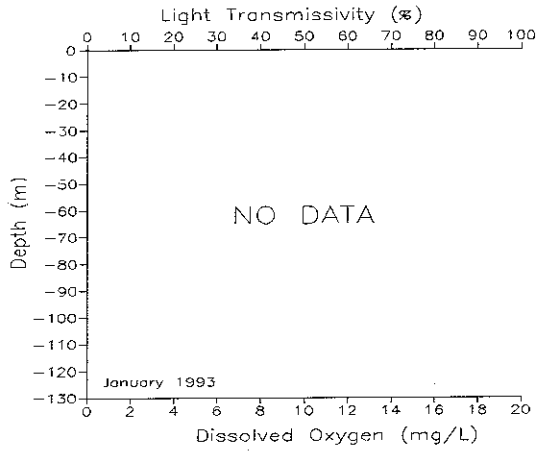
Part 1 of 2

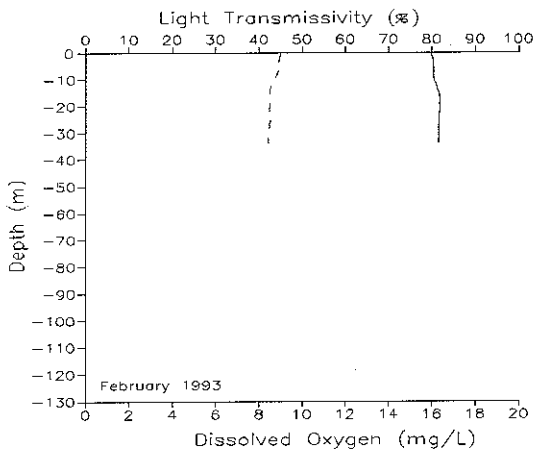
Puget Sound Main Basin - West Point (Station PSB003)

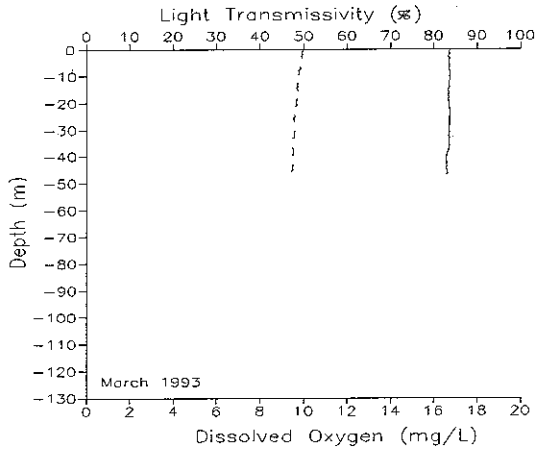










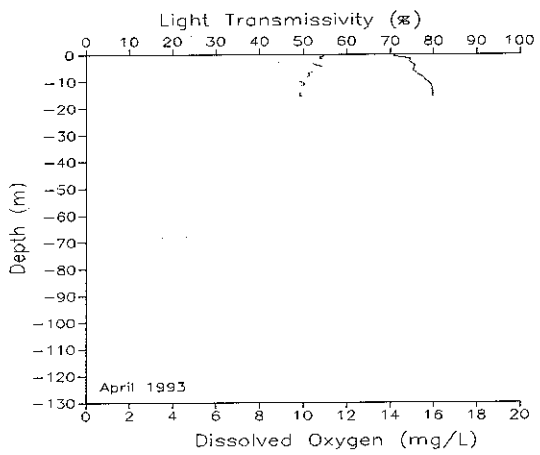


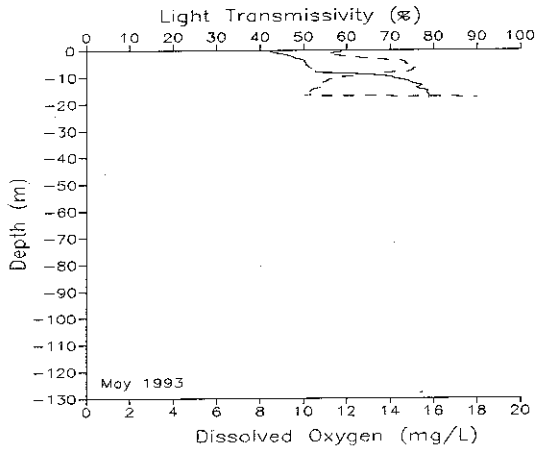
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

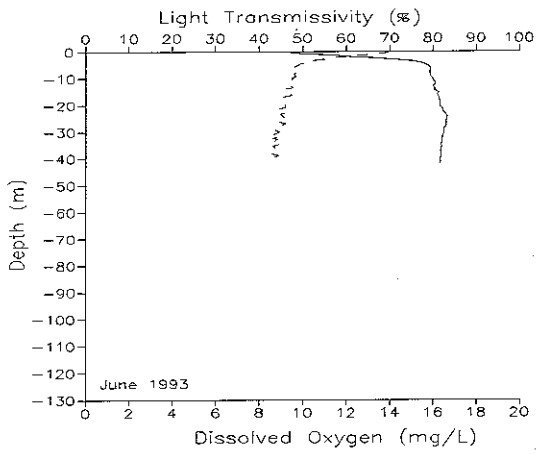
WATERYEAR 1993

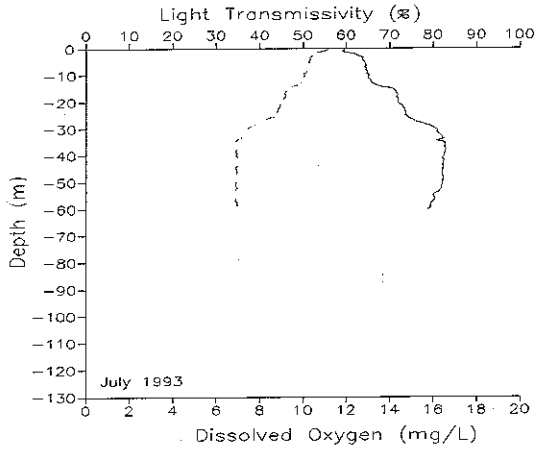
Part 2 of 2

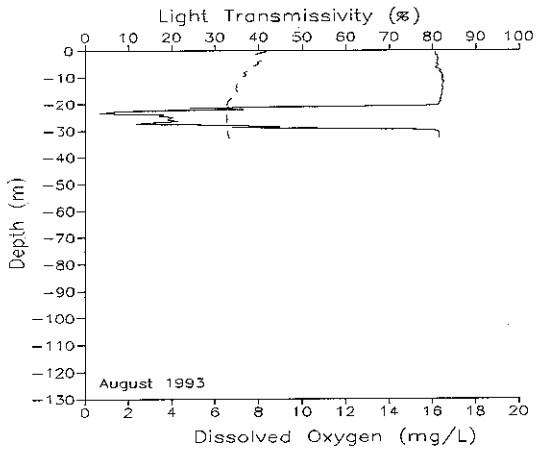
Puget Sound Main Basin - West Point (Station PSB003)

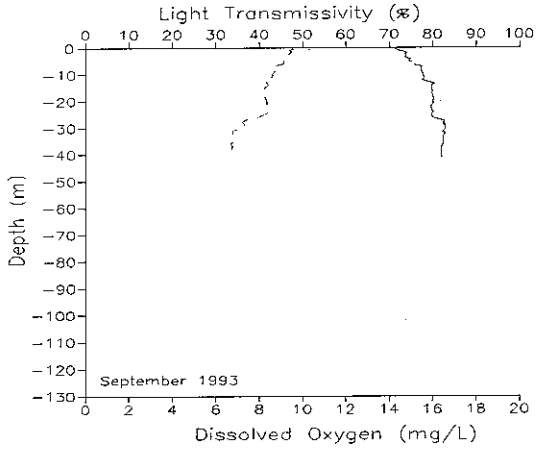










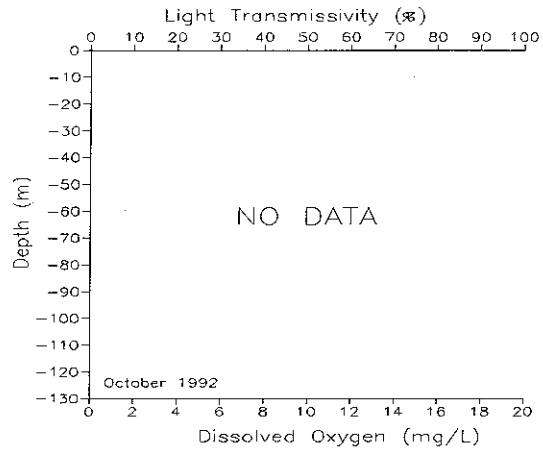


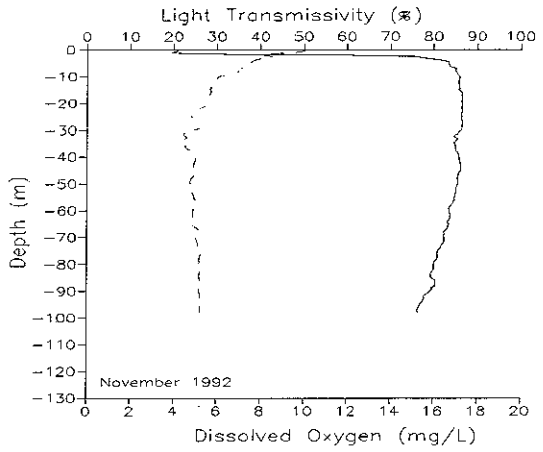
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

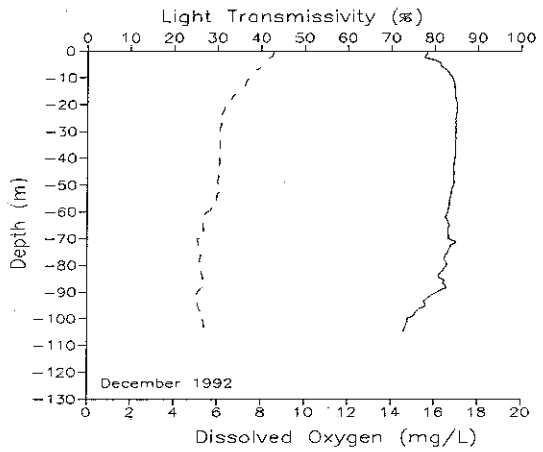
WATERYEAR 1993

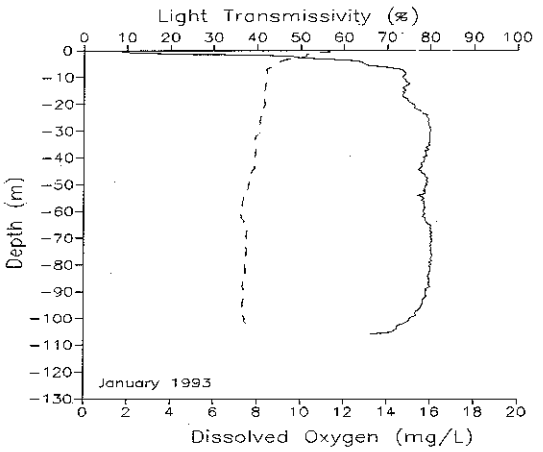
Part 1 of 2

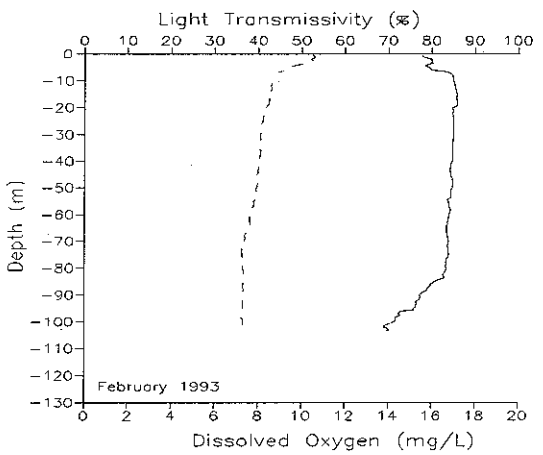
Possession Sound - Gedney Island (Station PSS019)

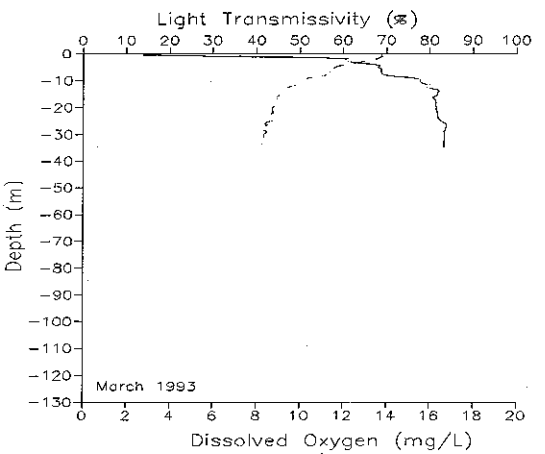










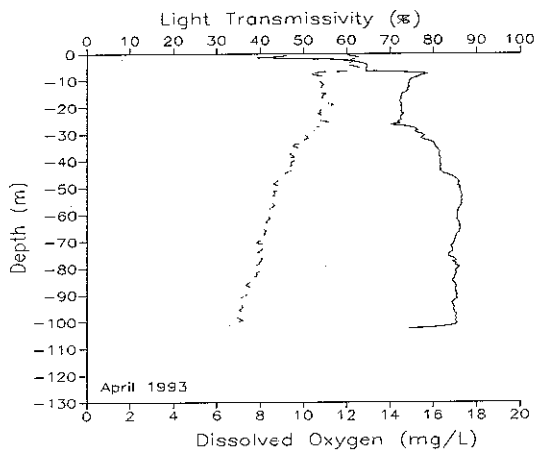


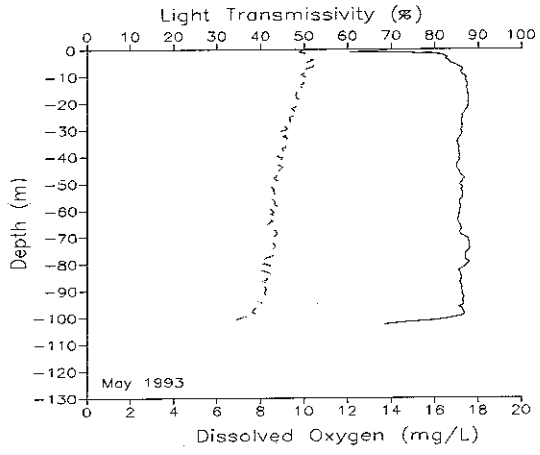
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

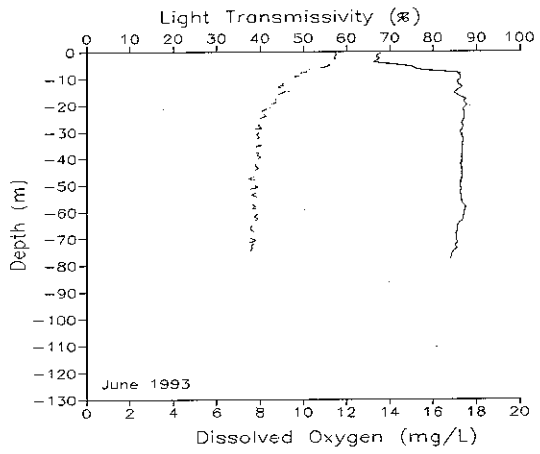
WATERYEAR 1993

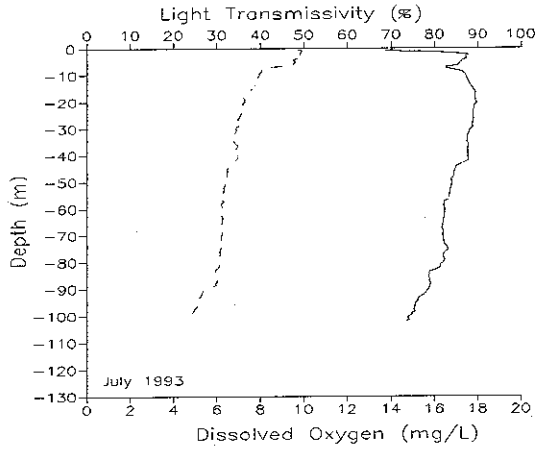
Part 2 of 2

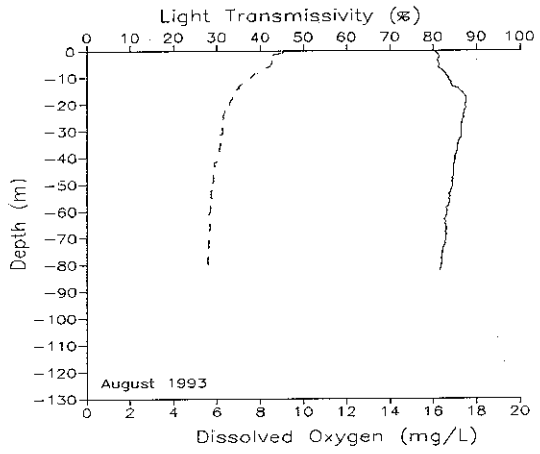
Possession Sound - Gedney Island (Station PSS019)

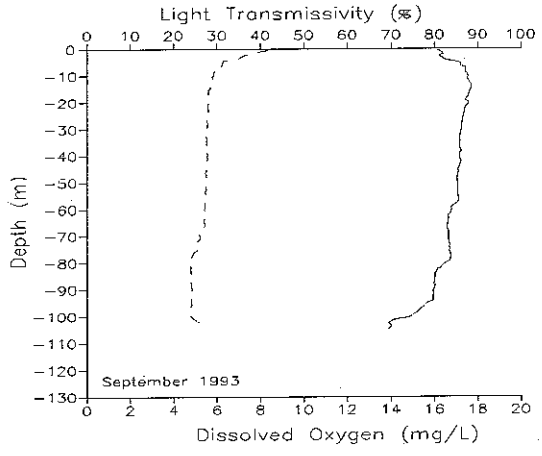








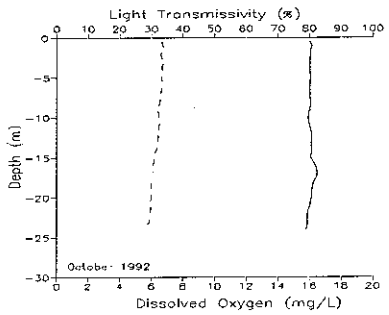


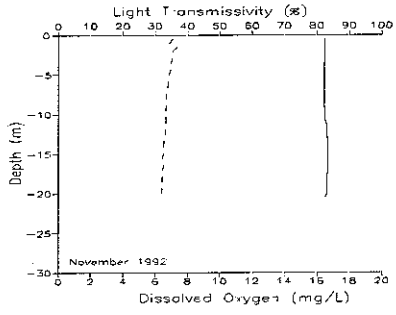


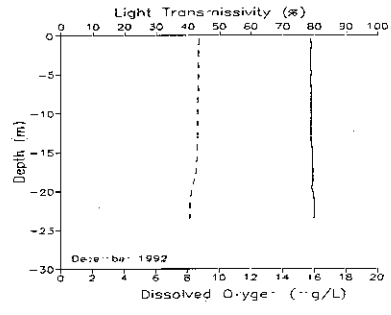
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

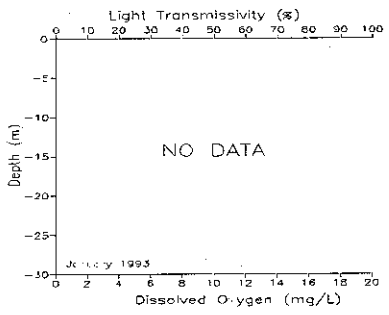
WATERYEAR 1993

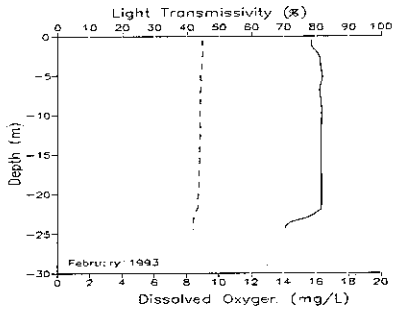
Port Townsend Harbor - Walan Pt. (Station PTH005)

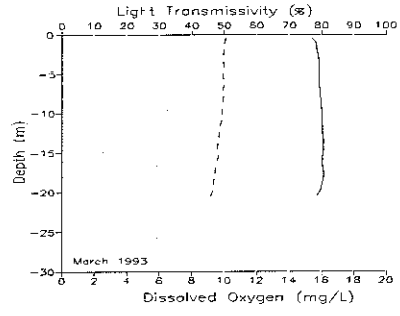


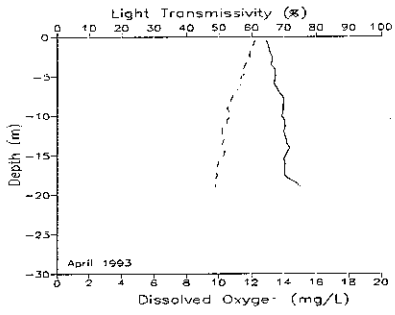


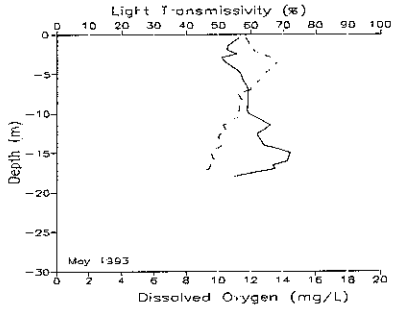


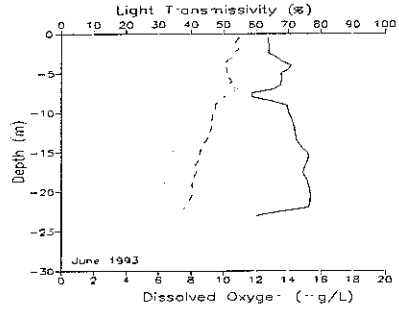


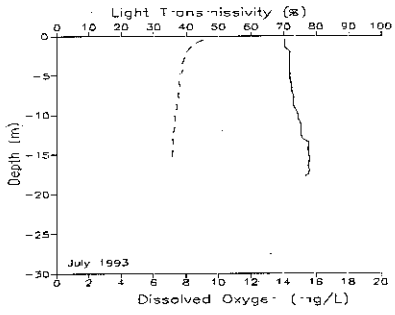


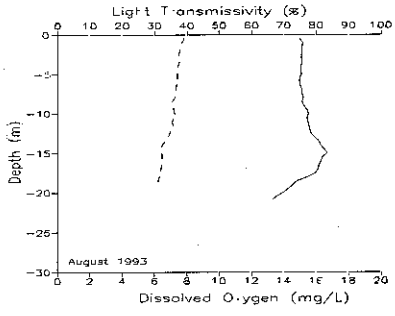


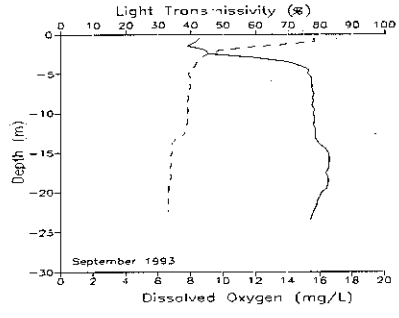










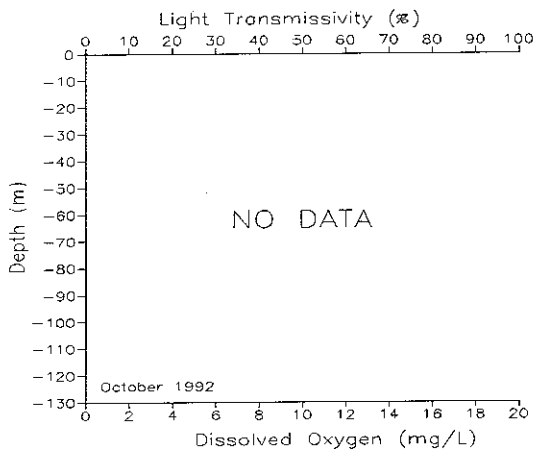


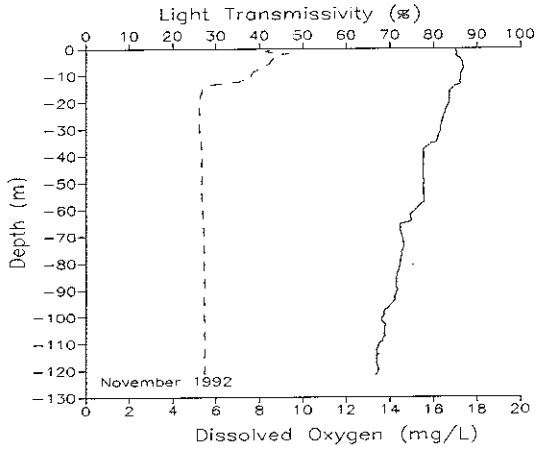
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

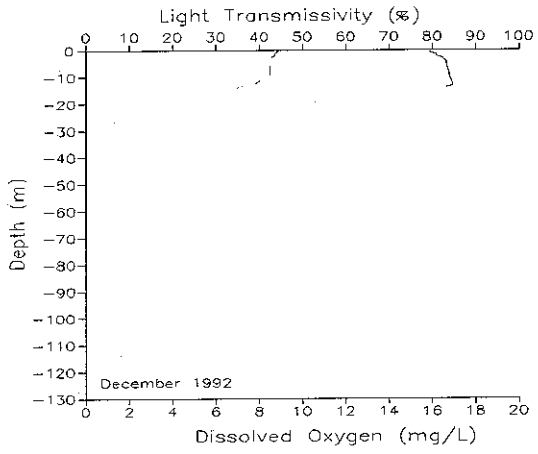
WATERYEAR 1993

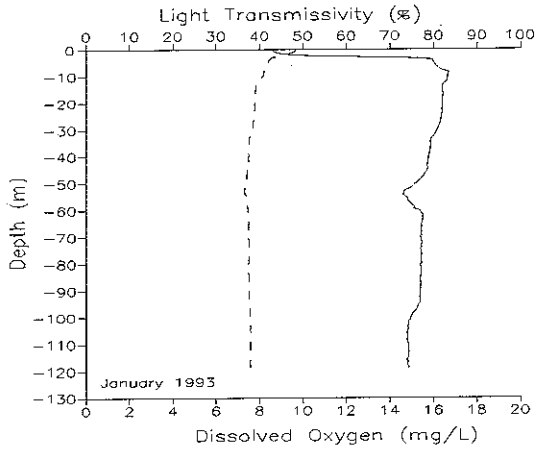
Part 1 of 2

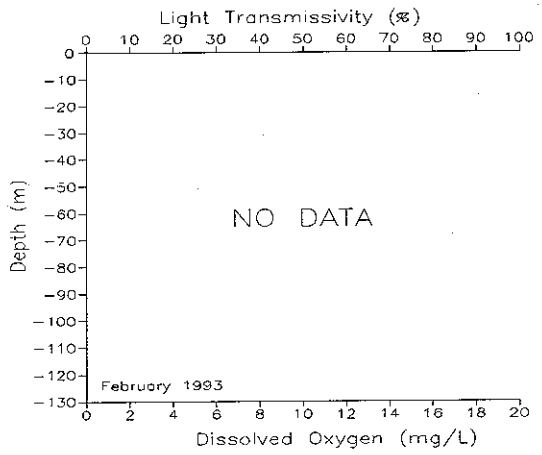
Saratoga Passage - East Point (Station SAR003)

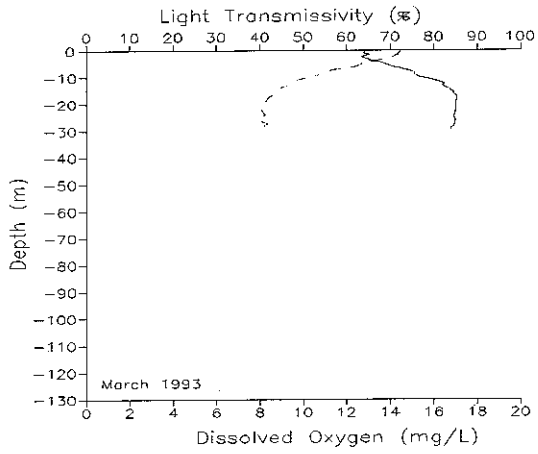










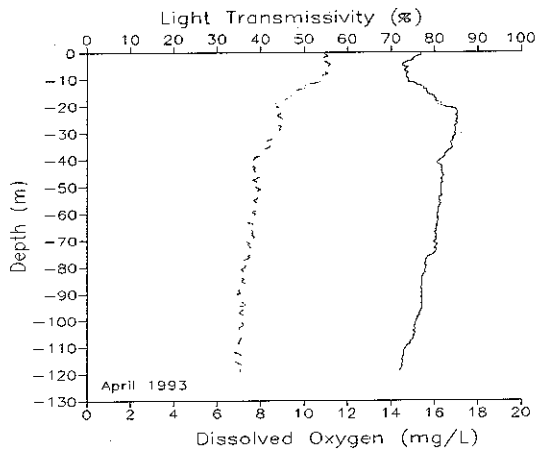


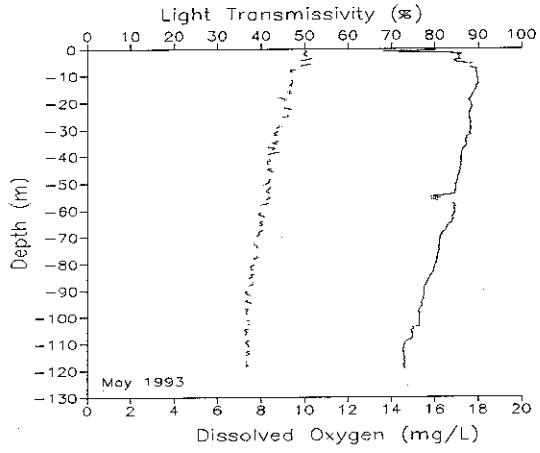
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

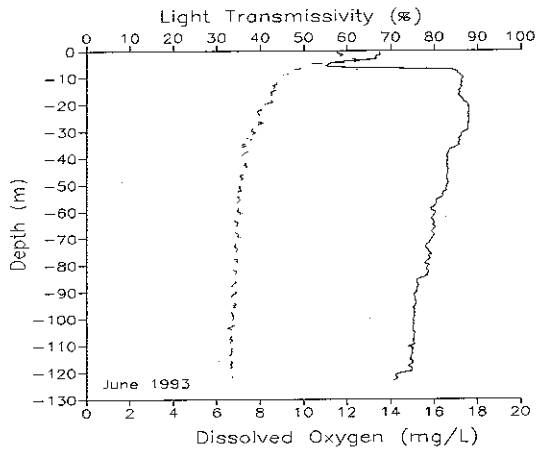
WATERYEAR 1993

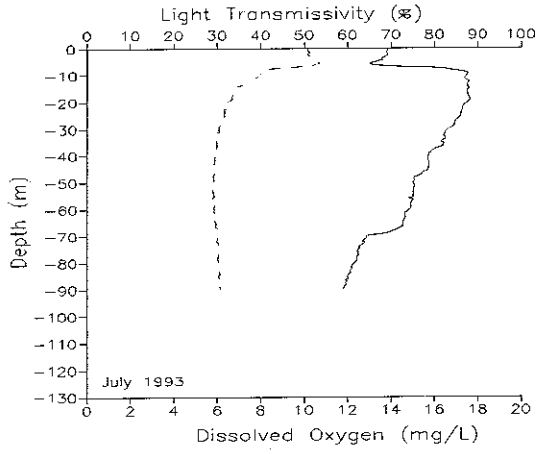
Part 2 of 2

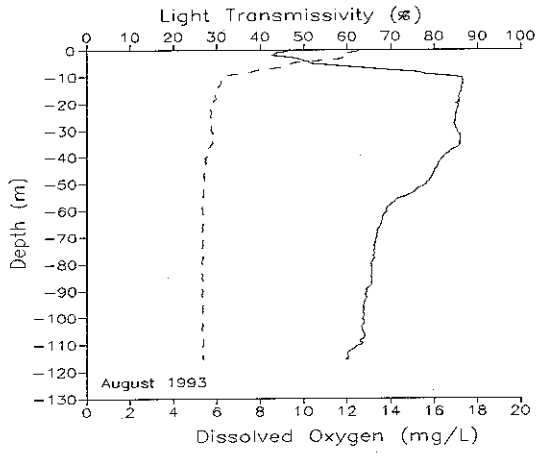
Saratoga Passage - East Point (Station SAR003)

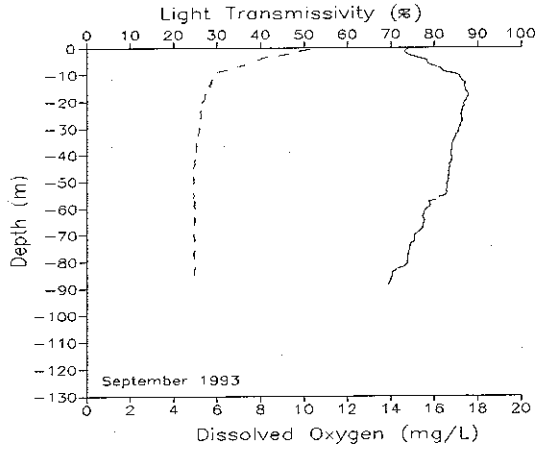








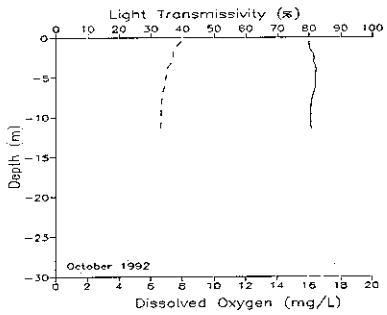


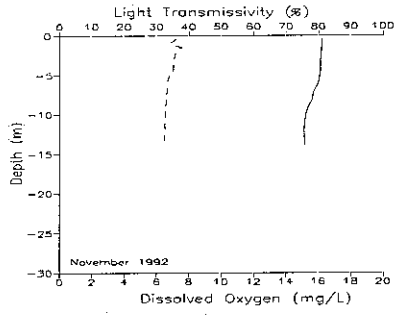


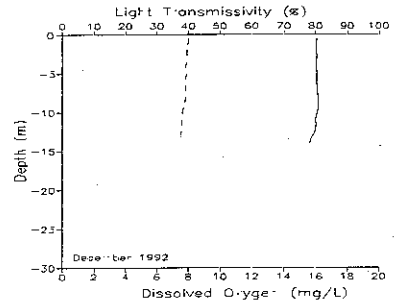
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

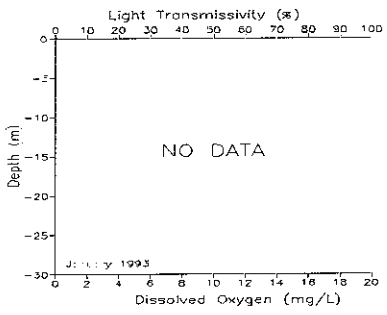
WATERYEAR 1993

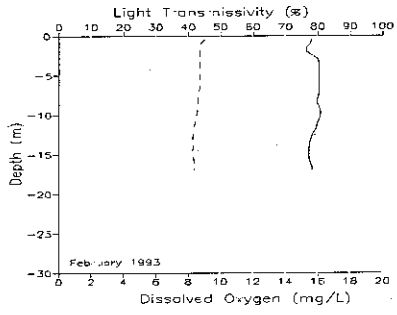
Sinclair Inlet (Station SIN001)

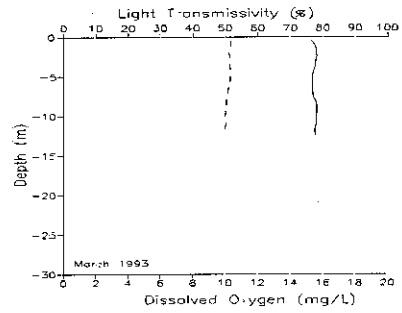


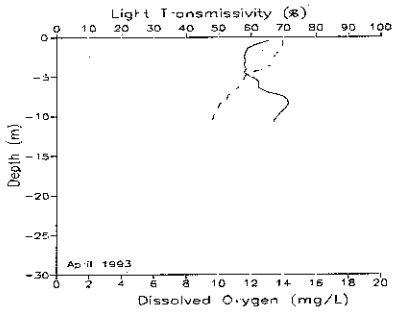


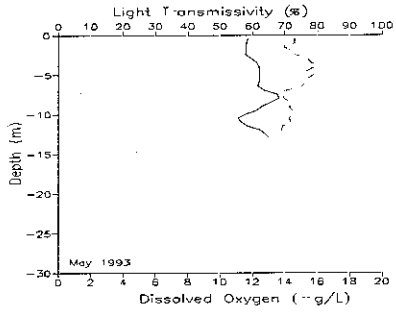


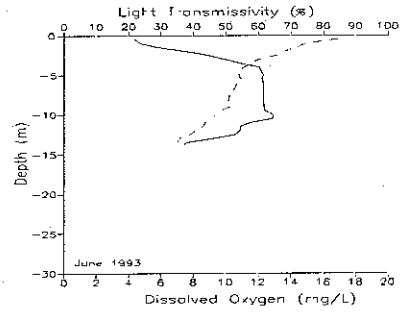


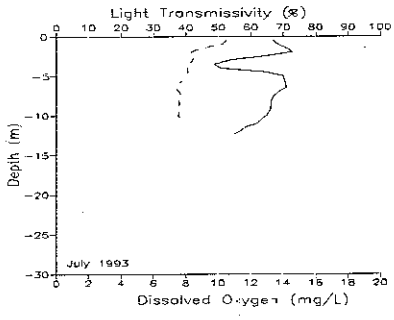


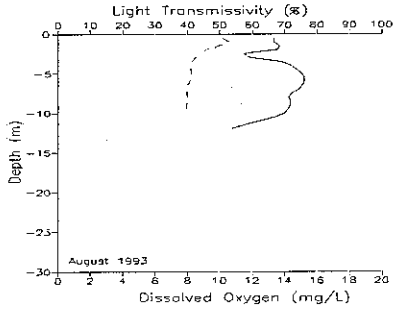


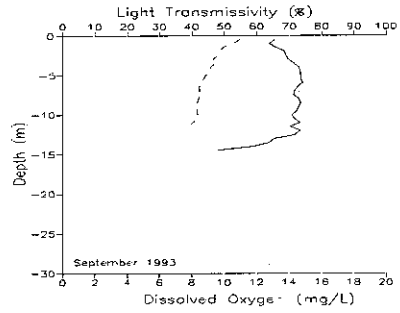








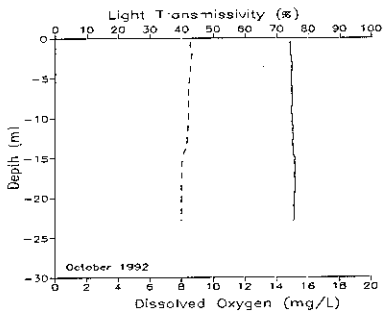


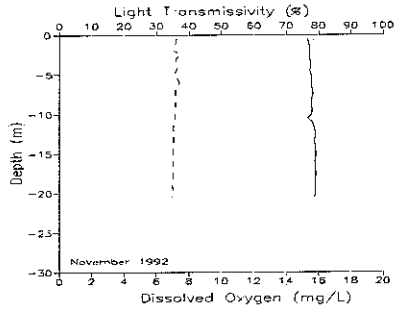


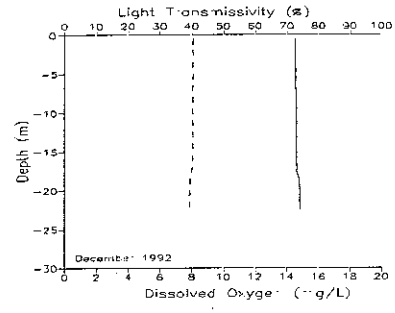
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

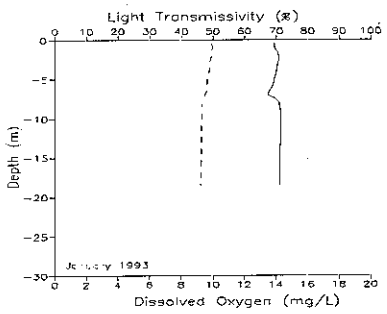
WATERYEAR 1993

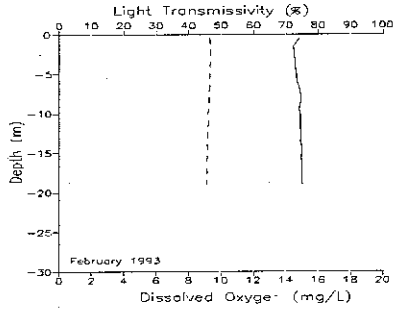
Totten Inlet (Station TOT001)

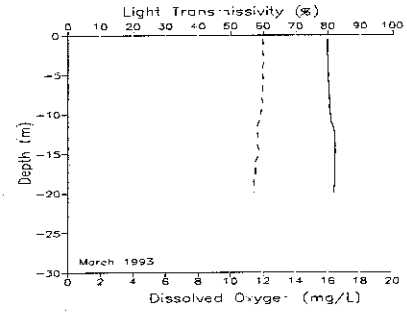


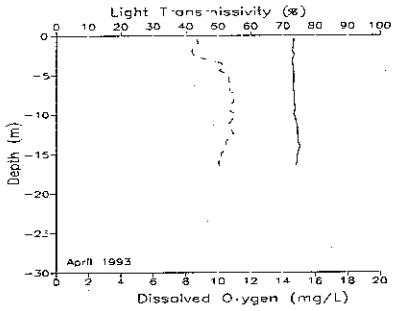


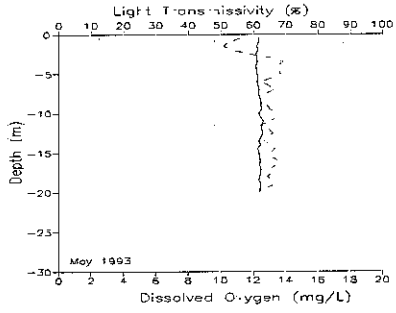


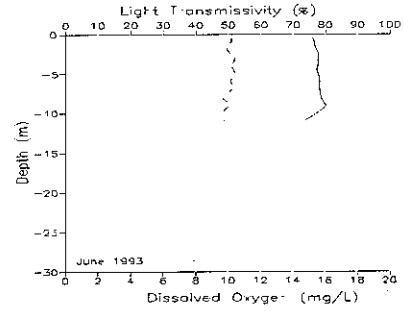


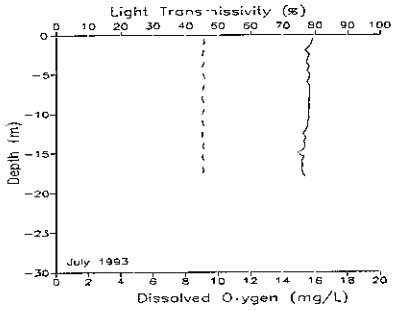


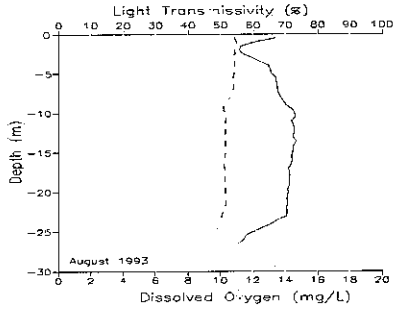


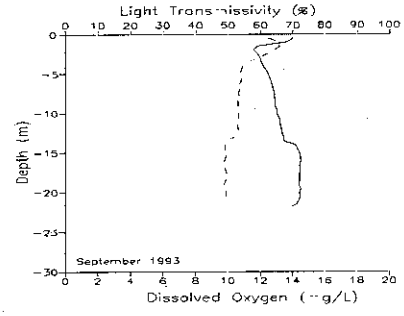










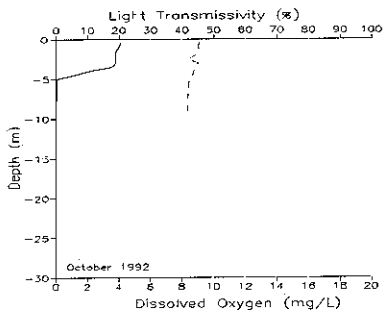


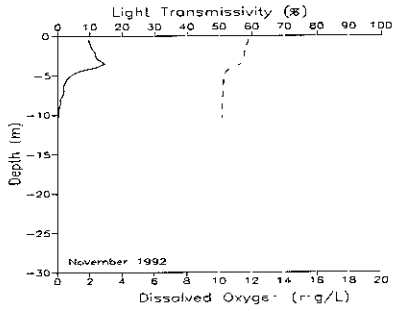
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

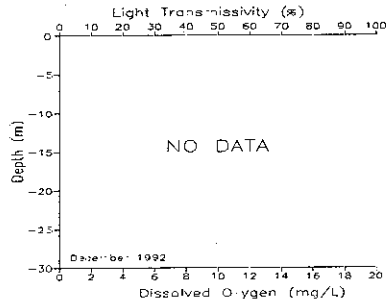
GRAYS HARBOR AND WILLAPA BAY STATIONS

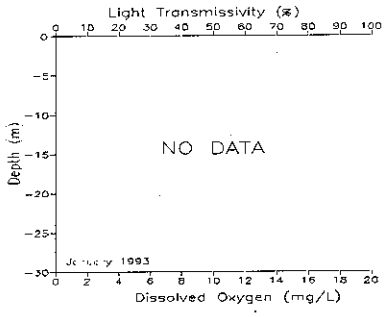
WATERYEAR 1993

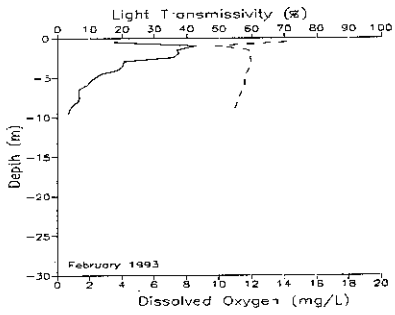
Gray's Harbor - Chehalis (Station GYS004)

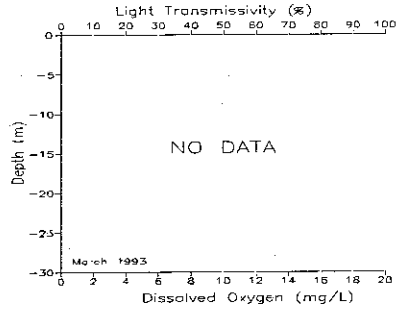


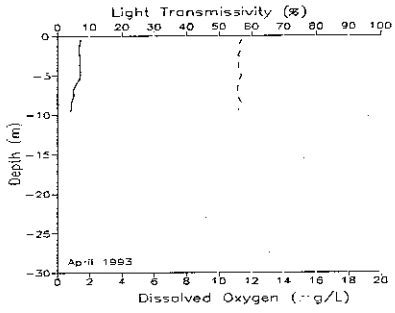


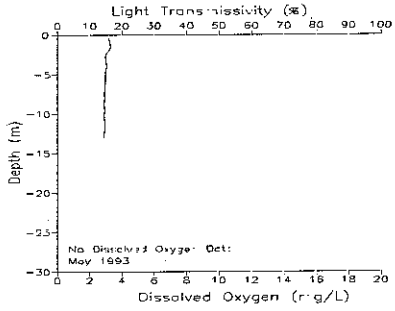


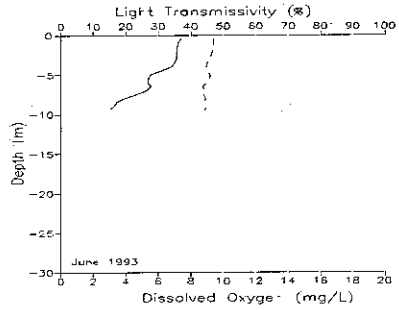


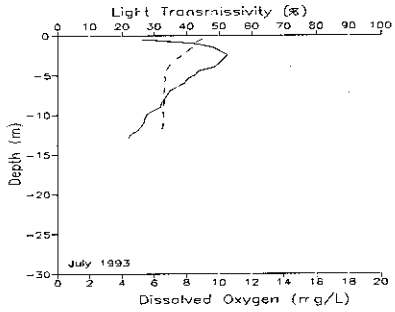


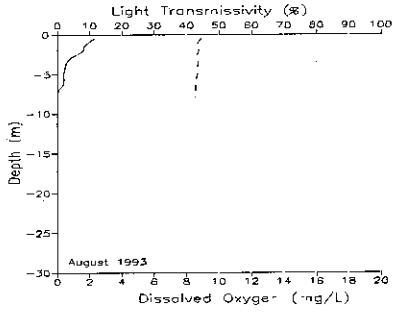


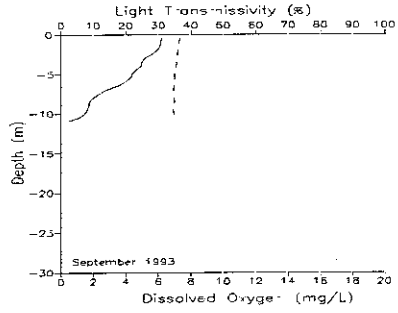








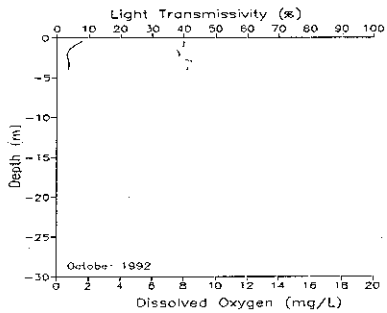


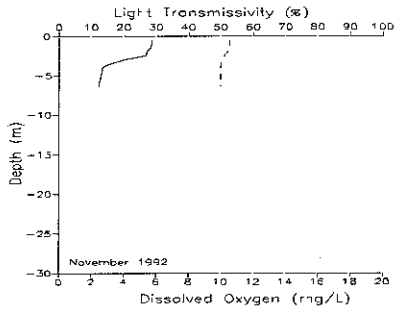


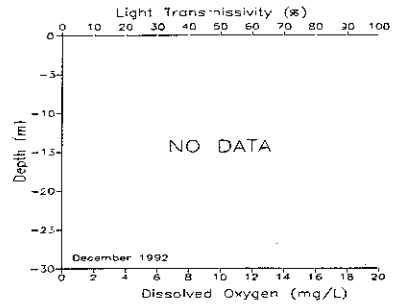
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

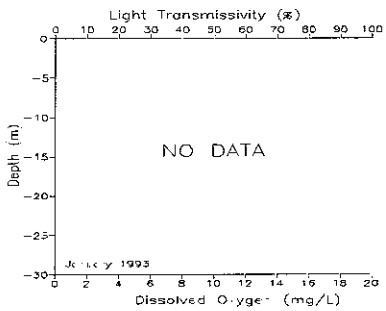
WATERYEAR 1993

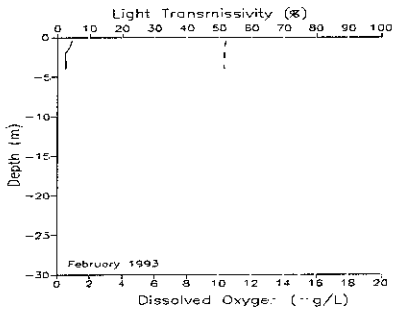
Gray's Harbor - South Channel (Station GYS008)

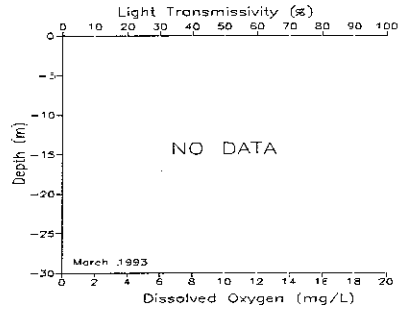


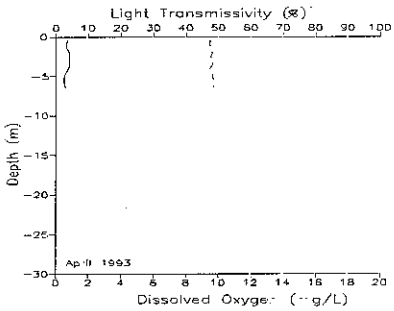


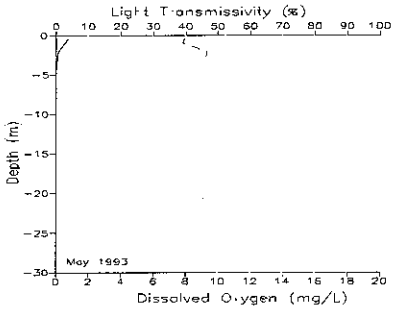


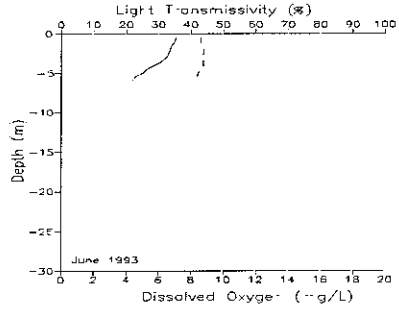


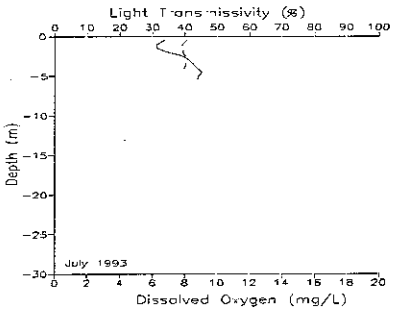


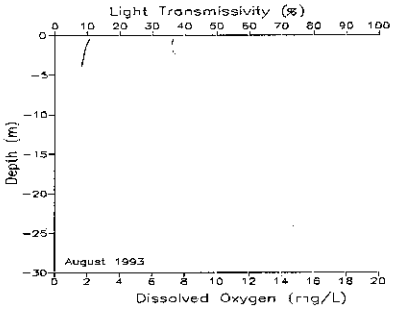


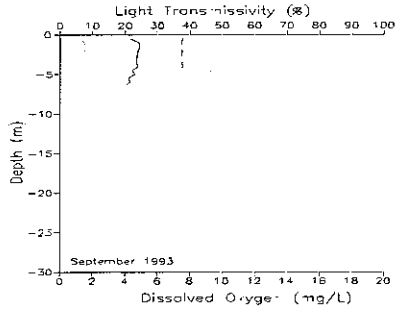








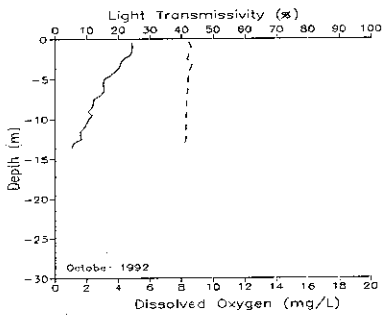


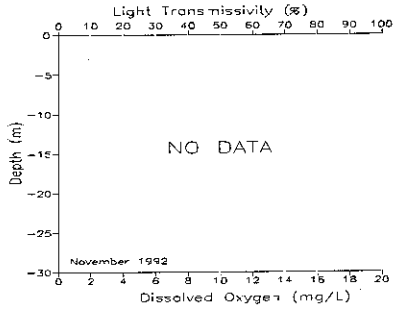


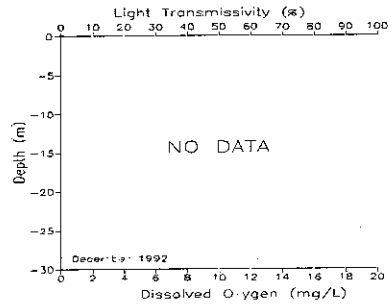
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

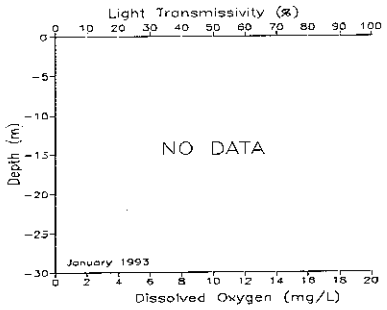
WATERYEAR 1993

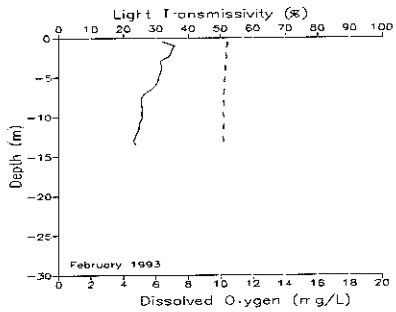
Gray's Harbor - North Channel (Station GYS009)

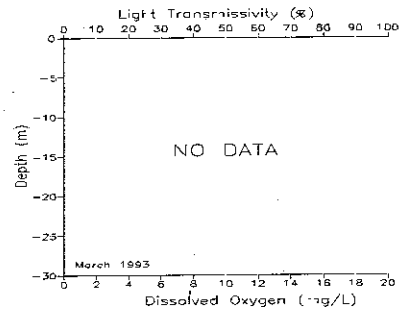


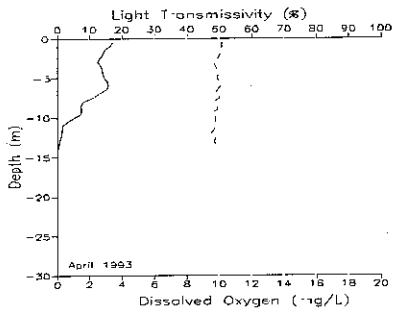


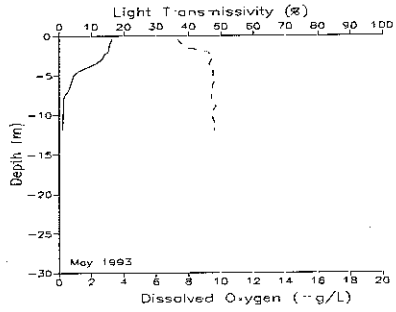


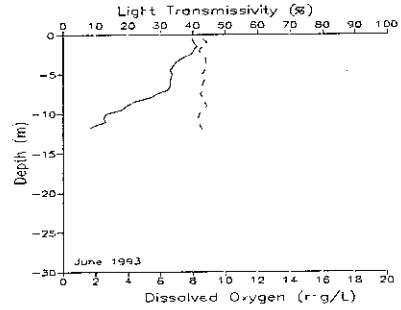


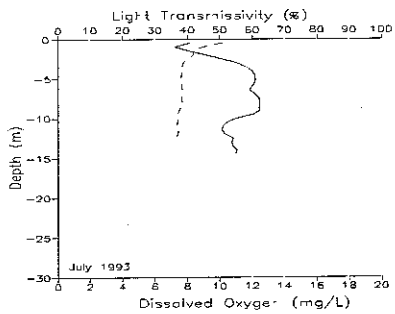


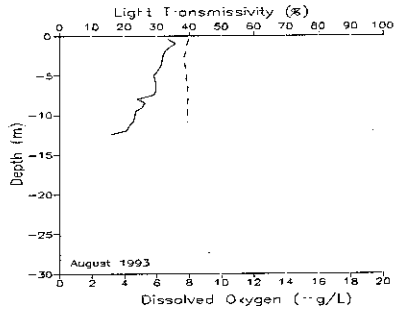


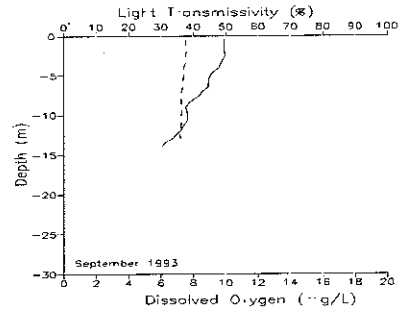








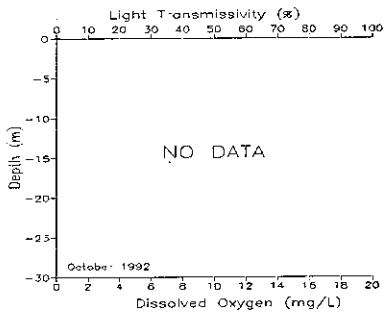


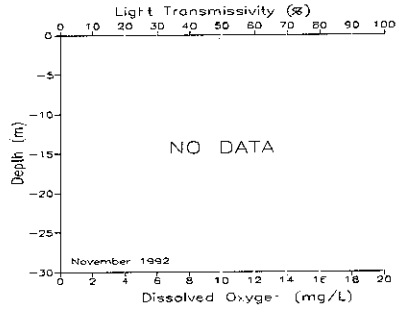


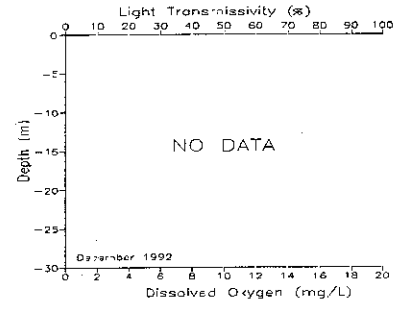
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

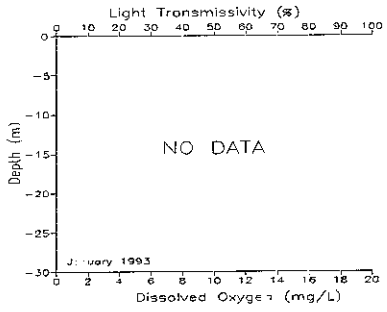
WATERYEAR 1993

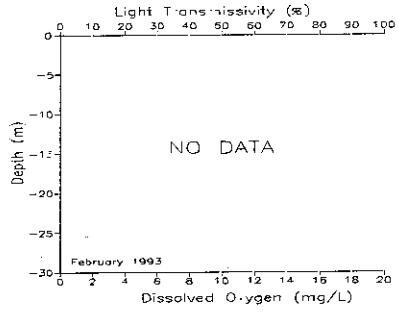
Gray's Harbor - N. Whitcomb Flats (Station GYS015)

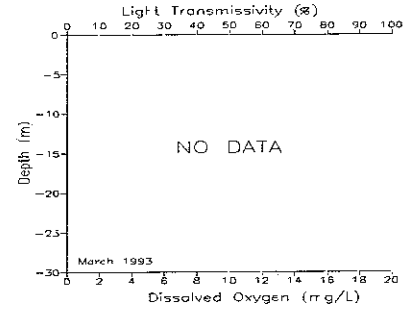


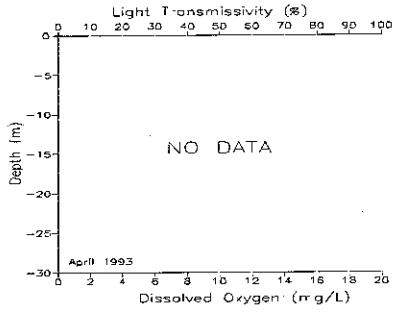


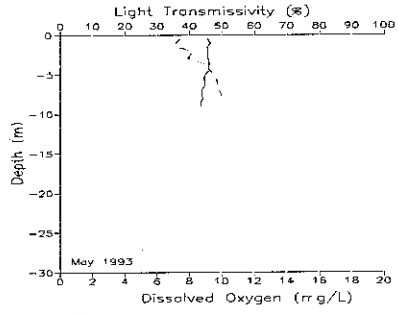


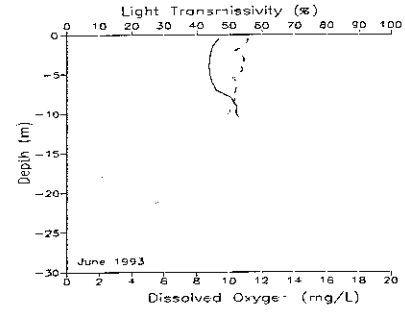


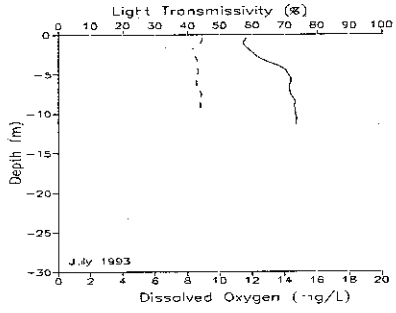


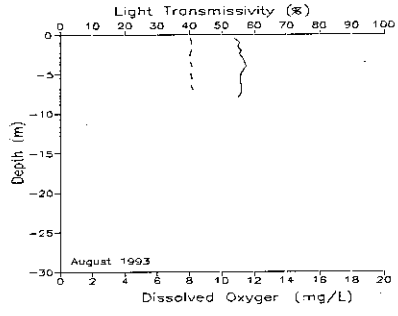


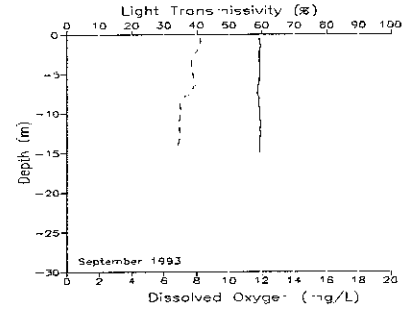








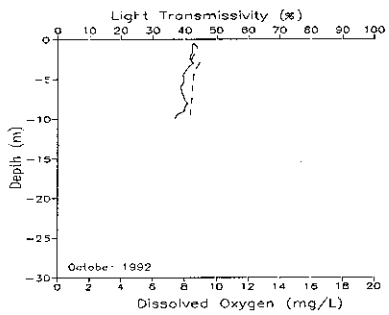


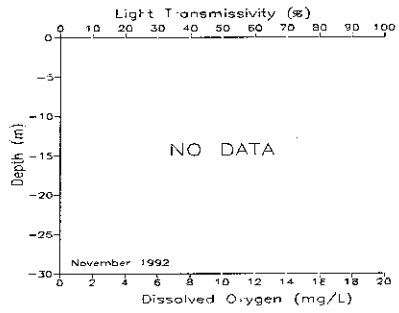


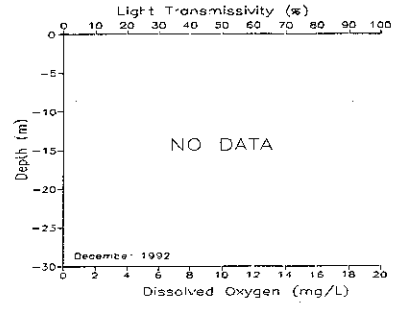
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

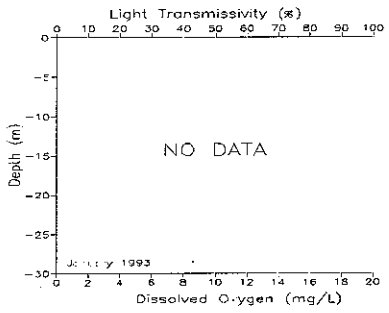
WATERYEAR 1993

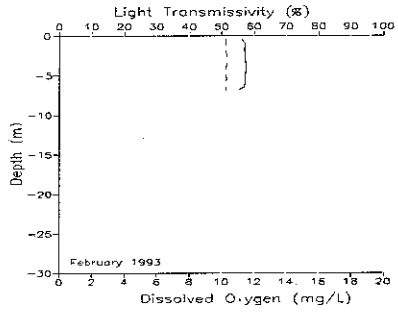
Gray's Harbor - Damon Point (Station GYS016)

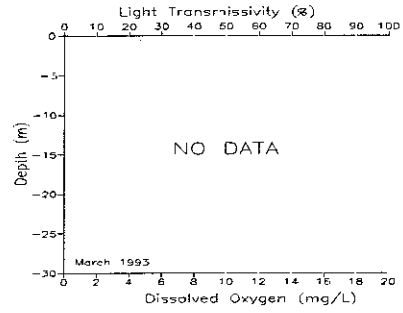


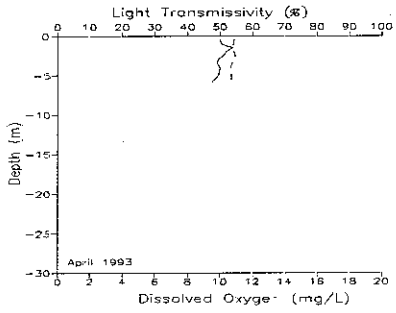


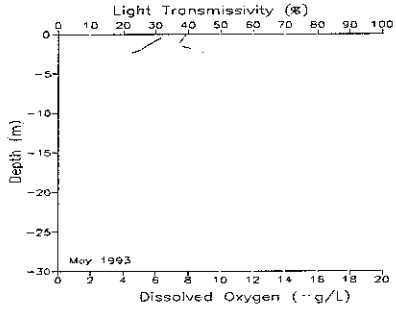


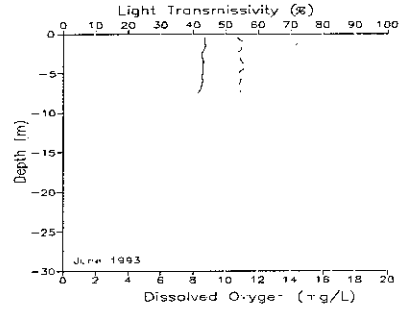


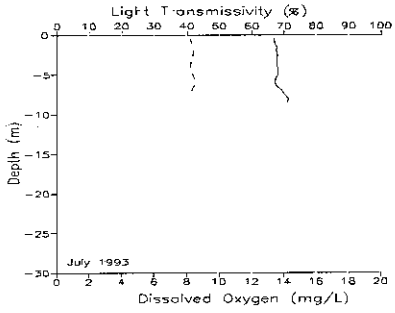


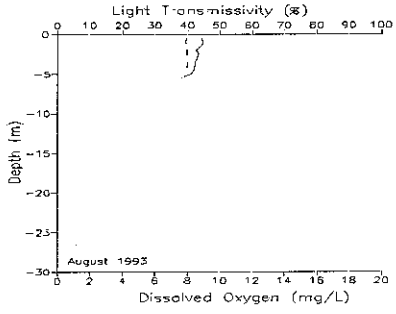


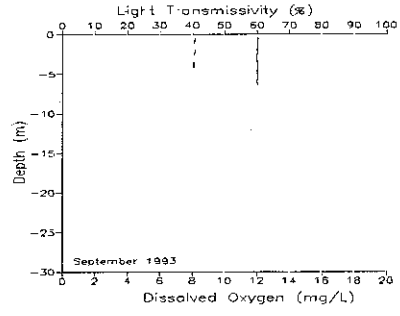








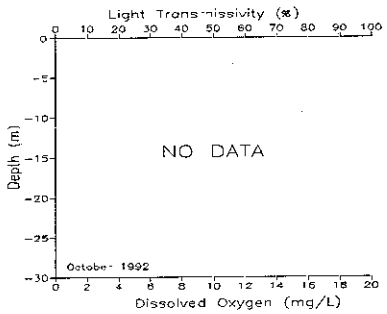


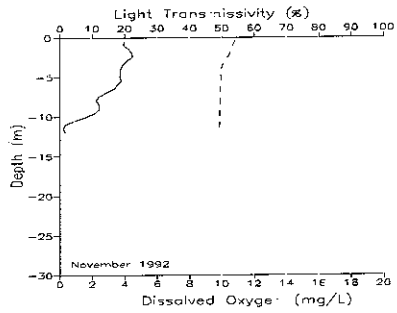


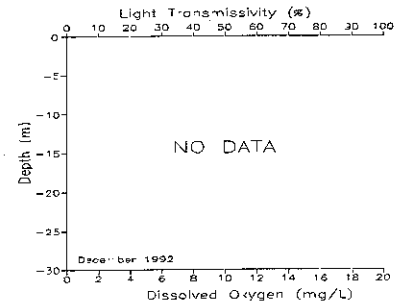
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

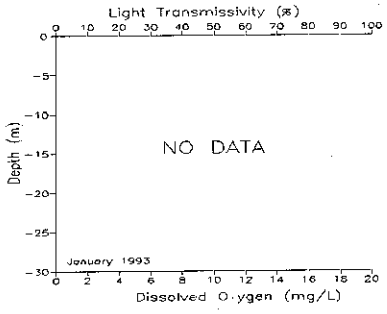
WATERYEAR 1993

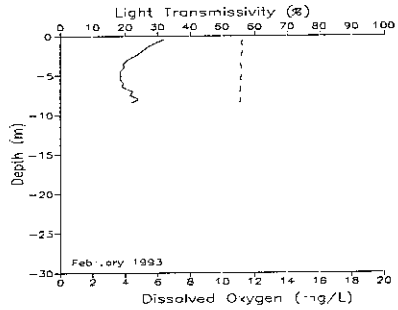
Willapa Bay - Willapa River (Station WPA001)

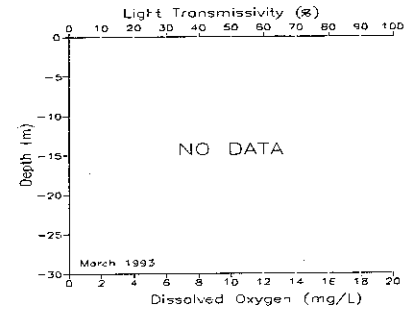


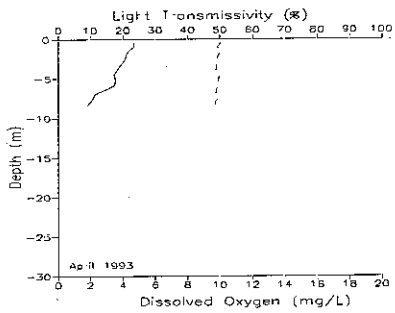


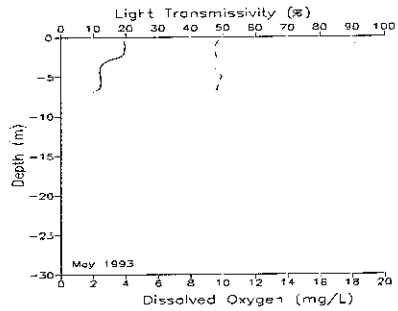


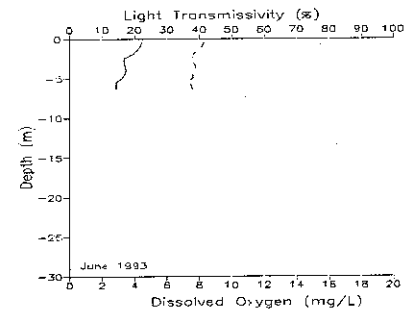


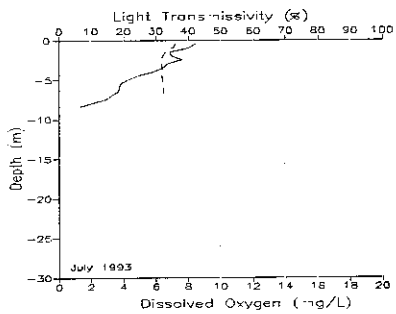


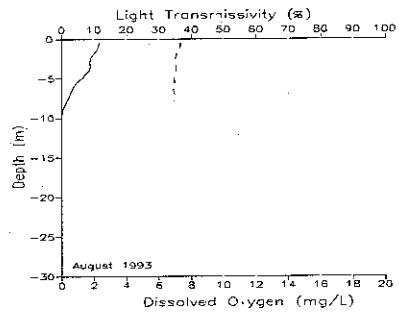


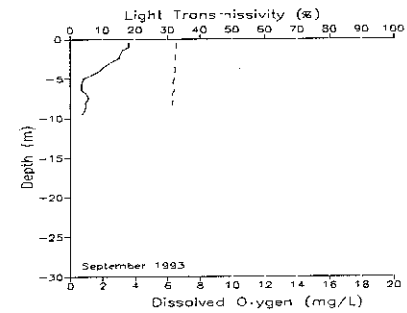








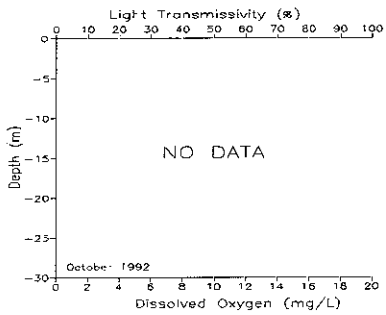


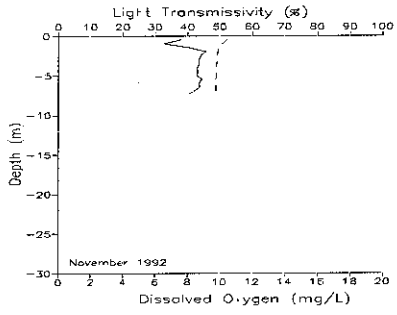


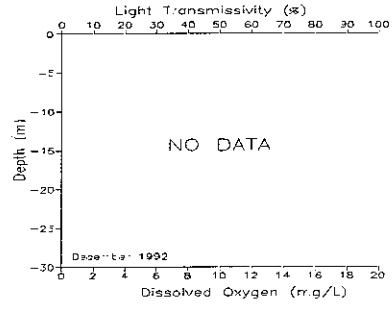
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

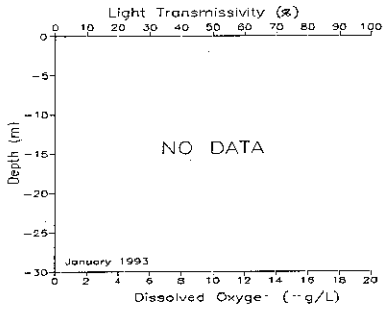
WATERYEAR 1993

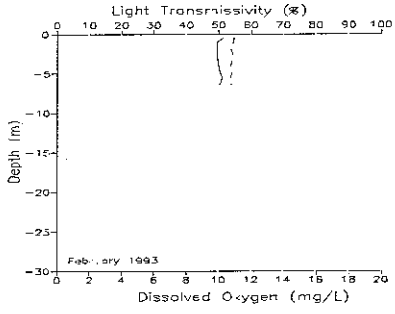
Willapa Bay - Johnson Slough (Station WPA003)

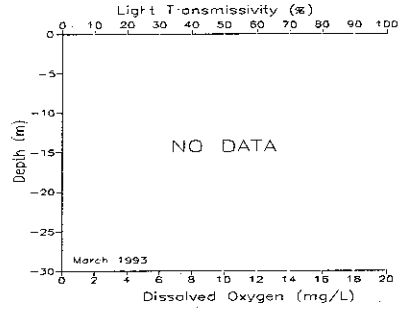


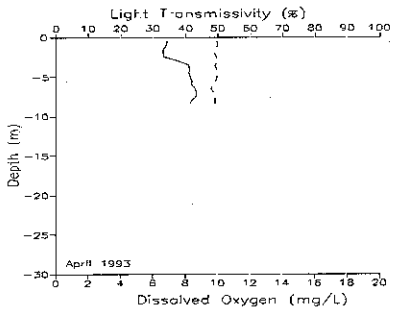


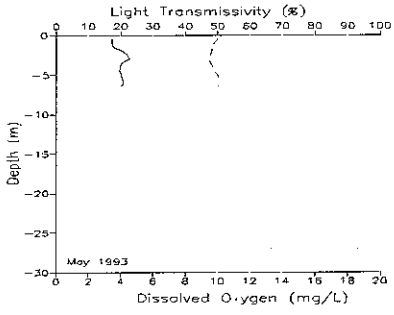


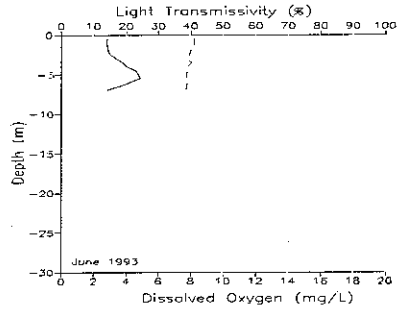


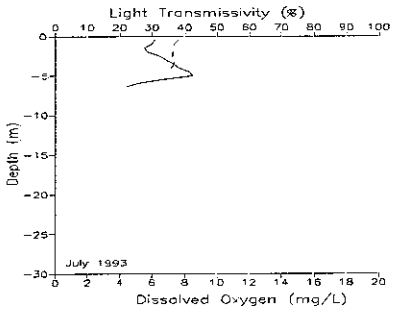


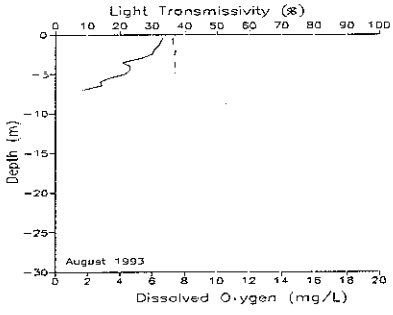


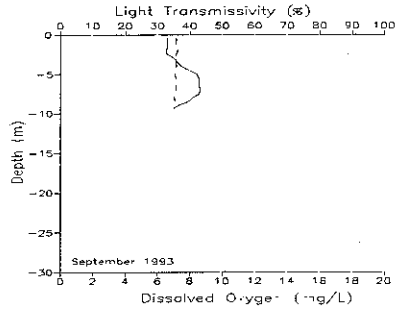








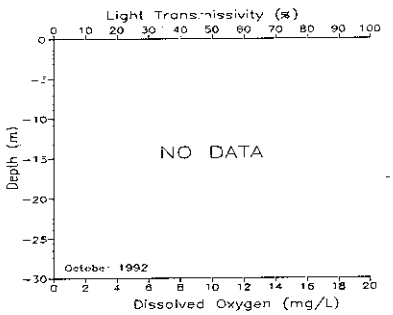


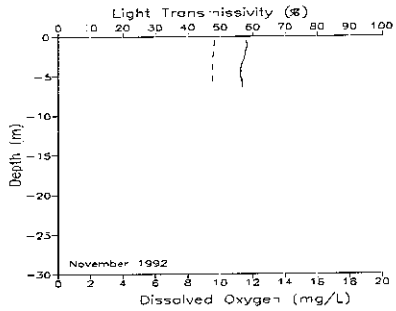


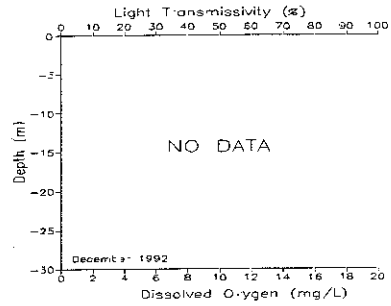
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

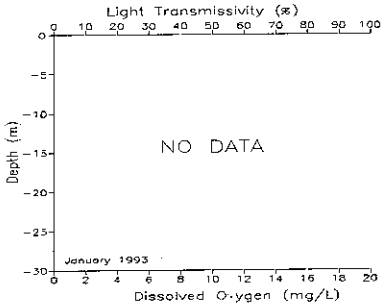
WATERYEAR 1993

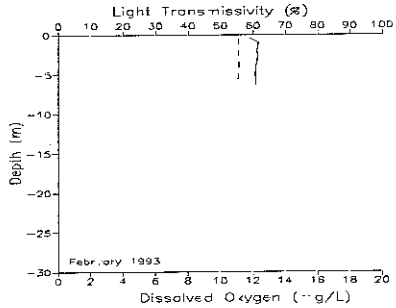
North Willapa Bay (Station WPA004)

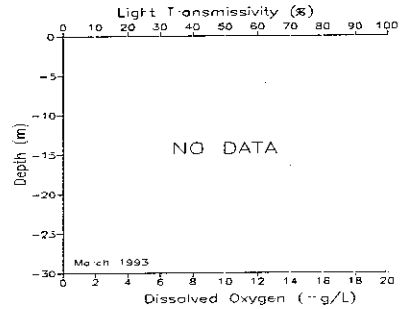


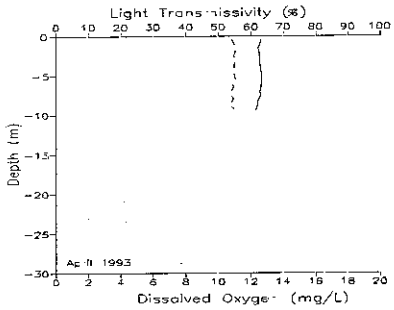


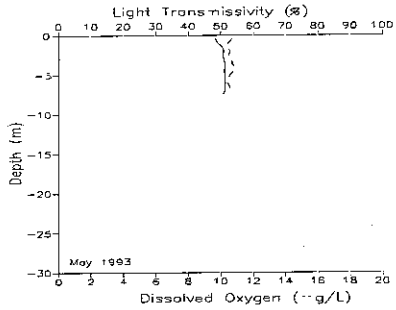


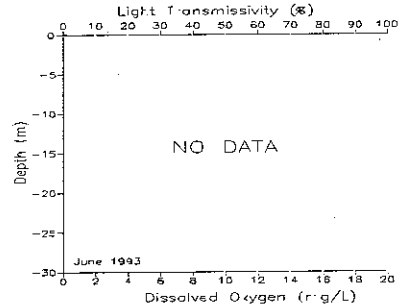


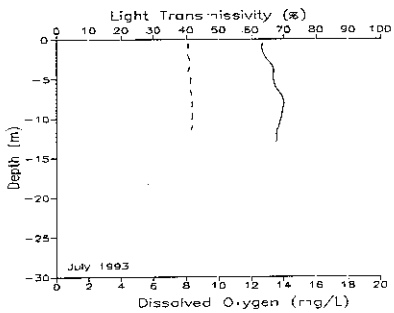


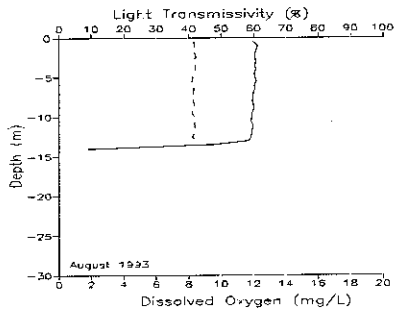


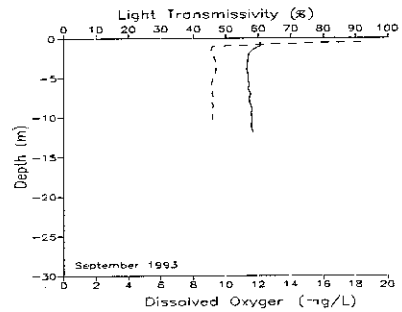








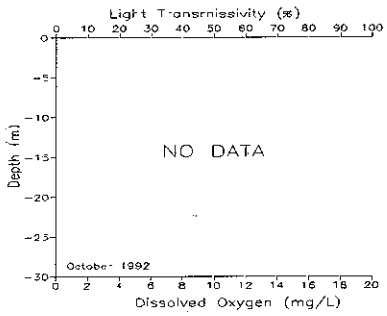


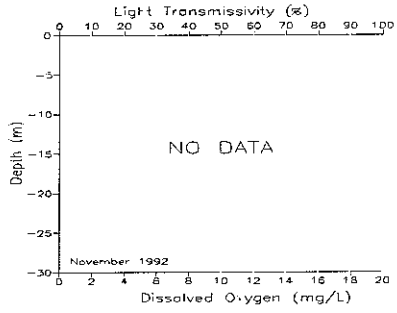


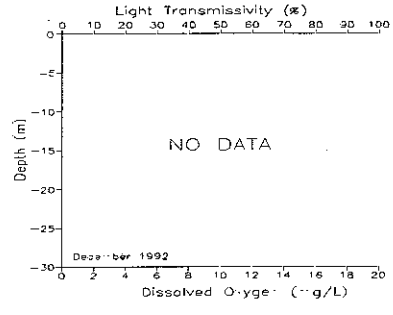
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

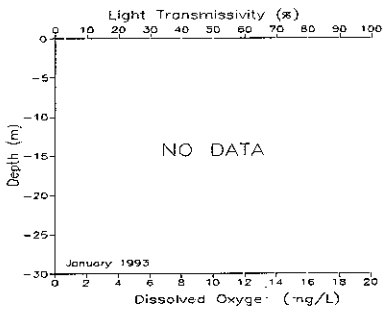
WATERYEAR 1993

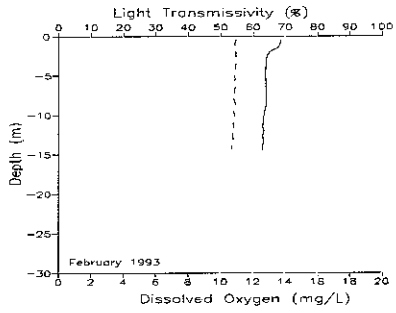
Willapa Bay - Nahcotta Channel (Station WPA006)

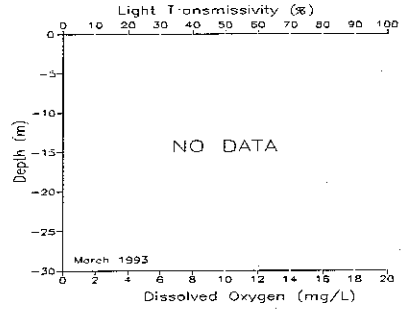


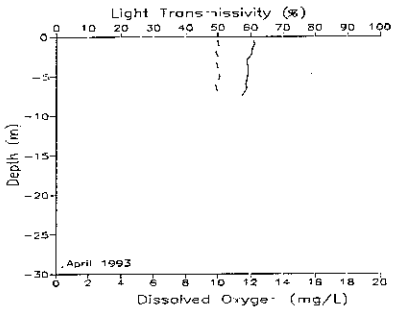


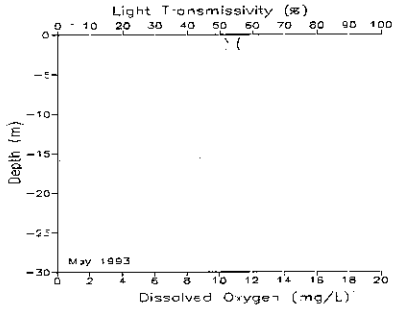


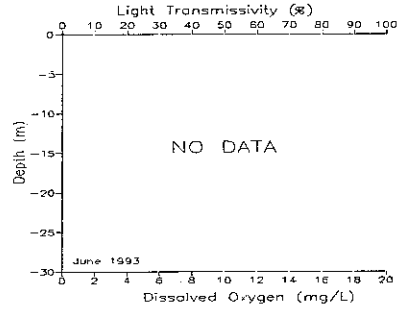


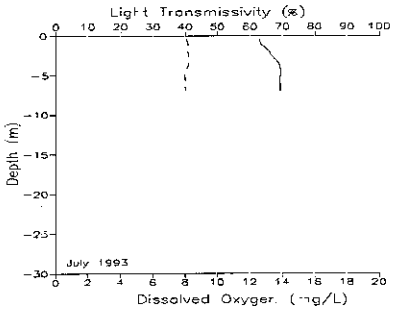


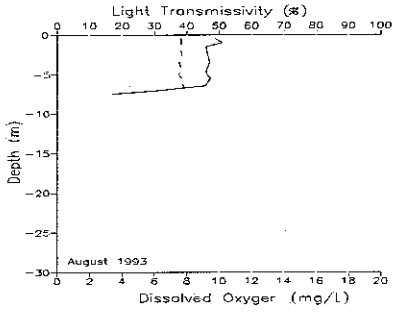


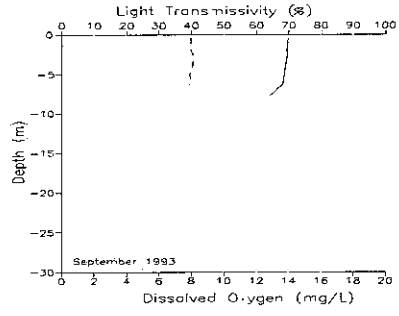








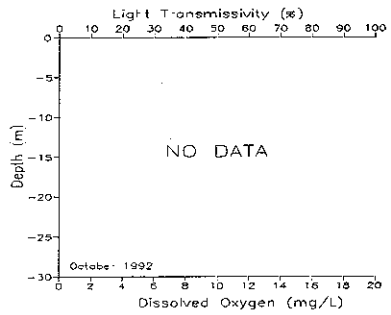


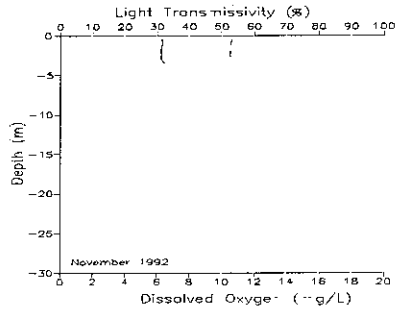


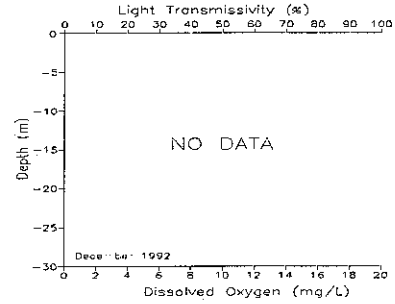
Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

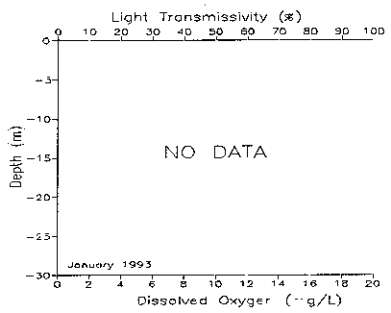
WATERYEAR 1993

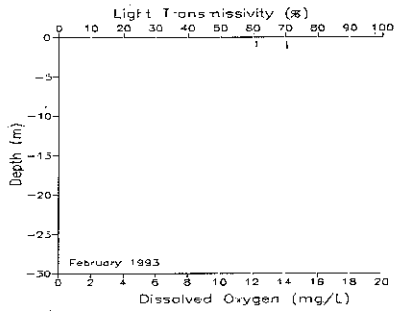
Willapa Bay - S. Jensen Pt. LI (Station WPA007)

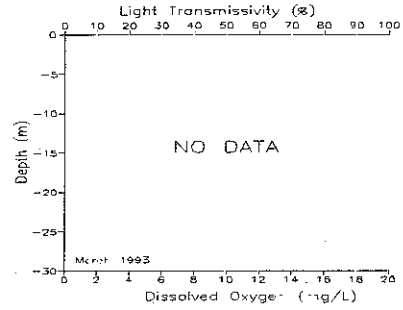


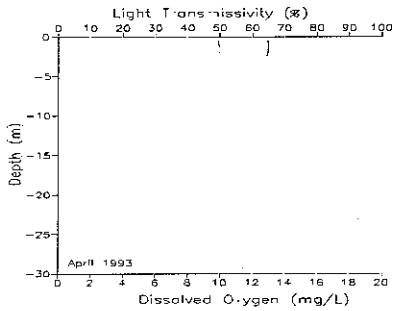


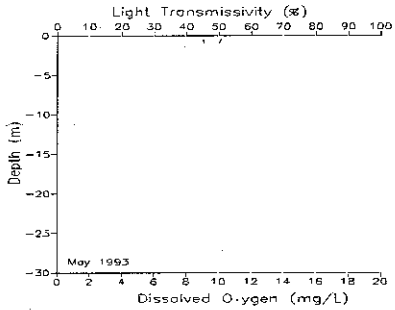


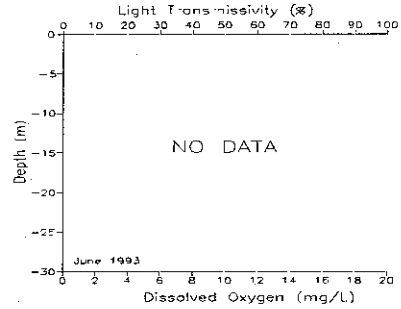


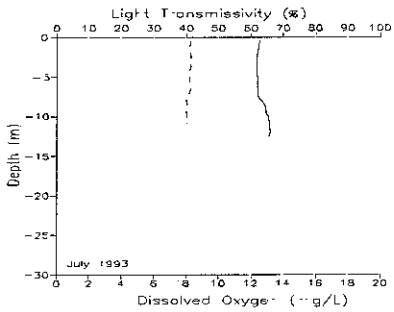


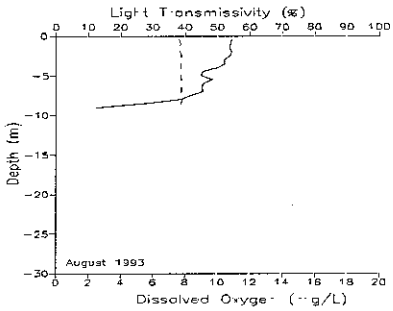


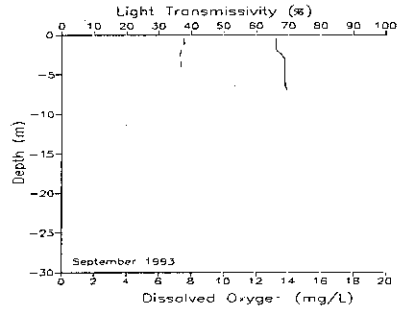












Key: Light Transmissivity = Solid Line Dissolved Oxygen = Dashed Line

APPENDIX D

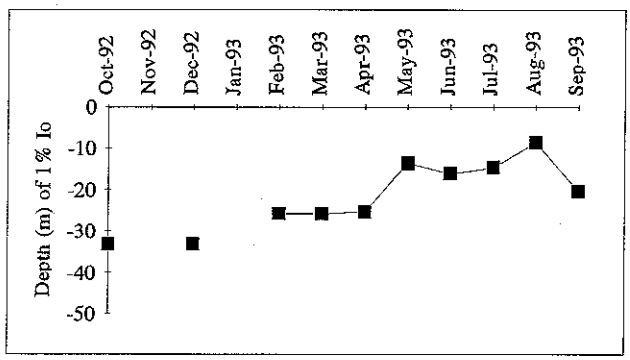
Seasonal plots of euphotic zone depth, concentrations of chlorophyll *a*, and nitrate + nitrite, and regressions of light extinction coefficient versus surface chlorophyll *a* concentration from WY 1993 data for:

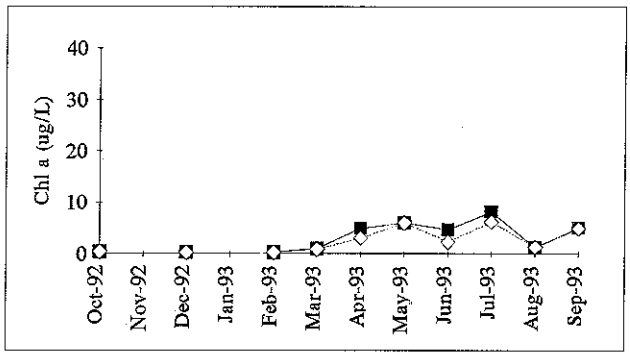
1) Puget Sound stations

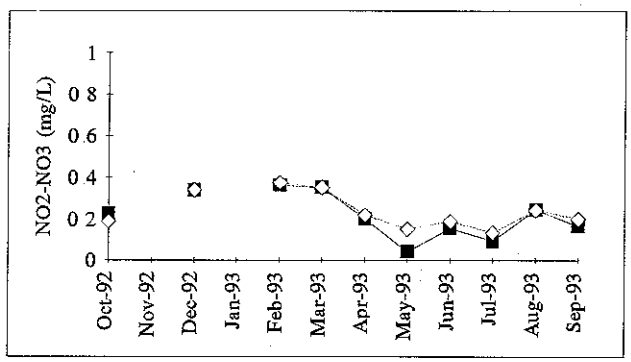
2) Grays Harbor and Willapa Bay stations

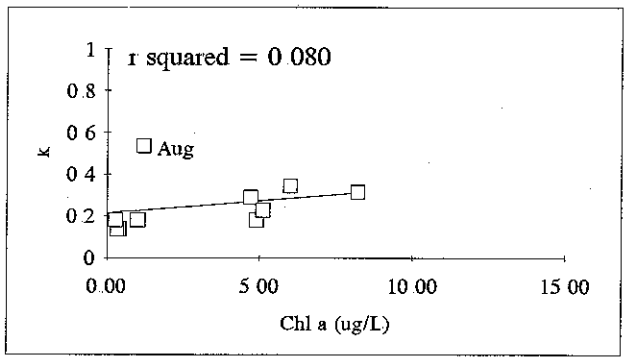
PUGET SOUND STATIONS

ADM001









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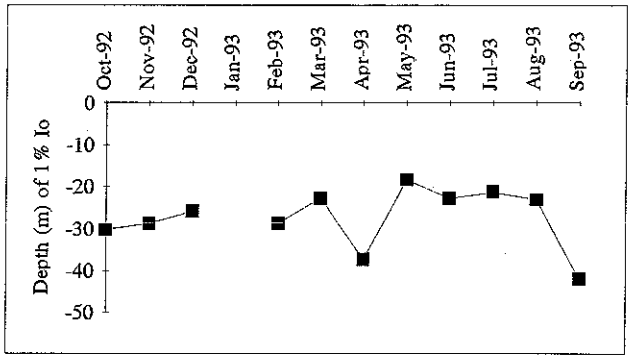

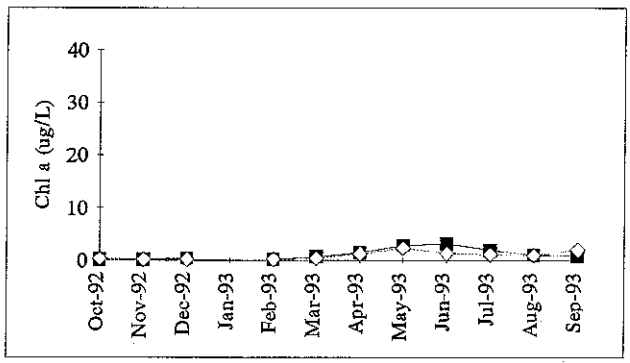

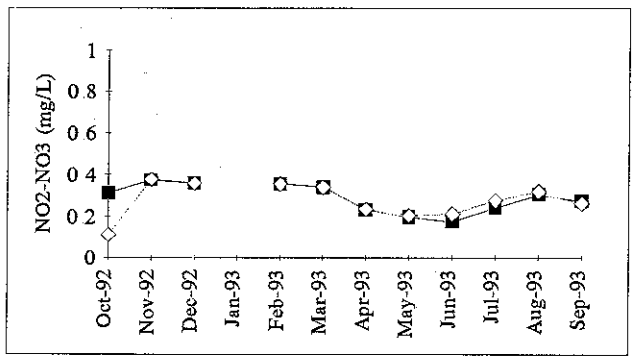

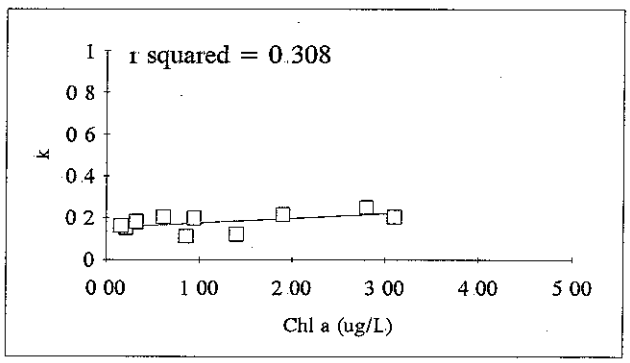

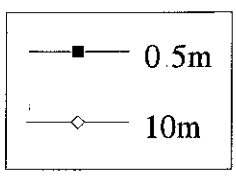

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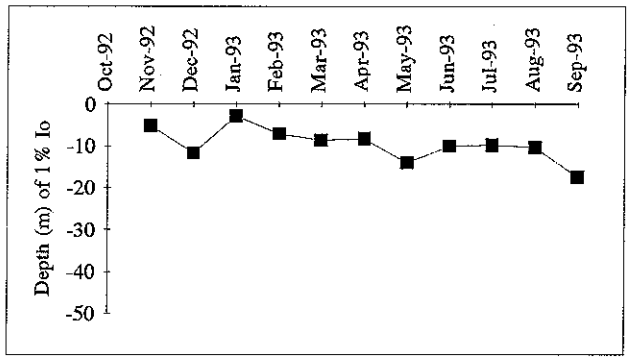

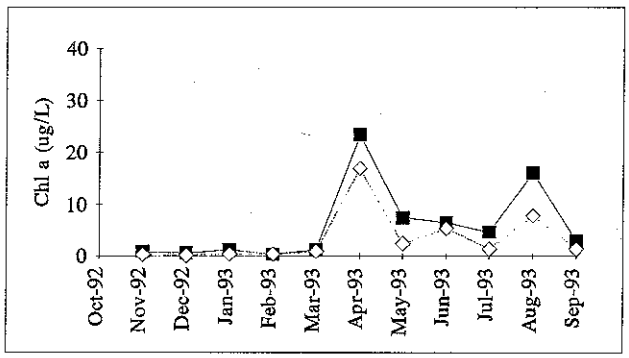

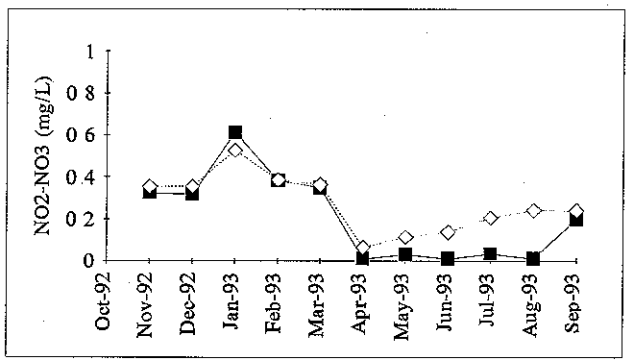

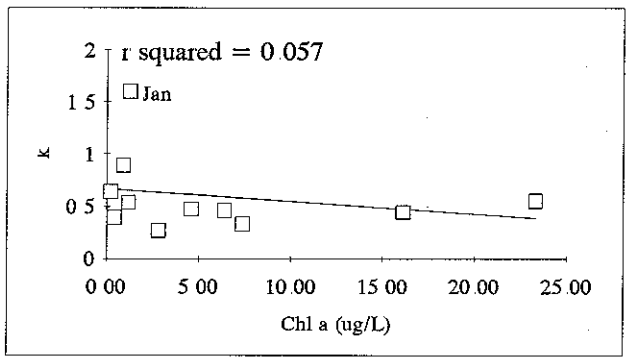

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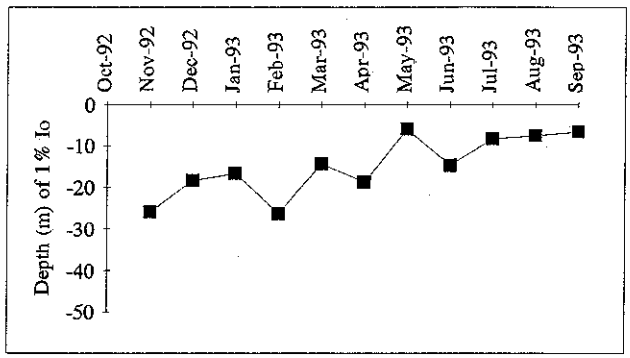

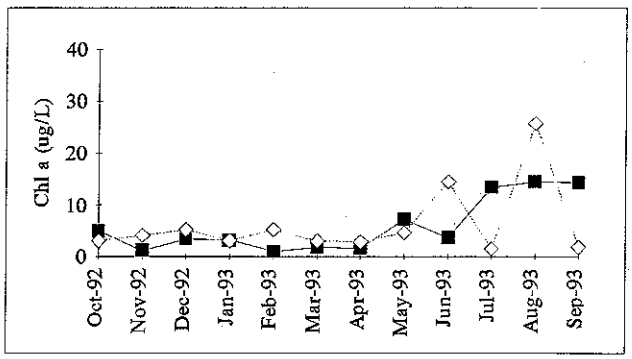

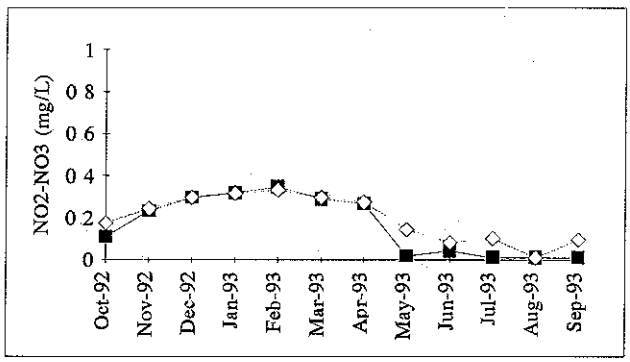

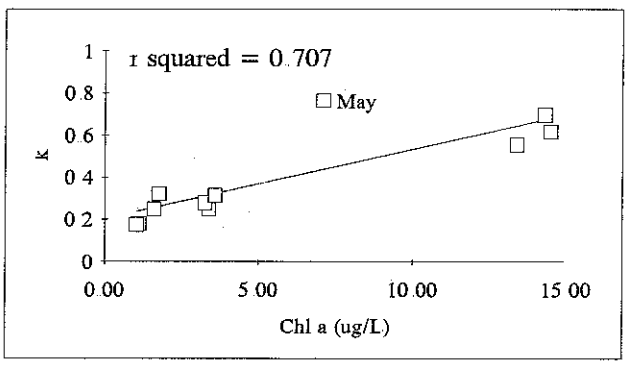

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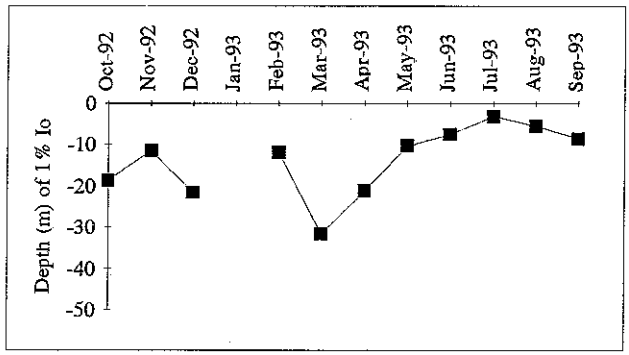

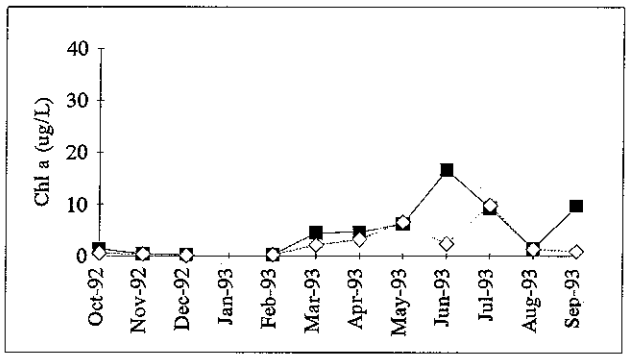

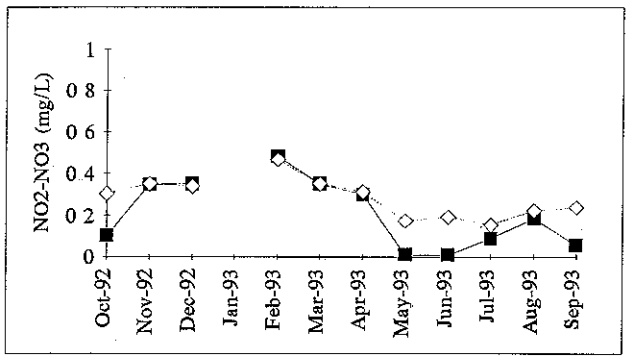

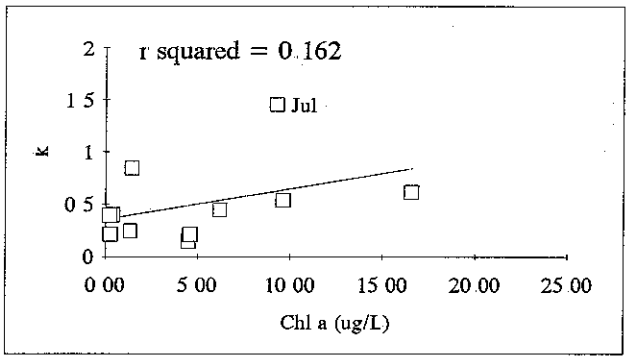

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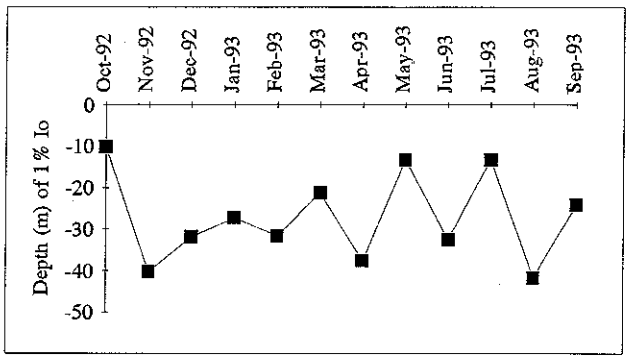

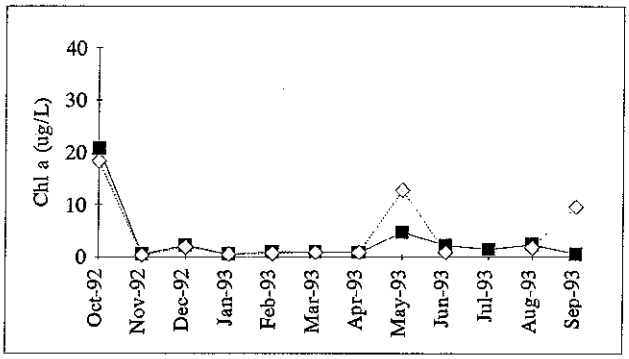

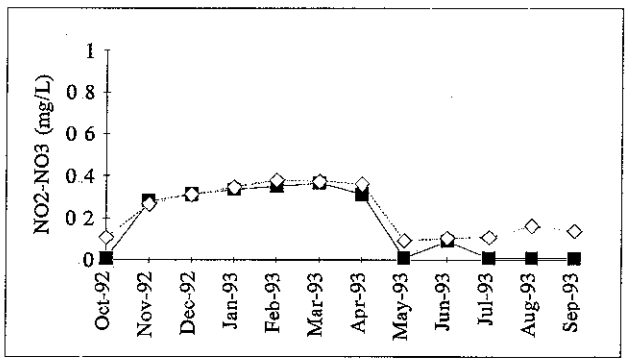

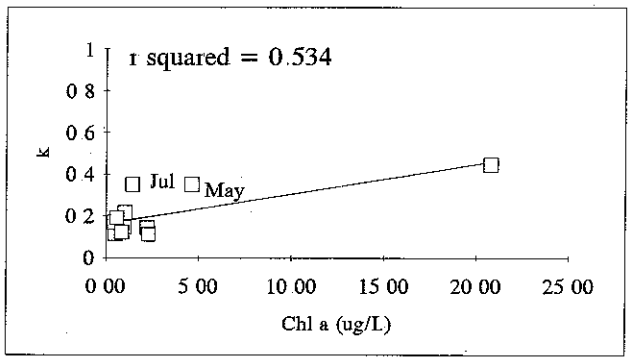

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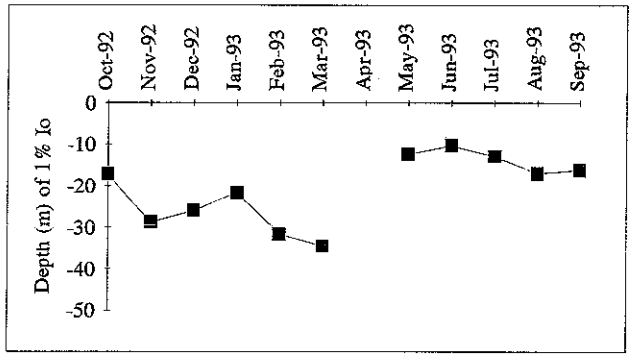

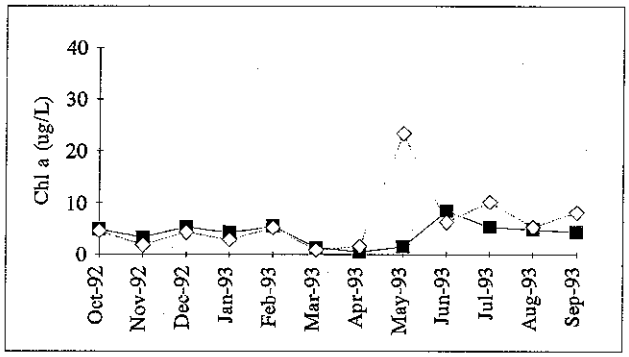

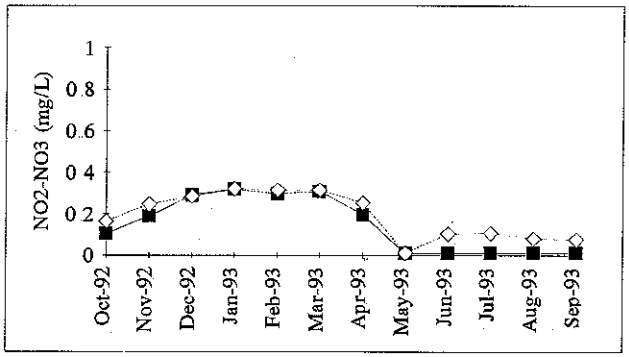

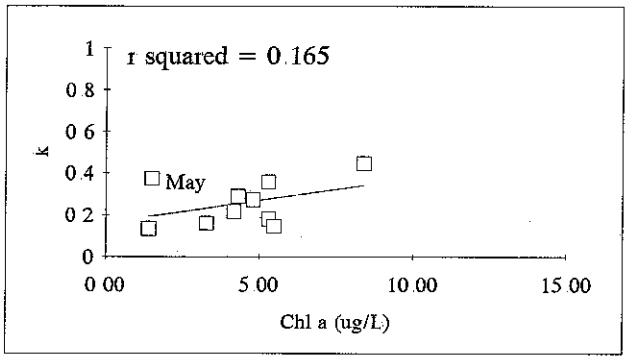

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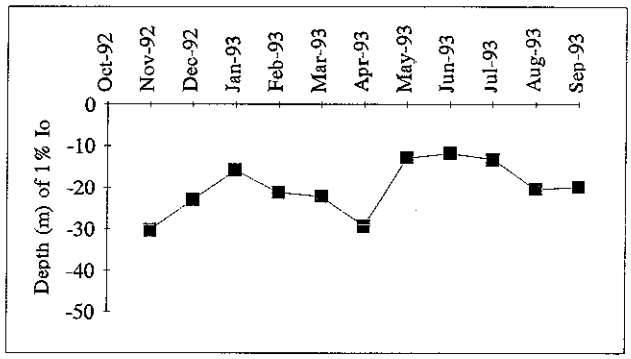

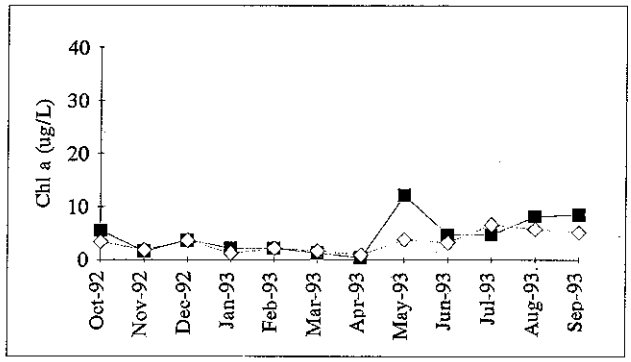

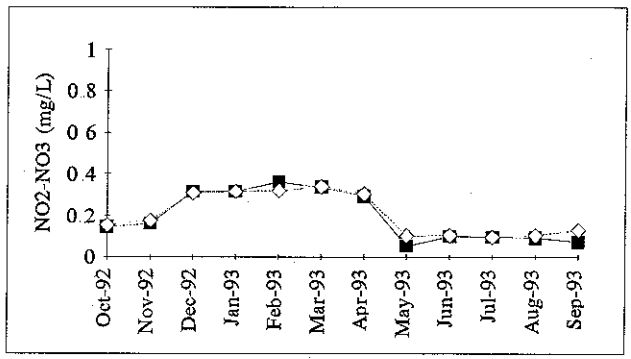

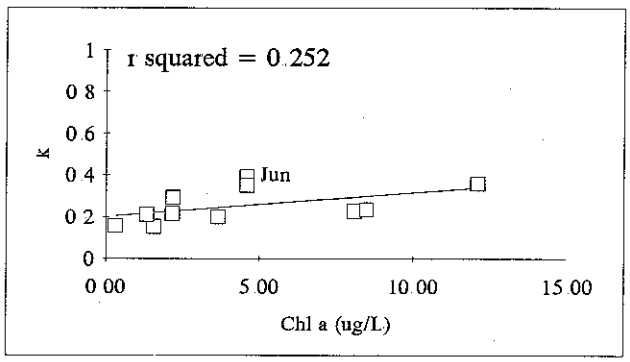

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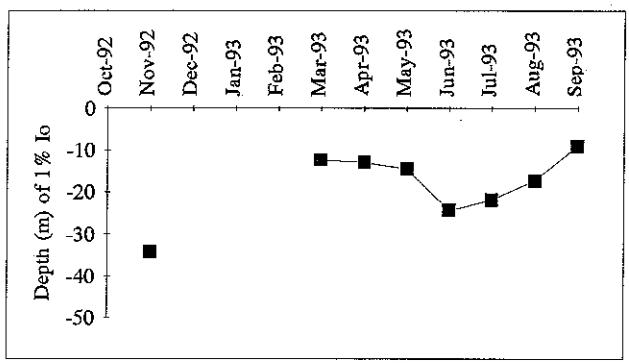

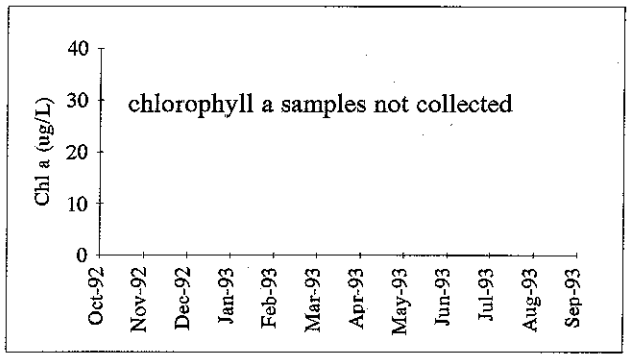

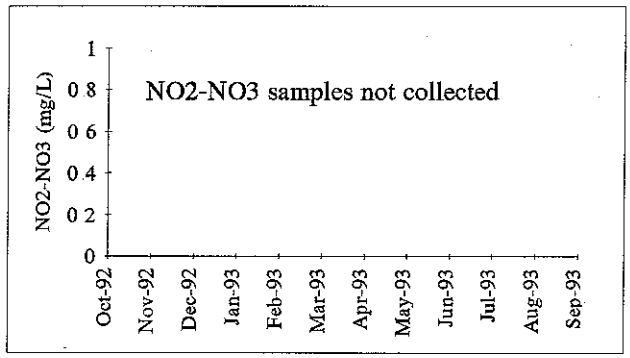

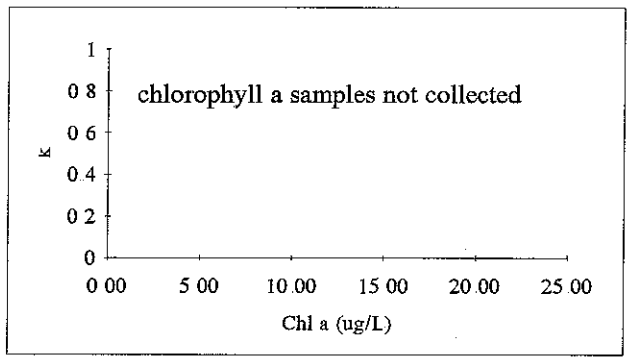

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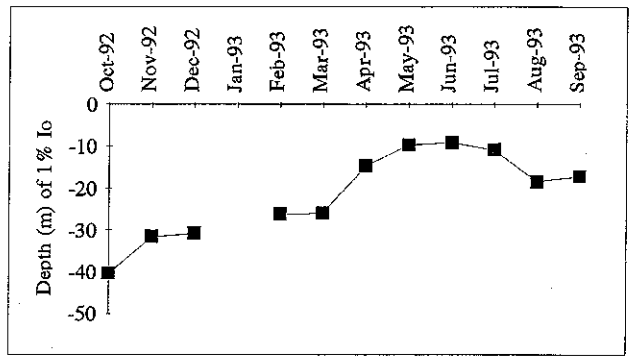

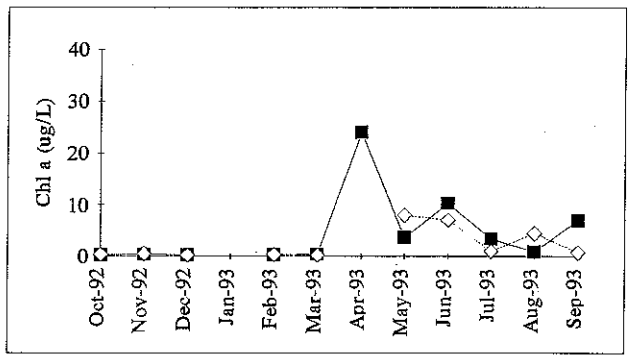

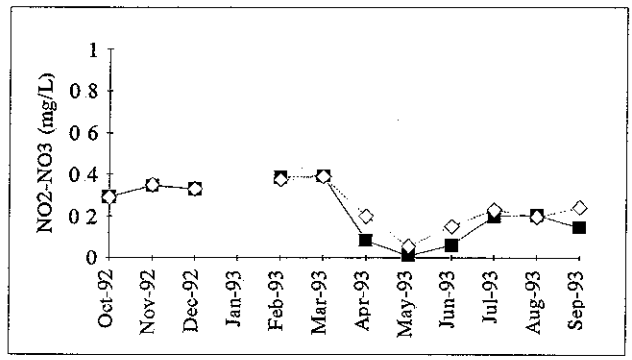

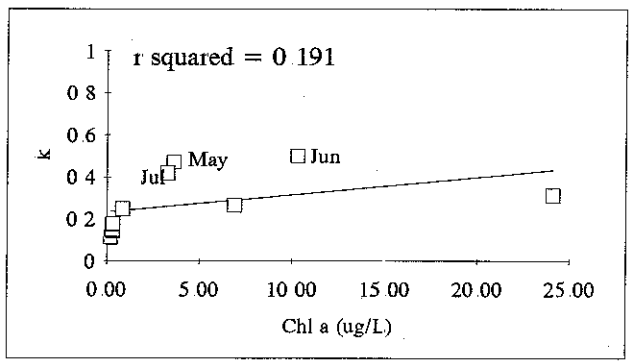

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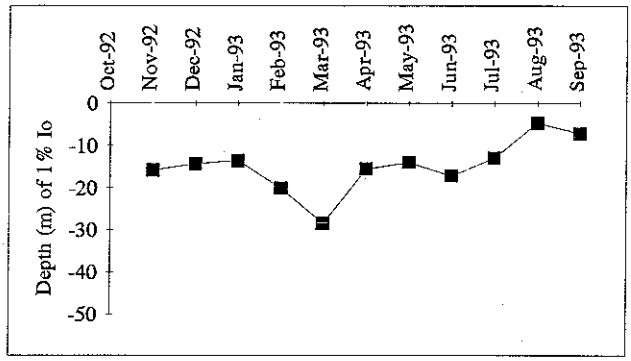

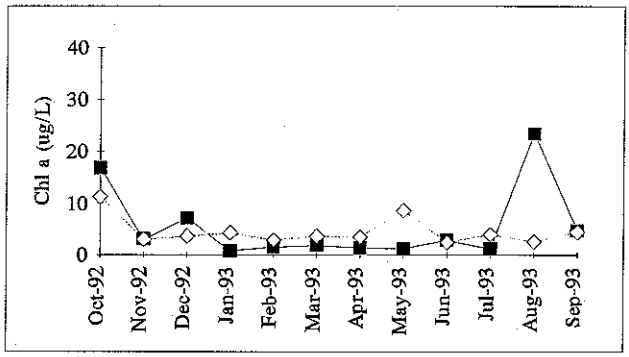

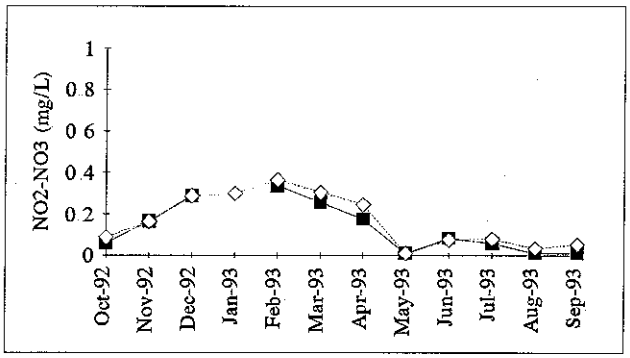

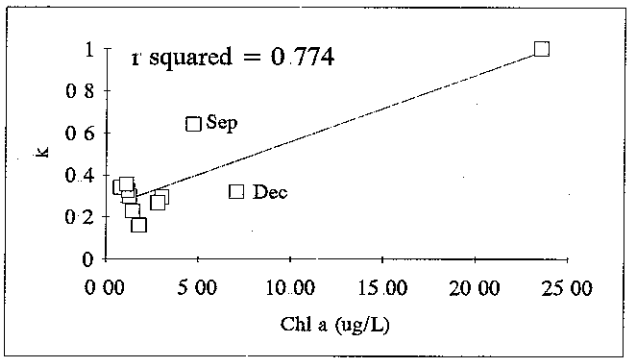

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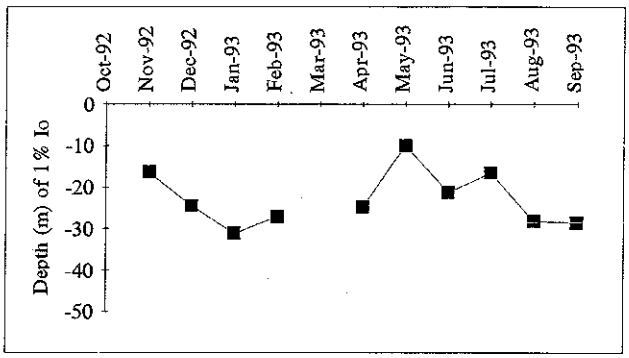

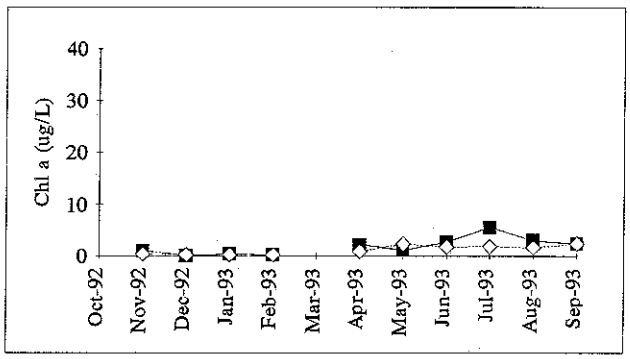

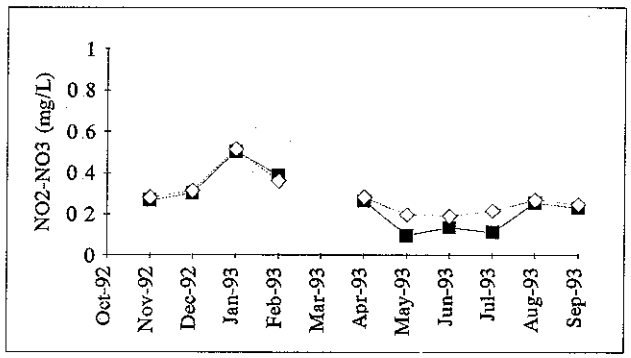

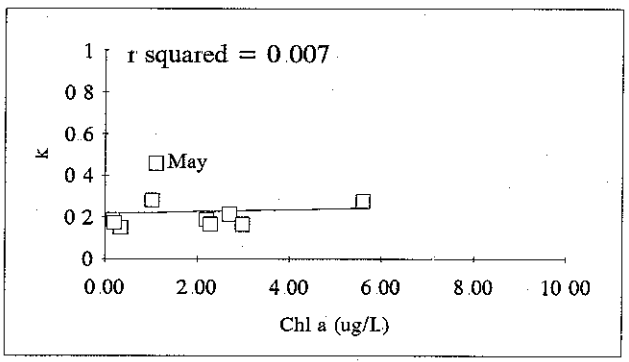

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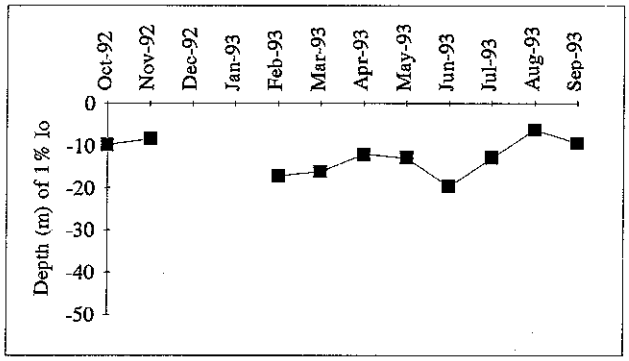

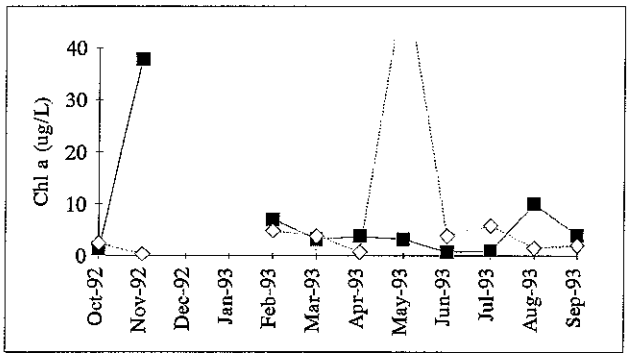

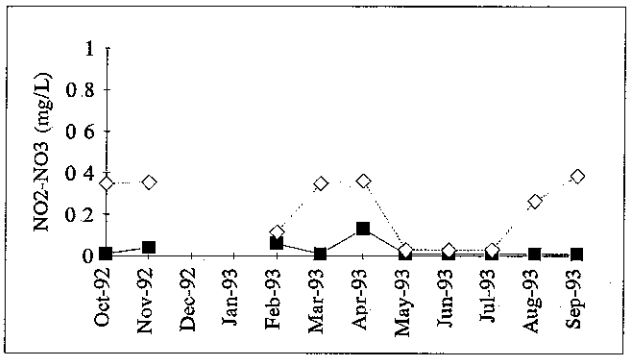

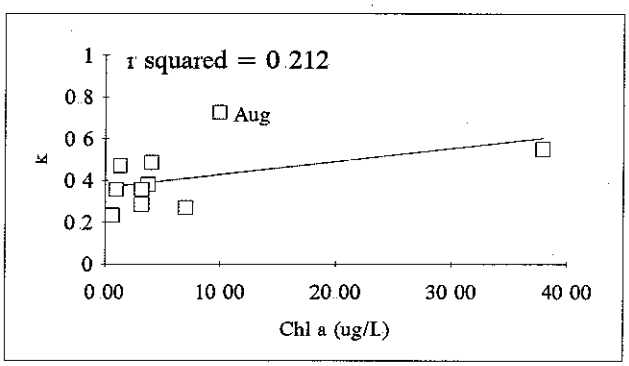

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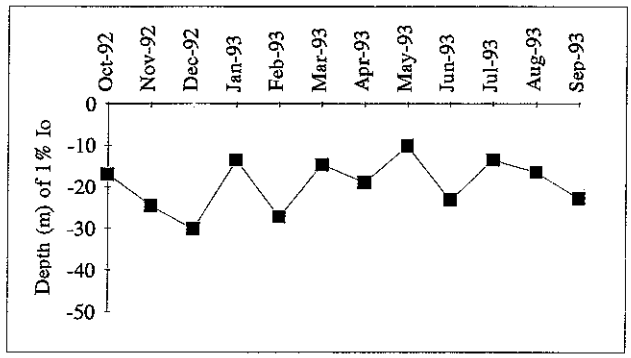

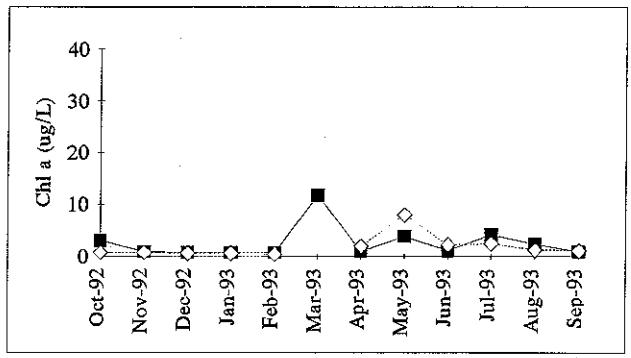

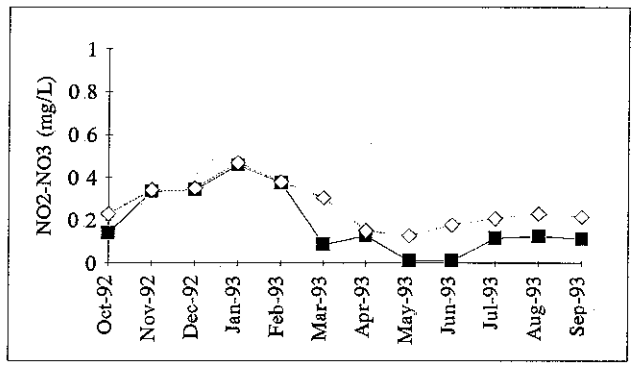

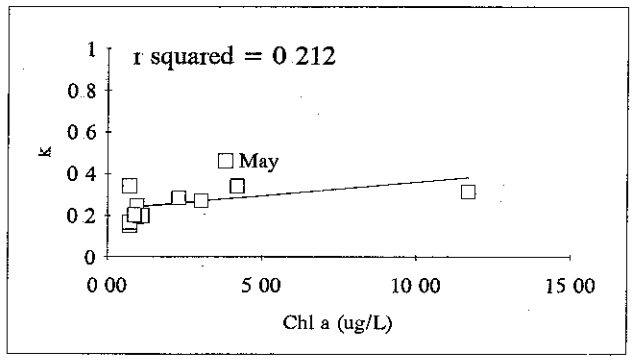

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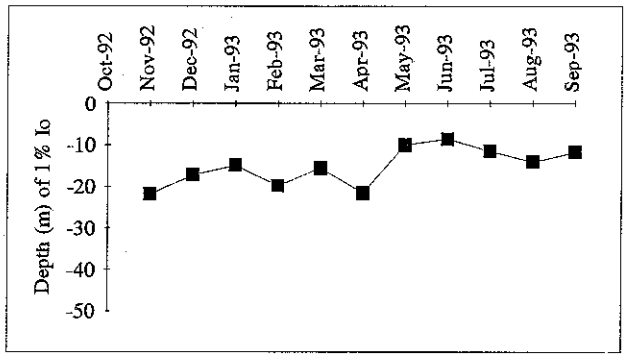
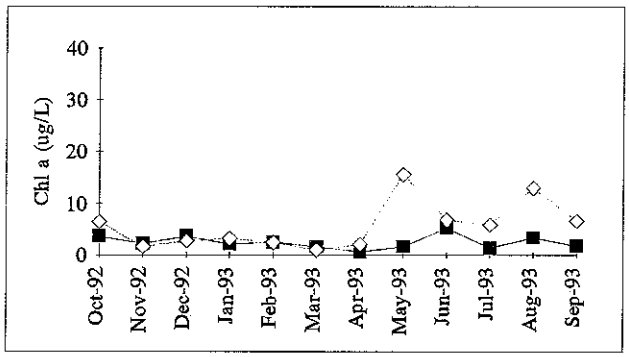
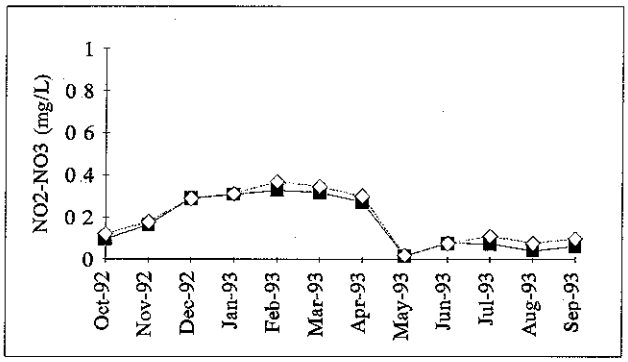
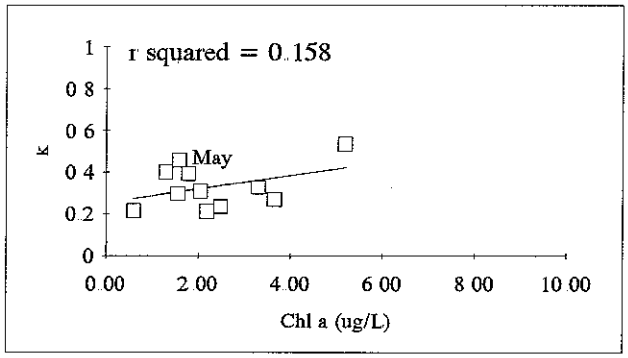
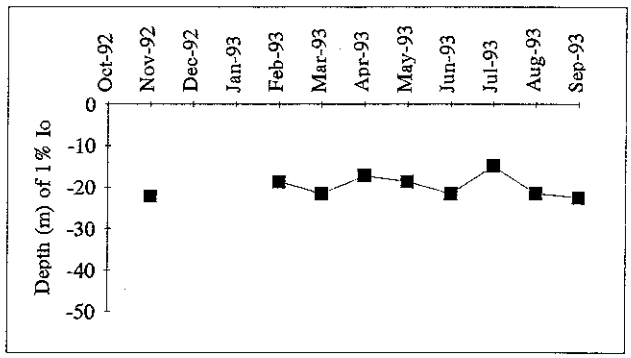


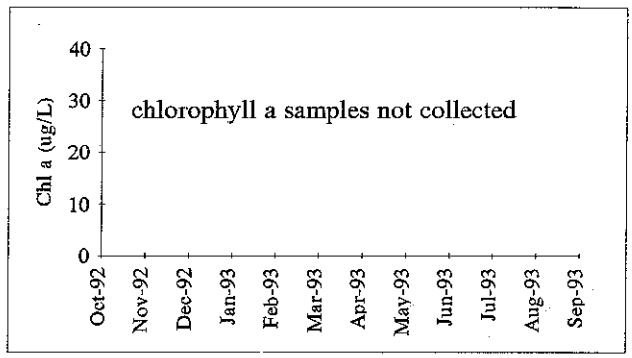


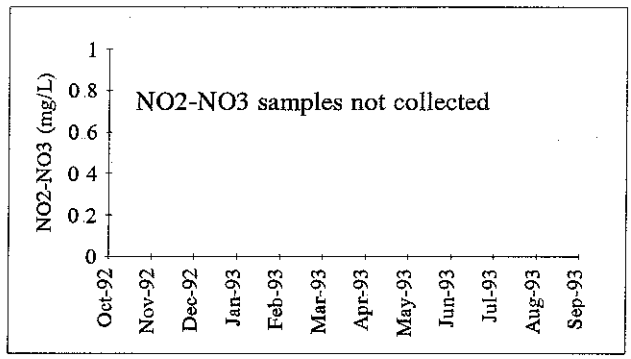


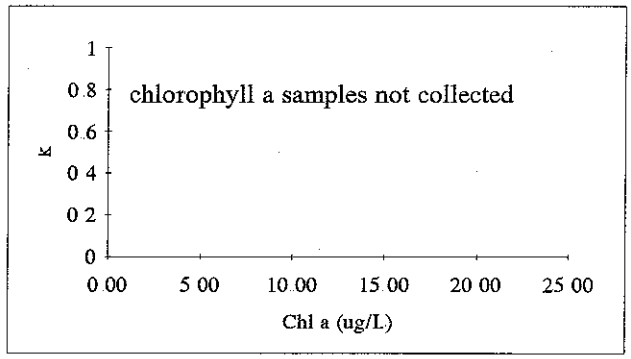


LOP001









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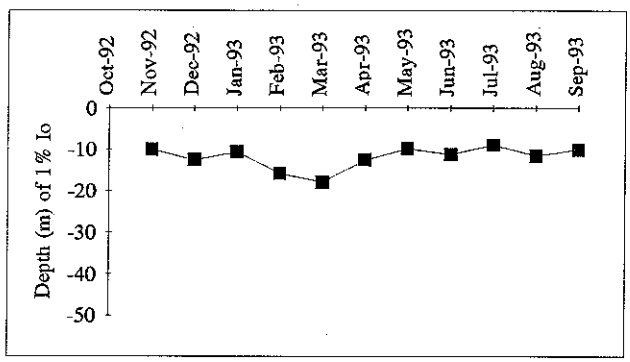
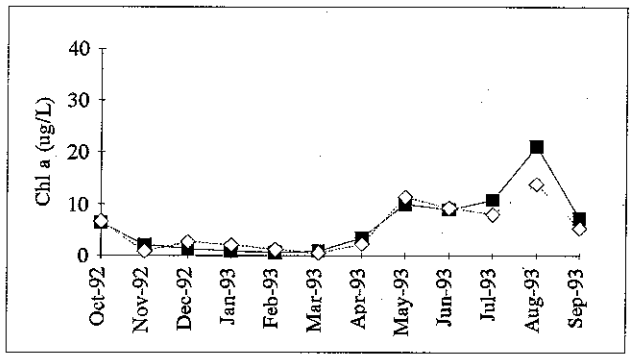
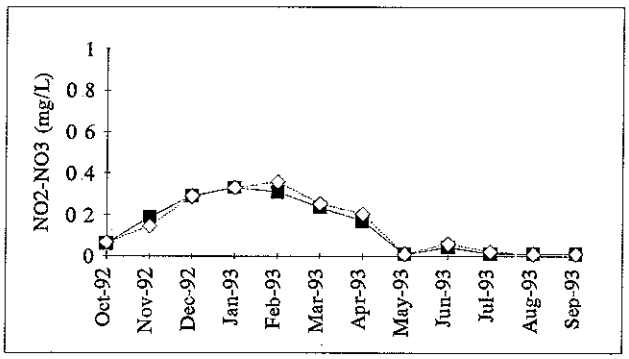
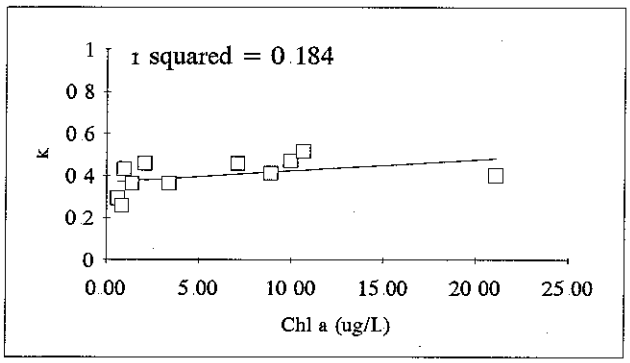
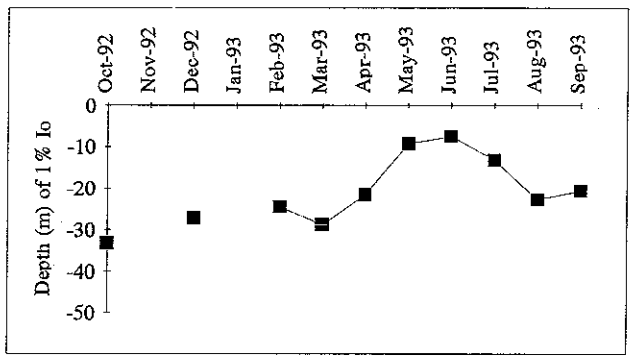


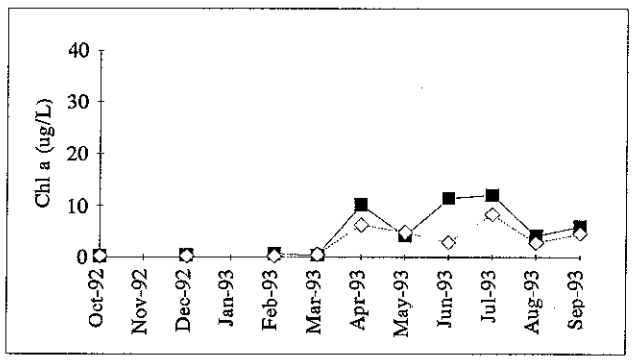


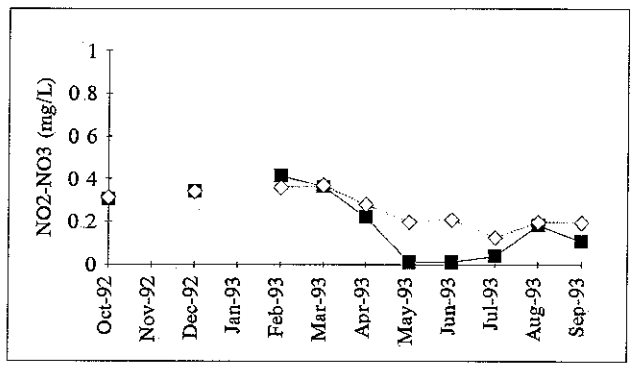


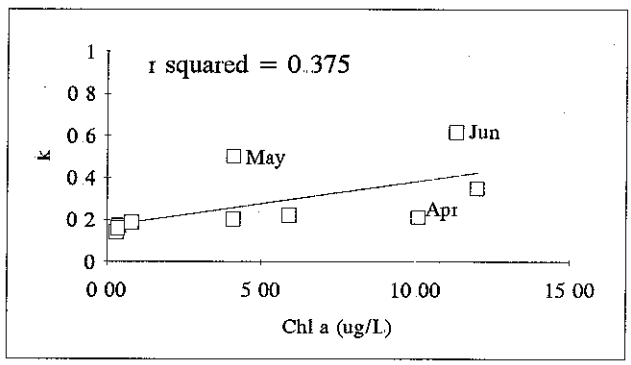


PSB003

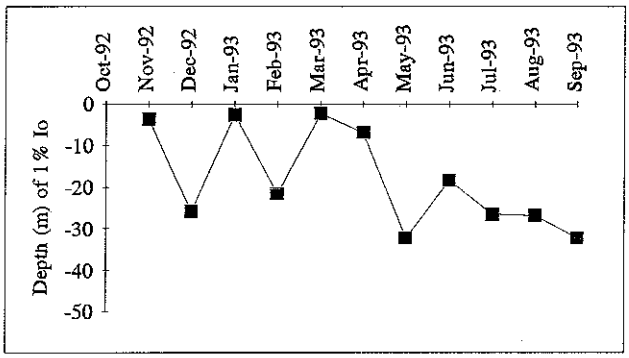


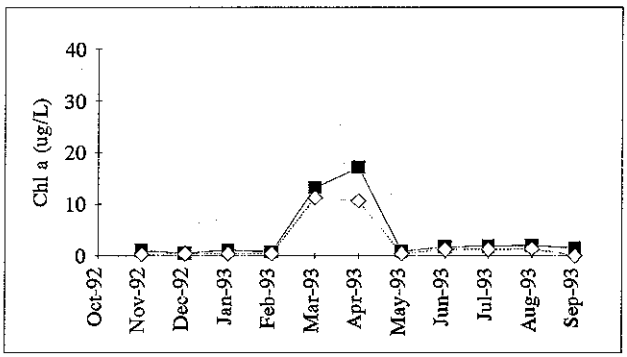


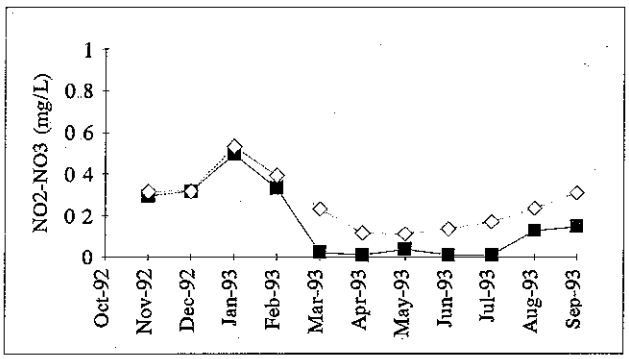


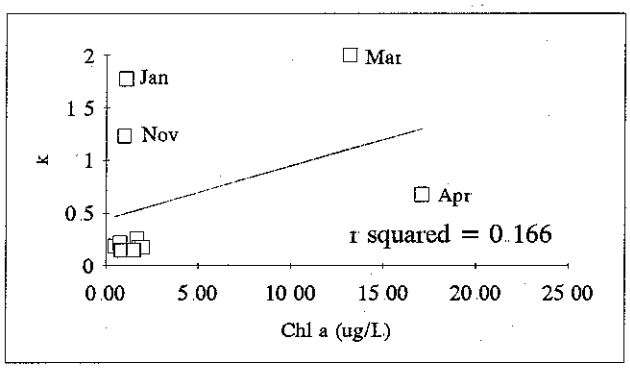


PSS019

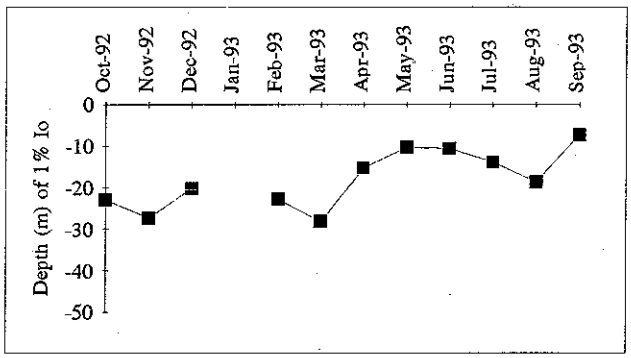


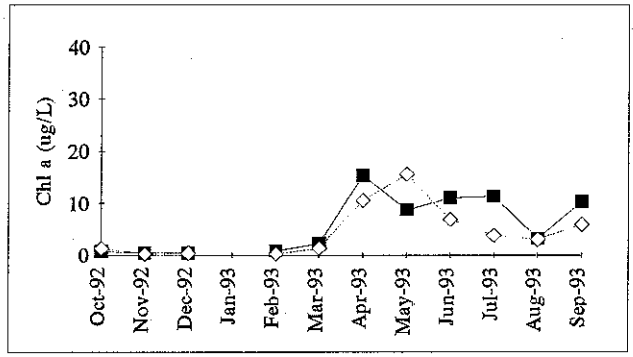


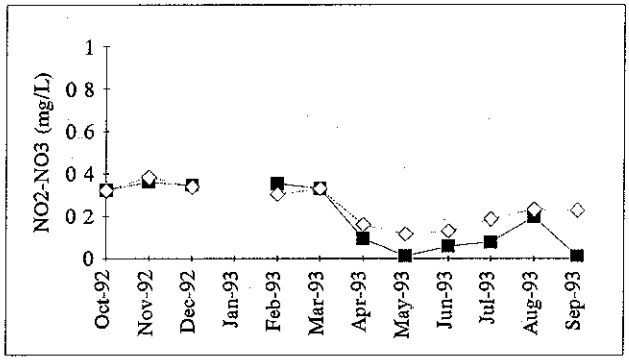


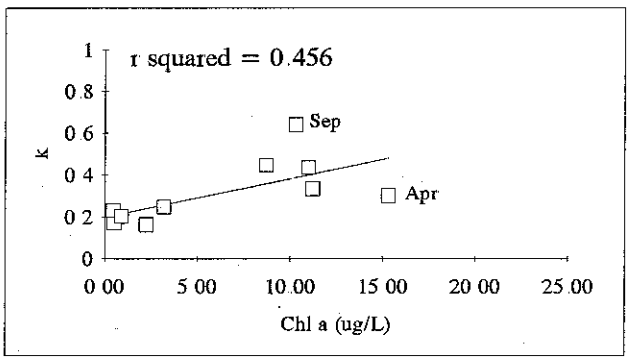


PTH005









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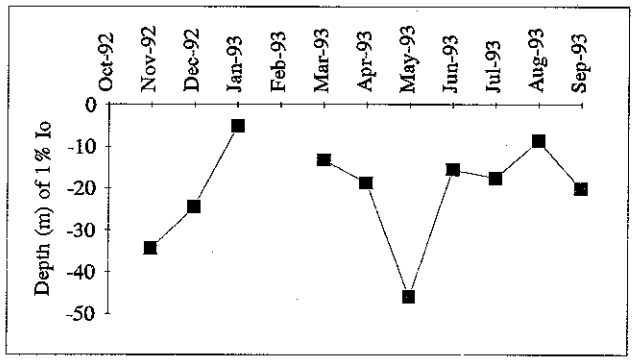

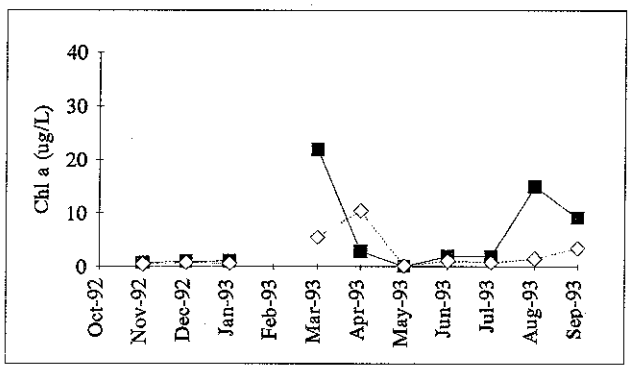

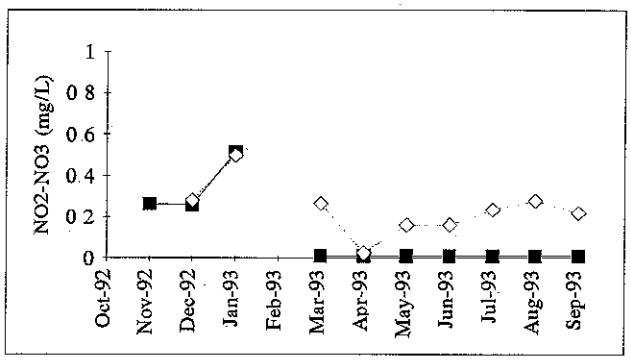

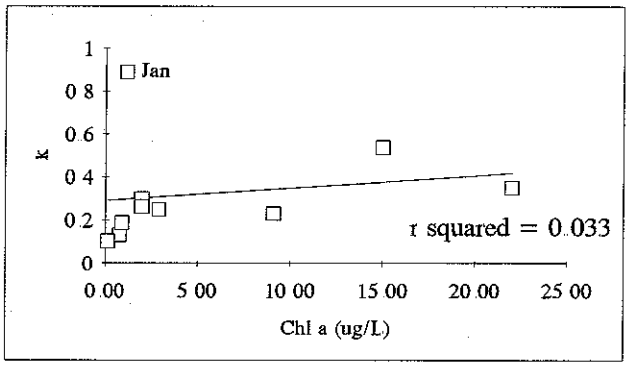

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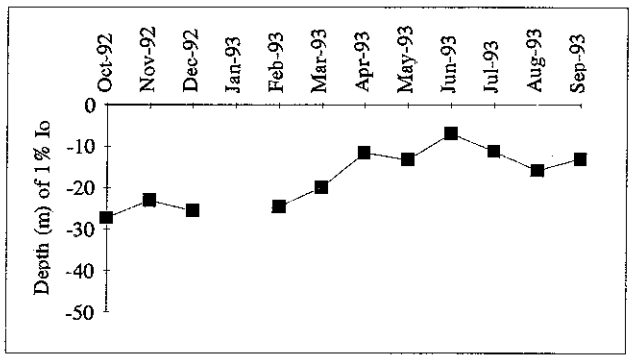
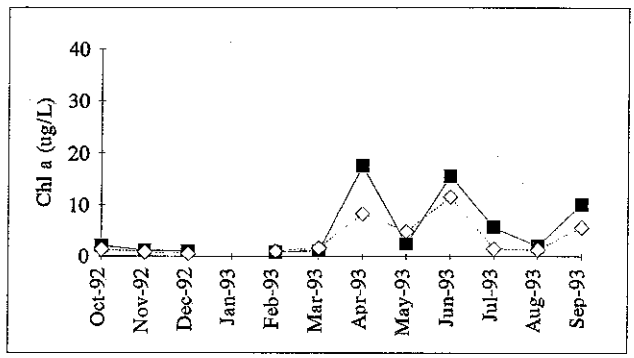
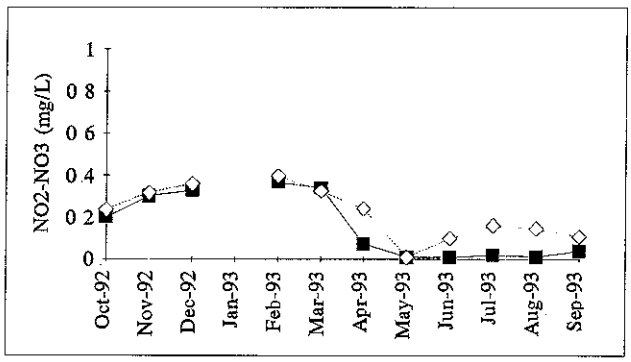
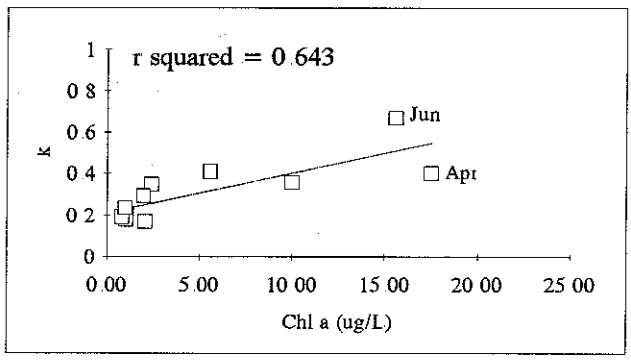
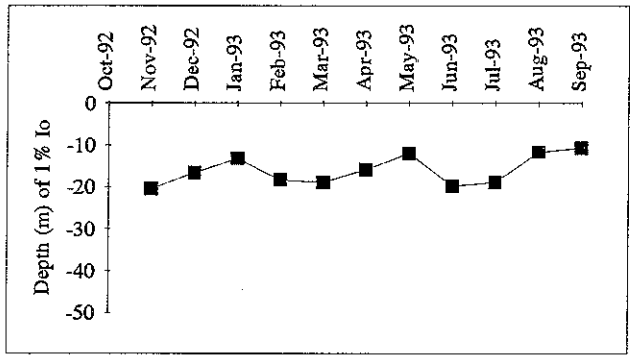


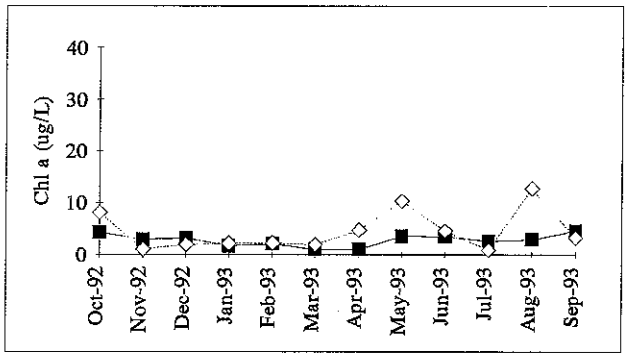


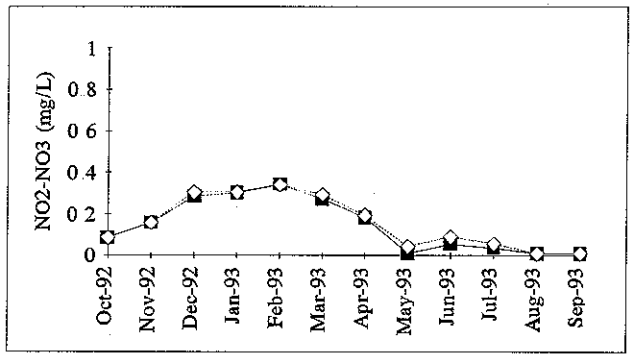




TOT001


Depth (m) of 1% Io
0
-10
-20
-30
-40
-50
Oct-92
Nov-92
Dec-92
Jan-93
Feb-93
Mar-93
Apr-93
May-93
Jun-93
Jul-93
Aug-93
Sep-93


Chl a (ug/L)
40
30
20
10
0
Oct-92
Nov-92
Dec-92
Jan-93
Feb-93
Mar-93
Apr-93
May-93
Jun-93
Jul-93
Aug-93
Sep-93


NO2-NO3 (mg/L)
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0 8
0 6
0 4
0 2
0
Oct-92
Nov-92
Dec-92
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Apr-93
May-93
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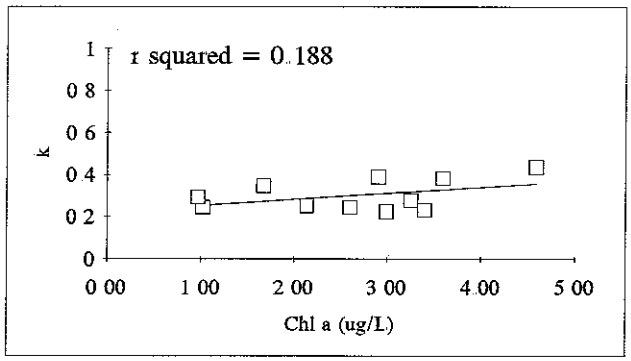
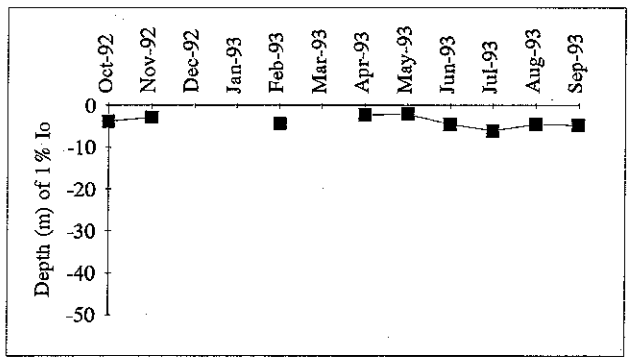
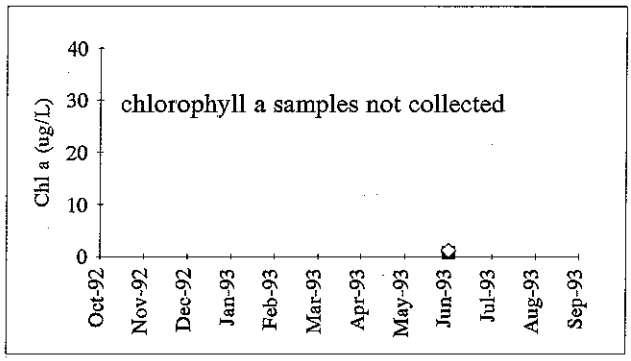
Aug-93
Sep-93

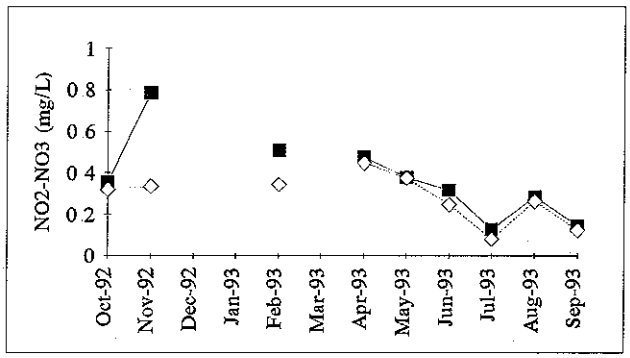

r squared = 0.188
k
1
0 8
0 6
0 4
0 2
0
0 00
1 00
2 00
3 00
4.00
5 00
Chl a (ug/L)

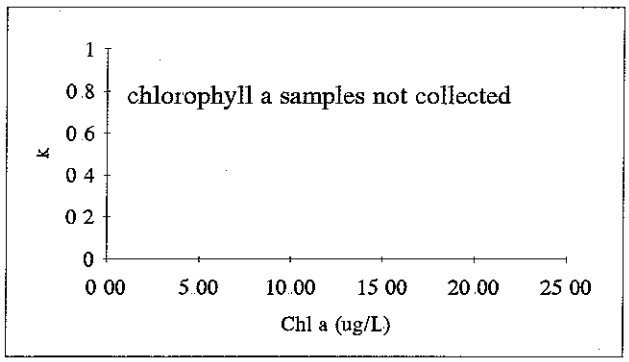
GRAYS HARBOR AND WILLAPA BAY STATIONS

GYS004

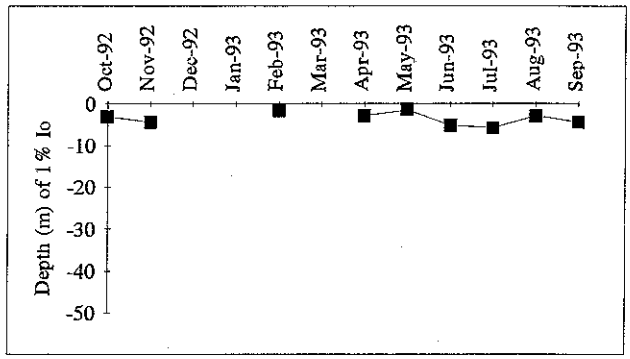


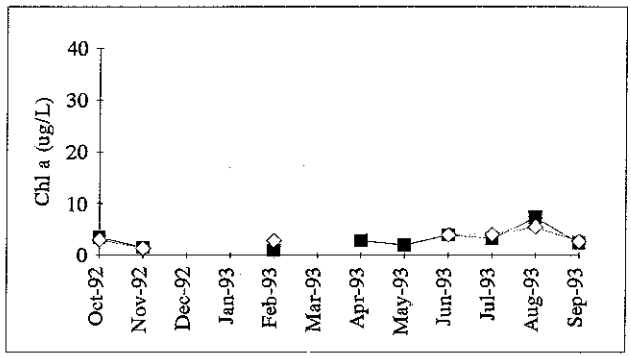


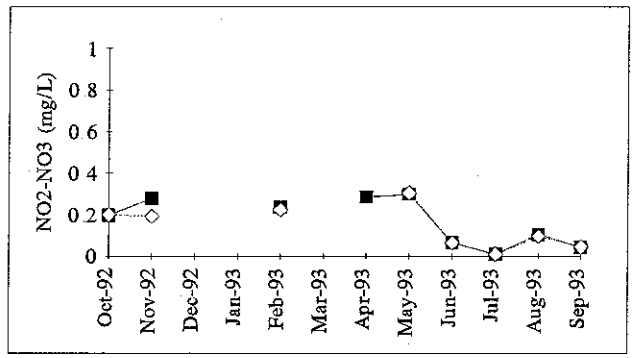


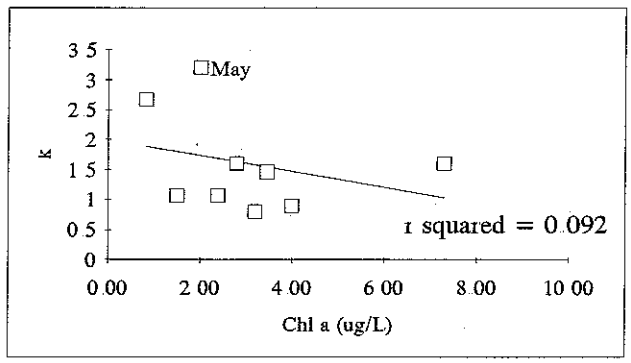


GYS008

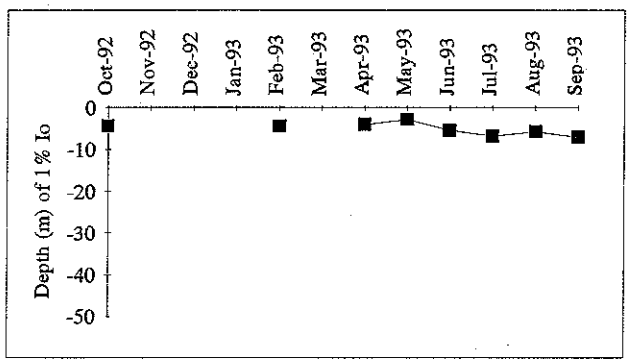


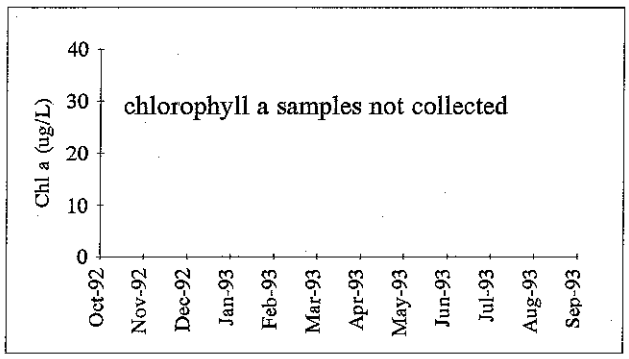


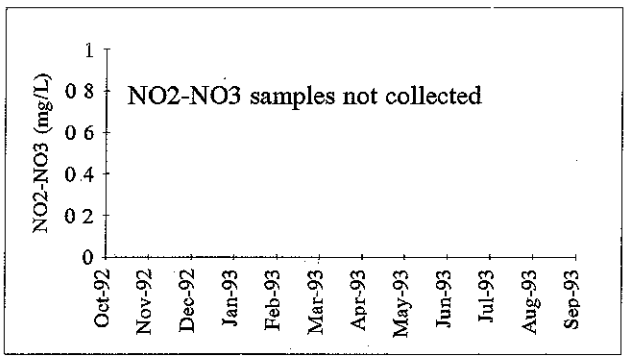


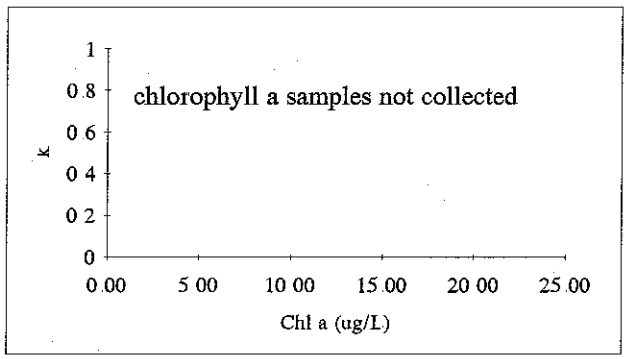


GYS009

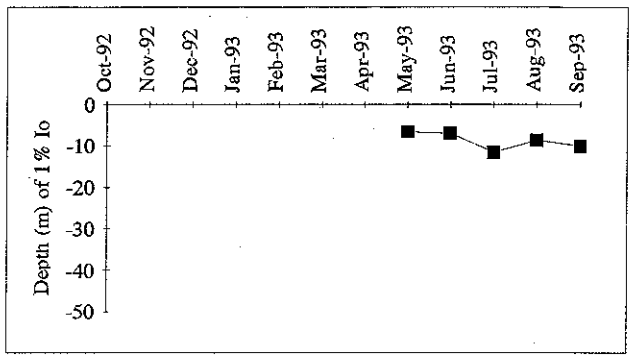


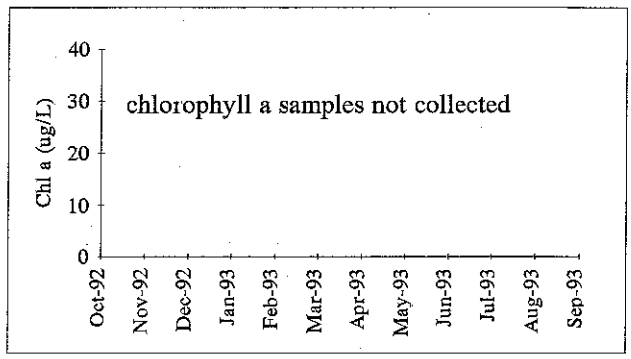


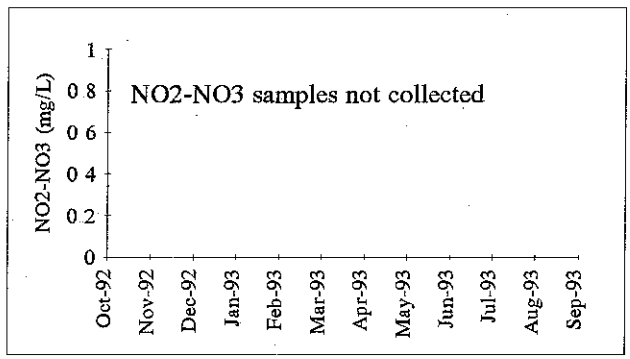


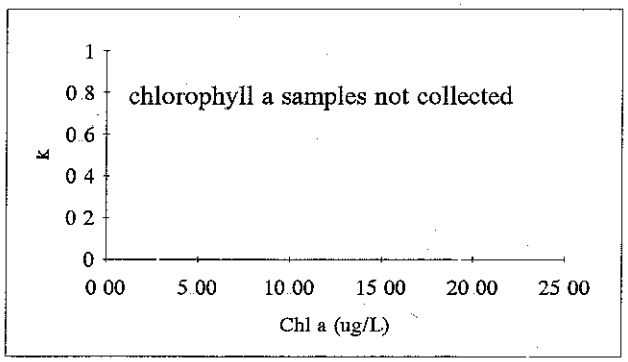


GYS015

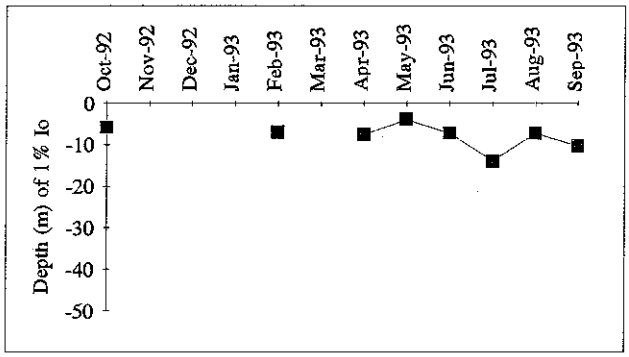


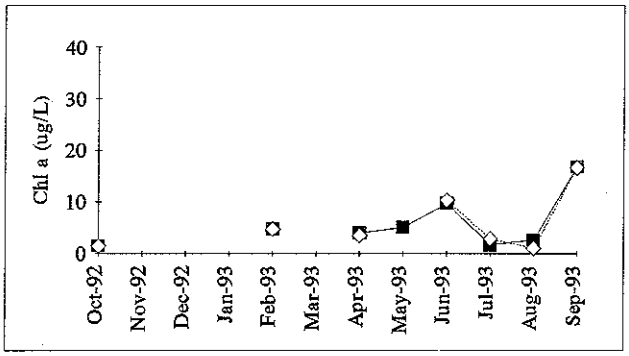


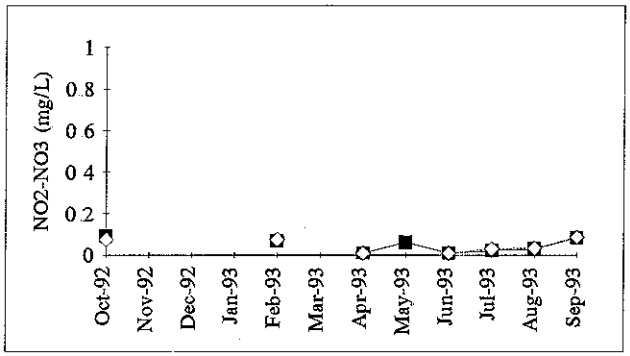


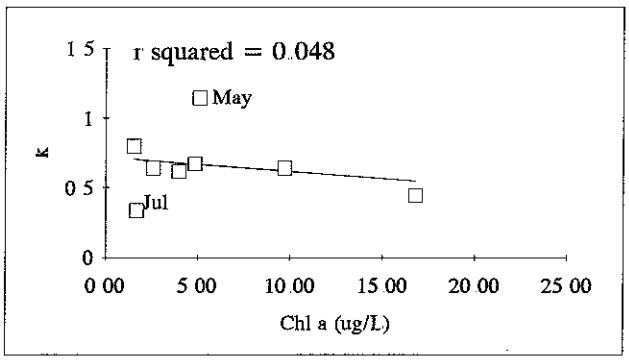


GYS016









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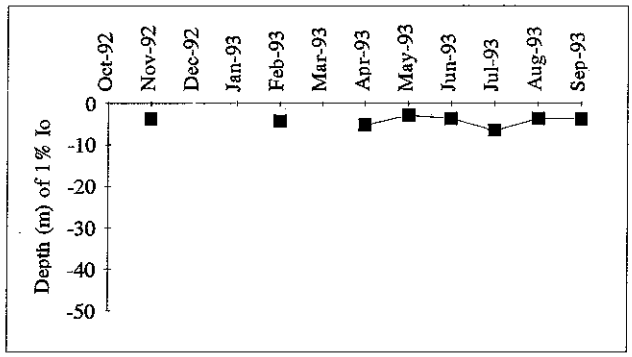

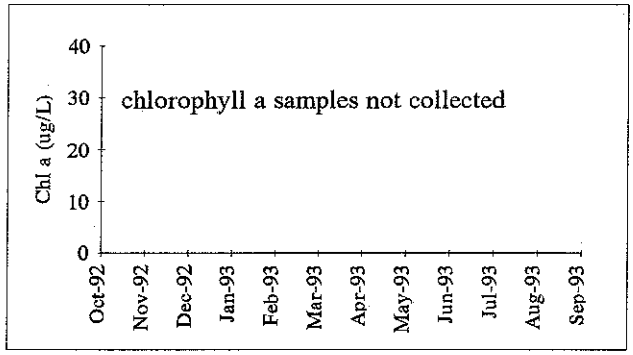

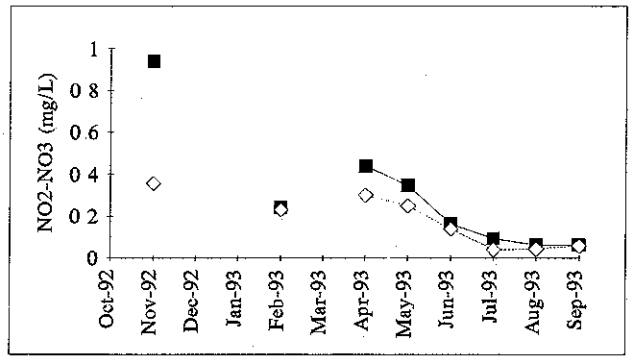

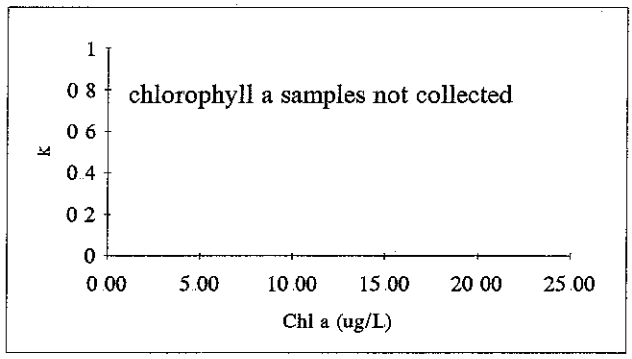

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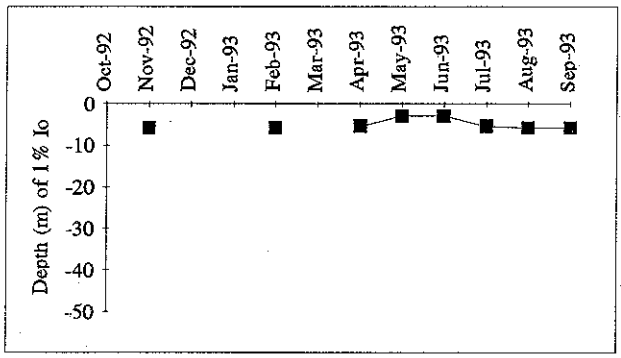

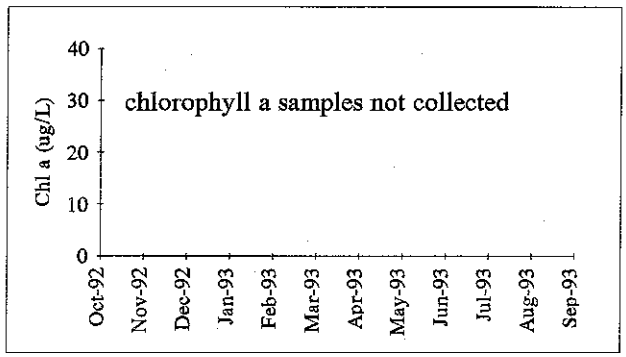

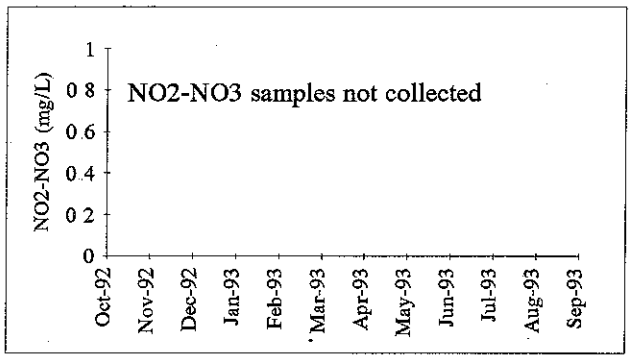

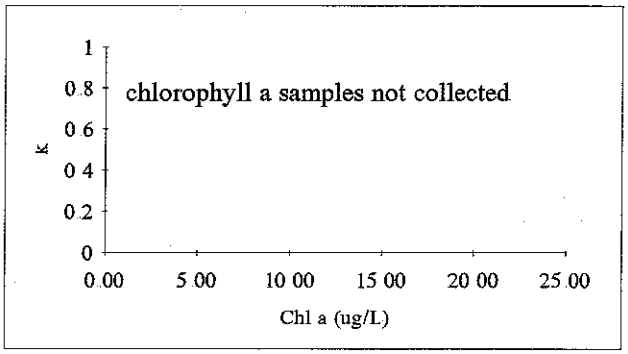

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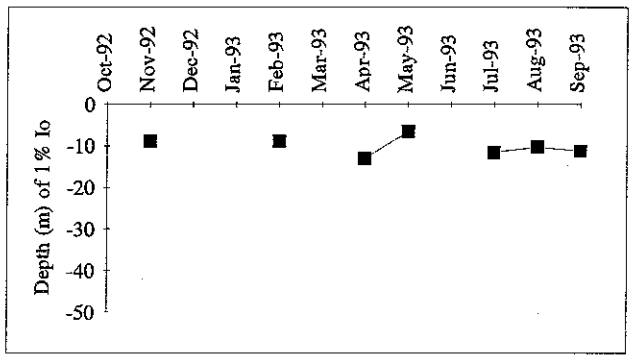

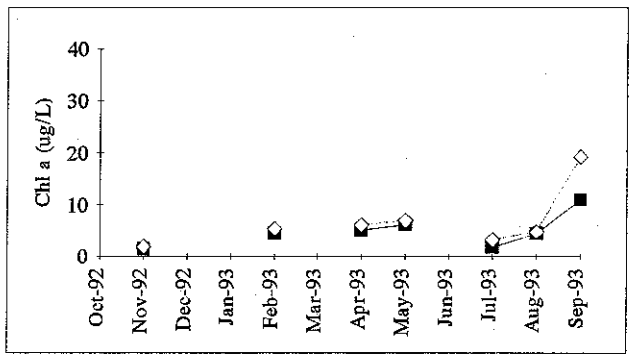

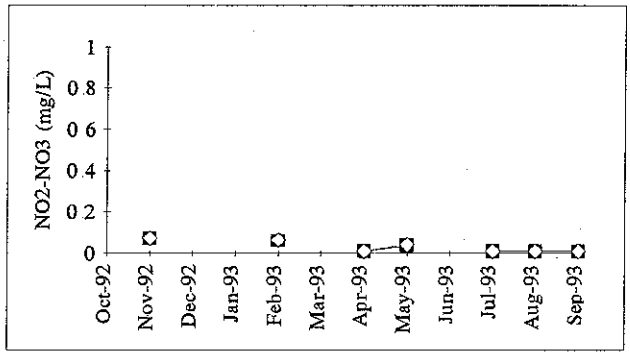

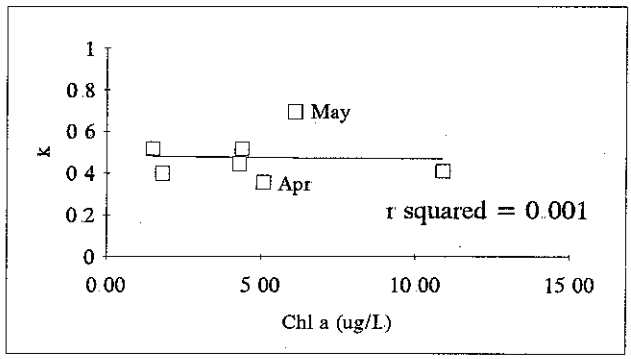

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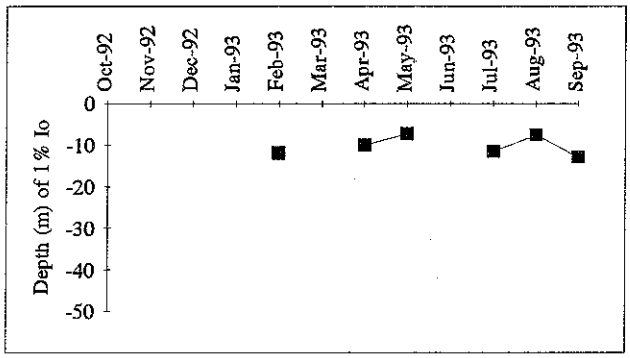

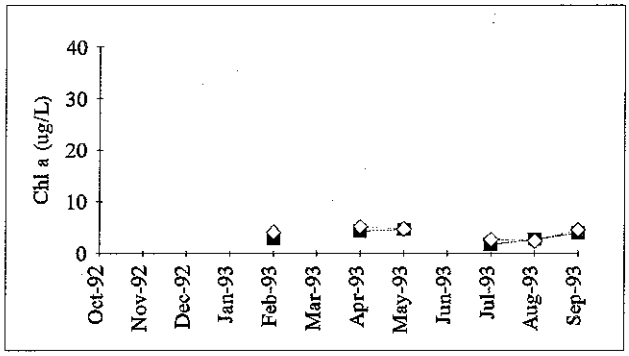

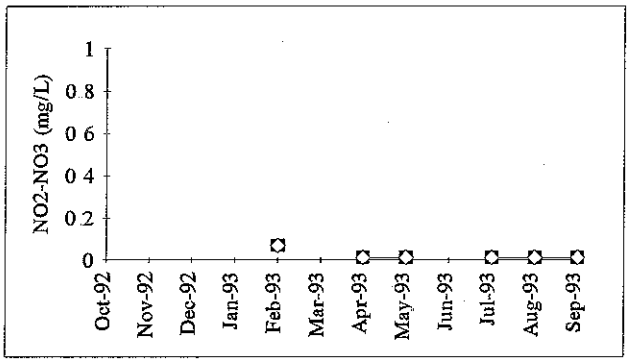

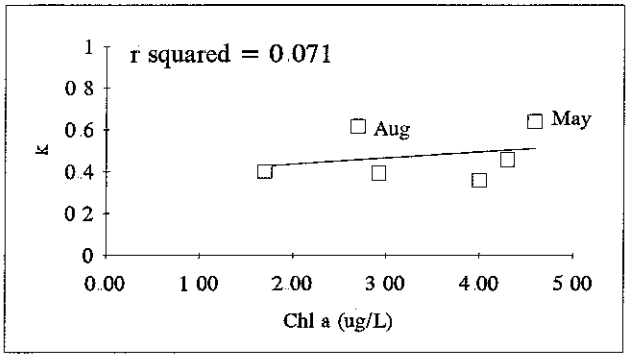

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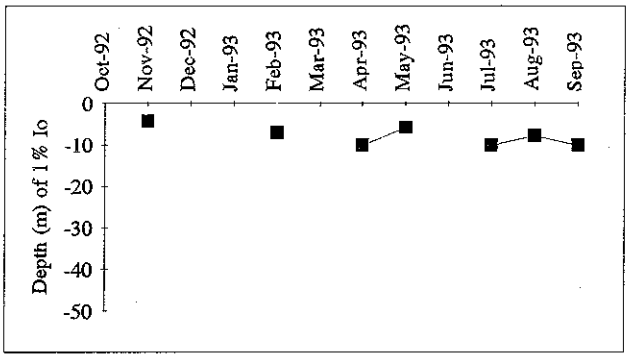

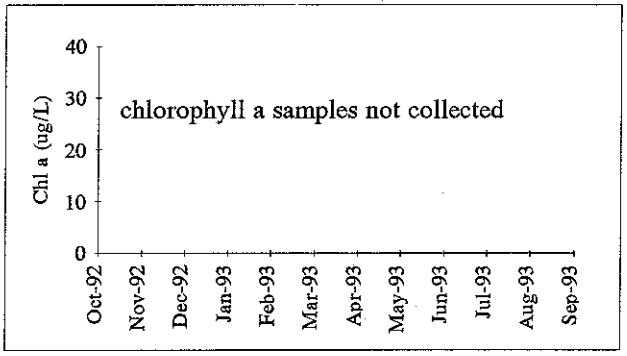

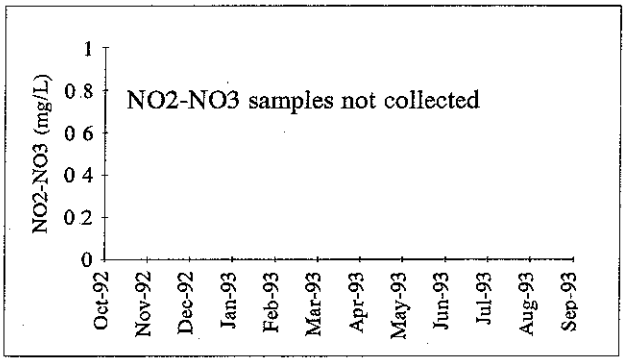

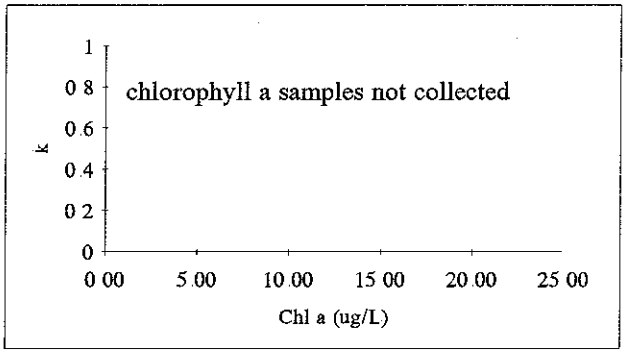

APPENDIX E

WY 1993 Quality Control Report of the Marine Water Column Ambient Monitoring Program

Wateryear 1993 Quality Control
Report of the Marine Water Column Ambient Monitoring Program

Prepared by
M.A. Golliet and J.A. Newton
December 1994

Washington State Department of Ecology
Environmental Investigations and Laboratory Services
Ambient Monitoring Section
Olympia, WA 98504-7710

INTRODUCTION

Quality control (QC) for Wateryear 1993 (WY 1993 = October 1992 through September 1993) included field replicate samples, laboratory replicate samples, blind split samples, field and laboratory method blanks, laboratory check standards, and matrix spike samples.

Parameters evaluated were: fecal coliform bacteria; pigments (chlorophyll *a* (chl *a*) and phaeopigment (phaeo)); and nutrients (dissolved ammonium-N (NH_4^+-N), dissolved nitrite (NO_2^--N), dissolved nitrate+nitrite-N ($NO_3^-+NO_2^-$-N), and dissolved orthophosphate (oPO_4^{-3}-P)).

METHODS

Field replicate samples were collected at the same stations and depths each month (typically one station per survey) by AMS staff. Field replicates for nutrients and pigments, were collected from three separate surface (0.5 m) Niskin® bottle casts. Field replicates for fecal coliform bacteria were collected from two surface (0.1 m) casts using separate sterile bottles. Field replicates provide an estimate of total variability in the results due to both field conditions and laboratory procedures.

Laboratory replicate samples (duplicates) were conducted by MEL for nutrients and fecal coliform bacteria. Laboratory replicates provide an estimate of analytical variability in the sample results. For nutrients, one of the field replicate samples was run through the entire analysis twice. This laboratory replicate does not include variability in filtering the sample. For fecal coliform bacteria, separate aliquots of

one field replicate sample were filtered and analyzed. For pigments, blind split samples were prepared by AMS staff by filtering two separate aliquots from the original sample and submitting the filters blind to the laboratory for analysis. The blind split samples are somewhat similar to laboratory replicates; the replication, however, was performed by AMS staff. The results provide an estimate of variability introduced by filtering and analyzing the samples.

Blanks were determined for nutrient and for pigment analyses. For nutrients, only laboratory method blanks were done; for pigments, both field blanks and laboratory method blanks were made. Laboratory method blanks, conducted by MEL, were used to determine the response of the analytical system to a standard with zero concentration of the analyte. The blank response determines the limit of detection. For nutrients, laboratory method blanks consisted of running deionized water through as a sample in the autoanalyzer. For pigments, laboratory method blanks were conducted by reading a 90% acetone blank in the fluorometer prior (pre) to, and just after (post), taking sample readings. High or very negative results for laboratory method blanks indicate contamination or analytical inaccuracies and can significantly bias sample results, particularly for samples with low concentrations. Field blanks for pigments were made by AMS staff by filtering deionized water (generally after filtering other seawater samples) and submitting the filter to the laboratory for analysis. High values for a pigment field blank indicate contamination during filtration/analytical processes or analytical inaccuracies.

Laboratory check standards are samples with a known concentration that are analyzed along with the other samples. Check standards are prepared independently of the calibration standards and are used to estimate analytical precision and check for bias due to calibration errors. Check standard samples were analyzed by MEL along with each batch of nutrient samples. Check standards were not used for pigment analyses.

Matrix spikes for nutrients were prepared in the laboratory by adding a known quantity of analyte (a spike) to an aliquot of a sample. The analysis consisted of determining the concentration of a nutrient sample (= reading #1), adding the spike to the sample, and determining the resultant concentration (= reading #2). The percent recovery of the spike is calculated using the formula:

((sample conc. + spike conc.) - sample conc.)/spike conc.
or, simply
(reading #2 - reading #1)/ known spike conc.

Matrix spike samples indicate the bias in laboratory procedures and instrumentation used in nutrient analysis. If the spike recovery is between 70% and 130%, no interference from the sample matrix is judged to be present, since recoveries will by randomly distributed about a mean of 100%. The acceptance range for spike recovery is wide because the random error in the difference between two measurements is relatively large.

RESULTS AND DISCUSSION

Precision

The precision of the results was estimated as the relative standard deviation (RSD) of the replicate or split sample results. The RSD, also known as the coefficient of variation, is a measure of sample variability relative to the mean and was calculated as:

$$\%RSD = (\text{sample standard deviation} / \text{sample mean}) * 100$$

Table E.1 lists the results for laboratory replicates, blind split samples, and field replicates. Results below reporting limit (BRL) were not included in the RSD calculations. Laboratory reporting limits were 0.01 mg/L for nutrients and 0.05 μg/L for chl *a* and phaeo.

For the period from 5 October 1992 through 3 March 1993, fluorometer calibration coefficients that were later determined to be inaccurate were used for chl *a* and phaeo calculations. Coefficients obtained in a subsequent calibration of the fluorometer were used to recalculate these chl *a* and phaeo concentrations. These results have been qualified as estimates (J quality code), and were not used in RSD calculations.

Table E.1 shows the percent of laboratory replicate samples, field replicate samples, and blind split samples with RSD values within various ranges. The target RSD ranges of 10% for nutrients and 20% for fecal coliform bacteria, chl *a,* and phaeo are based on the Ambient Marine Water Column Monitoring Plan (Janzen, 1992). The laboratory replicate nutrient samples always showed better estimated precision (a higher percentage of target RSD values) than field replicate nutrient samples. This could be expected because field replicate samples are affected by variable field conditions, sampling technique, as well as laboratory variability.

It also should be noted that there is an influence of the number of replicate sets on the percentage of the RSD values that fall into the target RSD range. The number of replicate sets for each category is shown in Table E.1. Comparing laboratory replicates with field replicates may be misleading when the number of replicate sets for each category are quite different. For instance, an influence on the higher percentage of ammonium-N laboratory replicates in the target RSD range (67%) than for the field replicates (54%), may be that there are 85 replicate sets for the laboratory replicates and only 24 for the field replicates.

Dissolved ammonium-N laboratory replicates had the lowest percentage of samples that fell within the target RSD range of all of the nutrients (Table E.1). This same result has been observed in the past two wateryears (Janzen and Eisner, 1993a,b). The majority of the chl *a* and phaeo results were in the target 0-20% RSD range. Blind splits and field replicates for chl *a* and phaeo samples showed comparable amounts of estimated precision. For chl *a* and phaeo, there were 73% and 60%,

Table E.1. Relative standard deviations (RSD) for laboratory replicates, field replicates, and blind laboratory splits of nutrient, fecal coliform bacteria, and pigment samples from WY 1993. Shading indicates the target RSD range (Janzen, 1992) and "n" refers to the total number of replicate sets in each category. Below reporting limit data for all parameters was excluded.

	NH_4^+-N		$NO_3^-+NO_2^-$-N		oPO_4^{-3}-P	
RSD (%)	lab rep.	field rep.	lab rep.	field rep.	lab rep.	field rep.
0-10	66.67%	54.17%	92.94%	76.32%	92.13%	68.18%
10-20	20.24%	29.17%	1.18%	21.05%	5.62%	22.73%
20-30	4.76%	8.33%	1.18%	0.00%	2.25%	6.82%
30-40	2.38%	4.17%	3.53%	2.63%	0.00%	0.00%
40-50	2.38%	0.00%	0.00%	0.00%	0.00%	2.27%
50-60	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
60-70	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
70-80	2.38%	0.00%	0.00%	0.00%	0.00%	0.00%
80-90	0.00%	4.17%	0.00%	0.00%	0.00%	0.00%
90-100	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
>100	1.19%	0.00%	1.18%	0.00%	0.00%	0.00%
n	84	24	85	38	89	44

	fecal coliform bacteria		chlorophyll *a*		phaeopigment	
RSD (%)	lab rep.	field rep.	field rep.	blind split	field rep.	blind split
0-10	64.29%	42.86%	35.00%	63.64%	11.11%	30.00%
10-20	14.29%	21.43%	35.00%	9.09%	55.56%	30.00%
20-30	0.00%	0.00%	20.00%	18.18%	22.22%	10.00%
30-40	2.38%	0.00%	5.00%	0.00%	5.56%	20.00%
40-50	2.38%	0.00%	0.00%	0.00%	5.56%	0.00%
50-60	0.00%	0.00%	0.00%	0.00%	0.00%	10.00%
60-70	0.00%	14.29%	5.00%	0.00%	0.00%	0.00%
70-80	2.38%	7.14%	0.00%	0.00%	0.00%	0.00%
80-90	0.00%	7.14%	0.00%	9.09%	0.00%	0.00%
90-100	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
>100	14.29%	7.14%	0.00%	0.00%	0.00%	0.00%
n	42	14	20	11	18	10

respectively, of the blind split samples in the target RSD range versus 70% and 67% for the field replicates. Because of the small sample size for pigment data, these results should be interpreted with caution. Fecal coliform bacteria displayed better precision for laboratory replicates than for field replicates (Table E.1). High RSD values would be expected for fecal coliform bacteria data due to the frequency of samples with low numbers of organisms since a difference in one organism has greater impact when total organism counts are low.

To determine if precision was influenced by sample concentration, RSD values were plotted against sample concentration for ammonium-N, nitrate+nitrite-N orthophosphate-P, and chl *a* (Figure E.1). These plots show a general trend of better precision with increasing concentration. The results for ammonium-N illustrate this trend particularly well. Chlorophyll *a* field replicate samples and blind split samples show a similar pattern of better precision with increasing concentration.

Accuracy

The accuracy of the laboratory nutrient analyses was indicated by the results of the check standard analyses. Check standards of high (0.5 mg/L) and low (0.075 mg/L) known concentrations were analyzed with each batch of nutrient samples processed. For each nutrient, the average and range of the concentration determined, and the average and range of the percent error were calculated for both the high concentration and low concentration check standards (Table E.2).

The check standard results indicate good accuracy ($\leq$5% error) for all nutrients when average values are considered. However, the ranges for most of the nutrients are quite broad and all but two of the eight categories include errors over 10%. The 35% error for low concentration orthophosphate-P is notable.

The range of the percent error was larger for the low check standard than for the high check standard. The vast majority of the marine water ammonium-N, nitrite-N, and orthophosphate-P concentrations are below 0.075 mg/L, and it is not uncommon for nitrate+nitrite-N concentrations to be below this level. The accuracy of samples with concentrations lower than 0.075 mg/L is impossible to determine without a lower concentration check standard.

Spiked Samples

The average and range of the percent recovery of nutrient spiked samples also give an indication of analytical accuracy (Table E.3). The spiked sample percent recovery for all nutrients fell within the acceptable range of 70% - 130% (S. Lombard, pers. comm.). All nutrients showed ranges of percent recovery greater than $\pm$ 10%.

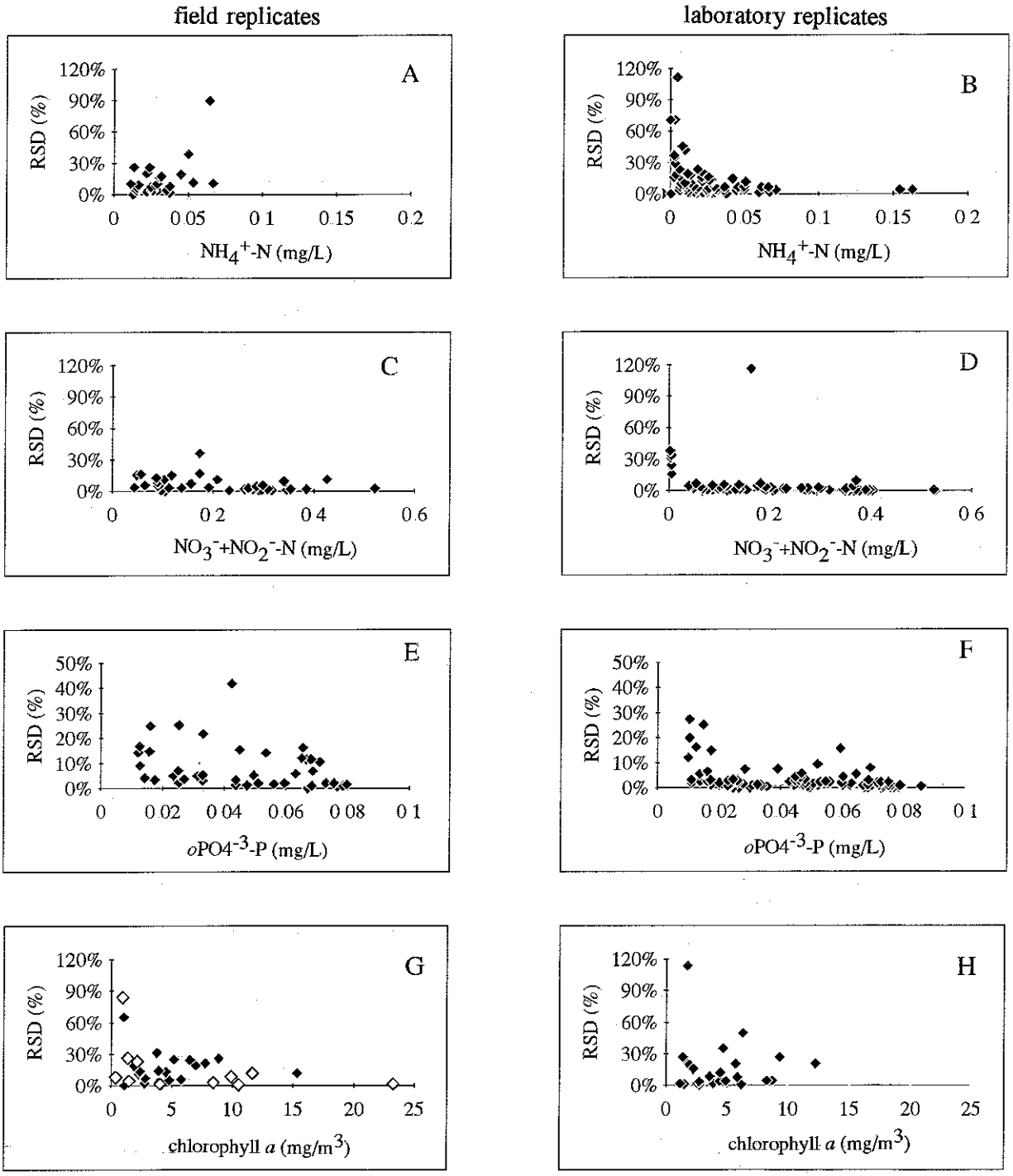

Figure E.1. Percent relative standard deviation versus concentration for: (A) NH_4^+-N field replicates; (B) NH_4^+-N laboratory splits; (C) NO_2^-+NO_3^--N field replicates; (D) NO_2^-+NO_3^--N laboratory splits; (E) oPO_4^{-3}-P field replicates; (F) oPO_4^{-3}-P laboratory splits; (G) chlorophyll *a* field replicates (solid diamonds) and blind laboratory splits (empty diamonds); and (H) chlorophyll *a* laboratory splits

Table E.2. Results of nutrient check standard analyses for WY 1993.

Parameter	n	Check standard concentration (mg/L)	Concentration determined (mg/L) average	Concentration determined (mg/L) range	% error average	% error range
NH_4^+-N	37	0.500	0.496	0.434 -- 0.532	-1.68%	-6.38% -- 13.14%
	37	0.075	0.075	0.063 -- 0.084	-0.31%	-11.47% -- 15.73%
NO_2^--N	29	0.500	0.492	0.473 -- 0.513	-1.57%	-2.66% -- 5.50%
	29	0.075	0.073	0.063 -- 0.086	-3.23%	-14.67% -- 13.87%
NO_3^-+NO_2^--	37	0.500	0.498	0.464 -- 0.578	-0.46%	-15.32% -- 7.18%
	37	0.075	0.075	0.067 -- 0.083	0.22%	-10.80% -- 10.13%
$o PO_4^{-3}$-P	39	0.500	0.498	0.447 -- 0.521	-0.50%	-4.34% -- 10.64%
	39	0.075	0.071	0.048 -- 0.080	-5.05%	-6.40% -- 35.47%

Percent error was calculated as:

% error + [(average conc. - standard conc.) / standard conc.] x 100

Table E.3. Spiked sample recovery results for WY 1993.
See text for calculation of the % recovery of the spike.
The range of acceptable recovery is 70% -- 130%.

Parameter	n	% recovery average	% recovery range
NH_4^+-N	37	90.31%	73.2% -- 111%
NO_2^--N	29	102.18%	90.8% -- 111%
$NO_3^-+NO_2^-$-N	38	97.40%	80.1% -- 130%
$o PO_4^{-3}$-P	37	98.61%	86.2% -- 123%

Blanks

The laboratory method blank average value and range were determined for each of the four nutrients analyzed by MEL (Table E.4). All values fell below the nutrient reporting limits. No field blanks were prepared for nutrients.

Both laboratory method blanks and field blanks for pigments were often higher than the reporting limit (Table E.4). Because pigment results from 5 October 1992 through 3 March 1993 were not used, there are only a few samples that comprise the WY 1993 results. Therefore, these results are not conclusive; however, since these high blank values are higher than many of the water column samples, investigation of both the field technique and laboratory analysis contamination or inaccuracies is indicated. Both of these are currently being done.

Below Reporting Limit (BRL) Data

Table E.5 summarizes the data that fell below the laboratory reporting limits for WY 1993. Analysis for nitrite-N was discontinued at all but three stations in May 1992, because a large percentage of the monitoring station samples had concentrations BRL. Samples from the three stations where nitrite-N was assumed to be most prevalent still showed 88% to be BRL. Almost half (44%) of the ammonium-N samples were BRL. This is expected because phytoplankton have high affinity for ammonium-N and, thus, concentrations are generally low.

SUMMARY

Data quality for WY 1993 was acceptable for most parameters. Chlorophyll *a* and phaeopigment data from 05 October 1992 through 03 March 1993 were qualified as estimates, because coefficients from a calibration done after this period were used to calculate the results. These data were not used in any QC evaluations.

For all nutrients and for fecal coliform bacteria, estimated precision was better for laboratory replicates than for field replicates. For pigments, blind split samples showed comparable precision with field replicates; however, the sample size was low for pigment results. Laboratory replicates of all nutrient parameters showed better estimated precision with increasing concentration, as did field replicate and blind split samples for chl *a* .

Accuracy of methods used to analyze nutrient samples is acceptable for samples with concentrations greater than 0.075 mg/L. Puget Sound nutrient sample concentrations are generally below this level. A lower concentration check standard is necessary for better determination of nutrient sample accuracy.

High laboratory method blanks and field blanks for pigment analysis indicate contamination or inaccuracies in the method and are currently being investigated.

Table E.4. Blank results for WY 1993. Both laboratory method blanks and field blanks are shown.

Parameter	n	blank value average	blank value range	detection limit
laboratory method blanks:				
NH_4^+-N	78	0.001	-0.001 -- 0.009	0.01
NO_2^--N	62	0.0002	-0.008 -- 0.009	0.01
$NO_3^-+NO_2^-$-N	80	-0.0004	-0.007 -- 0.007	0.01
oPO_4^{-3}-P	80	-0.0004	-0.004 -- 0.008	0.01
chlorophyll *a* (pre)	4	0.186	0.097 -- 0.381	0.05
chlorophyll *a* (post)	1	0.012	0.012	0.05
phaeopigment (pre)	4	0.152	0.03 -- 0.364	0.05
phaeopigment (post)	1	0.027	0.027	0.05
field blanks:				
chlorophyll *a*	3	0.677	0.17 -- 1.2	0.05
	2	BRL	BRL	
phaeopigment	4	0.175	0.09 -- 0.27	0.05
	7	BRL	BRL	

Table E.5. Number and percent of WY 1993 data with concentrations below detection limit (BRL).

	NH_4^+-N	NO_2^--N	$NO_3^-+NO_2^-$-N	oPO_4^{-3}-P
# of samples BRL	302	66	82	39
total # of samples	682	75	680	682
% of samples BRL	44.28%	88.00%	12.06%	5.72%

	chlorophyll *a*	phaeopigment	fecal coliform bacteria
# of samples BRL	1	1	153
total # of samples	527	527	265
% of samples BRL	0.19%	0.19%	57.74%

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