FINAL TECHNICAL REPORT (VERSION 2.0)

PHYSICAL OCEANOGRAPHY OF THE POINT THOMSON UNIT AREA: 1997 AND 1998 REGIONAL STUDIES

Prepared for

BP AMOCO
and
Pt. Thomson Unit Owners

May 25, 1999

URS Greiner Woodward Clyde
A Division of URS Corporation

3501 Denali Street, Suite 101
Anchorage, Alaska 99503

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BP AMOCO and its lease partners are currently evaluating coastal petroleum reservoirs for commercial development in the Pt. Thomson Unit. Foreseeable development may include a gravel-fill dock extending to the 10-ft isobath, coastal well pads, a central process facility, an in-field road and a pipeline system, an airstrip, and a transportation pipeline connecting with the Badami pipeline. Federal permits will be required to construct the proposed development, thus, an environmental impact analysis will be completed based on procedures promulgated in the National Environmental Policy Act (NEPA) of 1969.

There is a lack of available physical environment and ecology data available for the Pt. Thomson Unit to support a NEPA analysis, thus, BP AMOCO initiated several studies to collect area-wide or regional data sets. The goal of these studies is to collect baseline information on the physical environment and ecology such that potential habitat alteration and wildlife disturbance can be evaluated during the NEPA analysis. Site-specific environmental studies will be developed in subsequent years as facility engineering design evolves. The combination of regional and site-specific studies is necessary to meet U.S. Federal and State of Alaska regulatory requirements.

This report presents the findings from the 1997 and 1998 regional physical oceanography studies conducted within the lagoon system that extends the length of the Pt. Thomson Unit from Bullen Point to Brownlow Point (Figure 1-1). The lagoon, known as Lions Lagoon, is separated from the Beaufort Sea by a barrier island complex that includes the Maguire Islands and Flaxman Island. These reconnaissance studies were designed to:

- Collect a representative data set to verify that regional processes observed throughout the Beaufort Sea are valid to describe the behavior and character of lagoon waters
- Collect baseline water quality and current velocity data to support environmental permit applications
- Build a multi-year regional physical oceanography data set to support a comprehensive Environmental Impact Statement.

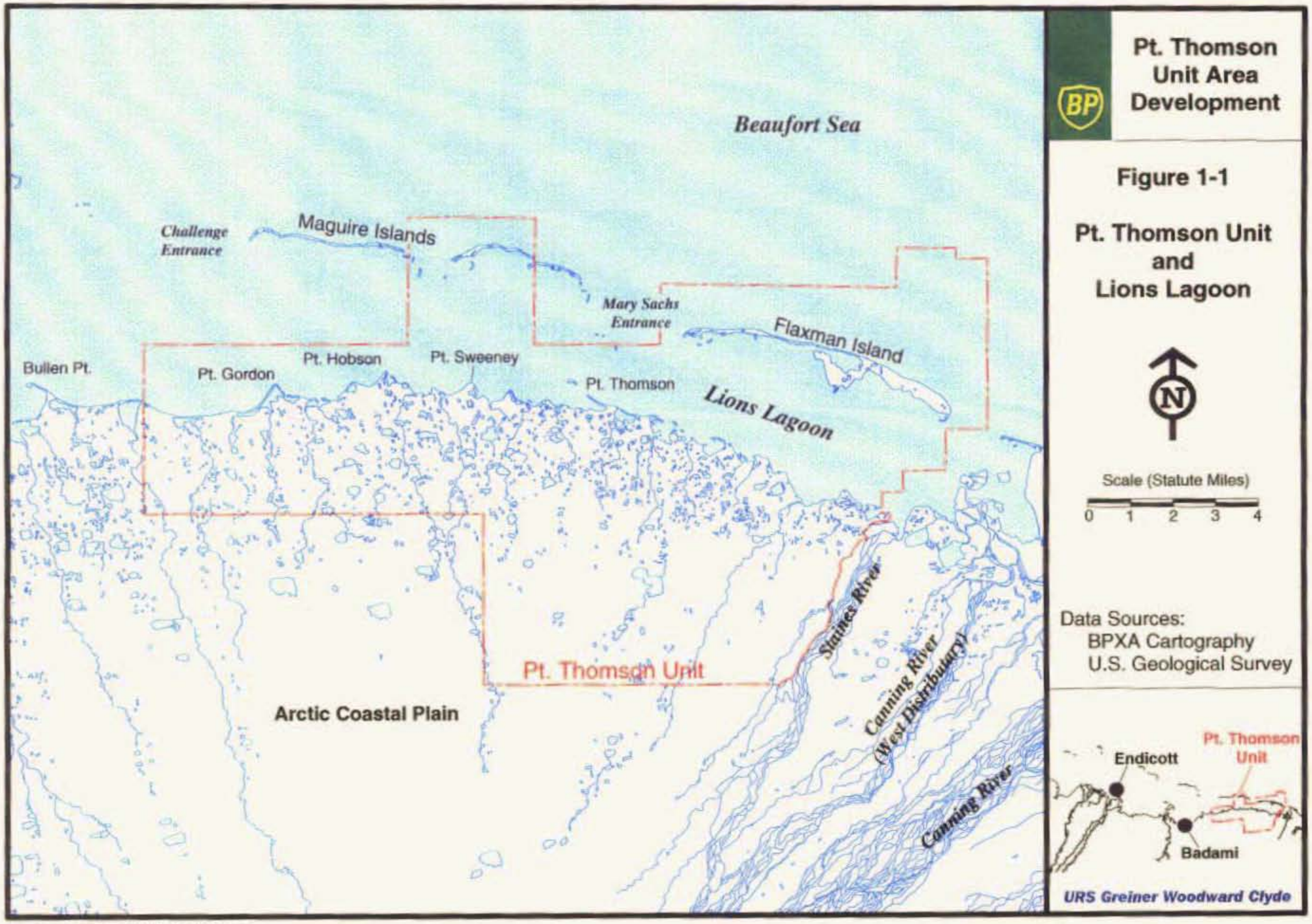


Figure 1-1

Pt. Thomson Unit and Lions Lagoon

2.1 REGIONAL PROCESSES

During the early 1980s, Kinnetic Laboratories, Inc. (1983) conducted an environmental study with physical oceanographic components that documented conditions within Lions Lagoon and adjacent waters. The study objectives were broad and focused on describing regional processes. Nearly two decades later, numerous observations and analyses throughout the coastal Beaufort Sea have provided a well-founded understanding of the regional oceanography (Colonell and Gallaway 1990). These studies indicate that the hydrography of virtually any location along the Alaska Beaufort coast is governed primarily by proximity of a freshwater source and recent wind history, and secondarily by the occasional profound effects of regional upwelling and downwelling phenomena. Substantial fresh water input results in brackish nearshore waters immediately adjacent to the river delta. Wind stress serves to advect this freshwater discharge down current and promotes vertical mixing. The prevailing winds tend to parallel the coast, such that easterly winds result in an offshore movement of surface water which is replaced with upwelled marine bottom waters. Conversely, westerly winds force surface waters onshore, resulting in elevated water levels and typically uniform brackish nearshore waters.

Lions Lagoon is not unique; Simpson Lagoon located west of Prudhoe Bay is similar in size, depth, orientation to prevailing winds, and fresh water input. Environmental studies (summarized by Colonell and Gallaway 1990) conducted within Simpson Lagoon indicate that the regional oceanographic processes influence the water quality and movement throughout the lagoon system. Thus, Simpson Lagoon serves as an useful analog to provide insight to the dynamics of Lion Lagoon.

2.2 STUDY OBJECTIVES

The 1997 and 1998 physical oceanography studies are based on the current understanding of regional physical oceanographic processes for the nearshore Beaufort Sea and Simpson Lagoon. The study objectives are to:

- Collect representative hydrodynamic (current velocity and water level), hydrographic (water column structure), water quality, and meteorological records for multiple years to construct a regional physical oceanography database
- Verify that the regional physical oceanographic processes control the water movement, water column structure, and water quality within the lagoon system

The sample design includes documenting the water exchange through the barrier island channels that separate the lagoon system with the Beaufort Sea. Sampling stations are positioned to document freshwater input from local rivers and observe marine water intrusions into the lagoon system. Relative water level measurements, correlated to wind stress and marine water intrusions serve to confirm the regional upwelling and downwelling phenomena. The objectives of the 1997 and 1998 physical oceanography studies have been to describe the regional physical oceanographic conditions for the Pt. Thomson Unit nearshore waters. They are not site-specific studies that will satisfy the data requirements for a comprehensive NEPA analysis. As the conceptual engineering process evolves to the point that coastal facilities can be determined, site-specific studies can be developed and integrated with regional studies to assure sufficient representative data are available.

2.3 DATA COLLECTION

The 1997 physical oceanography-meteorology study characterized the lagoon waters east of Pt. Thomson, in the vicinity of Flaxman Island. Current meters were deployed in Mary Sachs Entrance, east end of Flaxman Island, and in the lagoon north of an abandoned mainland drill pad. The lagoon mooring was lost, resulting in no data. A tide gauge was deployed on the south shore of Flaxman Island to measure the water level fluctuations within the lagoon. Nearby, a meteorological station was deployed on a bluff at the east end of Flaxman Island (Figure 2-1).

The 1998 study area was enlarged to include all of the lagoon system, extending from Bullen Point to Brownlow Point. Current meters, a tide gauge, and a meteorological station were deployed in the same locations as the 1997 survey; however, the lagoon mooring was lost, another current meter failed, and the other mooring could not be recovered due to sediment burial of the anchor. Four hydrography surveys were conducted between July and September 1998 to observe the natural variations in the water column structure and water quality (Figure 2-2). In situ measurements were made during all surveys, and water samples for chemical analyses were collected during the July and September surveys.

2.3.1 Meteorology

Coastal observations of wind velocity (e.g., speed and direction) collected within the study area support the physical oceanographic analyses. During 1997 and 1998, a portable meteorological station was established on top of a bluff at the east end of Flaxman Island. The 1997 record set was complete; however, the 1998 record was truncated when a severe storm damaged the station. The National Oceanic and Atmospheric Administration (NOAA) meteorological station at West Dock provided additional data to support analyses of regional processes.

2.3.2 Hydrodynamics (Water Movement)

The initial engineering design included one dock located east of Pt. Thomson. To reduce costs, all current meters and tide gauge moorings were located east of Pt. Thomson. Two moorings were positioned in the channels at each end of Flaxman Island to observe the water exchange between the Beaufort Sea and the eastern portion of Lions Lagoon. The current meter mooring deployed in the lagoon was to measure current velocities, temperature, and conductivity in the vicinity of the proposed dock.

2.3.3 Hydrography (Temperature and Salinity) and Water Quality

At each sampling station, a conductivity-temperature-depth (CTD) instrument recorded nearly continuous (0.5 second intervals) measurements of conductivity, temperature, and pressure as it was lowered through the water column. While salinity and density cannot be directly measured, they can be derived from CTD measurements. The CTD data (i.e., cast) collected at each station were presented as a vertical profile of temperature and salinity to delineate the water column structure.

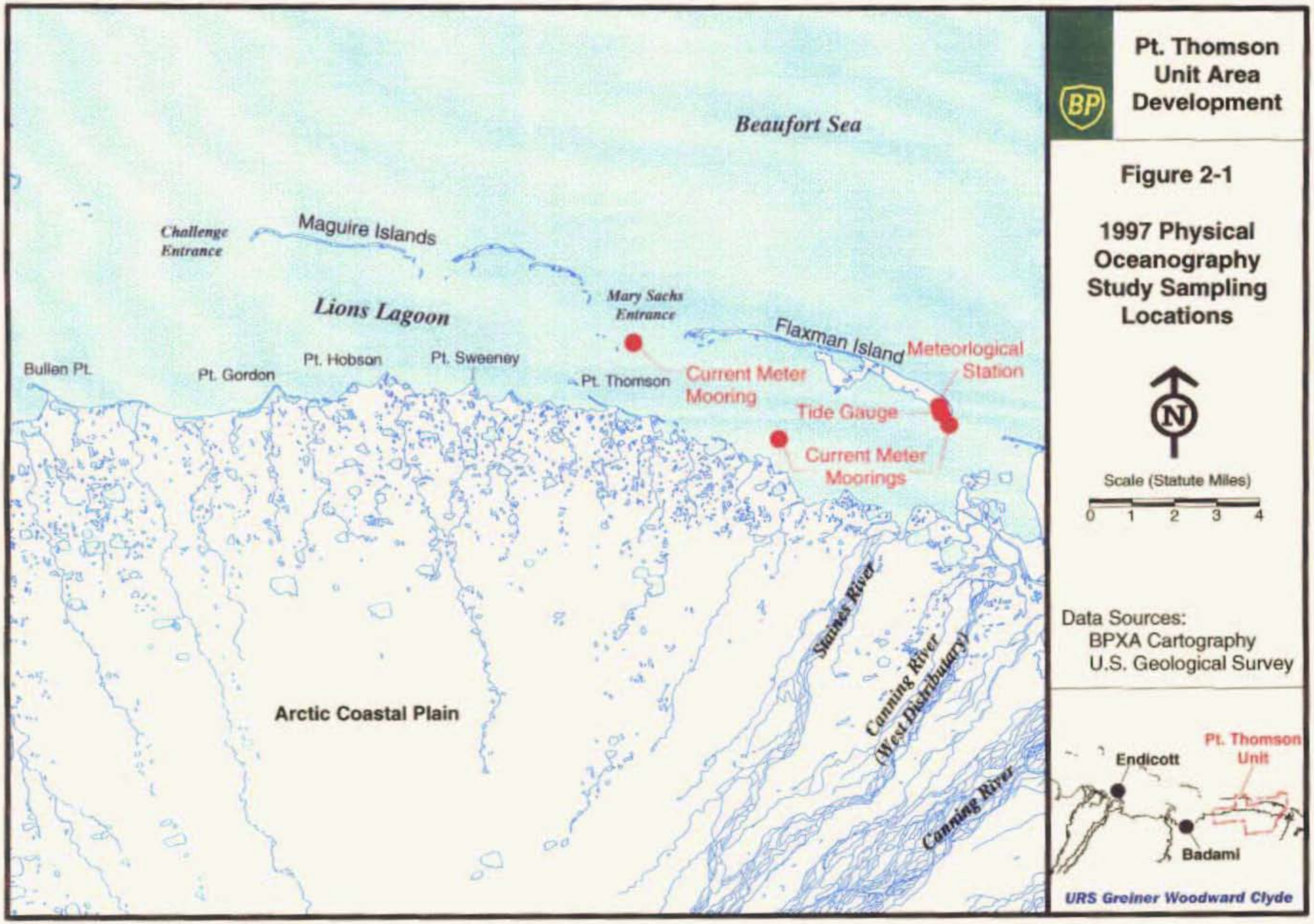
Standard water quality parameters monitored for typical industrial wastewater discharges were also measured in situ. Dissolved oxygen (DO), pH, and turbidity measurements were collected at depth intervals at selected stations to describe natural variations of Lions Lagoon waters.

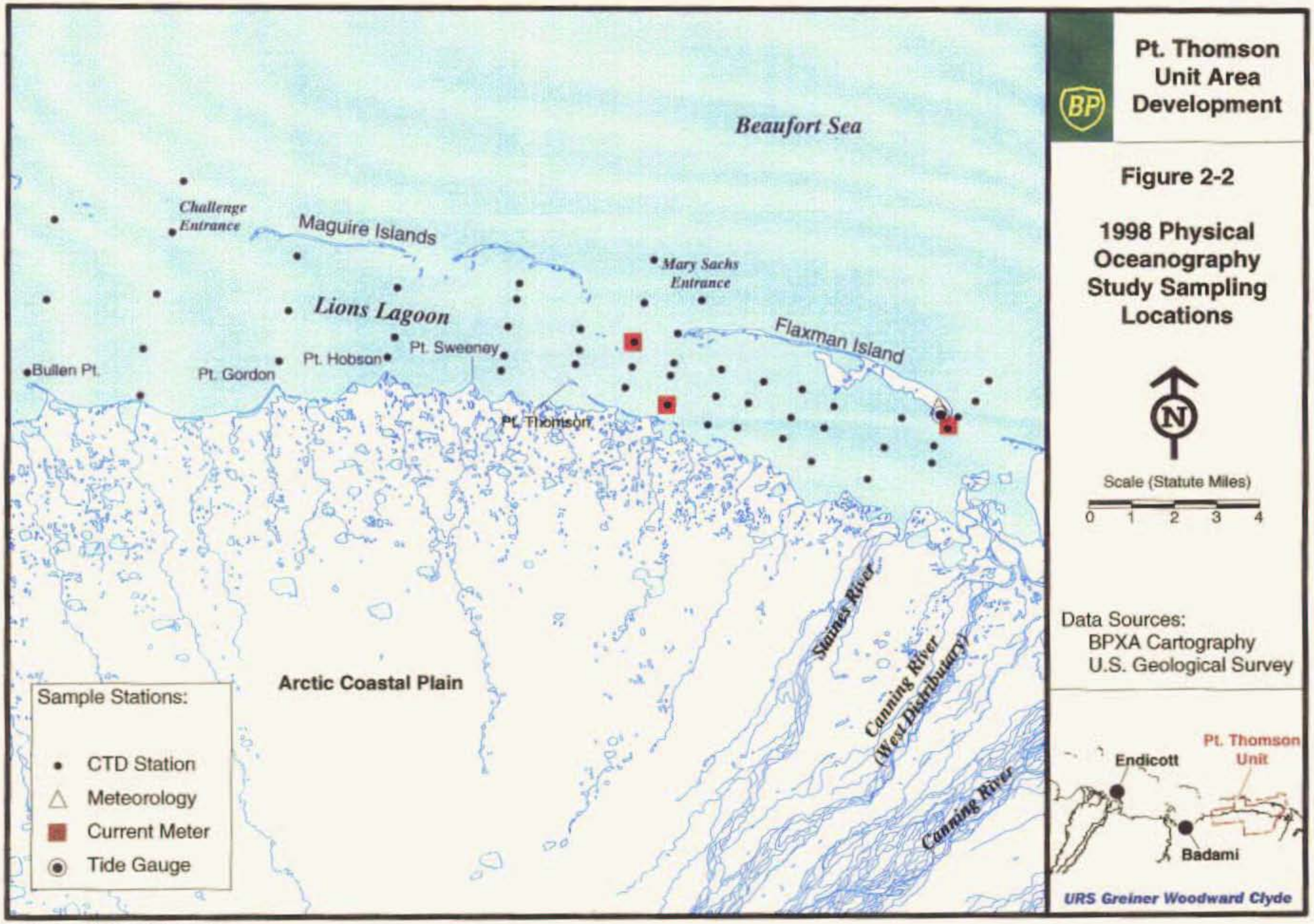
2.3.4 Water Chemistry

Discrete water samples were collected for laboratory analysis at three water depths at the lagoon current meter mooring (Station FLW-CM) with a Niskin Sample Bottle. Each sample was analyzed for selected heavy metals, total suspended sediment (TSS), total organic carbon (TOC), and chemical oxygen demand (COD). Table 2.1 presents the laboratory methods used for each analysis.

Table 2.1 Laboratory analyses for samples collected during the 1998 summer open-water season.

Analysis	Laboratory	Method
BOD_5	Prudhoe Bay Unit Laboratory (ARCO)	BOD 5-day method
TOC	MultiChem Analytical Services	9060
TSS	CT&E Environmental Services	160.2
COD	CT&E Environmental Services	410.1
Metal - Mercury	Quanterra Environmental Services	SW7470
Metals - Ar, Ba, Cr, Pb	Quanterra Environmental Services	6020M


Beaufort Sea
Challenge Entrance
Maguire Islands
Lions Lagoon
Mary Sachs Entrance
Flaxman Island
Meteorlogical Station
Bullen Pt.
Pt. Gordon
Pt. Hobson
Pt. Sweeney
Pt. Thomson
Current Meter Mooring
Tide Gauge
Current Meter Moorings
Staines River
Canning River (West Distributary)
Canning River
Arctic Coastal Plain
Pt. Thomson Unit Area Development
Figure 2-1
1997 Physical Oceanography Study Sampling Locations
N
Scale (Statute Miles)
0 1 2 3 4
Data Sources:
BPXA Cartography
U.S. Geological Survey
Endicott
Pt. Thomson Unit
Badami
URS Greiner Woodward Clyde


Pt. Thomson
Unit Area
Development
Figure 2-2
1998 Physical Oceanography Study Sampling Locations
Beaufort Sea
Challenge Entrance
Maguire Islands
Mary Sachs Entrance
Lions Lagoon
Flaxman Island
Pt. Sweeney
Pt. Hobson
Pt. Gordon
Bullen Pt.
Pt. Thomson
Arctic Coastal Plain
Staines River
Canning River (West Distributary)
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Meteorology
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Tide Gauge
Scale (Statute Miles)
0 1 2 3 4
Data Sources:
BPXA Cartography
U.S. Geological Survey
Endicott
Pt. Thomson Unit
Badami
URS Greiner Woodward Clyde

3.1 1997 PHYSICAL OCEANOGRAPHY RESULTS

The 1997 study collected time-series records from a meteorological station, a tide gauge (water level), and two current meter moorings. These instruments were deployed on 04 August 1997 and collected data until recovery on 12 September 1997.

3.1.1 Meteorological Data Set

The wind velocity (speed and direction) record indicated early to mid-August 1997 was a mixture of relatively short periods of east and west winds (Figure 3-1). Typically, winds shifted direction every 24 to 36 hours. Persistent easterly winds started on the 19 August 1997 and continued until the end of the survey, 12 September 1997. These persistent easterly winds were associated with relatively high wind speeds, with hourly averages reaching 30 knots on 26 August 1997. This 23 to 27 August storm caused damage to a marine geophysical survey working in the area.

3.1.2 Water Level

The tide gauge installed in a sheltered cove within Lions Lagoon at the east end of Flaxman Island provided a continuous water level record (Figure 3-1). All water elevations were relative, since the tide gauge elevation was not surveyed to a local datum. Astronomical tide fluctuations were evident by the 12-hour signal (period) that was an approximate height (magnitude) of 15 centimeters (cm) (0.5 foot); these measurements are consistent with regional observations.

The instrument record indicated that the water level varied approximately 1.2 meters (3.9 feet). During periods with persistent easterly winds, the water level dropped within the lagoon system, while periods of elevated water levels coincided with westerly winds. The water level can change rapidly; during the 23 to 27 August storm, the water level dropped 65 cm (2.1 feet) within 48 hours.

3.1.3 Hydrodynamics (Water Movement)

Two current meter moorings were recovered: one was positioned mid-channel in Mary Sachs Entrance and the other was located in the channel that separates the east end of Flaxman Island from Brownlow Point (Flaxman Pass). Both meters recorded mid-depth current velocities, water temperature, and conductivity. The current velocity records indicated that the direction of water movement was similar in both channels (Figure 3-2). The current direction records were correlated with local wind direction, indicating that water flowed toward the west during easterly winds and flowed eastward during westerly winds.

Current speeds were different; the median current speed recorded in Mary Sachs Entrance was 17 cm/s as compared to 35 cm/s in the Flaxman Pass. The cumulative frequency diagram (Figure 3-3) indicates that the current speeds in Flaxman Pass were higher than Mary Sachs Entrance.

3.1.4 Hydrography (Water Column Structure)

During instrument deployment, the field crew attempted to collect vertical water column profiles of conductivity and temperature; however, the CTD instrument failed. Complications in retrieving current moorings prevented a CTD survey at the end of the field program. However, the two recovered current meters provided an understanding of the interaction in water mass movement between the Beaufort Sea and the eastern portion of Lions Lagoon.

The computed salinity records for the Mary Sachs Entrance and Flaxman Pass current meter are similar (Figure 3-4). During deployment, both records indicated brackish, 21 to 23 part per thousand (‰) waters were present at mid-depth in both channels. Brackish conditions persisted for the next 6 days. On 10 August 1997, salinity abruptly rose to 30‰, in response to a period of easterly winds. This marked the first 1997 observation of marine water entering Lions Lagoon. After a period of mixed (easterly and westerly) winds, the salinity dropped back to brackish, 18 to 20‰, conditions.

During the 23 to 27 August storm, there was a sharp rise in salinity at the Mary Sachs Entrance mooring; however, salinity values at the Flaxman Pass mooring did not respond in a similar manner. The Flaxman Pass mooring is close to the Staines and Canning rivers and thus was exposed to a significant amount of fresh water compared to the Mary Sachs Entrance mooring. After the 23 to 27 August storm, the salinity values at the two moorings reflected nearly constant 30‰ marine conditions for the remainder of the deployment.

Temperature records from the two moorings corresponded with the salinity values. Water temperatures were relatively warm (5 to 6° Celsius [C]) for brackish waters, and dropped below 1°C during marine intrusions.

3.2 1998 PHYSICAL OCEANOGRAPHY RESULTS

The 1998 study attempted to collect time-series meteorological, current meter, and tide gauge data at the same locations as the 1997 study. However, the loss of current meter moorings and damage to the meteorological station resulted in a limited data set. Four CTD and two water quality surveys were conducted between late July and mid-September 1998. These surveys provided discrete snapshots of the regional water column structure and distribution of selected physical and chemical water quality parameters.

3.2.1 Meteorological Data Set

A partial wind velocity record was recovered from the meteorological station deployed on a bluff at the east end of Flaxman Island. The West Dock NOAA tide gauge and meteorological station were used to construct a complete record. Data from the two stations were compared for the period of overlapping records, and it was concluded that the records were sufficiently similar to support hydrography analysis. It is unlikely that the West Dock data would be adequate for detailed site-specific hydrodynamic analysis for Pt. Thomson waters; however, the loss of current meter moorings reduced the need for local meteorological observations.

Easterly winds persisted throughout much of July, with three consecutive storms having maximum average hourly speeds reaching 30 knots (Figure 3-5). By the end of July, the weather patterns switched to a period of mixed westerly and easterly winds for most of early and mid-August, with the exception of the 4 to 7 August easterly wind event. Easterly winds events dominated of record after 23 August 1998.

3.2.2 Hydrography (Water Column Structure)

Fifty four stations aligned on fifteen transects were occupied during the summer field study to describe the ambient waters within Lions Lagoon. The initial survey conducted on 31 July 1998 encountered saline marine conditions after nearly a month of steady easterly winds (Figure 3-6). Lagoon waters were vertically uniform and relatively warm, with temperatures between 7 and 8°C (Figure 3-7). Fresh water, discharged directly into the east end of Lions Lagoon from the Staines and Canning rivers, was not significant at the time of the survey as indicated by saline (31.5‰) waters adjacent to the river mouths.

Winds alternated between the prevailing easterly and westerly directions such that by the 12 August 1998 survey, Lion Lagoon waters were brackish and warm (Figure 3-8). Freshwater discharge was evident by the low (<5‰) salinities adjacent to the Staines and Canning river mouths located at the east end of the lagoon. A strong salinity front situated in Flaxman Pass marked the location of mixing between the relatively fresh waters from the river discharge and the Beaufort Sea shelf waters. Mixing of the fresh water within the shallow eastern portion of the lagoon indicated that saltier shelf waters were entering the lagoon through the Mary Sachs Entrance. Surface and bottom salinities increased toward the north for waters west of the Mary Sachs Entrance. As in the 31 July 1998 survey, surface salinities were slightly lower near Bullen Pt. This could have been a result of tundra stream runoff that entered into the protected lagoon, where there was an absence of notable river discharge and mixing with shelf waters.

The 25 August 1998 survey coincided with a persistent easterly wind event, and revealed upwelled marine (30‰) bottom waters entering the lagoon through the gaps between the barrier islands (Figure 3-9). These marine waters reached the water surface in Mary Sachs Entrance (Figures 3-10 and 3-11). Freshwater discharge from the Staines and Canning rivers quickly mixed with nearshore waters south of Flaxman Island, creating brackish (22 to 27‰) conditions.

Easterly winds continued and the 13 September 1998 survey observed >30‰ marine waters dominating the lagoon from Pt. Thomson to Bullen Pt (Figure 3-12). Freshwater discharge from the Staines and Canning rivers resulted in a brackish (26 to 30‰) plume extending from the delta, westward along the mainland shore. A cross-section along the length of Lions Lagoon illustrates the uniform marine conditions in the west of Mary Sachs Entrance, and the brackish distal portion of the river discharge plume toward the east (Figure 3-13).

3.2.3 Water Quality

Dissolved oxygen measurements were conducted in the field, and discrete water samples were sent to a Prudhoe Bay laboratory for the July and September surveys. For all samples, the dissolved oxygen values indicated that Lions Lagoon waters were saturated or supersaturated with values typically above 9.5 milligrams per liter (mg/L) (Appendix F). Surface waters tended to have a slightly higher dissolved oxygen value than bottom water; however, the differences were probably not statistically significant.

The average pH value for the summer measurements was 8.0 standard units. Water column profiles indicated that there was a slight increase in pH with depth; however, there was no relationship established with any other water quality parameter collected during the 1998 summer study.

In situ turbidity measurements results confirmed that the influence of wind and waves affected the clarity of the water column. The 12 August 1998 survey was conducted under calm conditions and turbidity measurements averaged 3.4 nephelometric turbidity units (NTU) west of the river mouths. Elevated turbidity values up to 173 NTU were recorded in the shallow waters adjacent to the Staines and Canning river mouths at the east end of Lions Lagoon.

During the 25 August 1998 survey, recent easterly winds exceeded 15 knots, and thus, turbidity values were >10 NTU for waters throughout Mary Sachs Entrance and waters adjacent to the river mouths. Other measurements collected within the protected areas of the lagoon system typically were ≤8 NTU. Similar turbidity values and distribution were observed during the 13 September 1998 survey.

3.2.4 Water Chemistry

Water samples were collected during the 29 July and 11 September surveys to determine the natural concentrations of selected metals and TOC (Appendix F). Arsenic, chromium, lead, and mercury were not detected above method detection limits in these water samples. Barium concentrations during the 29 July survey averaged 0.015 milligrams per liter (mg/L), while the 11 September survey averaged 0.019 mg/L. However, the differences were probably not statistically significant.

Figure 3-1: 1997 Wind Velocity and Water Level Records.

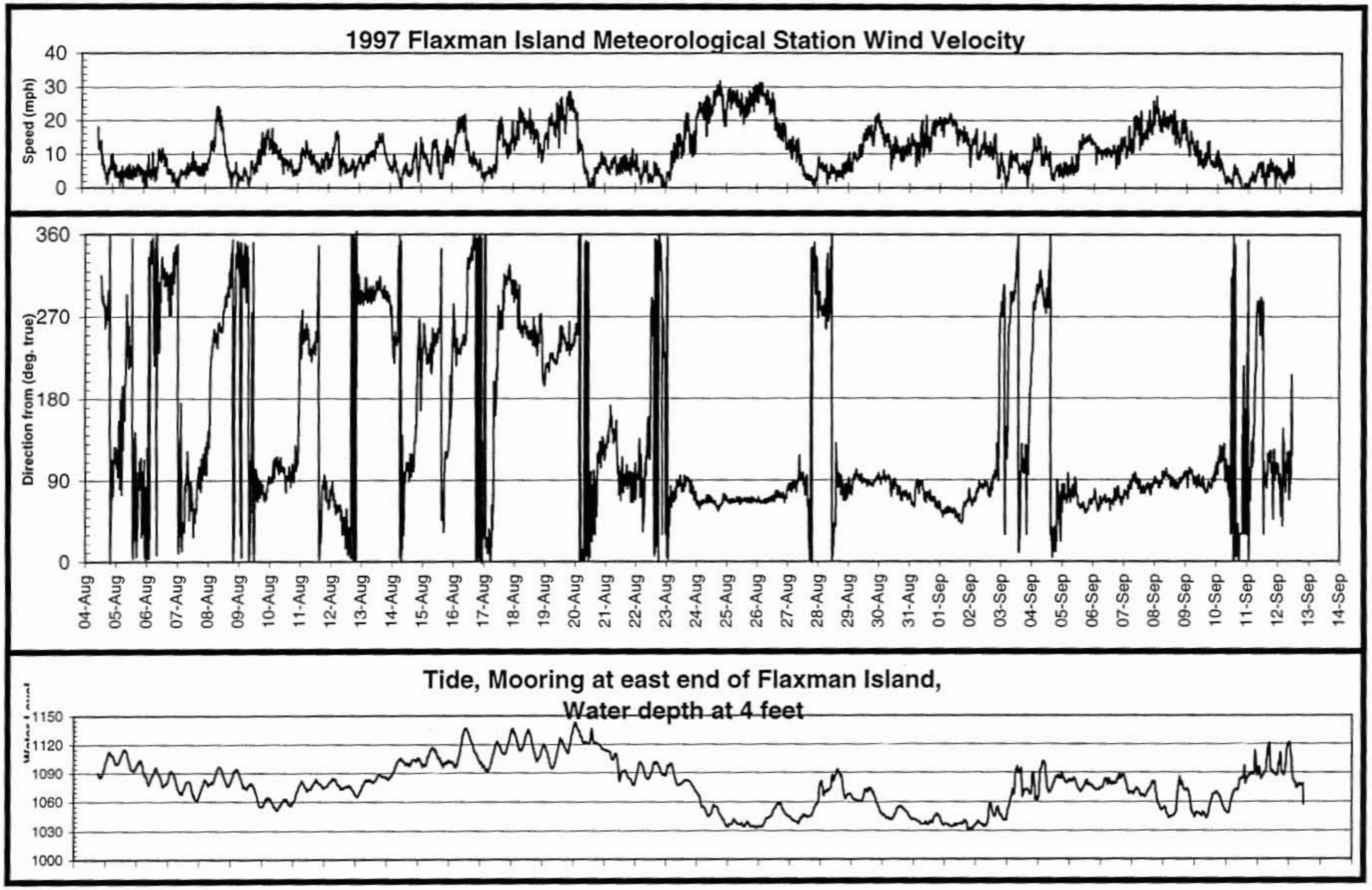

Figure 3-2: 1997 Current Meter Records.

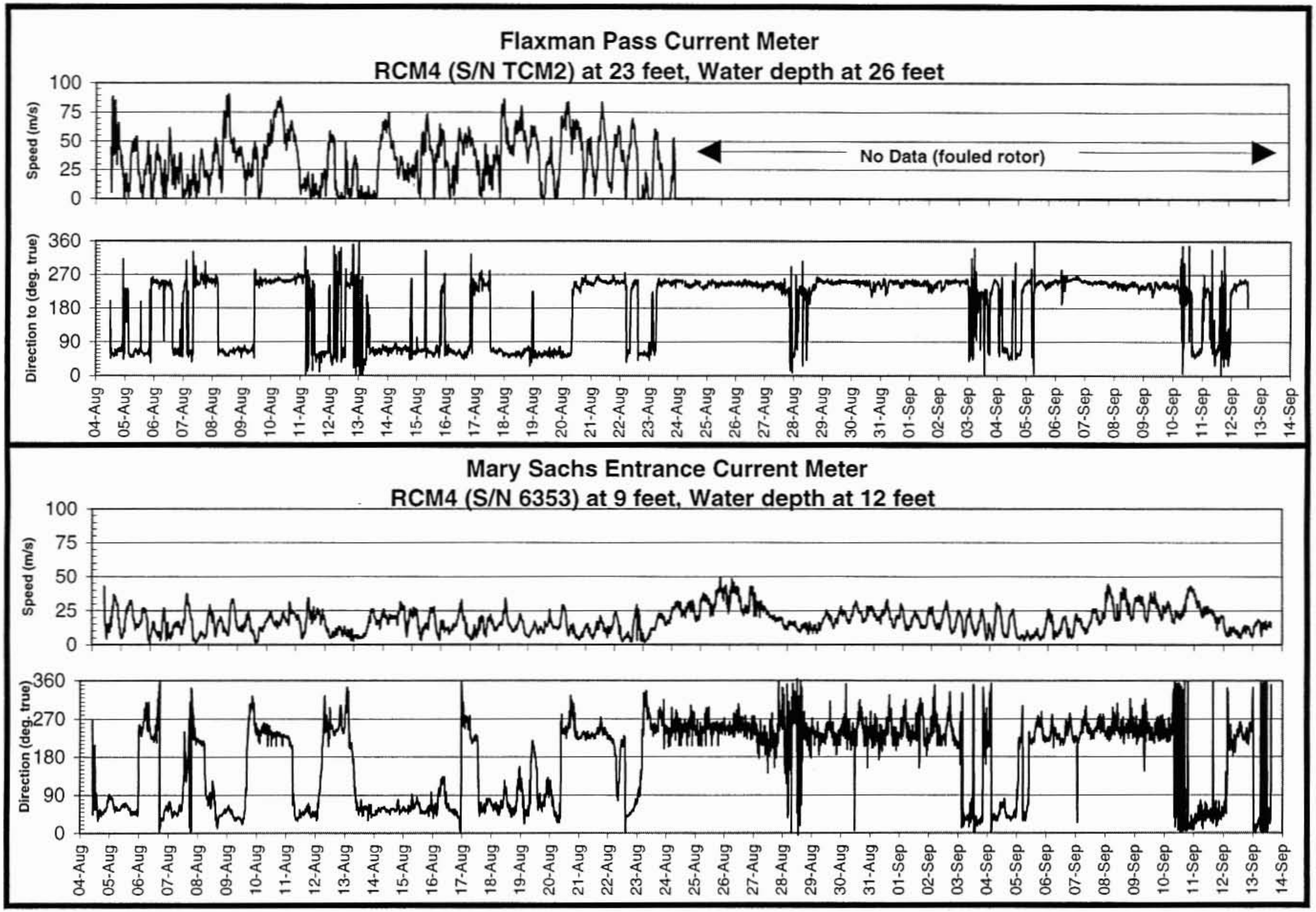

Figure 3-3: 1997 Current Speed Cumulative Frequency Diagram

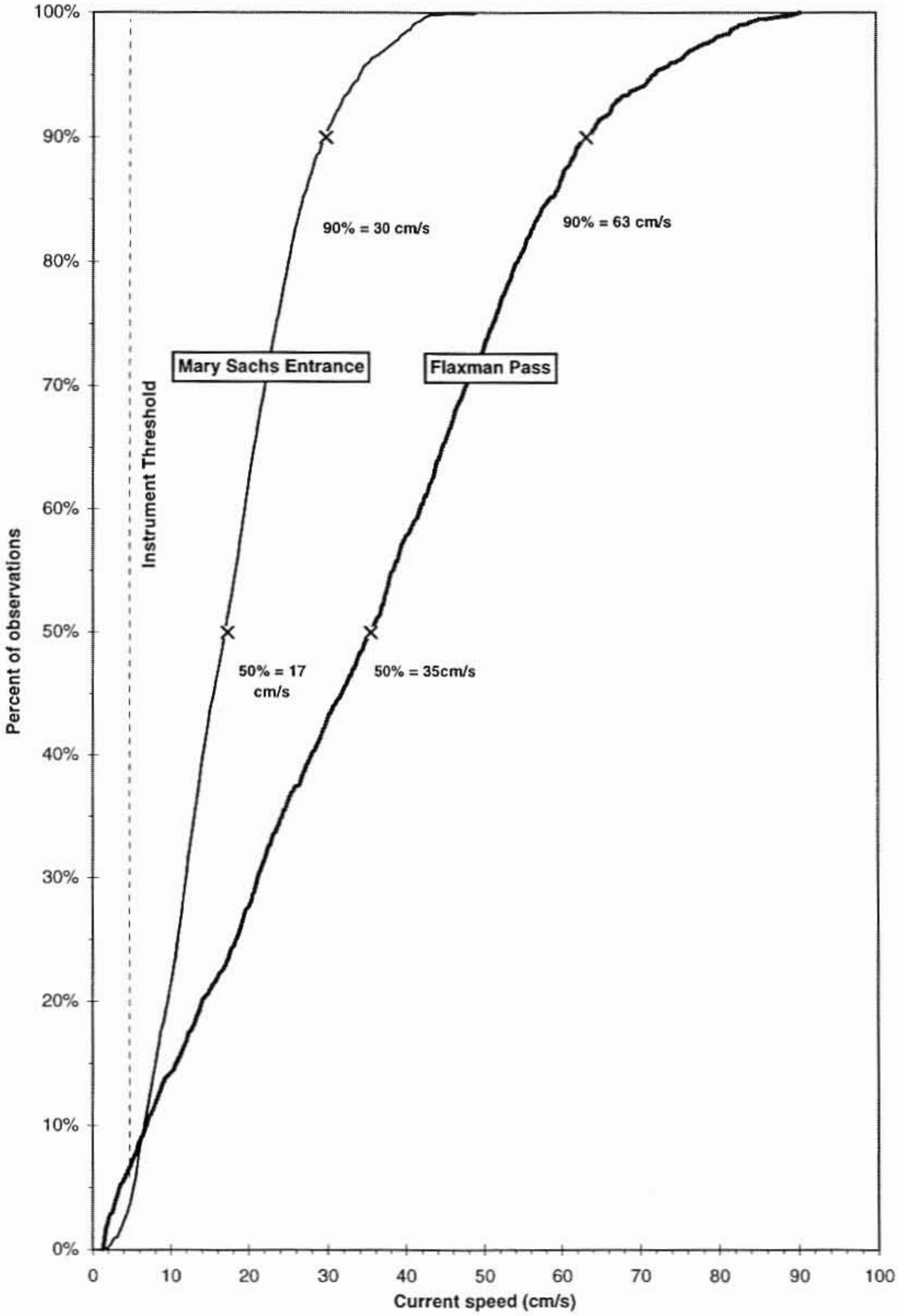

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Figure 3-4: 1997 Salinity and Temperature Records.

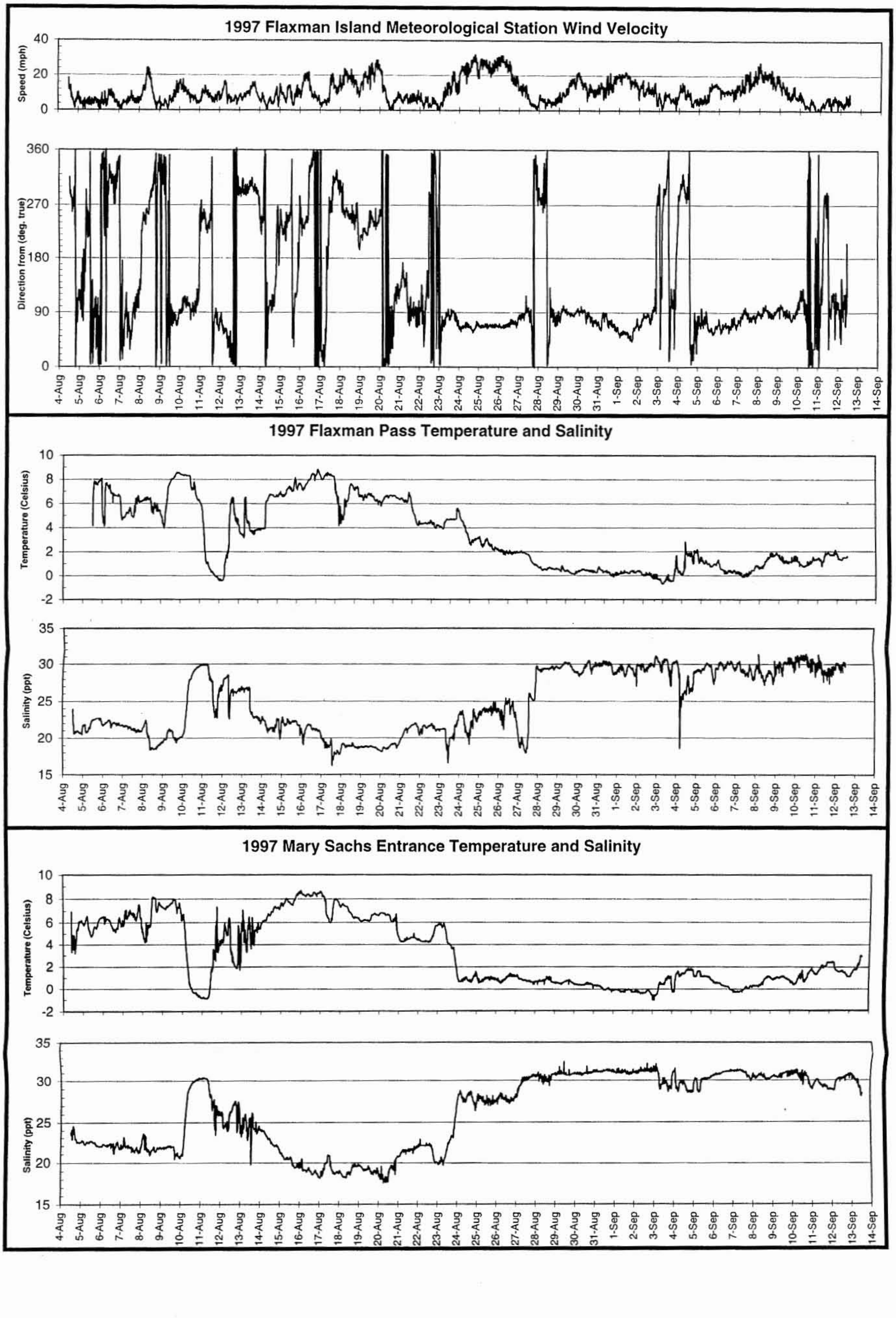
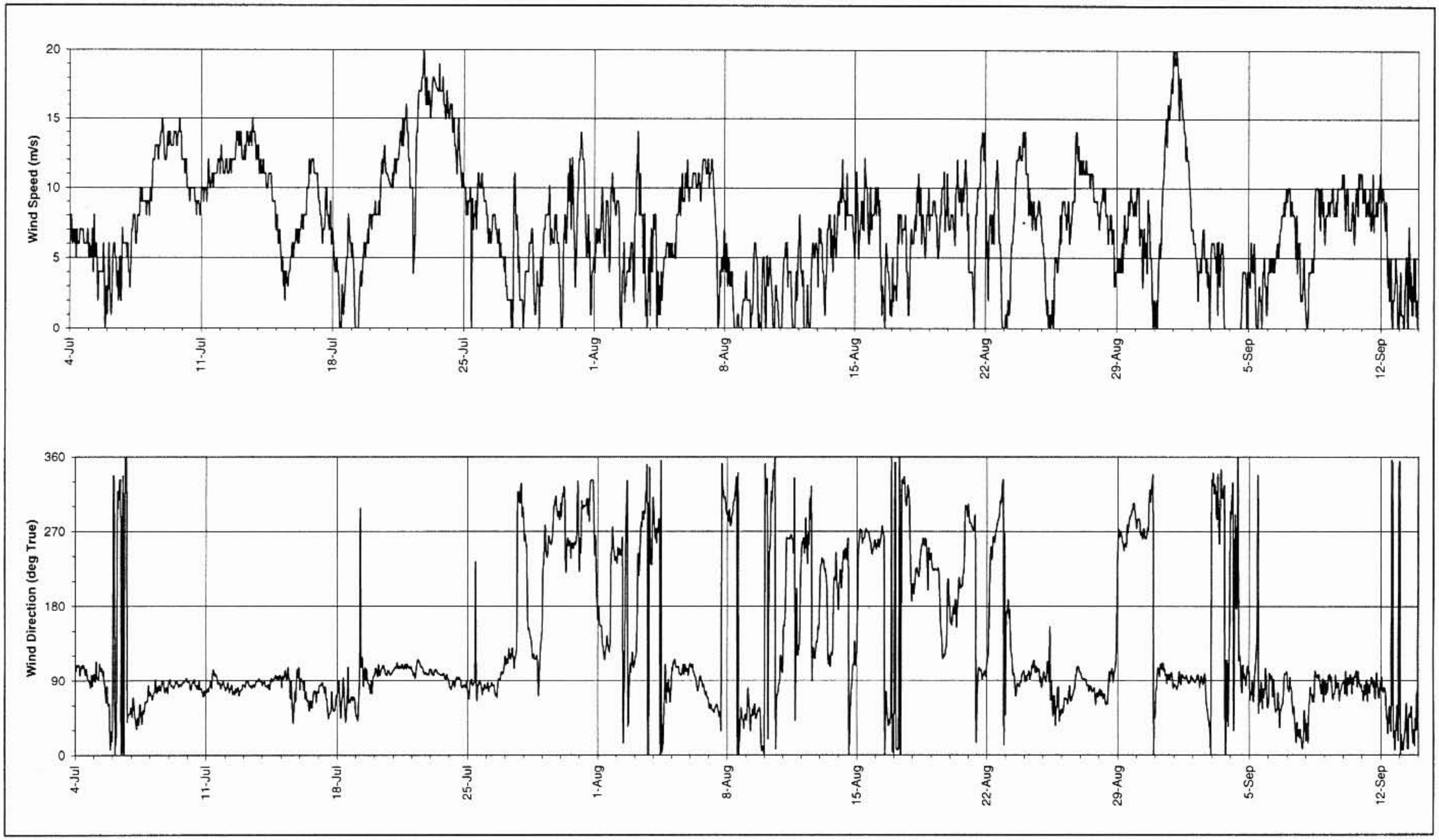


Figure 3-5: 1998 Summer Meteorology Record, NOAA Station #9497645 1, Prudhoe Bay, Alaska



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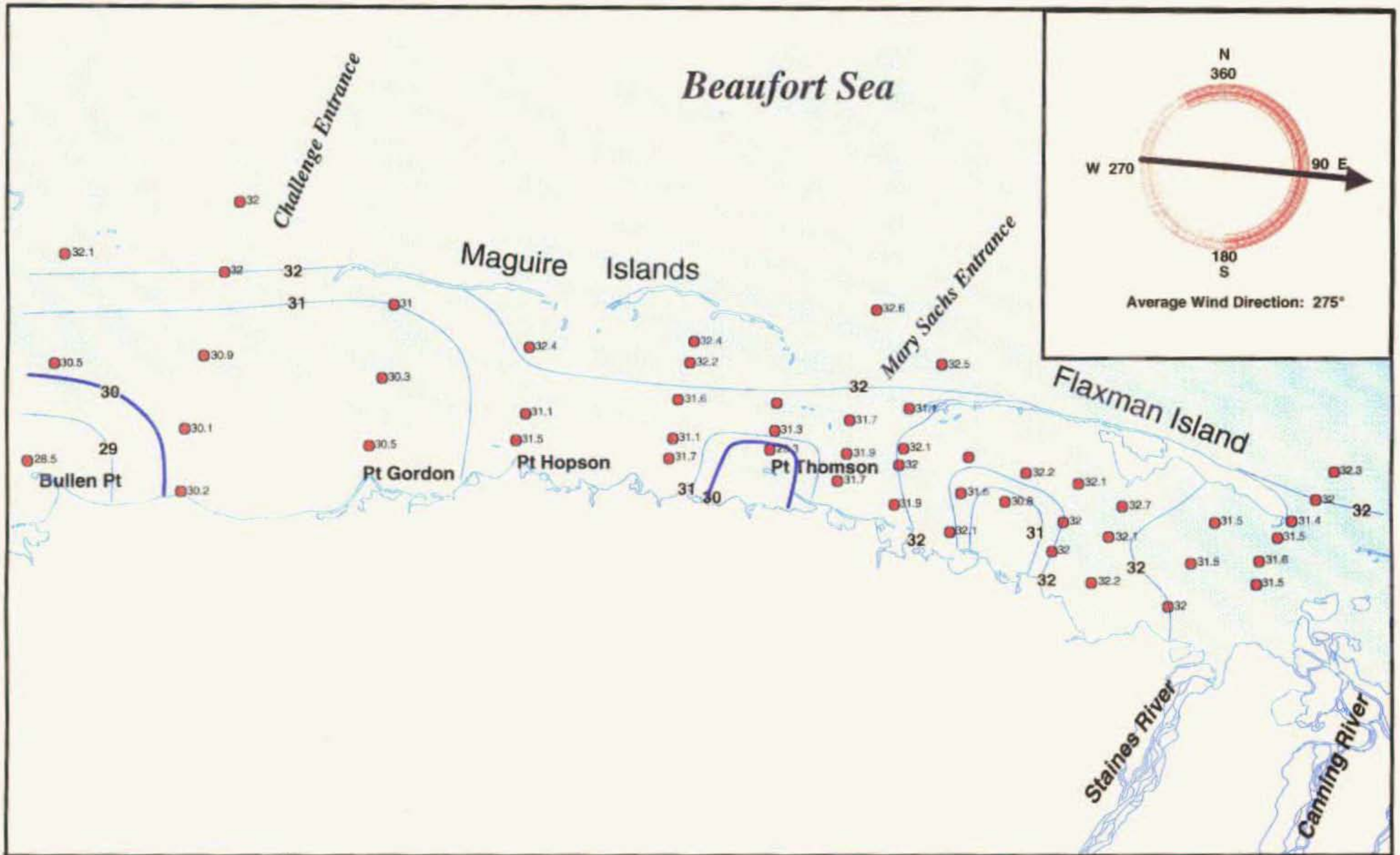

Contour Interval: 1 part per thousand

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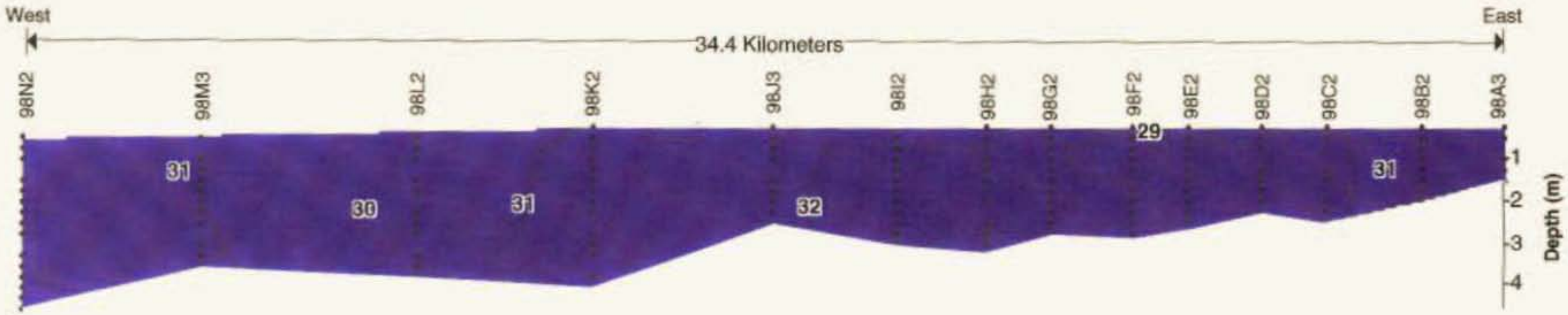
Surface Water Salinity Distribution
July 31, 1998

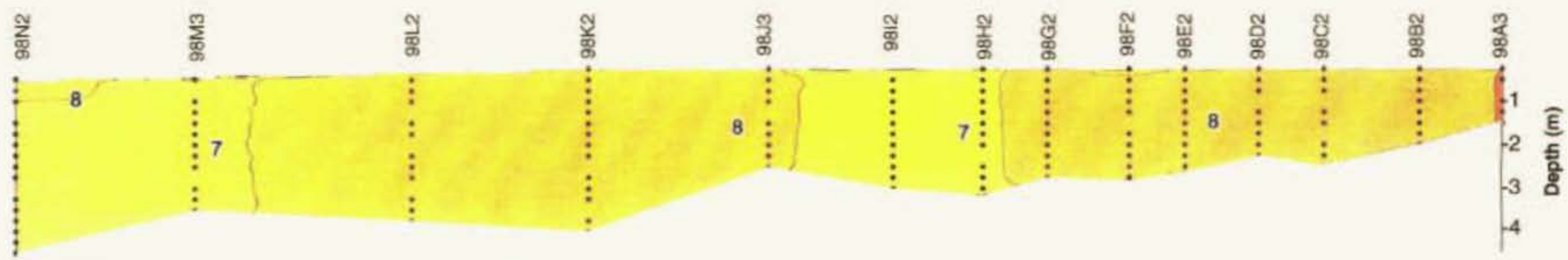
Figure 3-6

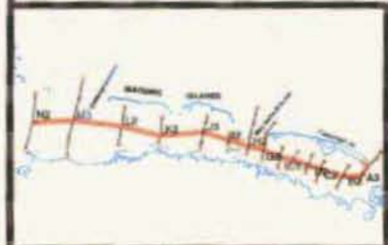
Cross Sectional Transect

Salinity (ppt) Profile



Temperature (Celsius) Profile





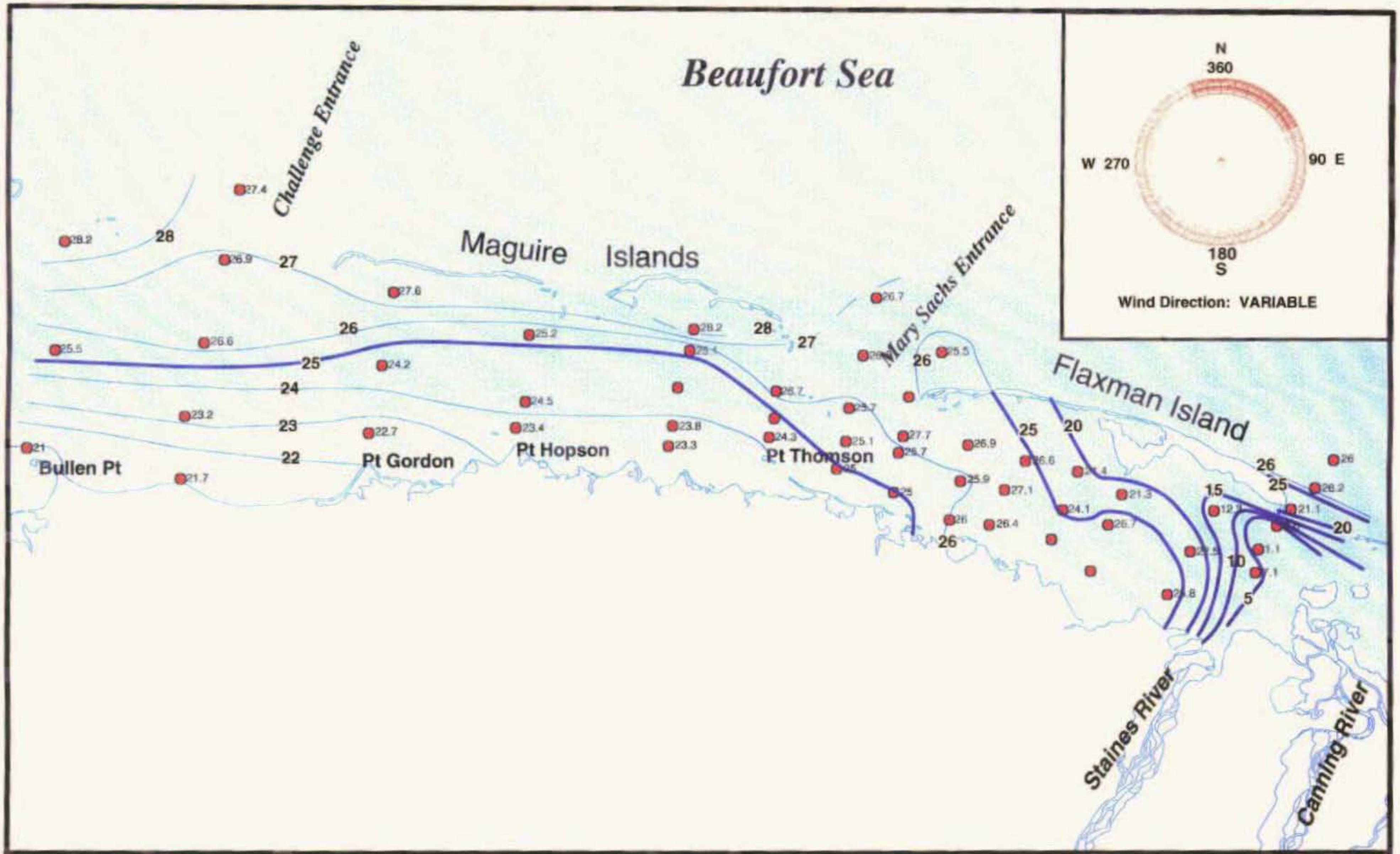
Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

URS Greiner Woodward Clyde

Temperature and Salinty Water Column Structure: Mid Channel Transect, July 31, 1998

Figure 3-7



Contour Interval:
5 parts per thousand (ppt);
1 ppt interval above 25 ppt.

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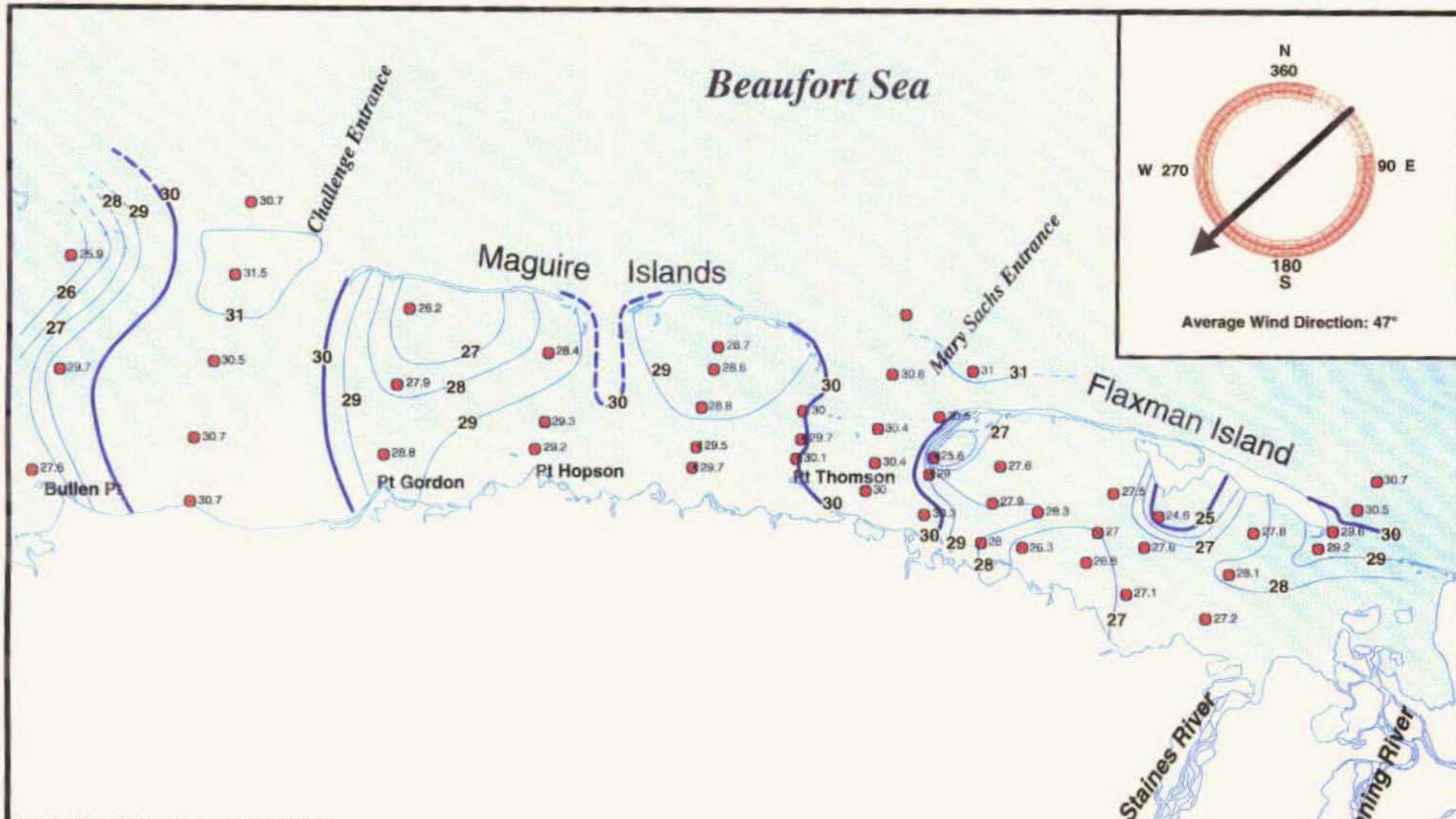
Surface Water Salinity Distribution
August 12, 1998

Figure 3-8



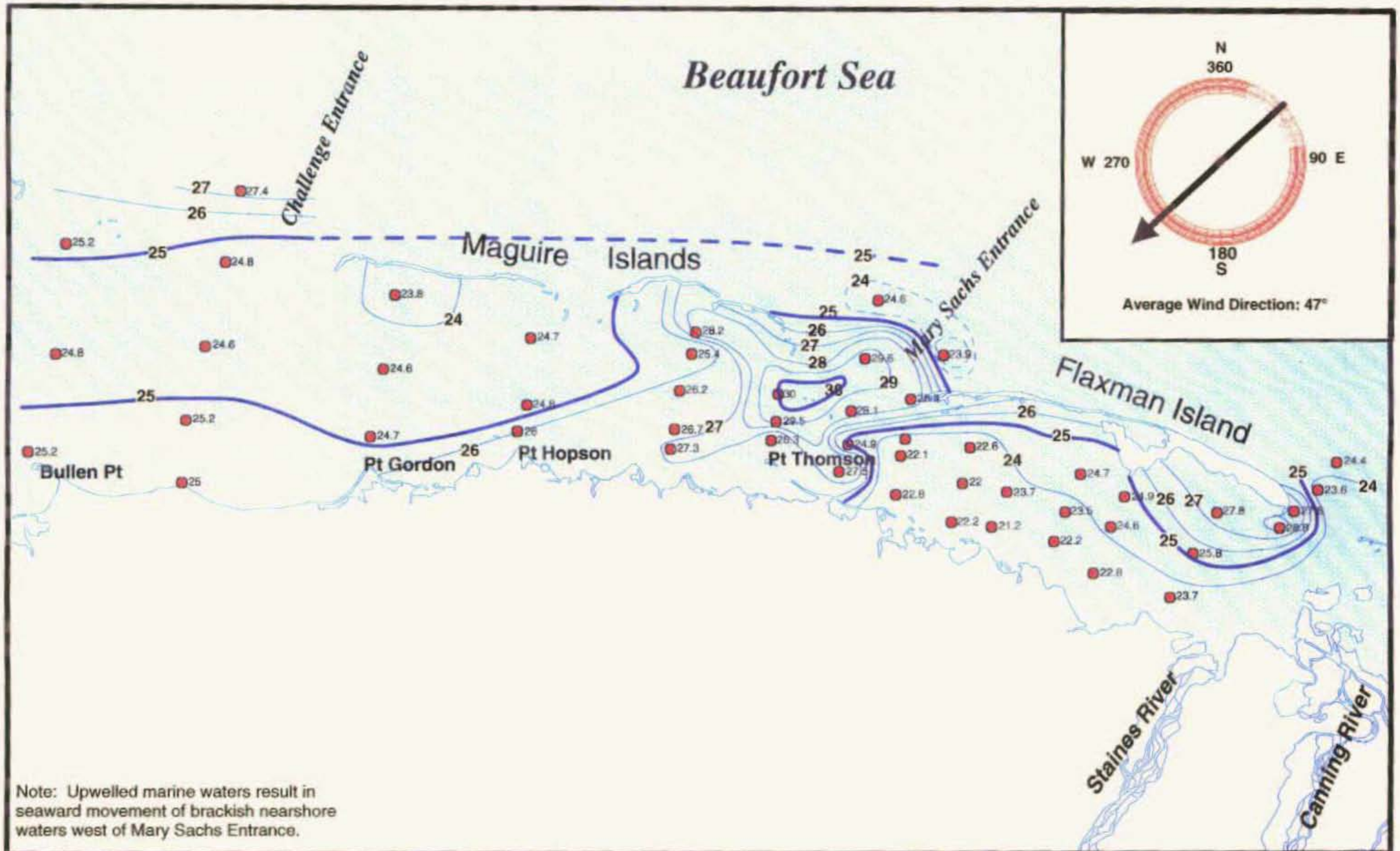
Note: Upwelled marine waters entering lagoon through passes and gap between barrier islands.

Contour Interval: 1 part per thousand

Bottom Water Salinity Distribution
August 25, 1998

Figure 3-9

URS Greiner Woodward Clyde

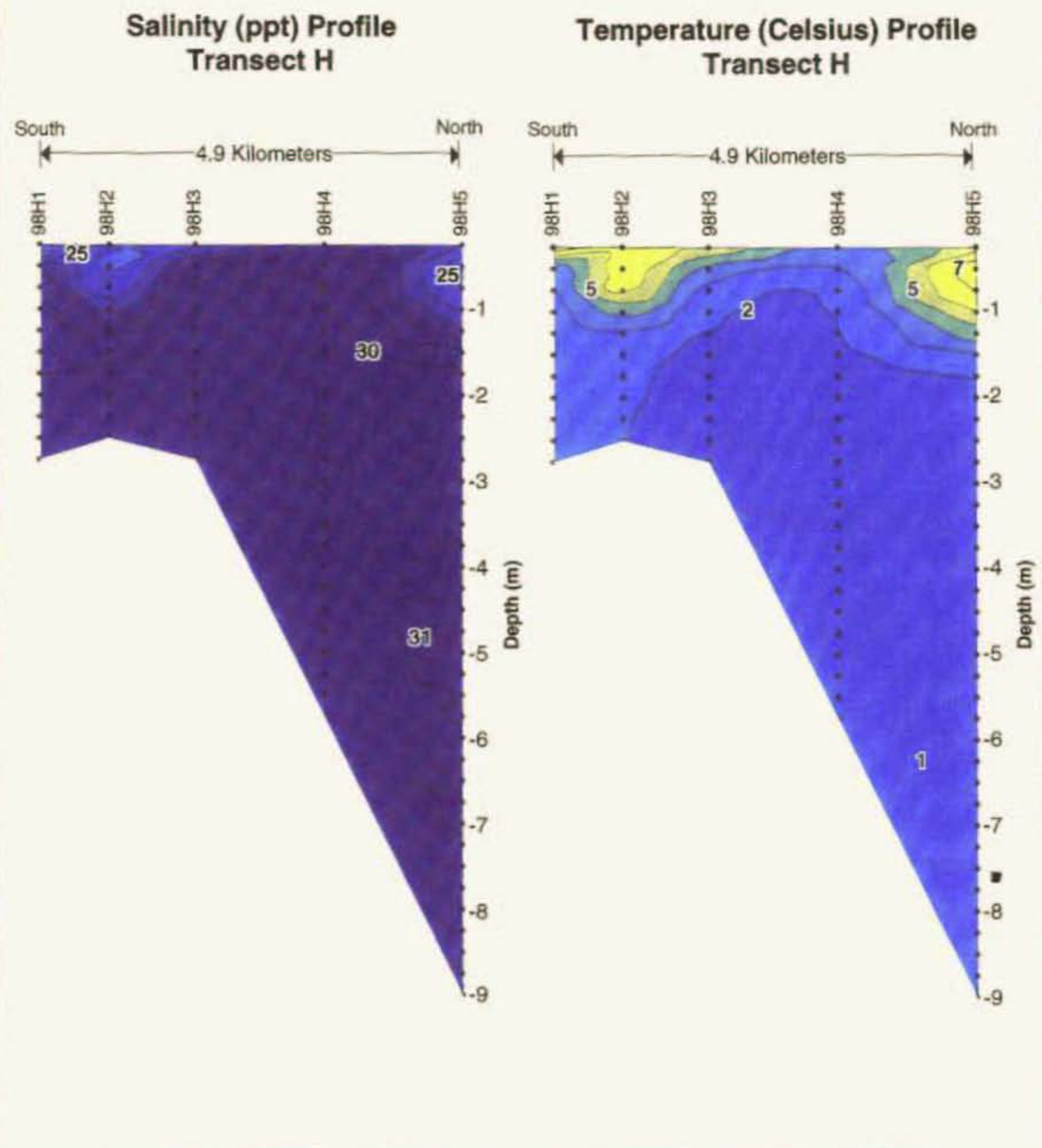


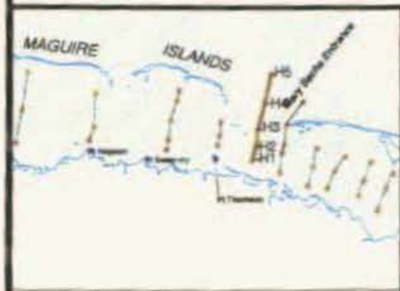
Contour Interval: 1 part per thousand

Surface Water Salinity Distribution
August 25, 1998

Figure 3-10

URS Greiner Woodward Clyde





URS Greiner Woodward Clyde

Temperature and Salinty Water Column Structure: Mid Channel Transect, July 31, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure 3-11

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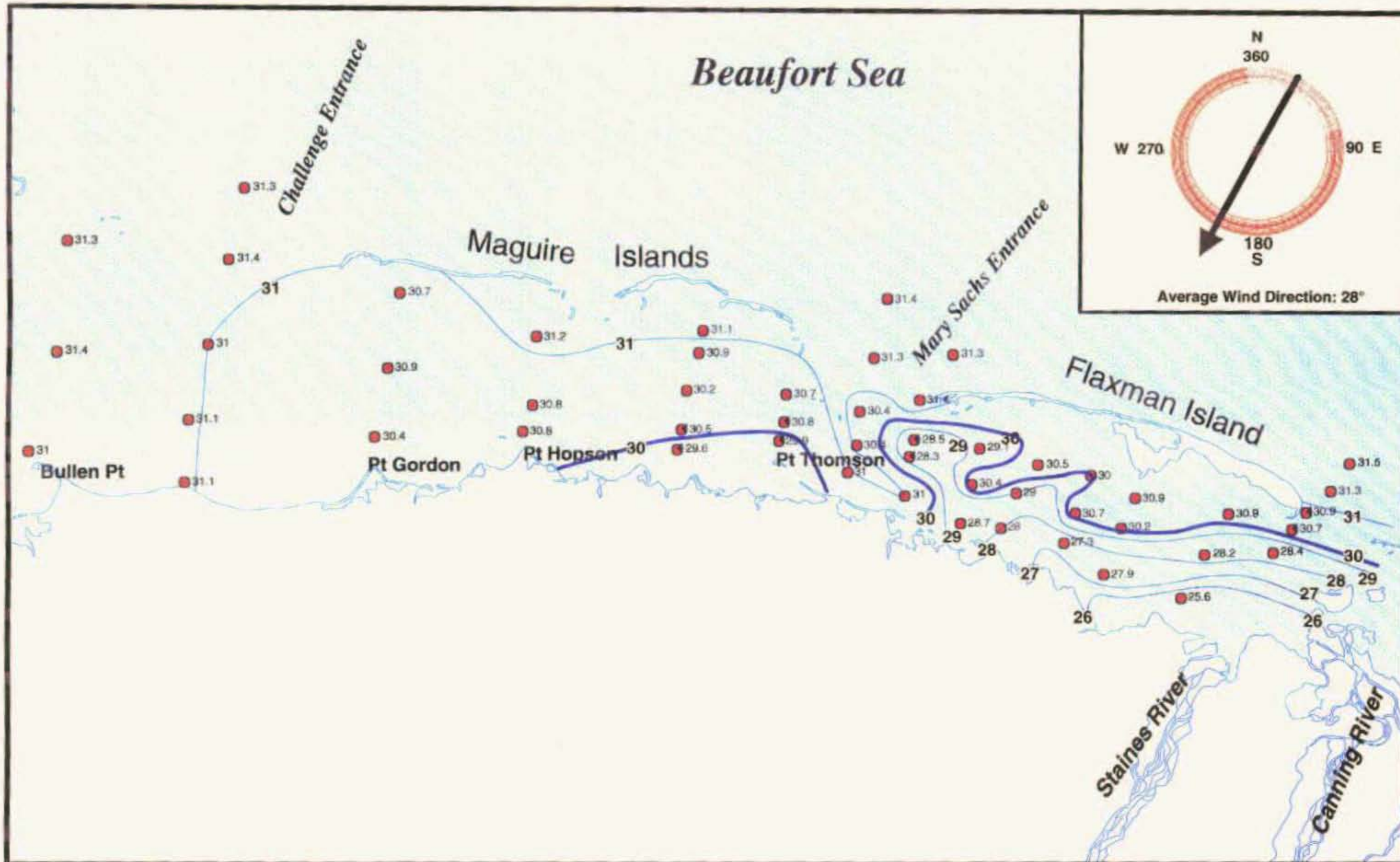


Contour Interval: 1 part per thousand

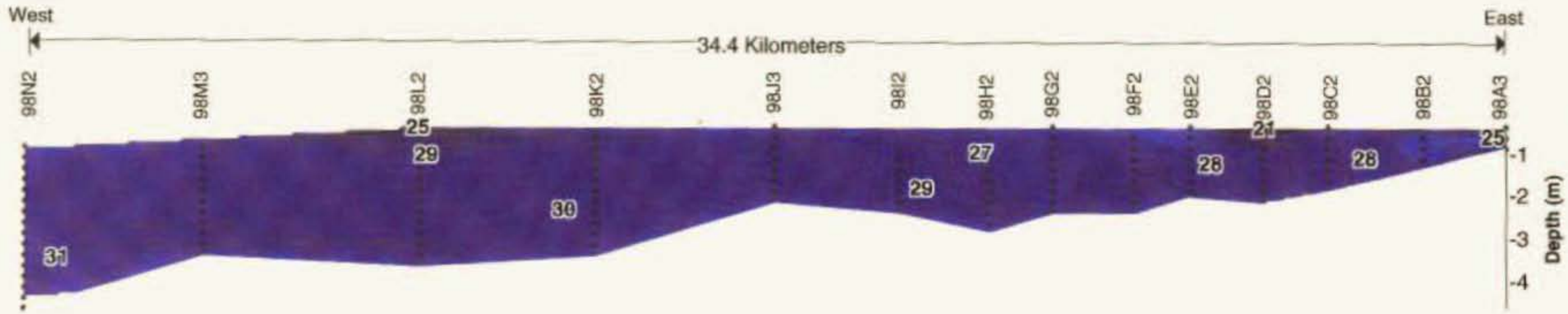
URS Greiner Woodward Clyde

Bottom Water Salinity Distribution
September 13, 1998

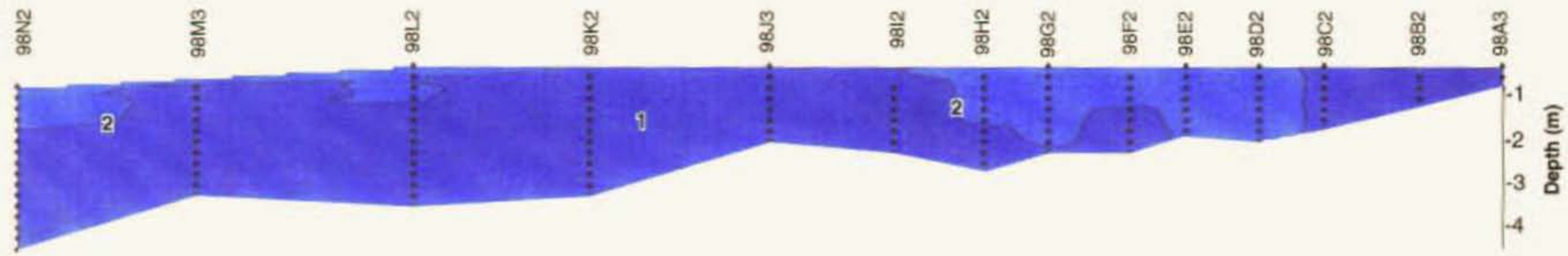
Figure 3-12

Cross Sectional Transect

Salinity (ppt) Profile



Temperature (Celsius) Profile



Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

URS Greiner Woodward Clyde

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Temperature and Salinty Water Column Structure: Mid Channel Transect, September 13, 1998

Figure 3-13

The oceanographic environment within Lions Lagoon is a relatively shallow marine lagoon that is situated south of a barrier island complex with a width of approximately 3 to 4 miles, and water depths typically between 5 and 13 feet (ft). The other marine environment is the Beaufort Sea. The barrier island complex parallels the coast and extends approximately 18 miles from Challenge Island on the west to Flaxman Island on the east and serves as a boundary that separates the two marine environments. Channels or gaps between the barrier islands serve to connect the lagoon waters with the Beaufort Sea and are an important pathway for hydraulic communication. Thus, this coastal lagoon system serves as an interface between freshwater sources and the ocean.

4.1 LIONS LAGOON BATHYMETRY

The barrier island complex serves to shelter much of Lions Lagoon from exposure to storm waves generated in the Beaufort Sea during the open-water periods. The lagoon is divided by the Mary Sachs Entrance, a broad 2.25-mile pass between North Star and Flaxman islands. The lagoon east of the Mary Sachs Entrance is shallow and is protected by Flaxman Island, while west of the Mary Sachs Entrance is a deeper and wider lagoon that is open at the west end.

The eastern third of the lagoon is shallow, with depths generally less than 10 ft. Shoals are common near the mouth of the Staines River and western distributary of the Canning River and extend toward Point Brownlow. The channel between the east end of Flaxman Island and Point Brownlow (Flaxman Pass) is narrow (1,200 ft) and relatively deep (26 ft). Historical soundings obtained from NOAA Chart No. 16045, revised in 1996, suggest the lagoon is asymmetrical, with deeper waters near the mainland shore and a gentle slope from the mid-channel north to Flaxman Island (Figure 4-1). Water depths within the lagoon gently increase towards the west to a depth of 8 ft approximately mid-length of Flaxman Island and reach 11 ft immediately northeast of Point Thomson.

Mary Sachs Entrance is a broad and relatively deep channel, with a northeast/southwest oriented channel that extends toward Point Thomson. Water depths within the channel are typically 9 to 11 ft with the 10-ft isobath approximately 2,400 ft north of the mainland shore in the vicinity of Point Thomson (Figure 4-2). Mary Sachs Entrance provides a break in the protection offered by the barrier islands, exposing the shoreline adjacent to and east of Point Thomson to offshore storm events. The increased exposure to waves is evident by the well developed spit and bar formation along the mainland shore.

The western portion of the lagoon is protected by a group of barrier islands known as the Maguire Islands (Challenge, Alaska, Duchess and Northstar islands). This portion of the lagoon widens from 1.5 miles at Point Thomson to 3.5 miles near Challenge Island. Water depths adjacent to the mainland between Point Thomson and Point Hobson are typically 7 to 10 ft and gently increase to 16 ft at the west end of the lagoon.

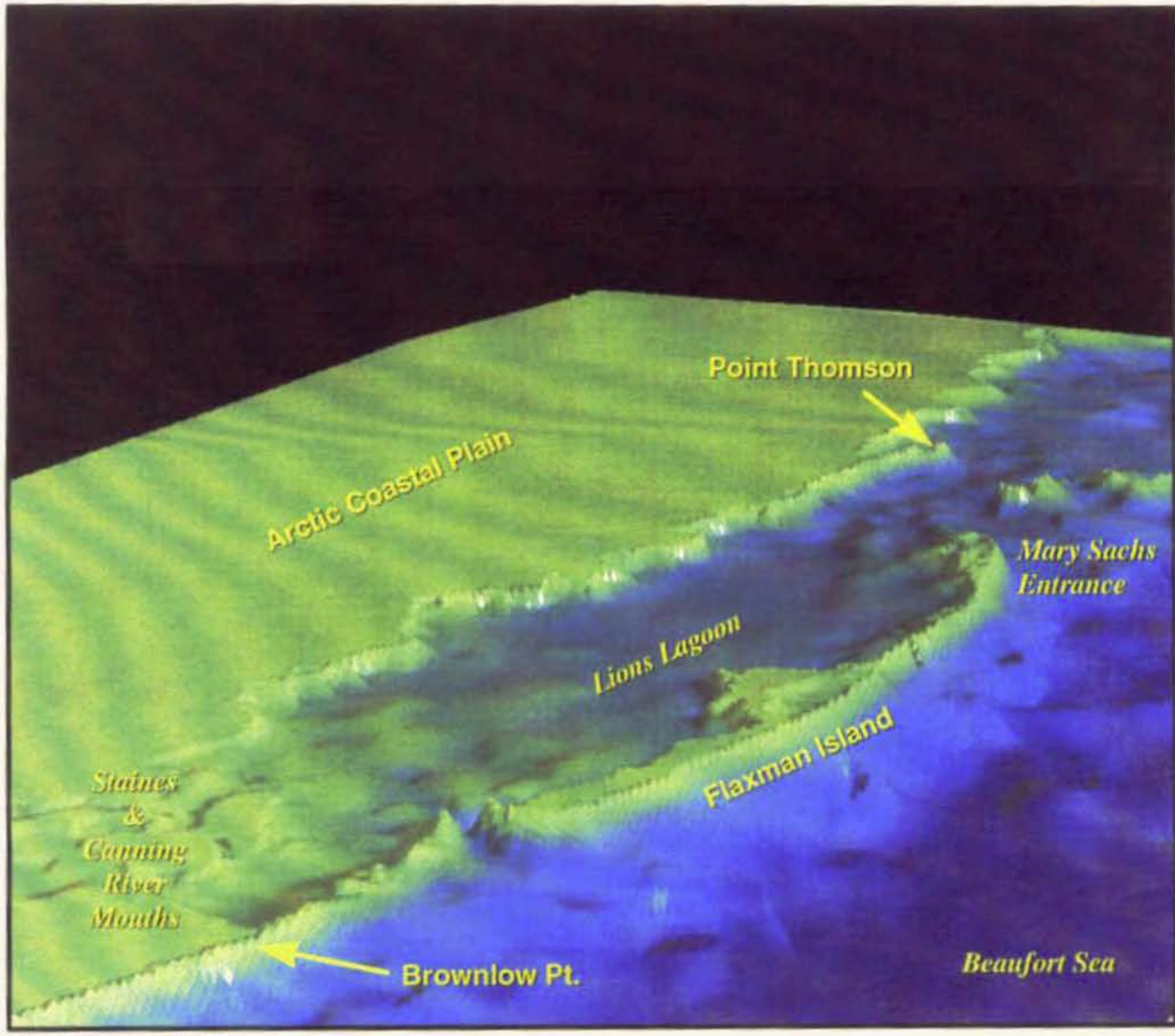
4.2 REGIONAL PROCESSES

The size, shape, and orientation of Lions Lagoon is similar to the geometry of Simpson Lagoon. The prevailing wind direction, hydraulic communication with Beaufort Sea, location and size of freshwater source (east end) all make Lions Lagoon a nearly perfect analog of Simpson Lagoon, about which much is known and therefore transferable to understanding of physics and biology of Lions Lagoon. Our present understanding of the regional processes indicate that the hydrography of virtually any location along the Alaska Beaufort coast is governed primarily by proximity of a freshwater source and recent wind history, and secondarily by the occasional profound effects of regional upwelling and downwelling phenomena.

The 1998 study documented substantial freshwater input that resulted in brackish nearshore waters immediately adjacent to the Staines and Canning rivers. During persistent easterly winds, the river discharge is advected toward the west, and thus dominates the water column within lagoon system south of Flaxman Island. The remainder of Lions Lagoon is not adjacent to a notable freshwater source; however, tundra stream runoff serves to create a thin brackish band of nearshore waters within the protected western portion of the lagoon system.

Mary Sachs Entrance and to a lesser extent, Flaxman Pass, and the other channels between the barrier island complex serve as pathways that connect the lagoon system with Beaufort Sea shelf and bottom waters. Meteorological and current velocity records collected in 1997 show quite clearly the hydraulic responsiveness of Lions Lagoon to wind direction. East winds produce a westward stress on the surface of Lions Lagoon, causing Beaufort Sea waters to be drawn southward into the lagoon system through its various entrances. The opposite effect is produced by west winds, causing water to flow northward out of the lagoon and into the Beaufort Sea.

The interaction between the brackish nearshore waters and marine bottom waters was clearly observed in the 1997 salinity time-series records. Pulses of cold, saline marine waters flowed through the barrier island channels (Mary Sachs Entrance and Flaxman Pass) and into the lagoon during persistent easterly winds. These upwelling events coincided with depressed water levels within the lagoon. The 1998 CTD surveys confirmed that the marine bottom waters enter Lions Lagoon through all of the barrier island channels during persistent easterly winds. Thus, the regional upwelling process affects Lions Lagoon in the same manner along the Beaufort Sea coast that has been observed in Simpson Lagoon and elsewhere.

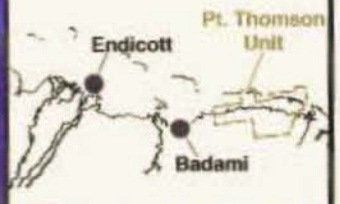


Pt. Thomson Unit Area Development

Figure 4-1

False Color Bathymetry of Lions Lagoon

Data Sources:
NOAA Chart 16045 (1996)
BPXA Cartography
U.S. Geological Survey



URS Greiner Woodward Clyde

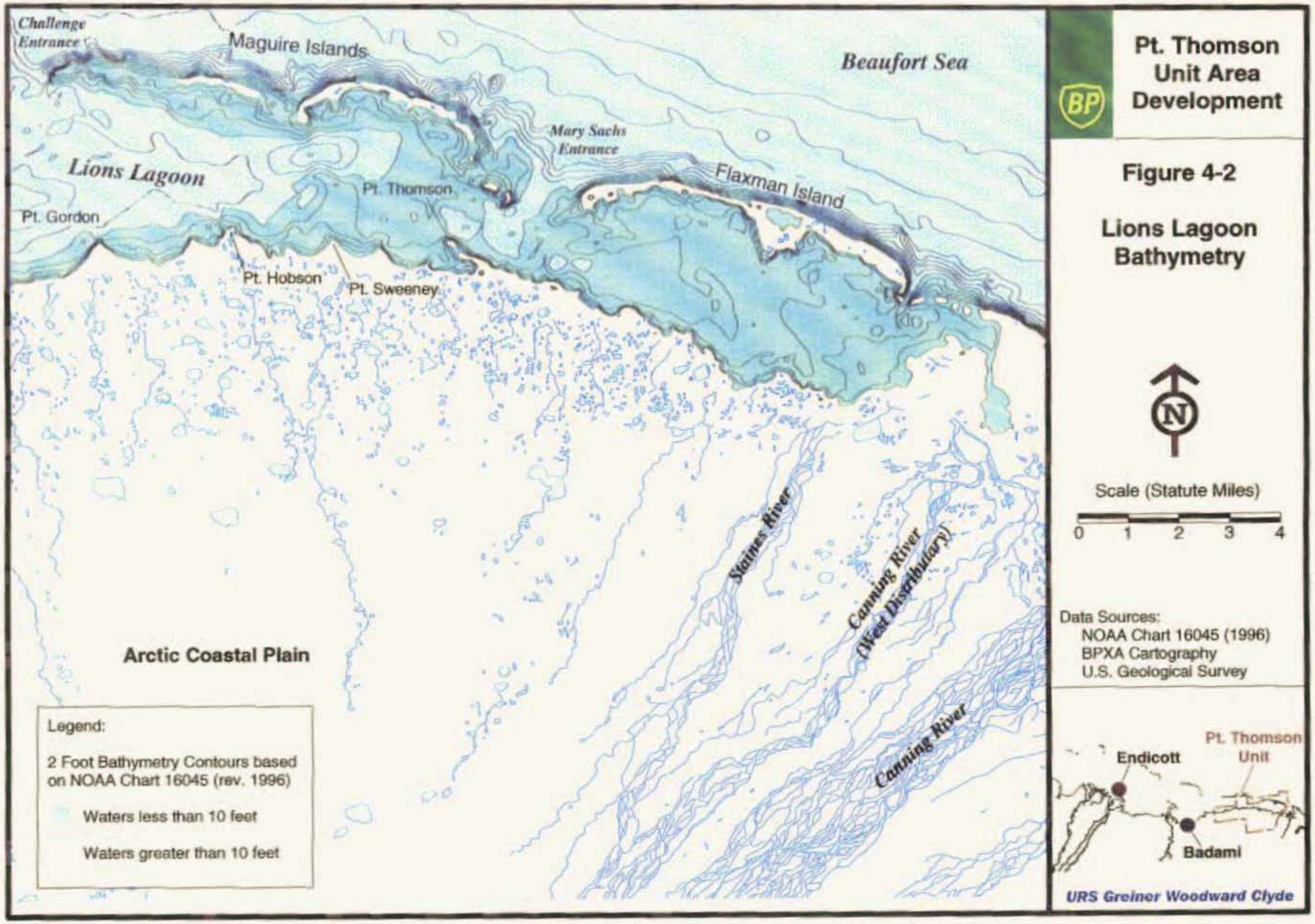


Figure 4-2

Lions Lagoon Bathymetry

The 1997 and 1998 physical oceanography studies confirmed that regional processes govern the water column structure, water movement, and water level within the lagoon system. Specific regional processes that were observed within Lions Lagoon include:

- Local freshwater input from the Staines and Canning rivers created brackish water conditions for lagoon waters south of Flaxman Island. The lack of notable fresh water was evident along the western portion of Lions Lagoon
- Upwelled marine bottom waters entered the lagoon system through the channels between the barrier islands during persistent easterly winds, that also depressed the water level
- Elevated water levels corresponded to persistent westerly winds and short (24 to 36 hour) periods of mixed easterly and westerly winds. Typically, uniform brackish ($\leq$25 part per thousand) conditions were observed throughout Lions Lagoon

The geometry of the lagoon system influenced water movement and water quality. Specific observations include:

- The channels between the barrier islands served as pathways for Beaufort Sea shelf and marine waters to enter Lions Lagoon during easterly winds
- Current direction within Mary Sachs Entrance and Flaxman Pass were parallel to the channel
- The barrier island complex effectively protected the lagoon waters. Turbidity and suspended sediment were elevated for waters adjacent to the Staines and Canning rivers, and in the channels between the barrier islands

The combination of regional and site-specific studies is necessary to meet U.S. Federal and State of Alaska regulatory requirements. As the conceptual engineering advances, the location and dimensions of the dock and other coastal structures will be established. At that time, physical environment studies will be designed to collect sufficient site-specific information to support the permitting process.

Colonell, J.M., and B.J. Gallaway (1990). An Assessment of Marine Environmental Impacts of West Dock Causeway. Report for the Prudhoe Bay Unit Owners represented by ARCO Alaska, Inc. prepared by LGL Alaska Research Associates, Inc. and Environmental Science and Engineering, Inc. Anchorage, Alaska. 132 pp. + appendices.

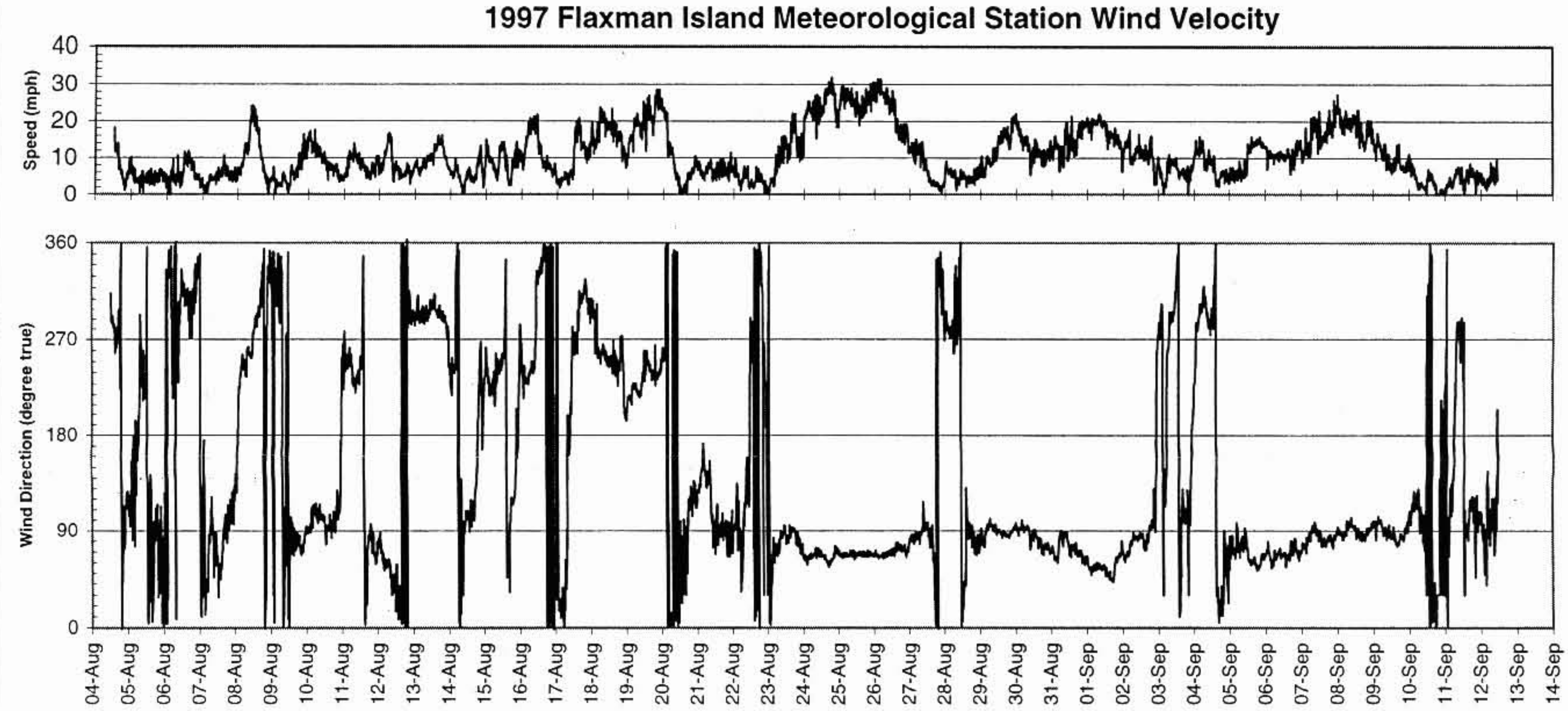
Kinnetic Laboratories, Inc. (1983). Oceanographic Engineering Services Point Thomson Development Project (Agreement Number PTD-8204). Prepared for EXXON Company U.S.A.. Volumes 1, 2A, and 2B.

Appendix A

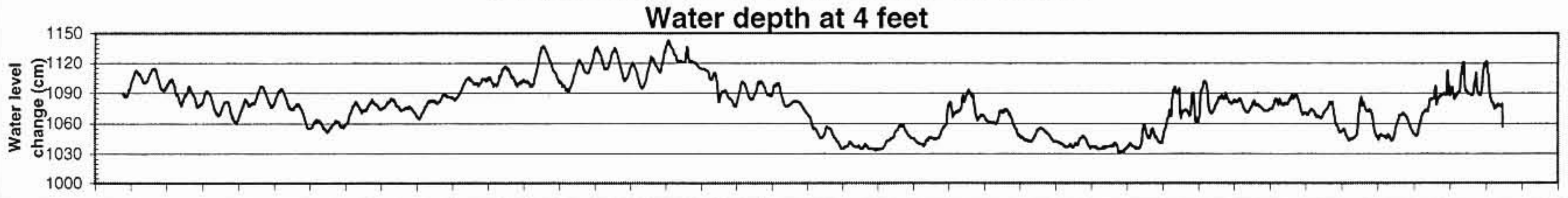
1997 Physical Oceanography And Meteorology Records

1997 Time Series of Flaxman Meteorology and Mary Sachs Entrance Current Meter RCM4 (S/N 6353)
04 Aug - 13 Sept 1997

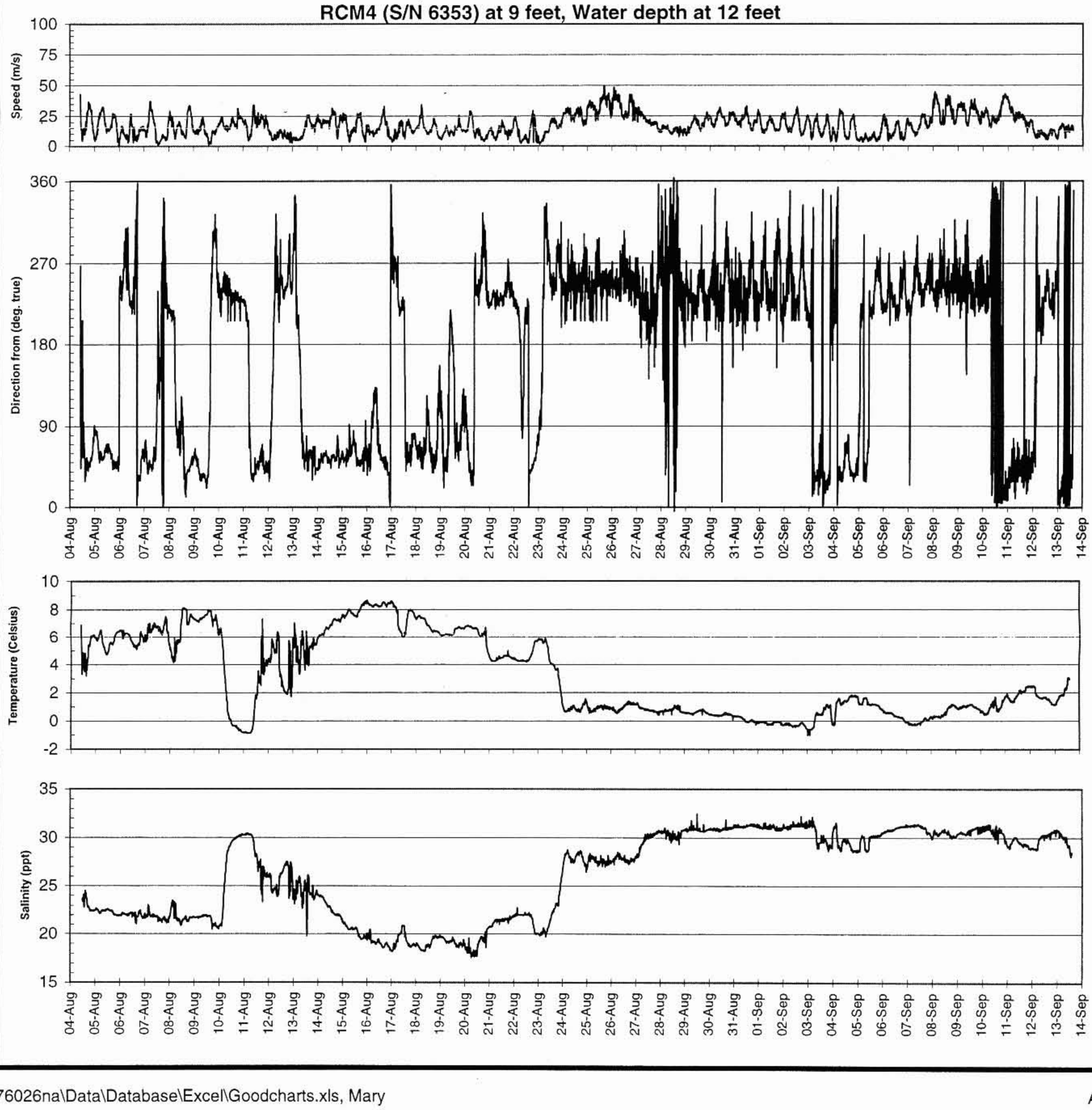
1997 Flaxman Island Meteorological Station Wind Velocity



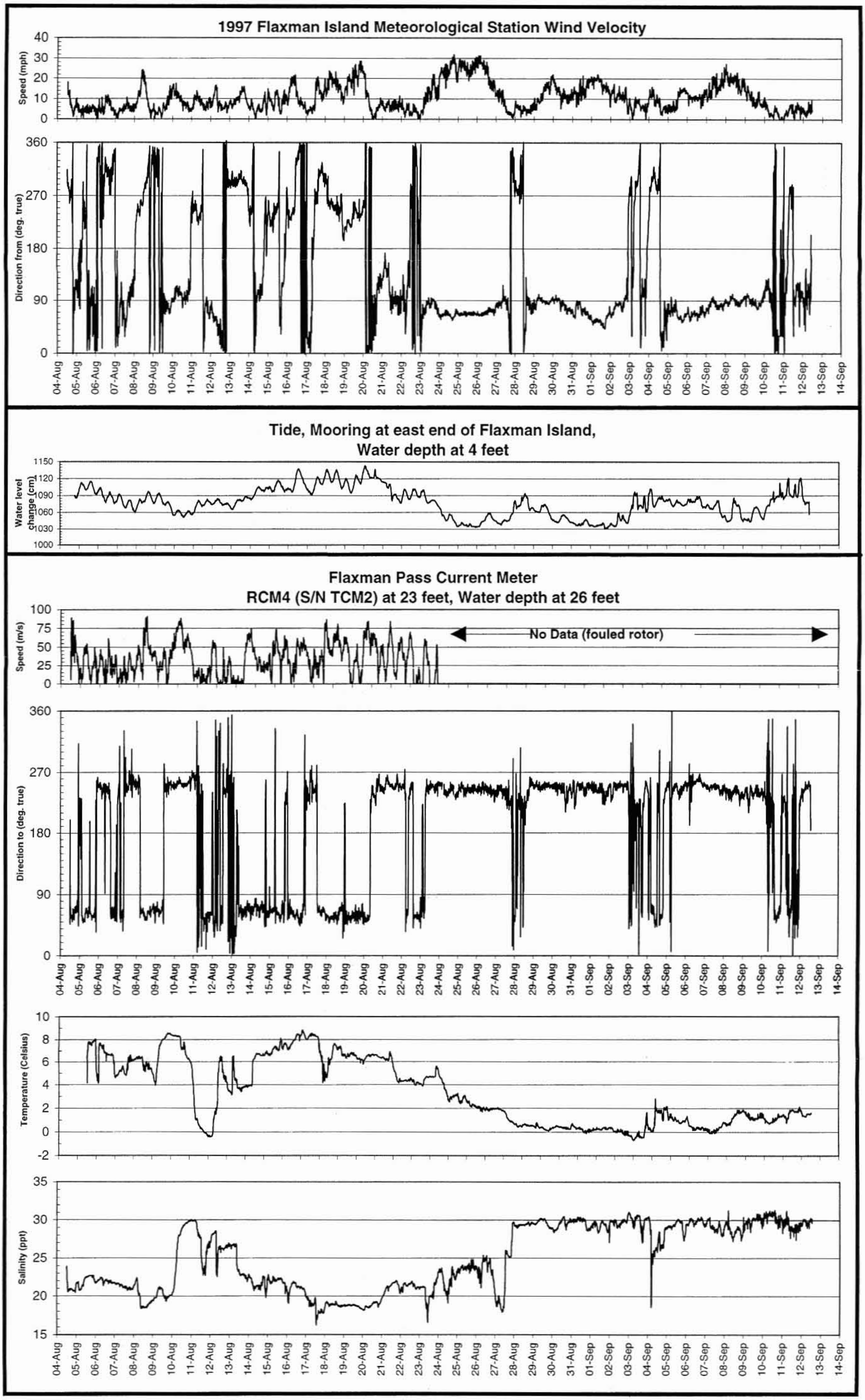
Tide, Mooring at east end of Flaxman Island, Water depth at 4 feet



Mary Sachs Entrance Current Meter RCM4 (S/N 6353) at 9 feet, Water depth at 12 feet



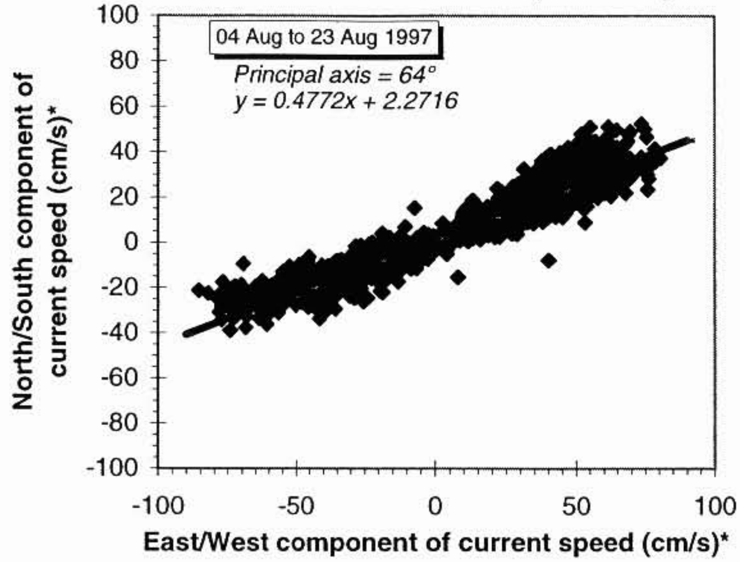
1997 Time Series of Flaxman Island Meteorology and Flaxman Pass Current Meter RCM4 (S/N TCM2)
04 Aug - 13 Sept 1997



Appendix B

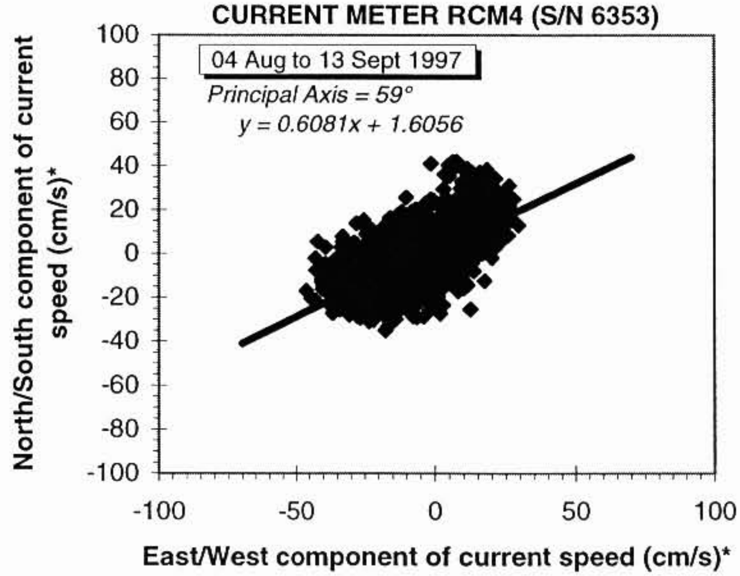
1997 Current Meter Data Analysis

CURRENT VELOCITY DISTRIBUTION
FLAXMAN PASS
CURRENT METER RCM4 (S/N TCM2)

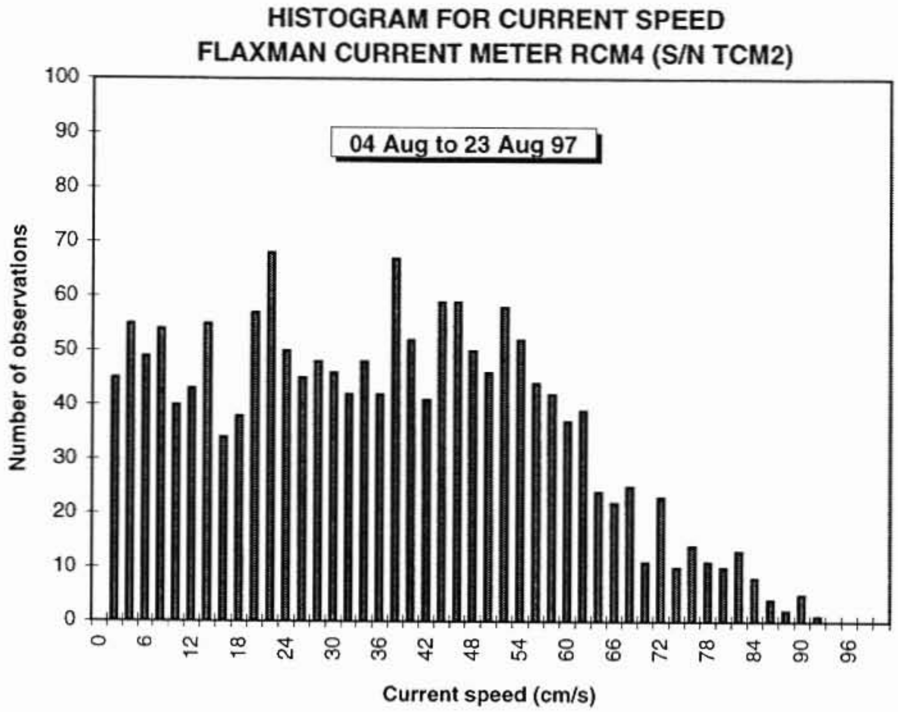


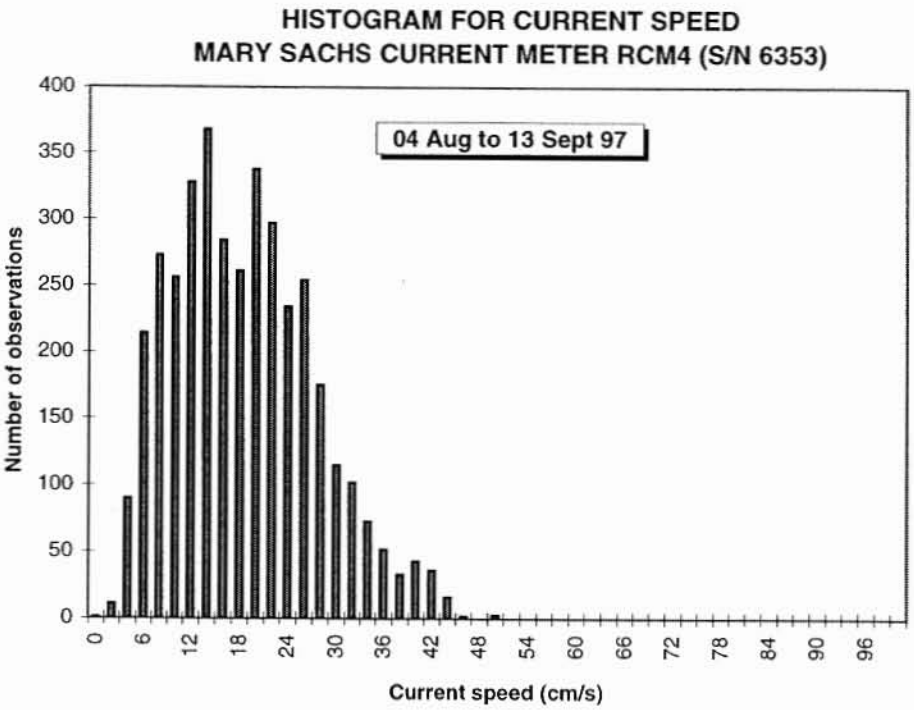
*Negative values signify southerly or westerly component of speed.

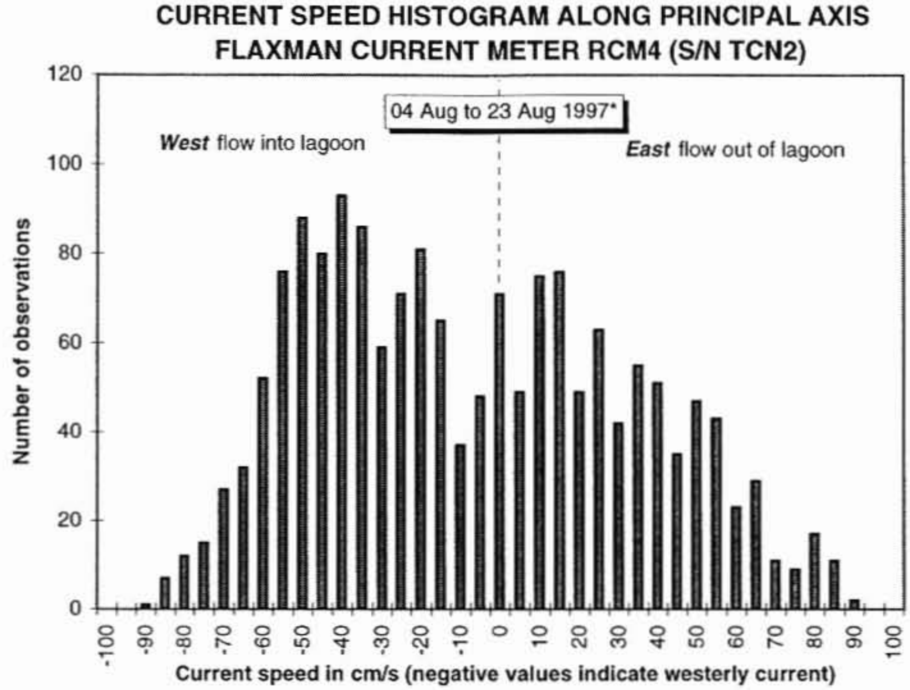
CURRENT VELOCITY DISTRIBUTION
MARY SACHS
CURRENT METER RCM4 (S/N 6353)



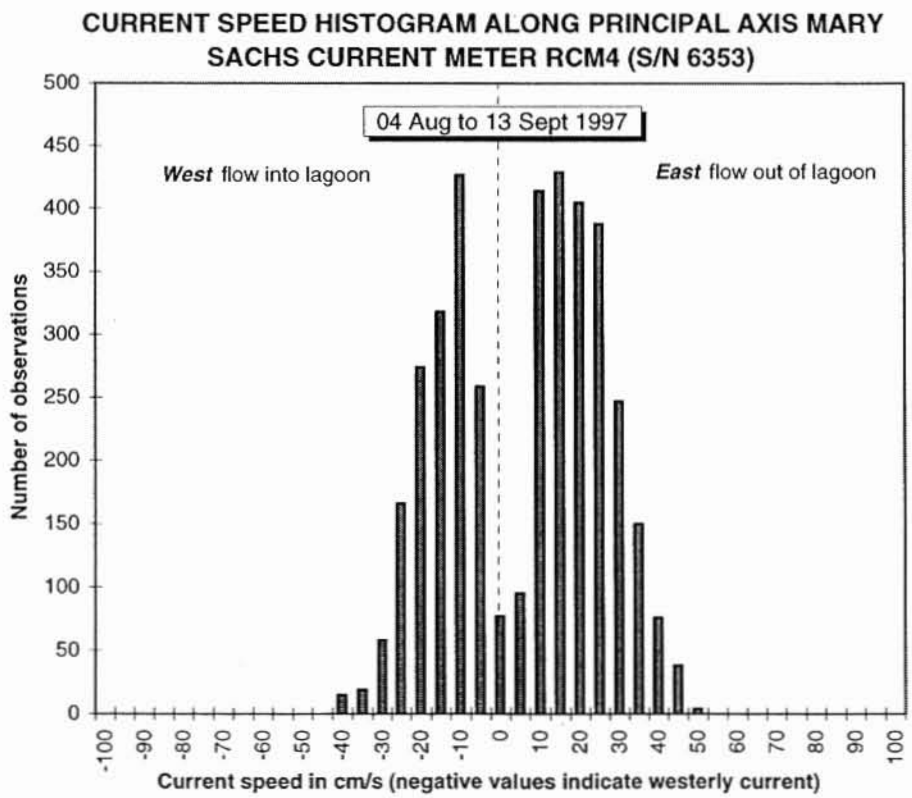
*Negative values signify southerly or westerly component of speed.


HISTOGRAM FOR CURRENT SPEED
FLAXMAN CURRENT METER RCM4 (S/N TCM2)
04 Aug to 23 Aug 97
Number of observations
Current speed (cm/s)
0
10
20
30
40
50
60
70
80
90
100
0 6 12 18 24 30 36 42 48 54 60 66 72 78 84 90 96

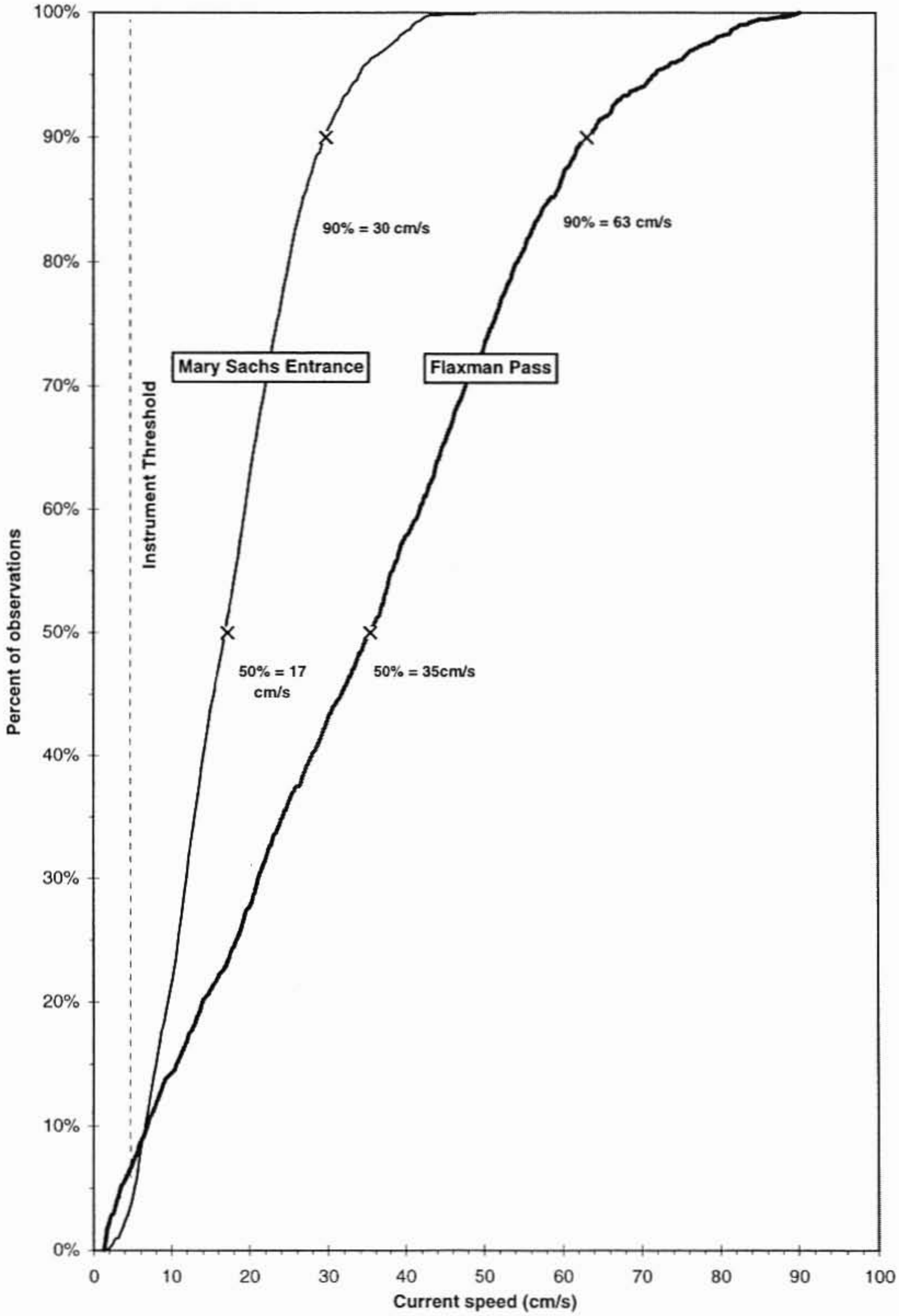

HISTOGRAM FOR CURRENT SPEED
MARY SACHS CURRENT METER RCM4 (S/N 6353)
04 Aug to 13 Sept 97
Number of observations
Current speed (cm/s)
0
50
100
150
200
250
300
350
400
0 6 12 18 24 30 36 42 48 54 60 66 72 78 84 90 96



*Current meter fouled by kelp

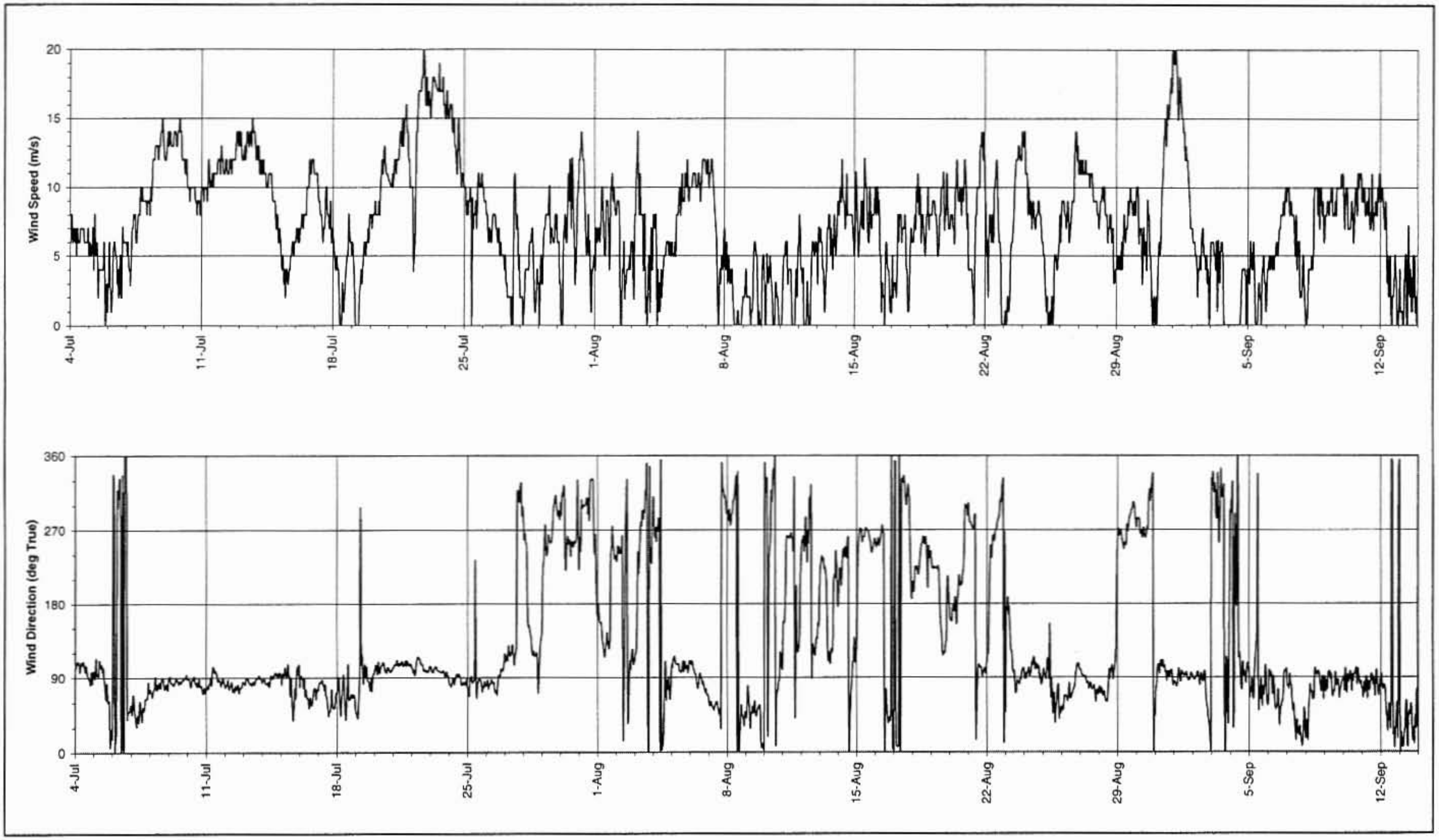


1997 Current Speed Cumulative Frequency Diagram



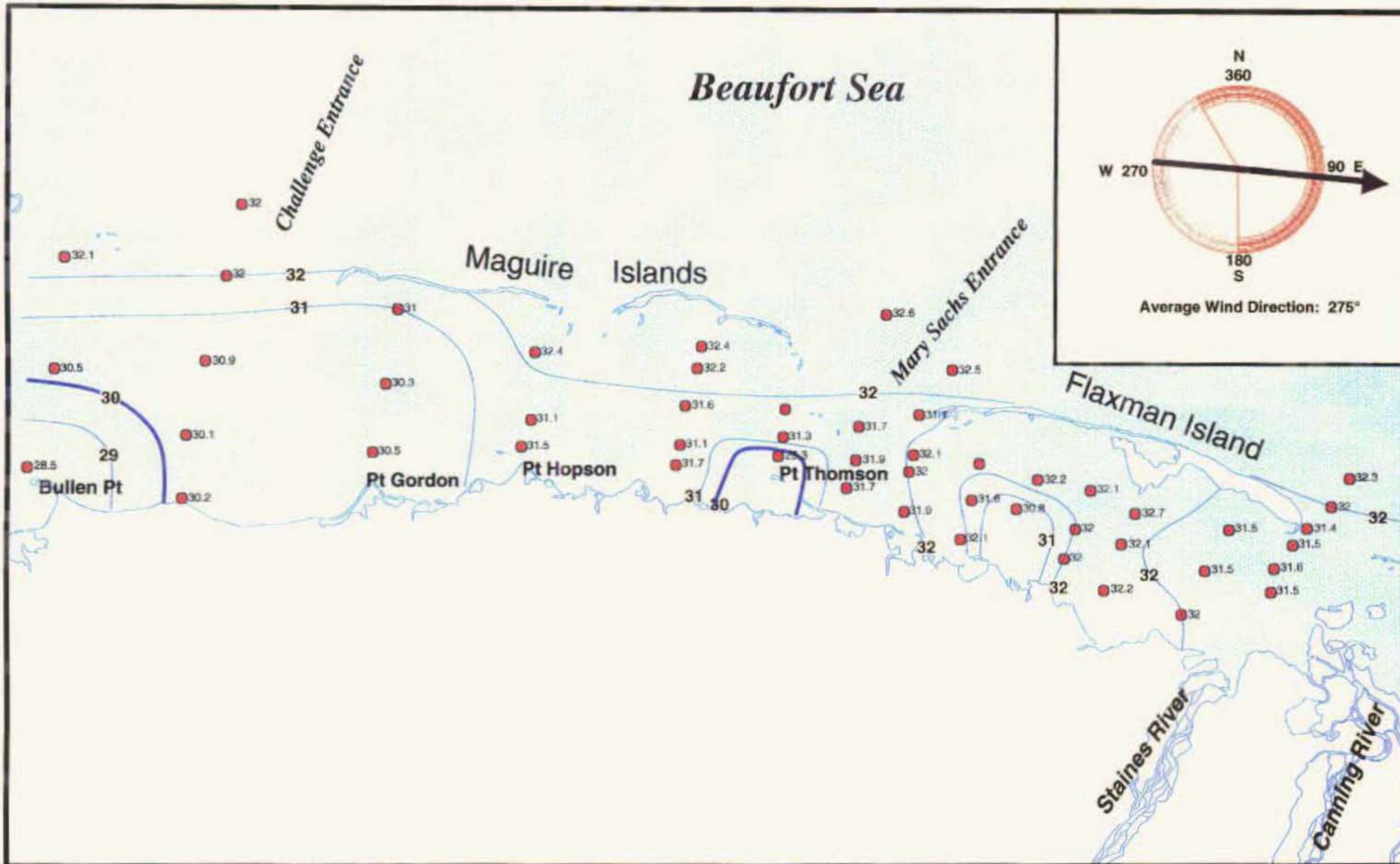
Appendix C
1998 Meteorology Records

1998 Summer Meteorology Record, NOAA Station #9497645 1, Prudhoe Bay, Alaska



Appendix D

1998 Hydrography - Maps Illustrating the Distribution of Surface and Bottom Water Salinity and Temperature

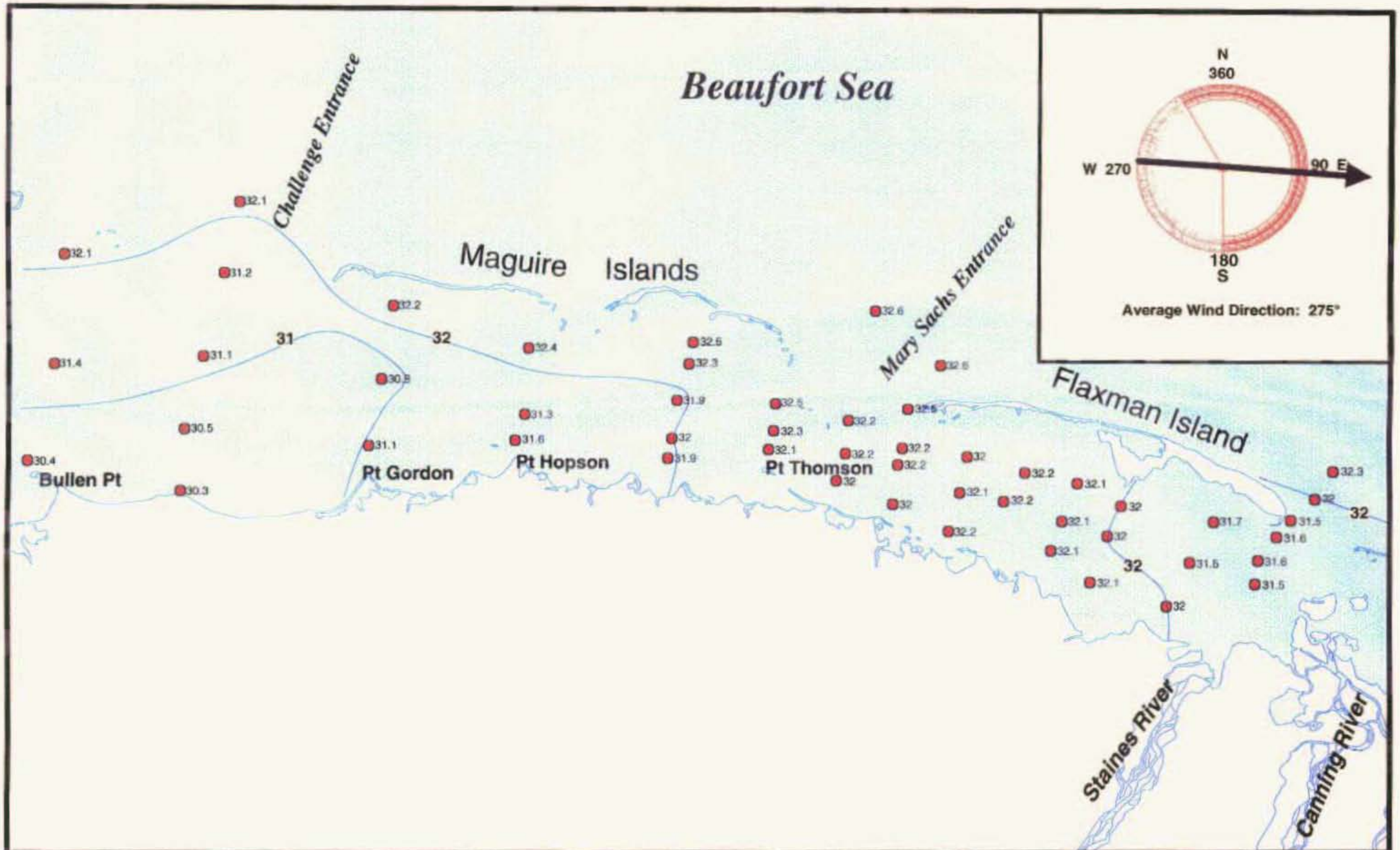


Contour Interval: 1 part per thousand

URS Greiner Woodward Clyde

Point Thomson Unit Area 1998 Physical Oceanography Study
Surface Salinity Map
July 31, 1998

Figure D-1



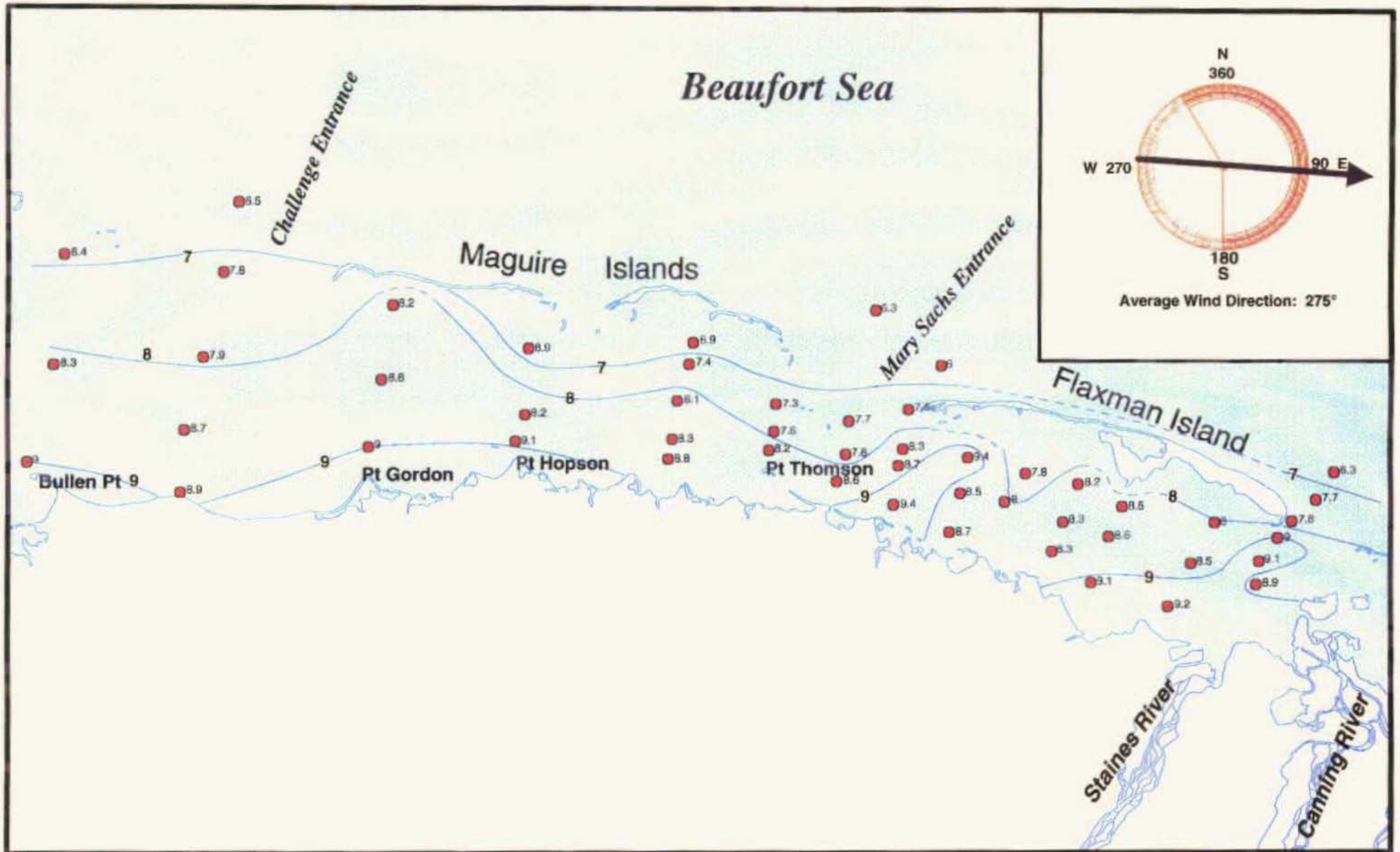
Contour Interval: 1 part per thousand

URS Greiner Woodward Clyde

Point Thomson Unit Area 1998 Physical Oceanography Study
Bottom Salinity Map
July 31, 1998

Figure D-2

S:\projects\wcc\98002na\gis\ctd\Bot&SurfMaps\31JulBSal.wor



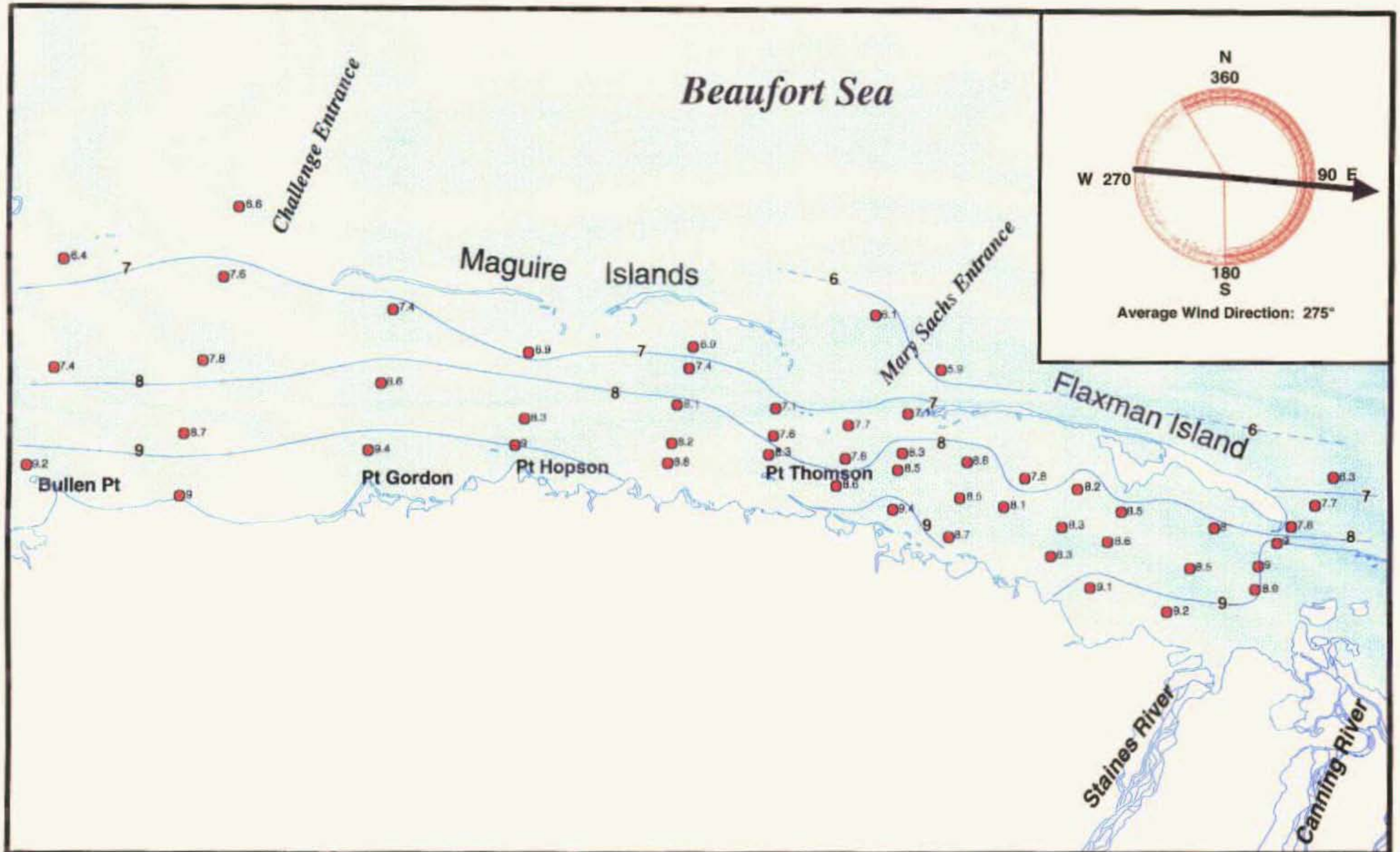
Contour Interval: 1 degree Celsius

Point Thomson Unit Area 1998 Physical Oceanography Study
Surface Temperature Map
July 31, 1998

Figure D-3

URS Greiner Woodward Clyde

S:\projects\wcc\986002ra\gis\cld\Bot&SurfMaps\31Jul\STemp.wor

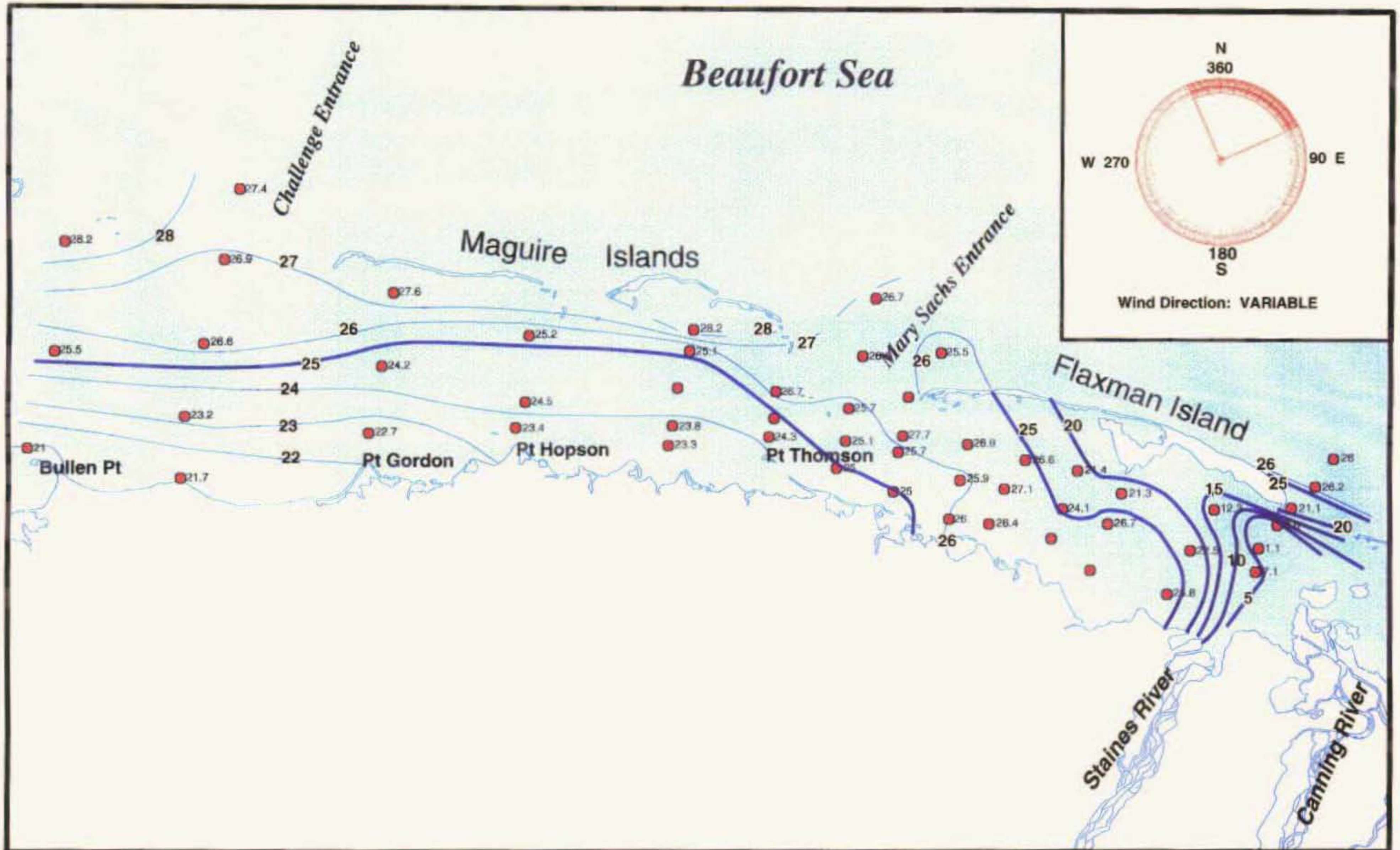


Contour Interval: 1 degree Celsius

URS Greiner Woodward Clyde

Point Thomson Unit Area 1998 Physical Oceanography Study
Bottom Temperature Map
July 31, 1998

Figure D-4



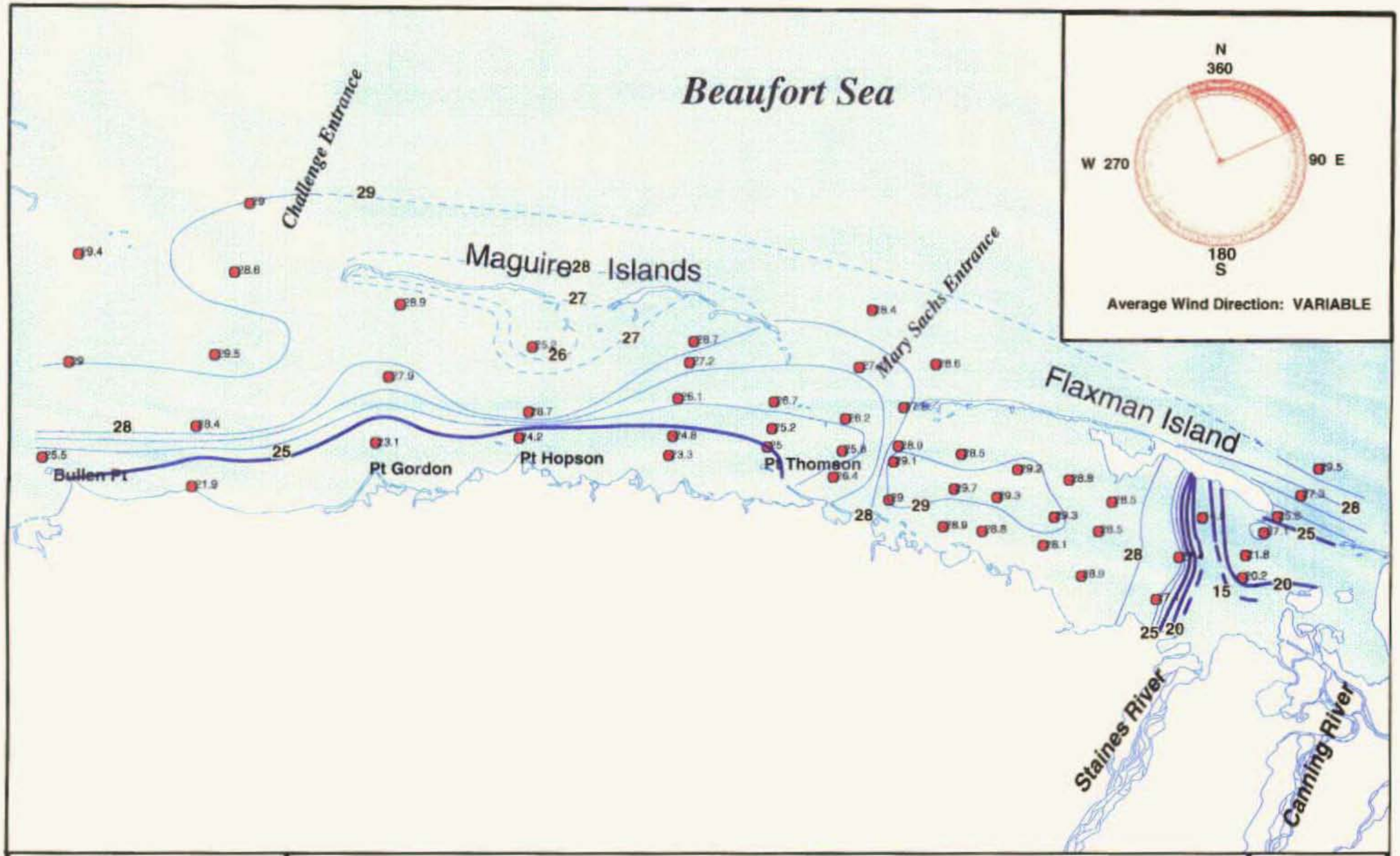
Contour Interval:
5 parts per thousand (ppt);
1 ppt interval above 25 ppt.

URS Greiner Woodward Clyde

Point Thomson Unit Area 1998 Physical Oceanography Study
Surface Salinity Map
August 12, 1998

Figure D-5

S:\projects\wcc\986002\na\gis\ctd\Bot&SurfMaps\12AugSSal.wor



Contour Interval:
5 parts per thousand (ppt);
1 ppt interval above 25 ppt.

URS Greiner Woodward Clyde

Point Thomson Unit Area 1998 Physical Oceanography Study
Bottom Salinity Map
August 12, 1998

Figure D-6

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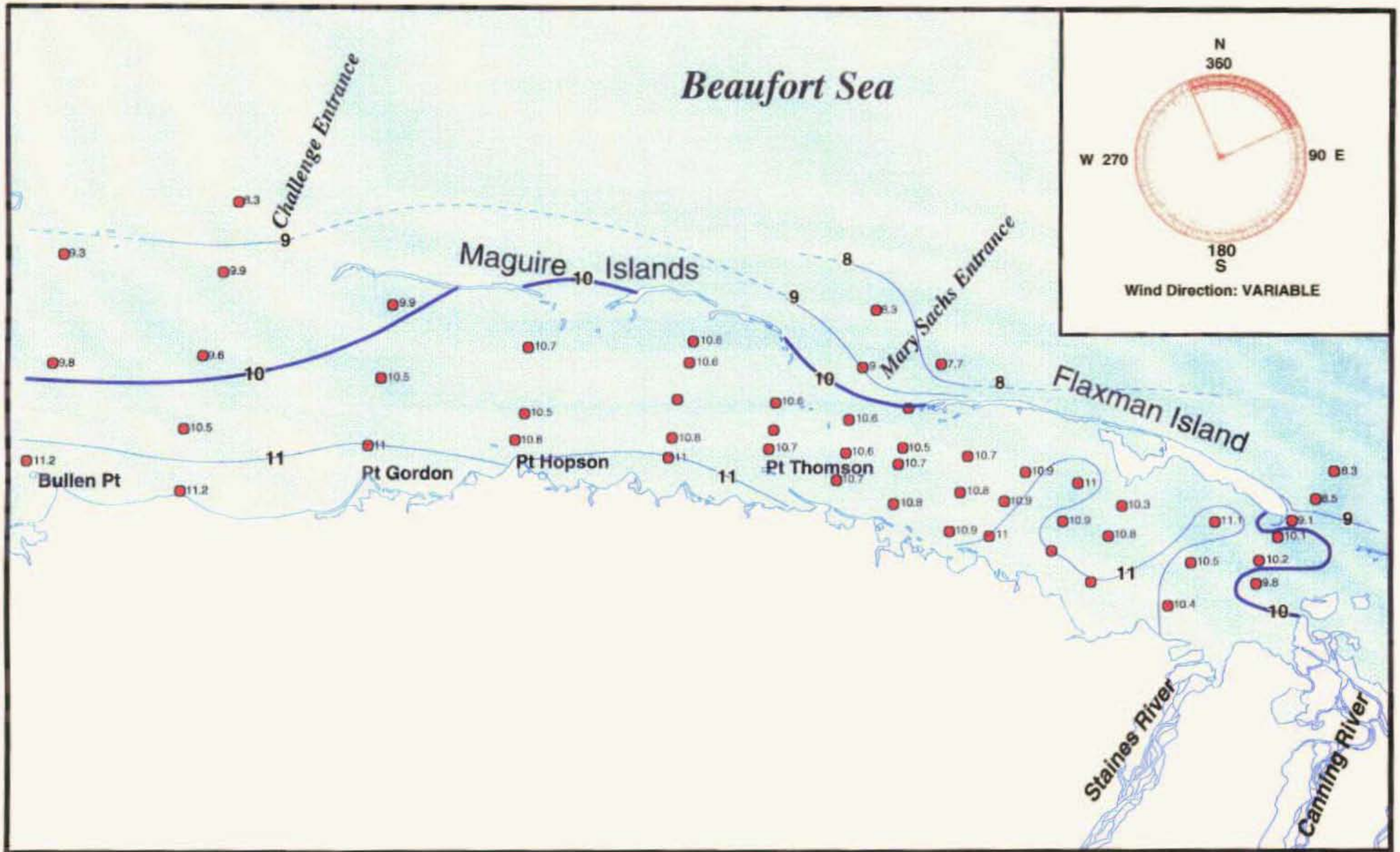
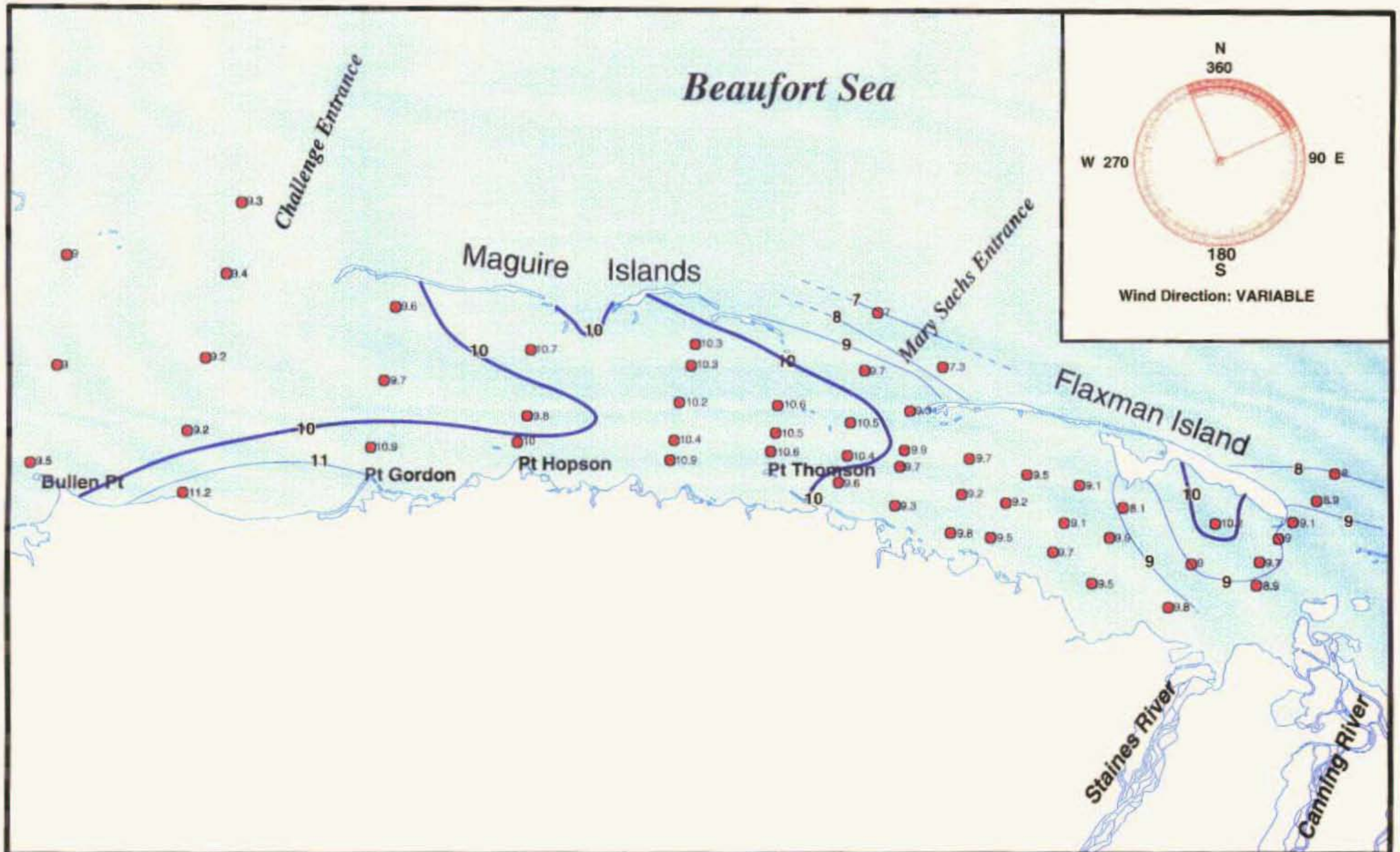


Contour Interval: 1 degree Celsius

URS Greiner Woodward Clyde

Point Thomson Unit Area 1998 Physical Oceanography Study
Surface Temperature Map
August 12, 1998

Figure D-7

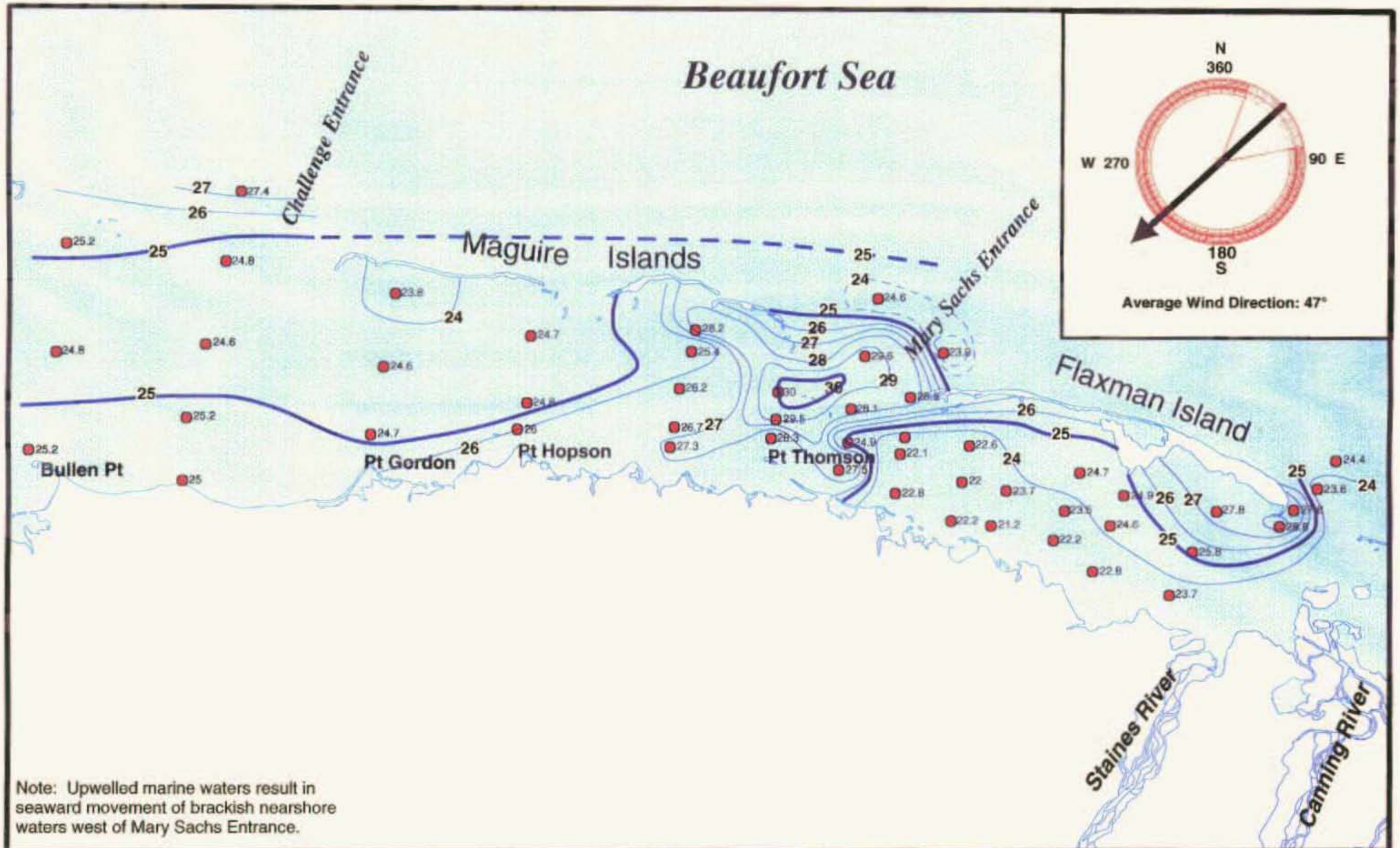


Contour Interval: 1 degree Celsius

URS Greiner Woodward Clyde

Point Thomson Unit Area 1998 Physical Oceanography Study
Bottom Temperature Map
August 12, 1998

Figure D-8



Contour Interval: 1 part per thousand

Point Thomson Unit Area 1998 Physical Oceanography Study
Surface Salinity Map
August 25, 1998

Figure D-9

URS Greiner Woodward Clyde

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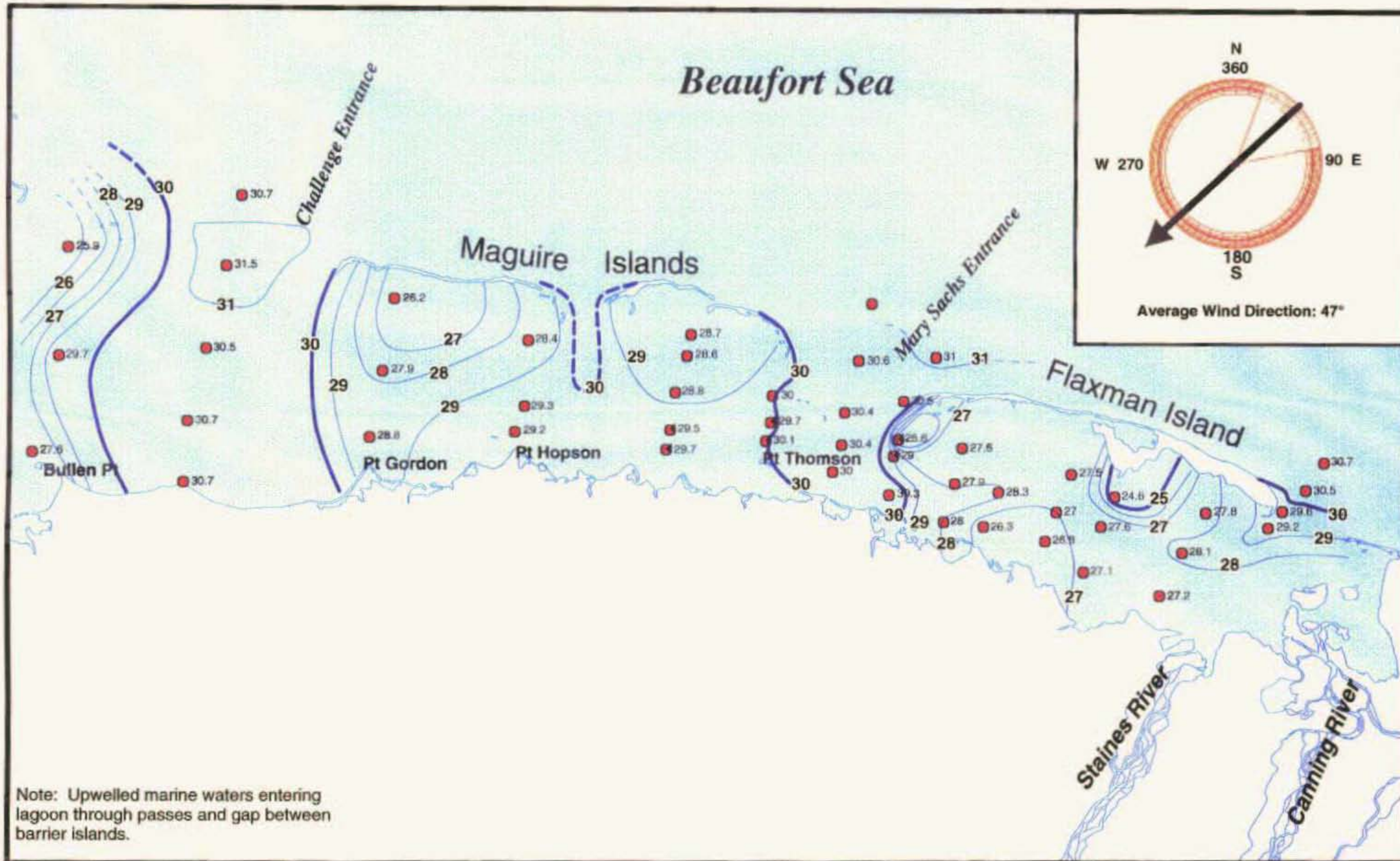


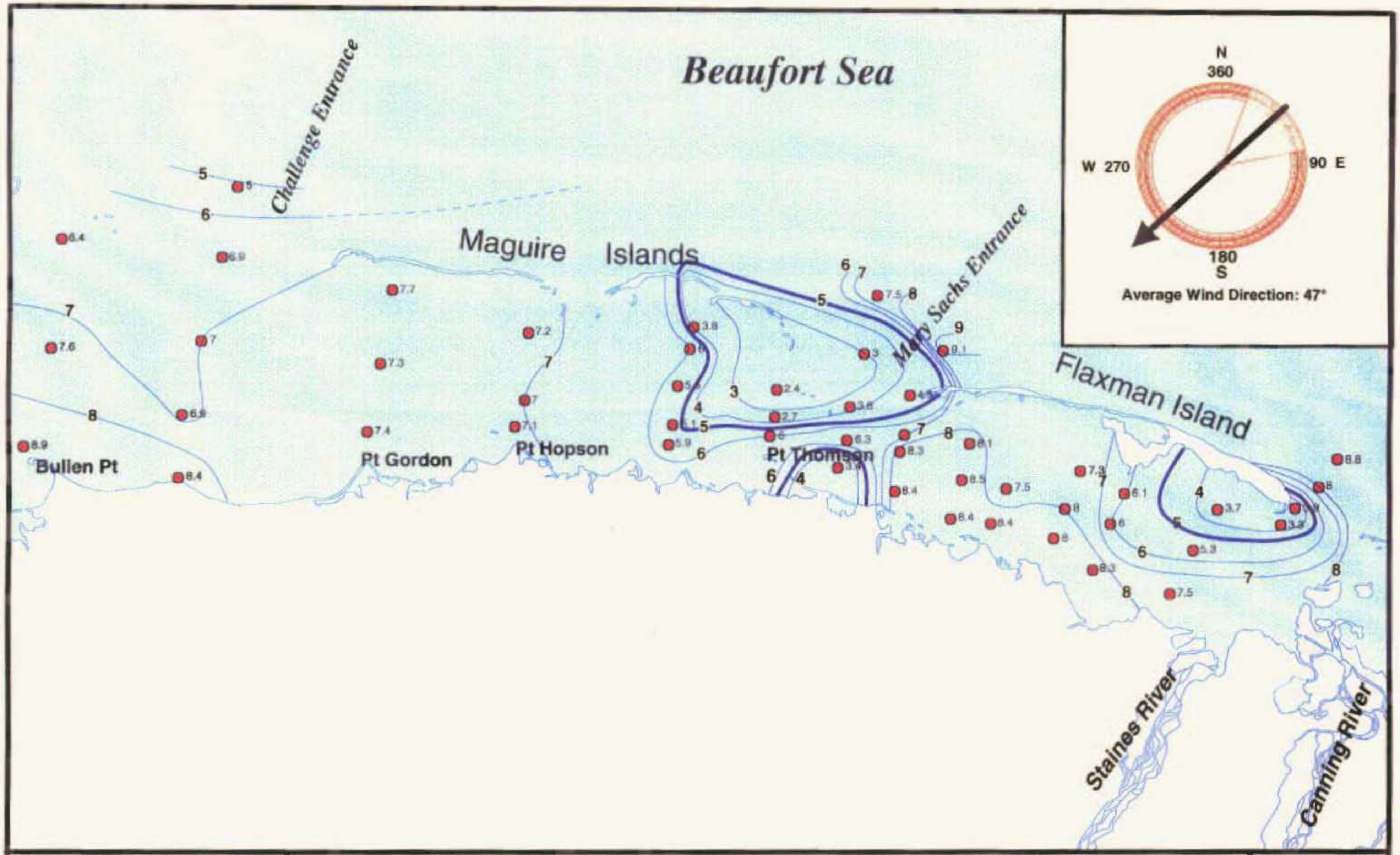
Contour Interval: 1 part per thousand

URS Greiner Woodward Clyde

Point Thomson Unit Area 1998 Physical Oceanography Study
Bottom Salinity Map
August 25, 1998

Figure D-10

S:\projects\wcc\986002\a\gis\ctd\Bot&SurfMaps\25AugBSal.wor

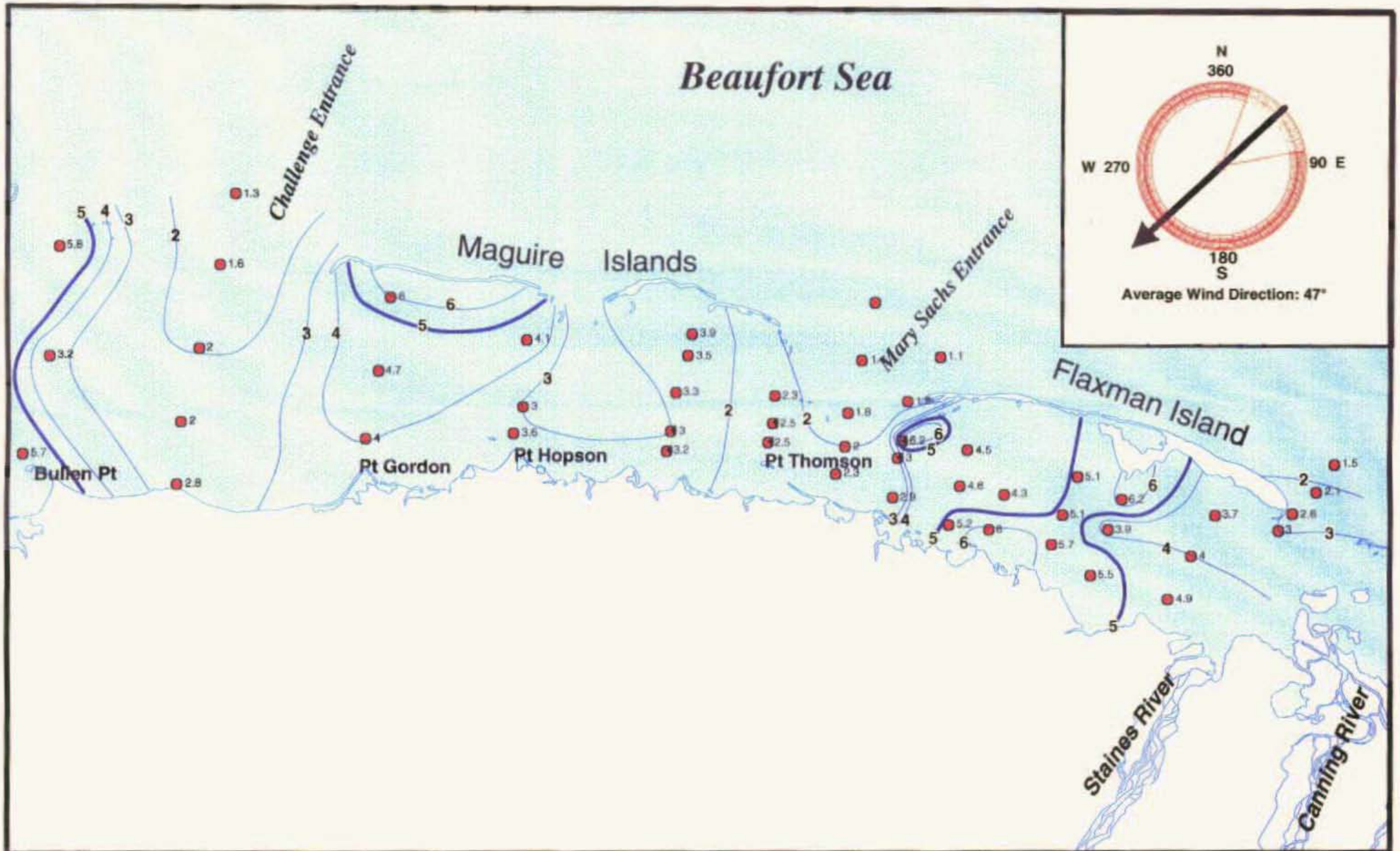


Contour Interval: 1 degree Celsius

URS Greiner Woodward Clyde

Point Thomson Unit Area 1998 Physical Oceanography Study
Surface Temperature Map
August 25, 1998

Figure D-11

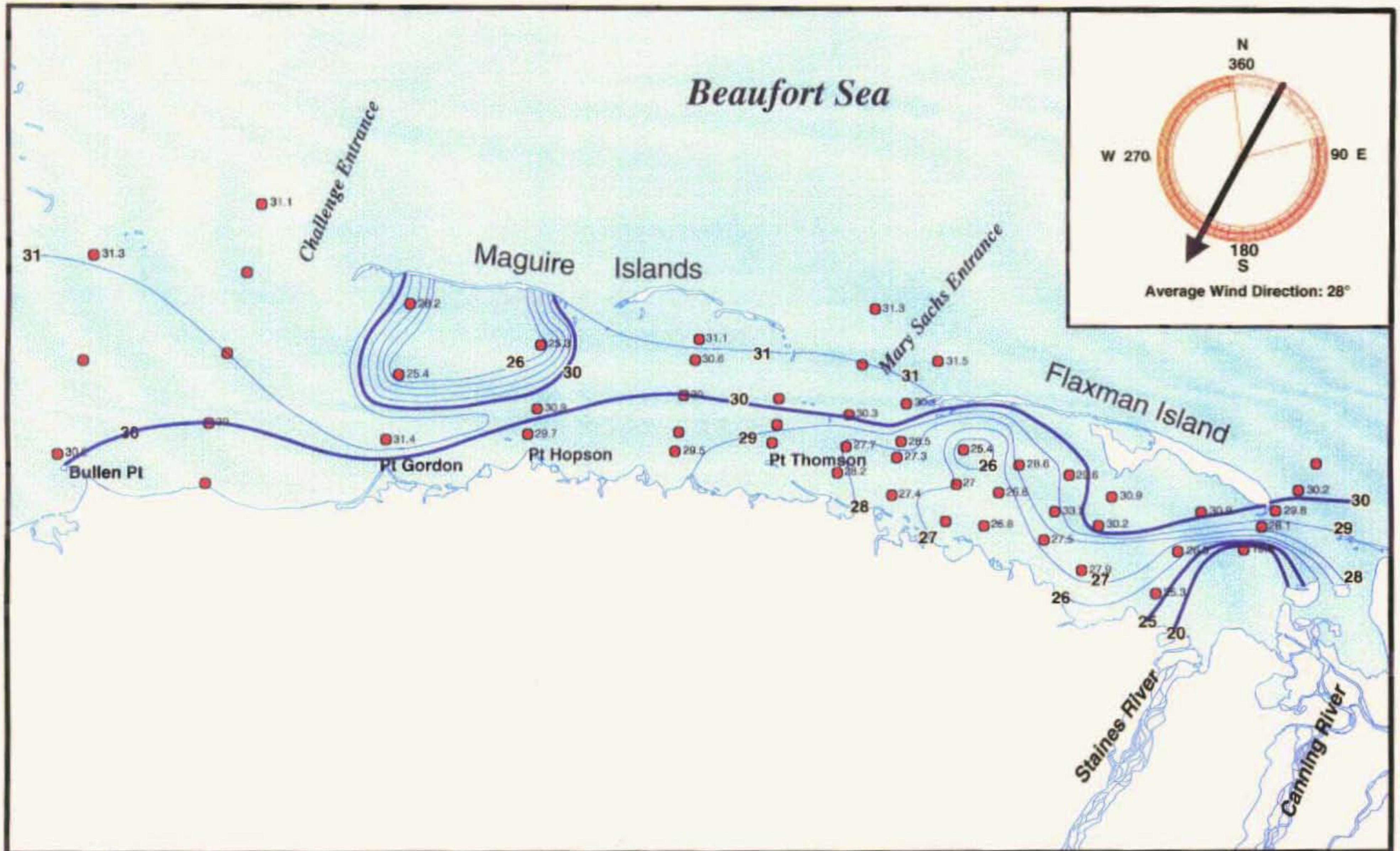


Contour Interval: 1 degree Celsius

URS Greiner Woodward Clyde

Point Thomson Unit Area 1998 Physical Oceanography Study
Bottom Temperature Map
August 25, 1998

Figure D-12

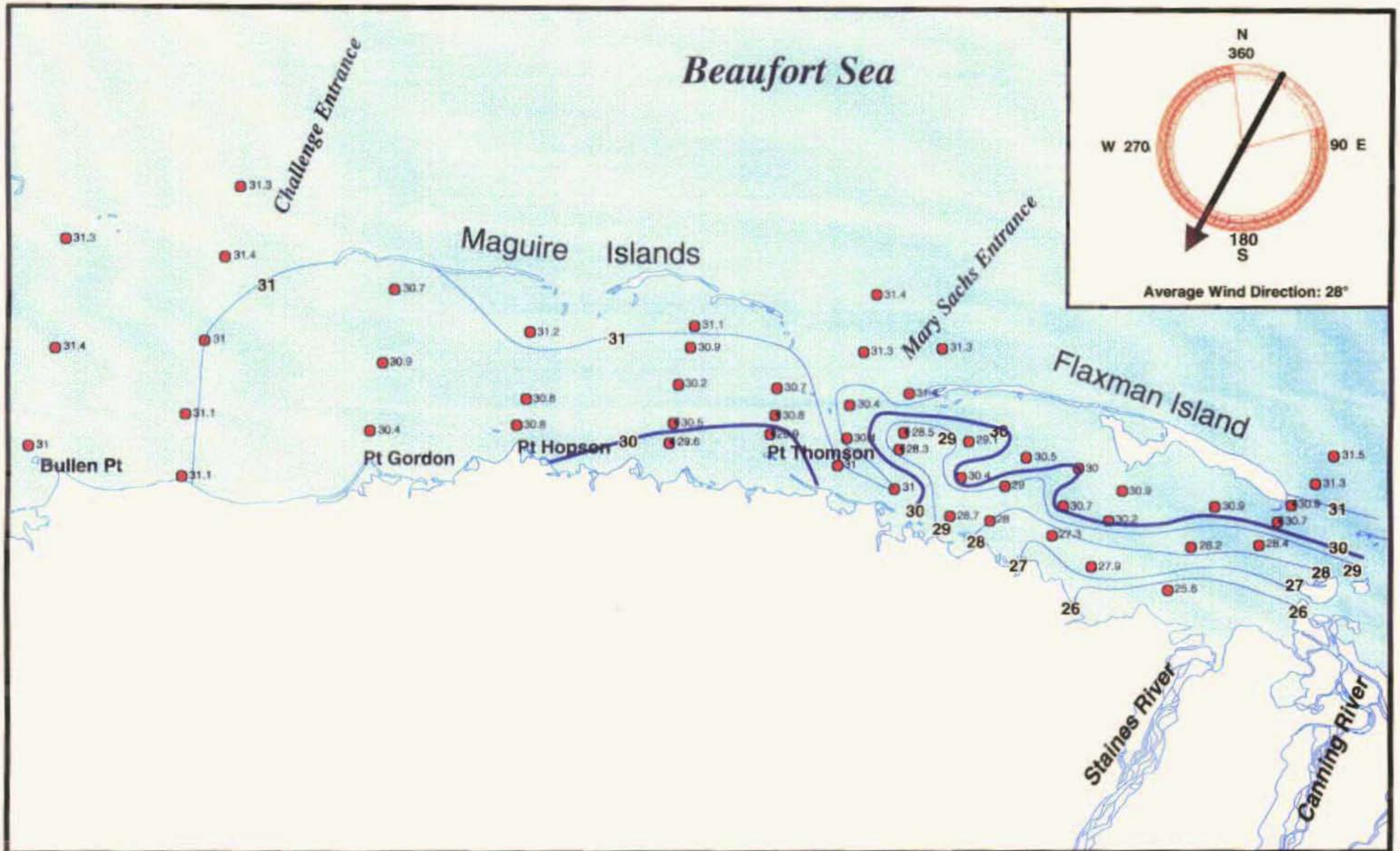


Contour Interval:
5 parts per thousand (ppt);
1 ppt interval above 25 ppt.

URS Greiner Woodward Clyde

Point Thomson Unit Area 1998 Physical Oceanography Study
Surface Salinity Map
September 13, 1998

Figure D-13

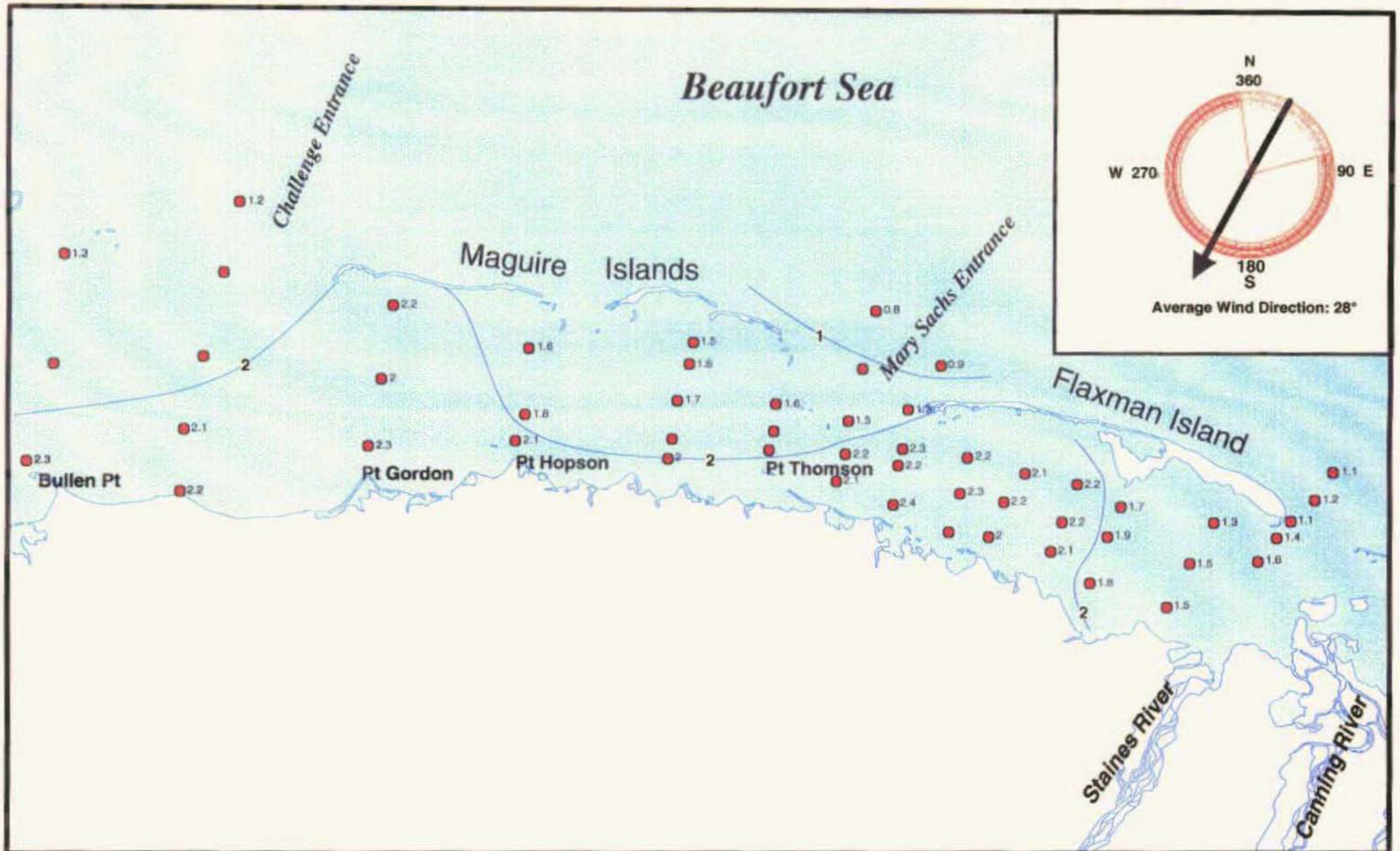


Contour Interval: 1 part per thousand

URS Greiner Woodward Clyde

Point Thomson Unit Area 1998 Physical Oceanography Study
Bottom Salinity Map
September 13, 1998

Figure D-14



Contour Interval: 1 degree Celsius

URS Greiner Woodward Clyde

Point Thomson Unit Area 1998 Physical Oceanography Study
Surface Temperature Map
September 13, 1998

Figure D-15

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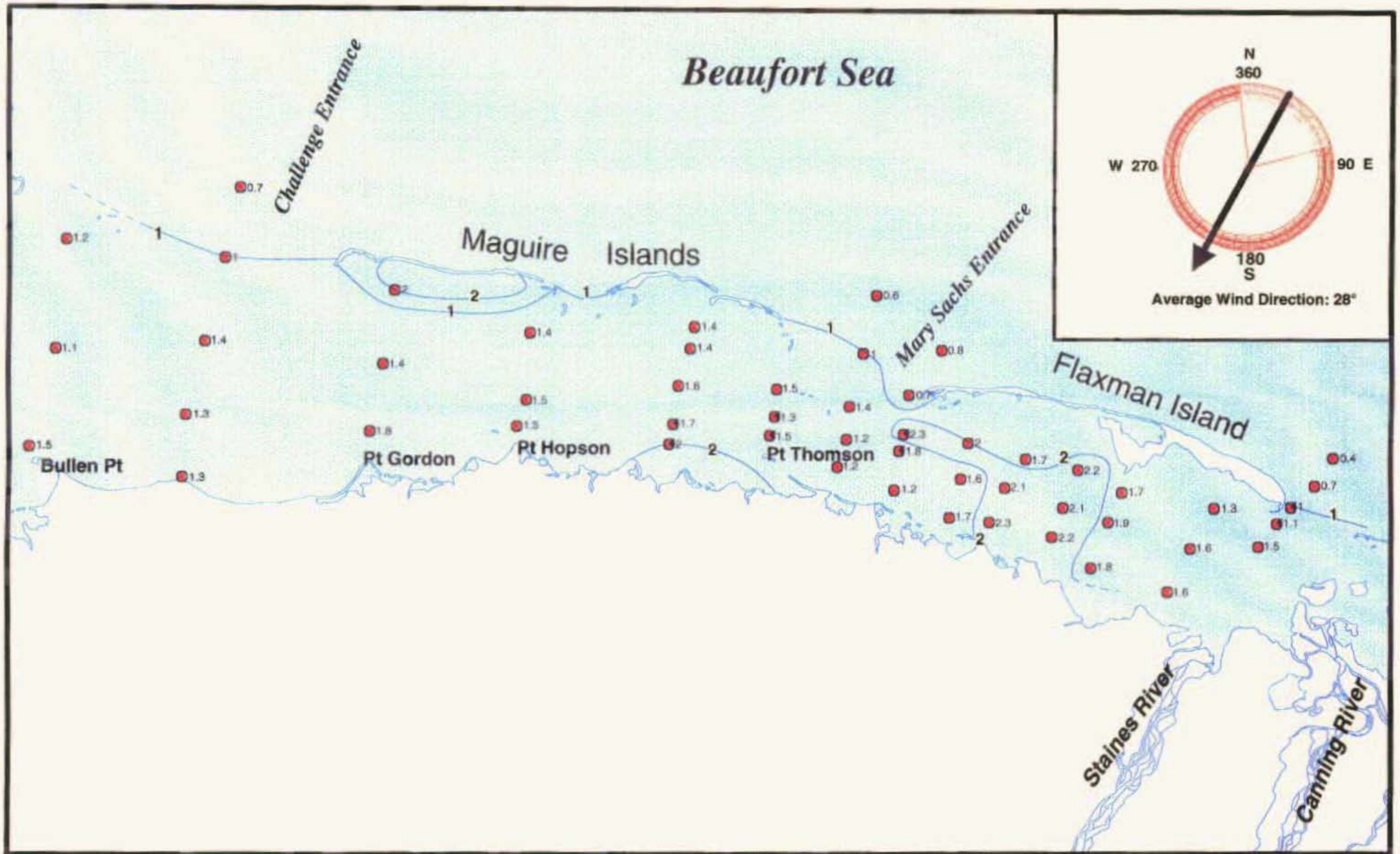


Contour Interval: 1 degree Celsius

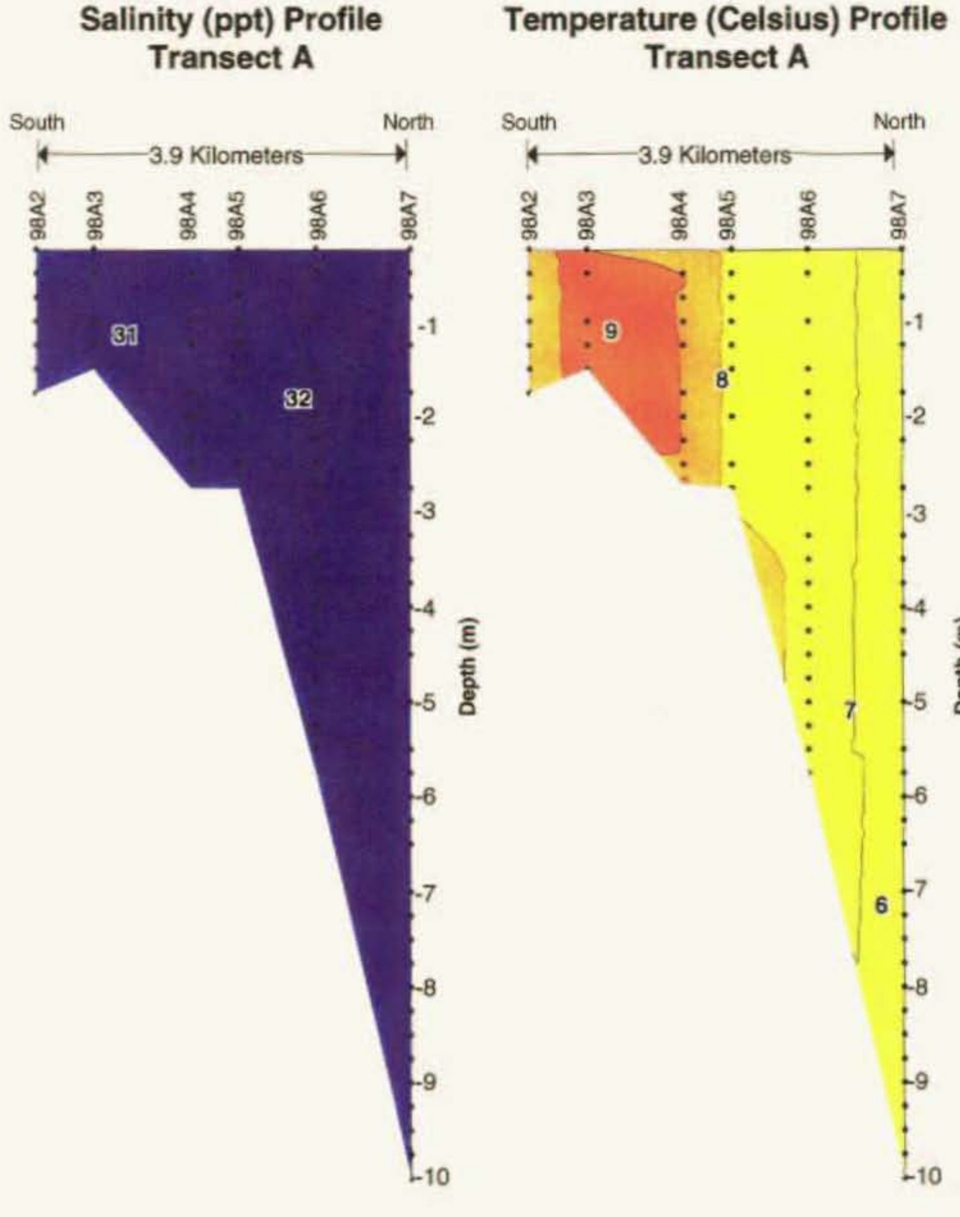
URS Greiner Woodward Clyde

Point Thomson Unit Area 1998 Physical Oceanography Study
Bottom Temperature Map
September 13, 1998

Figure D-16

Appendix E

1998 Hydrography - Water Column Temperature and Salinity Cross-Sections



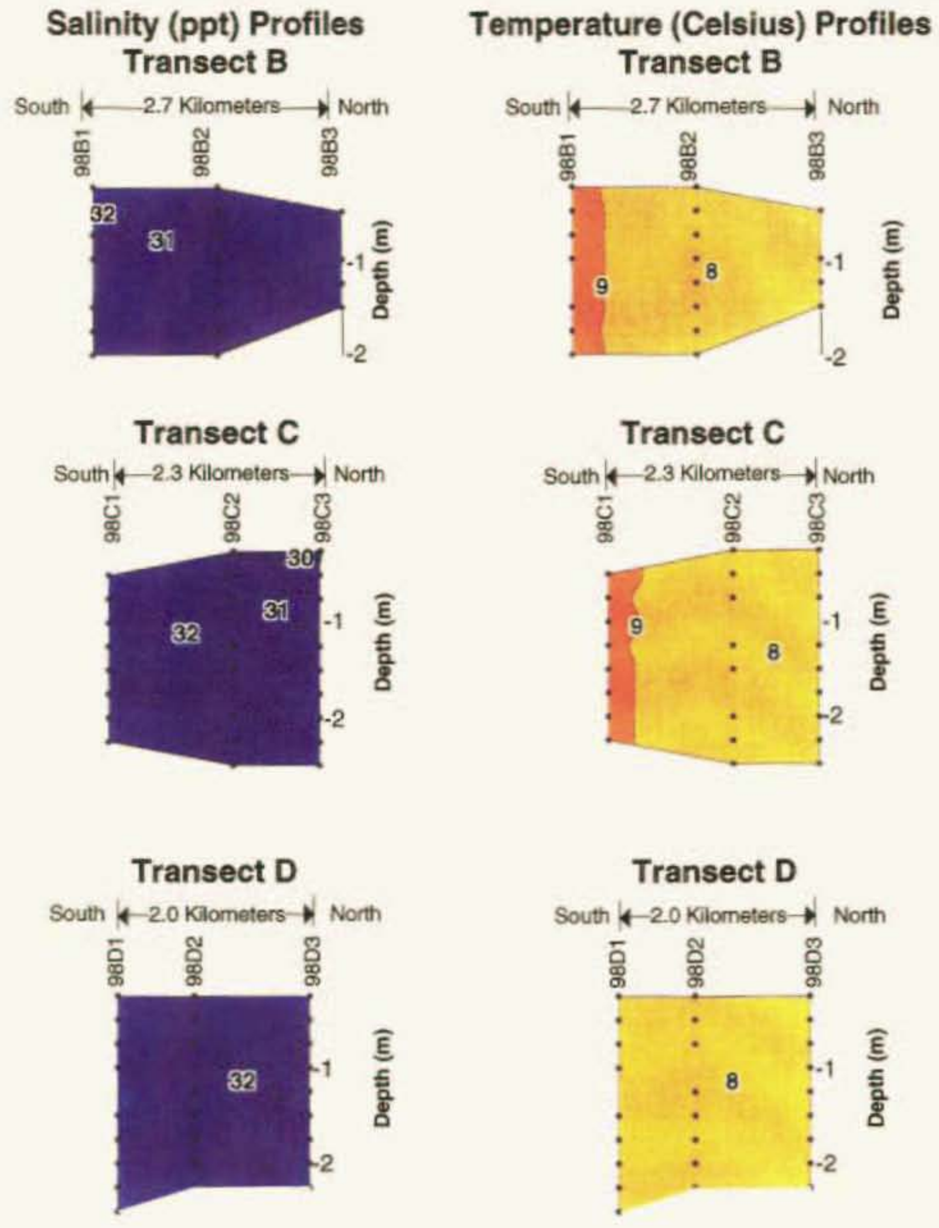
URS Greiner Woodward Clyde

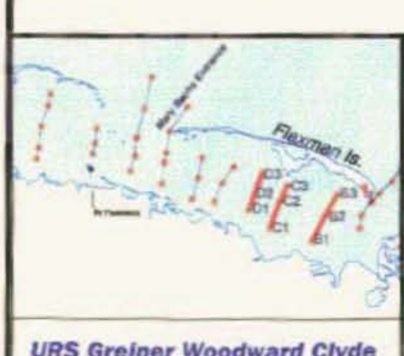
Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect A: July 31, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-1





URS Greiner Woodward Clyde

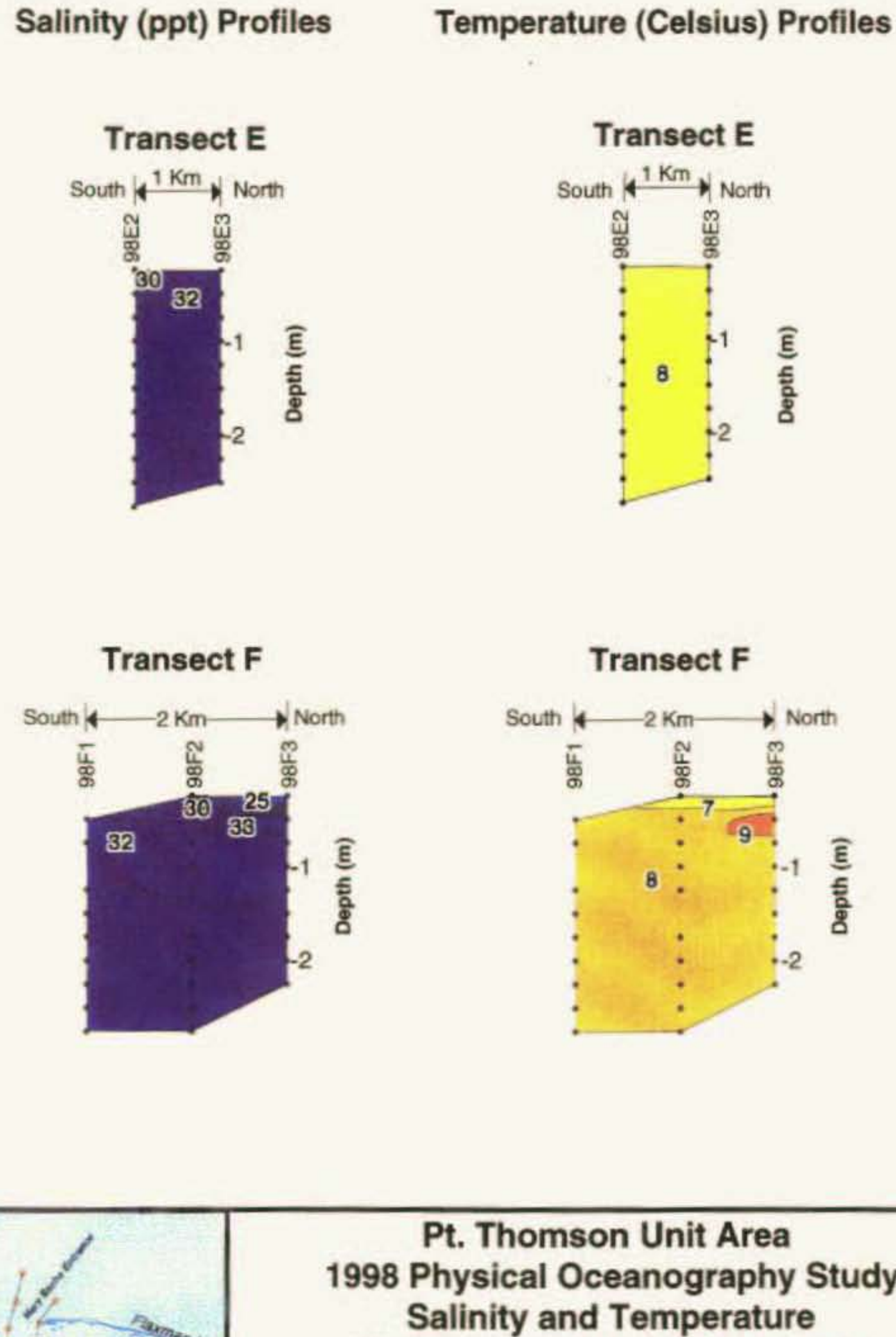
Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transects B, C, & D: July 31, 1998

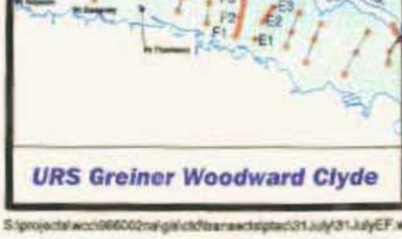
Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-2

S:\projects\wcc\986002\ai\gis\cld\transects\plac\31July\31JulyBCD.wor





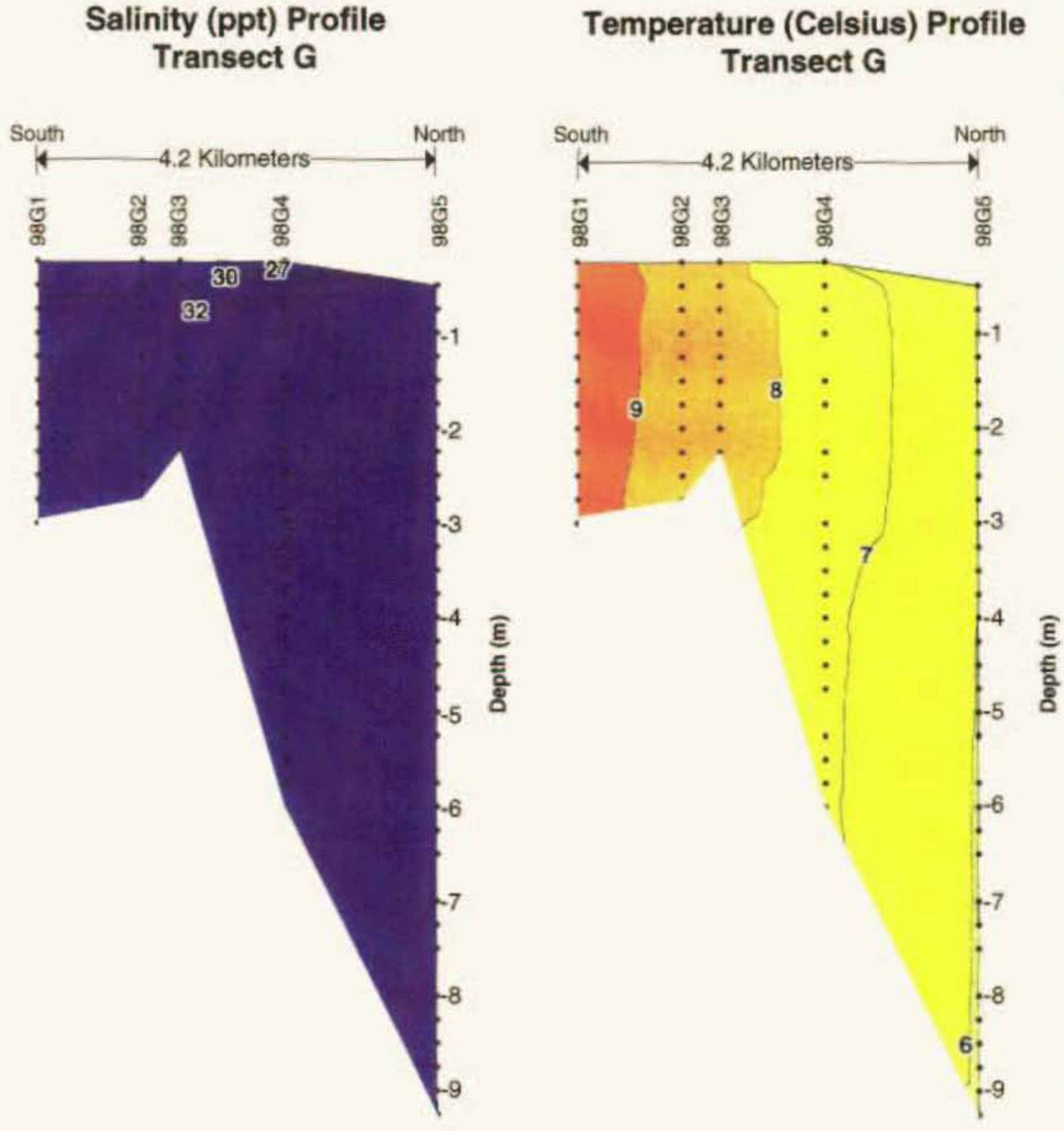
URS Greiner Woodward Clyde

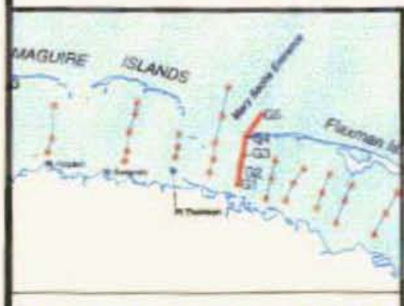
Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transects E & F: July 31, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-3





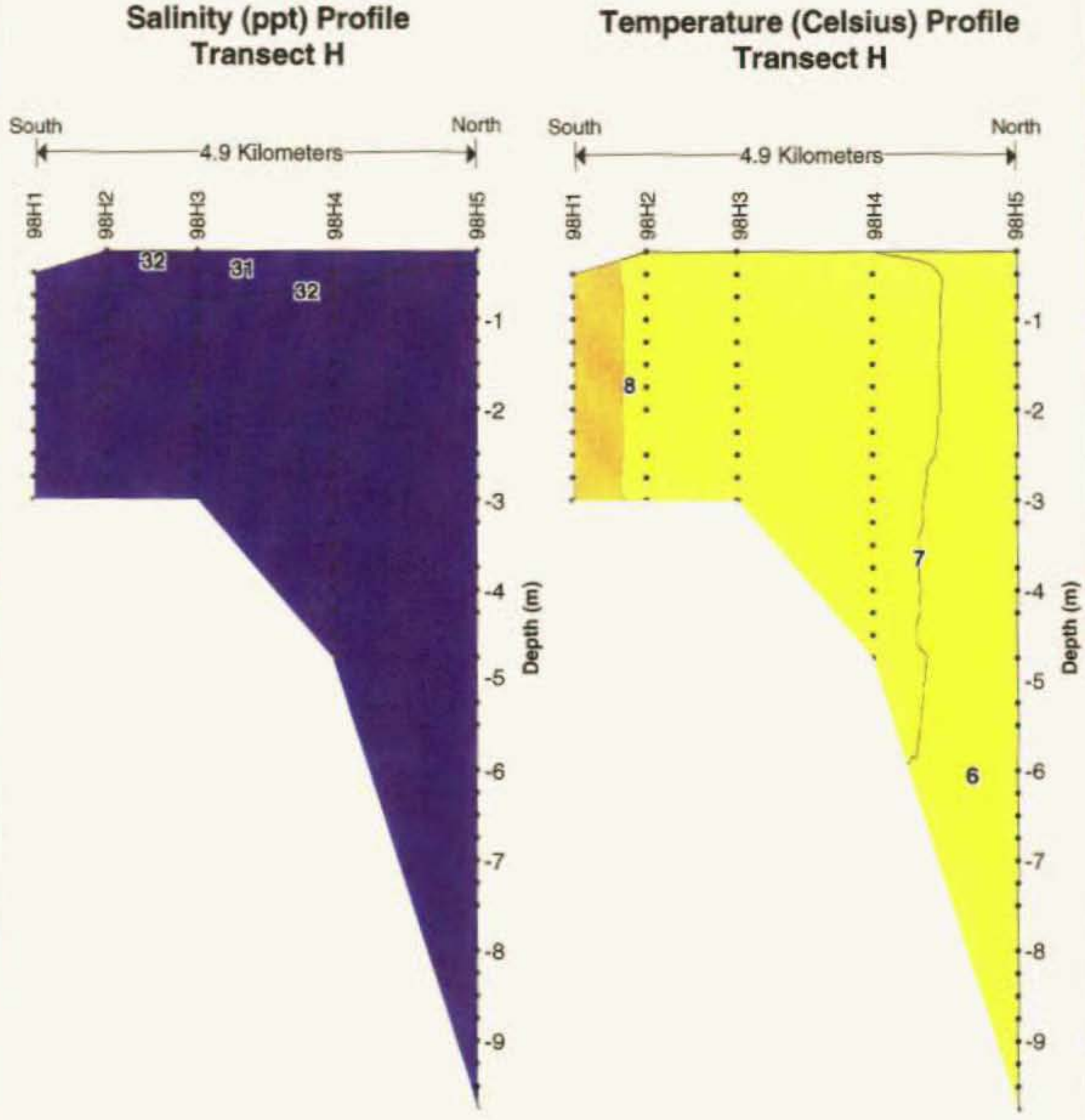
URS Greiner Woodward Clyde

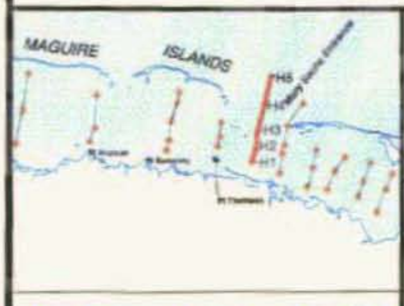
Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect G: July 31, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-4





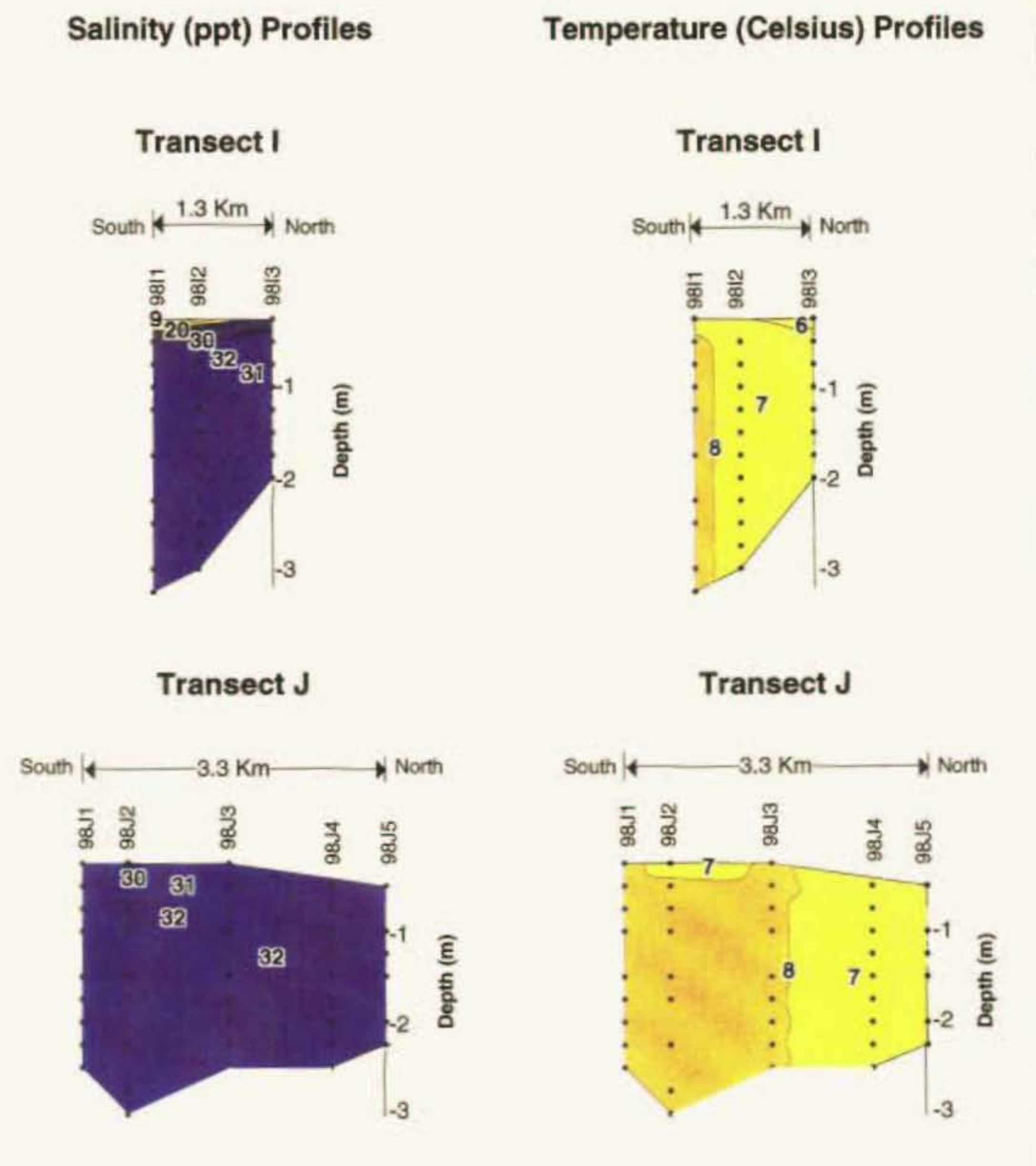
URS Greiner Woodward Clyde

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect H: July 31, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-5



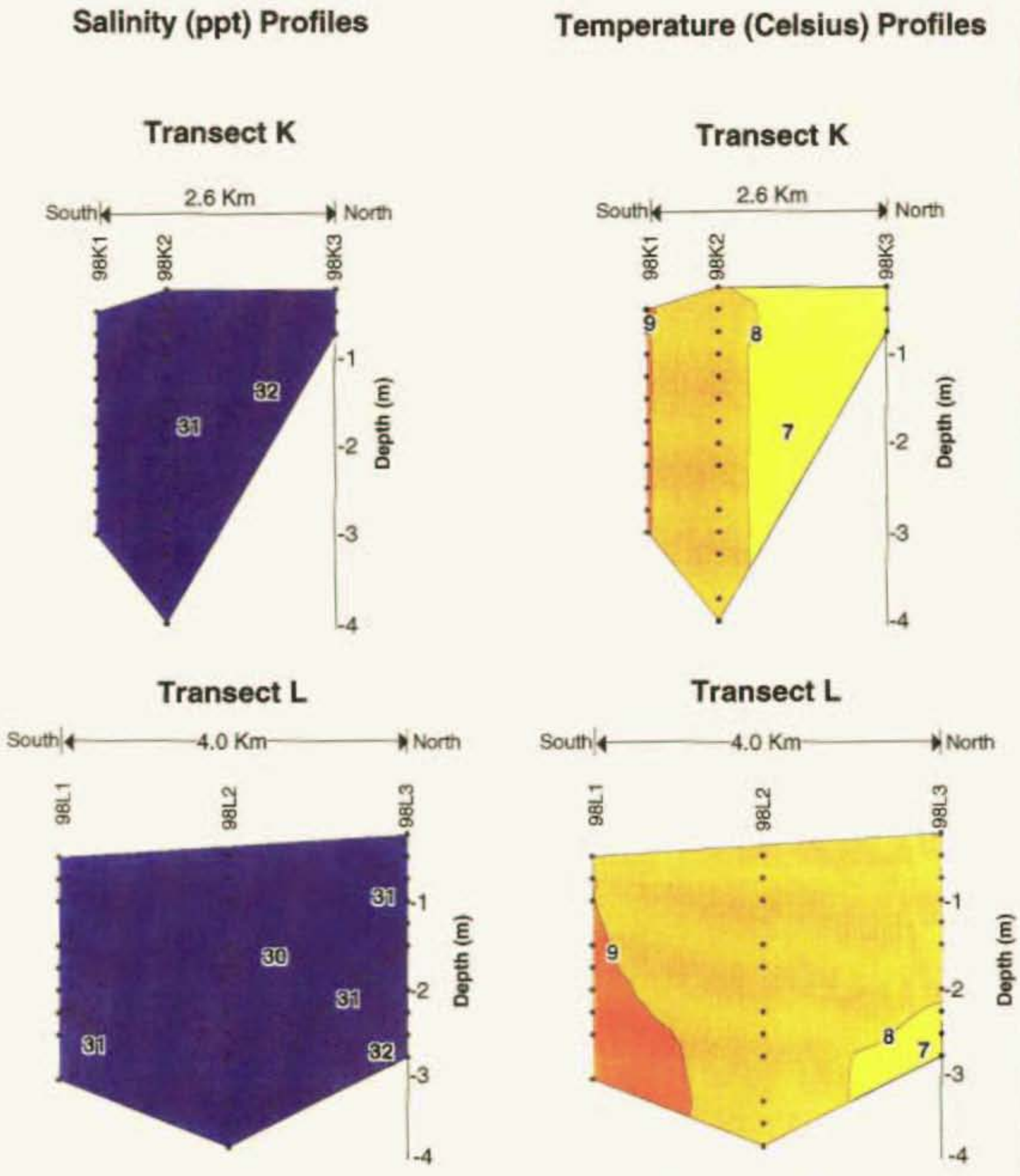
URS Greiner Woodward Clyde

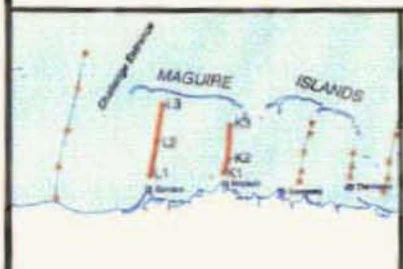
Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transects I & J: July 31, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-6





URS Greiner Woodward Clyde

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transects K & L: July 31, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

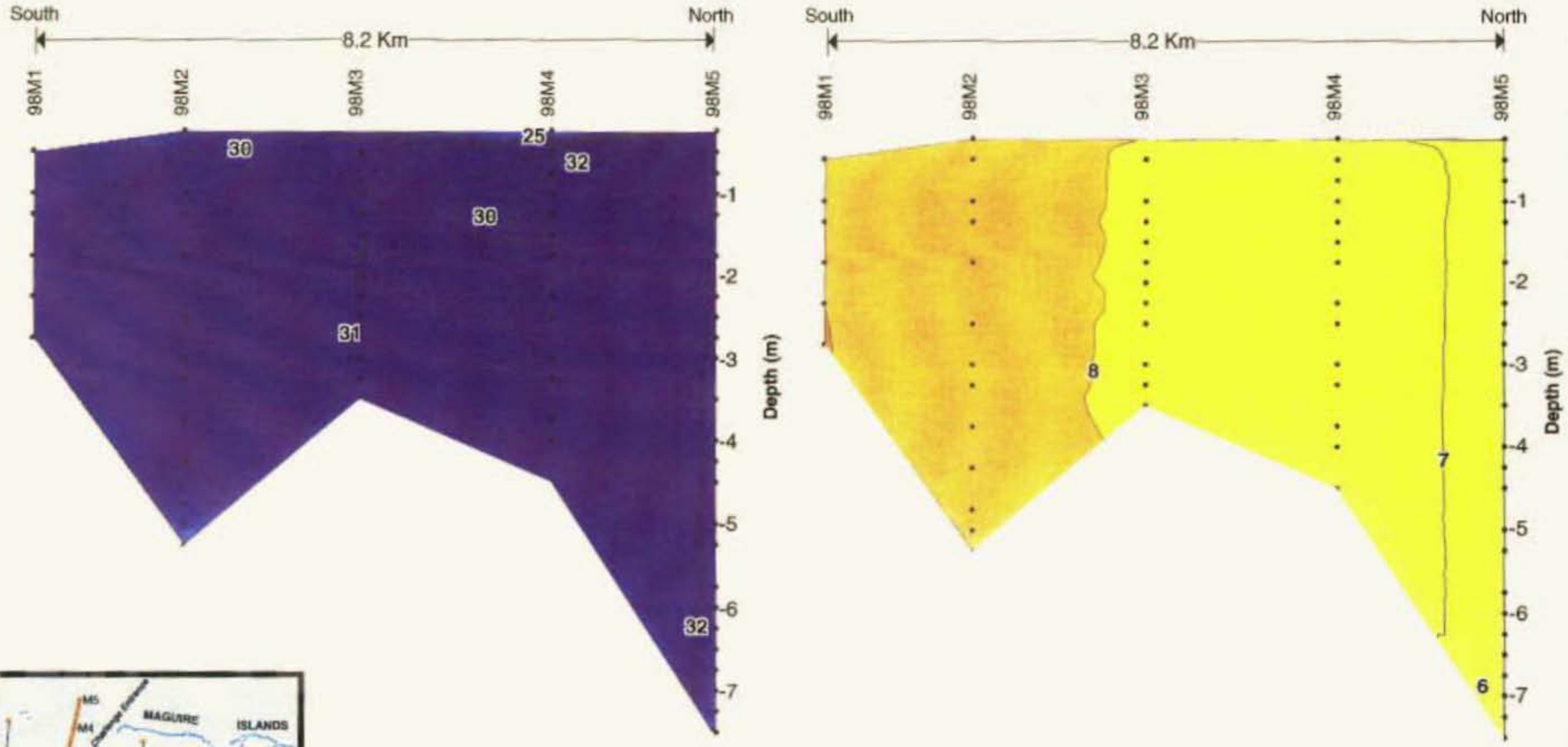
Figure E-7

Salinity (ppt) Profile

Transect M

Temperature (Celsius) Profile

Transect M



URS Greiner Woodward Clyde

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

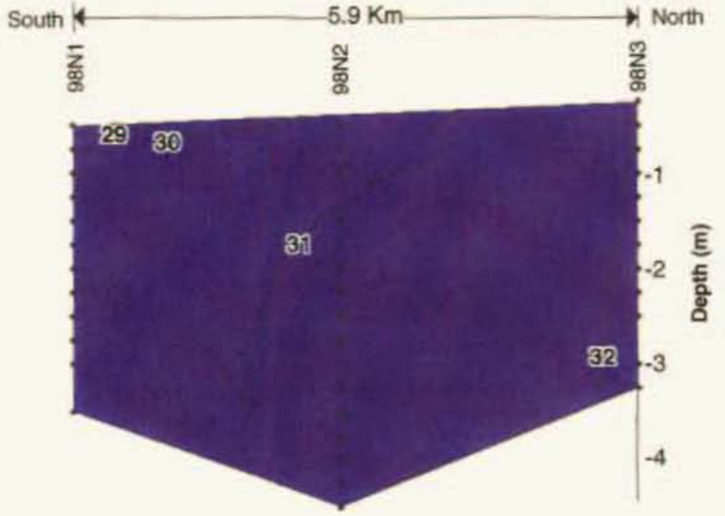
Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect M: July 31, 1998

Figure E-8

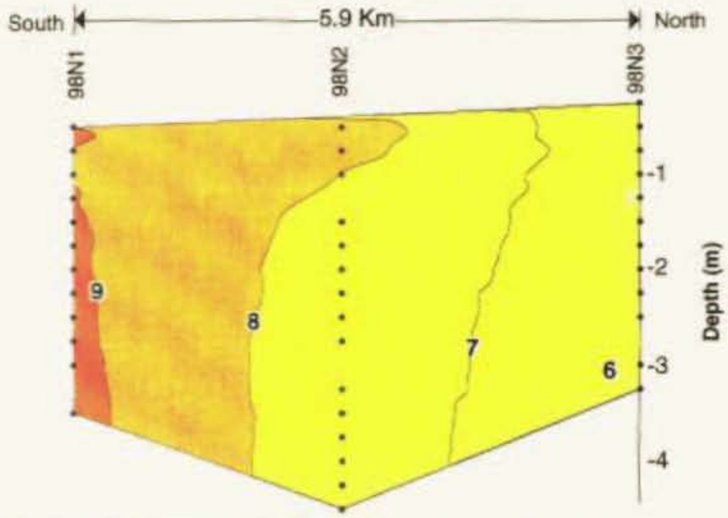
Salinity (ppt) Profile

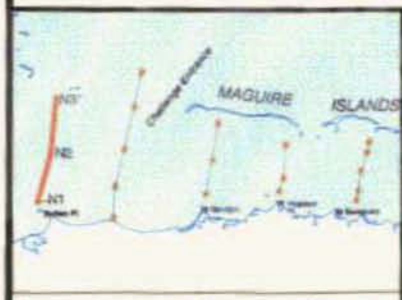
Transect N



Temperature (Celsius) Profile

Transect N





URS Greiner Woodward Clyde

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect N: July 31, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-9

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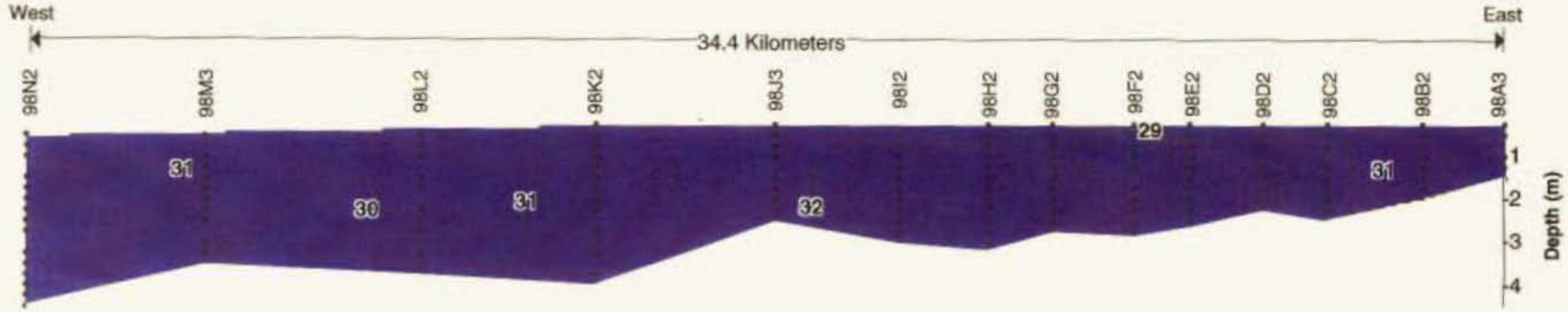
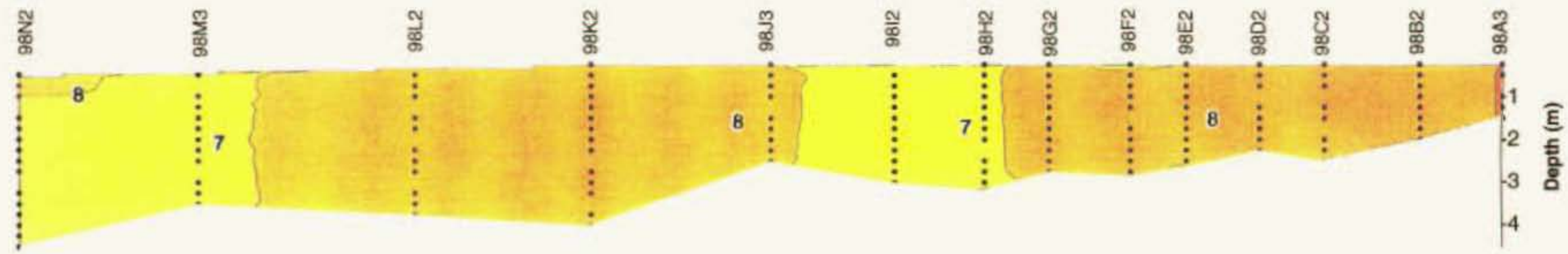
Cross Sectional Transect

Salinity (ppt) Profile



Temperature (Celsius) Profile



URS Greiner Woodward Clyde

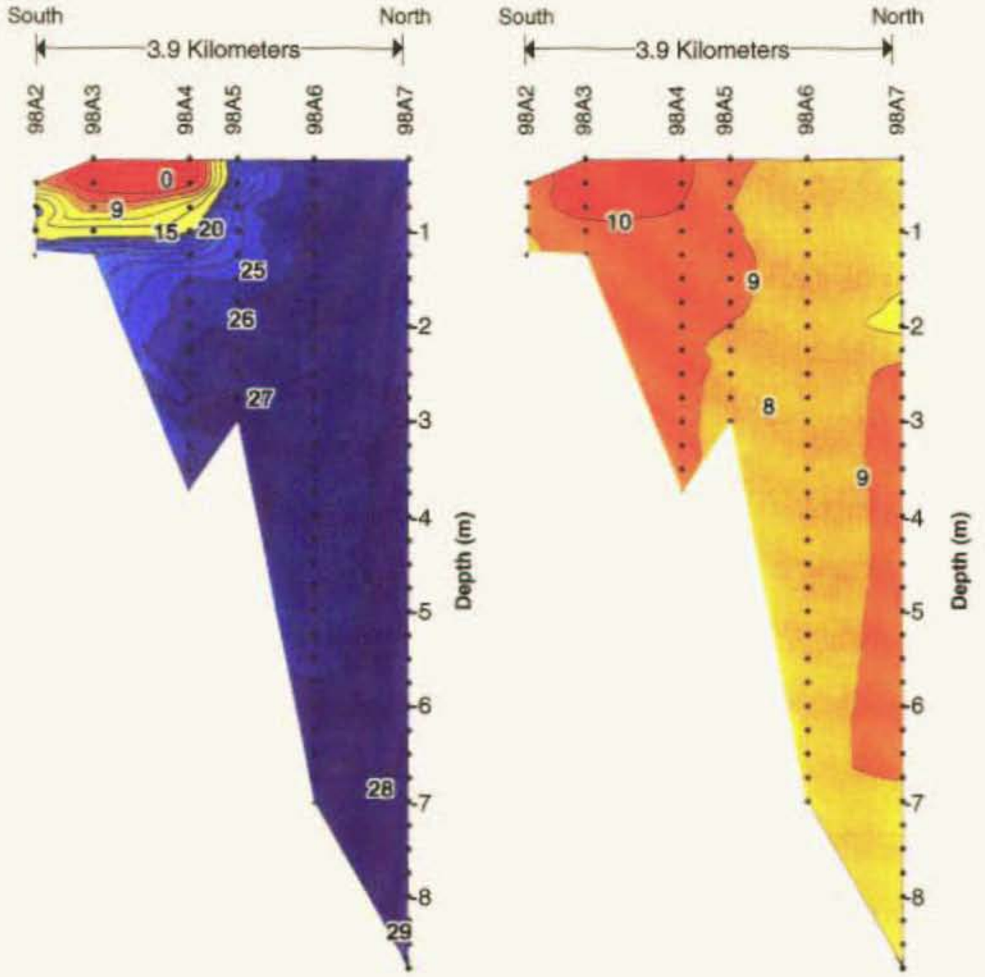
Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

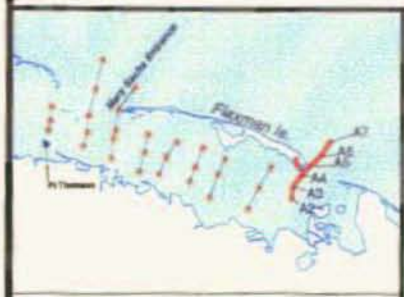
Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Cross Sectional Transect: July 31, 1998

Figure E-10

Salinity (ppt) Profile Transect A | **Temperature (Celsius) Profile Transect A**





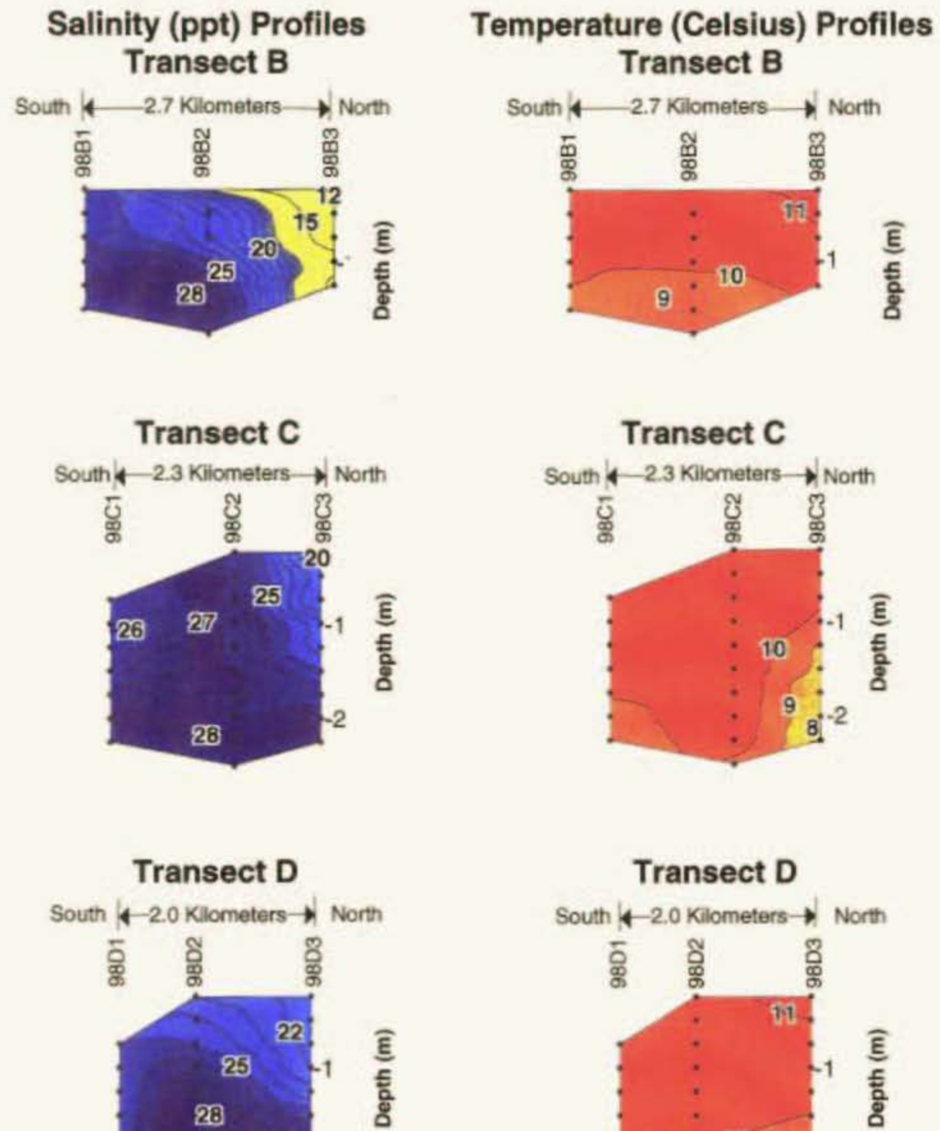
URS Greiner Woodward Clyde

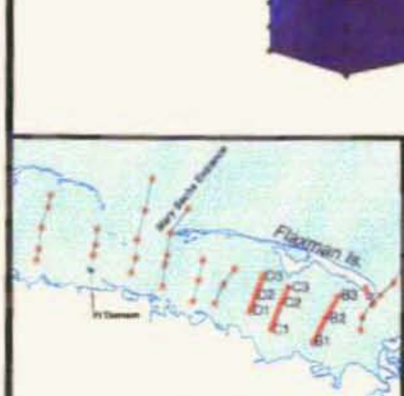
Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect A: August 12, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-11





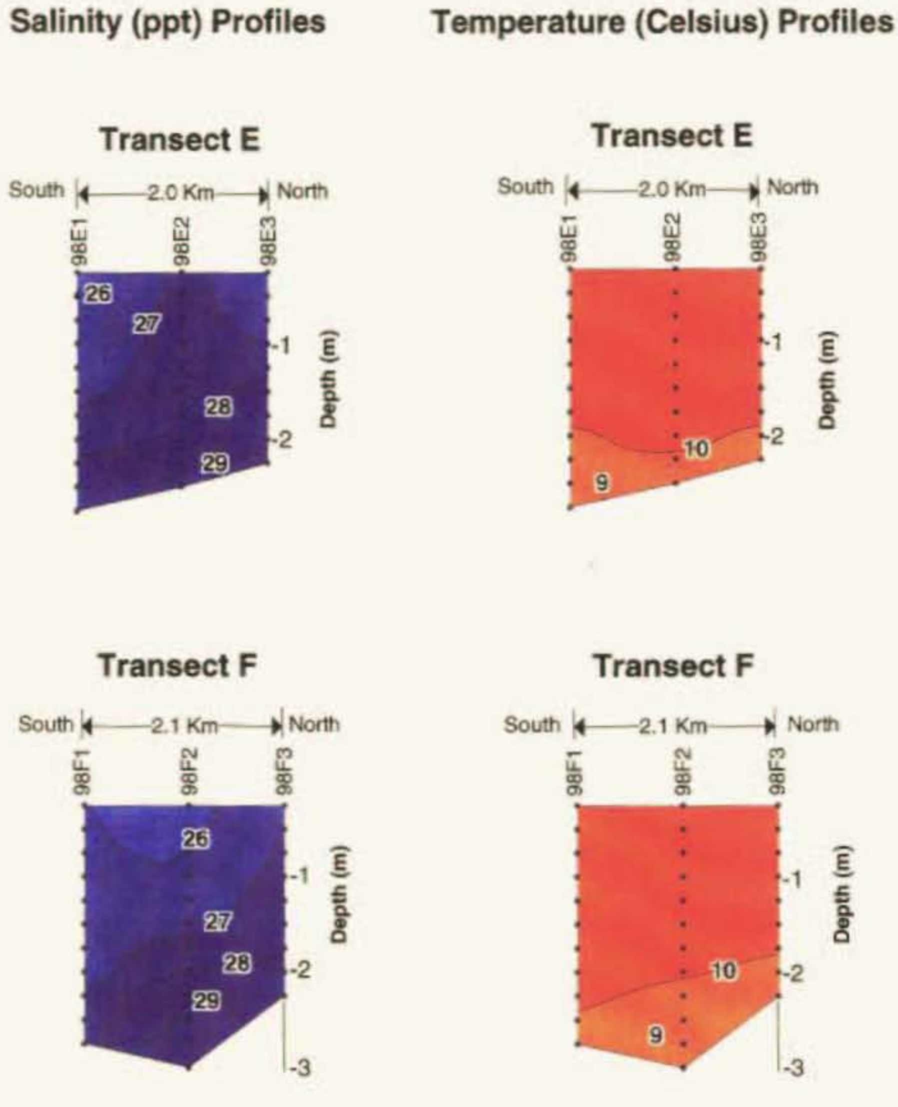
URS Greiner Woodward Clyde

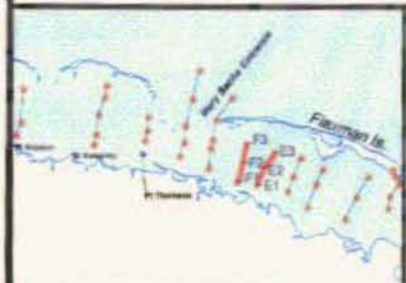
Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transects B, C, & D: August 12, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-12





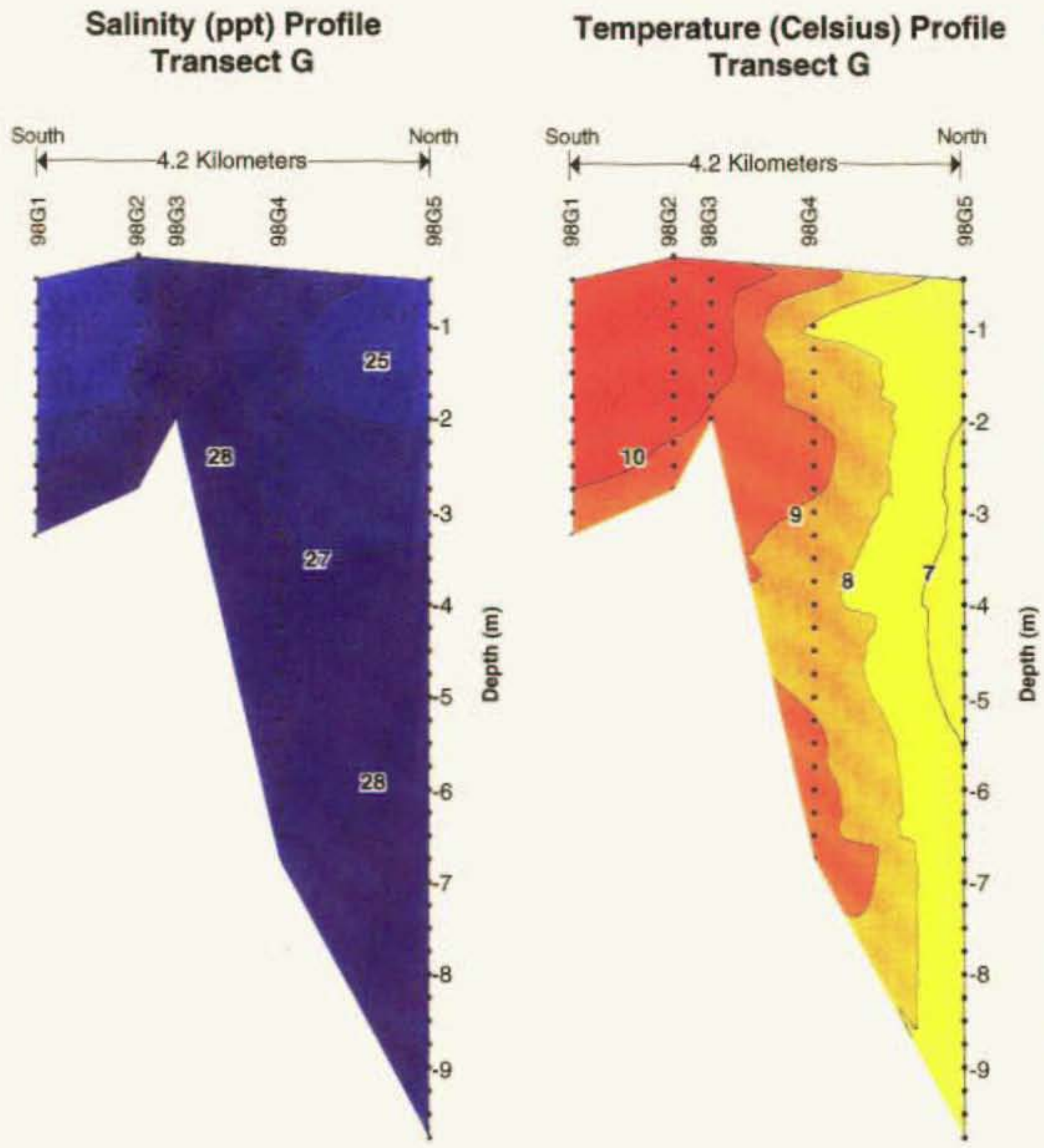
URS Greiner Woodward Clyde

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transects E & F: August 12, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-13



URS Greiner Woodward Clyde

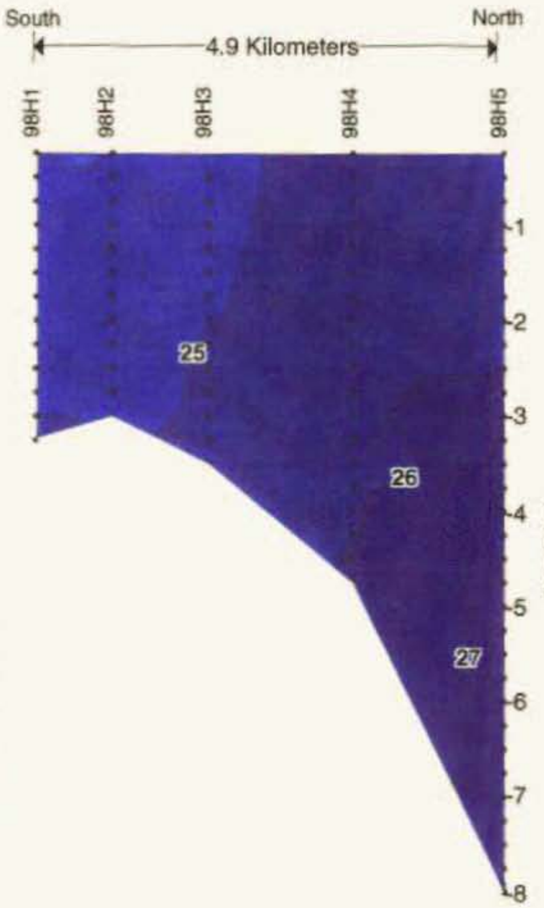
Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect G: August 12, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

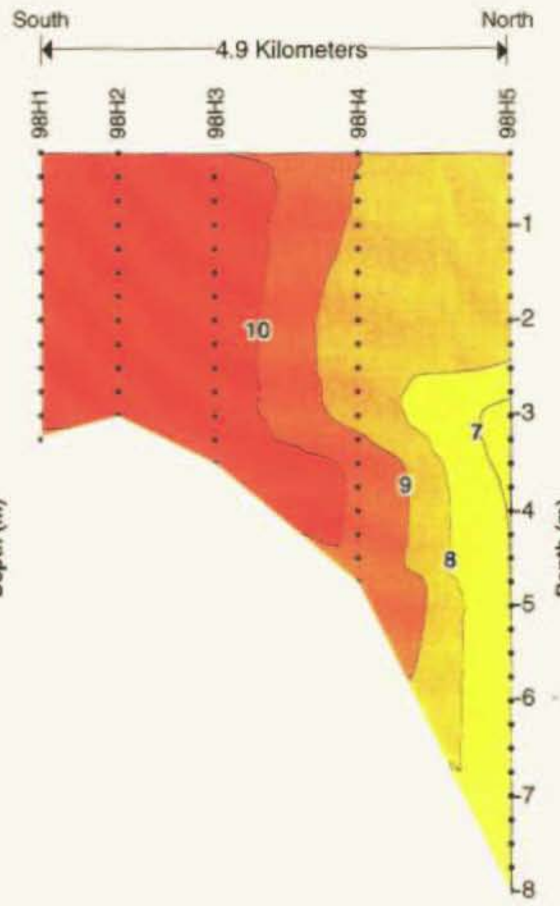
Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

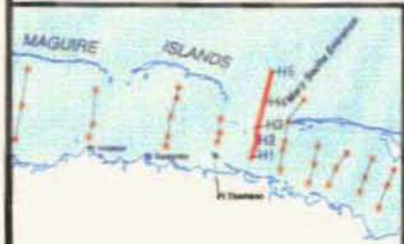
Figure E-14

Salinity (ppt) Profile
Transect H



Temperature (Celsius) Profile
Transect H





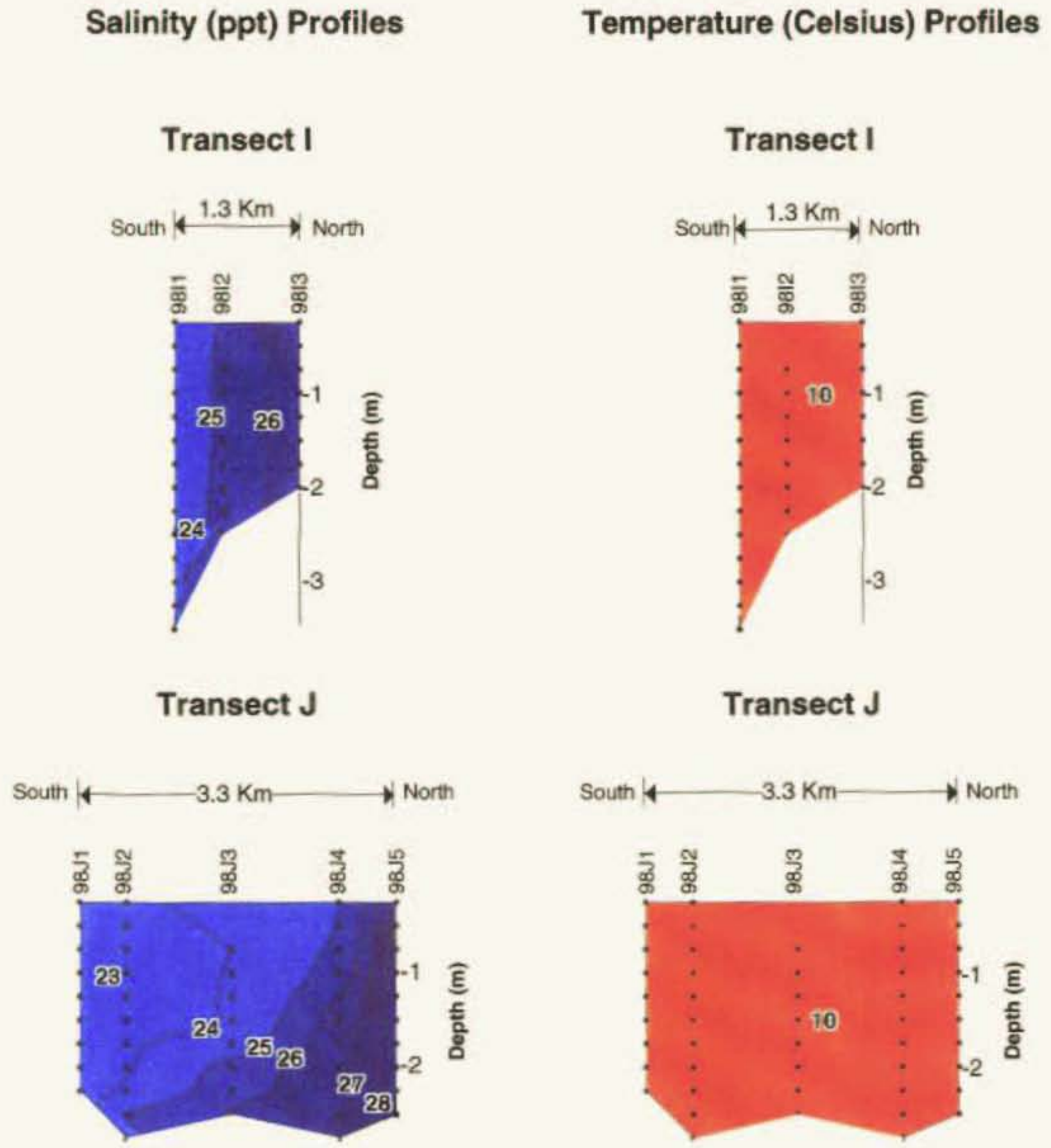
URS Greiner Woodward Clyde

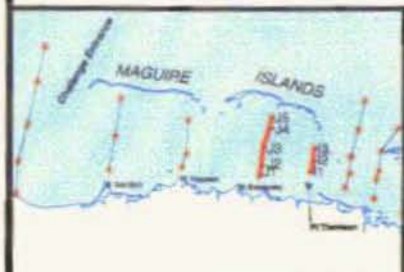
Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect H: August 12, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-15





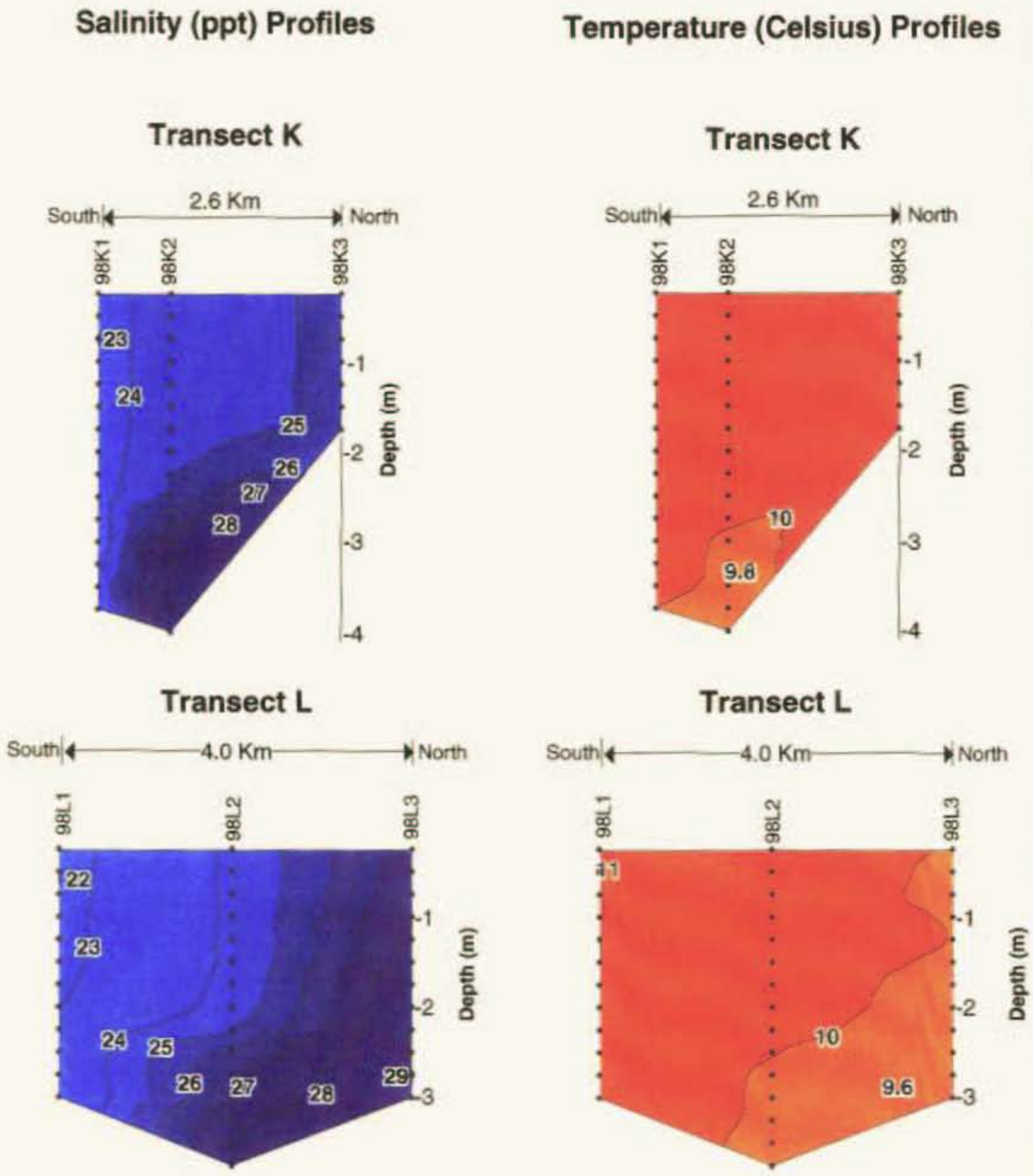
URS Greiner Woodward Clyde

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transects I & J: August 12, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-16



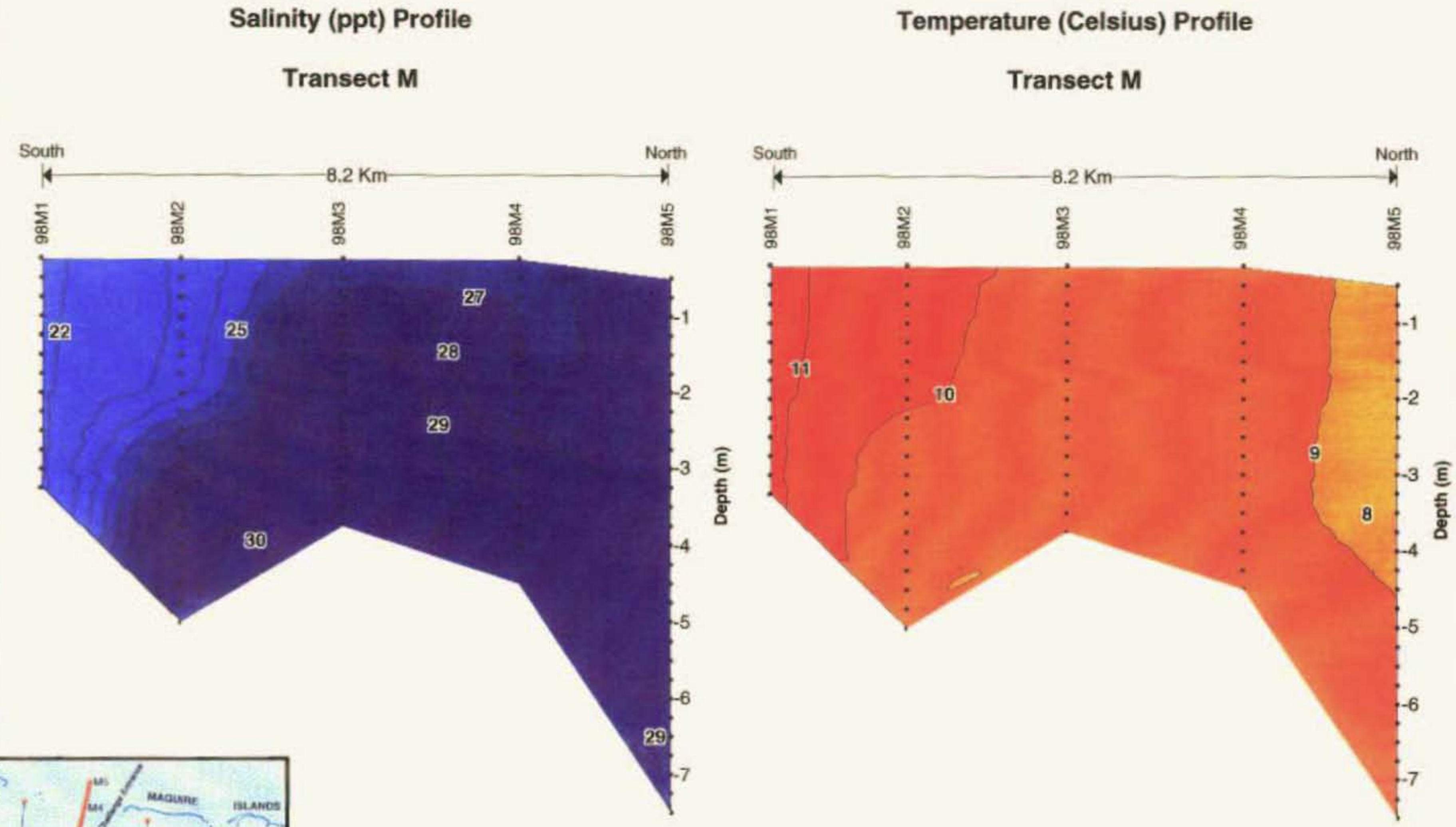
URS Greiner Woodward Clyde

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transects K & L: August 12, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-17



URS Greiner Woodward Clyde

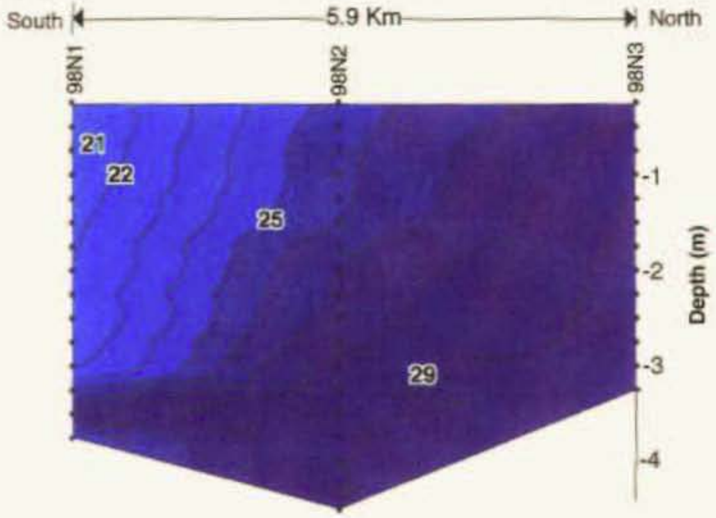
Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

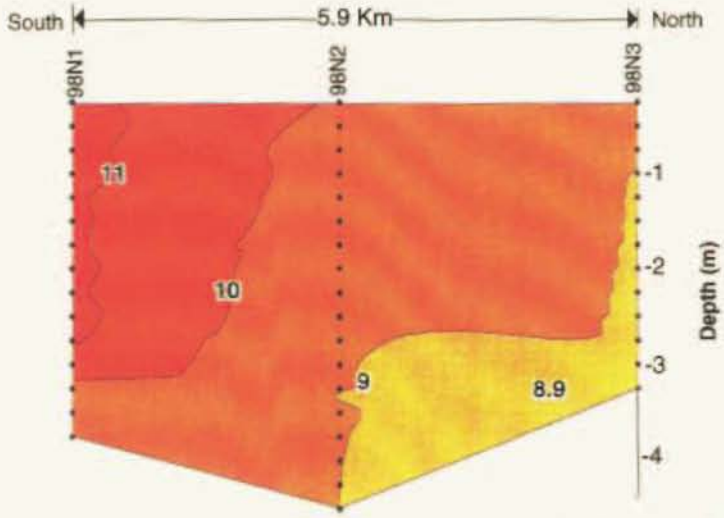
Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect M: August 12, 1998

Figure E-18

Salinity (ppt) Profile
Transect N



Temperature (Celsius) Profile
Transect N



URS Greiner Woodward Clyde

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect N: August 12, 1998

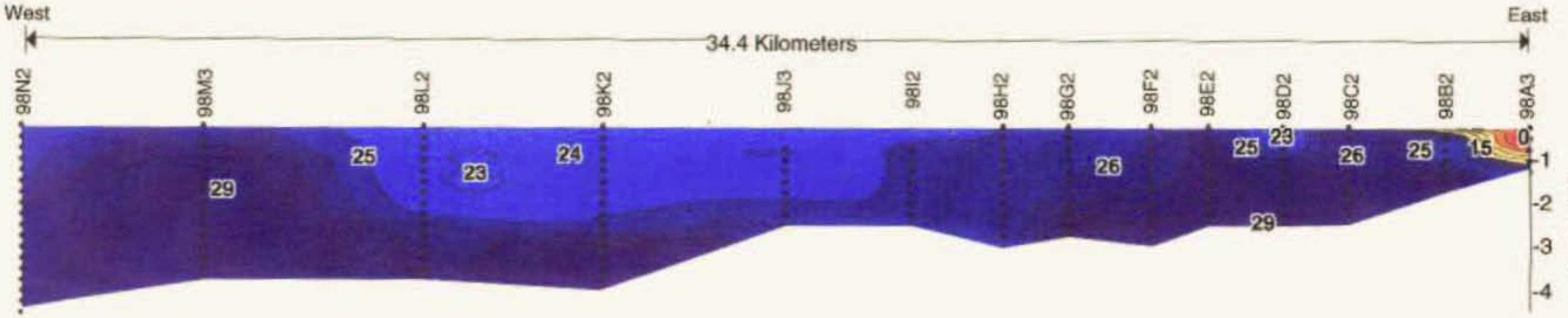
Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

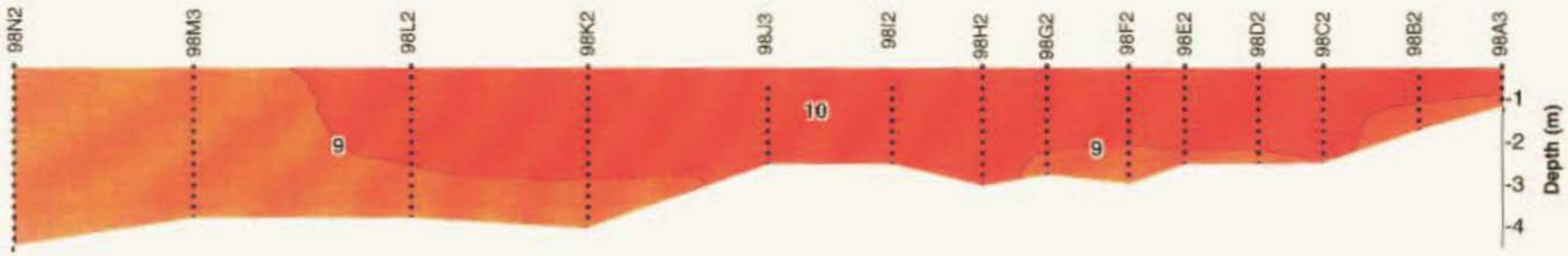
Figure E-19

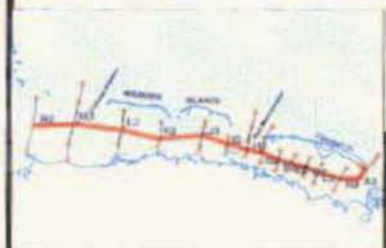
Cross Sectional Transect

Salinity (ppt) Profile



Temperature (Celsius) Profile





URS Greiner Woodward Clyde

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

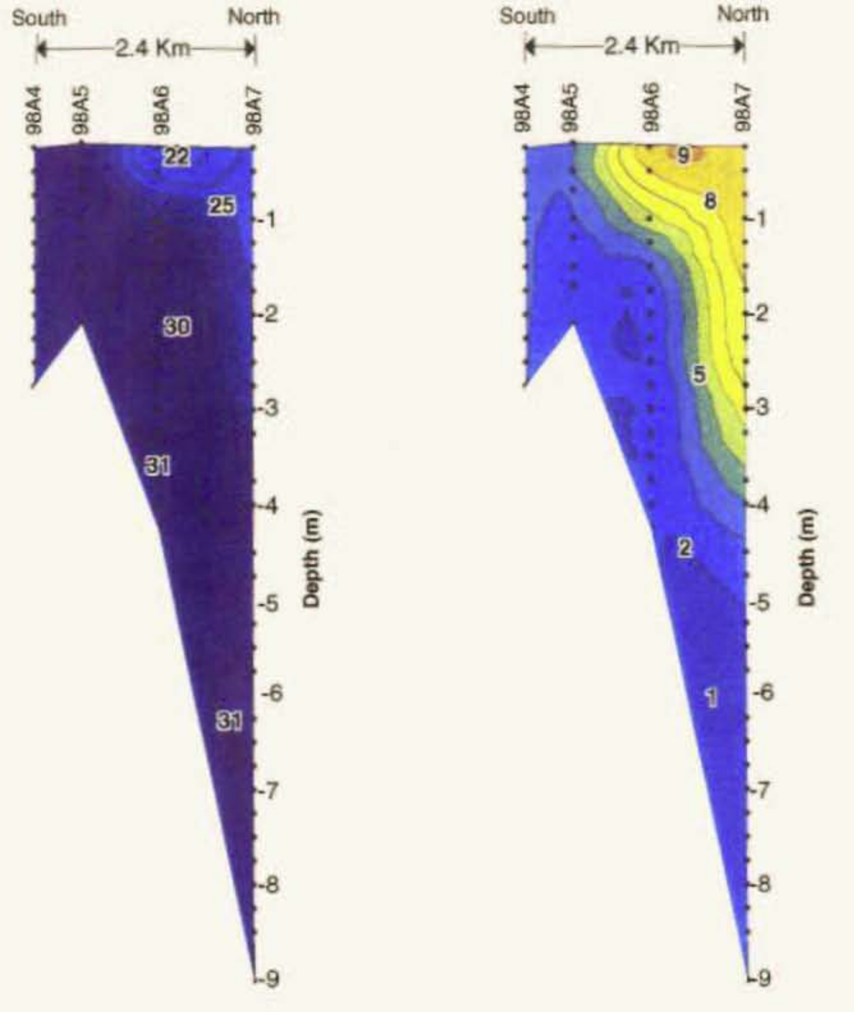
Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Cross Sectional Transect: August 12, 1998

Figure E-20

Salinity (ppt) Profile
Transect A

Temperature (Celsius) Profile
Transect A



URS Greiner Woodward Clyde

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect A: August 25, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-21

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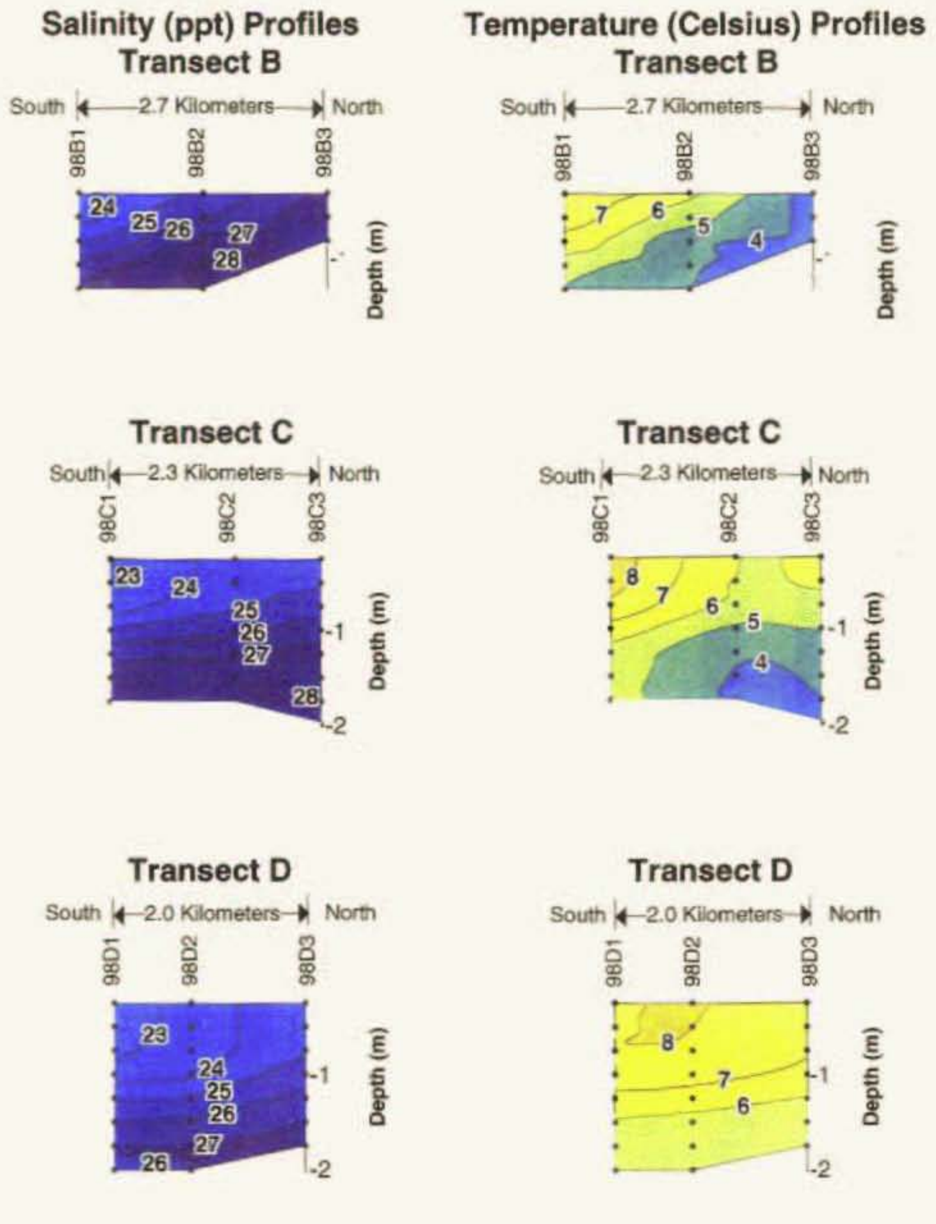
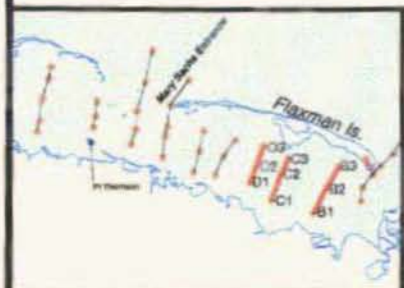




URS Greiner Woodward Clyde

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transects B, C, & D: August 25, 1998

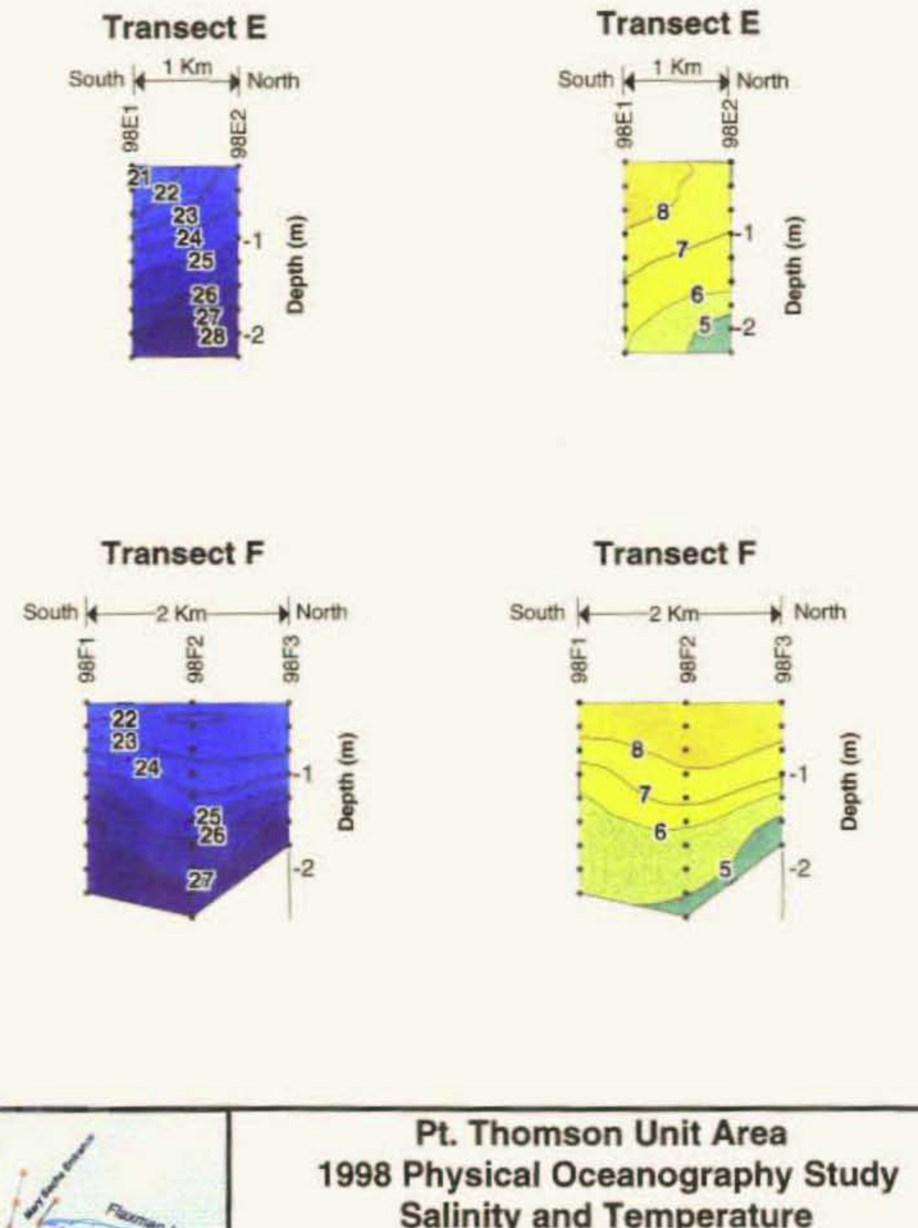
Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

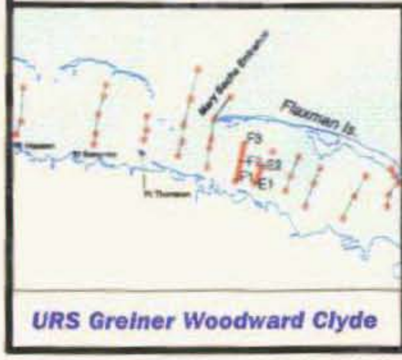
Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-22

Salinity (ppt) Profiles

Temperature (Celsius) Profiles





URS Greiner Woodward Clyde

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transects E & F: August 25, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-23

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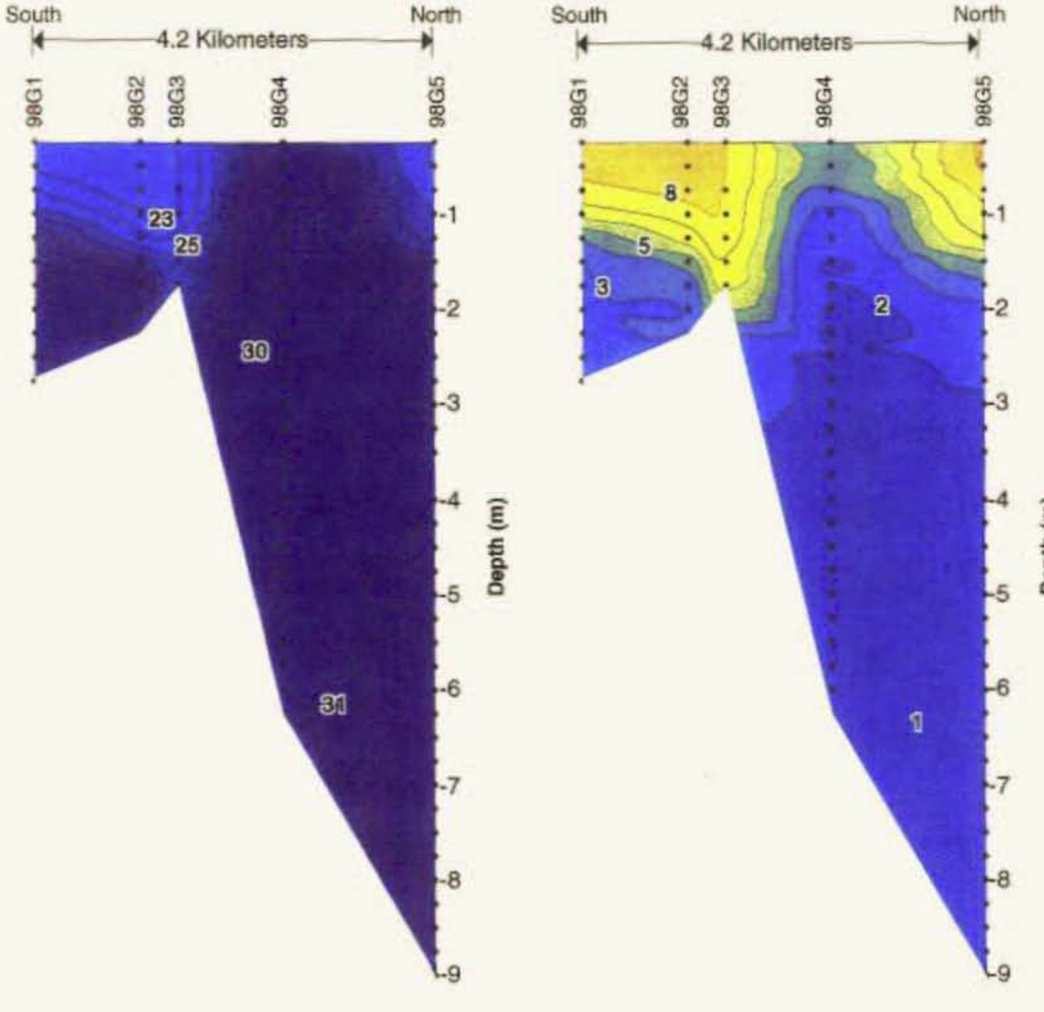
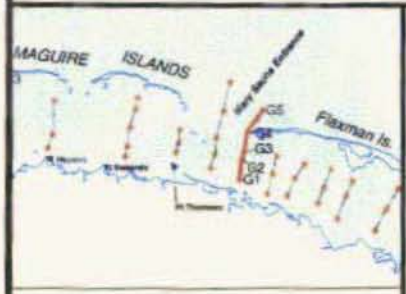
Salinity (ppt) Profile Transect G

Temperature (Celsius) Profile Transect G





URS Greiner Woodward Clyde

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect G: August 25, 1998

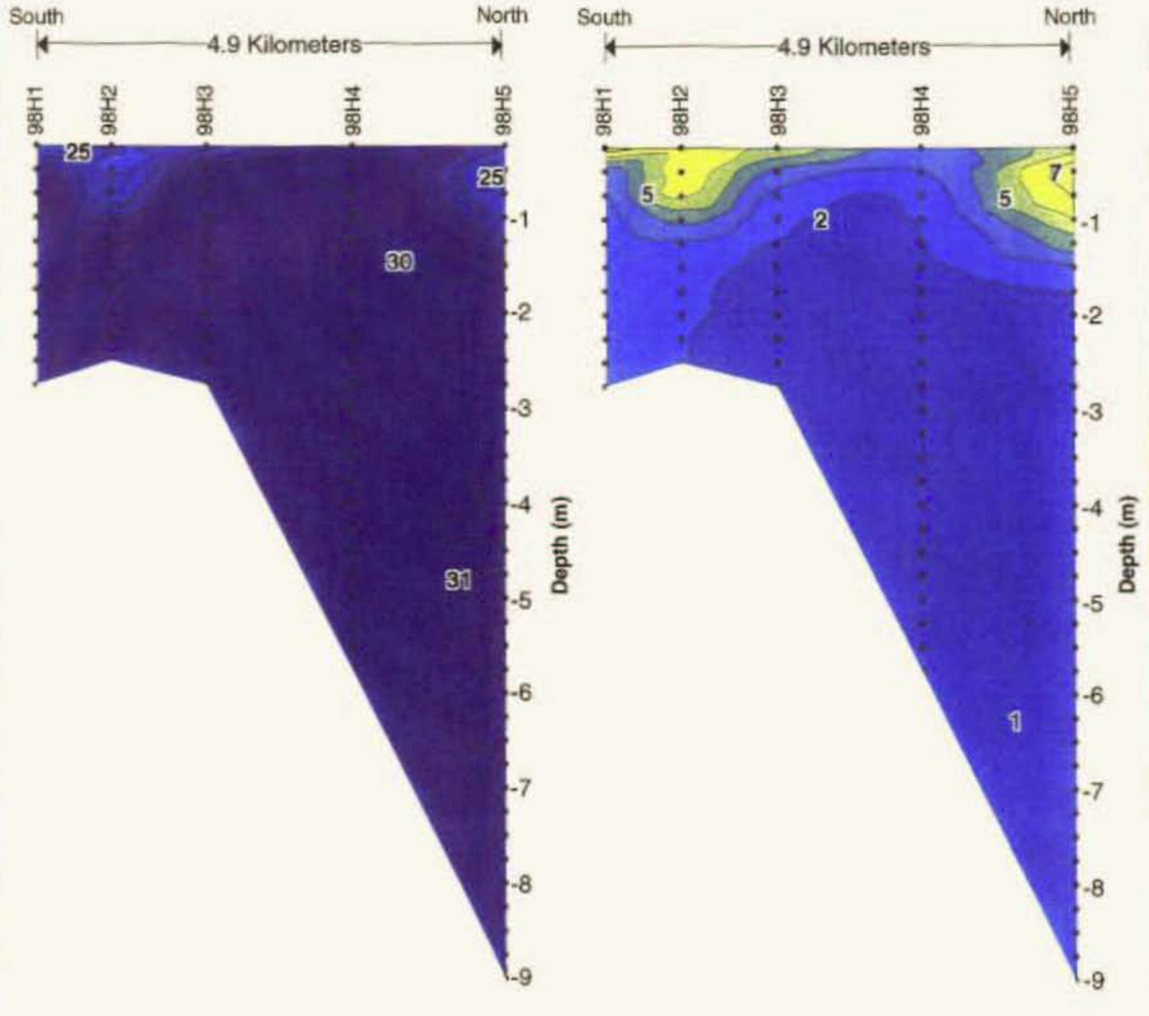
Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-24

Salinity (ppt) Profile
Transect H

Temperature (Celsius) Profile
Transect H



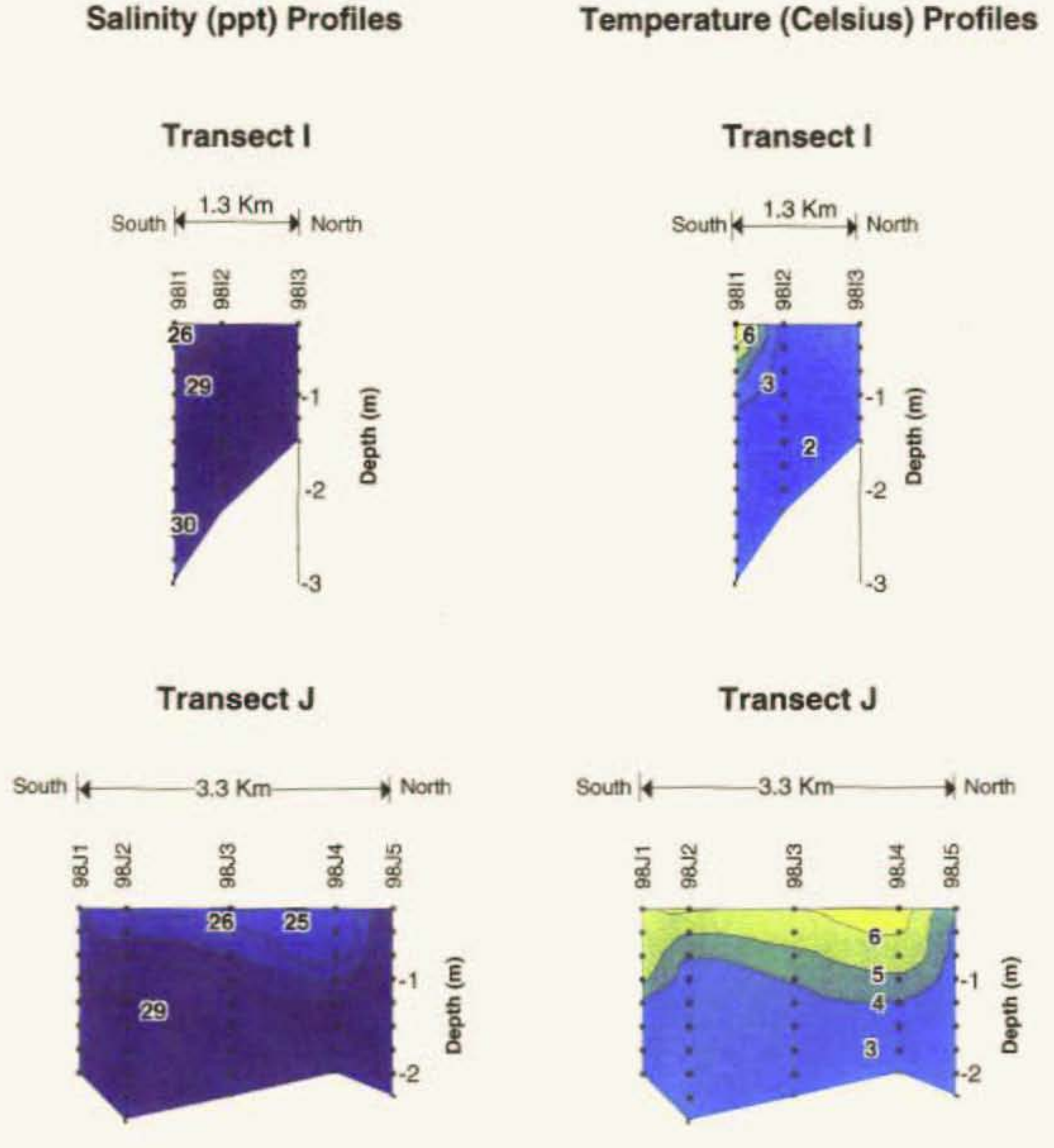
URS Greiner Woodward Clyde

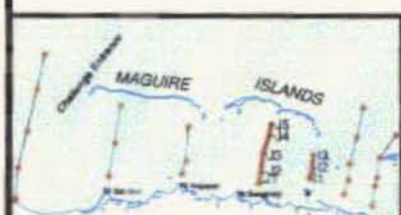
Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect H: August 25, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-25





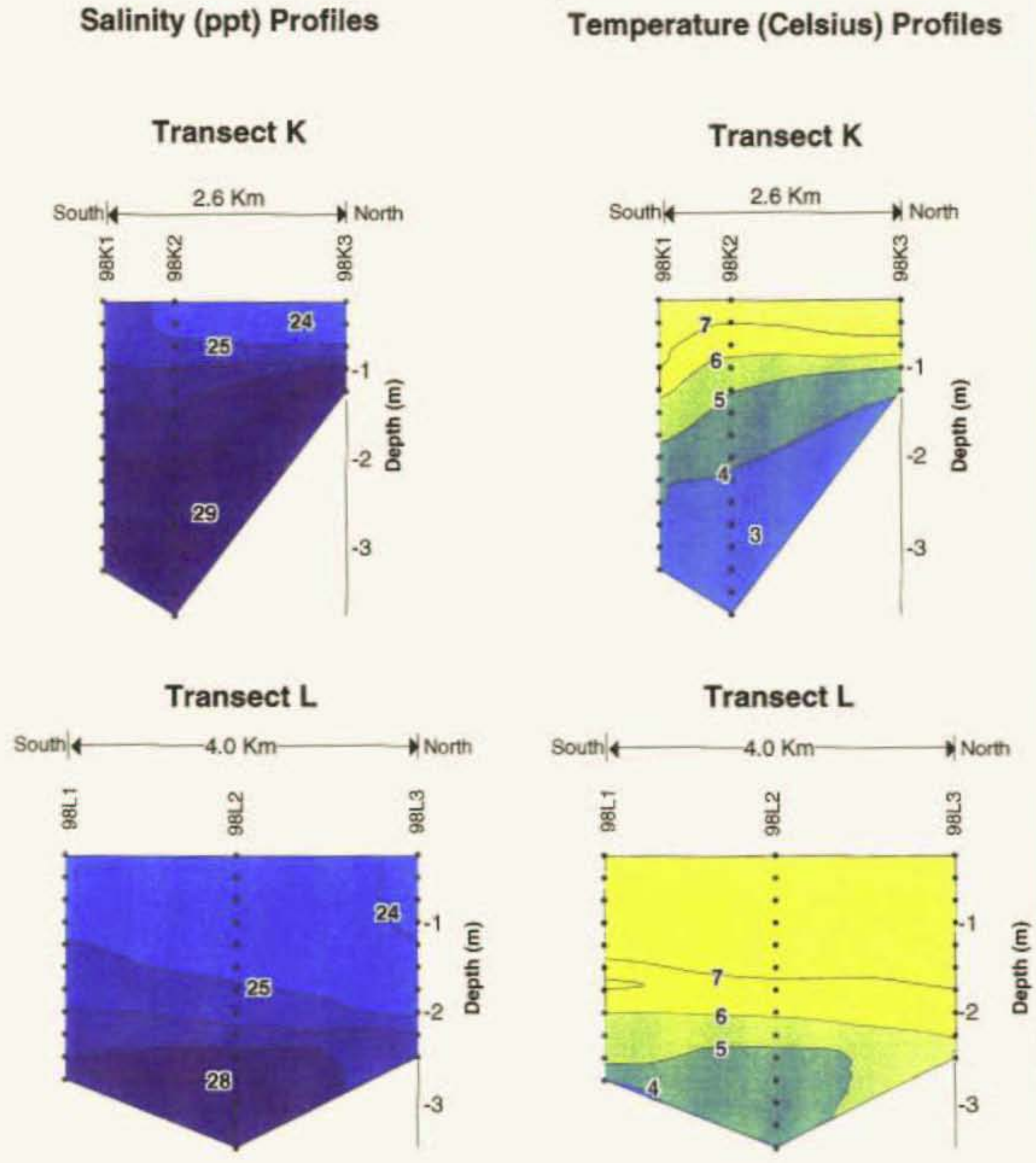
URS Greiner Woodward Clyde

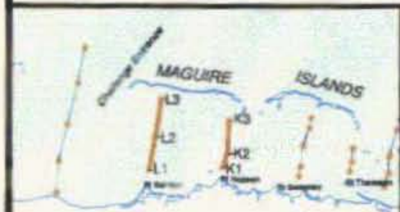
Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transects I & J: August 25, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-26





URS Greiner Woodward Clyde

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transects K & L: August 25, 1998

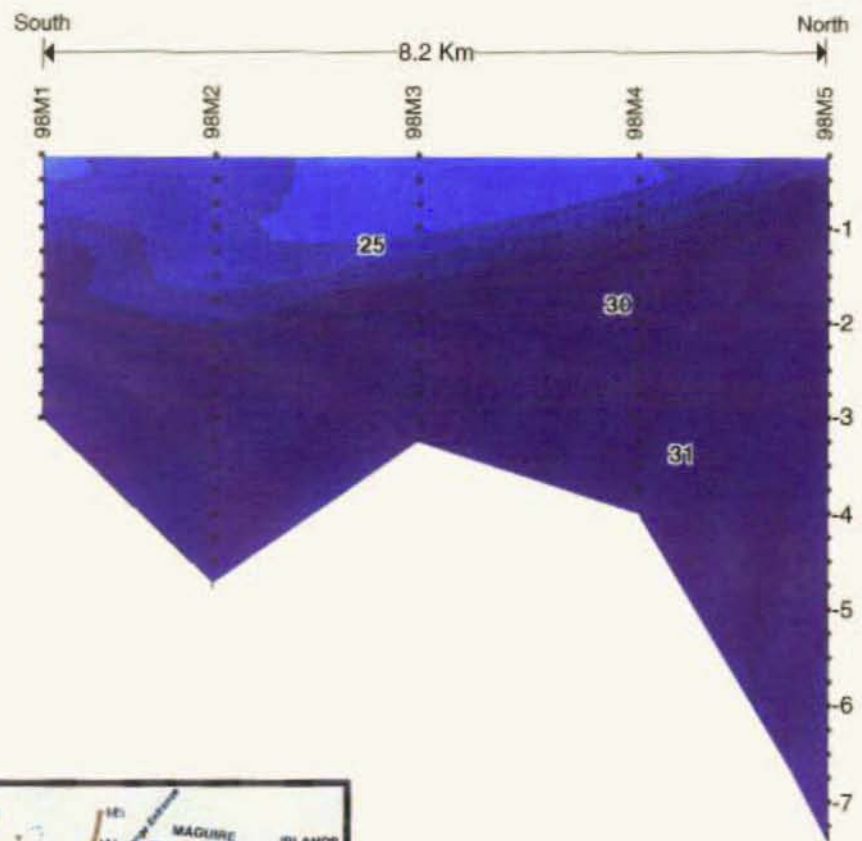
Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-27

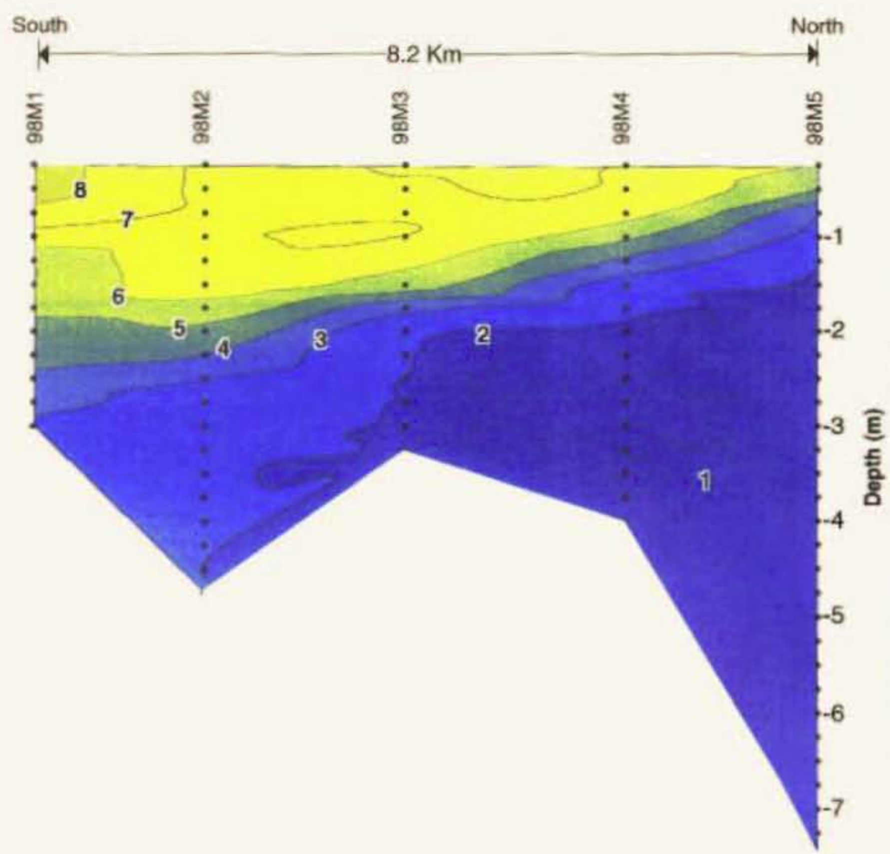
Salinity (ppt) Profile

Transect M



Temperature (Celsius) Profile

Transect M



URS Greiner Woodward Clyde

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

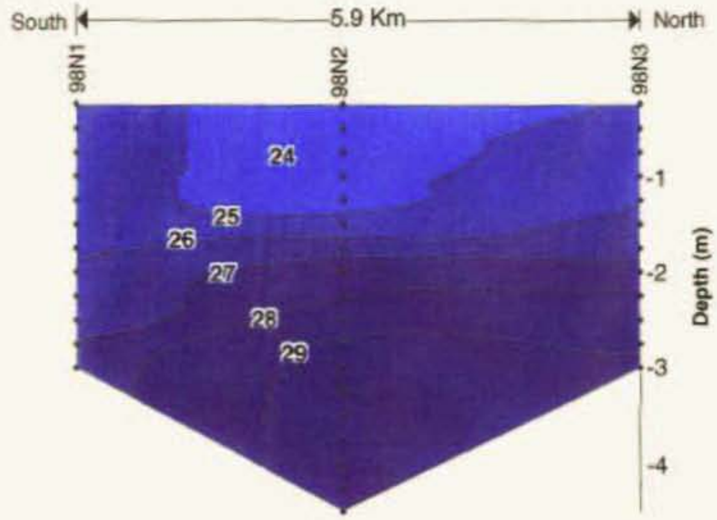
Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect M: August 25, 1998

Figure E-28

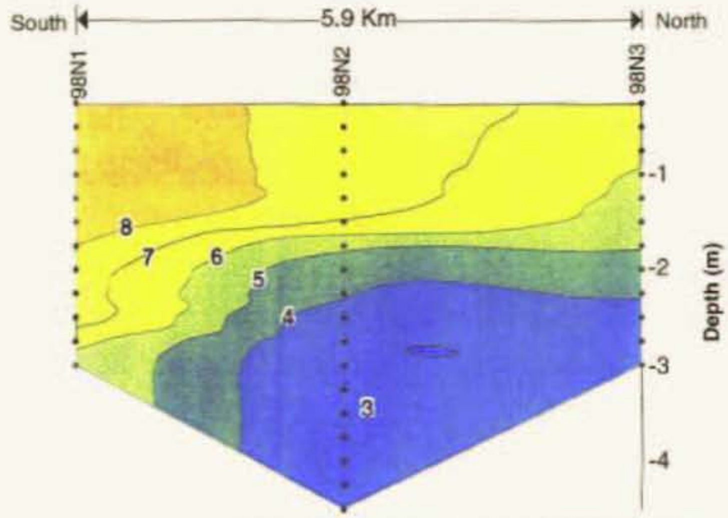
Salinity (ppt) Profile

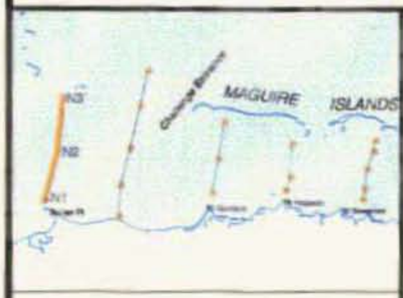
Transect N



Temperature (Celsius) Profile

Transect N





URS Greiner Woodward Clyde

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect N: August 25, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-29

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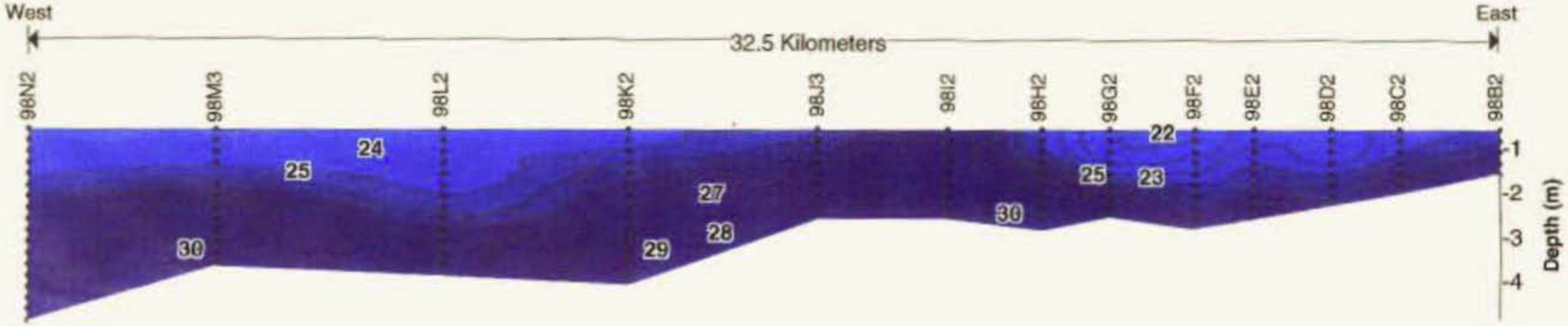
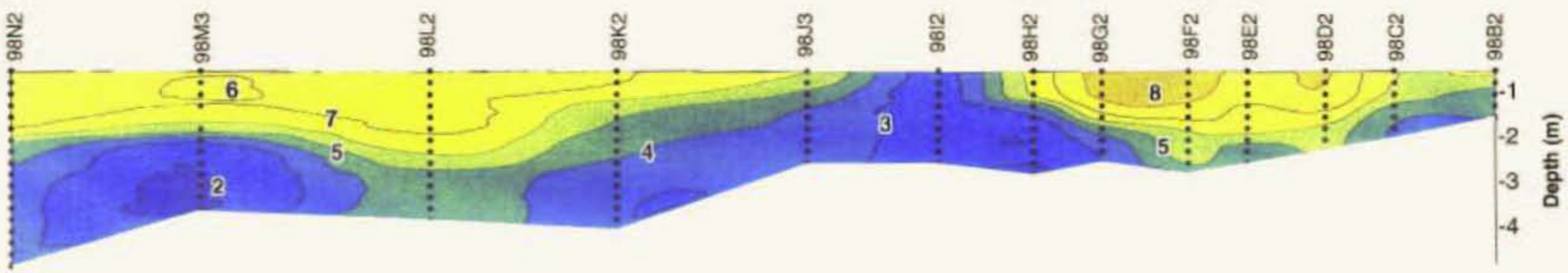
Cross Sectional Transect

Salinity (ppt) Profile



Temperature (Celsius) Profile



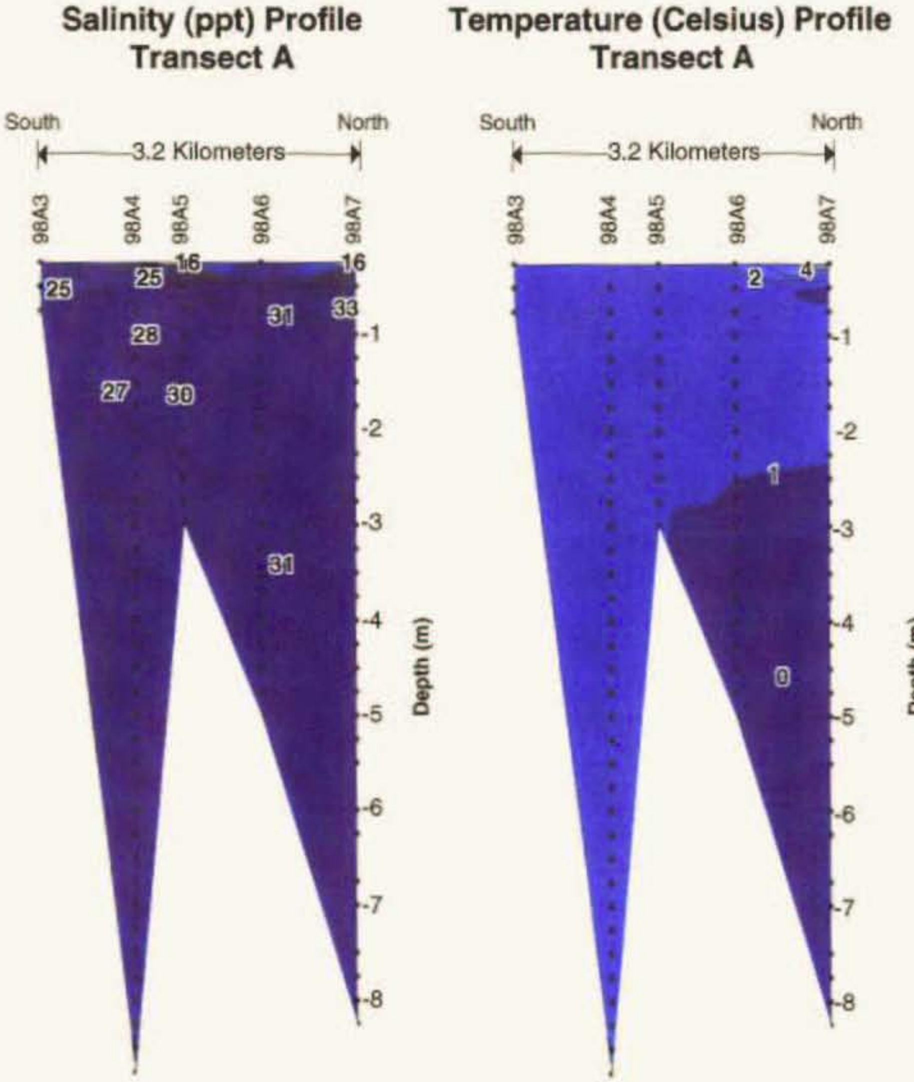
URS Greiner Woodward Clyde

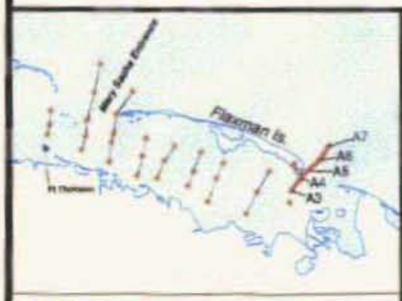
Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect A: August 25, 1998

Figure E-30





URS Greiner Woodward Clyde

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect A: September 13, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-31

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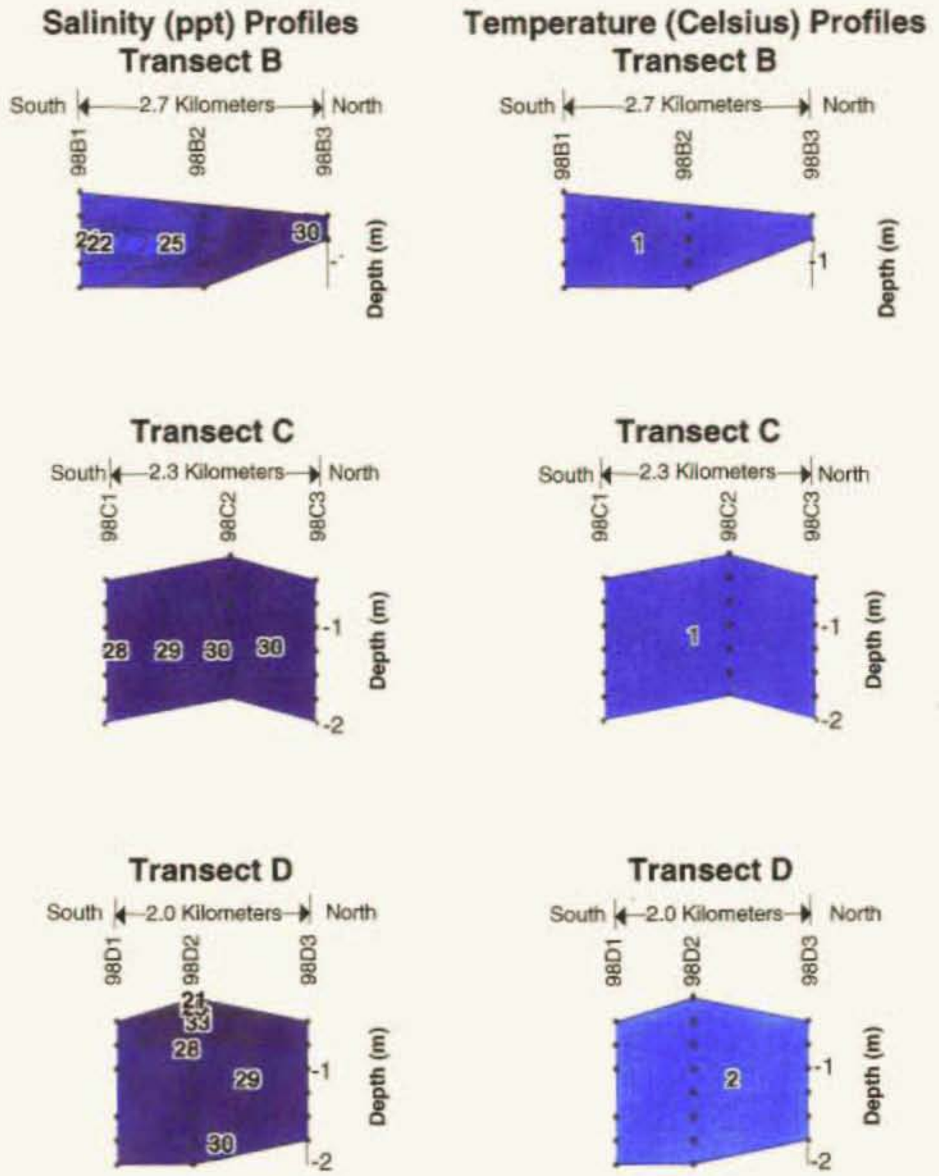
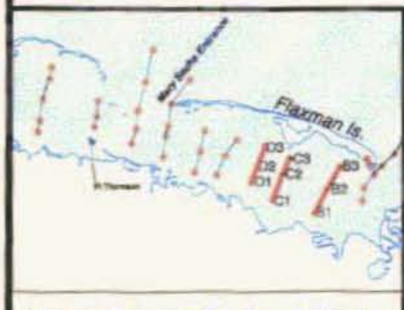




URS Greiner Woodward Clyde

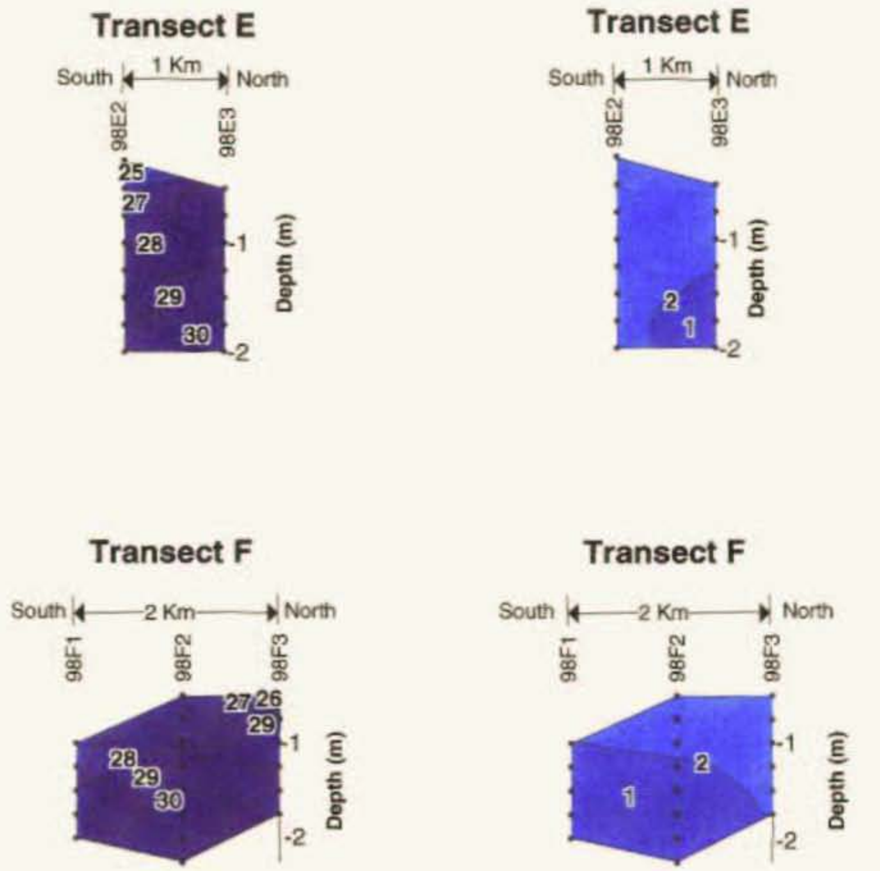
Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transects B, C, & D: September 13, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-32

Salinity (ppt) Profiles   Temperature (Celsius) Profiles



URS Greiner Woodward Clyde

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transects E & F: September 13, 1998

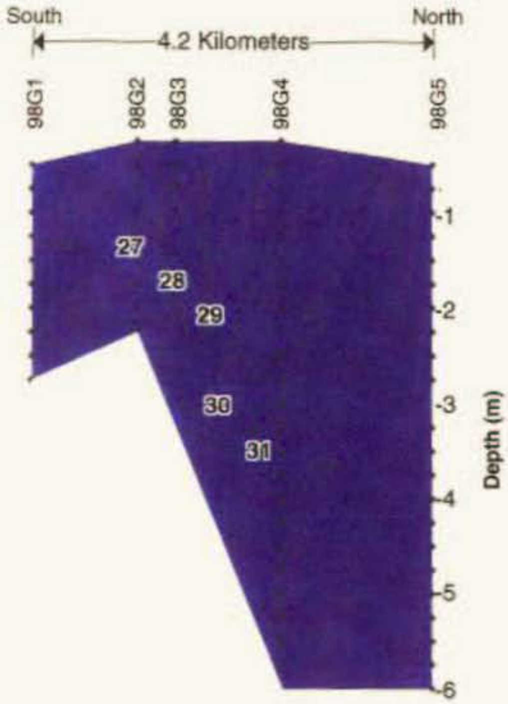
Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

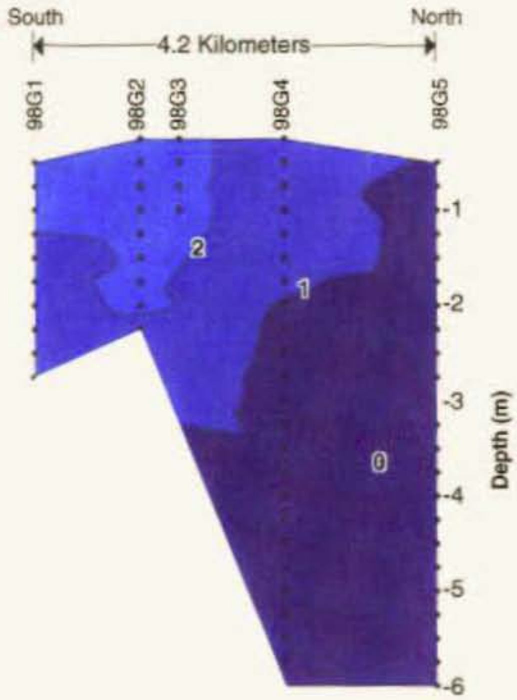
Figure E-33

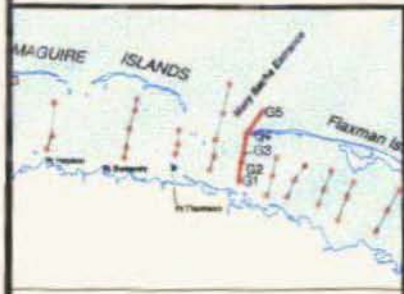
S:\projects\wcc\98800\gis\ctd\transects\plac\13Sep\13SepEF.wor

Salinity (ppt) Profile
Transect G



Temperature (Celsius) Profile
Transect G





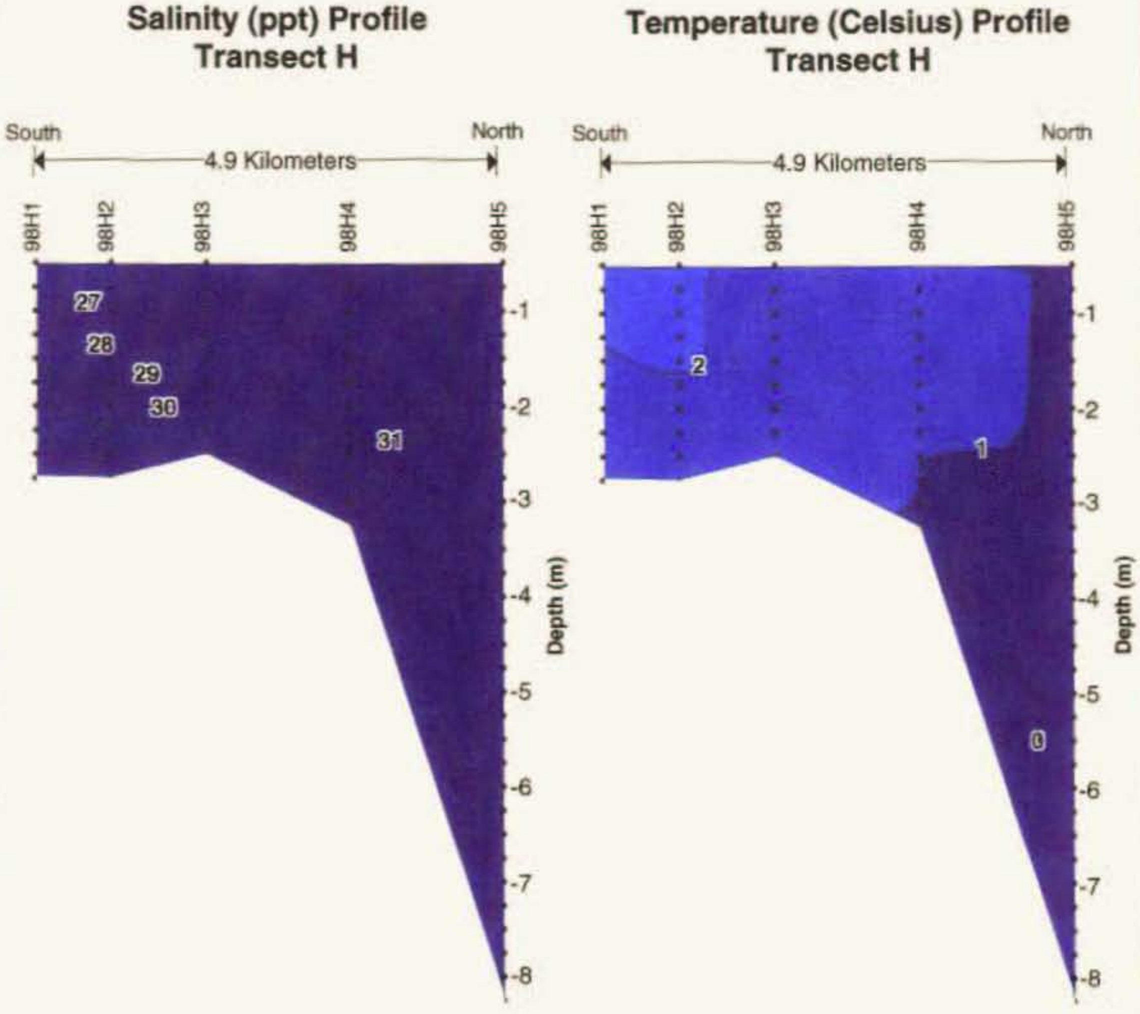
URS Greiner Woodward Clyde

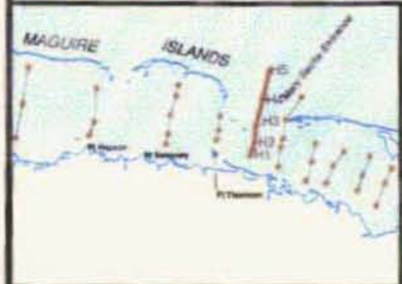
Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect G: September 13, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-34





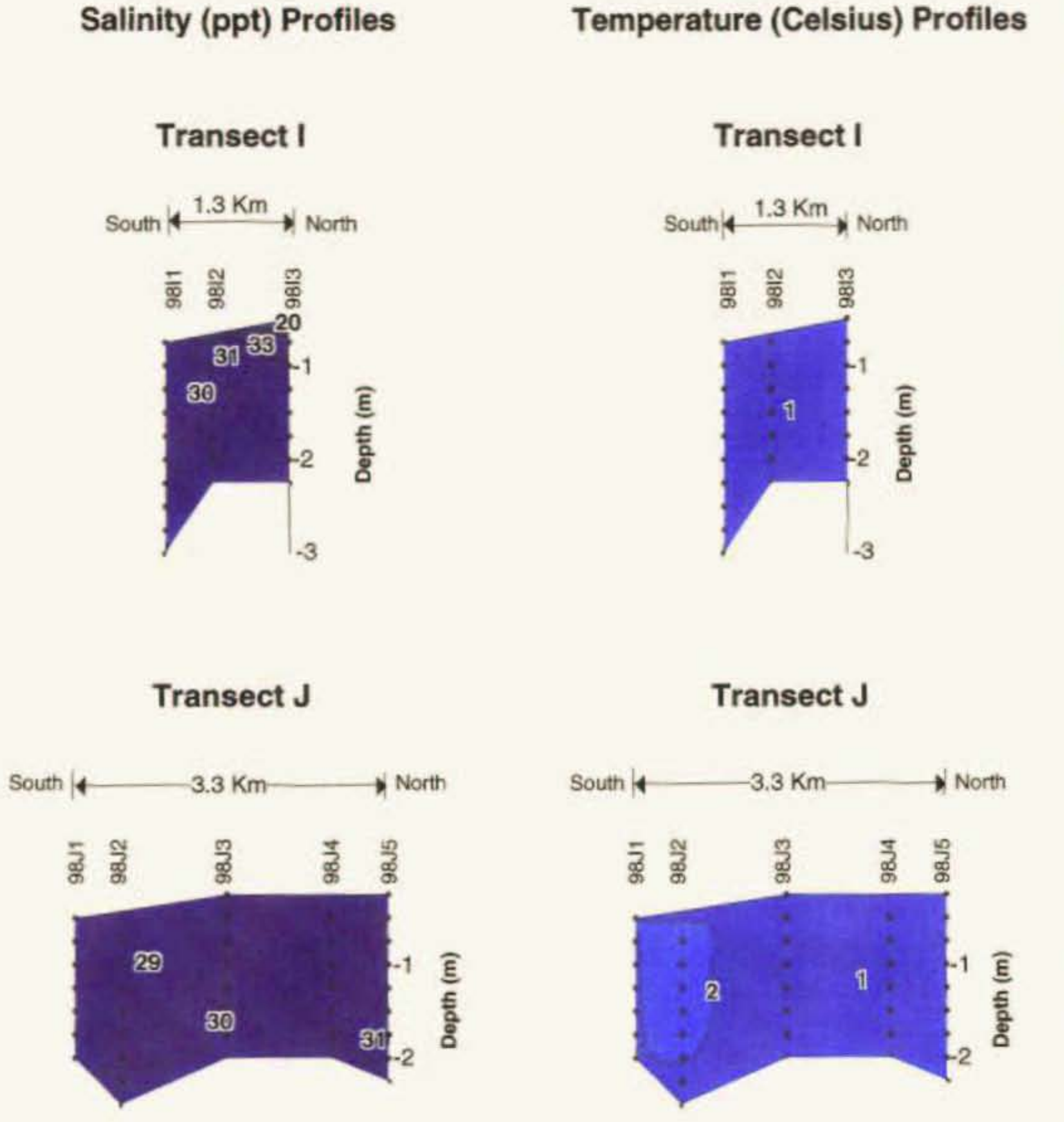
URS Greiner Woodward Clyde

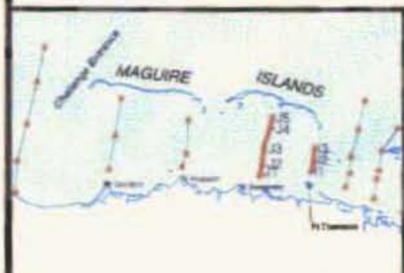
Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect H: September 13, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-35





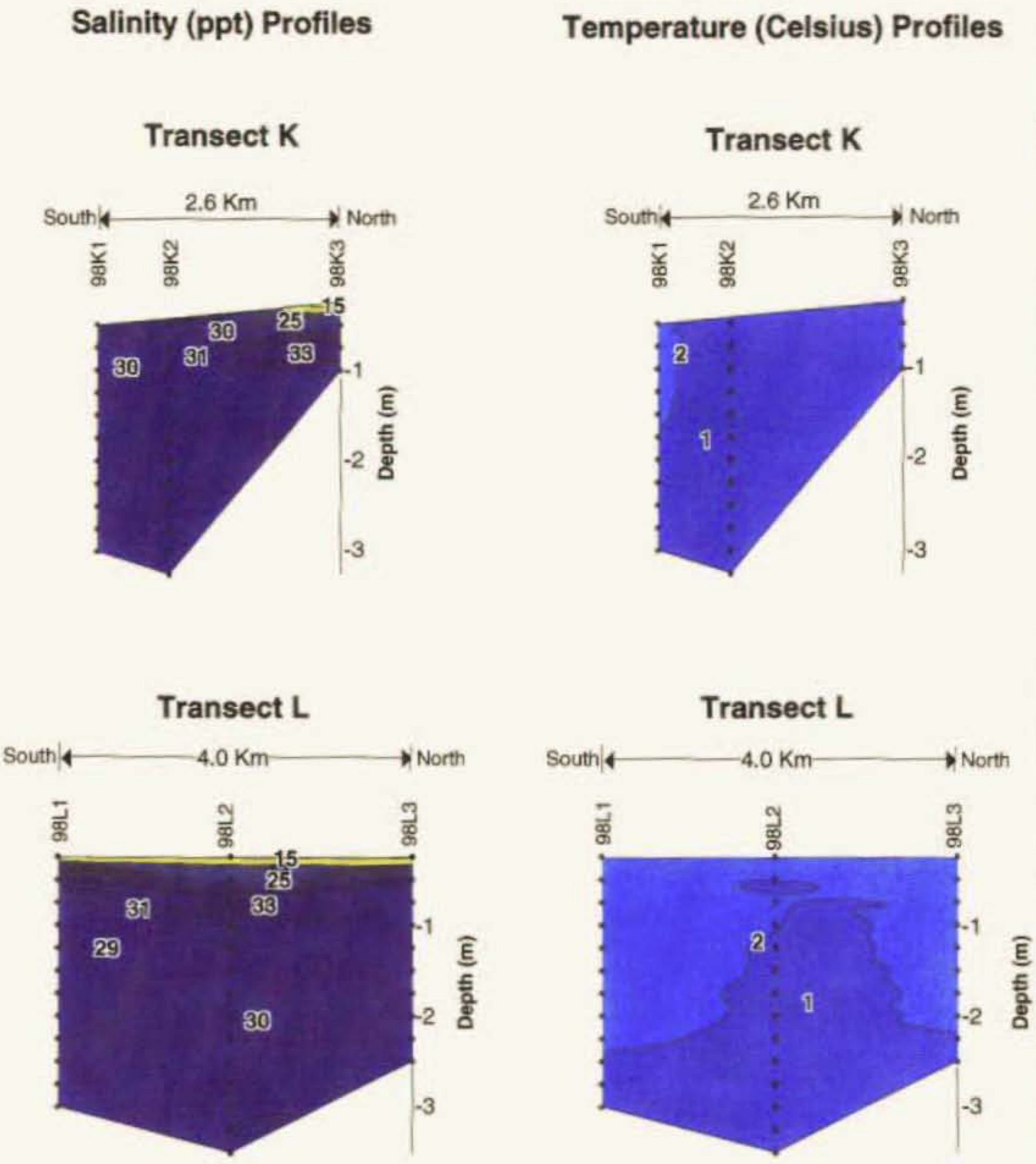
URS Greiner Woodward Clyde

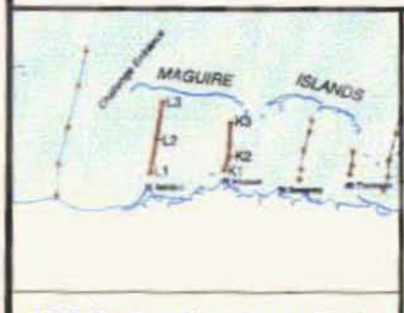
Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transects I & J: September 13, 1998

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-36





URS Greiner Woodward Clyde

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transects K & L: September 13, 1998

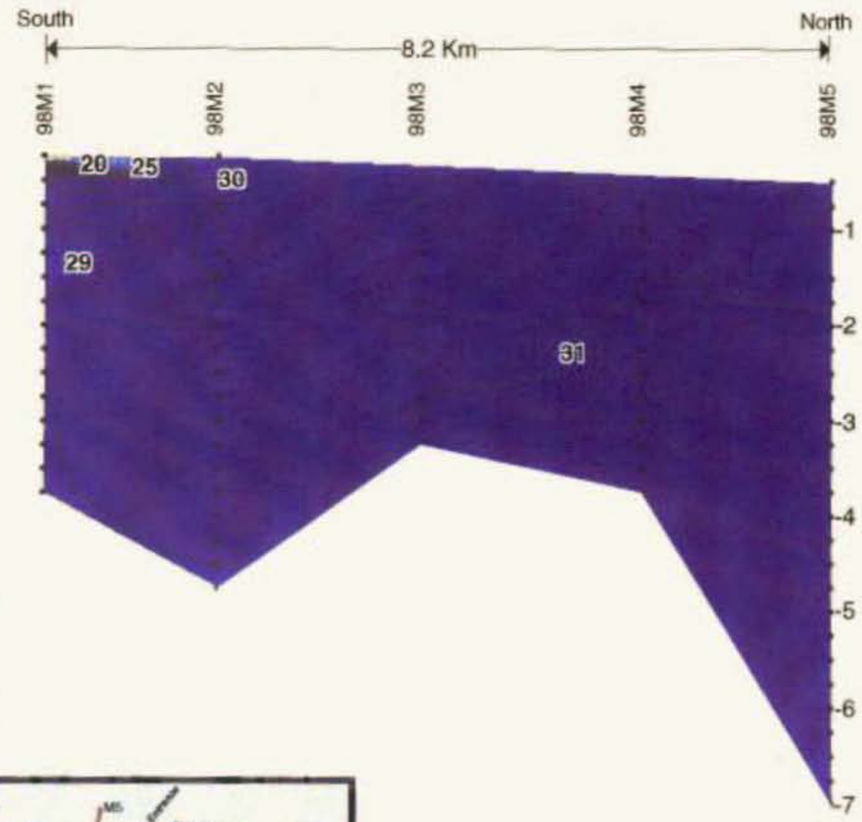
Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Figure E-37

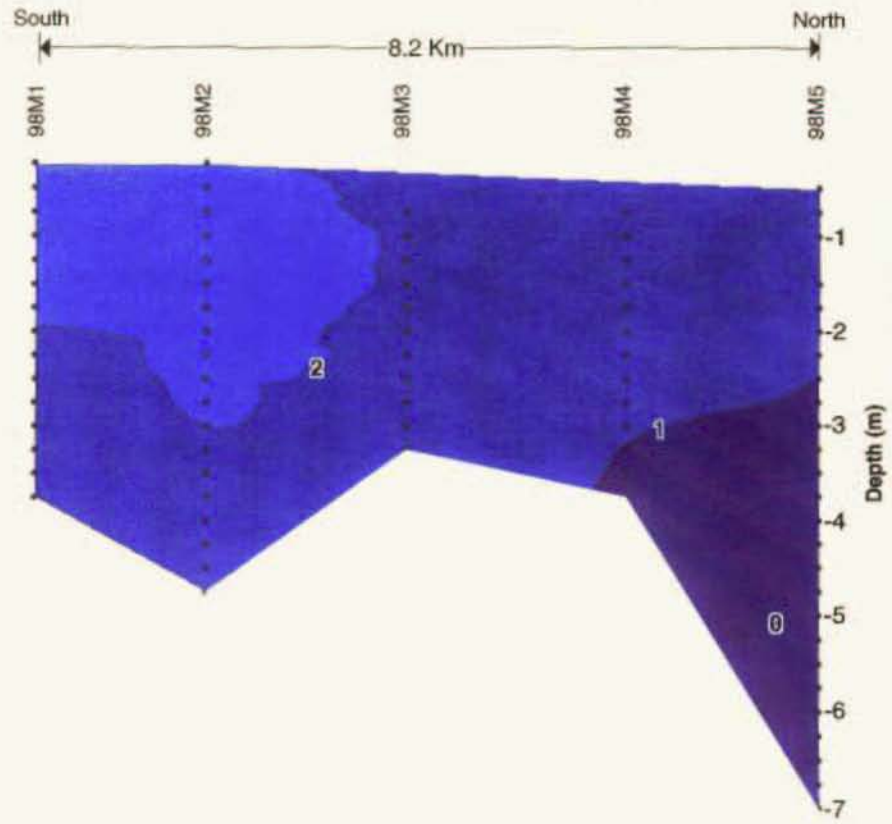
Salinity (ppt) Profile

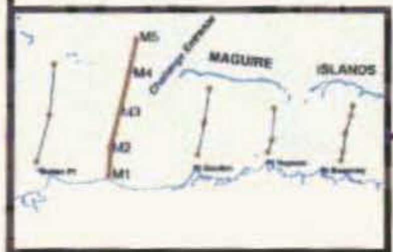
Transect M



Temperature (Celsius) Profile

Transect M





URS Greiner Woodward Clyde

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

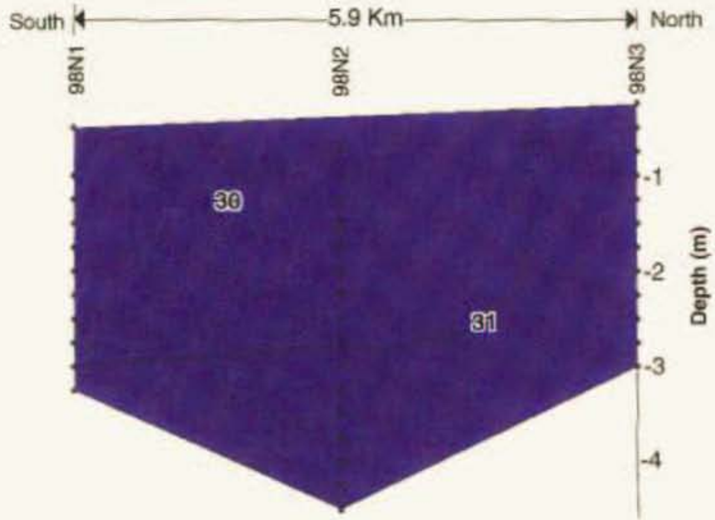
Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect M: September 13, 1998

Figure E-38

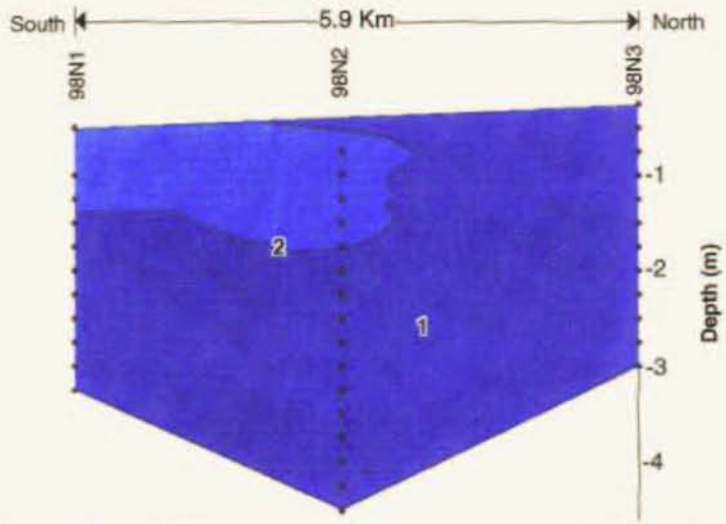
Salinity (ppt) Profile

Transect N



Temperature (Celsius) Profile

Transect N



URS Greiner Woodward Clyde

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Transect N: September 13, 1998

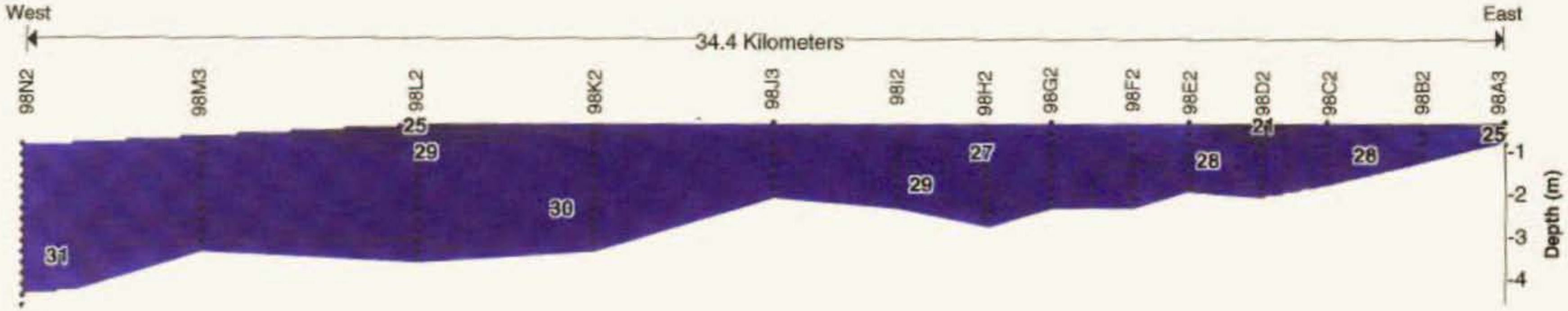
Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

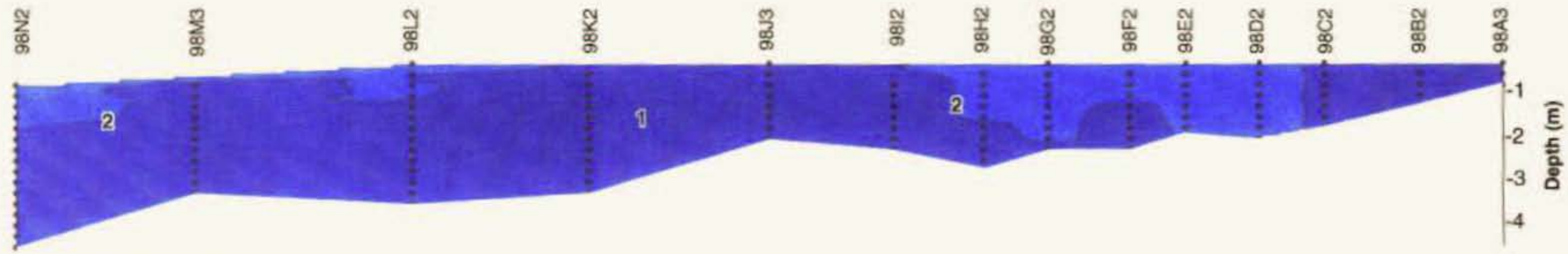
Figure E-39

Cross Sectional Transect

Salinity (ppt) Profile



Temperature (Celsius) Profile



URS Greiner Woodward Clyde

Vertical Sample Interval: 0.25 m
Vertical Exaggeration: 1000:1

Temperature Contour Interval: 1° Celsius
Salinity Contour Interval: 1 part per thousand

Pt. Thomson Unit Area
1998 Physical Oceanography Study
Salinity and Temperature
Cross Sectional Transect: September 13, 1998

Figure E-40

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Appendix F

1998 In Situ Water Quality and Water Chemistry Results

Wednesday, July 29, 1998

Sample ID	Sample Depth (ft)	Arsenic (mg/L)	Barium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	TSS (mg/L)	TOC (mg/L)	COD (mg/L)	BOD (mg/L)	DOi (mg/L)	DO (mg/L)	Temperature (C)	Salinity (ppt)	Conductivity (mS/cm)	pH	Turbidity (NTU)
		ANALYTICAL RESULTS										*FIELD MEASUREMENTS*					
FLW-CMA	3	ND (0.01)	0.015	ND (0.005)	ND (0.005)	ND (0.0002)	16.6	1.3	850	ND (2)	9.73	13.4	7.3	30.2	48.1	7.5	11
FLW-CMB	5	ND (0.01)	0.015	ND (0.005)	ND (0.005)	ND (0.0002)	16.8	1.2	420	ND (2)	9.95	13.5	7.4	30.5	48.4	7.6	11
FLW-CMC	9	ND (0.01)	0.016	ND (0.005)	ND (0.005)	ND (0.0002)	21.2	1.2	660	ND (2)	9.54	13.4	7.4	30.2	48.0	7.6	13
Daily Average:		**---**	**0.015**	**---**	**---**	**---**	**18.2**	**1.2**	**643**	**---**	**9.74**	**13.4**	**7.4**	**30.3**	**48.2**	**7.6**	**12**
Daily Minimum:		**---**	**0.015**	**---**	**---**	**---**	**16.6**	**1.2**	**420**	**---**	**9.54**	**13.4**	**7.3**	**30.2**	**48.0**	**7.5**	**11**
Daily Maximum:		**---**	**0.016**	**---**	**---**	**---**	**21.2**	**1.3**	**850**	**---**	**9.95**	**13.5**	**7.4**	**30.5**	**48.4**	**7.6**	**13**

Notes: NS indicates the corresponding parameter was Not Sampled/measured.
NA indicates the parameter was Not Analyzed.
ND( ) indicates the analyte was Not Detected at the specified limit shown in parentheses.
Average, Minimum, and Maximum values are calculated using the detection limit where ND is indicated.

TSS = Total Suspended Solids
TOC = Total Organic Carbon
COD = Chemical Oxygen Demand
BOD = Biological Oxygen Demand
DOi = Initial Dissolved Oxygen measured in the laboratory prior to BOD analyses.
DO = Dissolved Oxygen measured in the field.

Friday, September 11, 1998

Sample ID	Sample Depth (ft)	ANALYTICAL RESULTS Arsenic (mg/L)	Barium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	TSS (mg/L)	TOC (mg/L)	COD (mg/L)	BOD (mg/L)	DOi (mg/L)	FIELD MEASUREMENTS DO (mg/L)	Temperature (C)	Salinity (ppt)	Conductivity (mS/cm)	pH	Turbidity (NTU)
FLW-CMA	3	ND (0.01)	0.019	ND (0.005)	ND (0.005)	ND (0.0002)	57.3	1.4	535	ND (2)	10.40	9.5	2.9	26.7	24.6	7.9	31
FLW-CMB	4	ND (0.01)	0.019	ND (0.005)	ND (0.005)	ND (0.0002)	79.0	1.7	924	ND (2)	10.40	NS	NS	NS	NS	NS	NS
FLW-CMC	8	ND (0.01)	0.020	ND (0.005)	ND (0.005)	ND (0.0002)	68.6	1.4	1090	ND (2)	10.40	11.4	1.5	30.4	26.6	8.0	77
Daily Average:		---	0.019	---	---	---	68.3	1.5	850	---	10.40	10.5	2.2	28.5	25.6	7.9	54
Daily Minimum:		---	0.019	---	---	---	57.3	1.4	535	---	10.40	9.5	1.5	26.7	24.6	7.9	31
Daily Maximum:		---	0.020	---	---	---	79.0	1.7	1090	---	10.40	11.4	2.9	30.4	26.6	8.0	77
Project Average:		---	0.017	---	---	---	43.3	1.4	747	---	10.07	12.2	5.3	29.6	39.2	7.7	28
Project Minimum:		---	0.015	---	---	---	16.6	1.2	420	---	9.54	9.5	1.5	26.7	24.6	7.5	11
Project Maximum:		---	0.020	---	---	---	79.0	1.7	1090	---	10.40	13.5	7.4	30.5	48.4	8.0	77

Notes: NS indicates the corresponding parameter was Not Sampled/measured.
NA indicates the parameter was Not Analyzed.
ND( ) indicates the analyte was Not Detected at the specified limit shown in parentheses.
Average, Minimum, and Maximum values are calculated using the detection limit where ND is indicated.

TSS = Total Suspended Solids
TOC = Total Organic Carbon
COD = Chemical Oxygen Demand
BOD = Biological Oxygen Demand
DOi = Initial Dissolved Oxygen measured in the laboratory prior to BOD analyses.
DO = Dissolved Oxygen measured in the field.

Station_ID	Sample Depth (ft)	Water Depth (ft)	DO (mg/L)	Temperature (C)	Salinity (ppt)	Conductivity (mS/cm)	pH	Turbidity (NTU)	Wind Spd (mph)	Wind Dir.(mag)	Sea Ht. (ft)
	FIELD MEASUREMENTS										
Wednesday, July 29, 1998											
98FLW-CM	3	10	13.4	7.3	30.2	48.1	7.5	11	12	SW	NS
98FLW-CM	5	10	13.5	7.4	30.5	48.4	7.6	11	12	SW	NS
98FLW-CM	9	10	13.4	7.4	30.2	48.0	7.6	13	12	SW	NS
Daily Average:			**13.4**	**7.4**	**30.3**	**48.2**	**7.6**	**12**	**12**	---	---
Daily Minimum:			**13.4**	**7.3**	**30.2**	**48.0**	**7.5**	**11**	**12**	---	---
Daily Maximum:			**13.5**	**7.4**	**30.5**	**48.4**	**7.6**	**13**	**12**	---	---

Notes: NS indicates the corresponding parameter was Not Sampled/observed.

NA indicates the parameter was Not Analyzed and may be pending receipt of analytical results from the laboratory.

ND( ) indicates the analyte was Not Detected at the specified detection limit shown in parentheses.

Average, Minimum, and Maximum values are calculated using the detection limit where results indicate ND.

Station_ID	Sample Depth (ft)	Water Depth (ft)	DO (mg/L)	Temperature (C)	Salinity (ppt)	Conductivity (mS/cm)	pH	Turbidity (NTU)	Wind Spd (mph)	Wind Dir.(mag)	Sea Ht. (ft)
					FIELD MEASUREMENTS						
Wednesday, August 12, 1998											
98A2	3	4.5	11.1	9.8	13.5	28.7	8.0	173	4	NNE	1
98A3	3	3	11.1	10.4	5.5	9.2	7.9	75	4	NE	1
98A4	3	20.4	11.4	9.8	20.5	24.0	7.9	64	6	E	1
98A5	3	9.2	11.9	9.2	26.0	41.4	7.8	16	6	NE	1
98A6	3	18	12.3	8.6	26.1	41.7	7.7	2	4	ENE	1
98A7	3	29	12.6	8.7	25.2	41.0	6.8	1	4	ENE	1
98B2	3	5.6	11.5	10.5	24.1	38.8	8.0	10	3	NNE	1
98C2	3	7.1	11.4	10.9	26.5	42.0	8.0	5	6	N	1
98D2	3	7.6	11.4	11.0	26.1	40.8	8.1	7	7	NE	1
98E2	3	8.5	11.3	10.9	27.4	43.2	8.1	5	5	N	1
98F2	3	9.1	11.3	10.9	25.9	41.1	8.1	5	4.5	E	1
98G1	3	10.6	11.4	10.9	25.2	40.1	8.1	5	7	NE	1
98G2	3	8.6	11.4	10.7	25.9	41.1	8.1	4	7	NE	1
98G5	3	31.2	12.8	7.8	25.5	41.0	8.1	0	2	NNE	1
98H2	3	10	11.3	10.6	25.4	40.4	8.1	4	7	NE	1
98H5	3	29.1	12.4	8.4	26.8	42.8	8.2	0	6.5	E	1
98I2	3	8.1	11.2	10.6	25.3	40.4	8.1	4	5	E	1
98J3	3	8.4	11.1	10.8	24.2	38.7	8.1	5	1	NE	0
98K2	3	13	10.9	10.5	24.7	39.5	8.1	5	0	Calm	0
98L2	3	12.5	11.1	10.5	24.5	39.2	8.1	5	0	Calm	0
98M3	3	12.2	10.6	9.2	29.5	46.6	8.0	5	0	Calm	0
98N2	3	15.4	11.4	9.9	25.6	40.8	8.1	4	2	NNW	2
Daily Average:			**11.5**	**10.0**	**24.1**	**38.3**	**8.0**	**18**	**4**	**---**	**1**
Daily Minimum:			**10.6**	**7.8**	**5.5**	**9.2**	**6.8**	**---**	**0**	**---**	**0**
Daily Maximum:			**12.8**	**11.0**	**29.5**	**46.6**	**8.2**	**173**	**7**	**---**	**2**

Notes: NS indicates the corresponding parameter was Not Sampled/observed.
NA indicates the parameter was Not Analyzed and may be pending receipt of analytical results from the laboratory.
ND( ) indicates the analyte was Not Detected at the specified detection limit shown in parentheses.
Average, Minimum, and Maximum values are calculated using the detection limit where results indicate ND.

Station_ID	Sample Depth (ft)	Water Depth (ft)	DO (mg/L)	Temperature (C)	Salinity (ppt)	Conductivity (mS/cm)	pH	Turbidity (NTU)	Wind Spd (mph)	Wind Dir.(mag)	Sea Ht. (ft)
	FIELD MEASUREMENTS										
Tuesday, August 25, 1998											
98A7	3	30	12.0	8.8	23.8	26.2	8.3	4	5	N	NS
98B2	3	4.4	14.8	4.5	27.6	26.4	8.3	22	0	Calm	NS
98C2	3	6.2	13.1	6.5	24.5	25.0	8.4	13	0	Calm	NS
98D2	3	7	14.1	7.8	22.9	25.0	8.0	3	0	Calm	NS
98E2	3	8	14.0	7.3	23.9	25.4	7.9	6	5	N	NS
98F2	3	8	12.3	8.3	23.0	25.0	8.2	11	5	N	NS
98G1	3	10	14.1	7.5	24.0	25.6	8.2	11	0	N	NS
98G2	3	7.9	14.1	8.5	21.5	23.7	8.3	10	5	N	NS
98G5	3	33	12.4	8.3	24.2	25.9	8.3	19	5	N	NS
98H2	3	9.1	12.3	4.0	26.7	25.9	8.4	13	5	NNW	NS
98H3	3	8.1	13.3	3.5	28.0	26.2	8.3	16	5	NNW	NS
98H5	3	32	13.2	3.8	27.6	26.3	8.3	23	5	NNW	NS
98I2	3	7.7	14.3	2.8	28.9	26.3	8.4	33	5	NNW	NS
98J3	3	7.7	13.1	5.3	25.8	25.6	8.4	20	5	N	NS
98J4	3	7.2	17.0	5.6	25.3	25.3	8.4	10	7	NE	NS
98K2	3	11.5	13.0	7.5	23.8	25.2	8.4	7	6	NE	NS
98L2	3	12	12.7	7.3	23.9	25.3	8.1	6	6	NE	NS
98M3	3	11.8	15.1	7.1	23.9	25.1	8.1	13	6	N	NS
98N2	3	15.2	12.7	7.7	24.1	25.7	8.4	8	6	NE	NS
Daily Average:			**13.6**	**6.4**	**24.9**	**25.5**	**8.3**	**13**	**4**	---	---
Daily Minimum:			**12.0**	**2.8**	**21.5**	**23.7**	**7.9**	**3**	**0**	---	---
Daily Maximum:			**17.0**	**8.8**	**28.9**	**26.4**	**8.4**	**33**	**7**	---	---

Notes: NS indicates the corresponding parameter was Not Sampled/observed.
NA indicates the parameter was Not Analyzed and may be pending receipt of analytical results from the laboratory.
ND( ) indicates the analyte was Not Detected at the specified detection limit shown in parentheses.
Average, Minimum, and Maximum values are calculated using the detection limit where results indicate ND.

Station_ID	Sample Depth (ft)	Water Depth (ft)	DO (mg/L)	Temperature (C)	Salinity (ppt)	Conductivity (mS/cm)	pH	Turbidity (NTU)	Wind Spd (mph)	Wind Dir.(mag)	Sea Ht. (ft)
			FIELD MEASUREMENTS								
Friday, September 11, 1998											
98FLW-CM	3	8	9.5	2.9	26.7	24.6	7.9	31	5	Variable	NS
98FLW-CM	8	8	11.4	1.5	30.4	26.6	8.0	77	5	Variable	NS
Daily Average:			**10.5**	**2.2**	**28.5**	**25.6**	**7.9**	**54**	**5**	**---**	**---**
Daily Minimum:			**9.5**	**1.5**	**26.7**	**24.6**	**7.9**	**31**	**5**	**---**	**---**
Daily Maximum:			**11.4**	**2.9**	**30.4**	**26.6**	**8.0**	**77**	**5**	**---**	**---**

Notes: NS indicates the corresponding parameter was Not Sampled/observed.
NA indicates the parameter was Not Analyzed and may be pending receipt of analytical results from the laboratory.
ND( ) indicates the analyte was Not Detected at the specified detection limit shown in parentheses.
Average, Minimum, and Maximum values are calculated using the detection limit where results indicate ND.

Station_ID	Sample Depth (ft)	Water Depth (ft)	DO (mg/L)	Temperature (C)	Salinity (ppt)	Conductivity (mS/cm)	pH	Turbidity (NTU)	Wind Spd (mph)	Wind Dir.(mag)	Sea Ht. (ft)
	FIELD MEASUREMENTS										
Sunday, September 13, 1998											
98A3	3	3	10.7	1.7	28.8	26.0	8.2	30	12	NE	1
98A6	3	17	10.8	1.3	29.4	25.7	8.2	23	6	NE	2
98A7	3	26.7	10.9	1.1	29.9	26.0	7.0	16	6	NE	2
98B2	3	4.3	10.9	1.6	25.6	23.0	7.8	5	12	NE	1
98C2	3	5.6	10.8	2.1	29.6	26.4	8.3	11	12	NE	1
98D2	3	6.3	11.0	2.3	27.6	25.0	5.8	18	12	NE	2
98E2	3	7	11.3	2.2	26.6	24.1	7.9	12	10	NE	2
98F2	3	7.2	10.5	2.1	27.9	25.0	5.5	11	11	NE	2
98G1	3	8.9	10.9	1.7	30.0	26.0	7.8	1	7	NE	2
98G2	3	7.3	11.2	2.2	27.0	24.3	7.9	18	11	NE	2
98G5	3	29.5	11.3	0.9	29.9	26.4	6.3	13	11	NE	3
98H2	3	9	10.4	2.1	27.4	24.7	7.9	12	7	NNE	2
98H3	3	8	10.9	1.5	29.6	26.0	7.9	23	10	NNE	3
98H5	3	28.5	11.2	0.8	30.5	26.3	7.7	15	11	NE	3
98I2	3	7.2	10.7	1.6	29.6	26.2	8.3	16	11	NE	2
98J3	3	7	11.2	1.8	29.4	26.1	8.1	11	6	NE	2
98K2	3	11	10.9	1.9	29.5	26.4	6.6	12	11	NE	2
98L2	3	11	10.3	2.2	29.3	26.4	6.9	11	6	NE	1
98M3	3	9	10.1	2.0	29.7	26.7	7.9	14	6	NE	2
98N2	3	15	9.7	2.1	29.8	26.7	5.5	10	6	NE	1
Daily Average:			**10.8**	**1.8**	**28.9**	**25.7**	**7.4**	**14**	**9**	**---**	**2**
Daily Minimum:			**9.7**	**0.8**	**25.6**	**23.0**	**5.5**	**1**	**6**	**---**	**1**
Daily Maximum:			**11.3**	**2.3**	**30.5**	**26.7**	**8.3**	**30**	**12**	**---**	**3**
Project Average:			**11.9**	**6.1**	**26.2**	**30.9**	**7.9**	**16**	**6**	**---**	**1**
Project Minimum:			**9.5**	**0.8**	**5.5**	**9.2**	**5.5**	**---**	**0**	**---**	**0**
Project Maximum:			**17.0**	**11.0**	**30.5**	**48.4**	**8.4**	**173**	**12**	**---**	**3**

Notes: NS indicates the corresponding parameter was Not Sampled/observed.
NA indicates the parameter was Not Analyzed and may be pending receipt of analytical results from the laboratory.
ND( ) indicates the analyte was Not Detected at the specified detection limit shown in parentheses.
Average, Minimum, and Maximum values are calculated using the detection limit where results indicate ND.

Appendix G
1997 Station Positions

1997 Station Locations

Station ID	Degrees North Latitude	Degrees West Longitude	Station Activity
97A-2	70.1588	145.9677	CTD
97A-3	70.1647	145.9655	CTD
97A-4	70.1705	145.9518	CTD
97A-5	70.1747	145.9415	CTD
97A-6	70.1800	145.9240	CTD
97B-1	70.1533	146.0322	CTD
97B-2	70.1642	146.0153	CTD
97B-3	70.1743	145.9978	CTD
97C-1	70.1593	146.0885	CTD
97C-2	70.1708	146.0757	CTD
97C-3	70.1783	146.0657	CTD
97D-1	70.1672	146.1173	CTD
97D-2	70.1745	146.1092	CTD
97D-3	70.1840	146.0980	CTD
97E-1	70.1708	146.1633	CTD
97E-2	70.1795	146.1522	CTD
97E-3	70.1867	146.1367	CTD
97F-1	70.1720	146.1930	CTD
97F-2	70.1817	146.1848	CTD
97F-3	70.1907	146.1793	CTD
97G-1	70.1788	146.2342	CTD
97G-2	70.1887	146.2307	CTD
97G-3	70.1928	146.2273	CTD
97H-1	70.1847	146.2763	CTD
97H-2	70.1915	146.2697	CTD
97H-3	70.1998	146.2675	CTD
FL-CM	70.1714	145.9506	Current Meter
FL-TG	70.1753	145.9587	Tide Gauge
LL-CM	70.1667	146.1218	Current Meter
MET	70.1780	145.9608	Meteorological Station
MS-CM	70.1997	146.2683	Current Meter

Appendix H
1998 Station Positions

1998 Station Locations

Station ID	Degrees North Latitude	Degrees West Longitude	Station Activities
98A2	70.1588	145.9677	In-Situ Water Quality CTD
98A3	70.1647	145.9655	CTD In-Situ Water Quality
98A4	70.1705	145.9518	CTD In-Situ Water Quality
98A5	70.1747	145.9415	CTD In-Situ Water Quality
98A6	70.1800	145.9240	In-Situ Water Quality CTD
98A7	70.1869	145.9106	CTD In-Situ Water Quality
98B1	70.1533	146.0322	CTD
98B2	70.1642	146.0153	CTD In-Situ Water Quality
98B3	70.1743	145.9978	CTD
98C1	70.1593	146.0885	CTD
98C2	70.1708	146.0757	CTD In-Situ Water Quality
98C3	70.1783	146.0657	CTD
98D1	70.1672	146.1173	CTD
98D2	70.1745	146.1092	In-Situ Water Quality CTD
98D3	70.1840	146.0980	CTD
98E1	70.1708	146.1633	CTD
98E2	70.1795	146.1522	CTD In-Situ Water Quality
98E3	70.1867	146.1367	CTD
98F1	70.1720	146.1930	CTD
98F2	70.1817	146.1848	CTD In-Situ Water Quality
98F3	70.1907	146.1793	CTD
98FL-CM	70.1714	145.9506	CTD Current Meter
98FL-TG	70.1753	145.9586	Tide Gauge
98FLW-CM	70.1788	146.2342	CTD Current Meter In-Situ Water Quality Water Sampling
98G1	70.1788	146.2342	CTD In-Situ Water Quality
98G2	70.1887	146.2307	In-Situ Water Quality CTD
98G3	70.1928	146.2273	CTD
98G4	70.2028	146.2233	CTD

Station ID	Degrees North Latitude	Degrees West Longitude	Station Activities
98G5	70.2139	146.1992	CTD In-Situ Water Quality
98H1	70.1847	146.2763	CTD
98H2	70.1915	146.2697	CTD In-Situ Water Quality
98H3	70.1998	146.2675	CTD In-Situ Water Quality
98H4	70.2131	146.2572	CTD
98H5	70.2275	146.2475	CTD In-Situ Water Quality
98I1	70.1925	146.3267	CTD
98I2	70.1972	146.3231	CTD In-Situ Water Quality
98I3	70.2042	146.3217	CTD
98J1	70.1903	146.4017	CTD
98J2	70.1953	146.3987	CTD
98J3	70.2050	146.3949	CTD In-Situ Water Quality
98J4	70.2142	146.3861	In-Situ Water Quality CTD
98J5	70.2196	146.3831	CTD
98K1	70.1947	146.5153	CTD
98K2	70.2014	146.5082	CTD In-Situ Water Quality
98K3	70.2181	146.5056	CTD
98L1	70.1933	146.6236	CTD
98L2	70.2103	146.6142	CTD In-Situ Water Quality
98L3	70.2286	146.6056	CTD
98M1	70.1819	146.7611	CTD
98M2	70.1975	146.7583	CTD
98M3	70.2158	146.7447	CTD In-Situ Water Quality
98M4	70.2367	146.7297	CTD
98M5	70.2542	146.7186	CTD
98MET	70.1780	145.9608	Meteorological Station
98MS-CM	70.1997	146.2683	CTD Current Meter
98N1	70.1894	146.8731	CTD
98N2	70.2139	146.8536	CTD In-Situ Water Quality
98N3	70.2411	146.8461	CTD