CRUISE REPORT

ALPHA HELIX CRUISE 222

18 July 1999 to 22 August 1999

I. **Project Title:** **A COLLABORATIVE STUDY OF THE DYNAMICS AND ECOSYSTEM IMPLICATIONS OF POST-BLOOM PRODUCTION AT THE INNER FRONT OF THE SOUTHEASTERN BERING SEA**

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II. **Scientific Purpose:** We hypothesized that elevated primary production at the inner front of the southeastern Bering Sea continues longer than in the upper mixed layer of non-frontal waters, and that this production provides an energy source throughout the summer for a food web that supports shearwaters, salmon, and their zooplankton prey. To test this hypothesis, we collected and interpreted observations on physical and biological features in the vicinity of the inner front to determine: 1) the availability of nutrients in the euphotic zone, 2) the physical processes responsible for enhanced vertical flux of nutrients, 3) primary production, 4) the distribution, abundance, and trophic ecology of near-surface swarms of euphausiids and other zooplankton, 5) the distribution, abundance, and foraging ecology of shearwaters, and 6) by stable isotope enrichment, trophic pathways from phytoplankton to shearwaters at and away from the front. In addition, we examined grazing rates of phytoplankton of various size fractions to determine the fate of the coccolithophore bloom. This cruise is the sixth of six planned for these projects.

As part of this cruise, we also conducted brief investigations of shearwater foraging in the vicinity of Akutan Pass and of the conditions under which baleen whales were foraging over the mid shelf region of the southeastern Bering Sea. The latter study was funded by the National Marine Mammal Laboratory as an add-on to our cruise.

III. Personnel

George Hunt	Chief Sci.	UCI	USA	Ornithology
Steve Zeeman	Co-PI	U. New England	USA	Primary Production
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Lucy Vlietstra	Student	UCI	USA	Ornithology
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Edward Rodowicz	Student	U. New England	USA	Primary Production
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Carolina Pickens	Technician	UCI	USA	Ornithology
Alexei Pinchuk	Technician	U. AK Fairbanks	Russia	Zooplankton

IV. Cruise Schedule

DATE	TIME	ACTIVITY
18 July	10:30:	Castoff from Seward Marine Center
21 July	07:30:	Enter Bering Sea, begin bird survey to whale grid
	17:50:	Begin Bird/Whale, CTD and CalVET surveys of Central Line of Whale Grid from WC-7 to WC-1 At WC-7, 87m CalVET and 30 m CTD for microzooplankton grazing and DMS/DMSP lyase activity
22 July	03:50:	Complete CTD survey with a CTD at CNC-10
	07:40:	Begin Bird/Whale and Acoustic Survey of the WS-line
	20:07:	End Survey of WS-line
	22:11:	MOCNESS tow at WS-7
	23:00:	CalVET tow for microzooplankton HPLC
23 July	01:09:	MOCNESS tow, mid Whale Grid
	04:07:	CTD, Mooring 2
	07:45:	Bird/Whale and CTD survey of the WN-line; 60 m CalVET tow and 5 m CTD at WN-2 at edge of Coccolithophore Bloom for Micro-Zooplankton Grazing Experiment, HPLC, and DMS/DMSP lyase
	13:00:	Locate Fin Whales at Station WN-4
	14:30:	MOCNESS tow where whales foraging
	17:30:	MOCNESS tow WN-5
	20:40:	MOCNESS tow at WN-7
	23:32:	Completed Bird/Whale survey at WN-9 grid extension
24 July	00:55:	Completed CTD survey at WN-10 grid extension.
	01:20:	Underway to Dutch Harbor for new transducer
	14:35:	Arrive Unalaska Bay, Stand-by for arrival of parts
25 July	13:34:	Still Waiting for Transducer to arrive, depart for Akutan Pass study
	15:15:	Investigation of shearwater foraging in Pass; CTD survey across small convergence at side of pass.
	16:30:	MOCNESS survey across convergence zone
	18:10:	Collected 8 Shearwaters and 3 Fulmars in pass.
	20:41:	Begin Bird and CTD Survey from pass northward across Bering Canyon, end of flood tide (north-flowing) Stations AP-11 to AP-16

NOTE: AS OF CTD 31, CHANGE IN FLUOROMETER TO MEDIUM SENSITIVITY

26 July	01:11:	Complete CTD survey of AP-line
	01:50:	Underway to Dutch Harbor
	11:04:	Depart Dutch Harbor with new transducer
	12:57:	Begin bird and CTD section of AP-11, 12, and 13 at end of ebb tide (south-flowing)
	17:15:	Begin CTD cross-section of Unimak Pass along northern sill with stations UP-1 t0 UP-6
27 July	01:26:	Slime Bank: MOCNESS survey, inner and middle grid at SBE-1, and SBA-2, inner stations, and SBC-3, in fluorescence maximum.
	07:22:	Bird and Acoustic survey from SBE-1 to SBE-10
	11:45:	In Situ Productivity Station at SBE-10
	13:47:	Begin Bird and CTD section from SBE-10 to SBE-1 with stations at SBE-10, 8, 6,5, 4, 3, 2, and 1.
	12:30:	CalVET and CTDs for Micro-Zooplankton Grazing Experiment, HPLC, DMS/DMSP lyase and nutrient amendment studies
	18:40:	Begin Bird, CalVET and CTD section from SBC-1 to 11 with CTDs and CalVETs at all stations.
	20:04:	CalVET and CTDs for Micro-Zooplankton Grazing Experiment
28 July	00:08:	End Survey of SBC-line
	00:57:	Begin CTD section of SBA-line Stations at SBA-10, 8, 6, 5, 4, and 2
	05:57:	MOCNESS at SBE-6.5
	10:29:	Bird and Acoustic survey of A-line from SBA-10 to –1
	14:47:	In Situ Productivity station at SBA-1; Nutrient amendment study
	16:46:	End In Situ Prod, run for cover in heavy weather
29 July	00:45:	MOCNESS at SBC-9, SBA-7, SBE-4
	07:30:	Bird and Acoustic Survey of C-line from SBC-2 to 10
	11:20:	Bird Collecting near SBC-11
	12:57:	In Situ Prod, SBC-5; CTDs for nutrient amendment studies
	15:30:	In Situ Prod, SBE-4
	15:45:	48 m CalVET tow and 6 m CTDs for Micro-Zooplankton Grazing Experiment, HPLC, and DMS/DMSP lyase, nutrient amendment studies
	18:32:	CTD and bird re-survey post-storm E-line, 2, 3, 4, 5, 6, and 8
	23:30:	Depart for Nelson Lagoon

30 July	07:40:	Bird and Acoustic Survey Nelson Lagoon D-5 to D-1
	12:00:	Deploy Zeeman's TSRB sensor
	12:52:	CTD and bird survey of NSLGB, B-1 to B-5
	17:27:	Underway to Port Moller Grid with bird obs.
	20:20:	Bird Collecting Inner Grid between PMB-2 and PMD-2
31July	00:00:	MOCNESS survey inner grid PME-2, PMC-3, PMA-2
	07:06:	Bird and Acoustic Survey PME-1 to PME-11
	12:26:	In Situ Productivity, PMC-11
	13:00:	64 m CalVET and 9 m CTD for Micro-Zooplankton Grazing Experiment, HPLC, and DMS/DMSP lyase, and nutrient amendment studies
	14:33:	Bird and Acoustic Survey PMC-11 to PMC-1
	20:03:	Bird and Acoustic Survey of PMA-1 to PMA-11 with birds only to PMA-7
1 August	00:54:	MOCNESS survey outer grid PMA-11, PMC-9, PME-11
	07:04:	CTD and bird survey E-line, all stations PME-12 to PME-1
	12:30:	PMC-1, 21 m CalVET tow and 11 m CTD for Micro-zooplankton Grazing Experiment, HPLC, and DMS/DMSP lyase, and nutrient amendment studies
	12:30:	In Situ Productivity, PMC-1
	14:55:	CTD, bird and CalVET survey all stations PMC-1 to PMC-11
	21:29:	CTD and bird survey of PMA-line from PMA-10 to PMA-2; Stations at: PMA-10, 8, 6, 5, 4, and 2
2 August	01:35:	MOCNESS survey of mid grid: PMA-5, PMC-6, PME-5
	07:24:	Zig-Zag Grid for mapping foraging flocks between stations 1 and 3 starting at PME-3 and going to PMA line and return to E
	12:50:	In Situ Productivity Station PMC-5 plus nutrient amendment studies
	14:45:	Depart for Port Heiden Line, outer end, in bad weather
	21:23:	Port Heiden 2 to Port Heiden 1, bird Obs. Only
	22:08:	Change course for lee of coast Bird Obs. Continue
	23:24:	Anchored in lee
3 August		At anchor, waiting out bad weather

4 August	07:32:	Underway for Cape Newenham grid, with Bird Obs.
	17:24:	CTD at outer end Newenham trough (NT-1)
	19:00:	Abort NT line and head for shelter
	23:43:	Anchored in Security Harbor
5 August	07:30:	Begin CTD and CalVET survey, with bird observations along Cape Newenham C-line. Stations at: CNCX-17, X-16, X-15, X-14, X-13, X-12, X-11, / X-10, X-8, X-5, X-3, X-1, CNC-2, 4, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, and mooring 2.
	22:30:	MicroZooplankton Grazing experiment at CNC-7
6 August	07:35:	Acoustic and bird survey from CNC-14 to CNCX-1 for birds and CNCX-5 for acoustics.
	14:16:	In Situ Productivity Station at CNC-11; CalVET and CTDs for Micro-Zooplankton Grazing Experiment, HPLC, DMS/DMSP lyase and nutrient amendment studies
	19:32:	Collected 4 shearwaters near CNC-5;
7 August	00:22:	MOCNESS survey, CNCX-5, CNCX-3, CNCX-1, and CNC-4
	07:10:	Repeat CTD and bird survey of main grid and offshore from CNCX-1 to CNC-16, with break for two In Situ Prods.
	11:30:	In Situ Productivity station at CNC-5; and nutrient amendment studies
	14:35:	In Situ Productivity station at CNCX-2; CalVET and CTDs for Micro-Zooplankton Grazing Experiment, HPLC, DMS/DMSP lyase
8 August	00:18:	MOCNESS survey, CNC-15, Mooring 2 and one more
	07:11:	Acoustic and bird survey Whale Grid WN-5.5 to Mooring 2
	10:39:	In Situ Productivity Station, Mooring 2 with Repeat; CalVET and CTDs for Micro-Zooplankton Grazing Experiment, HPLC, DMS/DMSP lyase
	18:15:	Acoustic and bird survey Whale Grid WN-4 to WN-1
9 August	01:14:	MOCNESS survey, CNC-13, CNC-11, CNC-8; CalVET and CTDs at CNC-13 for Micro-Zooplankton Grazing Experiment, HPLC, DMS/DMSP lyase
	07:05:	Bird survey, CNC-8 to CNCX-13, with breaks for CTDs; no acoustics due to bad weather
	12:09:	CTD at CNCX11, CNCX-13, and CNCX-14 for Zee;
	19:32:	CTD and bird survey of Cape Newenham trough

10 August	00:34:	MOCNESS survey, CNCX15, CNCX-12 and CNCX-8
	07:02:	Acoustic and bird survey, CNCX-5 to CNCX-15
	16:00:	Depart for Nunivak Island
11 August	07:18:	Survey of the NIC line with CTDs, birds and CalVETs from CNCX-15 to NIC-16;
	11:22:	CalVET and CTDs at NICX-8 for Micro-Zooplankton Grazing Experiment, HPLC, DMS/DMSP lyase
	11:55:	Collected 1 shearwater
	20:15:	CalVET and CTDs at NIC-13 for Micro-Zooplankton Grazing Experiment, HPLC, DMS/DMSP lyase
12 August	01:17:	MOCNESS survey, NIC-11, NIC-13, NIC-15
	07:49:	Acoustic and bird survey from NIC-15 to NICX-8 for birds and to NICX-11 for acoustics with break for Prods.
	14:33:	In Situ Productivity station at NIC-4; CalVET and CTDs at for Micro-Zooplankton Grazing Experiment, HPLC, DMS/DMSP lyase, and nutrient amendment studies
13 August	00:44:	MOCNESS survey, NICX-11, NICX-13, NICX-15
	07:20:	CTDs and bird survey, off beach from NICX-17 to NICX-15 -8,
	08:49:	Water for Deck Prod at NICX-15; CalVet tows and CTDs for Micro-Zooplankton Grazing Experiment, HPLC, DMS/DMSP lyase
	09:14:	Acoustic and bird survey from NICX-15 to NICX-5
	15:04:	In Situ Productivity Station at NICX-8; and CTDs for nutrient amendment studies
	20:18:	Fine-scale CTD survey of central grid NIC-2 to NIC-8 with stations also at C-2.5, 3.5, and 4.5, with bird obs
14 August	00:23:	MOCNESS survey, NIC-8, NIC-5, NIC-3
	07:17:	CTD and bird survey NIA2 to NIA-13
	11:56:	collected 7 shearwaters from foraging group
	13:52:	In Situ Productivity station NIA-11, and CTD for nutrient amendment studies
	15:40:	collected 5 shearwaters from foraging flock
	18:19:	CTD and bird survey from NIE-14 to NIE-2
15 August	00:14:	MOCNESS survey, NIC-1, NICX-4, NICX-8
	06:49:	CTD and bird resurvey of C-line from NICX-2 to NIC-16 with breaks for a CTD at mooring IF2A, and a prod

	11:27:	In Situ Prod at station NIC-8; and CTDs for Micro-Zooplankton Grazing Experiment, HPLC, DMS/DMSP lyase, and nutrient amendment studies
	14:10:	CTD at Mooring IF2A
	18:52:	Begin NP line with CTD and CalVETs at stations at NP-1, Mooring 4, NP-2, NP-3, NP-4, NP-5, NP-6
16 August	00:40:	CalVETS and CTDs at for Micro-Zooplankton Grazing Experiment, HPLC, DMS/DMSP lyase
	03:23:	Acoustic survey from SPE-1 to SPE-4
	09:10:	In Situ Prod at SPE-4
	11:01:	CTD, CalVET and bird survey along SPE-4 to SPE-1
	16:30:	Acoustic and bird survey SPW-1 to SPW-3
	21:06:	CalVETs and CTDs at for Micro-Zooplankton Grazing Experiment, HPLC, DMS/DMSP lyase,
	21:13:	CTD, CalVET and bird survey SPW-4 to SPW-1
	23:01:	Water for Deck Prod taken at SPW-3
17 August	01:32:	CTD and CalVET survey of SPG1 to SPG-4 line
	05:34:	SPG-3 CalVETs and CTDs at for Micro-Zooplankton Grazing Experiment, HPLC, and DMS/DMSP lyase, studies
	09:30:	Depart Pribilof Islands for Akutan Pass with bird obs.
	12:19:	Begin two short lines over Pribilof Canyon PC-1 to PC-8
	12:38:	PC-1 water taken for a Deck Prod
18 August	08:18:	CTD and bird survey Akutan Pass AP-20 to AP-31
	14:16:	CTD and bird survey Akutan Pass AP-31 to AP-19
	19:40:	Collected 5 shearwaters
	20:17:	Acoustic and bird survey AP-19 to AP-23.5
	22:00:	Begin time series of CTDs at AP-23.5
19 August	04:31:	End time Series of CTD casts
	09:00:	Collected 5 shearwaters
	09:38:	NIO net tows (3) in area with shearwaters, AP-21
	10:48:	CTD to confirm water column structure at AP-21
	11:48:	CTD to confirm water column structure at AP-24
	11:51:	NIO net tows (3) in area with no shearwaters, AP-24
	15:30:	Depart for Seward

OVERVIEW

WHALE STUDY:

The purpose of this study was to compare prey availability in the vicinity of foraging baleen whales with prey availability elsewhere in the southeastern Bering Sea. Based on information gathered during aerial surveys for right whales and other species of large whales in the middle shelf, we developed a survey grid that included a segment of the inner domain immediately offshore of our Cape Newenham grid. We then conducted a combination of, acoustic, net, and visual surveys to compare plankton densities and seabird/whale distributions within the middle domain and the adjacent portions of the inner shelf.

The purpose of this study was to develop a profile of the conditions under which large baleen whales, especially right whales and fin whales could forage successfully. We were able to document that the region in which these whales had been observed during aerial surveys was centrally located in the middle shelf domain in well-stratified water. The top end of the whale grid intersected the coccolithophorid bloom, with stations WN-1 and 2 , and station WC-1 in the bloom. It appeared that none of the stations on the WS-line were within intense bloom conditions. A limited, single acoustic survey of the WS line showed considerable biomass at and above 30 m, and MOCNESS nets within the grid had high densities of *Calanus marshallae* and post-larval gaddid fishes in the water. Euphausiids were almost completely absent from samples. We surveyed most of three lines for seabirds and whales. Fulmars and storm-petrels were most abundant on the WS-line, and shearwaters were scarce throughout the grid. A group of about 12 fin whales was encountered along the WN-line near station WN-4. These whales appeared to be foraging. They surfaced in clusters, with whales facing in multiple directions, blew several times, then dove for up to six minutes, resurfacing close to where they dove. No birds were foraging in the vicinity of these whales, although one or two fulmars stopped briefly where a whale dove. A MOCNESS sample taken through the area where the whales had been diving contained high numbers of *C. marshallae* and some post-larval fishes. Data on the densities of zooplankton in the water will be available once the MOCNESS samples have been processed.

Equipment failures resulted in the loss of two MOCNESS samples and one complete acoustic survey.

SHEARWATER FORAGING IN AKUTAN PASS:

To take advantage of time available while waiting for the replacement transducer to arrive in Dutch Harbor, we undertook a brief preliminary study of shearwater foraging in the vicinity of Akutan Pass. We wished to determine the type of prey being taken by shearwaters near the pass, and the reason for the availability of prey aggregations in this area. In particular, we wished to determine the relative importance of upwelling as a physical mechanism forcing the aggregation of the euphausiids versus the role of enhanced production in providing forage for near-surface aggregations of euphausiids.

When we arrived at the northern end of the pass on 25 July, thousands of short-tailed shearwaters were foraging in association with what appeared to be convergence zones along the sides and at the northern end of the pass. These areas of convergence, usually marked by the accumulation of feathers, seaweed, and other floatsum, were lined up across the tidal flow, as well as parallel to the flow along the edges.

To document these activities, we undertook a cross-section through a convergence where shearwaters were foraging. We first did a CTD section, followed by a MOCNESS deployment, in which a series of nets were opened sequentially within the top 20 m as we traveled from one side of the convergence to the other. Throughout this MOCNESS deployment, we also collected an acoustic record using the three good transducers (420, 200, and 100 kHz). Subsequently we collected 8 short-tailed shearwaters and 3 northern fulmars.

We observed that the shearwaters aggregated loosely along the convergences, mostly on the Bering Sea side of the smooth water. They mostly sat on the water, occasionally sticking their heads under water or making surface plunges. There were occasional flurries of activity when a group of shearwaters would get up, fly along a portion of a convergence streak and then settle back on the water. After we passed through a group and scared them off the water, the gap gradually refilled with small groups of shearwaters flying in. Although there was some pecking at the surface, the overall impression was of a low-key desultory feeding effort by the shearwaters. There was no sign of the synchronous diving of large groups of shearwaters or hydroplaning seen on other cruises when shearwaters were foraging on near-surface swarms of adult euphausiids. Of the eight shearwaters collected, seven were eating small euphausiids and one was empty.

Fulmars were also observed foraging in the vicinity of the convergence lines. They were almost exclusively on the opposite side of the convergences from the shearwaters in what may have been water that had come through the pass from the Pacific side. Fulmars were often in tight clusters and pecked rapidly at the surface while sitting on the water. Phalaropes, also surface feeders, occurred in high numbers along the convergence line. They also pecked rapidly at the surface and moved along the line in large groups.

The CTD section showed warmer, fresher water over-riding cooler, saltier water, most likely from the Bering Sea. The acoustic section showed few echo returns and little was caught in the MOCNESS.

We also ran two CTD sections from the center of the channel in the pass to the northwest, out over the middle of Bering Canyon. The first run was at the end of the flood tide, the second at the end of the ebb. After the flood, the chlorophyll maximum was shifted offshore and there was evidence of down-welling into the canyon. At the end of the ebb tide, the chlorophyll was shifted over the pass, and water from within the canyon had moved up into the pass. On both runs, flocks of shearwaters were present on the water in the vicinity of convergence streaks.

We returned to Akutan Pass for a series of additional measurements on 18 and 19 August. Again we found areas of high fluorescence associated with upwelled water at the north end of the pass. High densities of juvenile euphausiids were documented foraging in these patches. Where convergences occurred, we again found high numbers of shearwaters foraging. Of the 10 shearwaters collected, most were foraging on juvenile euphausiids.

A preliminary interpretation of these results suggests that two mechanisms may be involved in providing foraging opportunities for shearwaters to forage at passes. First, particularly as seen in our earlier work in the western Aleutian Islands, strong, tidally-driven upwelling at the seaward edges of the passes results in the aggregation of adult euphausiids at depth. When these aggregations are sufficiently shallow, shearwaters are able to forage profitably. Secondly, upwelling of nutrient-rich water from depth supports enhanced standing stocks of phytoplankton offshore of the passes in stratified water. Euphausiids, and possibly in particular, juvenile euphausiids forage in these near-surface patches, and are concentrated in convergences as tidal movements periodically advect these patches into the passes.

THE INNER FRONT STUDIES

Slime Bank:

We worked the Slime bank grid from 27 July until 29 July. We completed CTD sections on the A-, C-, and E-lines, with a series of CalVET net tows on the C-line. We also obtained acoustic and bird surveys on these three lines. MOCNESS samples were obtained from the inshore portion of the grid (2), in the area of maximum fluorescence (2), and from the outer portion (3) of the grid. In Situ Productivity stations were also run in the inshore (1), fluorescence maximum (2), and outer portion (1) of the grid. Shearwaters (8) were collected at the outer end of the C-line.

When we arrived at Slime Bank, the weather had been calm for a considerable period, and neither the front nor the upper mixed layer were clearly defined. Maximum fluorescence values were present in the mid-grid regions, where expected if the frontal region was a source of nutrient flux to the upper mixed layer. Fluorescence was present inshore to near the bottom, but offshore was maximal in the vicinity of a weak pycnocline. Acoustic scattering showed abundant biomass near the bottom across much of the grid, and with a mid-water layer present in the outer end of the C-line. There was also abundant biomass throughout the water column in mid grid. Comparison of the acoustic signatures and preliminary inspection of the MOCNESS tows suggest that much of the biomass present at Slime bank was a combination of small euphausiids and post-larval gaddids, probably walleye pollock. Seabirds of all species were scarce in the grid. Most shearwaters seen were flying to the west as single birds; few birds were seen on the water and in only one or two cases were birds seen foraging. At the outer end of C-line, several hundred shearwaters and fulmars were on the water and possibly feeding. Six of eight shearwaters collected from this group had small juvenile fish in their stomachs; the other two were empty.

There was a storm on the night of 28 July with winds to 60 knots. We repeated the SBE-line to compare hydrographic structure and the distribution of nutrients before and after the storm. The pycnocline was deeper, and the fluorescence maximum, which had been around station SBE-4, was now inshore at about station SBE-2.

Nelson Lagoon:

We ran both an acoustic survey (D-line) and a CTD survey (C-line) in this grid. The wind was high and the planned work had to be curtailed. Few birds of any species were seen, although we did encounter a small group of foraging shearwaters and kittiwakes (attempts at collecting were unsuccessful). Several Kitletz' murrelets and a marbled murrelet were seen. There were what appeared to be small fish targets offshore in the vicinity of where we saw the foraging birds. No whales were seen, and no MOCNESS samples were taken.

Port Moller:

We were able to run three CTD lines, three acoustic lines, conduct nine MOCNESS tows, and collect foraging shearwaters from four different flocks in the inner portion of the grid. The Port Moller Grid was stratified offshore and well mixed inshore. The transition was diffuse and the frontal area was poorly defined. Fluorescence was generally low and was concentrated over the middle of the grid near a dip in the pycnocline. Seabird foraging flocks, consisting mostly of kittiwakes and murres, were concentrated in a band between stations 1 and 3, just offshore of the nearshore band of freshwater. Shearwaters were scarce in the grid, and the few collected from the mixed species foraging flocks were eating sandlance. Acoustic surveys indicated high concentrations of biomass from the middle of the grid to the offshore edge. MOCNESS tows showed much of this biomass to be small pollock and young stages of euphausiids.

Port Heiden:

We ran one bird survey from offshore to the beach at Port Heiden. The weather was very poor, and visibility was limited by high waves and spray. Few birds were seen, although we did encounter a couple of mixed species foraging flocks. There were essentially no shearwaters in the area.

Port Heiden to Cape Newenham:

We ran a bird survey while underway from Port Heiden to Cape Newenham. Again the weather conditions were marginal for observing. Few shearwaters were seen, most of which were flying.

Cape Newenham:

We arrived in Cape Newenham after two days of 35 to 45 knot winds. A CTD profile at the outer end of the Cape Newenham trough showed the water was well mixed to the bottom at 50 m. After waiting out the storm for the night, we ran a CTD line from the shore out to Mooring 2 in the middle shelf region. The water column was well mixed to a depth of about 50 m. In the vicinity of the 50-m isobath, there was a well-defined frontal system with evidence of vertical advection at its inner edge. Visual observations of white water, high levels of fluorescence, and high extinction coefficients showed that the coccolithophorid bloom was located on the seaward side of the front and extended out into the middle shelf for about 50 km. Nutrients were depleted at and inshore of the front, although there was some suggestion of vertical advection in the vicinity of the front. Subsequent acoustic and MOCNESS surveys of zooplankton showed that euphausiids were scarce inshore of the front, though juvenile fish, euphausiids, and copepods were abundant offshore in the middle domain. Acoustic biomass was deeper in the water under the bloom, and approached the surface at both the inshore and offshore edges of the region of white water. Foraging birds were concentrated on both the offshore and, in particular, the inshore side of the coccolithophorid bloom. Comparatively few birds were seen foraging within the bloom. The few flocks of foraging shearwaters seen were inshore of the inner edge of the white water, although probably within the edge of the bloom. Shearwaters collected here either were empty or had the remains of juvenile fish in their stomachs.

Nunivak Island:

At the Nunivak Island grid, we found well mixed water inshore of the 40 m isobath, a strongly demarked front between 40 and 55 m and stratified water offshore. Within the frontal zone, there were spikes of cold water projecting into the upper mixed layer, possibly to the surface. These appeared to be narrow regions where deeper, nutrient-rich water was being advected toward the surface. Much of the grid was covered by the coccolithophorid bloom, which was particularly at and just offshore of the front. At the front, elevated fluorescence was present from the surface to the bottom. Zooplankton was scarce inshore of the front, and more plentiful offshore. We encountered one small flock of shearwaters foraging inshore in an area where the water was darker colored, apparently a small area of lesser coccolithophorid density. A flock of shearwaters foraging offshore was determined to be eating juvenile pollock captured near the surface within the bloom. In general, few birds of any species were present in the grid.

An intriguing observation was the presence of warm, salty water above the cold pool, suggesting that advection of nutrients to the vicinity of the inner front could come from oceanic water that had moved across the shelf above the cold pool. A similar, though less distinct feature may have been present off the Cape Newenham grid.

This grid provides the clearest evidence that we have seen of how the front may act to inject nutrients into the upper water column. It suggests that the front may require particular circumstances if it is to support upward advection of nutrients, and thus production at the front supported by such advection may be only episodic. If upwelling is dependent on storms to set up the necessary conditions, then storm frequency and strength may be very important elements in determining prolonged production over the inner shelf.

Pribilof islands:

Transects to the east and west of St. Paul Island revealed different hydrographic structures and nutrient distributions on the two sides. East of St. Paul, there was well-mixed water inshore and thermally stratified water over the cold pool. To the west, stratification was much weaker. In the east, acoustically determined biomass was generally at or above the pycnocline, whereas west of St. Paul, acoustic biomass was more scattered throughout the water column. Shearwaters were scarce on both transects, and there were no obvious distribution patterns for any species other than a general decrease in density as a function of distance from the island.

The line between the islands was run at night, and physical patterns recorded are discussed in the physics section.

Of interest were a pair of short lines across the south arm of Pribilof Canyon. As we headed south to the Aleutians, we encountered huge flocks of fork-tailed storm-petrels feeding and resting on the water. We returned north toward St. George with a short CTD line, and then turned south again with a second short line running southeast across the south arm of the canyon. In both crossings with CTDs, we documented a domed clockwise rotating eddy with foraging storm-petrels, and fulmars sitting on the water at convergence lines near the middle of the dome. The area also supported unusually high numbers of fur seals and Dall's porpoises. The birds and porpoises appeared to be foraging, whereas the seals were resting in association with kelp paddies, which were numerous in the area. This was one of the richest aggregations of foraging birds and mammals that we have encountered along the shelf south of the Pribilofs.

REPORTS FROM INDIVIDUAL GROUPS

PHYSICAL OCEANOGRAPHY: Nancy Kachel

A total of 351 CTD casts were taken on the cruise, distributed as follows: 23 on the Whale grid; 62 in the vicinity of two Aleutian Passes; 41 at Slime Bank; 5 off Nelson Lagoon; 39 at Port Moller; 68 at the Cape Newenham grid; 88 at Nunivak Island, including 6 stations between Nunivak Island grid and St. Paul Island; 12 stations around the Pribilof Islands; and 8 stations across the south lobe of Pribilof Canyon.

Whale Grid:

We occupied a grid of stations in an area determined by D. Demaster's whale survey. This grid was situated just outside end of the Cape Newenham grid. It's location approximately coincided with the width of the middle regime defined by the physical structure of the water column. This structure consisted of a warm layer (8-9°C), underlain by the cold pool, which was unusually cold (0.5-1.4°C) this year. The thermocline between these layers was gradual and occupied a zone 10-15m thick. At most stations, the salinity structure was very weak, exhibiting salinity differences of <0.02 psu.

Akutan Pass:

On our first visit to Akutan Pass a line of five stations across the north side of the pass in the vicinity of a flock of ~8000 feeding shearwaters crossed a line of shear. The line was done as the tide was flooding through from the Pacific bringing with it somewhat warmer, higher salinity water. The northward tidal current occupied the eastern half of the section, while the southward return flow was found on the western side of Akutan Pass.

The other lines extended from near the pass outward into Bering Canyon. The first of these went out beyond the axis of the canyon, the second, only to a bottom depth of 150m. The longer section, which was begun late on the flooding tide shows downwelling on the south side of the canyon, but most apparently at the canyon lip near the entrance to the pass. The second occupation of the line consisted of 3 stations just after the tide had begun to flood. Upwelling of waters from the canyon had moved the 5.5°C water at least 6 km into the pass. Surface waters of 7 °C had been carried into the pass more than 13km.

At the end of the cruise, we returned to Akutan Pass, and a second CTD line was established from the Bering Sea slope to the Pacific side, which was occupied twice. Tidal currents greater than 7knots were flowing through the pass. The water on the Pacific side was well mixed top to bottom as it traverses the channels and basins from the Pacific slope to the pass. On the Bering side, colder, more saline water came come up from the canyon on the ebb tide. On the flood tide the mixed water from the Pacific side pushed through the pass and caused downwelling into the canyon. A patch of high fluorescence water sat over the nose of the water coming up from the canyon, just seaward of the tidal front.

Unimak Pass:

While in transit from Dutch Harbor to Slime Bank on 26 July, 5 CTD stations were taken along the ~75m deep sill at the north end on Unimak Pass during the flooding tide. Flow was northward over the center two-thirds of the section, while southward flow of warmer and fresher water from the Bering Sea was seen on both sides. Higher fluorescence was associated with the water coming in from the Bering Sea.

Slime Bank:

On 27-28 July, we occupied the CTD grid at Slime Bank. The temperature and salinity sections showed continuously stratified water of the "oceanic regime" and little indication of the two-layered structure expected in the middle domain. A core of 4.5 °C water was present below 60m.Isotherms of 6-7 °C on the E and C lines (done first) were nearly horizontal intersected the bottom. Winds shifted to southeast by the time the A line was run. This line shows a down turning of the isotherms and a movement of the 4.5 °C water farther offshore. A period of storm winds of up to 50 knots sustained winds followed, after which we reoccupied the E-line. Cooling of ~0.5 °C in the surface waters near shore was evident, as well as tightening of the isotherms into a more two-layered middle regime and downturning indicative of the location of the inner front at a bottom depth of 40-50m.

When we first arrived at Slime Bank, upwelling from Bering Canyon had likely disrupted the frontal structure, as evidenced by the shape of the isotherms and the colder temperatures. Wind mixing of the upper water column during the storm compressed the distance between isotherms at the thermocline. Downwelling pushed the colder waters offshore or down the canyon axis, and nearshore mixing reestablished a more typical inner front structure.

Nelson Lagoon:

The B-line of 5 CTD stations was occupied at Nelson Lagoon on 30 August during which time winds were blowing offshore at 20-30 knots. The tide is strong this far up into Bristol Bay, and it changed directions during the time it took to occupy the line. The section for this line reflects the changing tide, indicating northeastward flow nearshore and southwestward flow offshore. The typical inner front structure did not appear although the inshore waters were more weakly stratified than offshore. Fresh water influence was found at the inshore end, where less saline, warmer water was associated with the highest fluorescence. Between stations NLB3 and NLB4, there was a zone of relatively warm, higher salinity water with very low fluorescence and high transmission (low extinction coefficient). This water appears to have been advected into the grid by tidal currents.

Port Moller:

The Port Moller grid stations were occupied sequentially on 1-2 August. The inner front spread over a zone 20km wide centered at PMA04, PMC05, and PME05 at a bottom depth of 45-55m. A core of 3.5-4.0 °C water was present at the outer edge below the thermocline. The two-layered structure of the middle domain was more strongly expressed here than at either Nelson Lagoon or Slime Bank, with a 2-4 °C change in temperature across the thermocline. The effect of the storm before we arrived was to mix the upper layer to a depth of 12-23m. Highest fluorescence values were found seaward of the front on each of the lines. Stations closer to the beach had fresher (<30psu), warmer (>10 °C) water typically associated with runoff from the land.

Storm:

At the end of the Port Moller survey from August 2-5 there was another gale with sustained winds of 50 kts, and gusts over 60 kts. On the last day we transited to Cape Newenham to begin surveys there.

Cape Newenham:

Extended versions of line C were occupied twice at Cape Newenham. The inshore extension was run separately, after the second time through the main line. We also did four CTD casts up the axis of the 50 m trough that runs perpendicular to the grid lines and at the nearshore end.

The first occupation of the C line occurred as the major storm was waning. We began this line near the shore at CNCX17 and extended to the NOAA/PMEL Mooring 2 site. Nearshore waters were well mixed top to bottom from CNCX17 to CNC01. In this distance, the temperature steadily declined from >11°C to ~6°C, while salinity increased ~2psu. The nearshore freshwater signal shows the influence of the Kuskokwim River outflow, which originates 25-30 miles to the northeast. The offshore bottom cold pool (defined by waters >2°C) had temperatures that were much more variable along the line than measured prior to this year. Lobes of cold pool water easily seen when the CNC line is overlapped by the WC line. The thermocline between the warmer surface layer and the bottom waters was located between 22 to 29 m and occurred over a 5-8m interval.

The inner front was clearly expressed with its leading edge between CNC01-CNC02. The distance between the leading edge of the front and the cold pool was 60km. We observed a previously unidentified feature of the front consisting of a zone in which isotherms (here, 6°C) bow upward 10-15m above the thermocline over the cold pool. This must be the area of active mixing or upwelling into the upper layer of the waters previously contained below the thermocline.

The other feature of great interest on this line was the coincidence of the coccolithophorid bloom in the surface waters of the middle domain. On August 6 the bloom was first observed visually near the beach at Cape Newenham, but then it nearly disappeared. Just beyond the leading edge of the inner front, the bloom reached its maximum fluorescence at CNC11-12, then declined farther offshore. The extinction coefficient showed a similar pattern to the fluorescence; both patterns were contained above the thermocline. The second occupation of the line on August 7-8 began at CNCX1 and was extended 20 km beyond Mooring 2, deeper into the Whale grid (WC5.5), which permitted us to define the seaward extent of the surface expression of the bloom. On this line, the patch of high fluorescence (fluorescence >1.00Volts) was split into two centers, separated by lower fluorescence water. The bloom width along this transect had expanded from 55 to 85 km.

An extra line of 4 CTD stations between CNCX11 andCNCx14 was done to sample the higher fluorescence zone seen on the inner portion of the line. A near bottom peak in fluorescence was once again seen, as it was on other cruises, just seaward of the 25m depth ridge near CNCX12 and X13.

Four stations were taken parallel to the coast along the axis of a 45-50m trough to study the possibility that higher salinity water comes into the Cape Newenham nearshore region from the upper reaches of Bering Canyon. As we did this line, the tide turned to ebb, so fresher water from the Kuskokwim delta area to the north began to override the slightly cooler, saltier water in the trough. At the deepest station there was some indication that slightly higher salinity water might be coming into the trough near the bottom.

Nunivak Island:

On our first transit of NIC-line the inner front was spread over a 30 km zone and its structure of diving isotherms was complicated by a narrow zone of cooler water (expressed by the 6 °C isotherm) at NIC06 rising 15-20m above the thermocline before diving to the bottom. This feature was also expressed in lower sea surface temperatures than on either side of it. This cross-section of fluorescence showed a zone of lower values there, with regions of higher fluorescence both inshore and offshore of it. The coccolithophorid bloom was present throughout the entire area of the Nunivak grid, but the most intense regions were on either side of this feature. The inshore region of high fluorescence extended over the entire depth of the water column, while the offshore zone was confined to the waters above the thermocline. On the A-line the temperature difference between the cooler column and the water on either side of it was almost 2°C. On a second but more detailed section along the central grid portion of C-line the feature had widened to ~12 km expression above the thermocline from its ~ 6km width the first time. The feature was ~9km wide on A-line, and while its full width on the E-line was not well defined by the station spacing, the inshore half appears to be over 12 km wide. By August 15, the feature had a more complex structure with two wider humps, and the total width of the involved area was 25-30km. The temporal development of this feature could demonstrate the process by which overlapping tidal and wind mixing work to create waters of uniform temperature and salinity just inshore of the front. More likely, it could illustrate upwelling processes taking place in conjunction with surface wind mixing. Evidence for upwelling is the bowing upward of colder waters from below the thermocline.

Another phenomenon observed on the outer portions of these lines was the presence of warmer, higher salinity water (>33.9psu) lapping up over the cold potions of the cold pool (< 31.8psu) into the area just behind the inner front. This pattern was observed for several stations on both the A and C-lines. The evidence for this will become clearer after the salinity data have been de-spiked in processing.

The last run through the NIC line was extended to St. Paul Island. This section showed that the cool pool (T< 4°C) was approximately 150km wide. However, the cold pool (<2 °C) was separated into two sections, the western of which contained two separate areas of water <1 °C. This much variability in cold pool temperatures has not been reported previously.

Pribilof Islands:

Two lines of four CTD stations each were occupied due east and due west from St. Paul Island, as well as another running between St. Paul and St. George

Island to the southeast. The cold pool, the two-layered structure of the middle domain, and the inner front were all well-defined on the eastern side, while on the western side, the waters sampled were continuously stratified, typical of oceanic structure, away from the nearshore mixed zone. The line between the islands showed a frontal structure on the St. Paul end, and otherwise was continuously stratified with higher salinity, colder water at the bottom on the south side.

Pribilof Canyon:

Large numbers of birds were encountered as we crossed the center of the Pribilof Canyon, so a small CTD survey was done first back to the northeastern rim and then south across the width of the south lobe. Fluorescence was highest in the center of the canyon where isopycnals were bowed upwards, indicating a clockwise eddy within the canyon. On the north side an upwelling of colder water from the canyon onto the northeastern shelf region is also indicated.

NUTRIENTS, PIGMENTS and N-15 EXPERIMENTS: Dean Stockwell, T. Rho, and Heloise Chenelot

Nutrient samples were analyzed for nitrate, silicate, phosphate, nitrite and ammonium concentrations using an Alpkem model 300 segmented flow analyzer. Samples were collected on each grid at a total of 1300 depths. A cursory analysis of the plotted transects of nutrients are given below.

Slime Bank:

The C-line transect was somewhat stratified by temperature offshore and lower salinity inshore. As a result there was a relatively strong vertical gradient of nitrate, silicate and ammonium. The surface layer was depleted of nitrate across the entire transect while silicate and phosphate were only depleted inshore in the relatively low salinity waters of unknown source. Fluorescence indicates that most of the chlorophyll resides in the upper 10 m across the entire transect.

Port Moller:

The C-line transect had stronger vertical temperature and horizontal salinity gradients compared to Slime Bank. The warmer surface temperatures and inshore low salinity waters produced about three times as strong of density gradient. The resulting nutrient concentrations were very low for nitrate and silicate throughout the entire water column while chlorophyll fluorescence was high. The productivity depleted the water column of nutrients and the lack of bottom water exchange combined with the relatively large influx of low salinity water probably prevents nutrient renewal.

Cape Newenham:

The C-line transect presents the classic picture of the stratified middle shelf and unstratified inner shelf separated by the inner front at approximately the 50 m isobath. The nitrate, silicate and phosphate were depleted in the euphotic zone of the middle shelf and was depleted to the bottom in the inner shelf. The bottom layer of the middle shelf contains high concentrations of all nutrients. Ammonium concentrations were relatively large over the entire transect but were twice as large in the middle shelf bottom water. The fluorescence distributions indicate that significant chlorophyll biomass accumulated across the shelf but there were maxima observed at the surface on both sides of the inner front.

Nunivak Island:

The C-line displayed the classic picture of the stratified middle shelf and unstratified inner shelf waters. The inner frontal region is clearly delineated by temperature and density distributions. The nitrate, silicate and phosphate were depleted in the upper 20 m of the middle shelf while ammonium was present to about 2 μmole/l. The inner shelf was completed exhausted of nitrate while silicate was depleted to the bottom for about 20-30 km inshore of the inner front. The inner 100 km of shelf contained low but significant concentrations of ammonium, silicate and phosphate. The most interesting aspect of the transect occurs at the boundary of the stratified-unstratified water column. The vertical mixing on the inside edge of the inner front distributed 4 μmole/l nitrate, 6 μmole/l silicate, 0.6 μmole/l phosphate and 9 μmole/l ammonium over the entire water column. This enrichment produced approximately a doubling of chlorophyll on the middle shelf side of the front. This process is analogous to the erosion of the pycnocline by summer storms which have been described to maintain the summer phytoplankton populations over the middle shelf.

North St. Paul:

The transect crossed two lobes of the cold pool as evidenced by the low temperatures. The nutrient concentrations in surface were depleted in the upper 10-15 m and concentrations in the bottom waters were very high. The highest nutrients in bottom waters did not correlate with the distribution of physical variables so biological remineralization is a probable source of the high nutrient concentrations.

East St. Paul:

The transect contained some aspects of upwelling over the inner 20 km of the transect as shown by temperature, salinity and density. Likewise, small amounts of upwelling were observed in the nitrate, ammonium and phosphate distributions. Unfortunately, fluorescence data are not available to ascertain the chlorophyll distributions.

West St. Paul:

The transect had relatively large concentrations of all nutrients near the bottom. This transect has contained large concentrations in the past which were attributed to onshore transport near the bottom. The surface water was depleted of nitrate over most of the transect while the other nutrients were present in sufficient quantities to support active phytoplankton growth.

Whale Grid:

The C-line transect was positioned mostly over the stratified middle shelf and crossed two lobes of the relict cold pool. The nitrate, silicate and phosphate distributions show quite clearly the boundary of stratified waters where depleted waters reach the bottom.

N-15 Experiments:

Nutrient uptake studies using N-15 and C-13 isotopes were undertaken on each study grid at 16 productivity stations for a total of 280 samples. The samples were dried and prepared for analysis at the UAF mass spectrometry laboratory.

Nutrient Amendment Studies:

Seven nutrient amendment studies were completed to assess potential nutrient limitation on chlorophyll production. A preliminary examination of the data indicates that both nitrate and ammonium stimulated growth while phosphate, silicate, trace metals and iron additions had no effect.

Plant Pigments:

Chlorophyll samples were collected at 560 depths on hydrography stations and 96 depths on productivity stations.

PRIMARY PRODUCTION: Steve Zeeman and Edward Rodowicz

Primary production versus light intensity (P-I) was measured at 21 stations and included 17 stations where *in situ* measurements were made. Deck incubations were made on water from 10-25 m in depth, for the purpose of determining the P-I relationships. *In situ* production was measured at 4 depths, generally 0, 10, 20 and 30 m.

Production was highest at Slime Bank where maximum *in situ* measurements were about 2 mg C m^{-3} h^{-1} and at St. Paul Island which was about 1.3 mg C m^{-3} h^{-1}. The values at Nunivak Island were also fairly high at about 1 mg C m^{-3} h^{-1}. At the other two grids maximum values were in the range of 0.3-0.5 mg C m^{-3} h^{-1}. The P-I curves showed relatively low maximum production per unit chlorophyll, the highest being around 0.7 mg C mg^{-1} Chl^{-1} h^{-}

^{1} at SBE04. The others were lower, ranging from about 0.07 to 0.3 mg C mg^{-1} Chl^{-1} h^{-1}.

On each grid and transects to St. Paul, St. George and off St. George we collected a suite of samples for chlorophyll extraction, Lugol's preserved samples, dried filter preserved samples, and CDOM. These were taken at four depths: 0, 10, 20, and 30 m.

Chlorophyll extractions averaged 2.22 mg Chl m^{-3}, with a standard deviation of 1.7 mg Chl m^{-3}, a maximum of 8.66 mg Chl m^{-3} and a minimum of 0.03 mg Chl m^{-3}. The highest concentrations were at Nunivak Island, in the midst of the coccolithophore bloom. The bloom itself was present throughout most of the Cape Newenham grid and all of the Nunivak Island grid. High values (between 4 and 5 mg Chl m^{-3}) were also found Slime Bank and Cape Newenham.

The spectroradiometer (TSRB) deployments showed clear and distinct signatures for waters that were dominated by coccolithophorids and those that were not. The peak was shifted from the blue toward the red end of the spectrum in the coccolithophorid bloom.

Preserved samples will be counted when back at the laboratory in Maine.

1049 ^{14}C samples processed.
In situ production measured at 4 depths at each of 17 stations.
P-I measurements made at 21 stations.
281 chlorophyll samples extracted
192 CDOM samples collected
281 Lugol's preserved phytoplankton samples
281 Dry filter preserved phytoplankton samples
6 sets of radiance and irradiance measurements made with the Satlantic TSRB

ZOOPLANKTON: Kenneth O Coyle and Alexei Pinchuk

The initial goal of the Inner Front project was to document the effects of physical oceanographic processes on ecological conditions at the Inner Front in the southeastern Bering Sea. We sought to test the hypothesis that physical conditions at the inner front result in elevated phytoplankton production during summer and the additional production is transferred through the food web to apex predators. Short-tailed shearwaters served as the apex predator for this study. Since shearwaters feed primarily on euphausiids, the major goal of the zooplankton component was to document the abundance and distribution of the euphausiid prey relative to the front.

During years 1 and 2 of this study, unusual climatic conditions resulted in substantial disruption of physical structure at the Inner Front. In 1997, nutrient concentrations were unusually low, a dense coccolithophorid bloom was observed in the fall and a massive die off of shearwaters occurred. The coccolithophorid bloom persisted in 1998 and shearwater condition remained low. Comparison of zooplankton data from the Inner Front sampling grids with PROBES data from 1980 indicated that euphausiid abundance had declined by 1-2 orders of magnitude and copepod abundance was elevated by roughly the same amount during 1997 and 1998. The above anomalies are thought to be related to a climate-driven regime shift underway in the Bering Sea.

The major goal of the zooplankton component in 1999 was to determine the abundance and distribution of major zooplankton species on the inner shelf of the southeastern Bering Sea relative to anomalous conditions associated with the hypothesized regime shift. Since zooplankton are a major component of the pelagic food web, information on their distribution and abundance is central to understanding the mechanisms by which the climatic and physical oceanographic conditions impact fisheries and wildlife resources during the regime shift.

Although interpretation of the zooplankton data relative to climatic conditions is a major goal of the zooplankton component, information on zooplankton distribution and abundance relative to the position of the inner front was also sought. The inner front was well developed at Port Moller, Cape Newenham Nunivak Island during the July-August cruise. We therefore collected samples in the stratified, unstratified and frontal regions to document any consistent patterns of zooplankton distribution and abundance relative to the frontal regions.

In addition to the Inner Front zooplankton collections, information on zooplankton abundance and distribution in regions of whale foraging was sought. Unusually high densities of foraging whales have recently been reported in the Bristol Bay region and information on the density, horizontal and vertical distribution of potential whale forage may aid in interpreting the ecological reasons for the shift in the distribution of foraging whales. The specific techniques for sample collection are outlined below. The sampling effort for each region is summarized in the tables that follow.

Large zooplankton species were sampled with a 1-m MOCNESS equipped with 0.5 mm mesh nets. Samples were taken at night from 5 m above the bottom to the surface. Fifty MOCNESS tows were collected. Small zooplankton were sampled with a 25 cm CalVET with 0.15 mm mesh nets. Vertical tows from the bottom to the surface were taken with the CalVET at stations along the c line in the four sampling grids, in the whale grid and near the Pribilof Islands. Volume filtered was estimated with GO flowmeters. Seventy five

CalVET samples were collected. The samples were preserved in formalin and shipped to Fairbanks for processing. Two hundred samples of individual taxa were sorted from the MOCNESS tows, dried at 60 °C and returned to Fairbanks for stable isotope analysis. Acoustic data were collected in the sampling grids as summarized in the tables below. The data were collected using a Hydroacoustics Technology model 244 multifrequency echosounder. The system includes four transducers: 43 kHz 6° split beam, 120 kHz 6° split beam, 200 kHz 3° split beam and 420 kHz 6° single beam. The acoustic array was towed at 6 knts beside the vessel at about 2-3 m depth. Volume scattering was measured at the four frequencies in 15 second intervals and 1-m depth increments along the transects. The split beam transducers also record the target strength of discrete targets. In addition to transect data, acoustic data were collected concurrently with the MOCNESS tows. The MOCNESS data can therefore be used to scale the acoustic data.

Preliminary observations indicate that the zooplankton in the Whale Grid was dominated by *Calanus marshallae* stage V and pollock. Samples from the near-shore mixed regime at Cape Newenham and Nunivak Island were dominated by mysids, crangonid shrimp and sand lance. Samples from the frontal zones and stratified regions were dominated by *Thysanoessa raschii* and pollock. Samples from all other grids included fish (predominantly pollock with some sand lance) and euphausiids (predominantly *Thysanoessa raschii* adults and juveniles).

Acoustical transects taken during Alpha Helix cruise HX222

File Name	Transect	Date	Length
whale	Cape Newenham s whale line	22-July	115 km
Akutan	Akutan Pass	25-July	1.6 km
slmbe	Slime Bank e line	27-July	45 km
slmba	Slime Bank a line	28-July	45 km
slmbc	Slime Bank c line	29-July	40 km
pmle	Port Moller e line	31-July	50 km
pmlc	Port Moller c line	31-July	50 km
pmla	Port Moller a line	31-July	50 km
cpnmc	Cape Newenham c line	6-August	140 km
cpnmw	Cape Newenham c whale line	8-August	35 km
cpwn	Cape Newenham n whale line	8-August	35 km
cpnmcx	Cape Newenham cx line	10-August	73 km
nvkc	Nunivak Island c line	12-August	145 km
nvkcx	Nunivak Island cx line	13-August	70 km
stple	St. Paul Island east	16-August	55 km
stplw	St. Paul Island west	16-August	38 km
Akutan2	Akutan Pass	18-August	16 km

CalVET net samples taken during Alpha Helix cruise HX222

CalVET sample numbers	Region	Date
CalVET 1-4	Whale Grid c line	21-July
CalVET5-15	Slime Bank c line	27-July
CalVET16-26	Port Moller c line	1-August
CalVET17-48	Cape Newenham c line	5-6 August
CalVET49-63	Nunivak Island c line	11-12 August
CalVET64-67	St. Paul e line	16-August
CalVET68-71	St. Paul w line	16-17 August
CalVET72-75	St. Paul-St. George Line	17-August

MOCNESS samples taken during Alpha Helix cruise HX222

MOCNESS sample numbers	Region	Dates
MOCNESS 1 - 7	Whale grid	22-23 July
MOCNESS 8	Akutan Pass	25 July
MOCNESS 9-15	Slime Bank	27-29 July
MOCNESS 16-24	Port Moller	31 July – 2 August
MOCNESS 25-37	Cape Newenham	6-10 August
MOCNESS 38-50	Nunivak Island	12-15 August

MICRO ZOOPLANKTON GRAZING: M. Brady Olson

The purpose of our lab attending *Alpha Helix* cruise 222 was to establish phytoplankton growth rates and mortality due to microzooplankton grazing across 3 size classes of phytoplankton. In addition, we had specific interests in the ability of microzooplankton to graze on the coccolithophorid *Emeliania huxleyi*, which has shown spatial and temporal persistence in recent years. Grazing experiments were conducted at 18 different locations, 10 of which were associated with the coccolithophorid bloom. In addition to grazing experiments, water was collected at the same stations to analyze microplankton community composition, particulate DMSP, dissolved DMSP and DMSP lyase activity. *E. huxleyi* is known to produce DMSP, and we wished to test the hypothesis that it may serve as a grazing suppressant.

Calvet tows were done at the same locations as grazing experiments to determine macrozooplankton grazing rates and to identify what taxa of phytoplankton macrozooplankton are removing. HPLC analysis of gut pigments will help determine this.

Dilution Experiments were done at the following locations:

WC07, WN02, SBE10, SBE04, PMC11, PMC01, CNC07, CNC11, M2, CNCX02, CNC13, NICX8, NIC13, NIC04, NICX15, NP04, SPW04, SPG03

MARINE BIRDS: George Hunt, Lucy Vlietstra, Jaime Jahnke, Carolina Pickens

To determine the role of physical-biological coupling in the transfer of energy to upper trophic levels, we documented the distribution and abundance of foraging short-tailed shearwaters (*Puffinus tenuirostris*) and their diets within the inner portion of the southeastern Bering Sea shelf. The objectives of the ornithological portion of this study were:

1)-To determine the abundance and foraging patterns of short-tailed shearwaters relative to the structural inner front located within each of the study areas

2)-To determine the diet composition of foraging shearwaters relative to prey abundance and availability

3)-To collect information on stable isotope ratios and fatty acid composition relative to trophic structure and long-term diet trends of short-tailed shearwaters in the eastern Bering Sea.

Bird observations were made when the ship was underway at speeds of 5 knots or greater. All birds within a 300 m arc 90^{o} from the bow to the side with the best visibility were counted from the bridge and were recorded on a laptop computer for later analysis. Behaviors of all birds were recorded, with particular attention paid to whether shearwaters were feeding at the surface by hydroplaning or were diving deeply.

On this cruise we conducted 4,220 km of surveys during which we documented the distribution and behaviors of 106,573 marine birds. We collected a total of 71 birds for diet analyses, of which 61 were short-tailed shearwaters, 5 were northern fulmars, and 5 were fork-tailed storm-petrels. Samples of pectoralis muscle and liver were obtained from 51 shearwaters for stable isotope analyses, and samples of fat from 51 shearwaters were collected for fatty acid analyses of diets. Samples of several prey species were collected to supplement our library of prey for both stable isotope analyses and for fatty acid analyses.

In general, short-tailed shearwaters were scarce in our primary study areas. Shearwaters were largely absent from the grids and lines along the north side of the Alaska Peninsula, a pattern similar to that in the historical data for this region in mid to late summer. Low numbers were found foraging near the outer end and at the inner portion of the Slime Bank grid and in the inner portion of the Port Moller grid. At Slime Bank, the shearwaters were foraging at the outer end of the grid were in mixed-species flocks with fulmars and were taking juvenile gaddids. At Port Moller, the shearwaters were in mixed flocks with black-legged kittiwakes, fulmars, arctic terns and common murres and were taking primarily sandlance.

At both the Cape Newenham and at Nunivak Island grids, the coccolithophorid bloom covered much of each grid. Shearwaters and other species were generally scarce in bloom-covered waters. At Cape Newenham, most shearwaters and numerous murrelets and murres were concentrated just inshore of the bloom where a layer of acoustic biomass containing fish and euphausiids came to the surface. Of the 12 shearwaters collected in this region, 6 had no food in their proventriculus and the others had remains of juvenile fish. At Nunivak Island, we observed foraging shearwaters on only two instances; once inshore of the main grid where the one bird collected had two euphausiids in its proventriculus, and once near the outer end of the A-line where 11 of 12 birds collected from two flocks had juvenile fish, most likely gaddids.

CTD Lines Occupied During July-August, 1999

Line Name	Station IDs	Station Nos.	Comment
Whale Grid			
WC	WC7-1, 0(CNC10)	3, 5-11	
WN	WN1- 10	14-23	Fin whales at WN4
Aleutian Passes and Bird Study			
AP	AP1-5	26-30	Birds in shear zone near Akutan Pass
AP1 or (BC)	AP11-16	31-36	Akutan Pass to axis of Bering Canyon "late flood"
AP2	AP11-13	37-39	Akutan Pass to Bering Sea slope "early flood"
UP	UP1-6	40-45	Along sill at north end of Unimak Pass
AP3	AP20-31	311-322	From Bering Sea to Pacific side against flood tide
AP4	AP31-28, AP26-19	324-335	From Pacific side to Bering Sea against ebb tide
APTS	AP23.5	336-349	Time series at one station near fluorescence max
Slime Bank Grid			
SBE	SBE10, 08, 06, 04, 03, 02, 01	49-56	Before Storm
SBC	SBC1- 11	57-67	
SBA	SBA10, 08, 06, 05, 04, 02	68-73	
SBE	SBE02-06, 08	81-86	After a storm
Nelson Lagoon			
NLB	NLB01-05	87-92	
Port Moller			
PME	PME12-01	97-108	
PMC	PMC01-11	112-122	
PMA	PMA11, 10, 08, 06, 05, 04, 02	123-129	
MAJOR STORM			
Cape Newenham Grid			
CNC(1)	CNCX17-X10, X8, X5, X3, X1, CNC01, 02, 04, 06-10, 12-16, M2	133-144, 146-157	
CNC(2)	CNCX1, CNC01, 02, 04, 06, 07, 08 (break) CNC08, 10-16, M2, WC5.5	163-169, 174-181, 183-184	
CNC-X line	CNCX11-X14	192-194, 196	Zeeman's Inshore "Green Zone"
NT	NT2-5	197-200	"Newenham inshore trough"

CTD Lines Occupied During July-August, 1999 (continued)

Line Name	Station IDs	Station Nos.	Comment
Nunivak Is. Grid			
NIC(1)	NICX15, X13, X11, X8, X4, NIC01, 03, 05-09, 11, 13-16	201, 210, 212-215, 217, 219	
NIC-X line	NICX17, X16, X15	224-226	
NIC(2)	NIC02, 2.5, 03, 3.5, 04, 4.5, 05-08	230-239	Extra detail of Inner Front structure
NIA	NIA2-8 (break), NIA08,09, 11, 13	240-246, (break) 248-250, 252-253	Break for foraging birds
NIE	NIE13, 11, 9, 07-02	254-261	
NIC(3)	NICX8, X5X, X2, NIC01-08, (break) 10, 11, 13, 14, 16	262-272, 277-281	This continues to St. Paul as the NP line.
NP	NP1-6	282, 284-288	From end of Nunivak NIC line to St. Paul Is.
Pribilof Islands			
SPE	SPE4-1	290-293	East of St.Paul Is.
SPW	SPW4-1	294-297	West of St. Paul Is.
SPG	SPG1-4	298-301	From St. Paul Is. to St George Is.
Pribilof Canyon			
PC1	PC1-4	302, 304-306	South lobe of Pribilof canyon, from mid-point to north rim
PC2	PC4-PC8	306-310	N-S line across south lobe of Pribilof Canyon

Table of all CTD casts

CTD Sta.	Station Name	Date(GMT)	Time(GMT)	Date(ADT)	Time(ADT)	lat(°N)	long(°W)	depth	Comment
1	RES2.5	7/18/99	19:19:21	7/18/99	11:19:21	60.0251	149.3563	295	
2	GA2K1	7/18/99	20:45:38	7/18/99	12:45:38	59.8453	149.466	270	
3	WC7	7/22/99	1:35:25	7/21/99	17:35:25	56.3453	164.5666	89	
4	WC7	7/22/99	1:58:37	7/21/99	17:58:37	56.3466	164.5628	89	Brady's micro-zooplankton
5	WC6	7/22/99	3:14:59	7/21/99	19:14:59	56.4986	164.4118	81	
6	WC5	7/22/99	4:31:27	7/21/99	20:31:27	56.652	164.2465	75	
7	WC4	7/22/99	5:55:41	7/21/99	21:55:41	56.8051	164.0806	73	
8	WC3	7/22/99	7:07:58	7/21/99	23:07:58	56.9549	163.9169	70	
9	WC2	7/22/99	9:48:52	7/22/99	1:48:52	57.1111	163.7502	67	
10	WC1	7/22/99	11:01:57	7/22/99	3:01:57	57.2658	163.5848	62	
11	WC0-	7/22/99	11:52:31	7/22/99	3:52:31	57.3441	163.5005	55	
12	CNC17	7/23/99	12:17:36	7/23/99	4:17:36	56.8092	163.9931	74	
13	WN1	7/23/99	15:48:30	7/23/99	7:48:30	57.364	163.9722	61	
14	WN2	7/23/99	17:08:26	7/23/99	9:08:26	57.2196	164.1427	67	
15	WN2	7/23/99	17:31:00	7/23/99	9:31:00	57.2204	164.1417	67	Brady's micro-zooplankton
16	WN3	7/23/99	18:46:17	7/23/99	10:46:17	57.0756	164.3148	69	
17	WN4	7/23/99	20:31:29	7/23/99	12:31:29	56.9322	164.486	71	
18	WN5	7/24/99	1:14:12	7/23/99	17:14:12	56.7892	164.655	76	
19	WN6	7/24/99	3:05:26	7/23/99	19:05:26	56.644	164.8265	77	
20	WN7	7/24/99	4:25:31	7/23/99	20:25:31	56.4995	164.9977	81	
21	WN8	7/24/99	6:18:21	7/23/99	22:18:21	56.3563	165.1704	87	
22	WN9	7/24/99	7:34:40	7/23/99	23:34:40	56.2116	165.3403	94	
23	WN10	7/24/99	8:58:54	7/24/99	0:58:54	56.0683	165.5092	98	
24	DUTCH	7/24/99	23:29:43	7/24/99	15:29:43	53.9822	166.4768	114	CTD test
25	DUTCH	7/24/99	23:49:34	7/24/99	15:49:34	53.9786	166.4783	111	CTD test
26	AP1	7/25/99	23:18:32	7/25/99	15:18:32	54.0868	166.3648	90	
27	AP2	7/25/99	23:35:02	7/25/99	15:35:02	54.0823	166.3678	90	
28	AP3	7/25/99	23:49:56	7/25/99	15:49:56	54.0771	166.3729	89	
29	AP4	7/26/99	0:05:50	7/25/99	16:05:50	54.0726	166.3769	86	
30	AP5	7/26/99	0:20:19	7/25/99	16:20:19	54.0693	166.3805	83	
31	AP11	7/26/99	4:43:40	7/25/99	20:43:40	54.0373	166.1513	80	medium sensitive cable for fluormeter now in use

Table of all CTD casts (continued)

32	AP12	7/26/99	5:21:37	7/25/99	21:21:37	54.1022	166.2125	84	
33	AP13	7/26/99	5:59:16	7/25/99	21:59:16	54.1669	166.2766	152	
34	AP14	7/26/99	6:44:03	7/25/99	22:44:03	54.2307	166.3397	768	
35	AP15	7/26/99	7:54:53	7/25/99	23:54:53	54.294	166.4029	1149	
36	AP16	7/26/99	9:13:06	7/26/99	1:13:06	54.3596	166.4679	660	
37	AP11	7/26/99	21:01:03	7/26/99	13:01:03	54.0385	166.151	79	
38	AP112	7/26/99	21:38:17	7/26/99	13:38:17	54.1025	166.2142	85	
39	AP13	7/26/99	22:14:07	7/26/99	14:14:07	54.1677	166.2762	153	
40	UP1	7/27/99	1:17:18	7/26/99	17:17:18	54.3753	165.5615	84	
41	UP2	7/27/99	2:08:52	7/26/99	18:08:52	54.4513	165.4663	100	
42	UP3	7/27/99	2:53:05	7/26/99	18:53:05	54.5263	165.3749	143	
43	UP4	7/27/99	3:37:23	7/26/99	19:37:23	54.6009	165.2829	86	
44	UP5	7/27/99	4:11:06	7/26/99	20:11:06	54.6009	165.1652	79	
45	UP6	7/27/99	4:45:56	7/26/99	20:45:56	54.602	165.0475	70	
46	SBE10	7/27/99	19:47:35	7/27/99	11:47:35	55.4165	164.3269	100	Zeeman's Prod Cast
47	SBE10	7/27/99	20:14:39	7/27/99	12:14:39	55.4155	164.329	100	Rho's Prod Cast
48	SBE10	7/27/99	20:50:33	7/27/99	12:50:33	55.4166	164.331	100	Brady's micro-zooplankton
49	SBE10	7/27/99	21:50:00	7/27/99	13:50:00	55.417	164.3289	100	Dean's cast
50	SBE08	7/27/99	22:38:28	7/27/99	14:38:28	55.3361	164.2609	97	
51	SBE06	7/27/99	23:43:14	7/27/99	15:43:14	55.255	164.1929	75	
52	SBE05	7/28/99	0:12:39	7/27/99	16:12:39	55.2138	164.1593	63	
53	SBE04	7/28/99	0:41:01	7/27/99	16:41:01	55.1738	164.1256	64	
54	SBE03	7/28/99	1:08:33	7/27/99	17:08:33	55.1331	164.0915	45	
55	SBE02	7/28/99	1:34:53	7/27/99	17:34:53	55.0923	164.0582	42	
56	SBE01	7/28/99	2:00:07	7/27/99	18:00:07	55.0515	164.0259	30	
57	SBC01	7/28/99	2:41:14	7/27/99	18:41:14	55.0983	163.8542	29	
58	SBC02	7/28/99	3:07:55	7/27/99	19:07:55	55.1374	163.8899	33	
59	SBC03	7/28/99	3:36:01	7/27/99	19:36:01	55.1786	163.9228	45	
60	SBC04	7/28/99	4:04:13	7/27/99	20:04:13	55.2191	163.9567	54	Brady's micro-zooplankton
61	SBC05	7/28/99	4:35:33	7/27/99	20:35:33	55.2597	163.9875	59	
62	SBC06	7/28/99	5:07:05	7/27/99	21:07:05	55.3008	164.024	77	
63	SBC07	7/28/99	5:40:54	7/27/99	21:40:54	55.3418	164.0555	85	
64	SBC08	7/28/99	6:14:46	7/27/99	22:14:46	55.3821	164.0899	95	
65	SBC09	7/28/99	6:47:59	7/27/99	22:47:59	55.4229	164.1217	97	
66	SBC10	7/28/99	7:22:10	7/27/99	23:22:10	55.464	164.1553	99	
67	SBC11	7/28/99	7:56:45	7/27/99	23:56:45	55.5019	164.1908	99	

Table of all CTD casts (continued)

68	SBA10	7/28/99	8:59:35	7/28/99	0:59:35	55.5095	163.9858	93	
69	SBA08	7/28/99	9:46:56	7/28/99	1:46:56	55.4272	163.9176	90	
70	SBA06	7/28/99	10:31:09	7/28/99	2:31:09	55.3461	163.851	72	
71	SBA05	7/28/99	10:58:34	7/28/99	2:58:34	55.3052	163.8174	65	
72	SBA04	7/28/99	11:24:38	7/28/99	3:24:38	55.2648	163.7838	58	
73	SBA02	7/28/99	12:08:25	7/28/99	4:08:25	55.1758	163.7172	44	
74	SBA01	7/28/99	22:51:30	7/28/99	14:51:30	55.1431	163.6883	41	Zeeman's Prod Cast
75	SBA01	7/28/99	23:24:04	7/28/99	15:24:04	55.142	163.6837	40	Rho's Prod cast
76	SBC05	7/29/99	21:01:26	7/29/99	13:01:26	55.2586	163.9912	58	Prod cast
77	SBC05	7/29/99	21:35:27	7/29/99	13:35:27	55.2582	163.9926	58	Rho's Prod
78	SBC05	7/29/99	22:07:04	7/29/99	14:07:04	55.2587	163.9899	58	Dean's cast
79	SBE04	7/29/99	23:43:47	7/29/99	15:43:47	55.1723	164.1245	53	Brady's micro-zooplankton
80	SBE04	7/30/99	0:21:45	7/29/99	16:21:45	55.1735	164.1251	53	Zeeman's Prod Cast
81	SBE02	7/30/99	2:36:52	7/29/99	18:36:52	55.0927	164.0569	42	
82	SBE03	7/30/99	3:03:18	7/29/99	19:03:18	55.1331	164.0916	44	
83	SBE04	7/30/99	3:31:09	7/29/99	19:31:09	55.1736	164.1276	56	
84	SBE05	7/30/99	4:01:20	7/29/99	20:01:20	55.2143	164.1615	65	
85	SBE06	7/30/99	4:31:01	7/29/99	20:31:01	55.2564	164.1947	77	
86	SBE08	7/30/99	5:14:57	7/29/99	21:14:57	55.3366	164.2619	99	
87	NLB01	7/30/99	20:55:09	7/30/99	12:55:09	56.0789	161.017	24	
88	NLB02	7/30/99	21:28:16	7/30/99	13:28:16	56.142	161.1029	36	
89	NLB03	7/30/99	22:02:03	7/30/99	14:02:03	56.2052	161.1877	46	
90	NLB04	7/30/99	22:37:08	7/30/99	14:37:08	56	162	49	
91	NLB05	7/30/99	23:10:53	7/30/99	15:10:53	56.3317	161.3587	63	
92	NLB05	7/30/99	23:18:19	7/30/99	15:18:19	56.3337	161.361	63	
93	PMC11	7/31/99	20:29:57	7/31/99	12:29:57	56.8698	160.521	69	Zeeman's Prod Cast
94	PMC11	7/31/99	21:00:21	7/31/99	13:00:21	56.8692	160.5177	69	Rho's prod cast
95	PMC11	7/31/99	21:25:31	7/31/99	13:25:31	56.8691	160.5205	69	Brady's micro-zooplankton
96	PMC11	7/31/99	21:44:06	7/31/99	13:44:06	56.8687	160.5162	69	Dean's cast
97	PME12	8/1/99	15:08:15	8/1/99	7:08:15	56.8336	160.7221	69	
98	PME11	8/1/99	15:35:41	8/1/99	7:35:41	56.7998	160.6719	68	
99	PME10	8/1/99	16:01:58	8/1/99	8:01:58	56.7649	160.6161	70	
100	PME09	8/1/99	16:31:41	8/1/99	8:31:41	56.731	160.5647	69	
101	PME08	8/1/99	16:56:55	8/1/99	8:56:55	56.6959	160.5118	68	

Table of all CTD casts (continued)

102	PME07	8/1/99	17:21:28	8/1/99	9:21:28	56.6614	160.4599	63	
103	PME06	8/1/99	17:49:31	8/1/99	9:49:31	56.6283	160.4064	57	
104	PME05	8/1/99	18:19:26	8/1/99	10:19:26	56.5939	160.3533	52	
105	PME04	8/1/99	18:43:54	8/1/99	10:43:54	56.5591	160.3006	45	
106	PME03	8/1/99	19:07:08	8/1/99	11:07:08	56.525	160.2481	35	
107	PME02	8/1/99	19:30:38	8/1/99	11:30:38	56.4907	160.1952	26	
108	PME01	8/1/99	19:53:16	8/1/99	11:53:16	56.4561	160.1438	23	
109	PMC01	8/1/99	20:37:34	8/1/99	12:37:34	56.5248	159.9924	23	Brady's micro-zooplankton
110	PMC01	8/1/99	20:57:12	8/1/99	12:57:12	56.5245	159.9931	23	Zeeman's Prod Cast
111	PMC01	8/1/99	21:18:43	8/1/99	13:18:43	56.5251	159.9891	23	Rho's prod
112	PMC01	8/1/99	22:56:27	8/1/99	14:56:27	56.5256	159.9921	23	
113	PMC02	8/1/99	23:31:25	8/1/99	15:31:25	56.5597	160.0471	31	
114	PMC03	8/1/99	23:59:23	8/1/99	15:59:23	56.5931	160.0996	44	
115	PMC04	8/2/99	0:29:13	8/1/99	16:29:13	56.627	160.1526	48	
116	PMC05	8/2/99	0:58:20	8/1/99	16:58:20	56.6621	160.2055	50	
117	PMC06	8/2/99	1:26:58	8/1/99	17:26:58	56.6967	160.2581	61	
118	PMC07	8/2/99	1:56:55	8/1/99	17:56:55	56.7318	160.3111	60	
119	PMC08	8/2/99	2:28:11	8/1/99	18:28:11	56.7655	160.3642	62	
120	PMC09	8/2/99	2:59:14	8/1/99	18:59:14	56.7991	160.4167	68	
121	PMC10	8/2/99	3:41:06	8/1/99	19:41:06	56.8316	160.4708	62	
122	PMC11	8/2/99	4:13:05	8/1/99	20:13:05	56.8688	160.5218	67	
123	PMC11	8/2/99	4:32:02	8/1/99	20:32:02	56.8638	160.5289	67	
124	PMA10	8/2/99	5:29:11	8/1/99	21:29:11	56.9021	160.3179	65	
125	PMA08	8/2/99	6:13:00	8/1/99	22:13:00	56.8356	160.2107	58	
126	PMA06	8/2/99	6:56:13	8/1/99	22:56:13	56.7671	160.106	57	
127	PMA05	8/2/99	7:25:02	8/1/99	23:25:02	56.7327	160.0524	52	
128	PMA04	8/2/99	7:52:37	8/1/99	23:52:37	56.6988	159.9995	50	
129	PMA02	8/2/99	8:37:51	8/2/99	0:37:51	56.6304	159.8939	36	
130	PMC05	8/2/99	20:53:21	8/2/99	12:53:21	56.6629	160.2077	52	Zeeman's Prod Cast
131	PMC05	8/2/99	21:15:53	8/2/99	13:15:53	56.6635	160.201	52	Rho's prod cast
132	NT01	8/5/99	1:25:25	8/5/99	17:25:25	57.9868	161.3154	53	
133	CNCX17	8/5/99	15:34:36	8/5/99	7:34:36	58.6199	162.125	35	
134	CNCX16	8/5/99	16:31:26	8/5/99	8:31:26	58.5436	162.2079	44	
135	CNCX15	8/5/99	17:23:18	8/5/99	9:23:18	58.468	162.2902	47	
136	CNCX14	8/5/99	18:17:44	8/5/99	10:17:44	58.3913	162.3734	37	
137	CNCX13	8/5/99	19:33:46	8/5/99	11:33:46	58.3125	162.459	31	

Table of all CTD casts (continued)

138	CNCX12	8/5/99	20:27:51	8/5/99	12:27:51	58.2365	162.5412	36	
139	CNCX11	8/5/99	21:21:40	8/5/99	13:21:40	58.1588	162.6228	38	
140	CNCX10	8/5/99	22:16:51	8/5/99	14:16:51	58.0812	162.7058	37	
141	CNCX08	8/5/99	23:11:43	8/5/99	15:11:43	58.0035	162.7882	41	
142	CNCX05	8/6/99	0:18:41	8/5/99	16:18:41	57.8865	162.9127	45	
143	CNCX03	8/6/99	1:11:55	8/5/99	17:11:55	57.8102	162.9974	45	
144	CNCX01	8/6/99	2:03:23	8/5/99	18:03:23	57.7294	163.081	45	
145	CNC02	8/6/99	2:55:33	8/5/99	18:55:33	57.6493	163.1624	47	
146	CNC04	8/6/99	4:59:46	8/5/99	20:59:46	57.5747	163.2483	48	
147	CNC06	8/6/99	5:53:50	8/5/99	21:53:50	57.4979	163.3319	49	
148	CNC07	8/6/99	6:30:13	8/5/99	22:30:13	57.4578	163.3759	51	Brady's micro-zooplankton
149	CNC08	8/6/99	7:07:01	8/5/99	23:07:01	57.4202	163.4168	51	
150	CNC09	8/6/99	7:48:35	8/5/99	23:48:35	- 57.3801	163.4593	52	
151	CNC10	8/6/99	8:19:31	8/6/99	0:19:31	57.3437	163.4985	54	
152	CNC12	8/6/99	9:19:36	8/6/99	1:19:36	57.266	163.5817	62	
153	CNC13	8/6/99	10:18:43	8/6/99	2:18:43	57.1883	163.6638	65	
154	CNC14	8/6/99	11:19:30	8/6/99	3:19:30	57.1108	163.7469	68	
155	CNC15	8/6/99	12:24:31	8/6/99	4:24:31	57.0332	163.829	69	
156	CNC16	8/6/99	13:27:03	8/6/99	5:27:03	56.9549	163.9138	70	
157	MOOR2	8/6/99	14:51:17	8/6/99	6:51:17	56.8133	164.0019	73	Zeeman's Deck Prod
158	MOOR2	8/6/99	15:16:17	8/6/99	7:16:17	56.8156	163.9983	73	Rho's Prod cast
159	CNC11	8/6/99	22:18:34	8/6/99	14:18:34	57.3045	163.5405	58	Zeeman's Prod Cast
160	CNC11	8/6/99	22:39:51	8/6/99	14:39:51	57.3045	163.5409	58	Rho's prod
161	CNC11	8/6/99	23:20:17	8/6/99	15:20:17	57.3029	163.5394	58	Brady's micro-zooplankton
162	CNC11	8/6/99	23:39:11	8/6/99	15:39:11	57.3025	163.5412	58	Dean Chla
163	CNCX01	8/7/99	15:11:42	8/7/99	7:11:42	57.7307	163.0792	46	
164	CNC01	8/7/99	15:36:10	8/7/99	7:36:10	57.6912	163.1223	46	
165	CNC02	8/7/99	16:00:39	8/7/99	8:00:39	57.6518	163.1647	47	
166	CNC04	8/7/99	16:39:46	8/7/99	8:39:46	57.5751	163.2476	48	
167	CNC06	8/7/99	17:17:53	8/7/99	9:17:53	57.4968	163.332	50	
168	CNC07	8/7/99	17:40:27	8/7/99	9:40:27	57.4577	163.3737	51	
169	CNC08	8/7/99	18:04:02	8/7/99	10:04:02	57.4184	163.4176	52	
170	CNC05	8/7/99	19:10:09	8/7/99	11:10:09	57.5353	163.2903	48	Zeeman's Prod Cast
171	CNC05	8/7/99	19:31:29	8/7/99	11:31:29	57.5343	163.2958	48	Rho's prod

Table of all CTD casts (continued)

172	CNCX02	8/7/99	22:36:33	8/7/99	14:36:33	57.7705	163.0409	45	Zeeman's Prod cast
173	CNCX02	8/7/99	23:03:55	8/7/99	15:03:55	57.7716	163.0407	45	Brady's micro-zooplankton
174	CNC08	8/8/99	2:56:34	8/7/99	18:56:34	57.4189	163.4122	52	
175	CNC10	8/8/99	3:39:27	8/7/99	19:39:27	57.3411	163.4981	55	
176	CNC11	8/8/99	4:06:51	8/7/99	20:06:51	57.3021	163.5395	58	
177	CNC12	8/8/99	4:33:13	8/7/99	20:33:13	57.2634	163.5812	62	
178	CNC13	8/8/99	5:15:53	8/7/99	21:15:53	57.1861	163.665	65	
179	CNC14	8/8/99	6:01:19	8/7/99	22:01:19	57.1084	163.7477	67	
180	CNC15	8/8/99	6:47:44	8/7/99	22:47:44	57.0302	163.8324	68	
181	CNC16	8/8/99	7:31:43	8/7/99	23:31:43	56.9533	163.9155	70	
182	CNC15	8/8/99	8:19:25	8/8/99	0:19:25	57.0319	163.8312	68	
183	MOOR2	8/8/99	10:34:00	8/8/99	2:34:00	56.8173	164.0002	73	
184	WC5.5	8/8/99	14:22:52	8/8/99	6:22:52	56.5727	164.3331	78	
185	MOOR2	8/8/99	18:41:24	8/8/99	10:41:24	56.8137	164.0057	73	Zeeman's Prod Cast
186	MOOR2	8/8/99	19:07:15	8/8/99	11:07:15	56.8144	164.0231	73	Rho's prod -lost
187	MOOR2	8/8/99	19:38:22	8/8/99	11:38:22	56.8154	164.0112	73	Brady's micro-zooplankton
188	MOOR2	8/8/99	19:53:16	8/8/99	11:53:16	56.8162	164.0212	73	Dean's cast
189	MOOR2	8/8/99	22:03:27	8/8/99	14:03:27	56.8145	164.0073	73	Zeeman's Prod Cast Re-done
190	WC4.5	8/9/99	0:29:58	8/8/99	16:29:58	56.7321	164.163	75	Possible prod
191	CNC13	8/9/99	9:09:31	8/9/99	1:09:31	57.1883	163.6673	65	Brady's micro-zooplankton
192	CNCX11	8/9/99	20:25:09	8/9/99	12:25:09	58.1583	162.6252	38	
193	CNCX12	8/9/99	21:13:07	8/9/99	13:13:07	58.2358	162.5448	35	
194	CNCX13	8/9/99	22:08:23	8/9/99	14:08:23	58.3136	162.4641	30	Zeeman's Prod Cast
195	CNCX13	8/9/99	23:35:47	8/9/99	15:35:47	58.3143	162.4596	30	nutrients
196	CNCX14	8/10/99	0:47:24	8/9/99	16:47:24	58.3908	162.3761	36	
197	NT2	8/10/99	3:34:23	8/9/99	19:34:23	58.077	161.8384	54	
198	NT3	8/10/99	4:58:02	8/9/99	20:58:02	58.2509	161.9863	46	
199	NT4	8/10/99	6:21:10	8/9/99	22:21:10	58.4026	162.1378	45	
200	NT5	8/10/99	7:44:44	8/9/99	23:44:44	58.5663	162.2702	48	
201	NICX15	8/11/99	15:19:43	8/11/99	7:19:43	59.64	167.2332	30	
202	NICX13	8/11/99	16:42:53	8/11/99	8:42:53	59.4846	167.4028	32	

Table of all CTD casts (continued)

203	NICX11	8/11/99	18:03:41	8/11/99	10:03:41	59.3286	167.5761	37	
204	NICX08	8/11/99	19:22:21	8/11/99	11:22:21	59.1726	167.7493	41	Brady's micro-zooplankton
205	NICX4	8/11/99	21:15:24	8/11/99	13:15:24	59.0175	167.9252	43	
206	NIC01	8/11/99	22:27:19	8/11/99	14:27:19	58.8613	168.0987	44	
207	NIC03	8/11/99	23:07:47	8/11/99	15:07:47	58.7844	168.1857	47	
208	NIC05	8/11/99	23:50:02	8/11/99	15:50:02	58.707	168.2713	49	
209	NIC06	8/12/99	0:18:44	8/11/99	16:18:44	58.6681	168.3147	52	
210	NIC07	8/12/99	0:44:14	8/11/99	16:44:14	58.6295	168.357	52	
211	NIC08	8/12/99	1:13:32	8/11/99	17:13:32	58.5906	168.3997	55	
212	NIC08	8/12/99	1:30:17	8/11/99	17:30:17	58.5912	168.402	55	repeated station
213	NIC09	8/12/99	1:57:50	8/11/99	17:57:50	58.5516	168.4453	58	
214	NIC11	8/12/99	2:46:41	8/11/99	18:46:41	58.4741	168.5305	63	
215	NIC13	8/12/99	3:53:29	8/11/99	19:53:29	58.3573	168.6591	67	
216	NIC13	8/12/99	4:15:31	8/11/99	20:15:31	58.3611	168.6533	67	Brady's micro-zooplankton
217	NIC14	8/12/99	4:57:37	8/11/99	20:57:37	58.279	168.7456	68	
218	NIC15	8/12/99	5:48:36	8/11/99	21:48:36	58.1986	168.8341	70	
219	NIC16	8/12/99	6:37:03	8/11/99	22:37:03	58.124	168.9175	71	
220	NIC04	8/12/99	22:36:23	8/12/99	14:36:23	58.7449	168.2286	48	Zeeman's Prod Cast
221	NIC04	8/12/99	23:05:58	8/12/99	15:05:58	58.7455	168.2276	48	Rho's prod
222	NIC04	8/12/99	23:45:00	8/12/99	15:45:00	58.7449	168.2275	48	Brady's micro-zooplankton
223	NIC04	8/13/99	0:01:56	8/12/99	16:01:56	58.7458	168.2283	48	Dean's cast
224	NICX17	8/13/99	15:21:43	8/13/99	7:21:43	59.7964	167.0594	11	
225	NICX16	8/13/99	16:06:49	8/13/99	8:06:49	59.7189	167.1429	32	
226	NICX15	8/13/99	16:49:12	8/13/99	8:49:12	59.6398	167.2303	31	Zeeman'xDeck prod
227	NICX15	8/13/99	17:05:42	8/13/99	9:05:42	59.6399	167.23	31	Brady's micro-zooplankton
228	NICX08	8/13/99	23:04:21	8/13/99	15:04:21	59.1731	167.7501	41	Zeeman's Prod Cast
229	NICX08	8/13/99	23:23:50	8/13/99	15:23:50	59.1727	167.7503	41	Rho's prod
230	NIC2	8/14/99	4:19:27	8/13/99	20:19:27	58.8239	168.1377	45	
231	NIC2.5	8/14/99	4:38:22	8/13/99	20:38:22	58.807	168.1574	46	
232	NIC3	8/14/99	4:57:30	8/13/99	20:57:30	58.7846	168.1816	46	
233	NIC3.5	8/14/99	5:13:58	8/13/99	21:13:58	58.7659	168.2047	47	
234	NIC4	8/14/99	5:34:21	8/13/99	21:34:21	58.7452	168.2248	48	

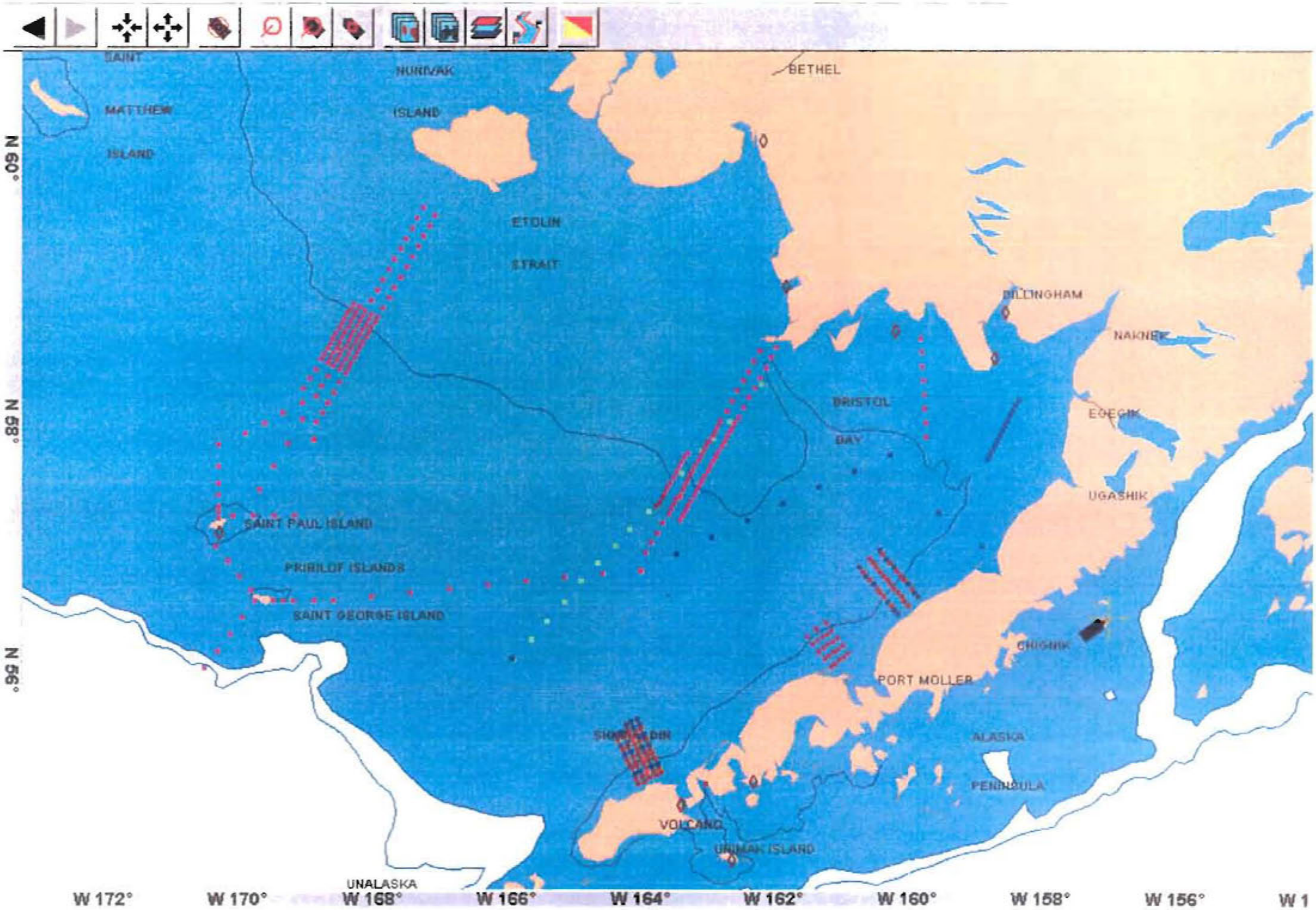
Table of all CTD casts (continued)

235	NIC4.5	8/14/99	5:54:45	8/13/99	21:54:45	58.7256	168.2488	48	
236	NIC5	8/14/99	6:14:23	8/13/99	22:14:23	58.7064	168.2672	50	
237	NIC6	8/14/99	6:40:18	8/13/99	22:40:18	58.6677	168.3103	52	
238	NIC7	8/14/99	7:09:04	8/13/99	23:09:04	58.6287	168.3522	53	
239	NIC8	8/14/99	7:36:56	8/13/99	23:36:56	58.5898	168.3954	55	
240	NIA02	8/14/99	15:19:35	8/14/99	7:19:35	58.8777	168.32	46	
241	NIA03	8/14/99	15:45:31	8/14/99	7:45:31	58.8372	168.3625	47	
242	NIA04	8/14/99	16:09:20	8/14/99	8:09:20	58.7985	168.4065	49	
243	NIA05	8/14/99	16:34:09	8/14/99	8:34:09	58.7602	168.4491	49	
244	NIA06	8/14/99	17:00:12	8/14/99	9:00:12	58.7209	168.4908	52	
245	NIA07	8/14/99	17:27:36	8/14/99	9:27:36	58.6828	168.5336	55	
246	NIA08	8/14/99	17:55:26	8/14/99	9:55:26	58.6436	168.5778	56	
247	NIA5B	8/14/99	19:00:54	8/14/99	11:00:54	58.7322	168.4798	52	Thermal dip
248	NIA7B	8/14/99	20:25:45	8/14/99	12:25:45	58.654	168.5533	56	Bird's shot/ feeding here
249	NIA09	8/14/99	21:09:32	8/14/99	13:09:32	58.6034	168.6165	59	
250	NIA11	8/14/99	21:53:58	8/14/99	13:53:58	58.5258	168.7062	64	Zeeman's Prod Cast
251	NIA11	8/14/99	22:17:00	8/14/99	14:17:00	58.5269	168.7066	64	Rho's prod
252	NIA13	8/15/99	0:46:31	8/14/99	16:46:31	58.4094	168.836	66	
253	NIE14	8/15/99	2:20:39	8/14/99	18:20:39	58.224	168.5657	68	
254	NIE13	8/15/99	3:06:52	8/14/99	19:06:52	58.3036	168.4805	67	
255	NIE11	8/15/99	4:04:23	8/14/99	20:04:23	58.4204	168.3506	61	
256	NIE7	8/15/99	5:18:43	8/14/99	21:18:43	58.5765	168.1779	52	
257	NIE6	8/15/99	5:46:02	8/14/99	21:46:02	58.616	168.1339	51	
258	NIE5	8/15/99	6:11:11	8/14/99	22:11:11	58.6542	168.0909	50	
259	NIE4	8/15/99	6:36:34	8/14/99	22:36:34	58.6956	168.043	48	
260	NIE3	8/15/99	6:59:17	8/14/99	22:59:17	58.7321	168.0035	47	
261	NIE2	8/15/99	7:21:43	8/14/99	23:21:43	58.7704	167.961	45	
262	NICX8	8/15/99	12:48:27	8/15/99	4:48:27	59.1714	167.7502	40	
263	NICX5	8/15/99	13:40:40	8/15/99	5:40:40	59.0552	167.8798	41	
264	NICX2	8/15/99	14:51:56	8/15/99	6:51:56	58.9387	168.012	42	
265	NIC01	8/15/99	15:50:46	8/15/99	7:50:46	58.8613	168.0981	44	
266	NIC02	8/15/99	16:13:17	8/15/99	8:13:17	58.8223	168.1403	46	
267	NIC03	8/15/99	16:37:52	8/15/99	8:37:52	58.783	168.1865	47	
268	NIC04	8/15/99	16:59:55	8/15/99	8:59:55	58.7453	168.2276	48	
269	NIC05	8/15/99	17:24:43	8/15/99	9:24:43	58.7058	168.2699	50	
270	NIC06	8/15/99	17:50:02	8/15/99	9:50:02	58.6673	168.3136	52	
271	NIC07	8/15/99	18:16:01	8/15/99	10:16:01	58.6283	168.3551	53	

06/16/99 INStar - 15:40:03

Scale: 398.5NM 1:3428000 Chart: World UNDER

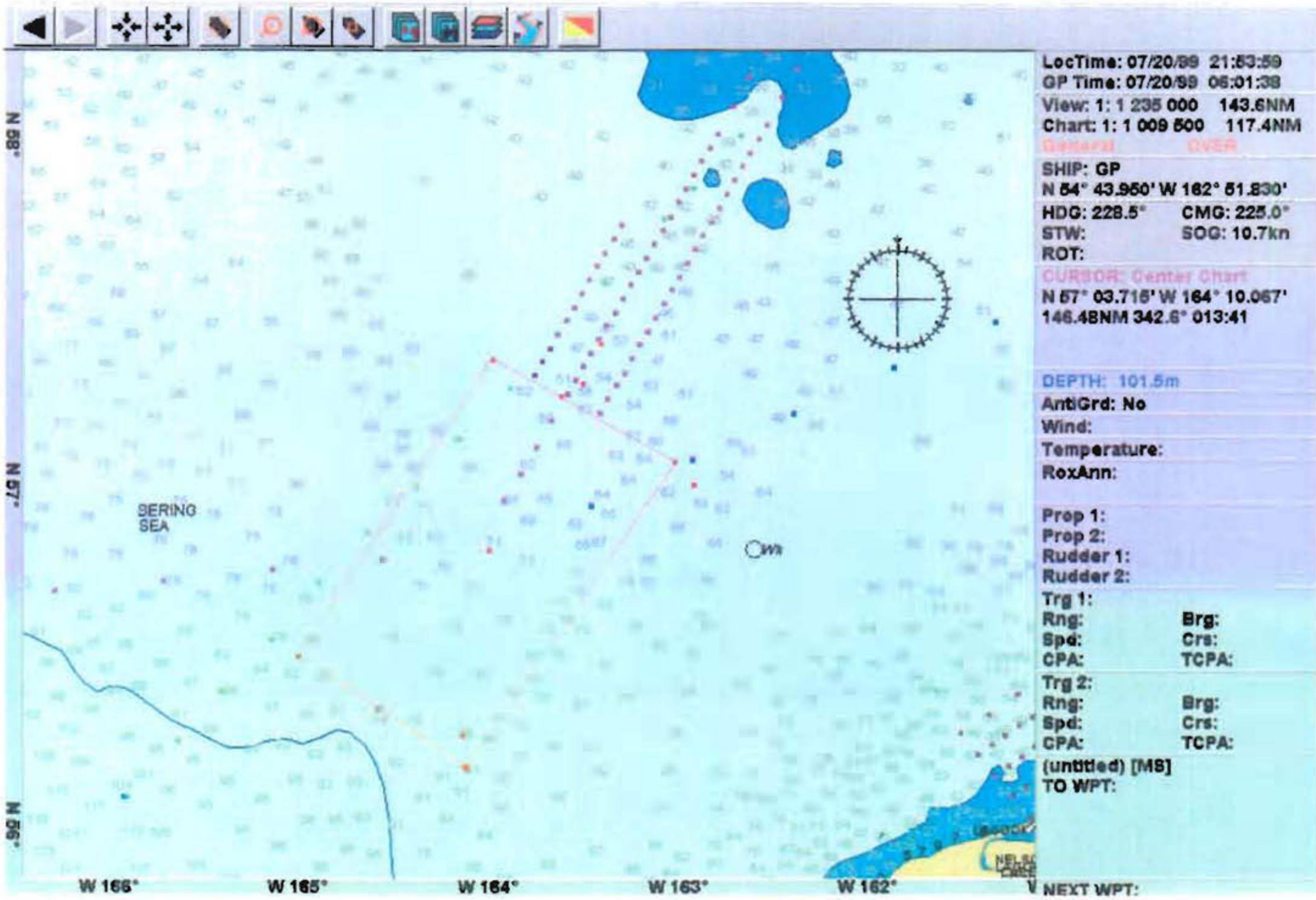
CAUTION: Chart Printouts should not be used as the primary navigational means.



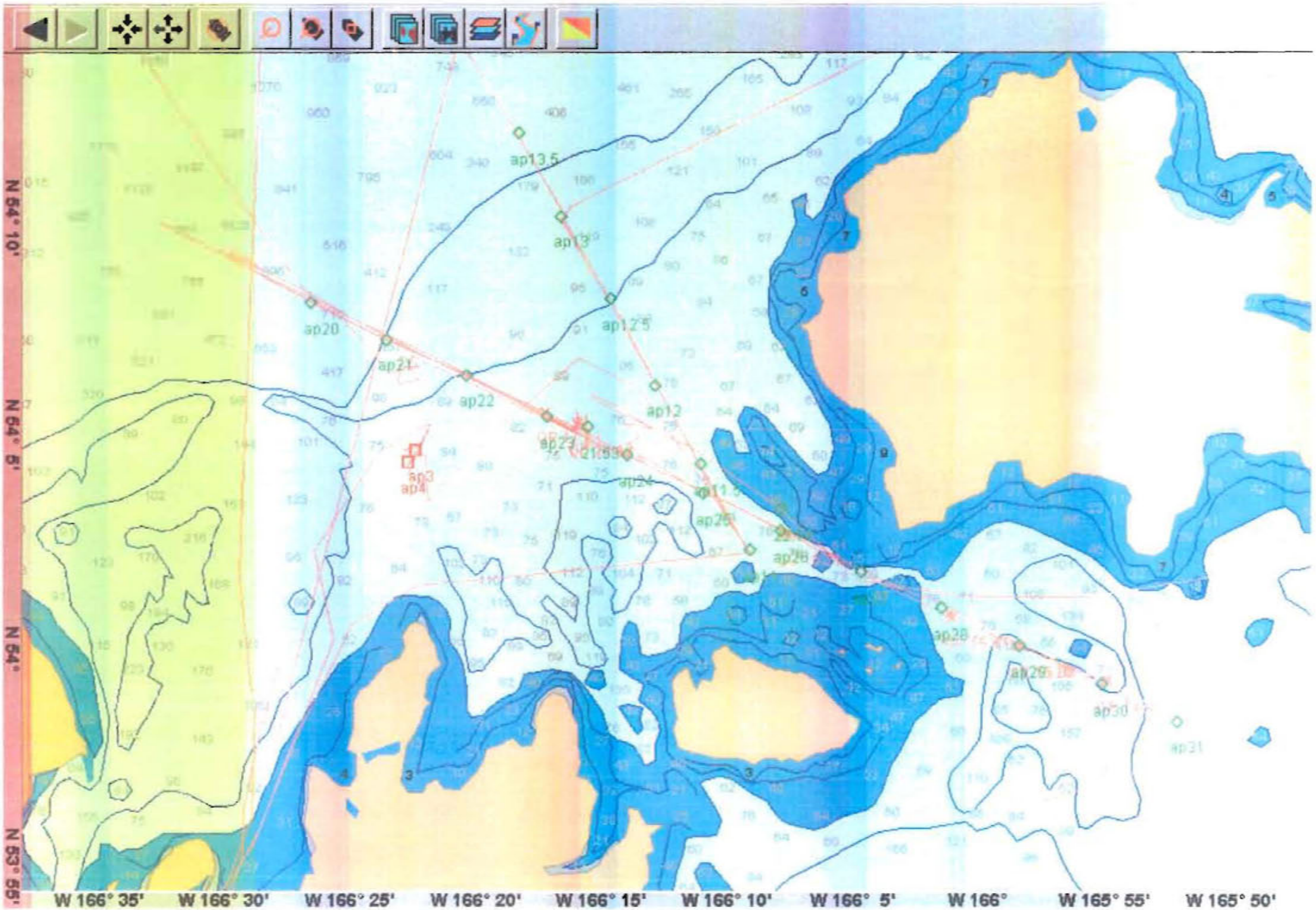
07/20/99 INStar - 21:53:59

Scale: 143.6NM 1:1235000 Chart: General OVER

CAUTION: Chart Printouts should not be used as the primary navigational means.



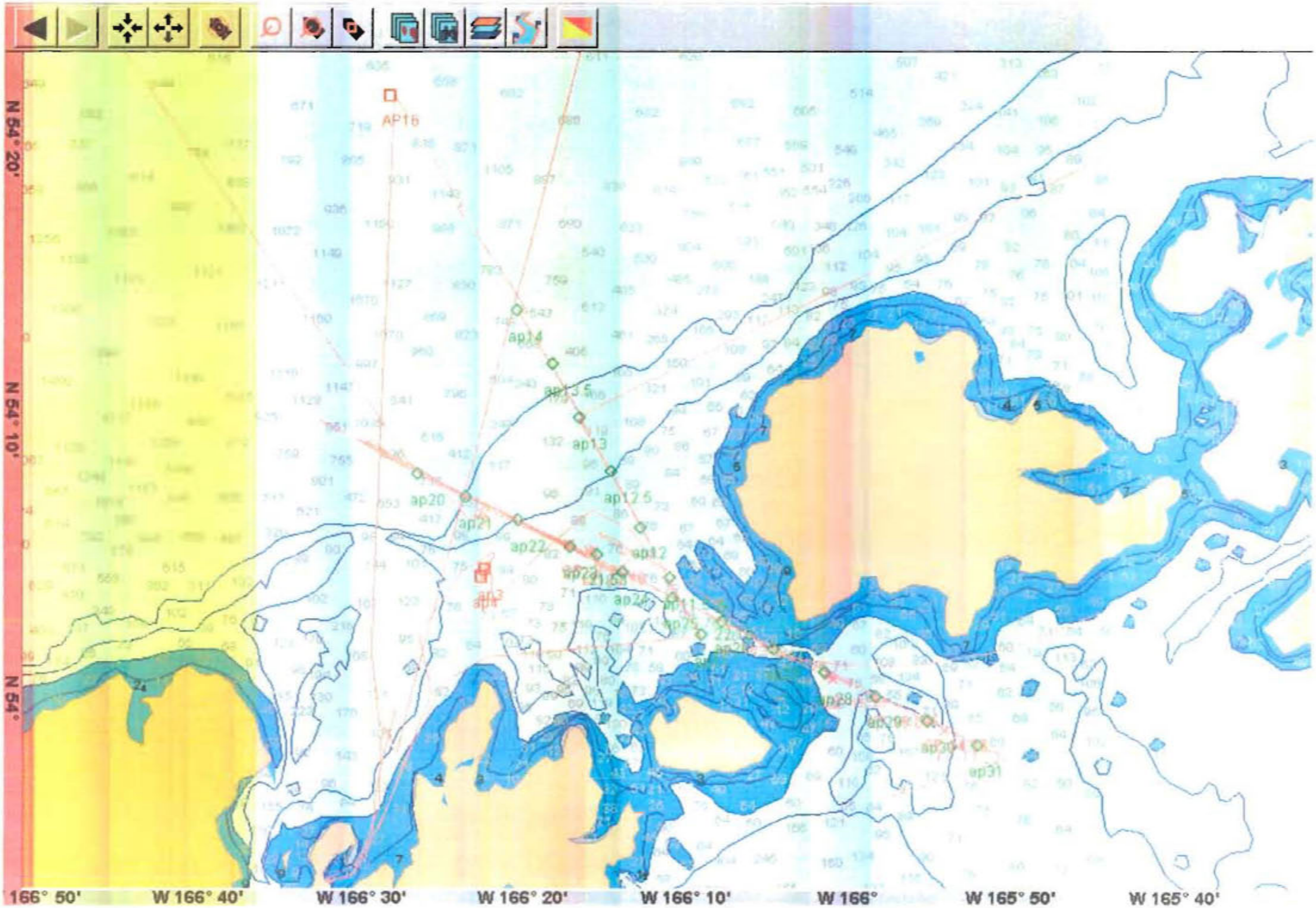
CAUTION: Chart Printouts should not be used as the primary navigational means.



08/21/99 INStar - 22:14:47

Scale: 29.9NM 1:257000 Chart: Coastal UNDER

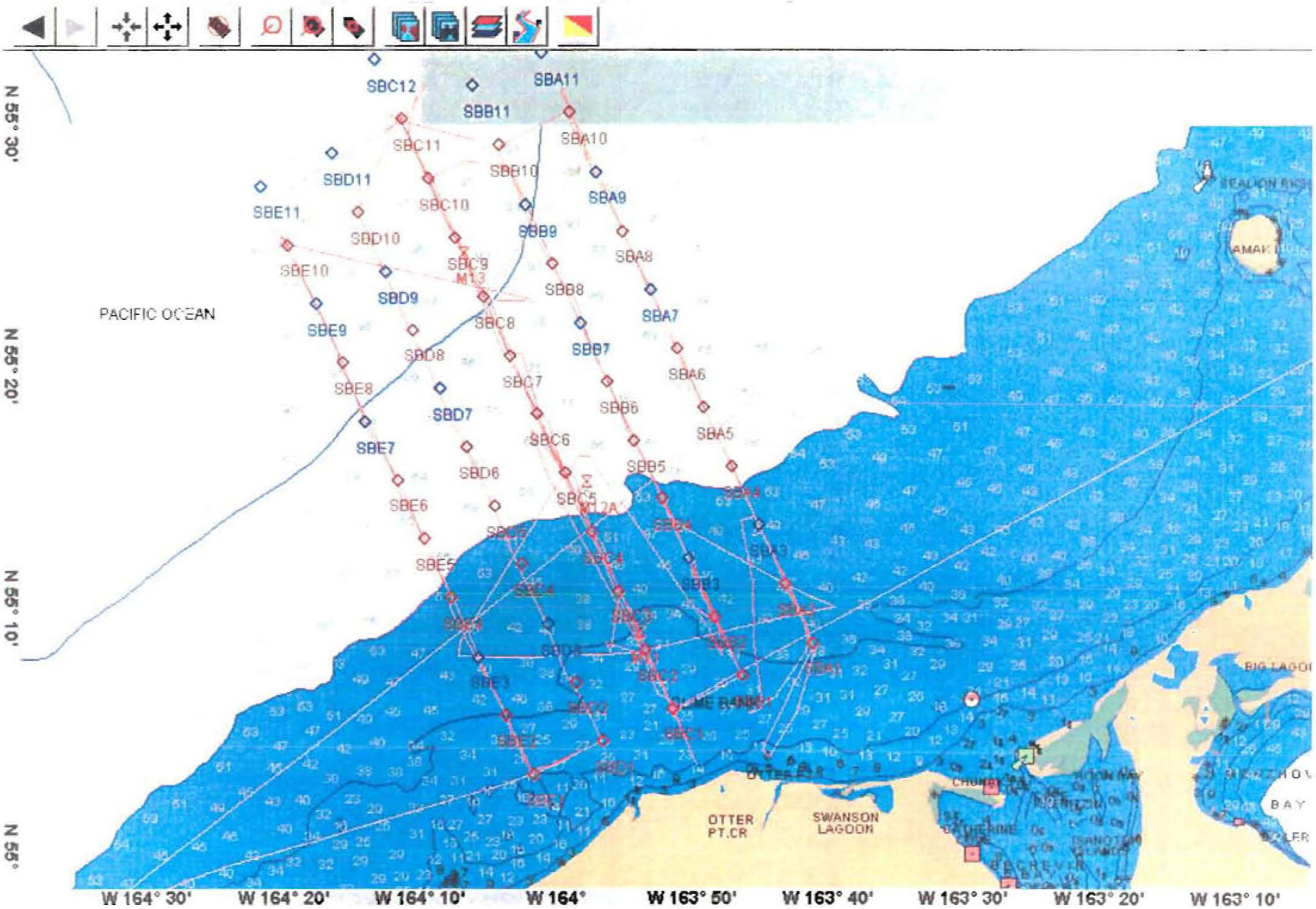
CAUTION: Chart Printouts should not be used as the primary navigational means.



06/16/99 INStar - 16:17:32

Scale: 34.8NM 1:299000 Chart: Coastal UNDER

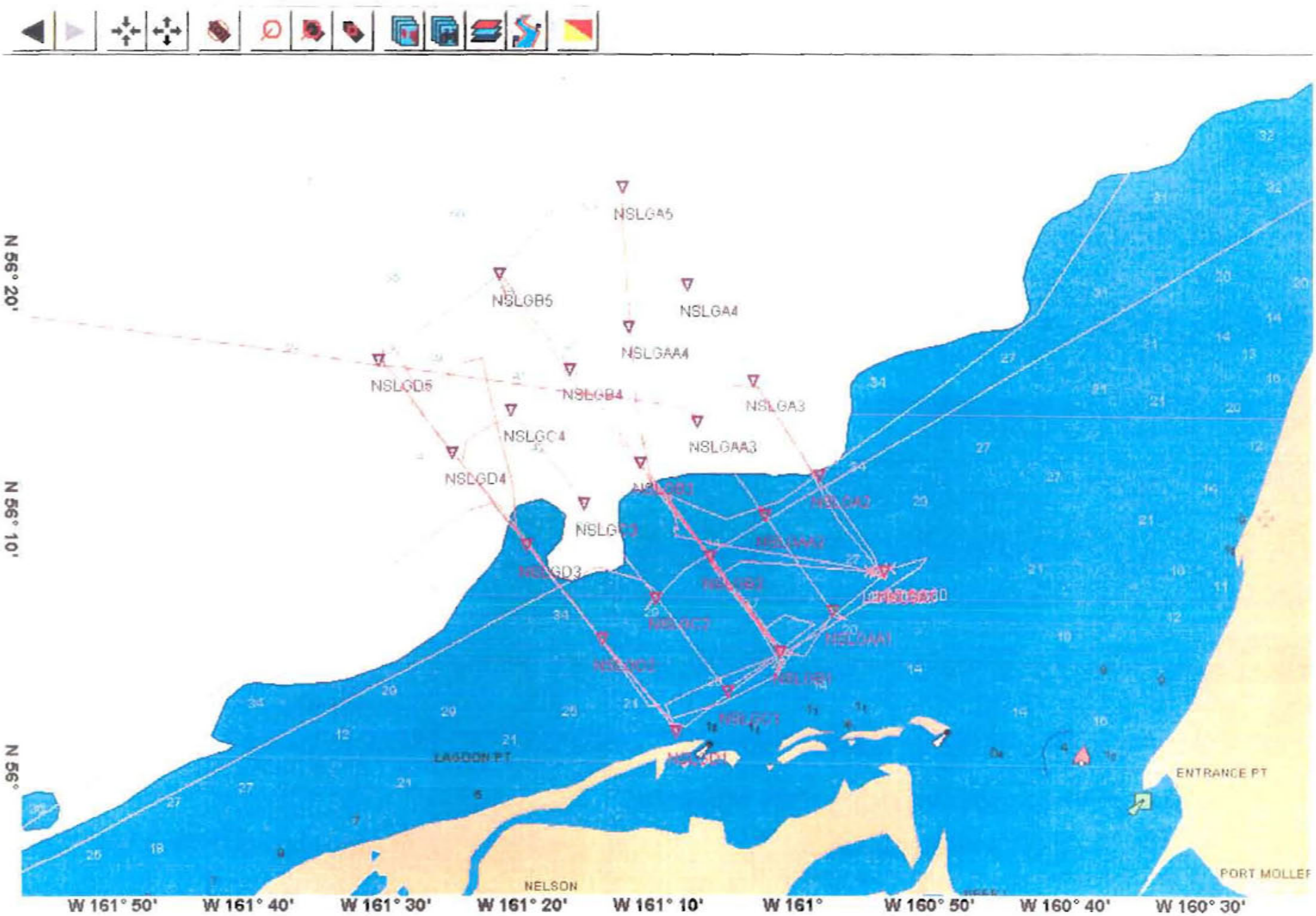
CAUTION: Chart Printouts should not be used as the primary navigational means.



06/16/99 INStar - 16:16:24

Scale: 33.9NM 1:292000 Chart: General UNDER

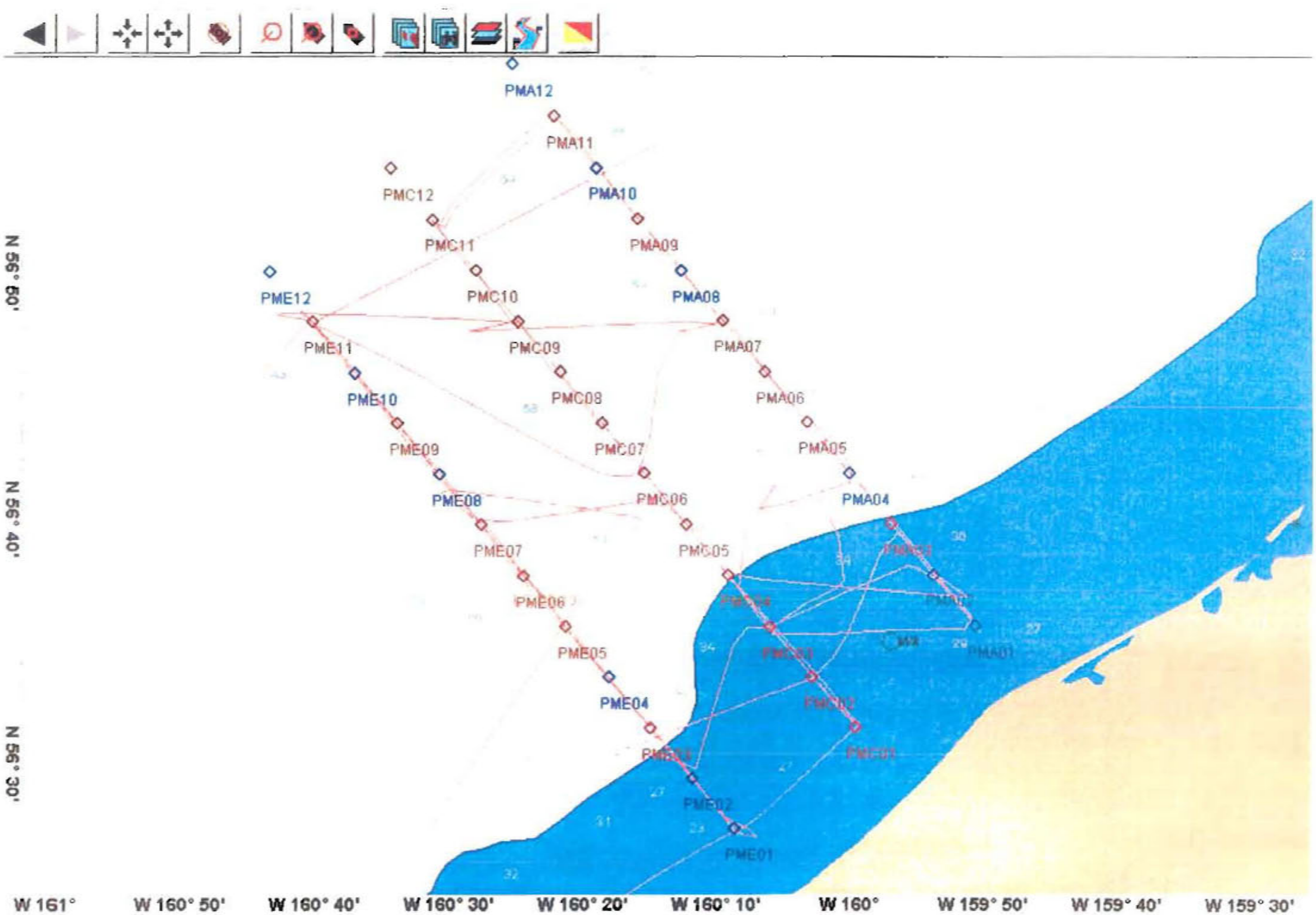
CAUTION: Chart Printouts should not be used as the primary navigational means.



06/16/99 INStar - 16:14:15

Scale: 34.0NM 1:293000 Chart: General UNDER

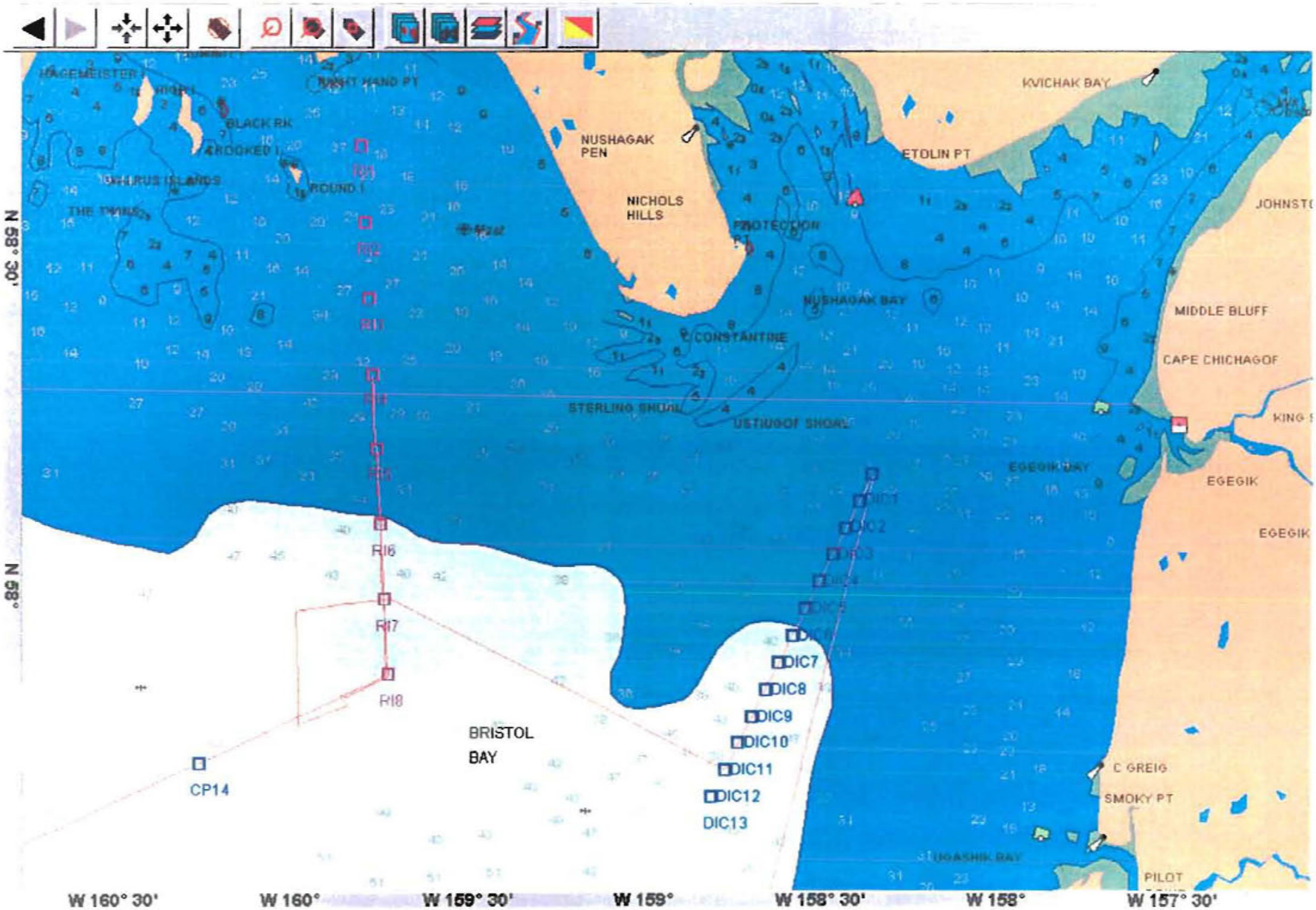
CAUTION: Chart Printouts should not be used as the primary navigational means.



06/16/99 INStar - 16:12:41

Scale: 74.4NM 1:640000 Chart: General UNDER

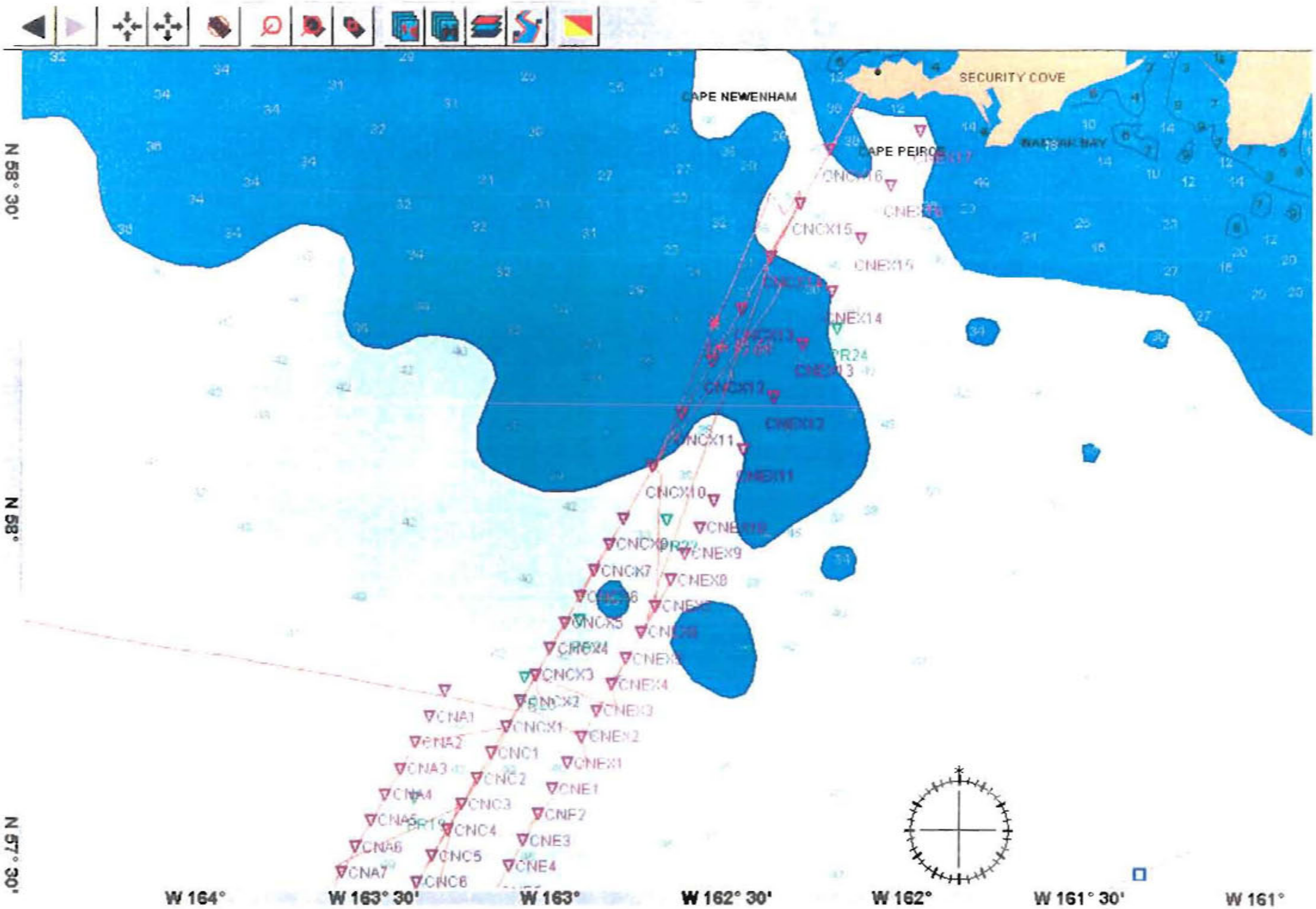
CAUTION: Chart Printouts should not be used as the primary navigational means.



06/16/99 INStar - 16:11:37

Scale: 74.6NM 1:641000 Chart: General UNDER

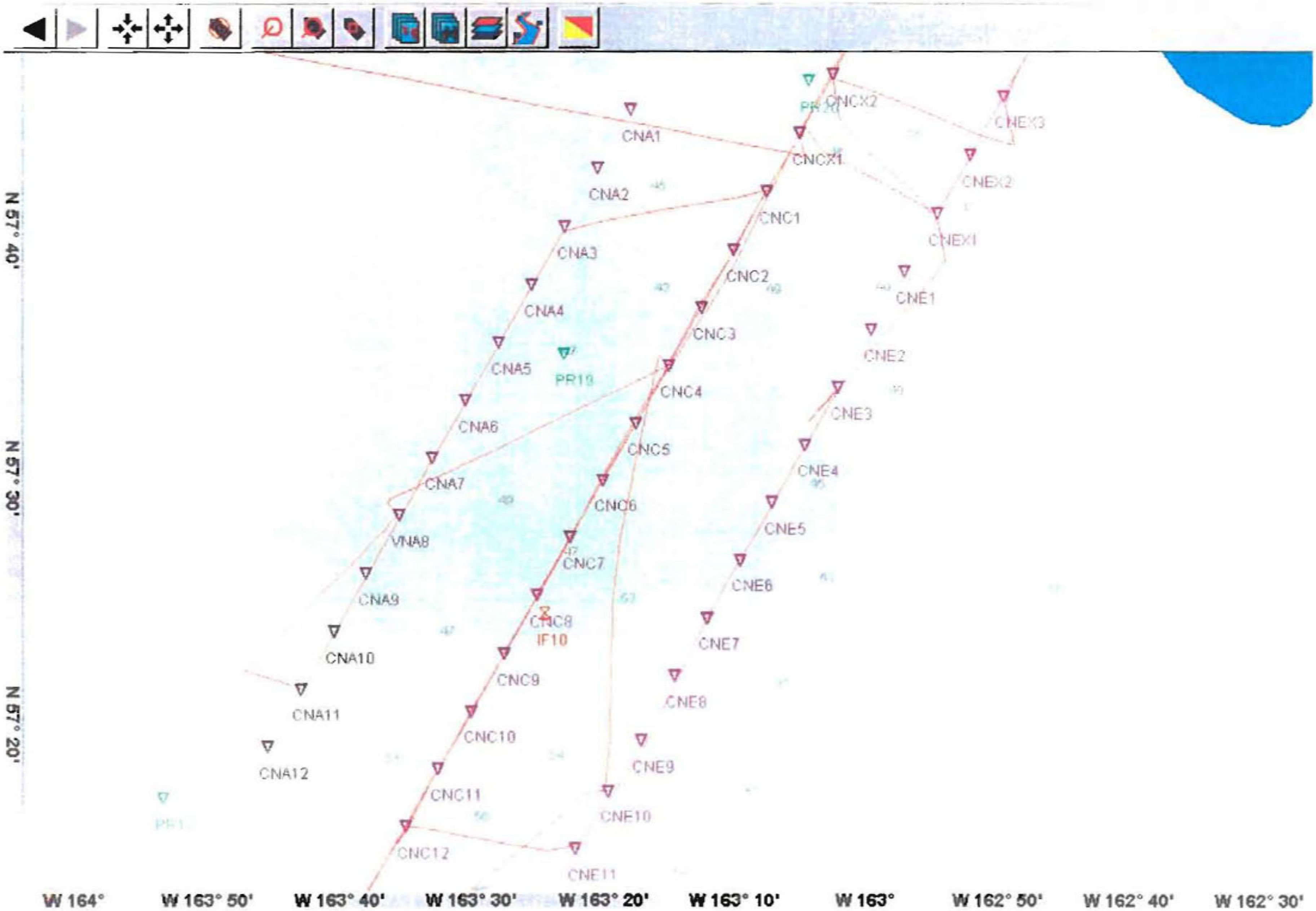
CAUTION: Chart Printouts should not be used as the primary navigational means.



06/16/99 INStar - 15:51:20

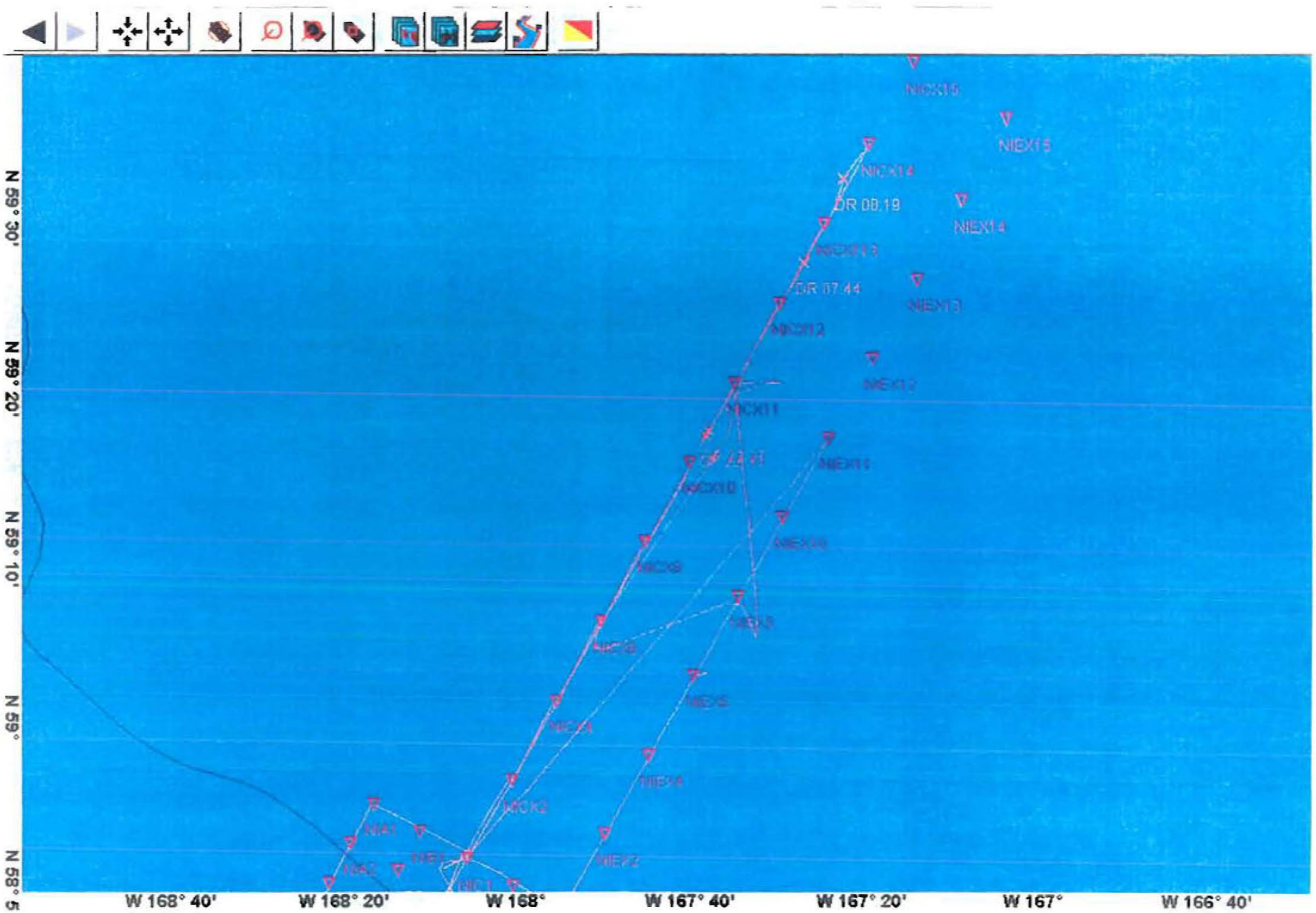
Scale: 33.8NM 1:291000 Chart: General UNDER

CAUTION: Chart Printouts should not be used as the primary navigational means.



06/16/99 INStar - 15:49:23

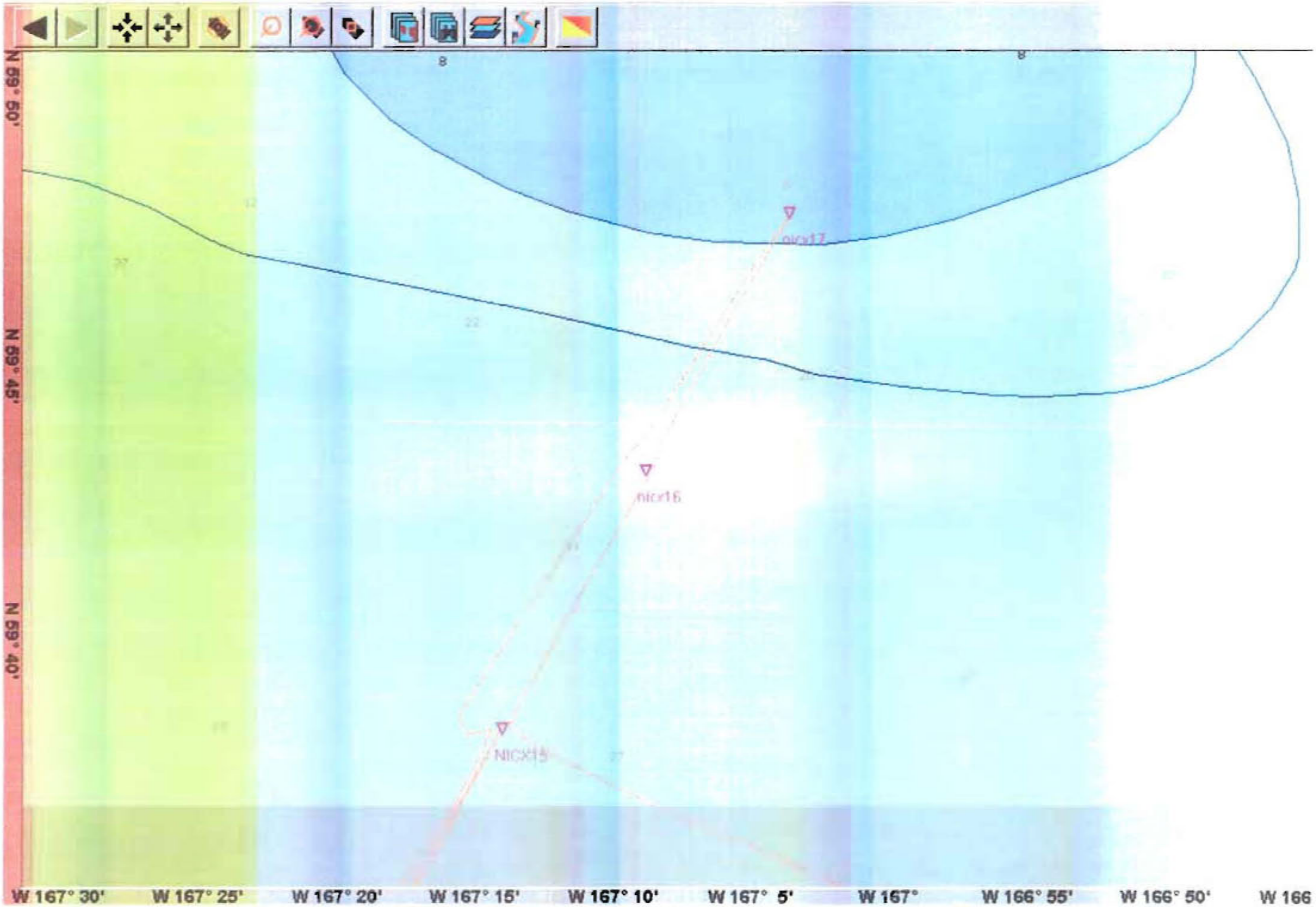
CAUTION: Chart Printouts should not be used as the primary navigational means.



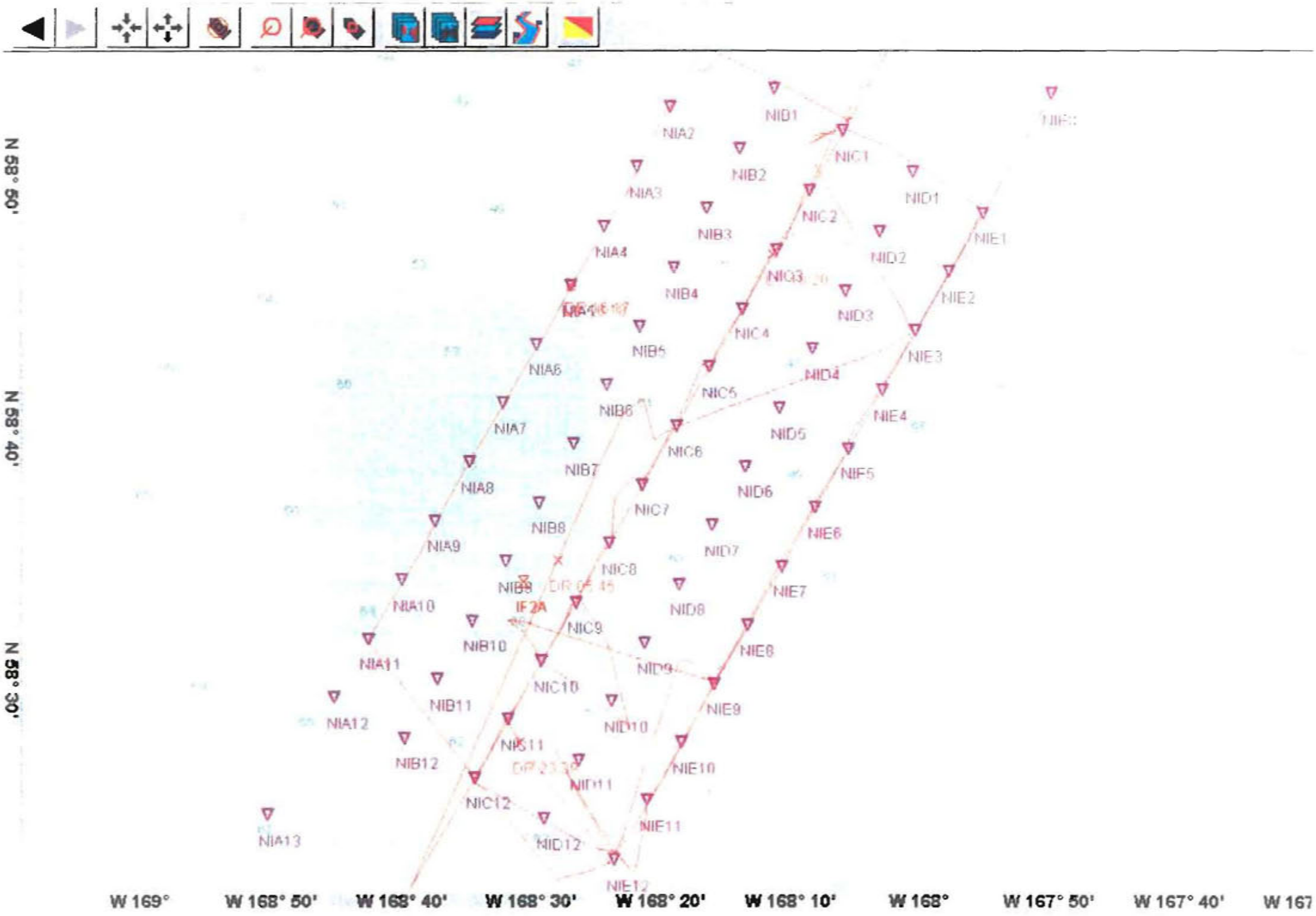
08/21/99 INStar - 22:22:12

Scale: 15.1NM 1:130000 Chart: Coastal UNDER

CAUTION: Chart Printouts should not be used as the primary navigational means.



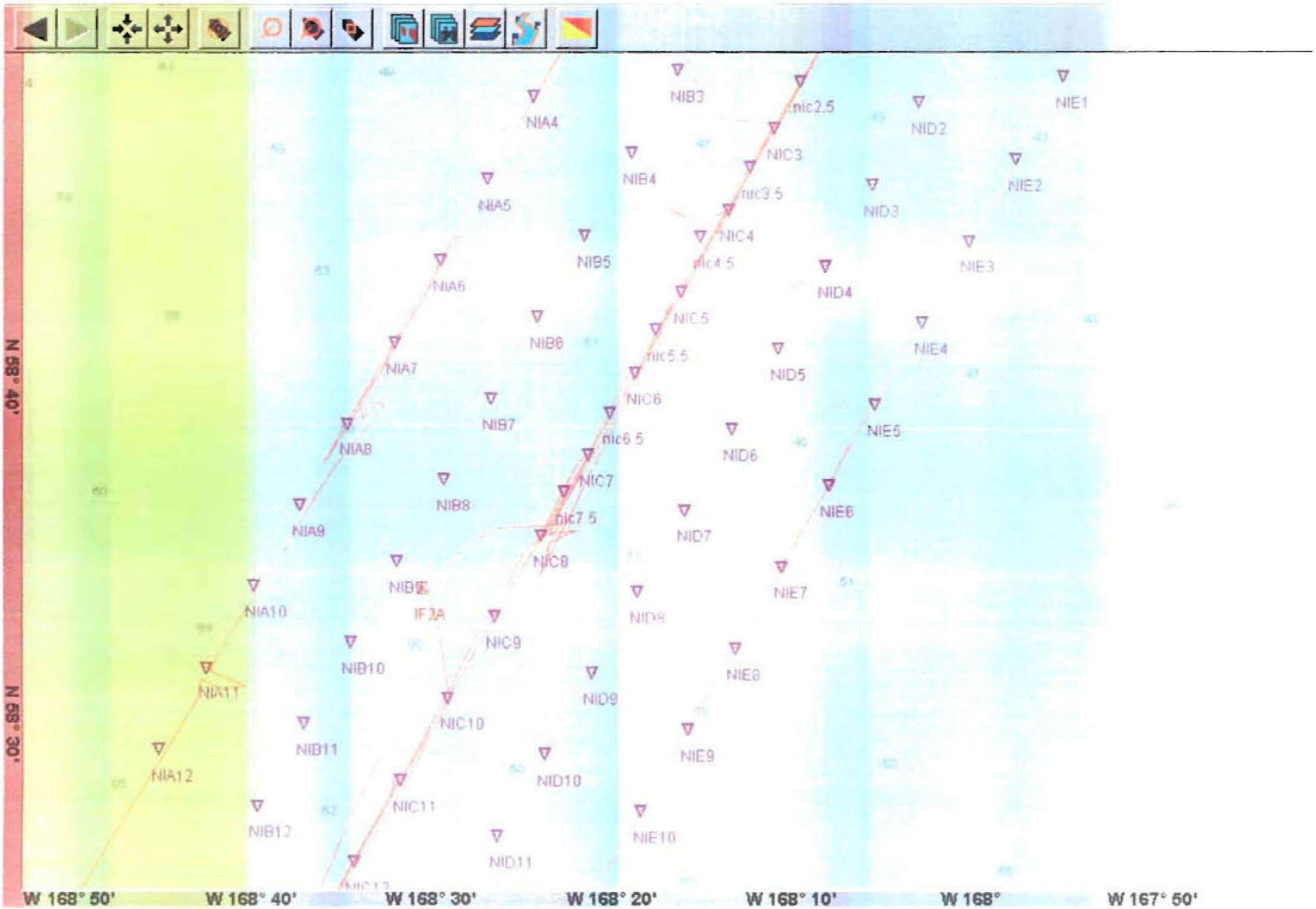
CAUTION: Chart Printouts should not be used as the primary navigational means.



08/21/99 INStar - 22:21:34

Scale: 24.0NM 1:206000 Chart: General UNDER

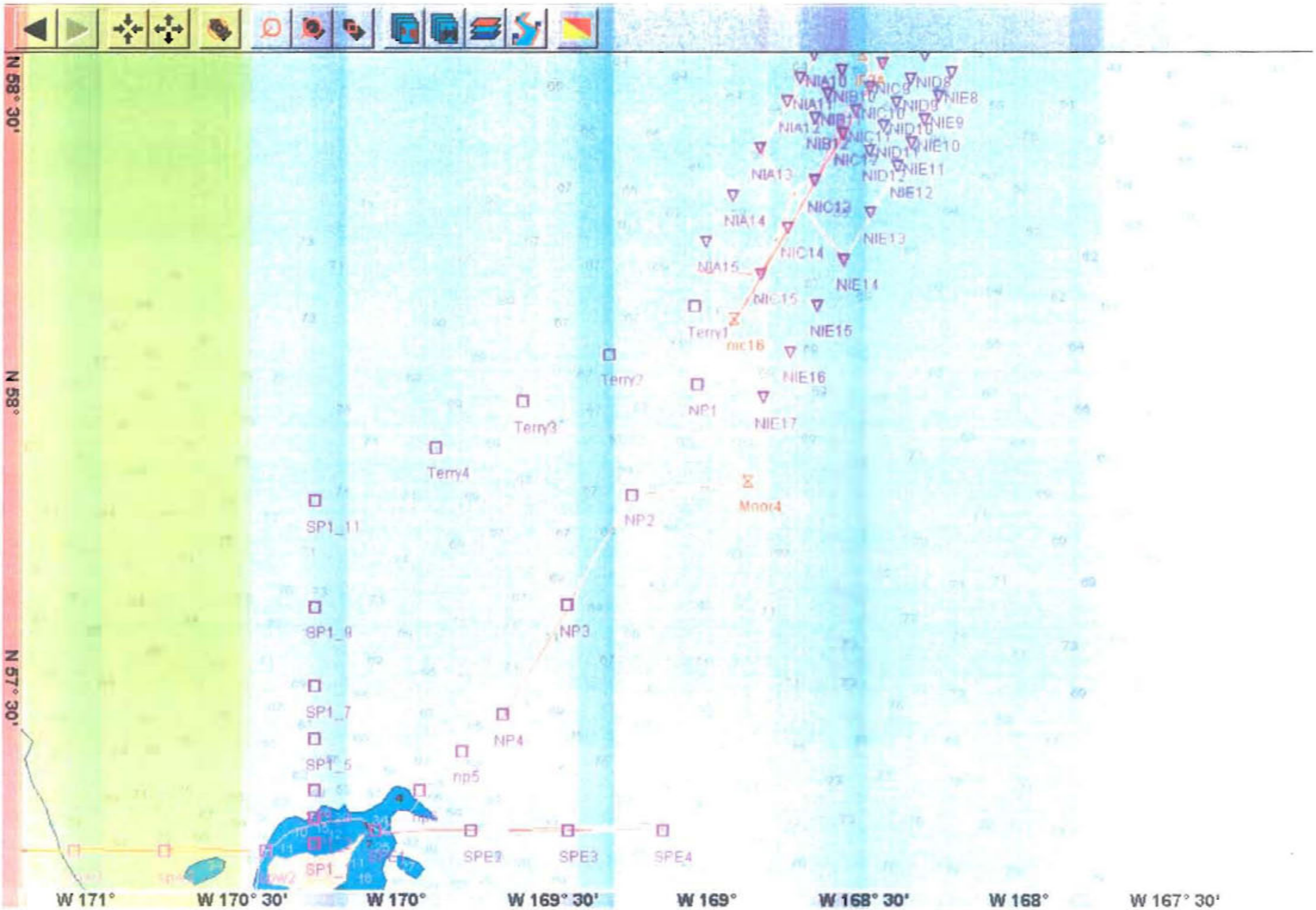
CAUTION: Chart Printouts should not be used as the primary navigational means.



08/21/99 INStar - 22:19:02

Scale: 85.1NM 1:732000 Chart: General UNDER

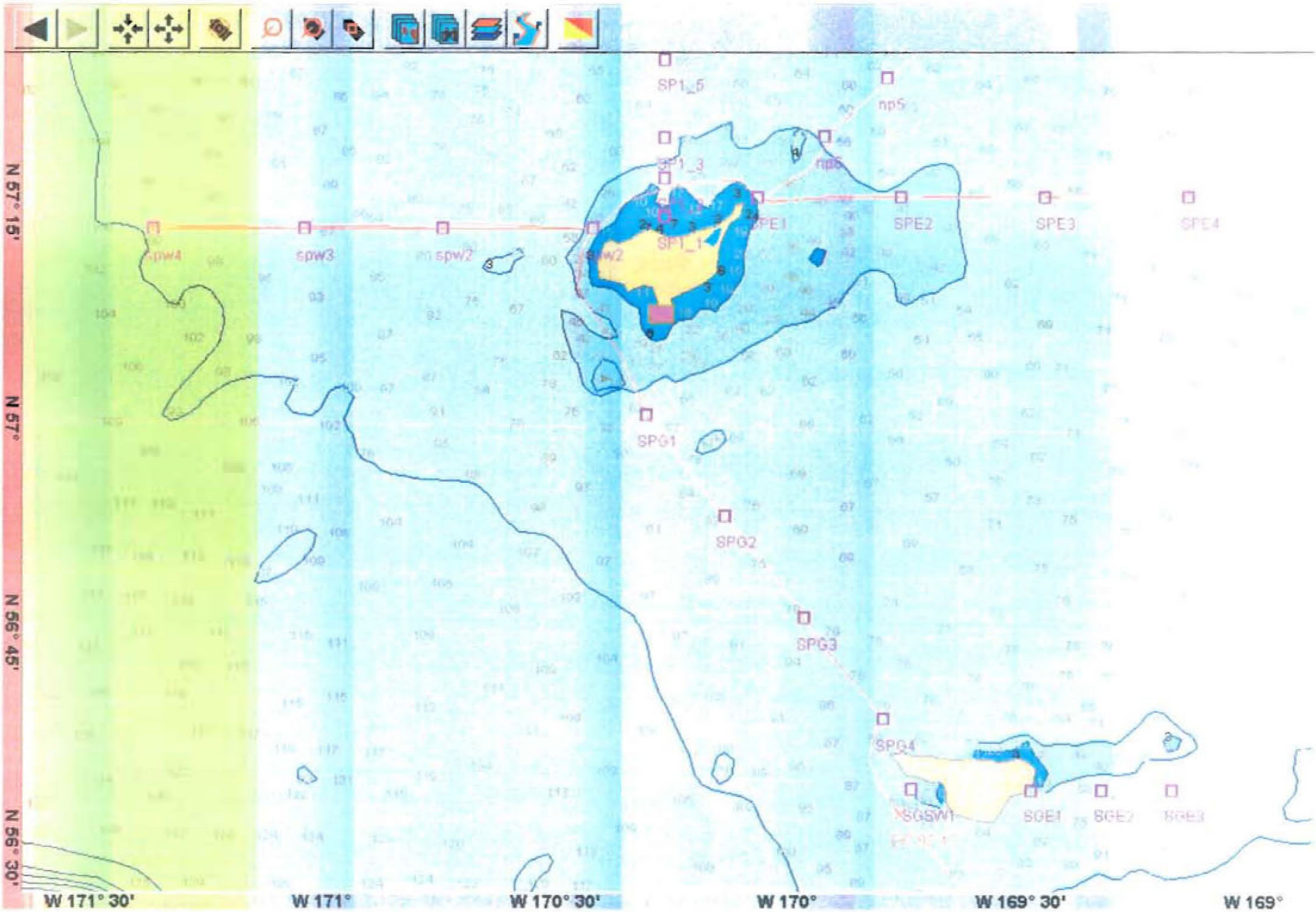
CAUTION: Chart Printouts should not be used as the primary navigational means.



08/21/99 INStar - 22:17:58

Scale: 58.4NM 1:502000 Chart: ˇ

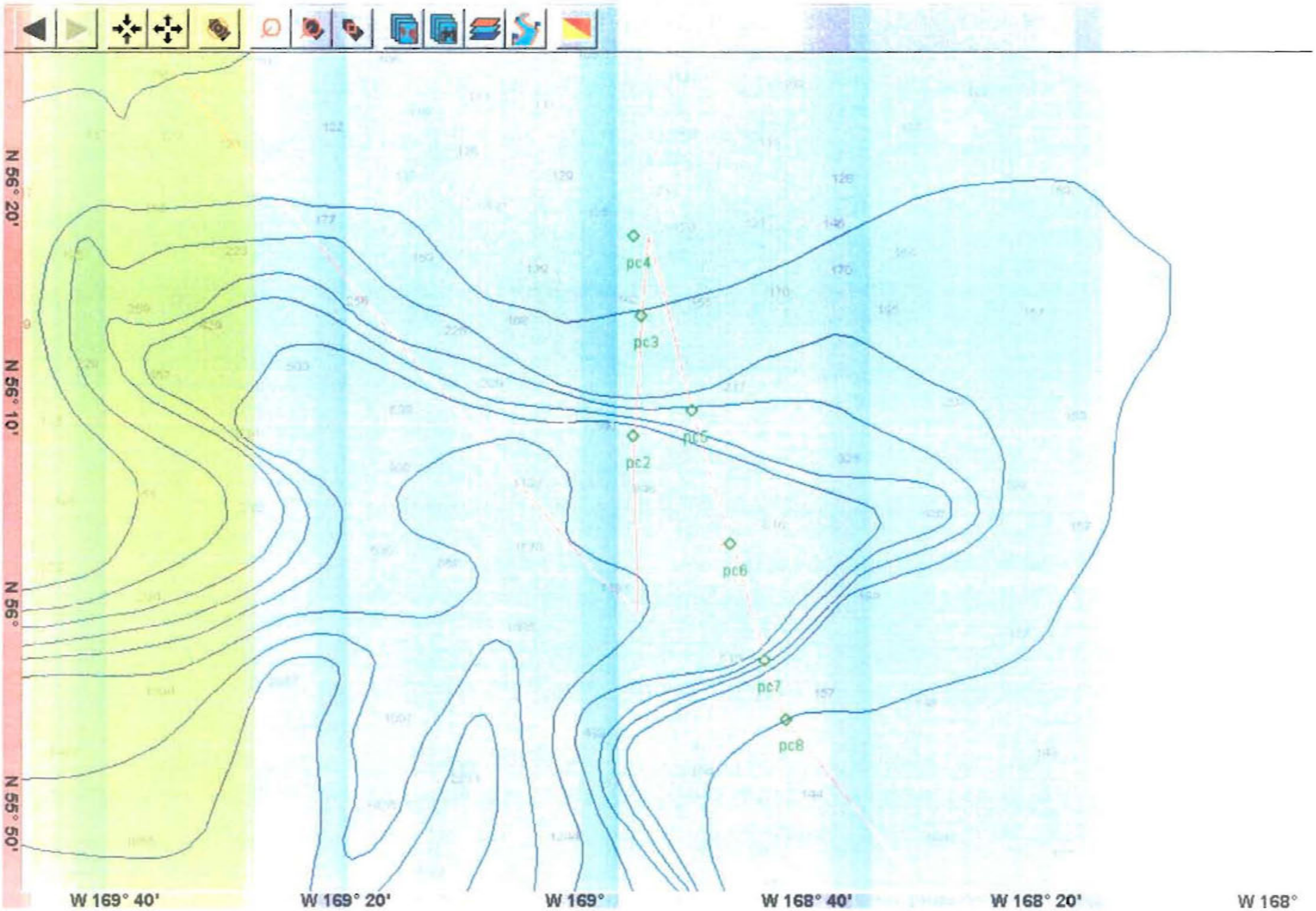
CAUTION: Chart Printouts should not be used as the primary navigational means.



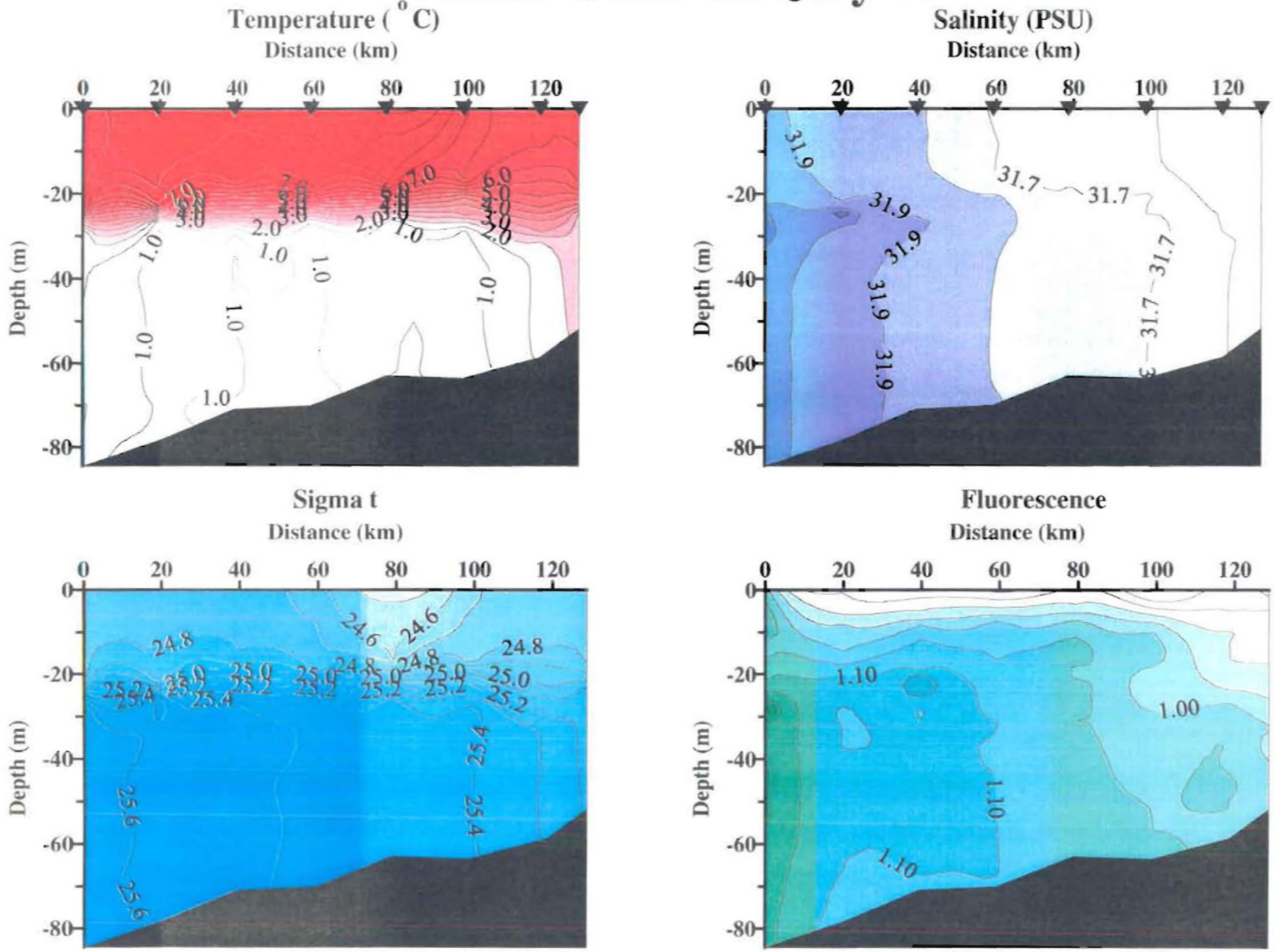
08/21/99 INStar - 22:17:11

Scale: 40.2NM 1:345000 Chart: Coastal UNDER

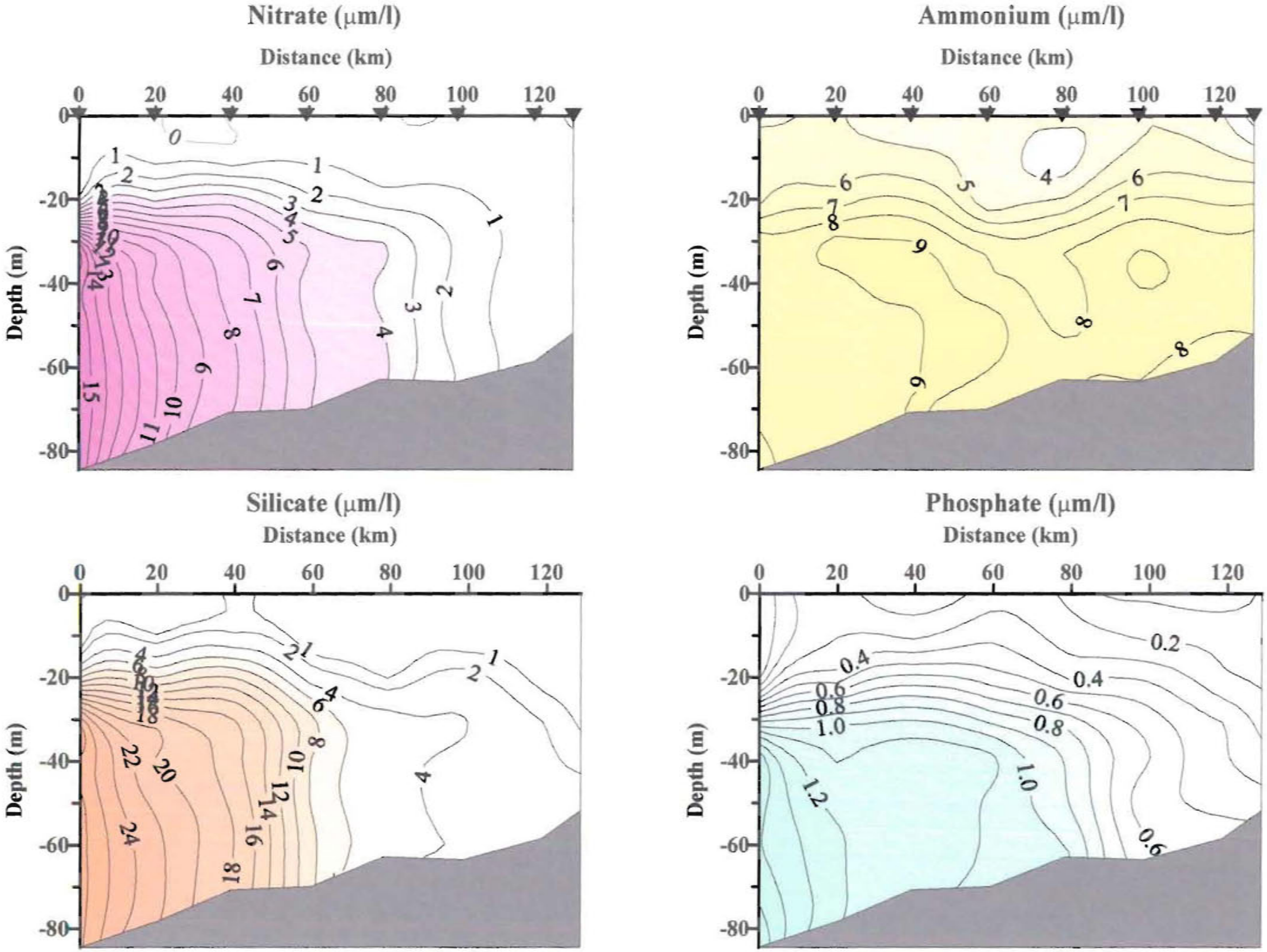
CAUTION: Chart Printouts should not be used as the primary navigational means.



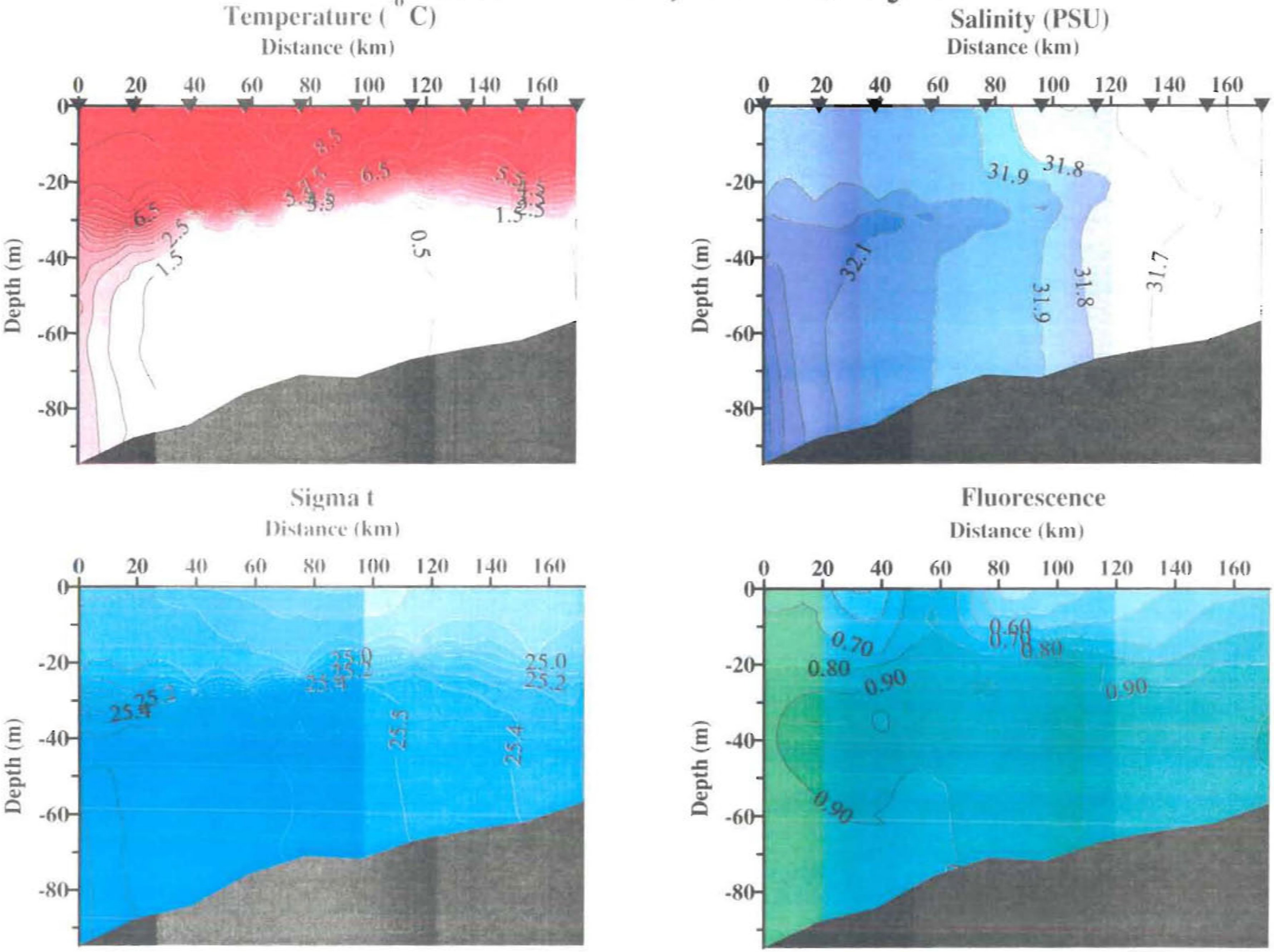
Whale-C line 22 July '99



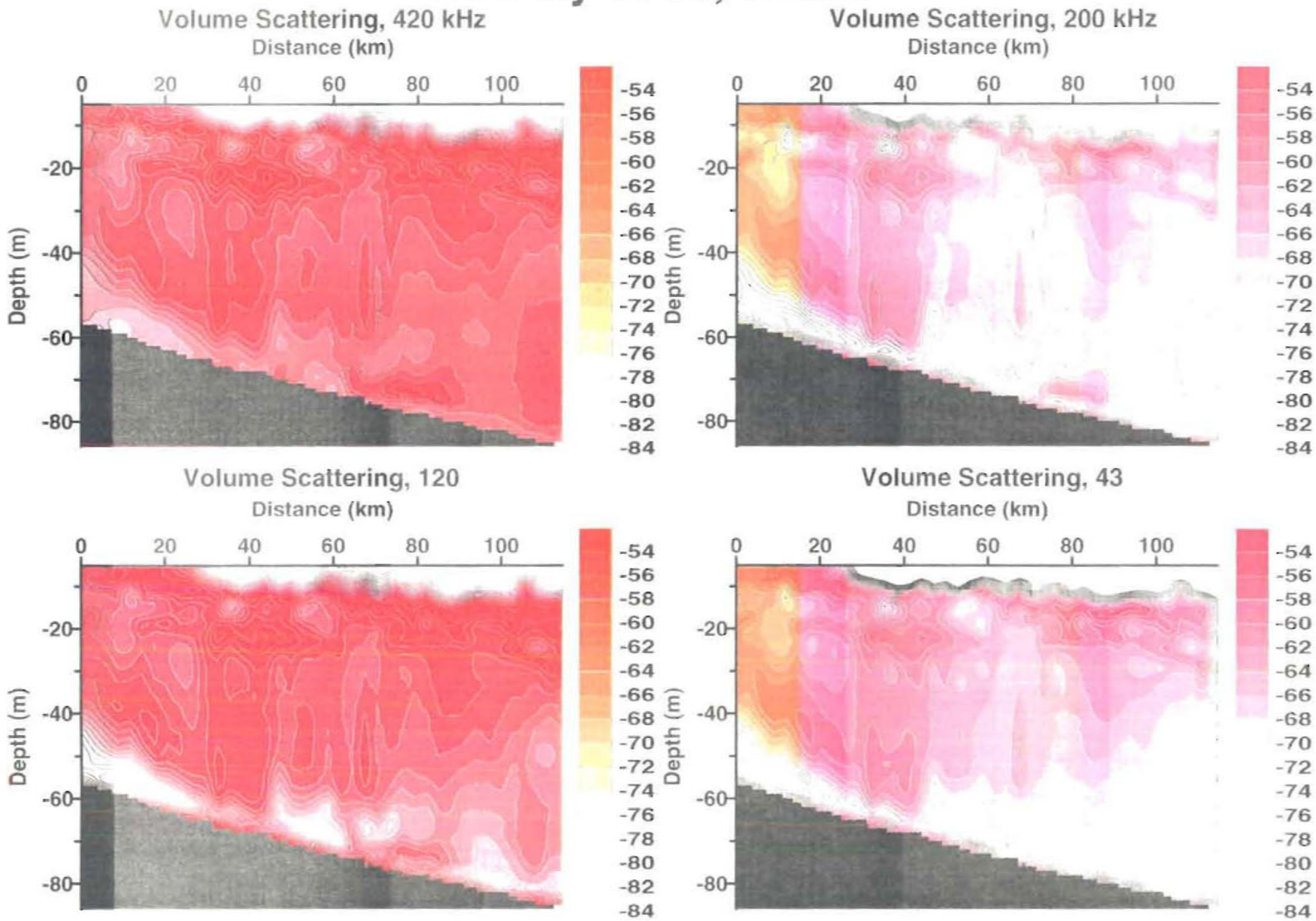
HX222 - Whale grid-C - 22 July 1999



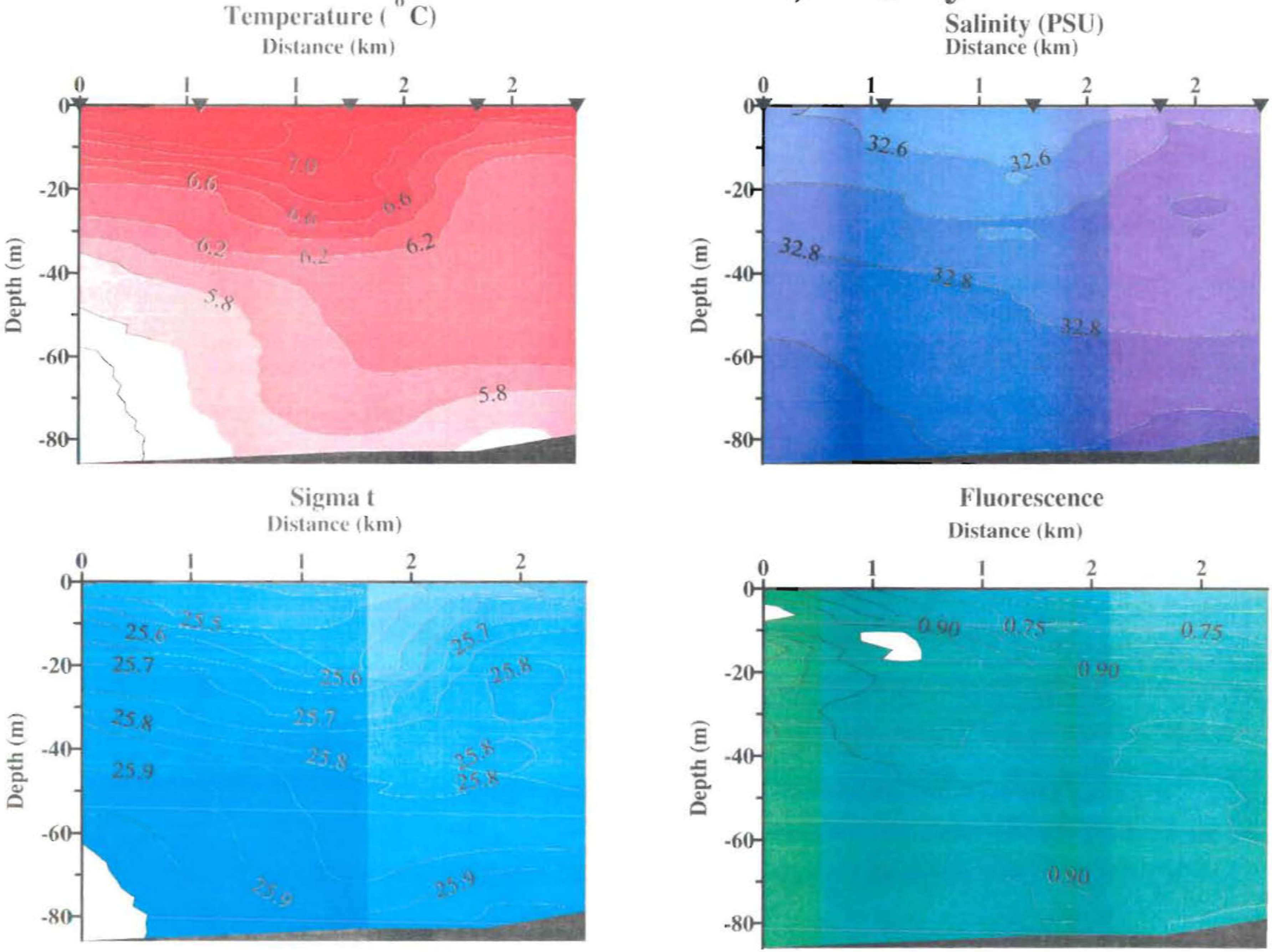
Whale N-Line, 23-24 July '99



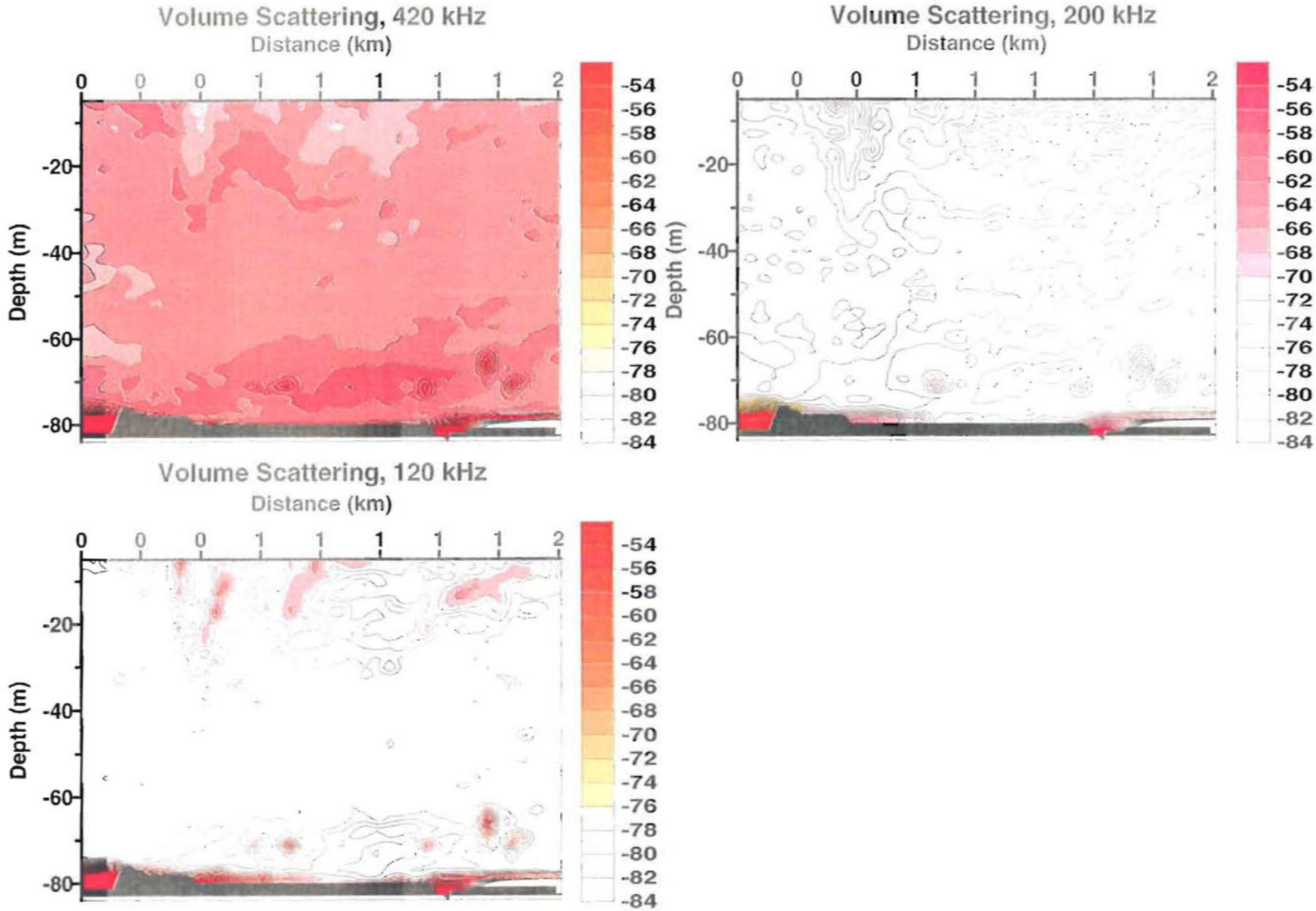
22 July 1999; whale



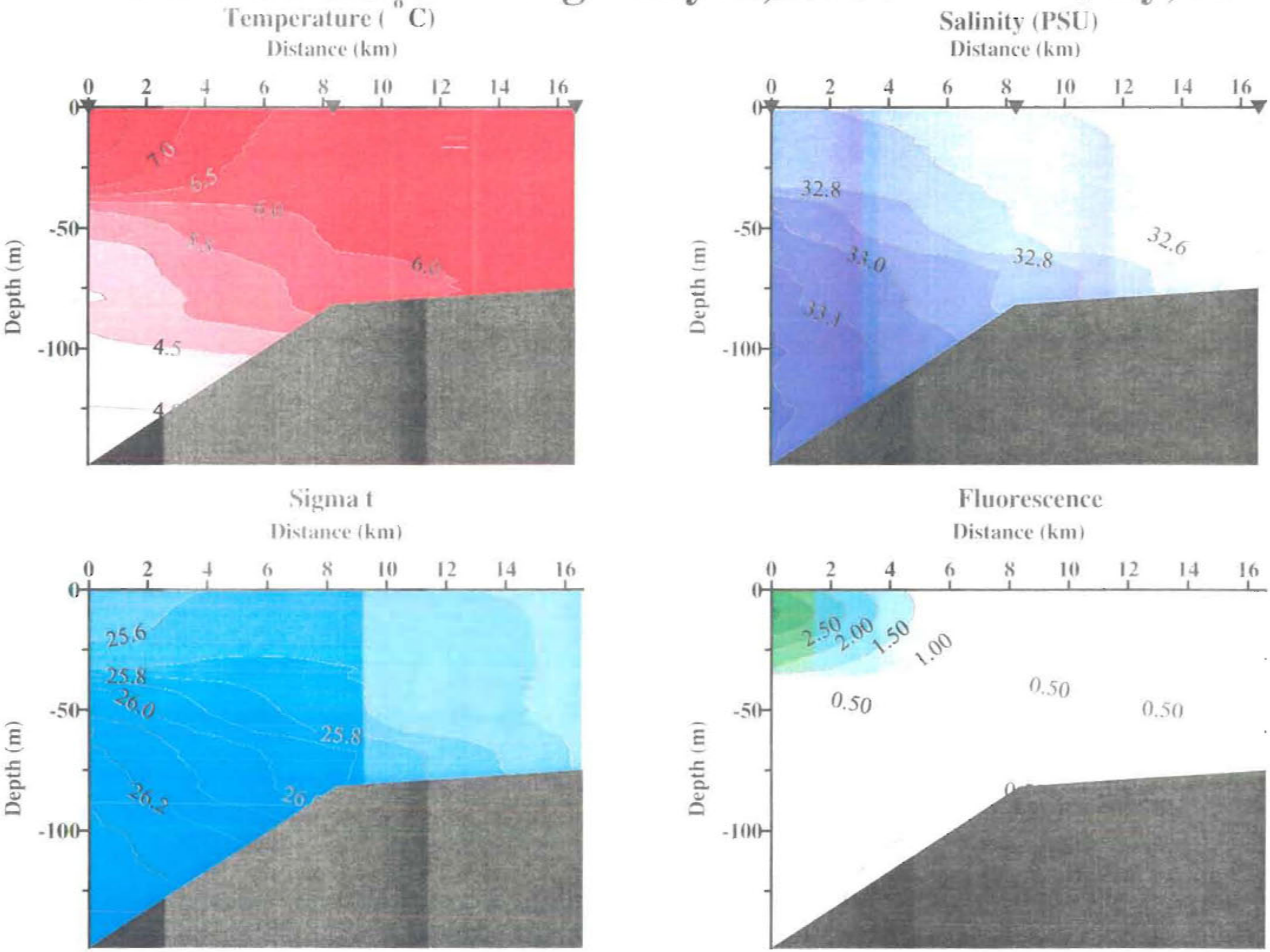
Akutan Pass Bird Line, 25 July '99



25 July 1999; Akutan

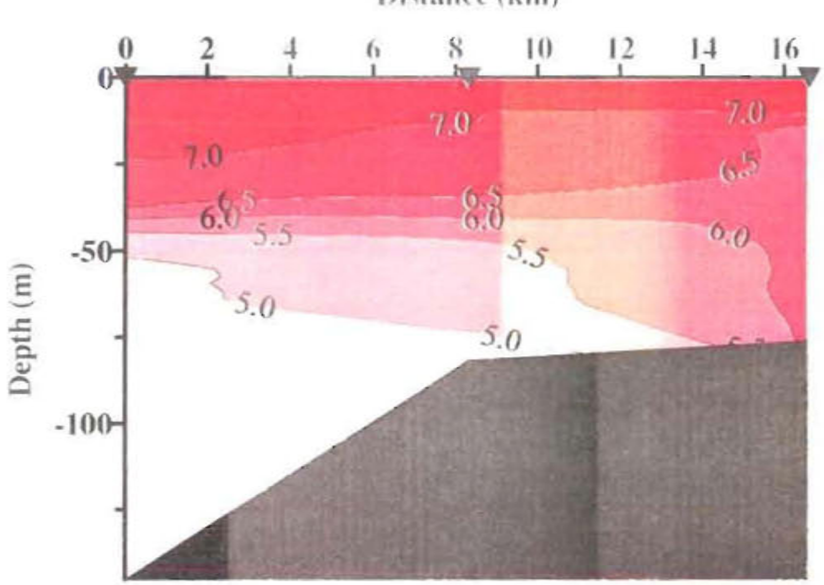


Akutan Pass to Bering Canyon,Late Flood 25 July,'99

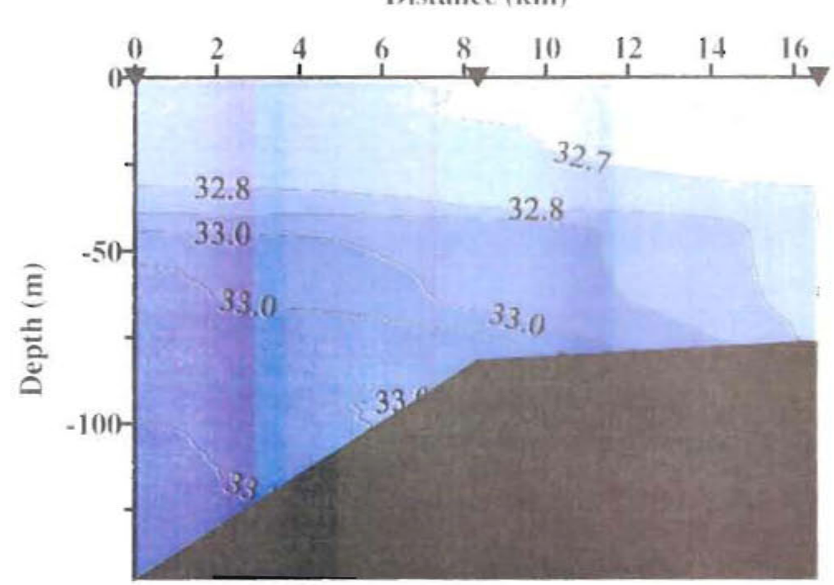


Akutan Pass to Bering Canyon, Early Flood, 26 July '99

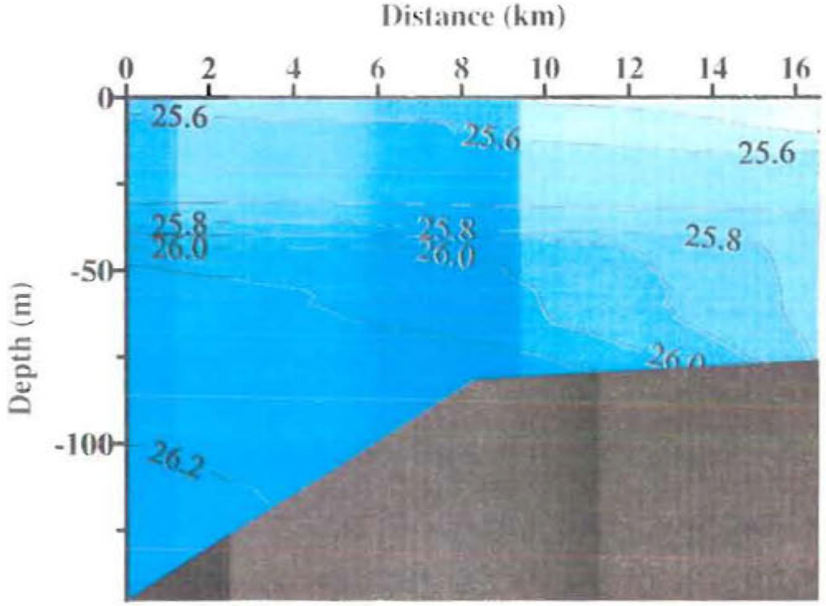
Temperature (°C)



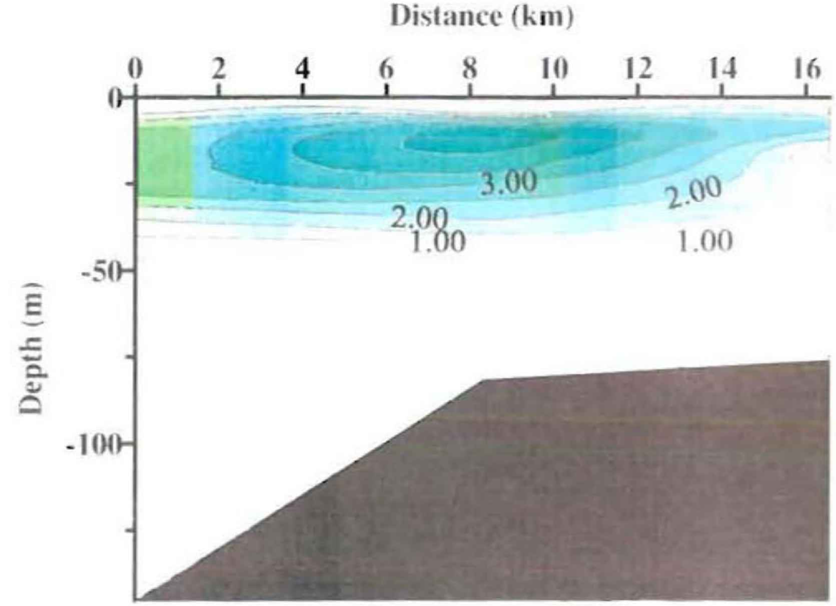
Salinity (PSU)



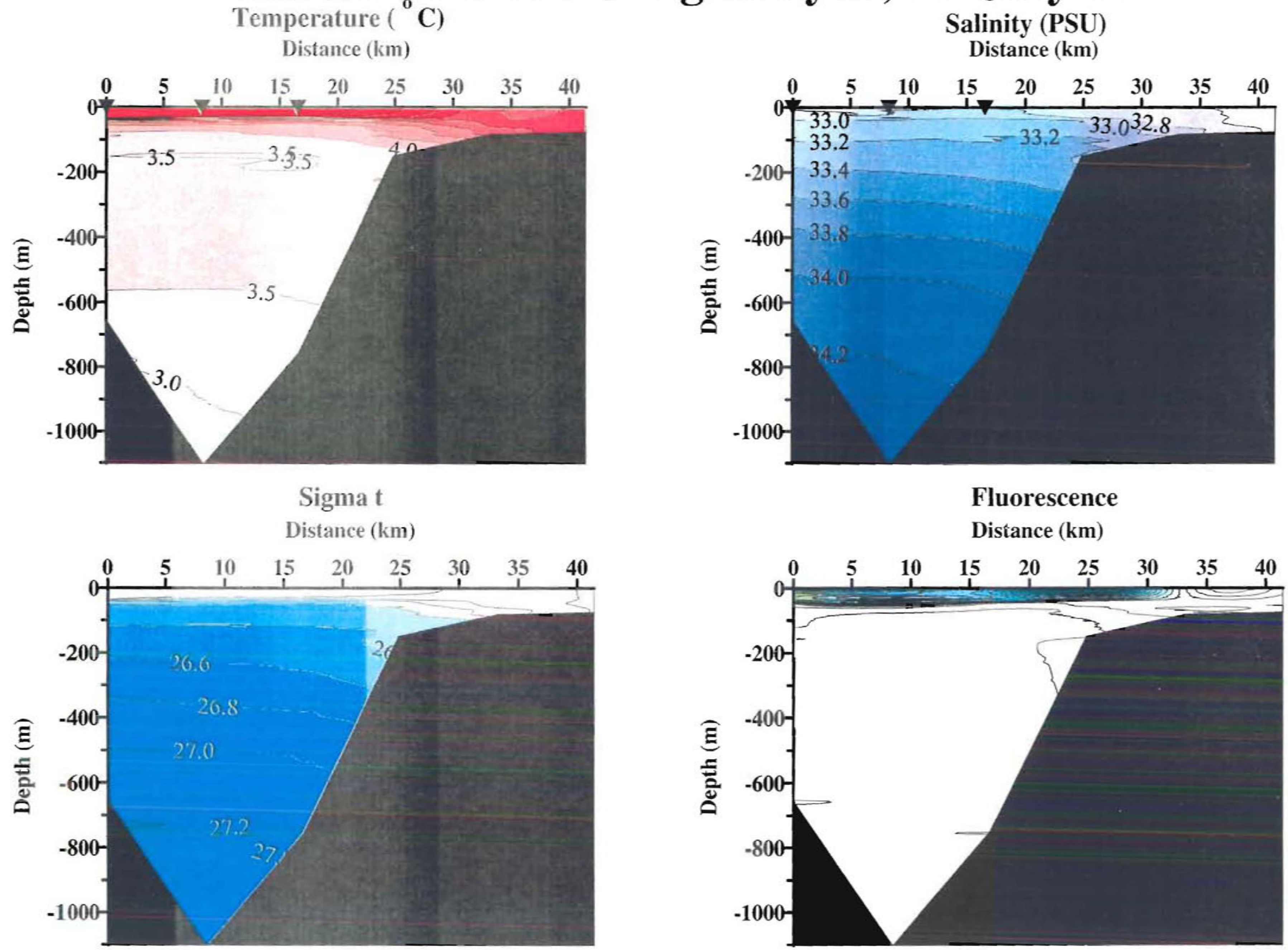
Sigma t



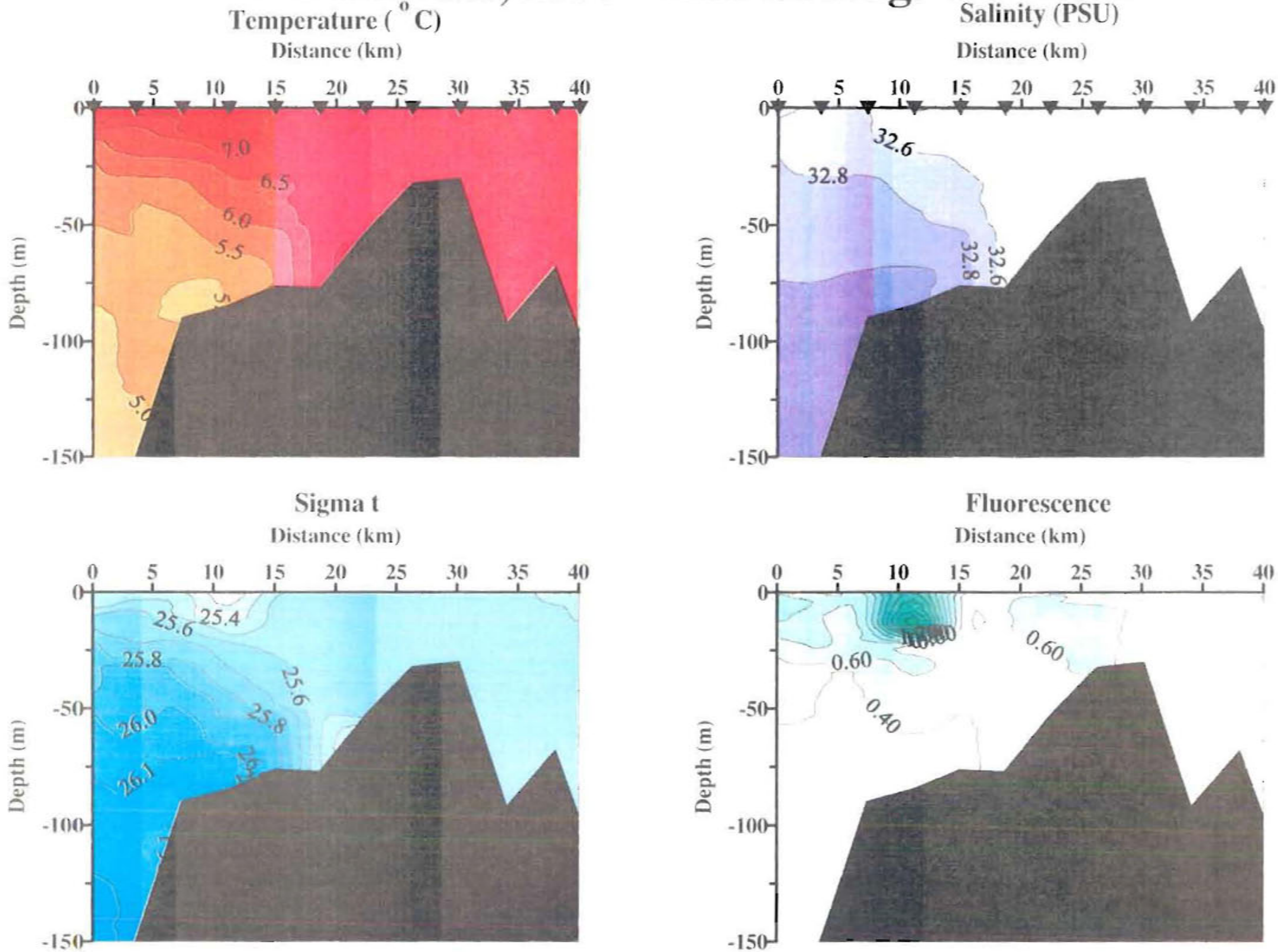
Fluorescence



Akutan Pass to Bering Canyon, 26 July '99

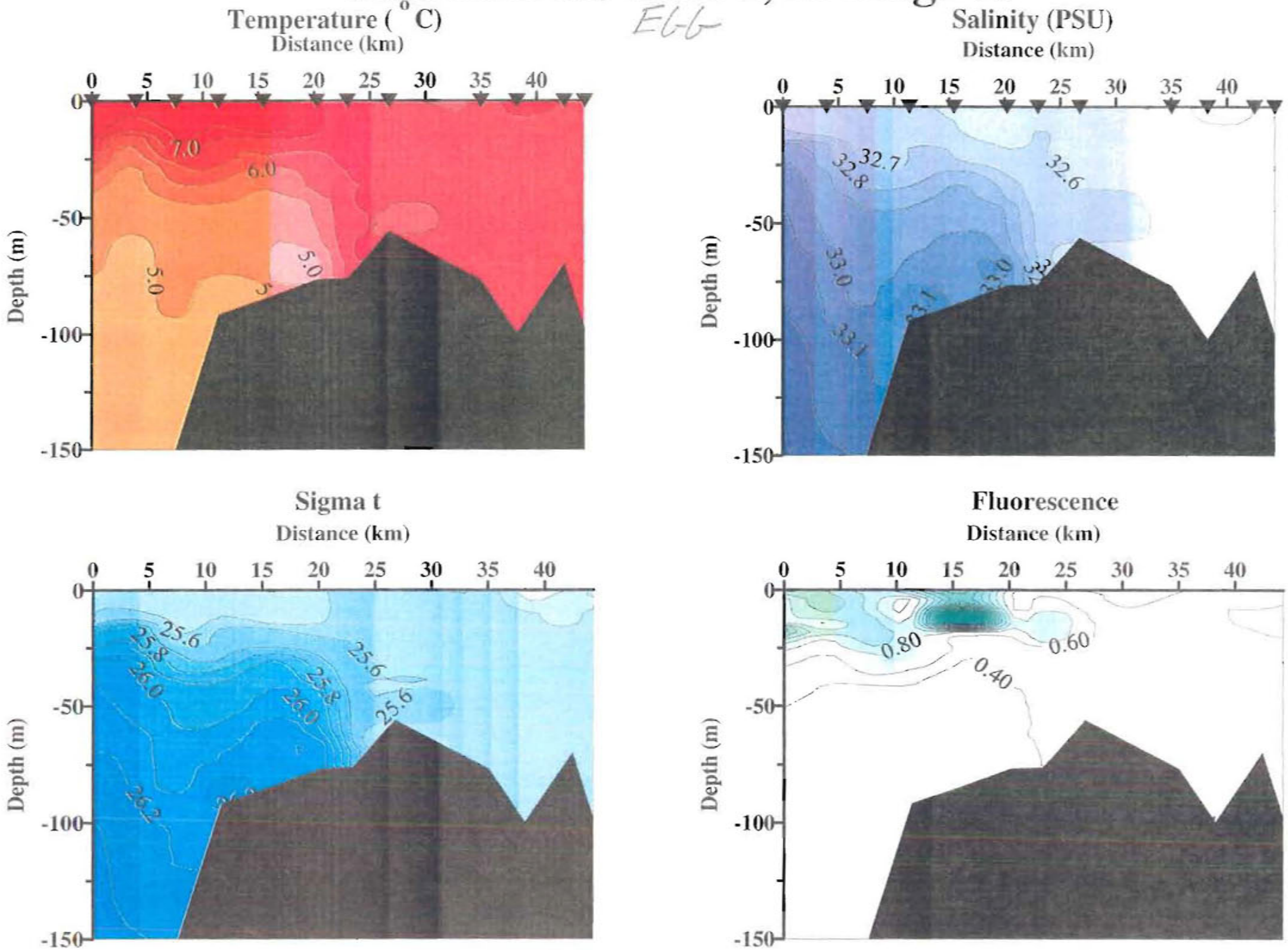


Akutan Pass, Flood Tide 18 Aug. '99 -A.M.



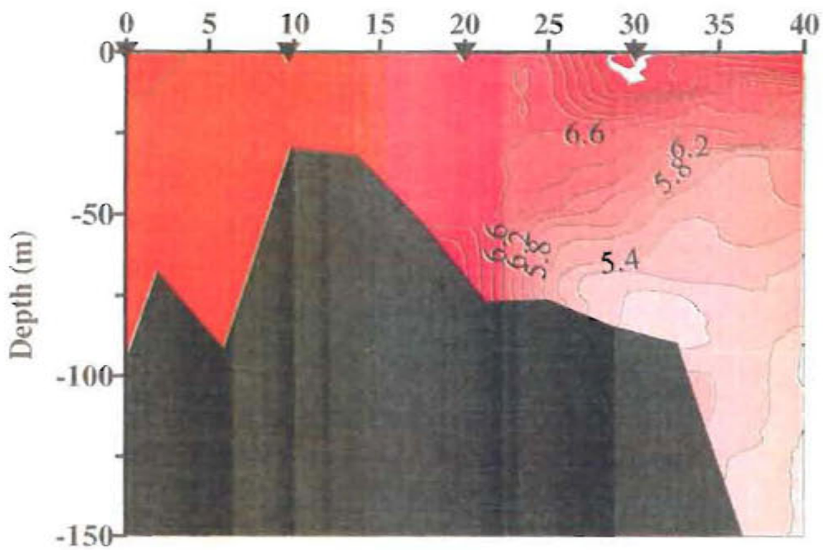
Akutan Pass Line 2, 18 Aug. '99

Ebb
Ebb

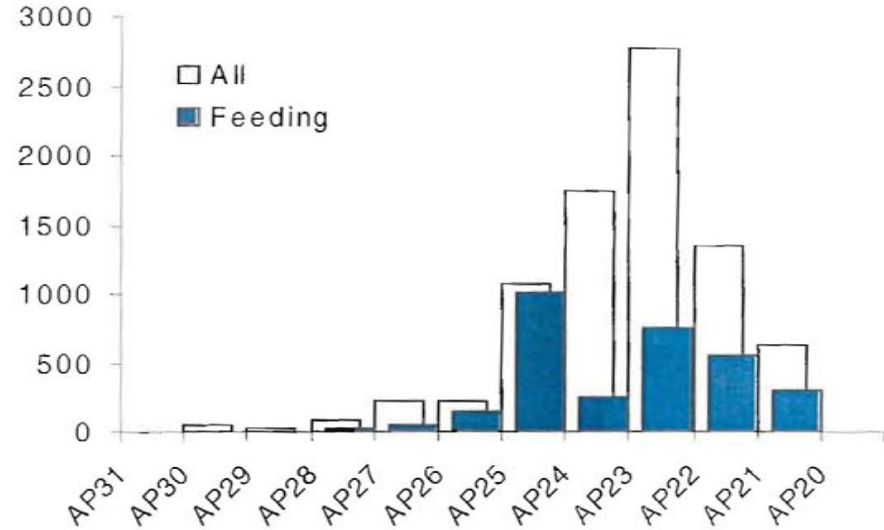


AKUTAN PASS (Flood), 18 August 1999, 8:21-12:52

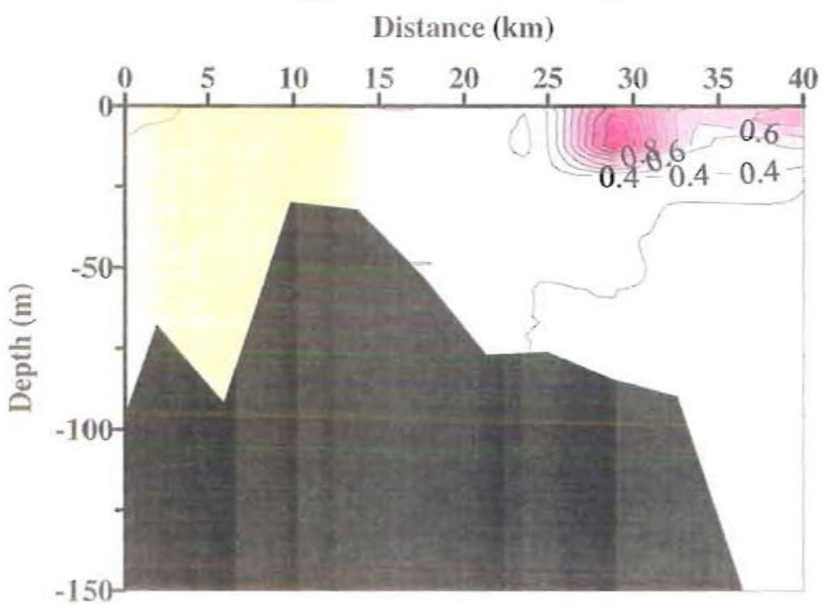
Temperature (^{o}C)



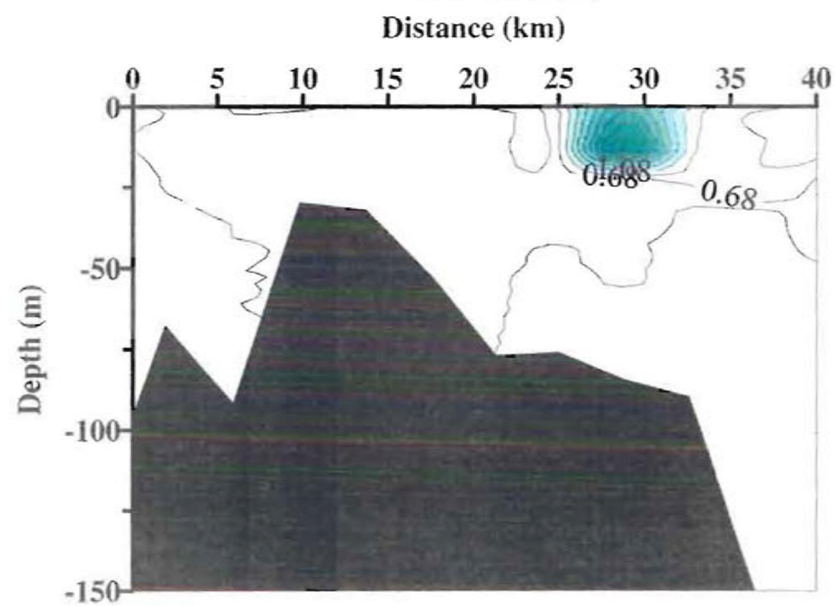
Dark Shearwaters, feeding and on the water, stations AP20 to AP31



Extinction Coefficient

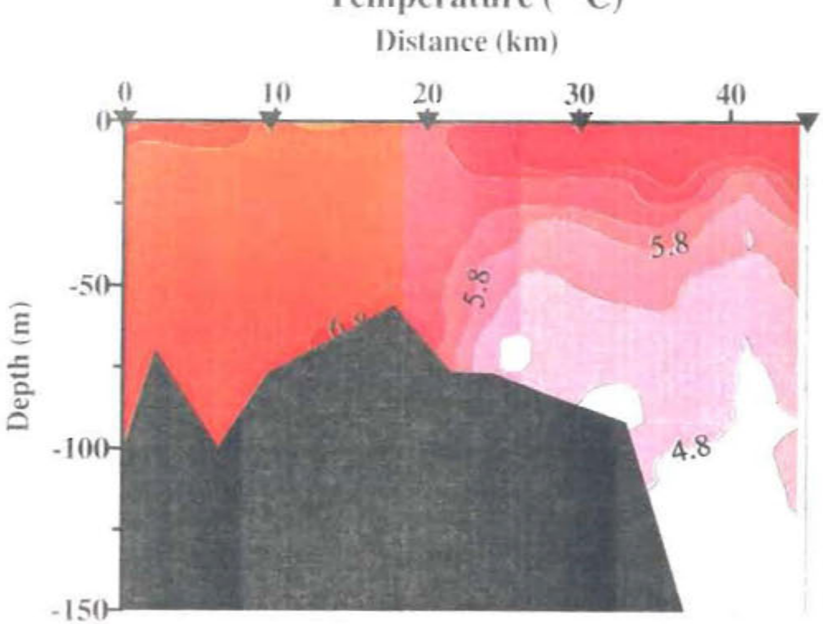


Fluorescence

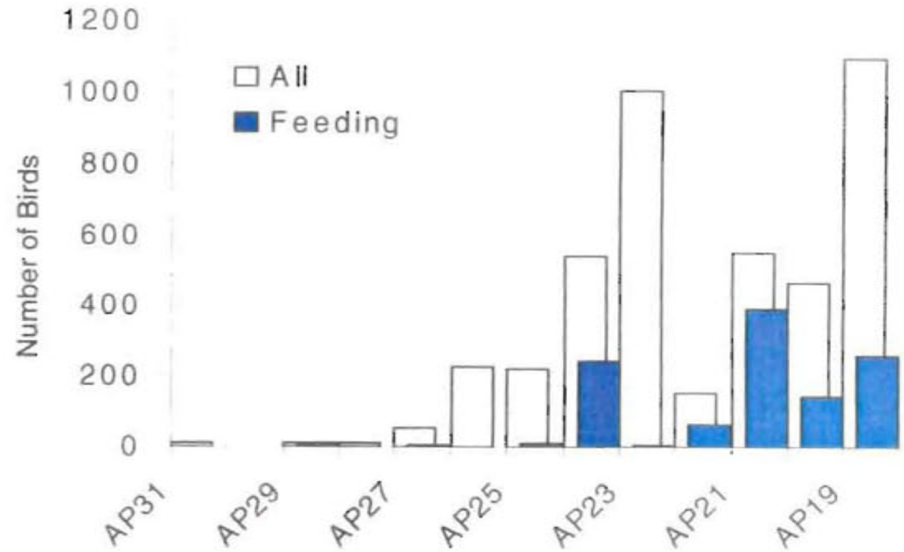


AKUTAN PASS (Ebb), 18 August 1999, 14:17-19:21

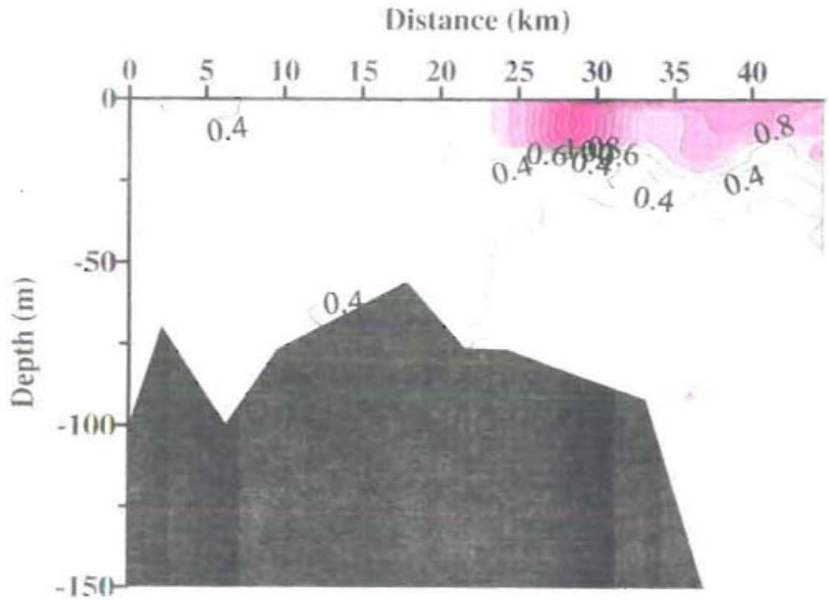
Temperature (^{o}C)



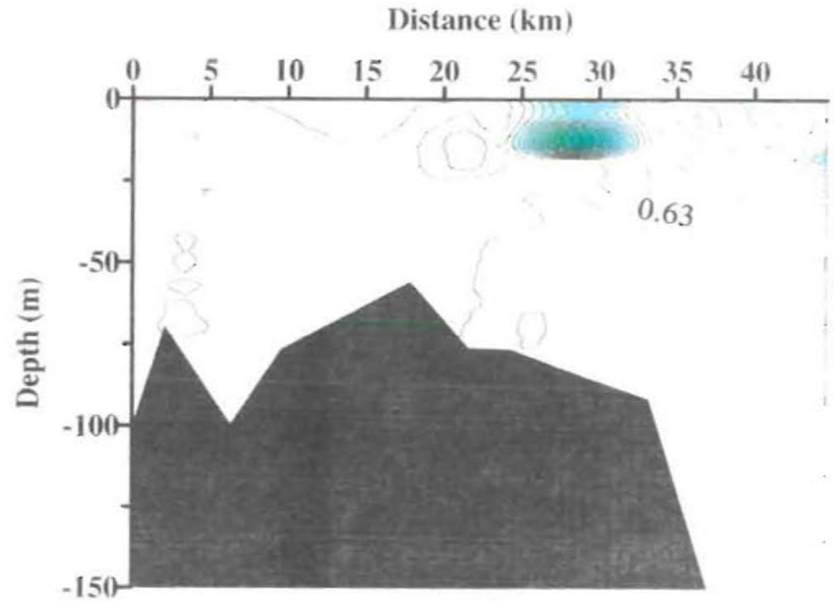
Dark Shearwaters, feeding and on the water, stations AP31 to AP19



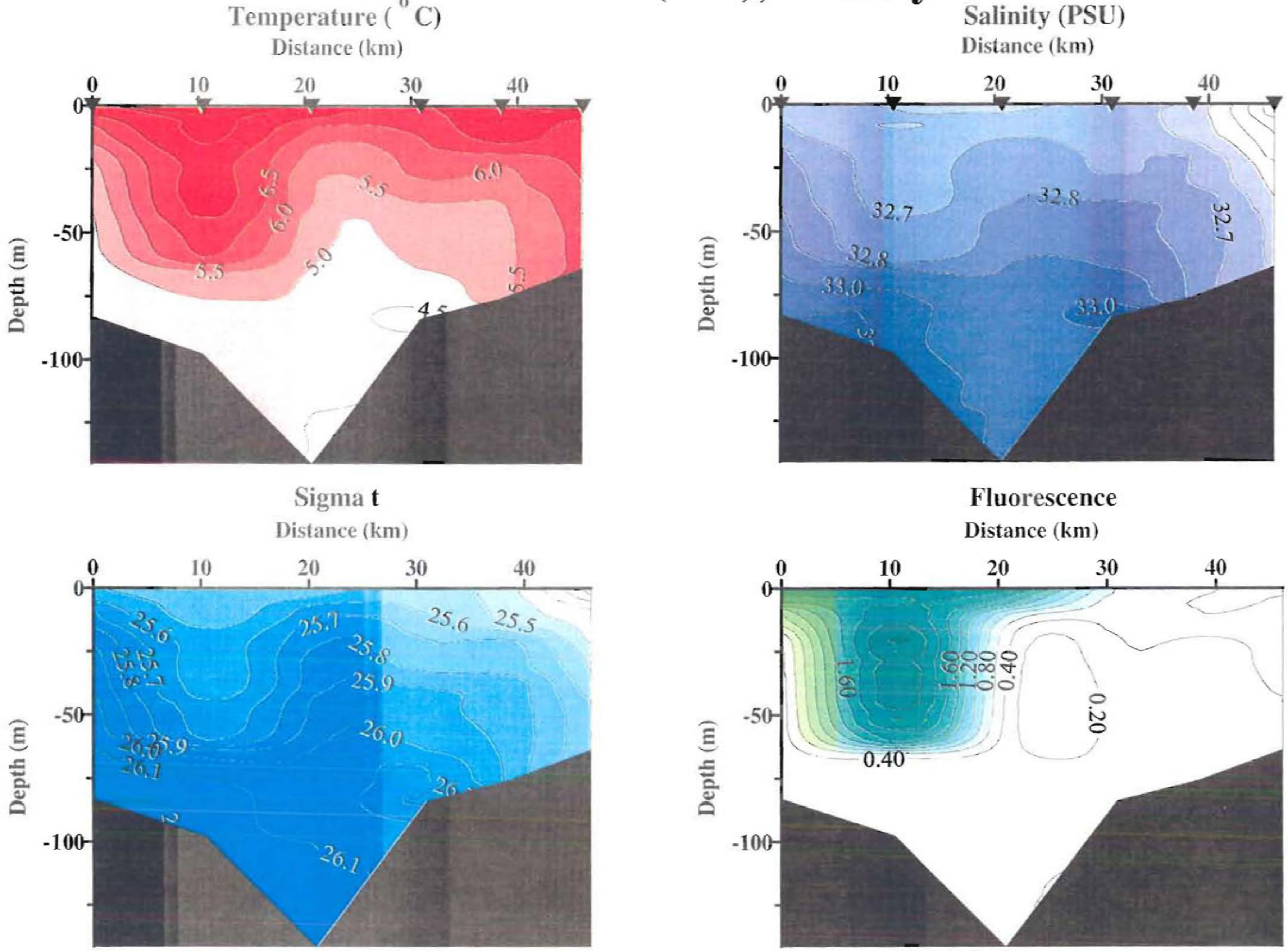
Extinction Coefficient



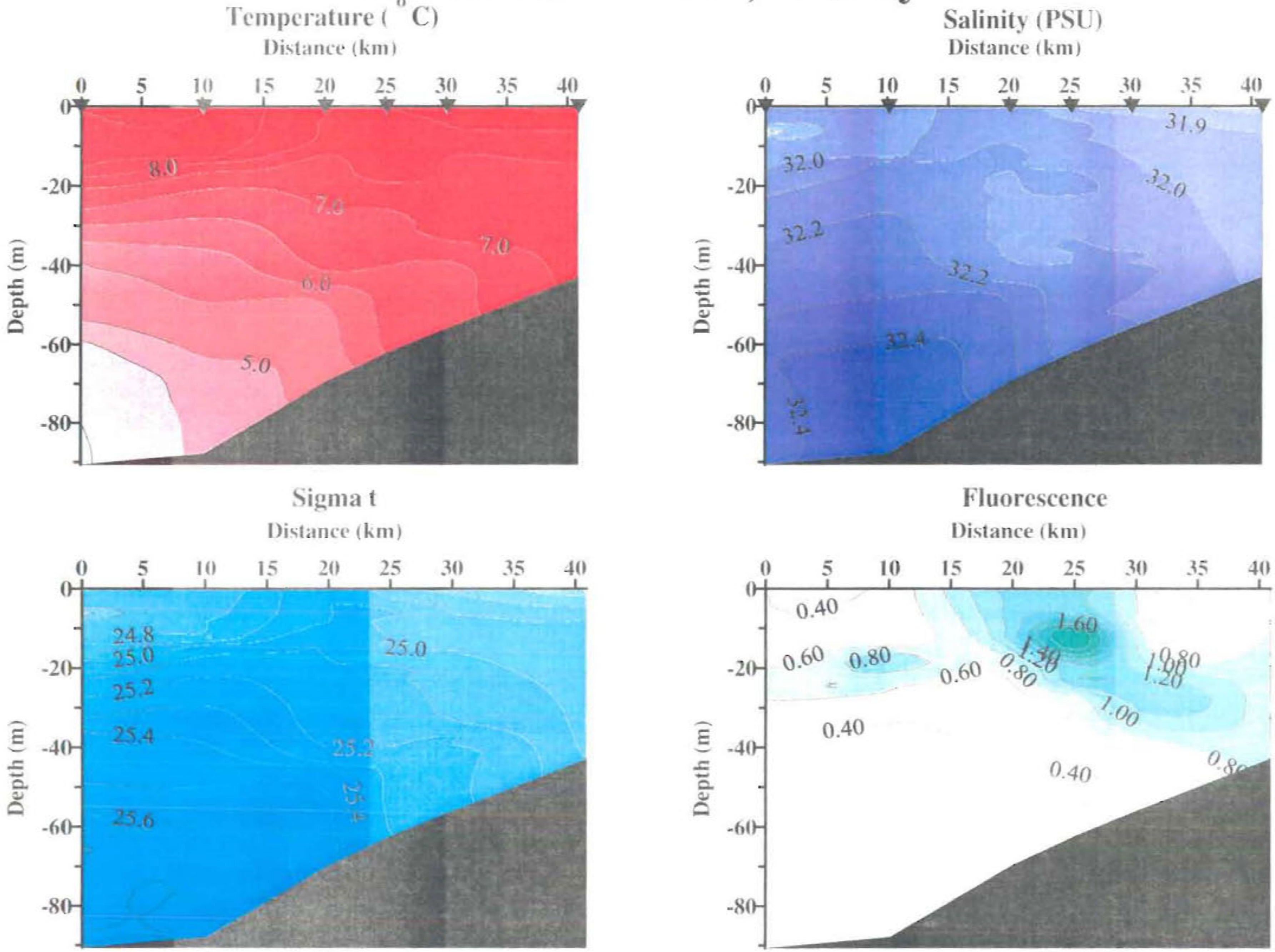
Fluorescence



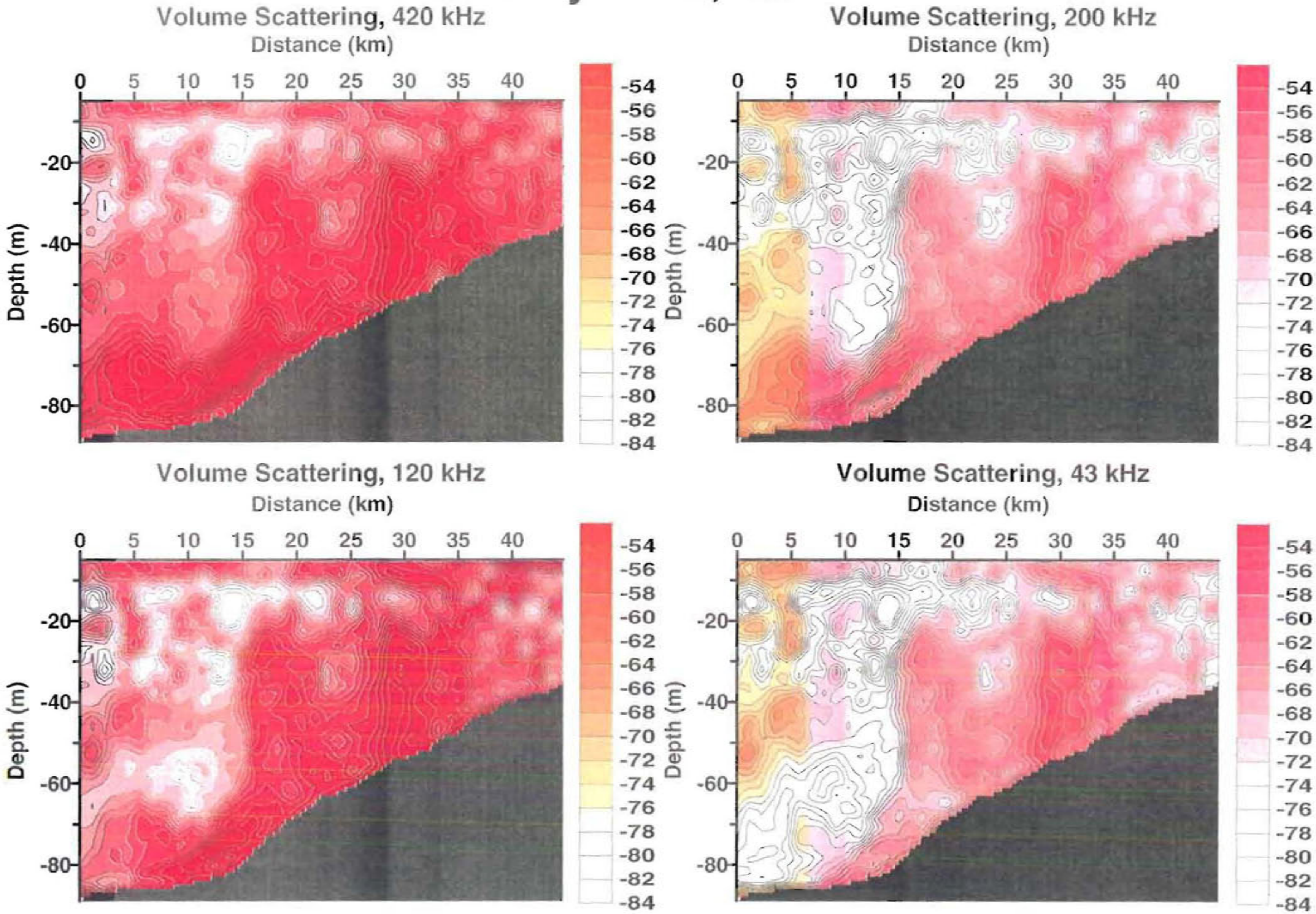
Unimak Pass (w-e), 26 July '99



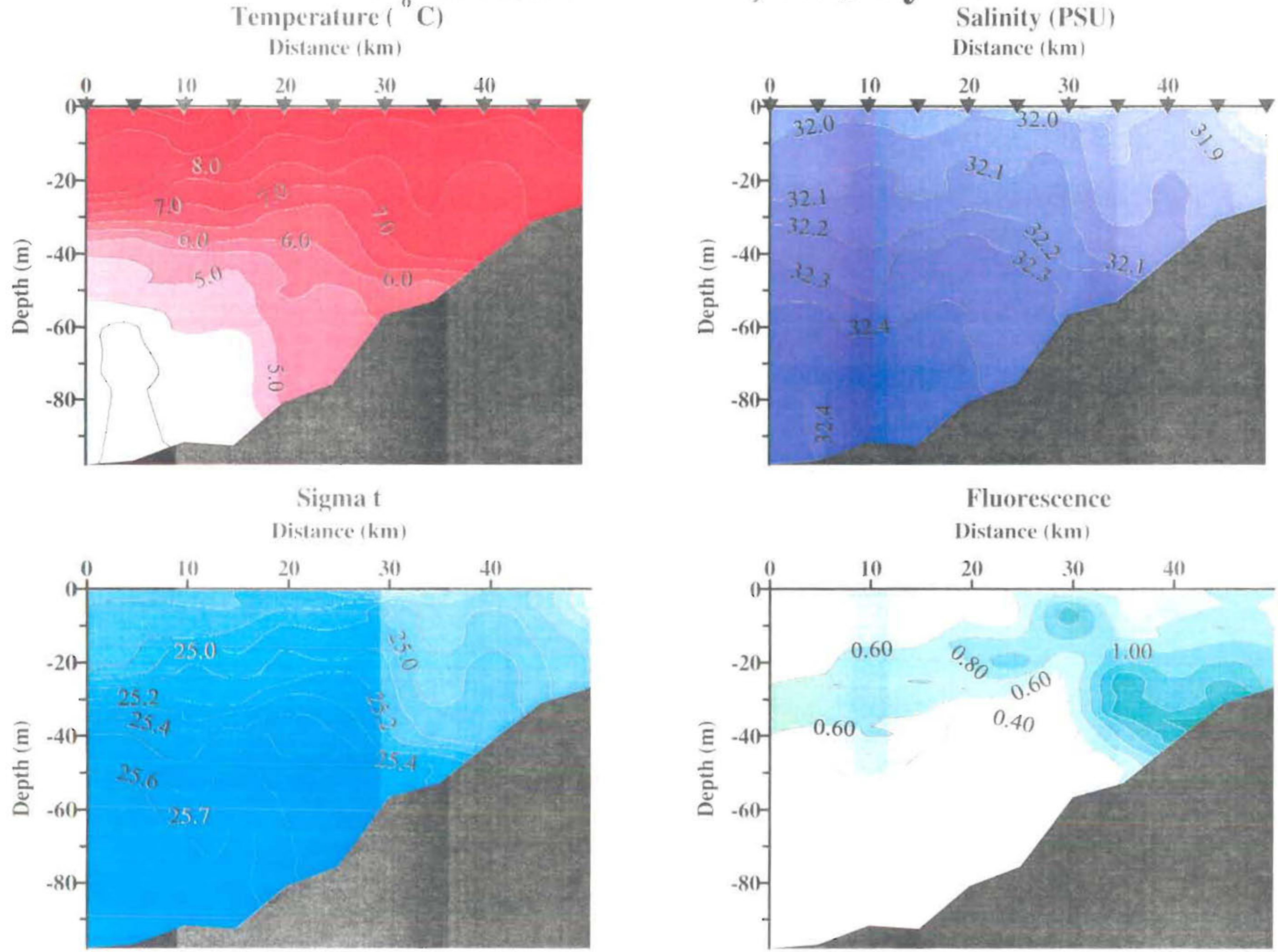
Slime Bank A-line, 28 July '99



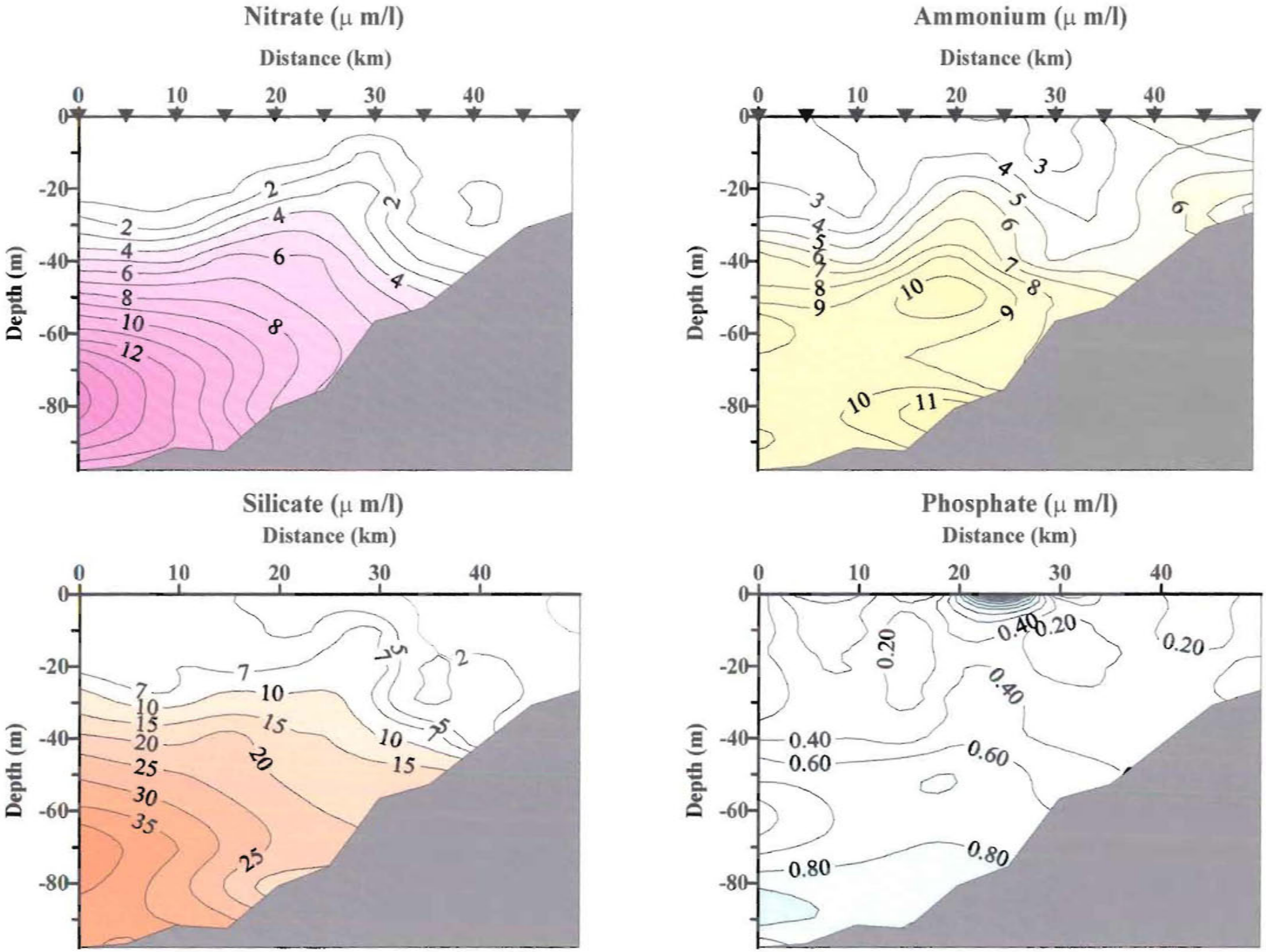
28 July 1999; slmba



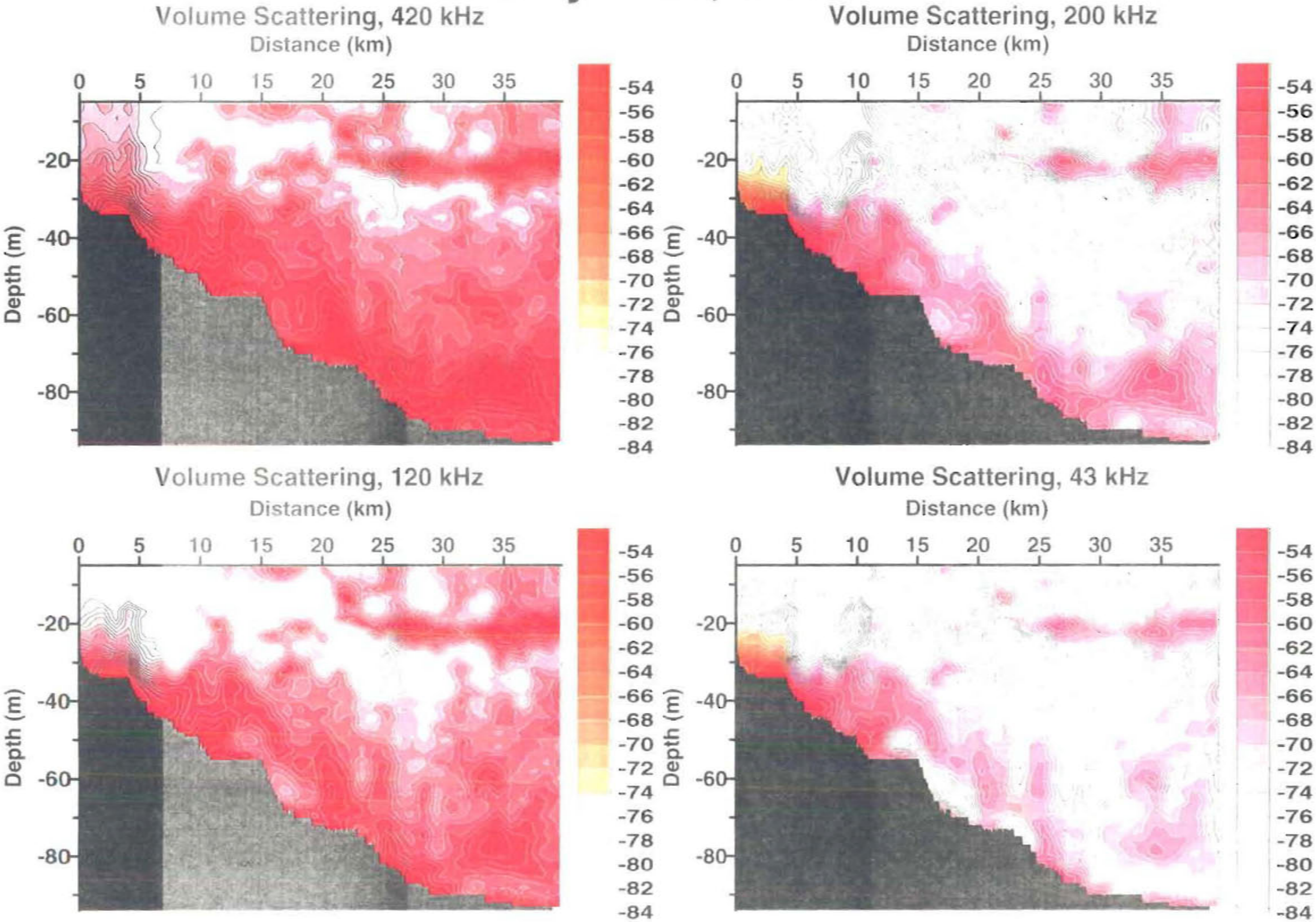
Slime Bank C-line, 28 July '99



HX222 - Slime Bank-C - 27 July 1999

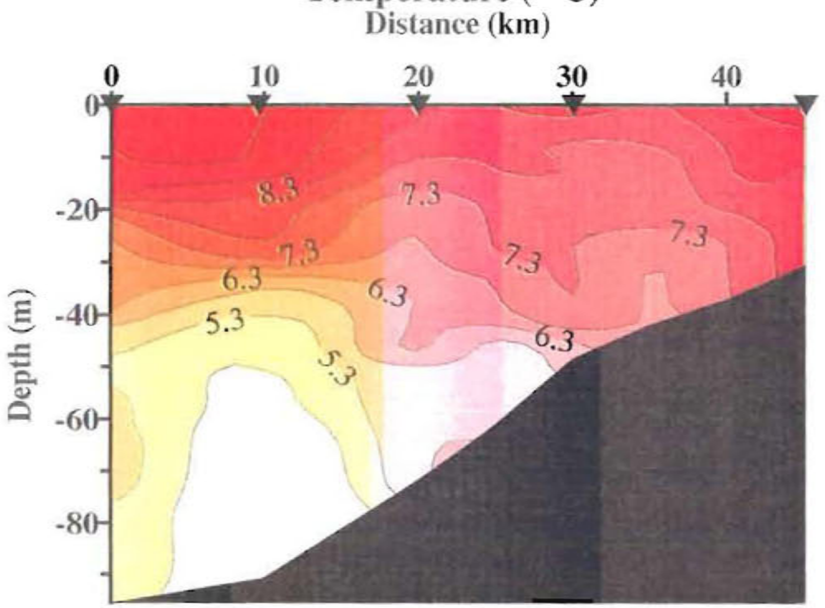


29 July 1999; slmbc

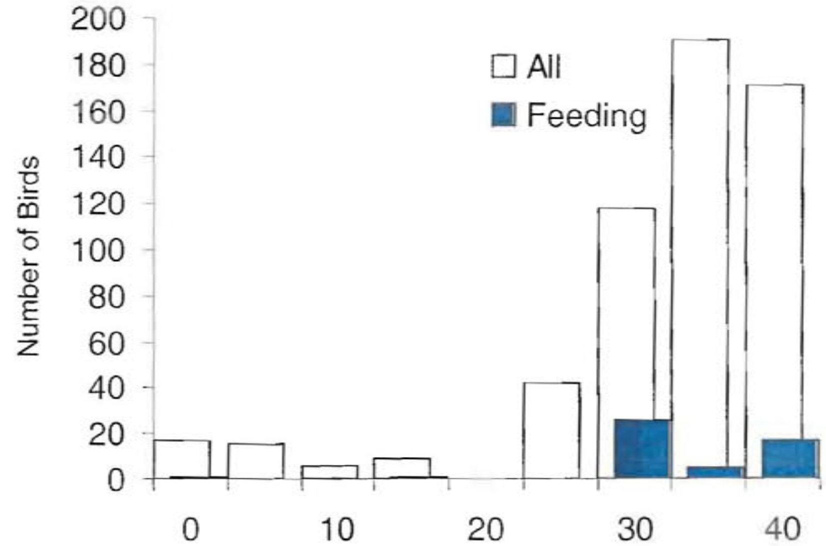


SLIME BANK (C Line), 27 July 1999, 12:50-18:00

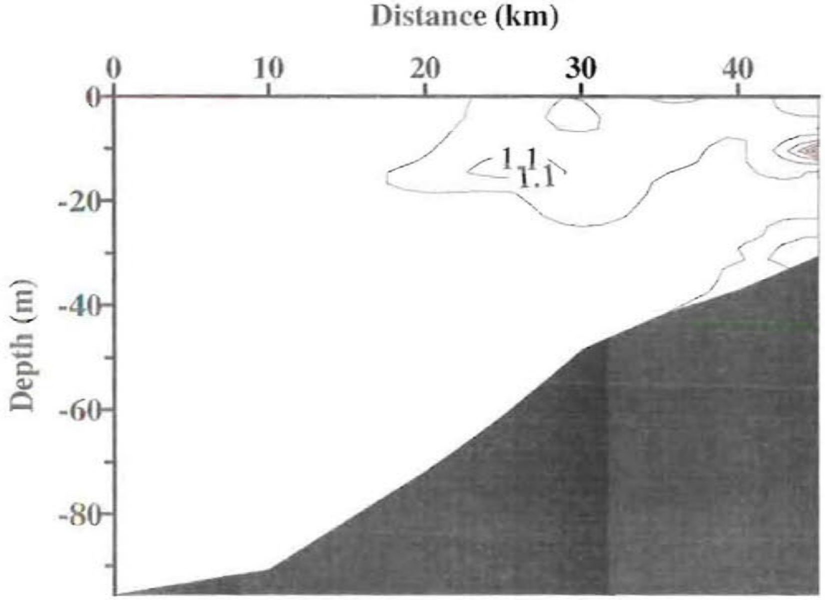
Temperature (°C)



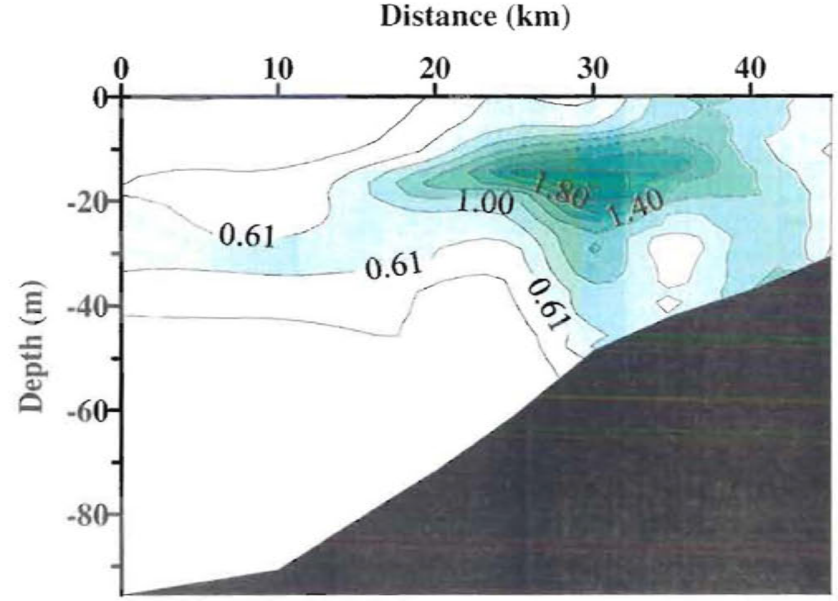
Dark Shearwaters, feeding and on the water, stations SBE10 to SBE01, 8:25-12:35



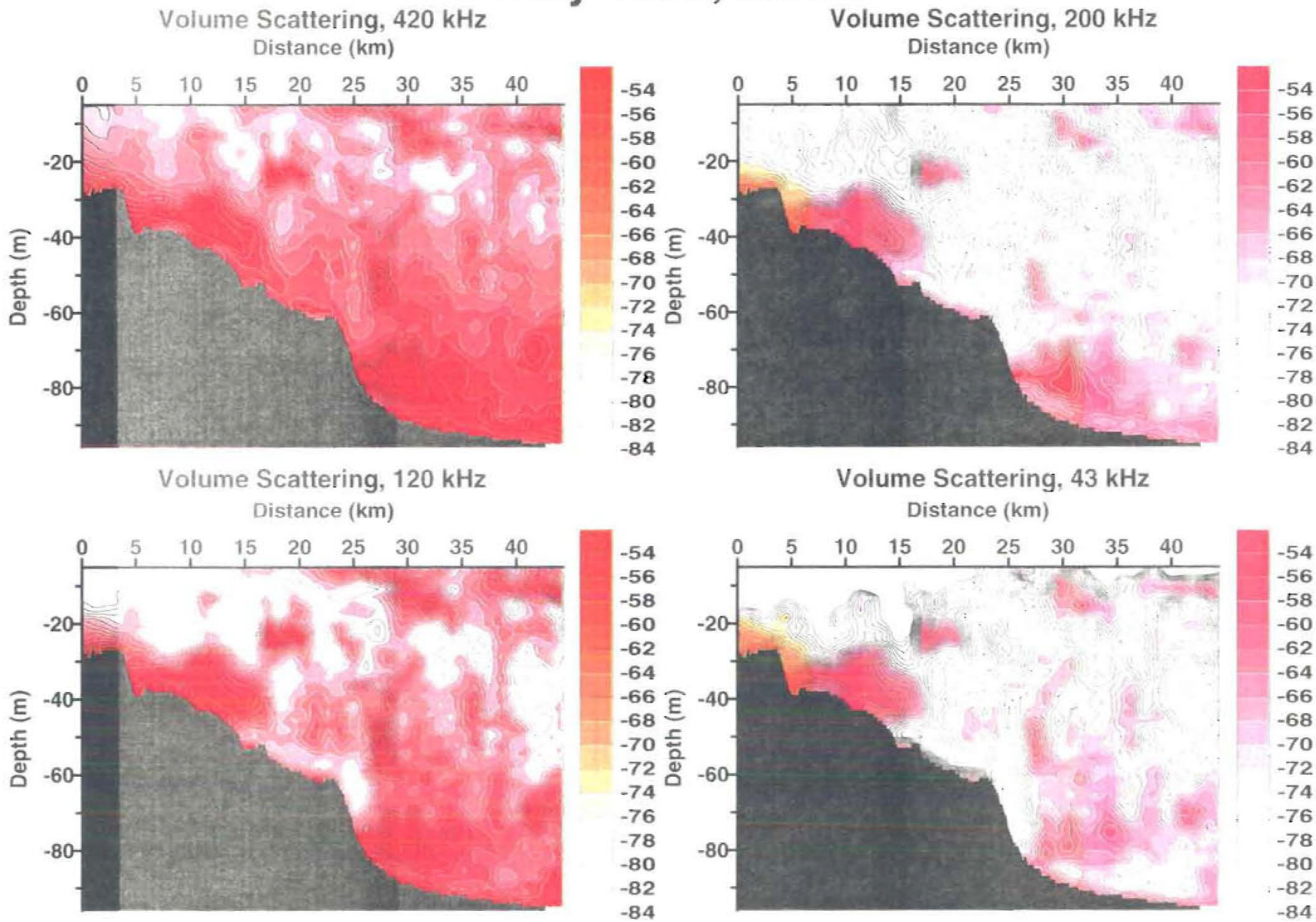
Extinction Coefficient



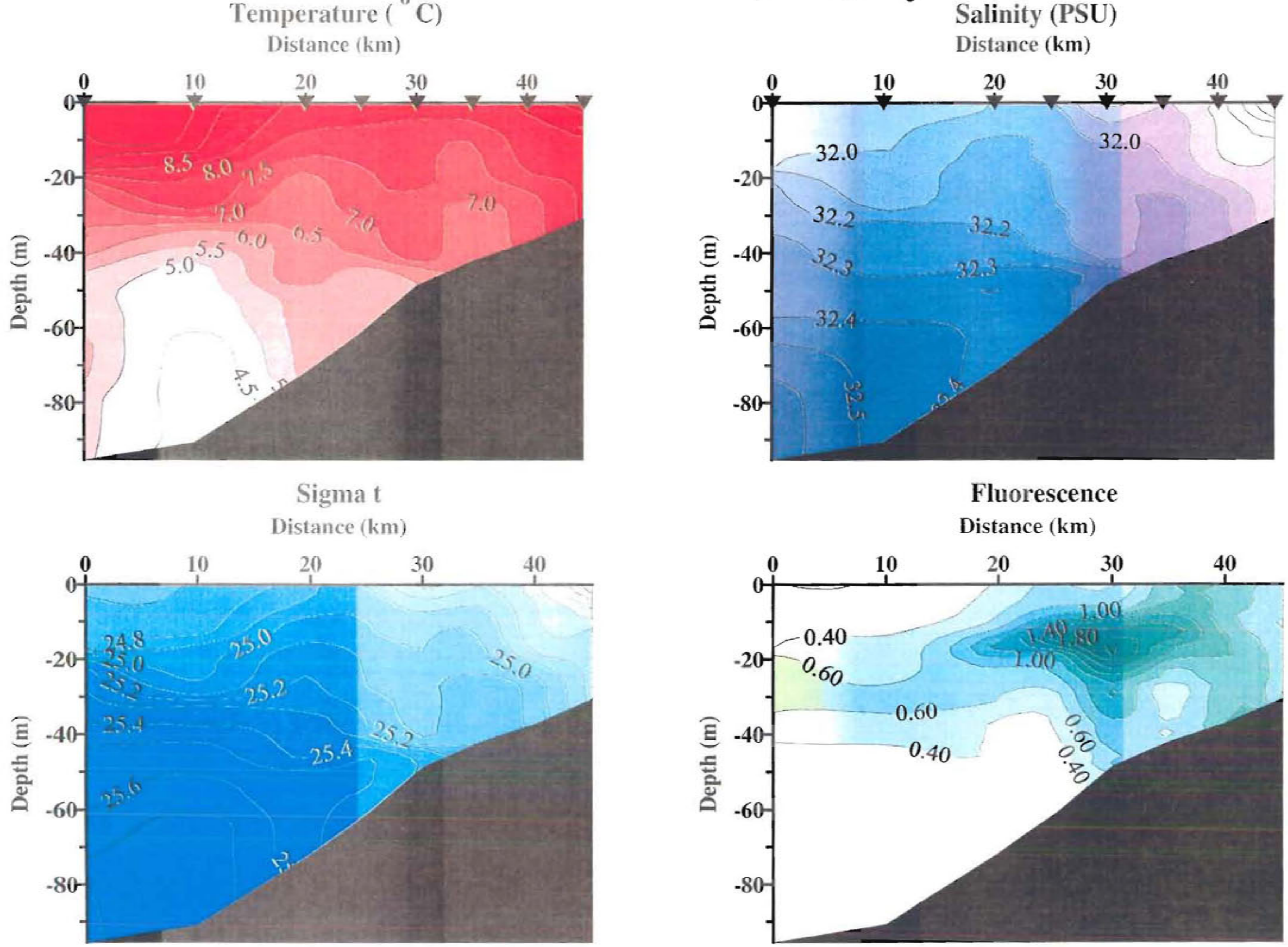
Fluorescence



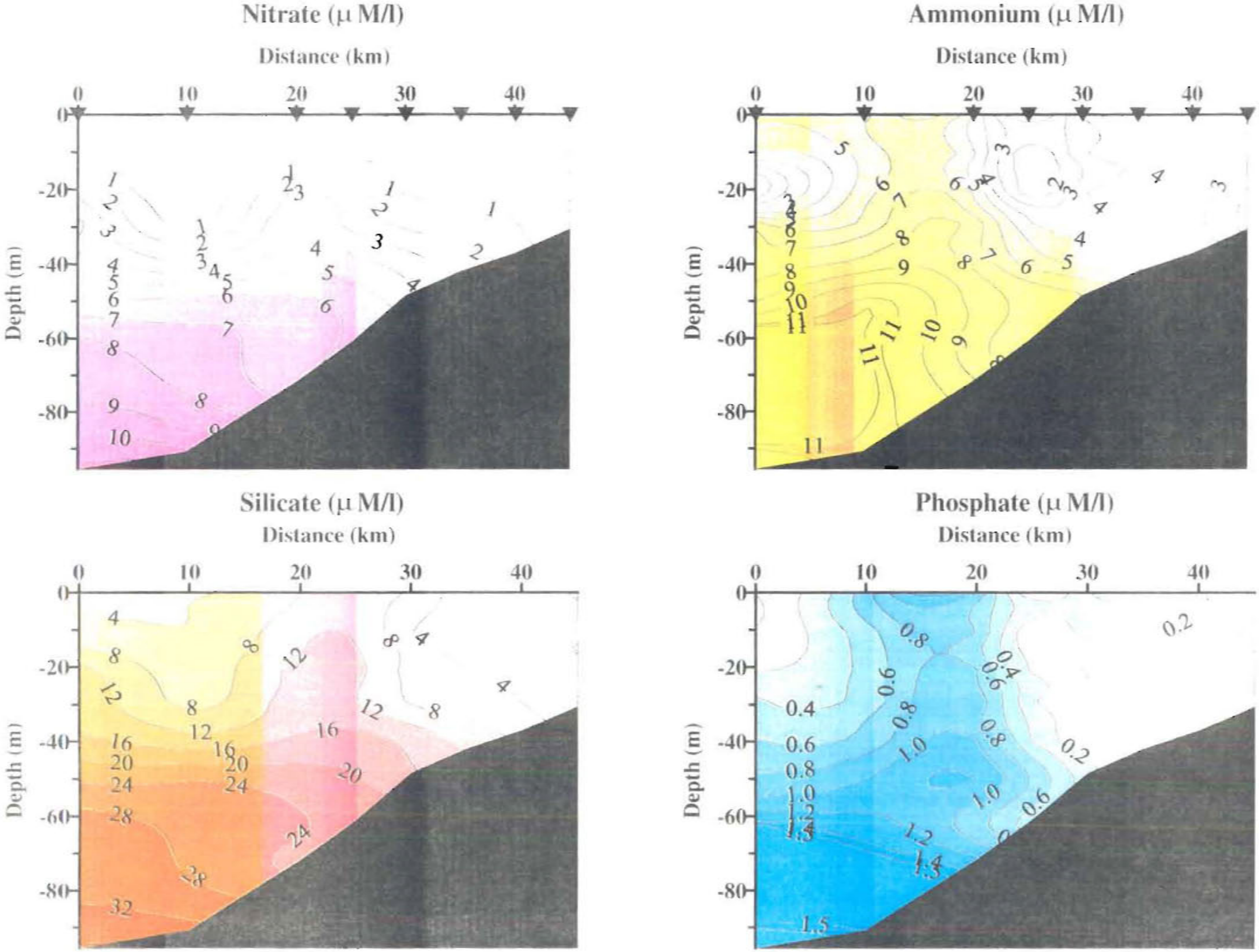
27 July 1999; slmbe



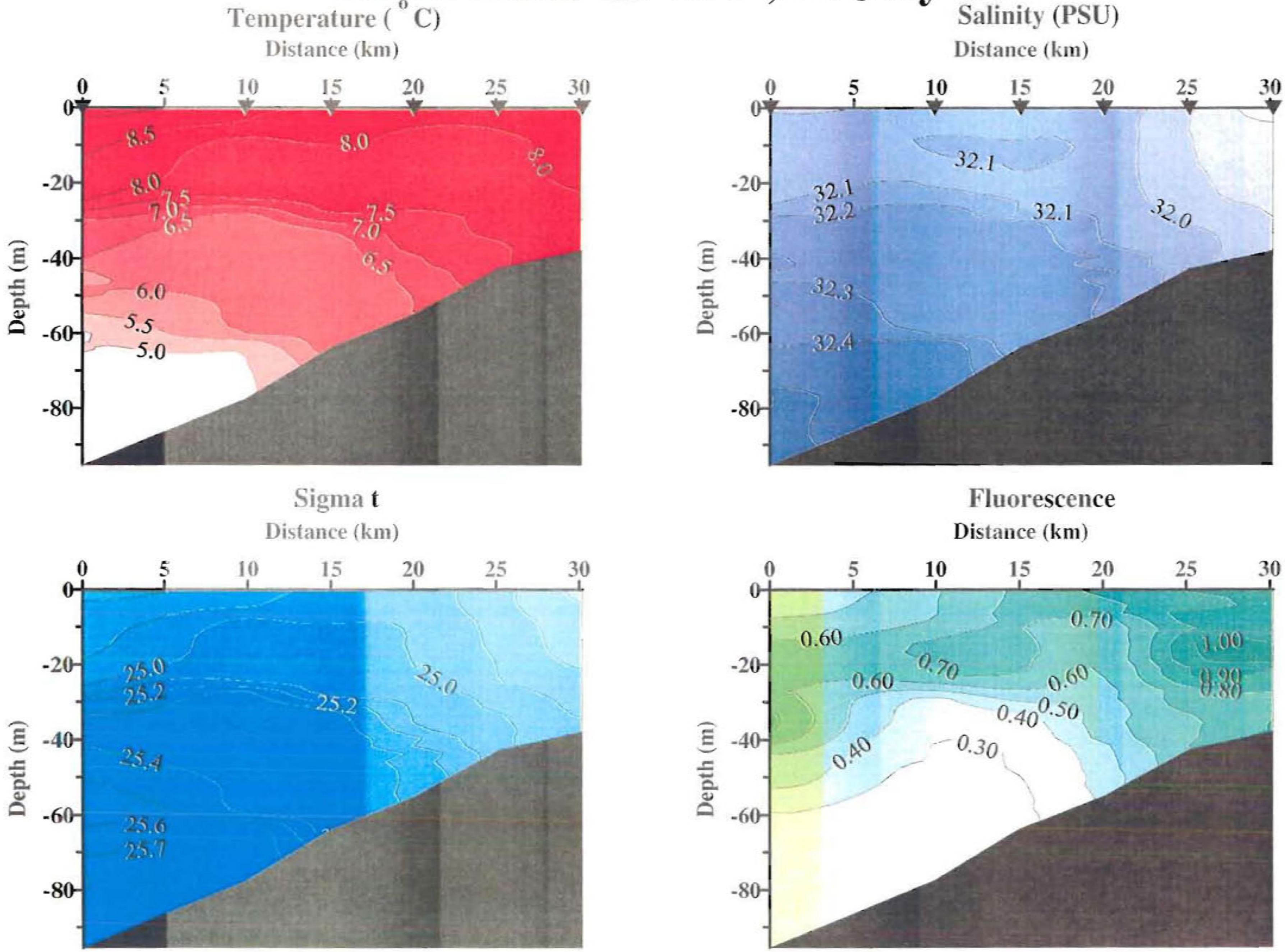
Slime Bank E-line, 27 July '99



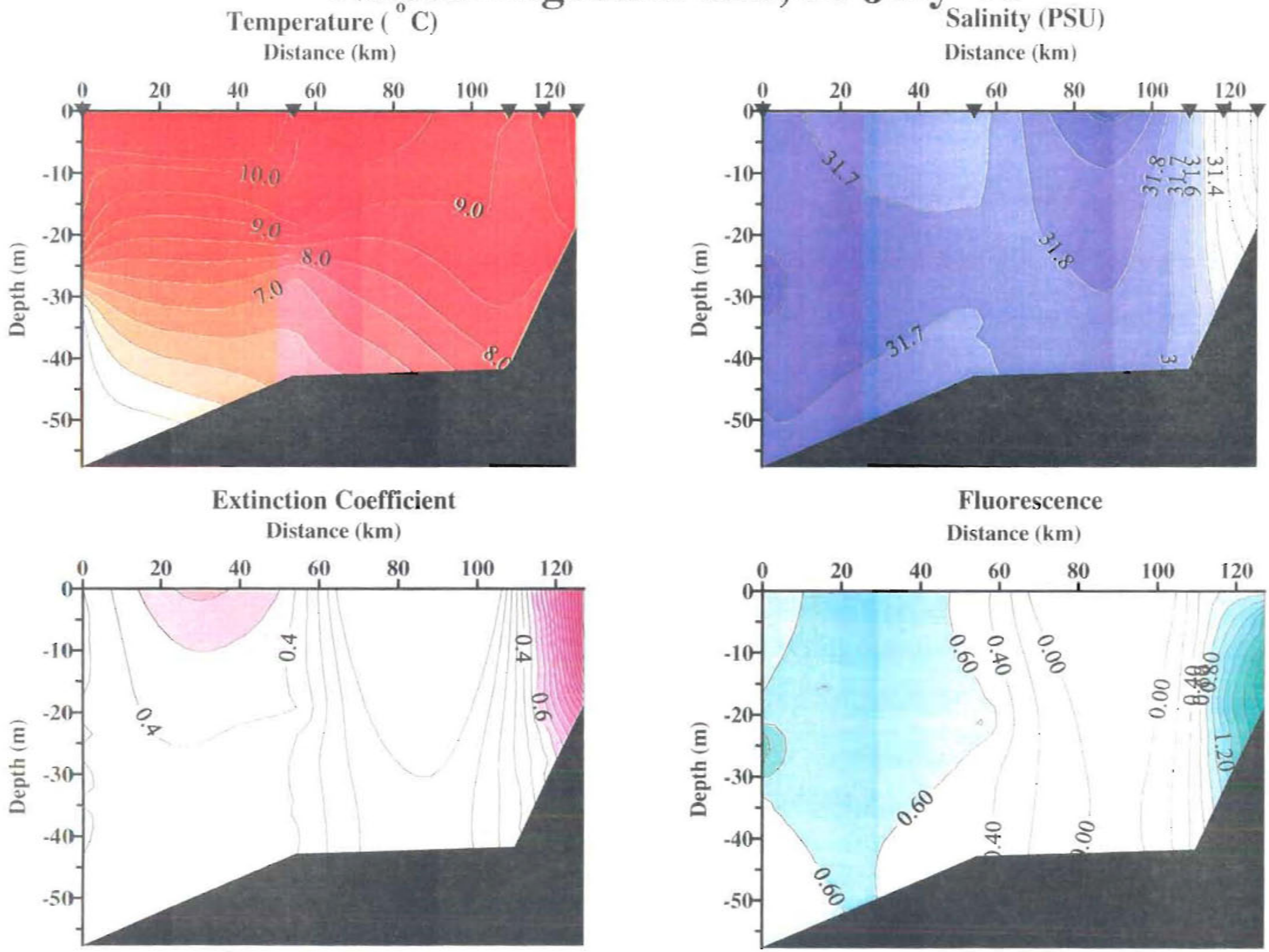
Slime Bank E-line, 27 July '99



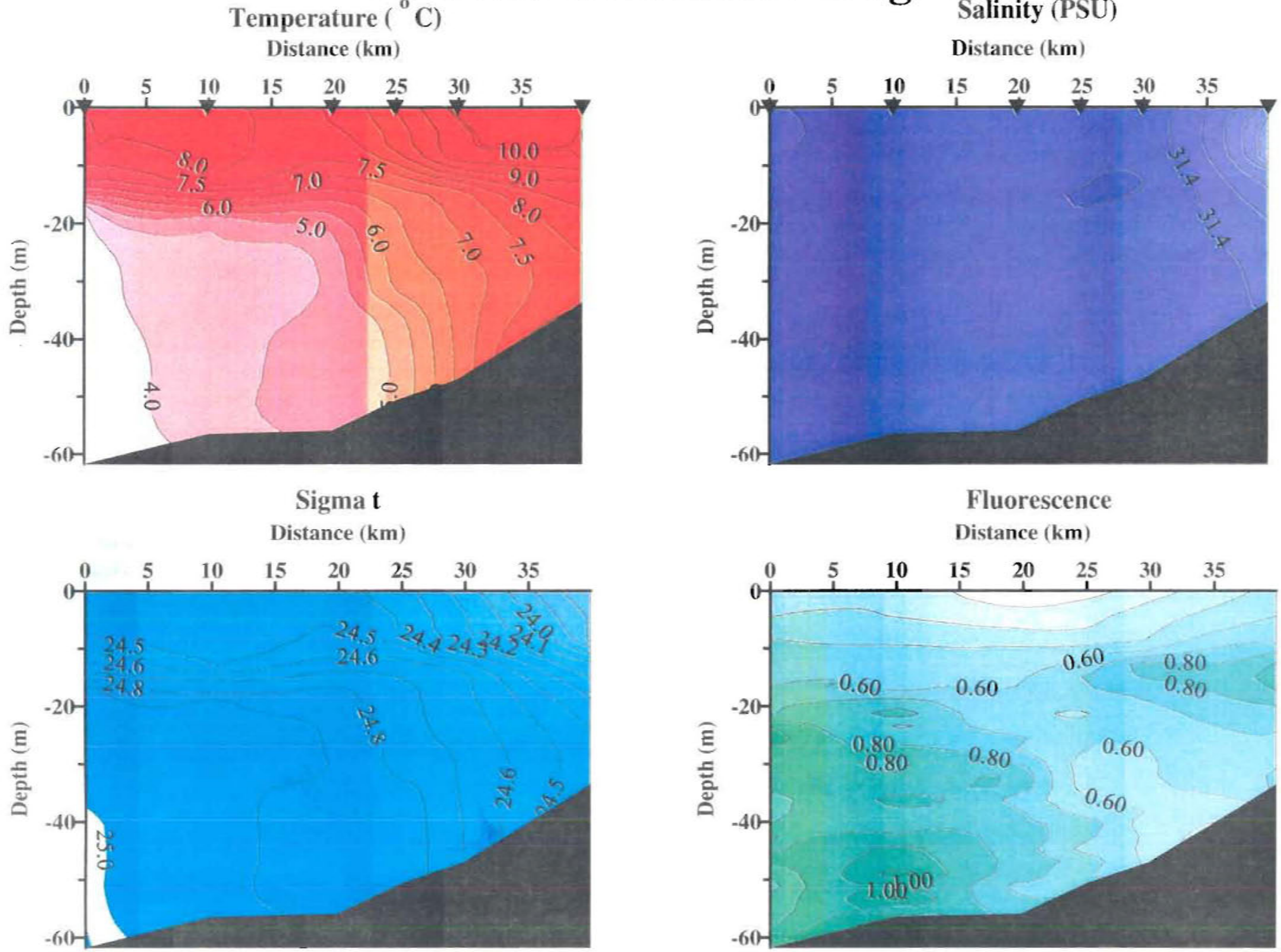
Slime Bank E2-Line, 30 July '99



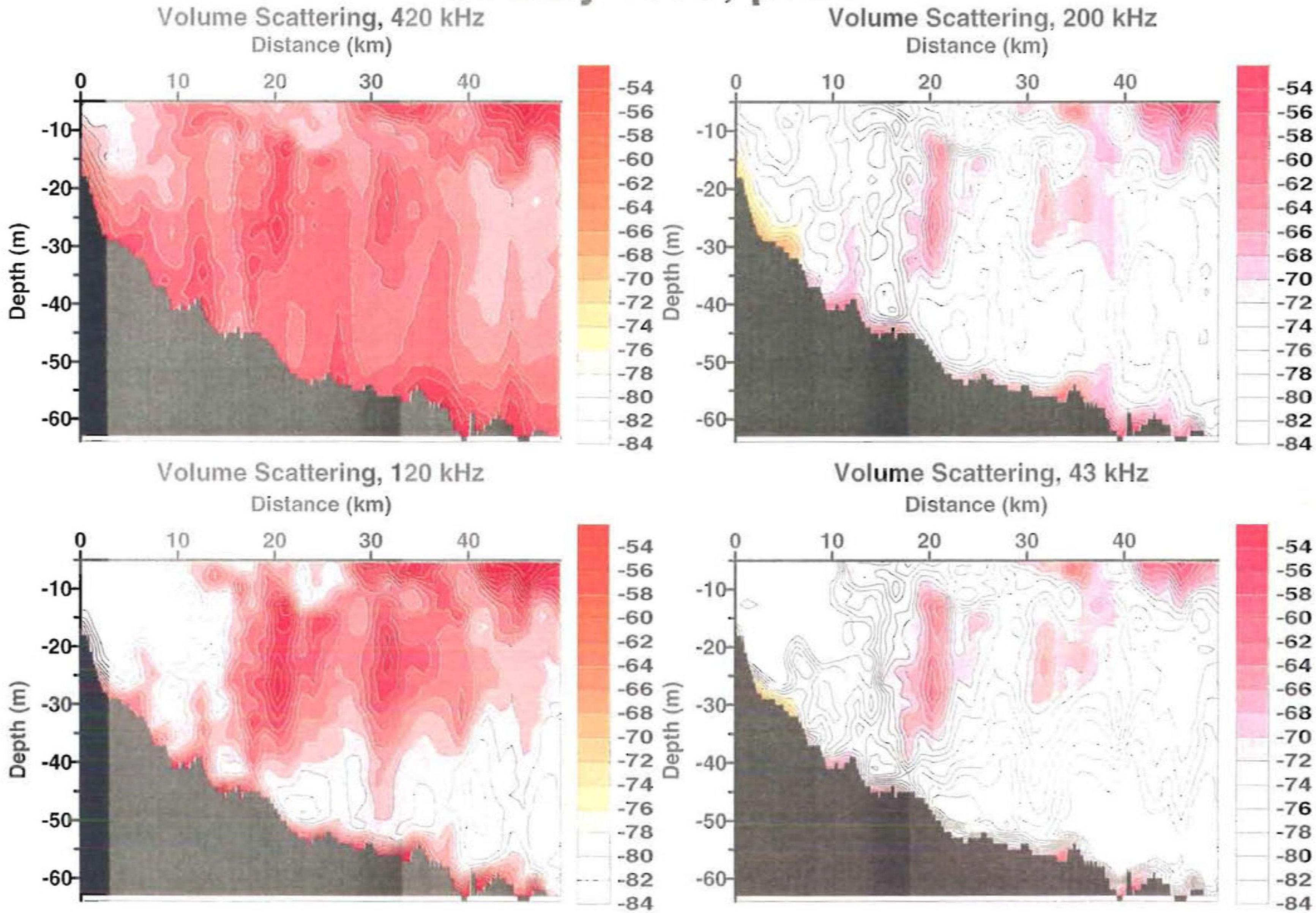
Nelson Lagoon B-line, 30 July '99



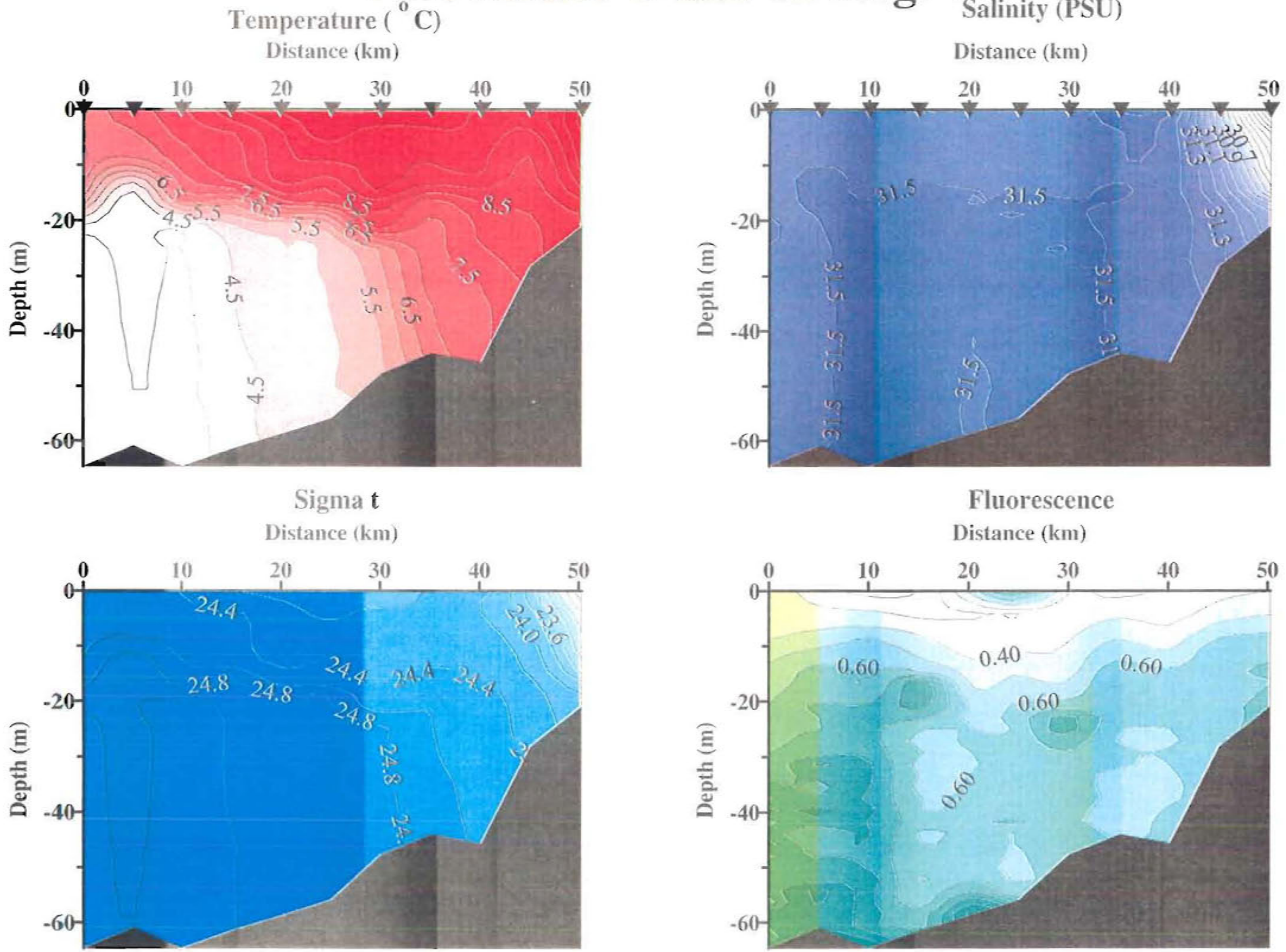
Port Moller A-Line 2 Aug. '99



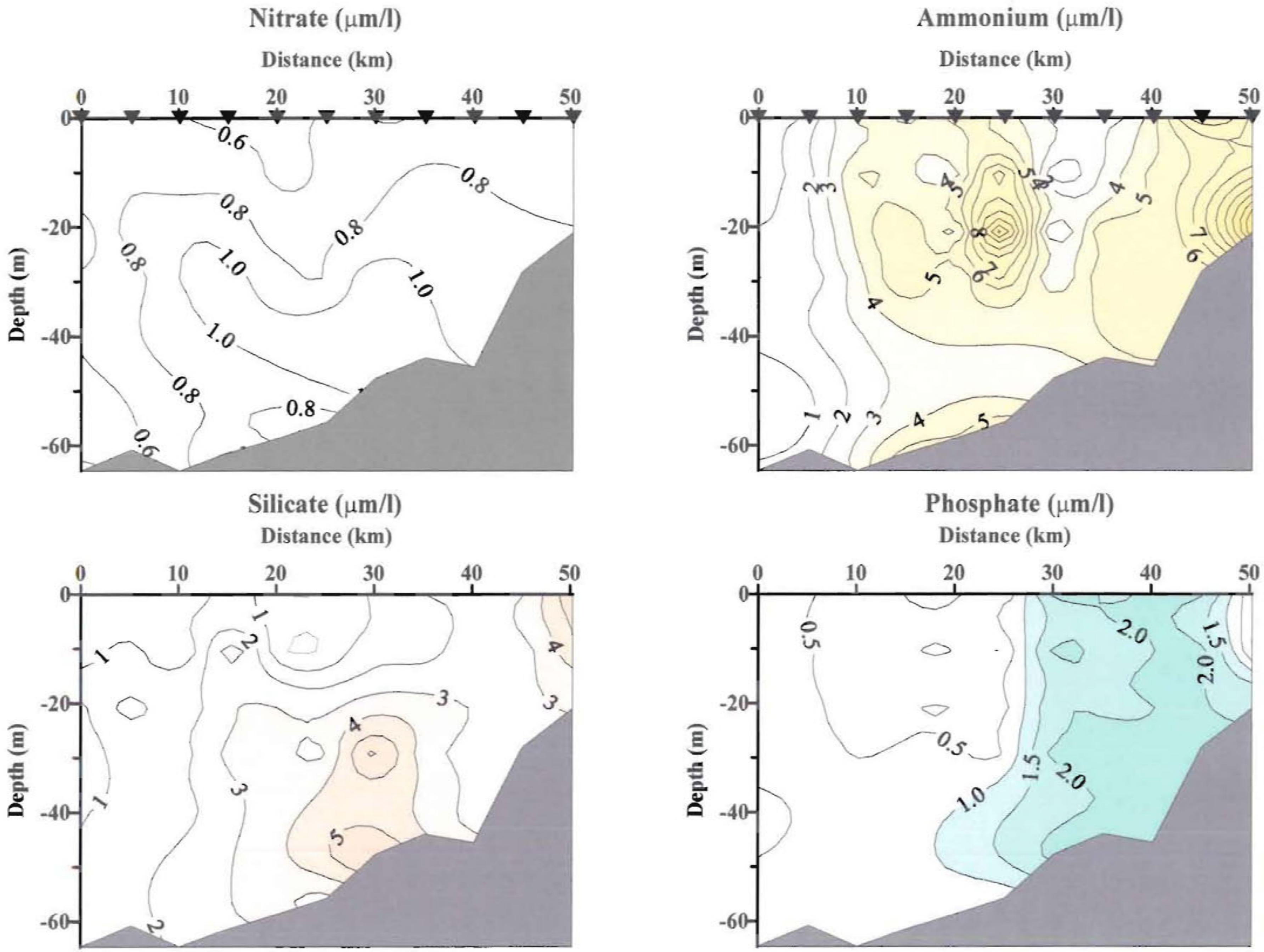
31 July 1999; pmla



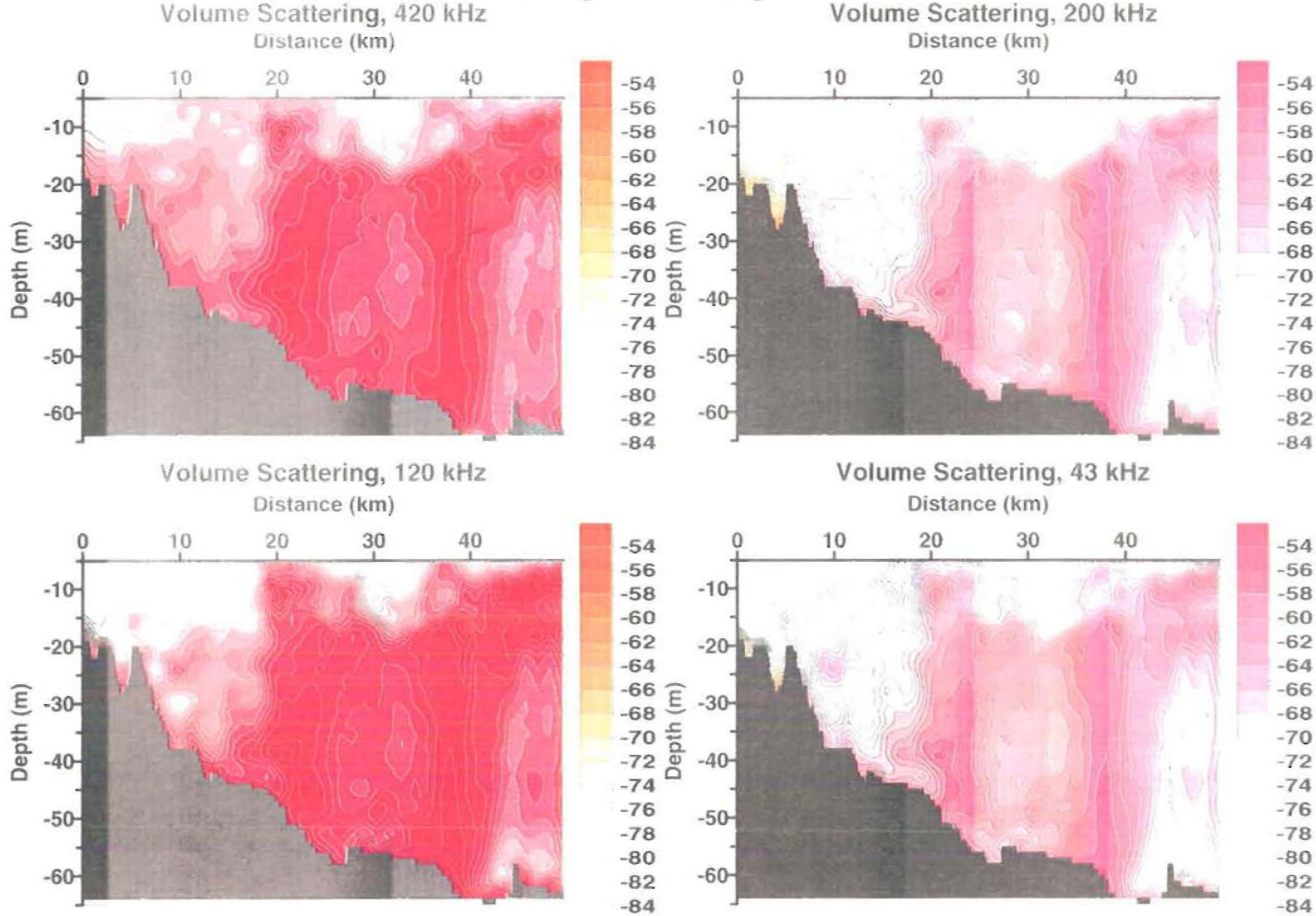
Port Moller C-line 02 Aug. '99



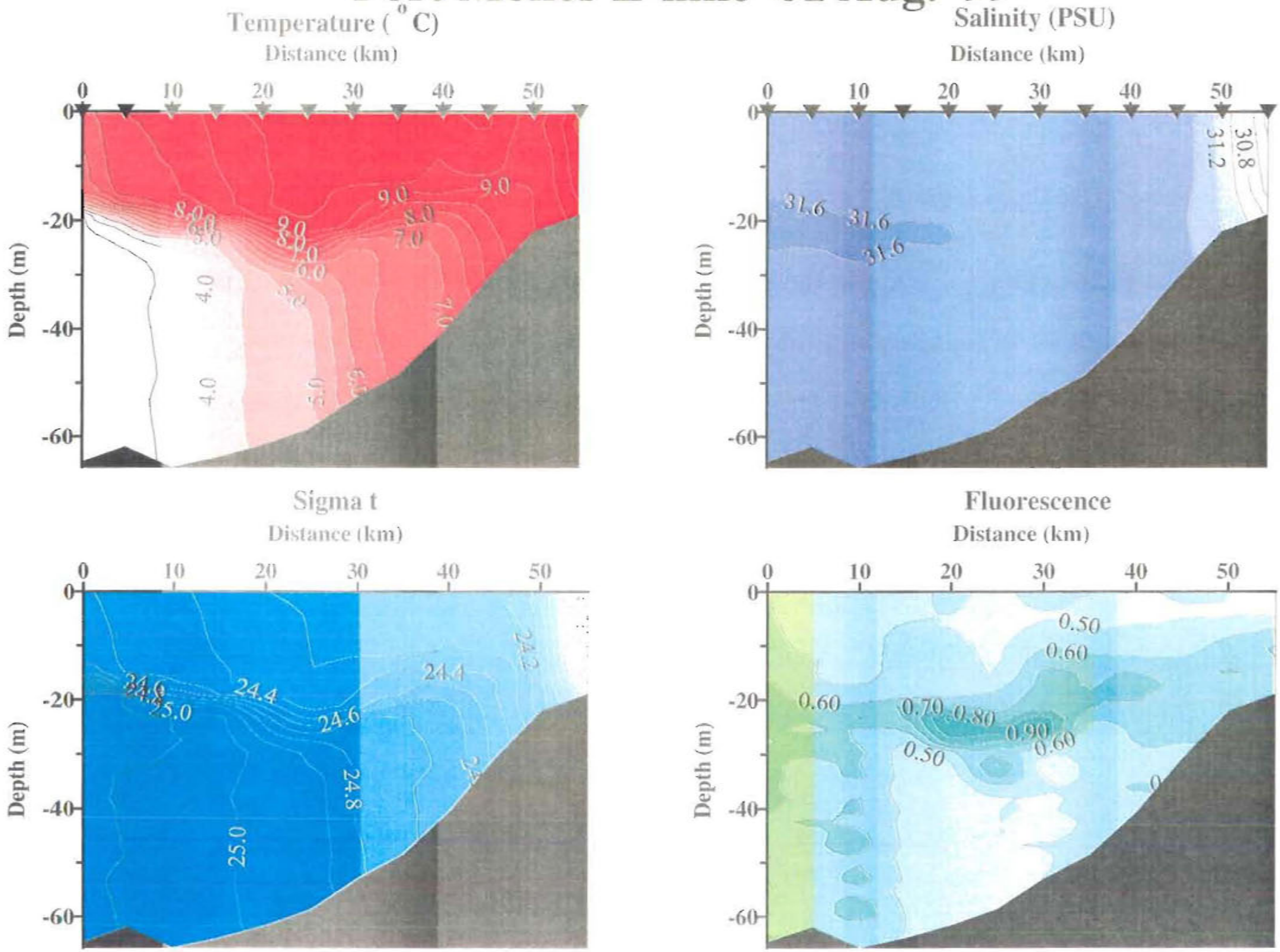
HX222 - Port Moller-C - 01 August 1999



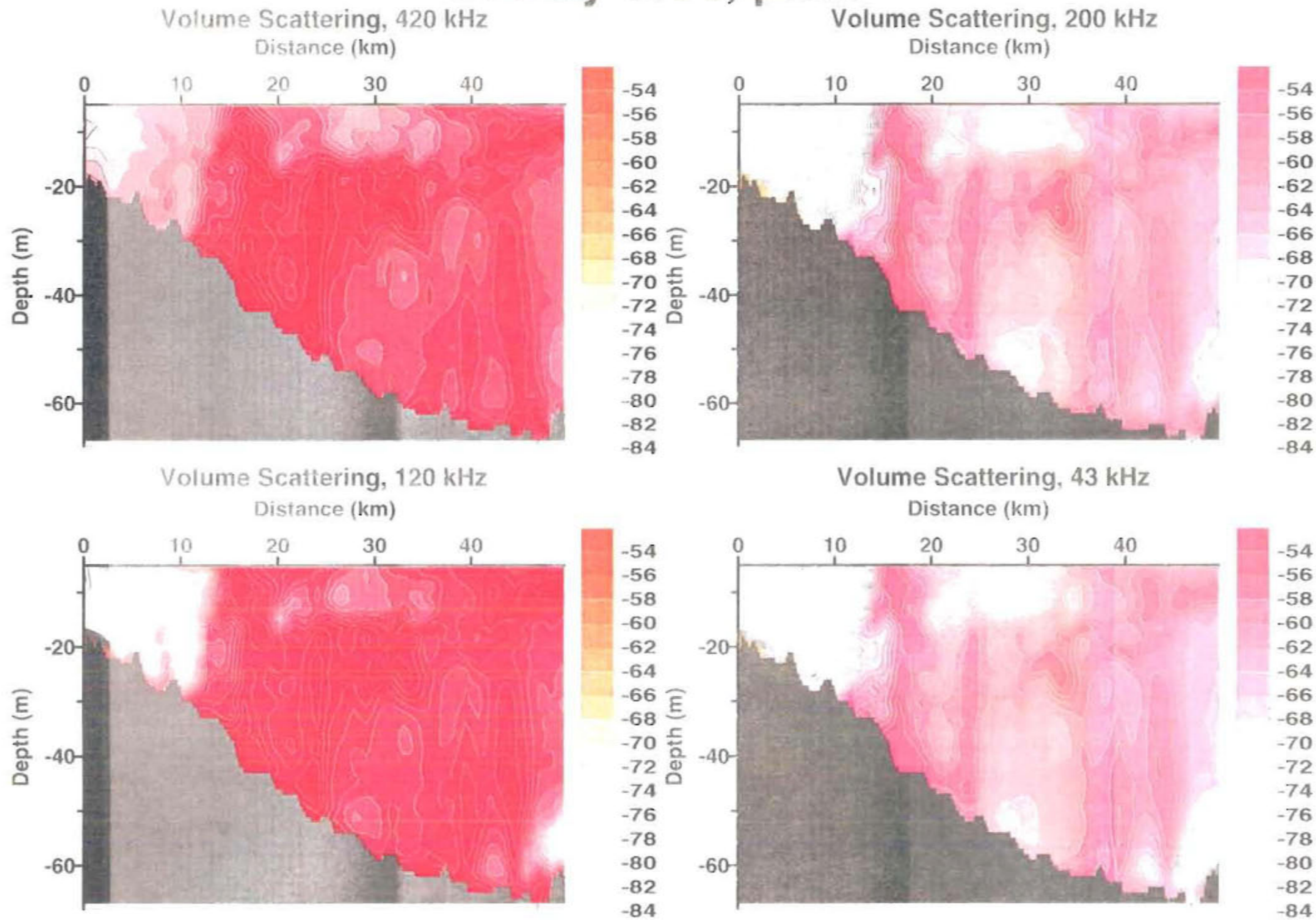
31 July 1999; pmlc

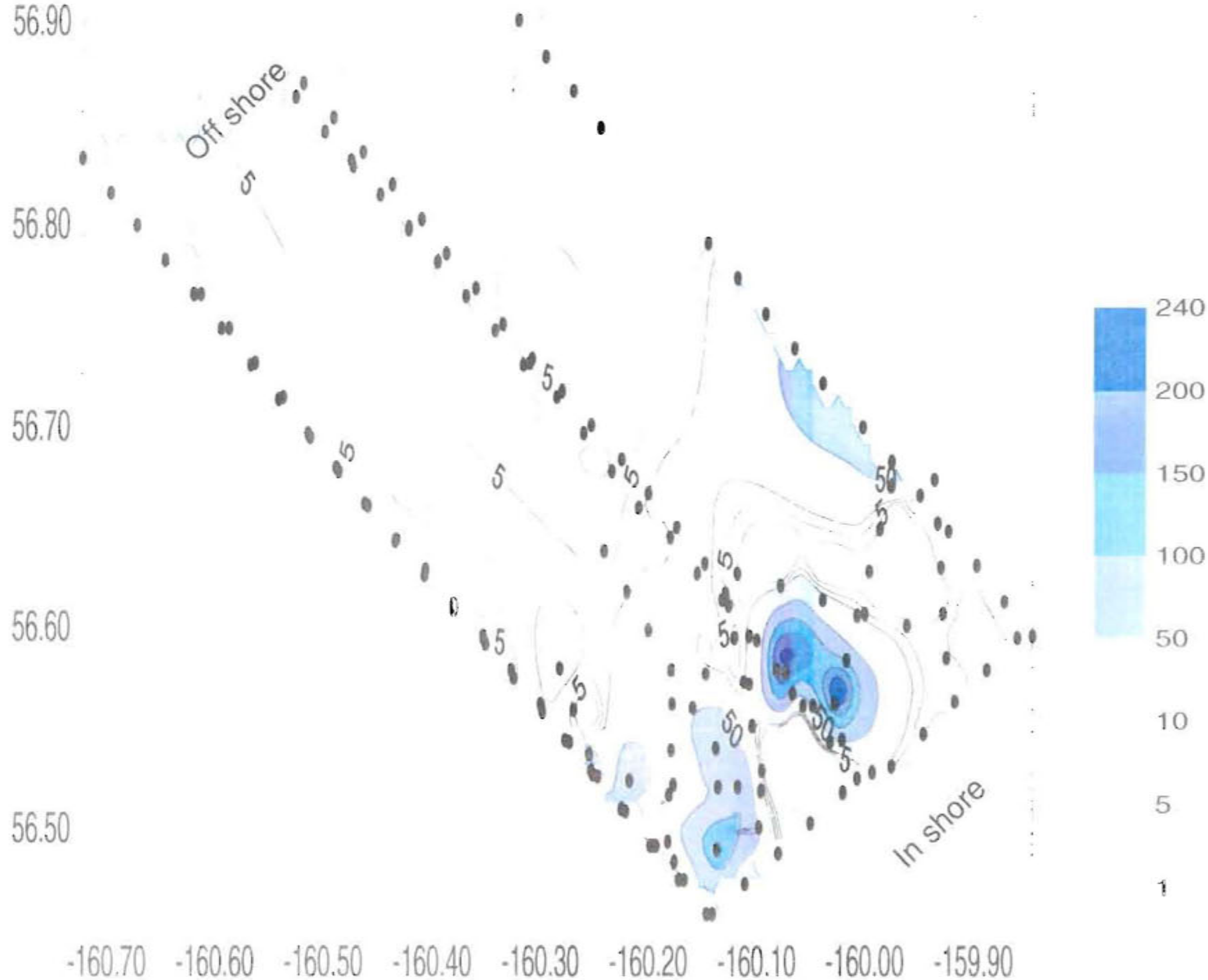


Port Moller E-liine 01 Aug. '99



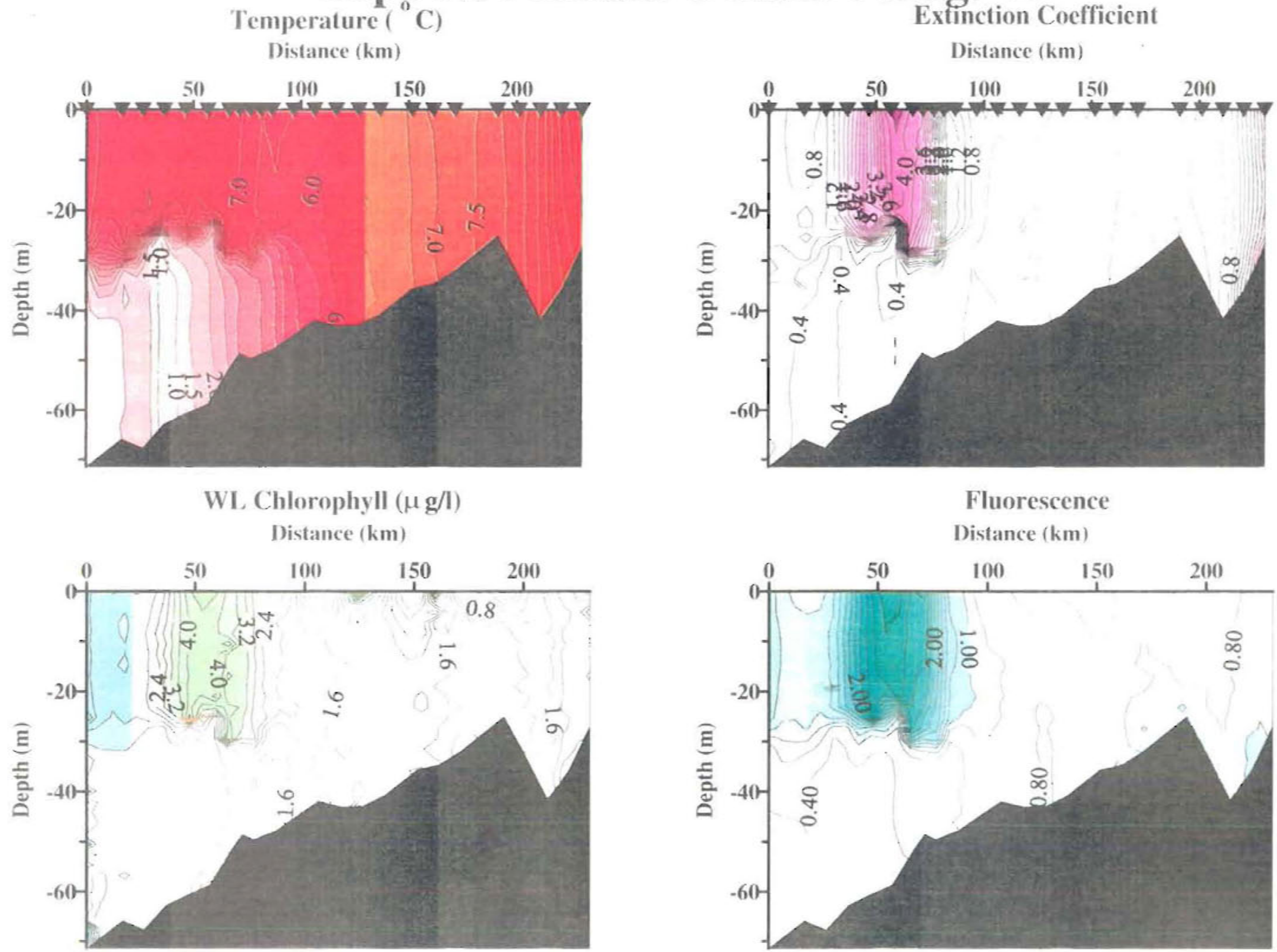
31 July 1999; pmle



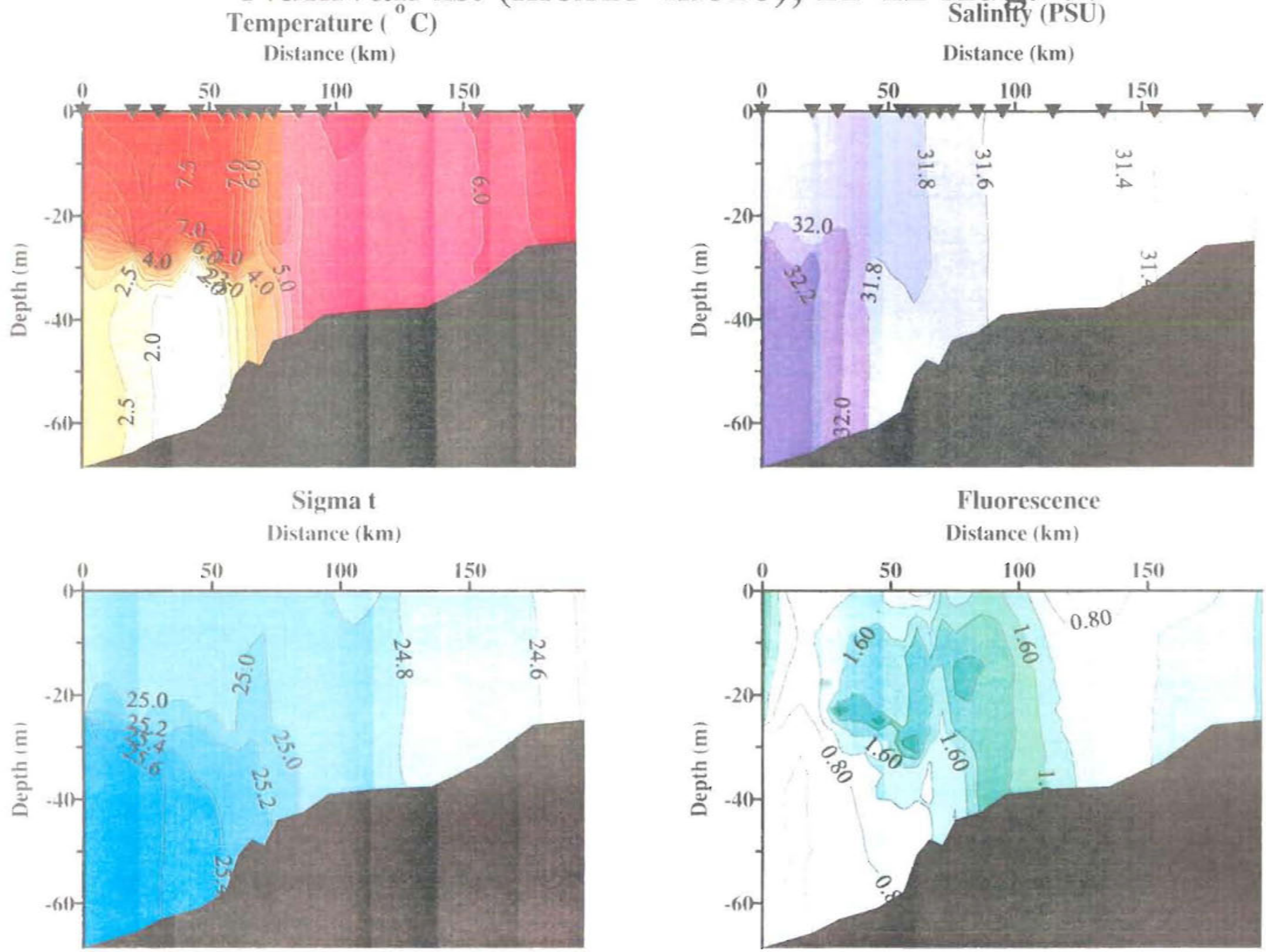


Distribution of Dark Shearwaters, Murres and Kittiwakes observed feeding and on the water at Port Moller, July 31 to Aug 2.

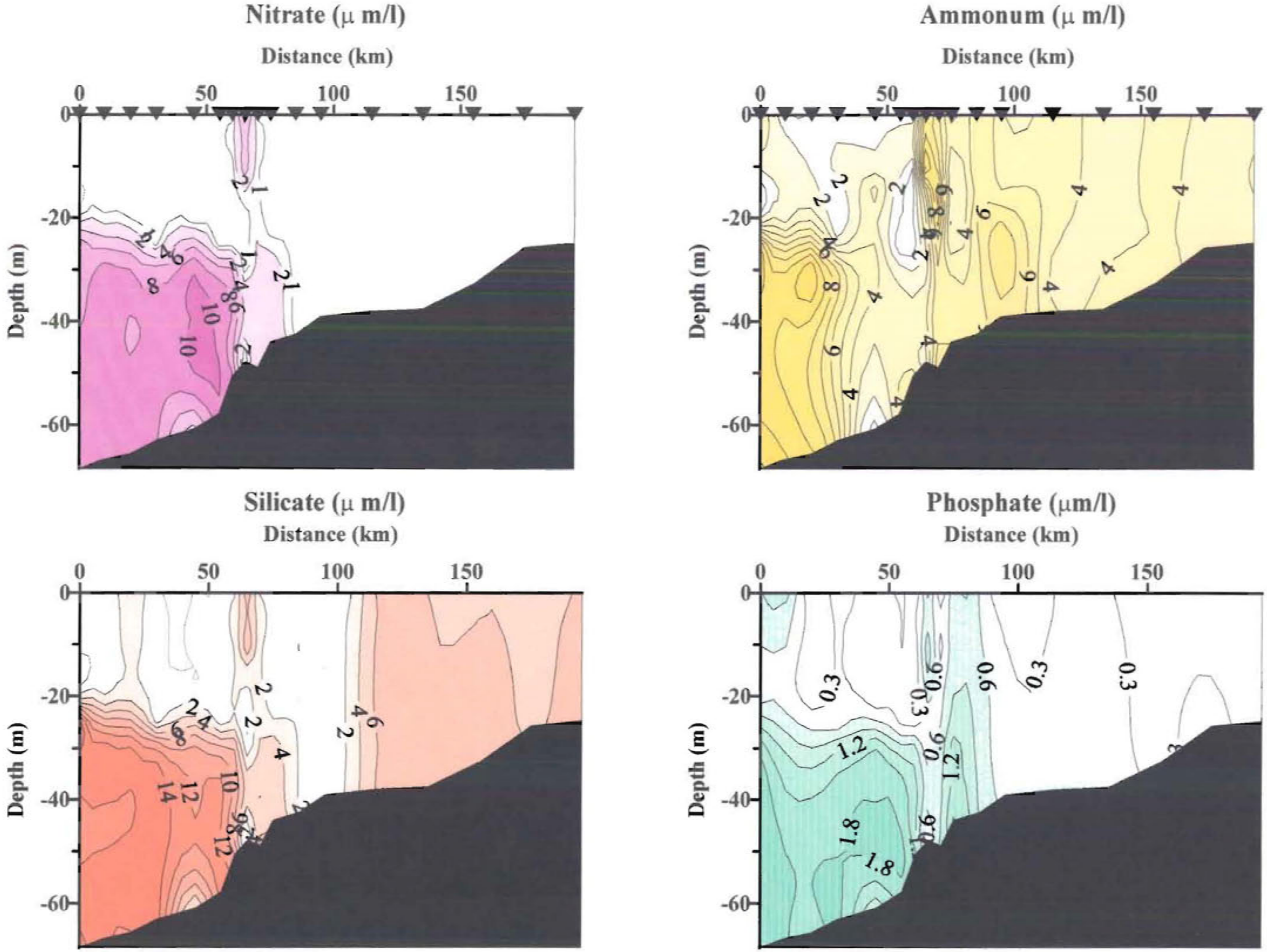
Cape Newenham C-LIne 6 Aug. '99



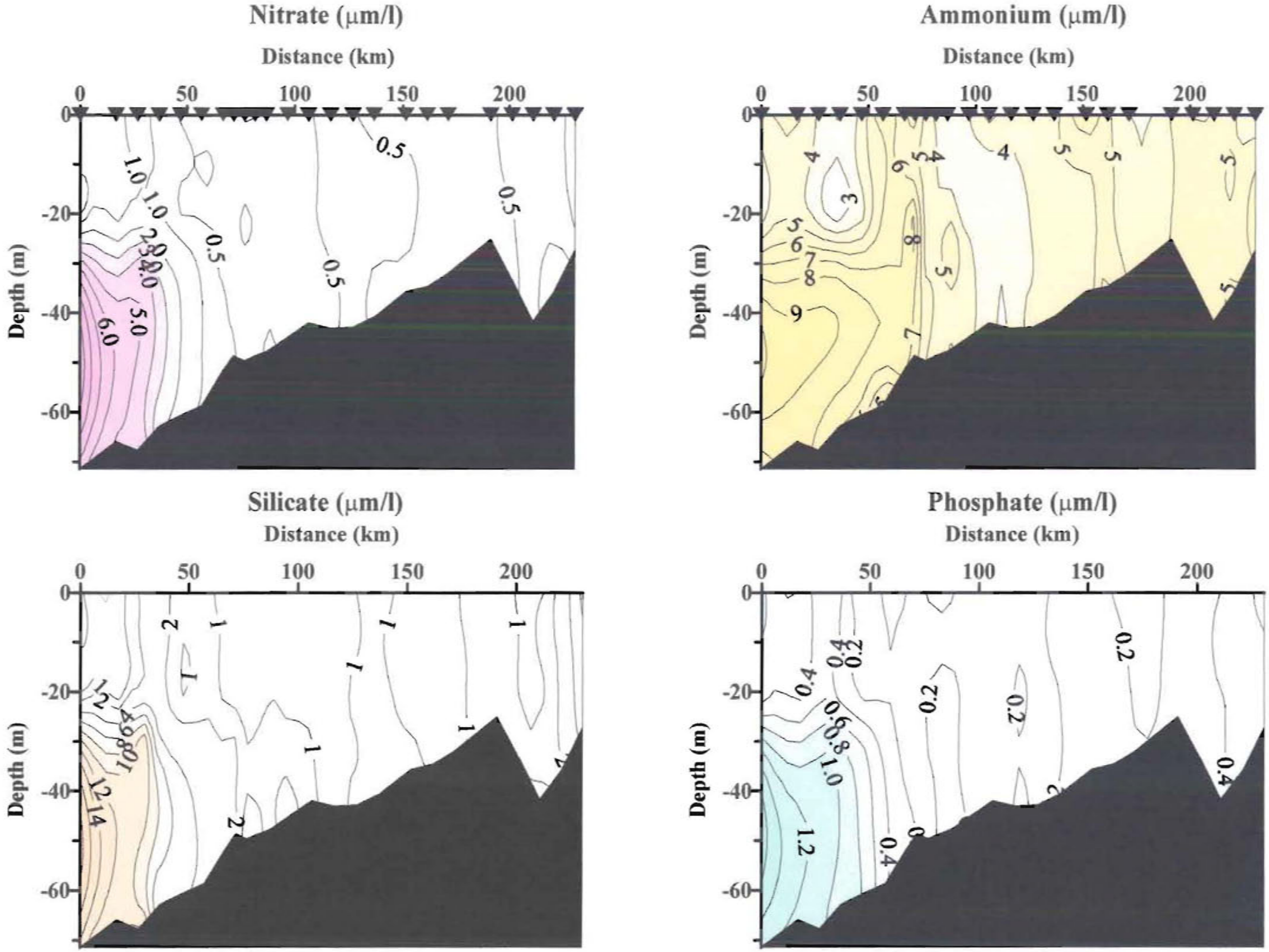
Nunivak Is. (nicx15-nic16), 11-12 Aug. '99



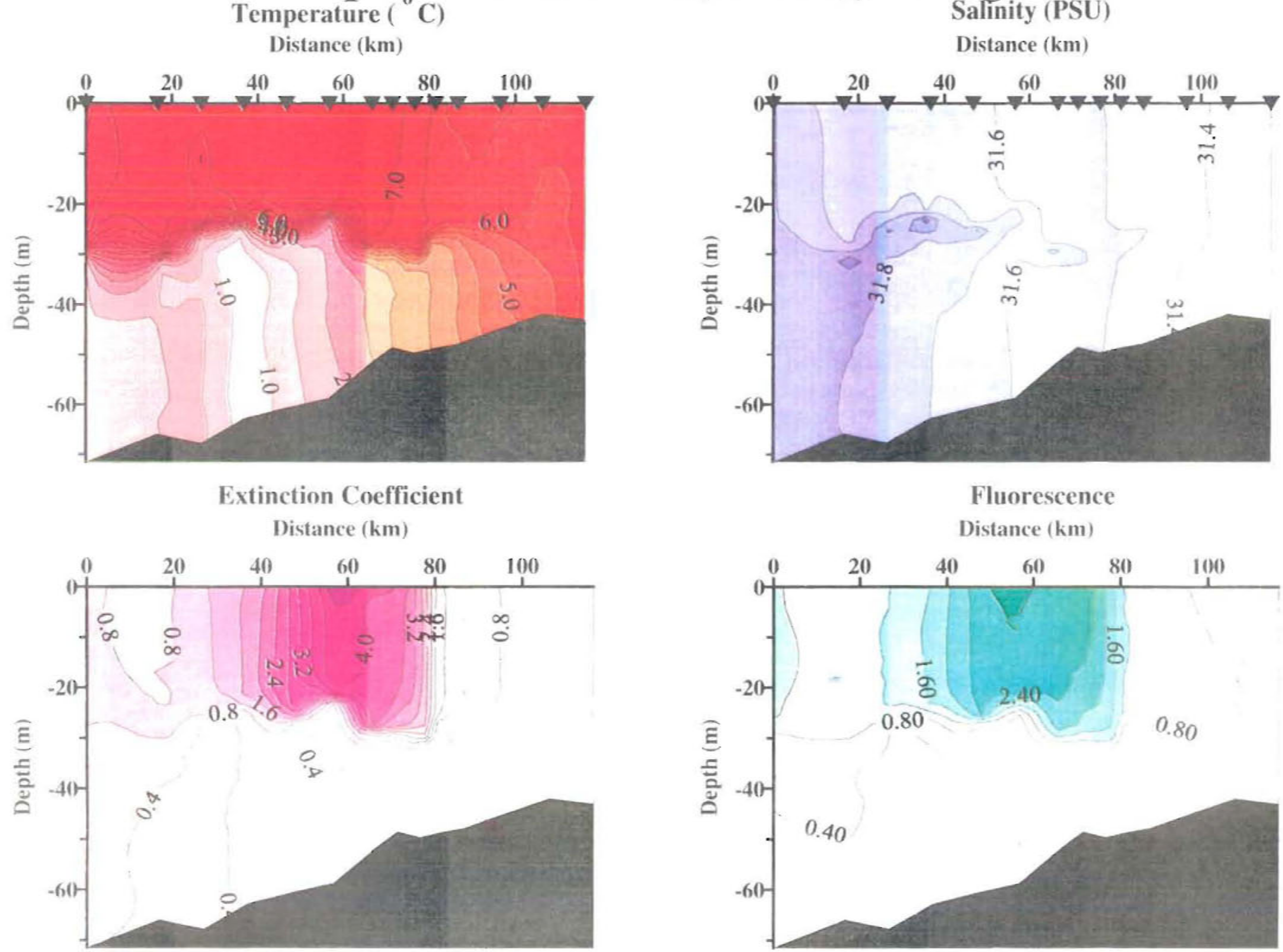
HX222; Nunivak Island-C



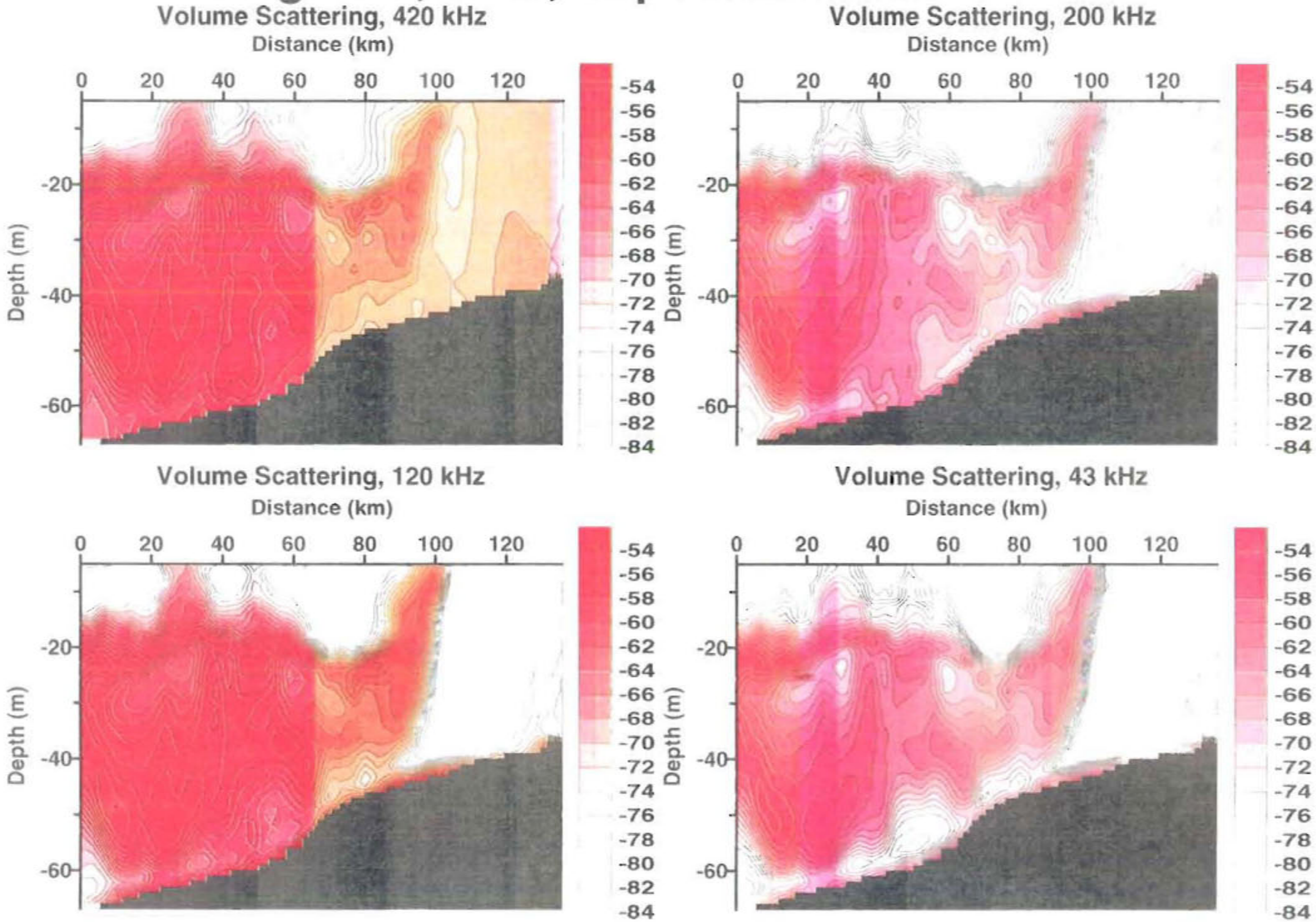
HX222 - Cape Neweham-C - 06 August 1999



Cape Newnham C1(x1-m2), 6 Aug. '99

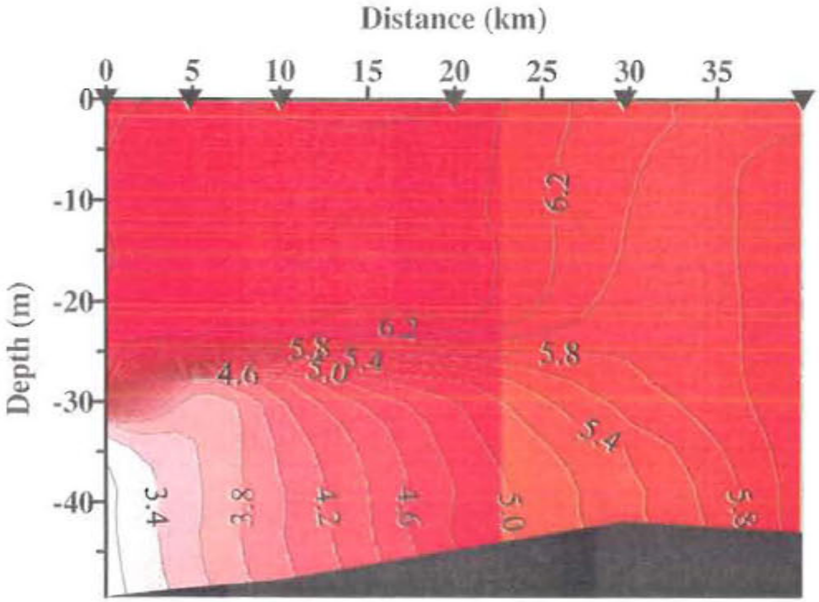


August 6, 1999; Cape Newenham C line

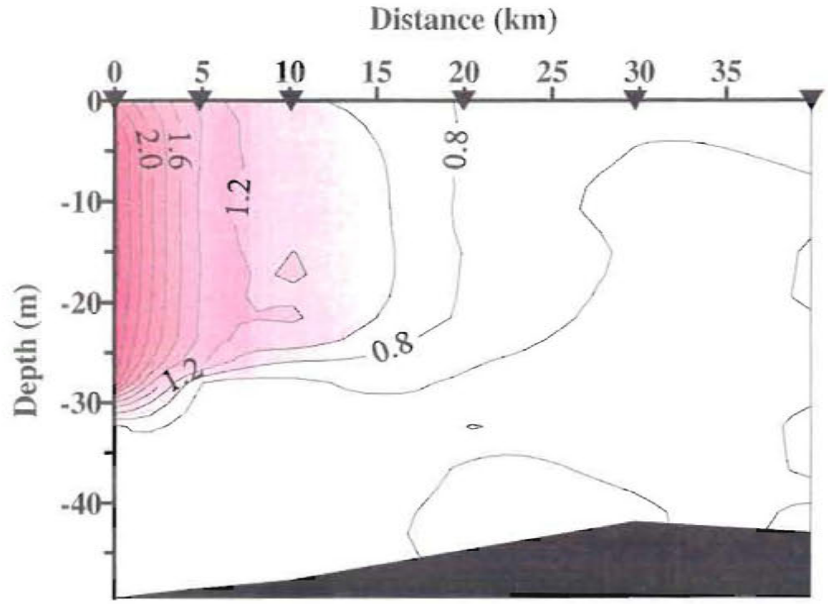


Cape Newenham C-detail, 5Aug. '99

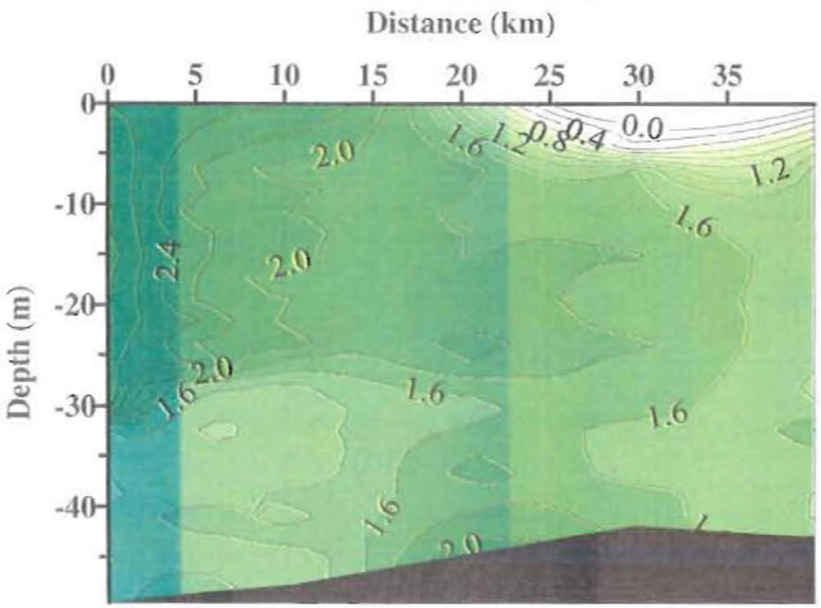
Temperature (^{o}C)



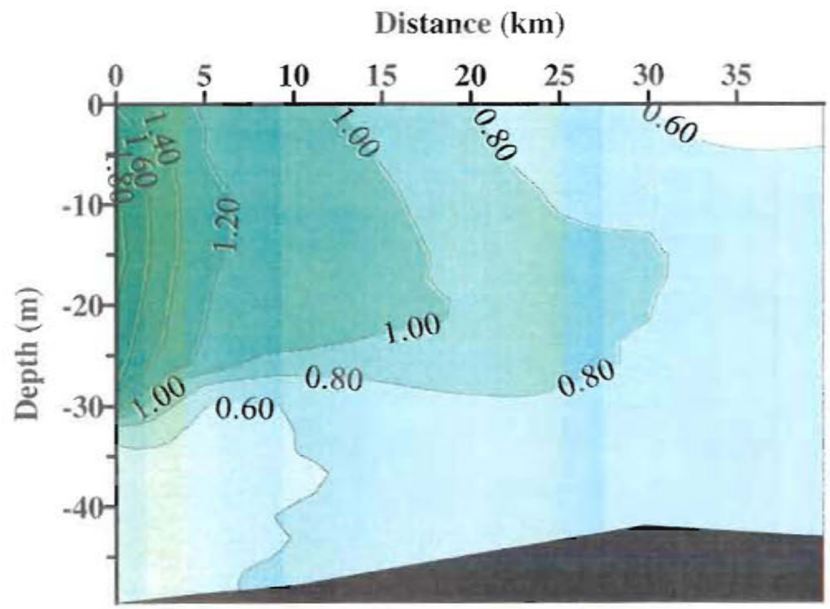
Extinction Coefficient



WL Chlorophyll (μ g/l)

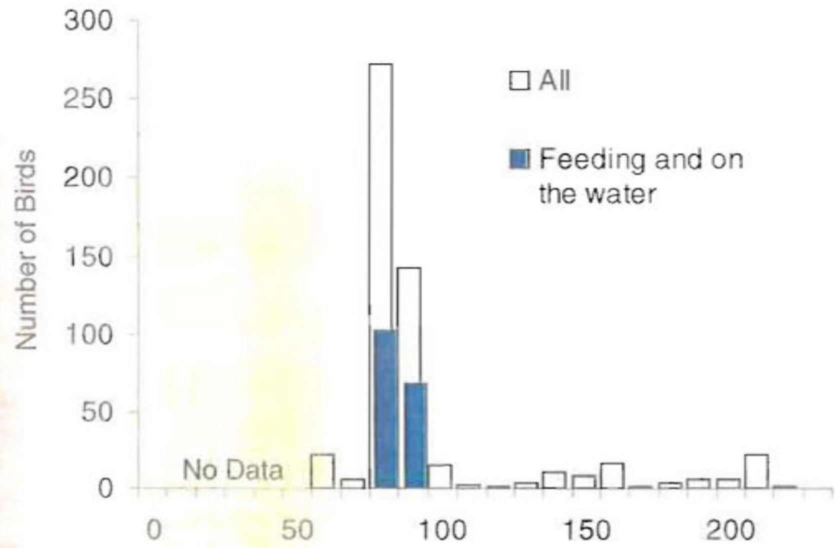


Fluorescence

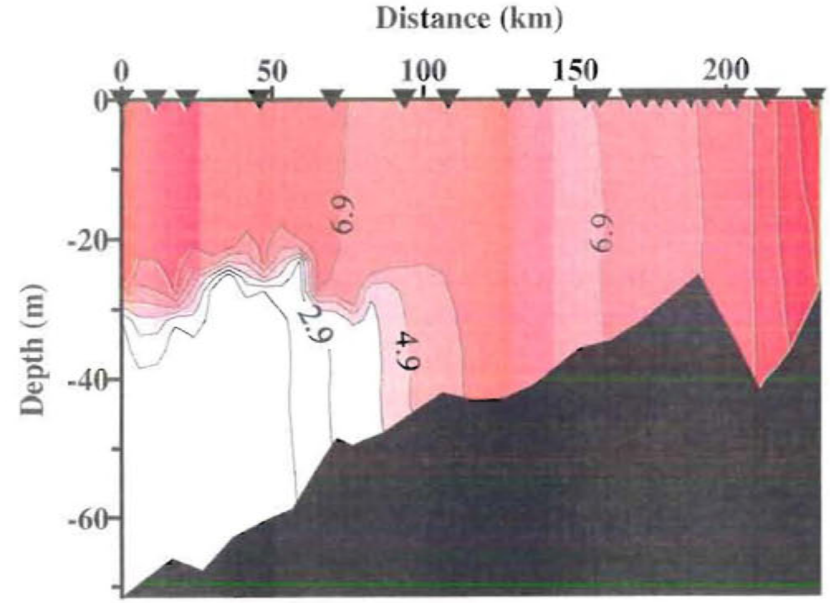


CAPE NEWENHAM (C Line), 5-6 August 1999, 7:34-6:51

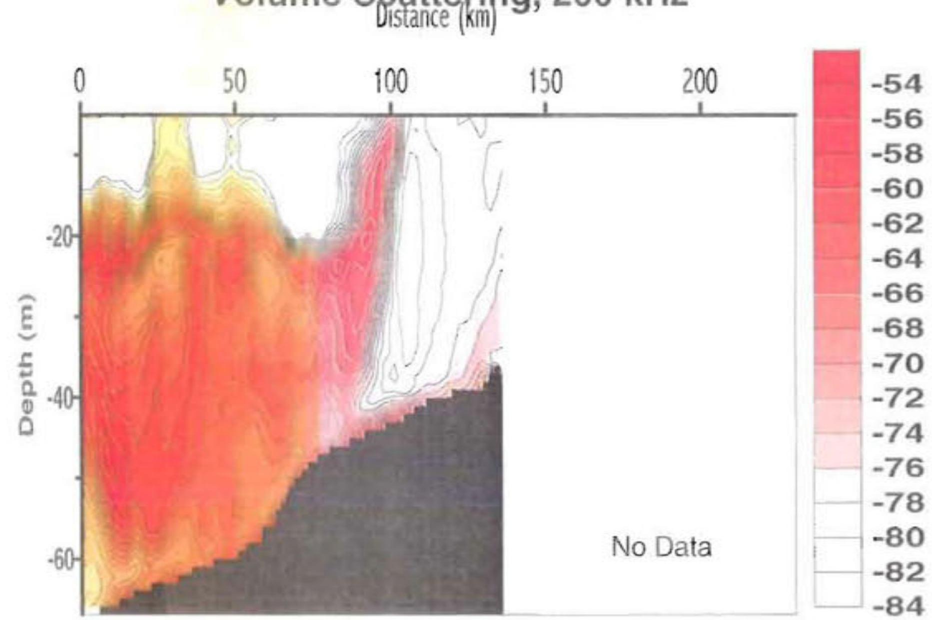
Dark Shearwaters, stations CNCX17 to CNC07, 7:34-22:30



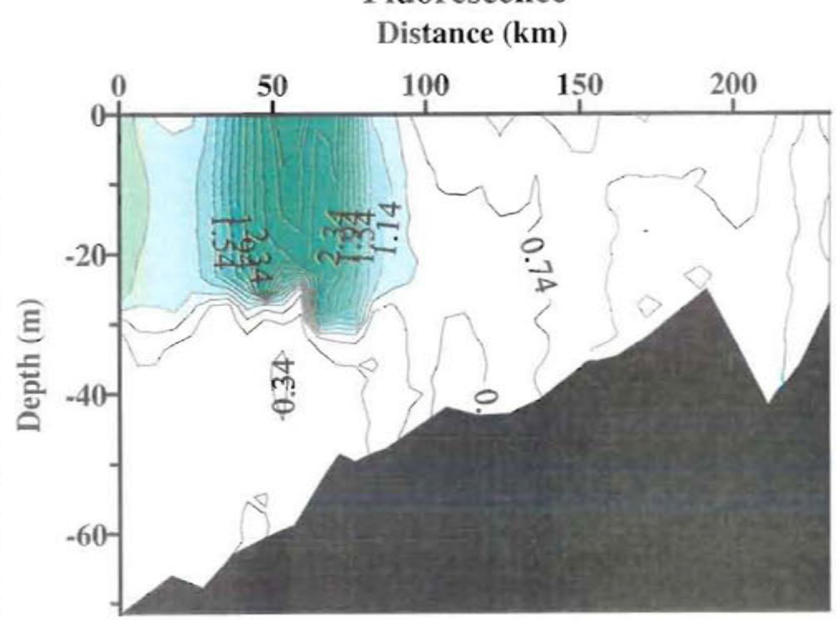
Temperature (°C)



Volume Scattering, 200 kHz

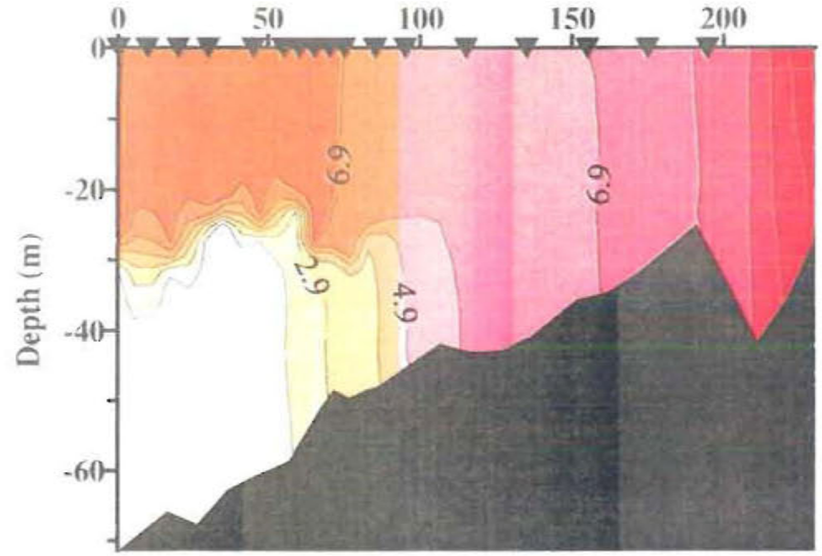


Fluorescence

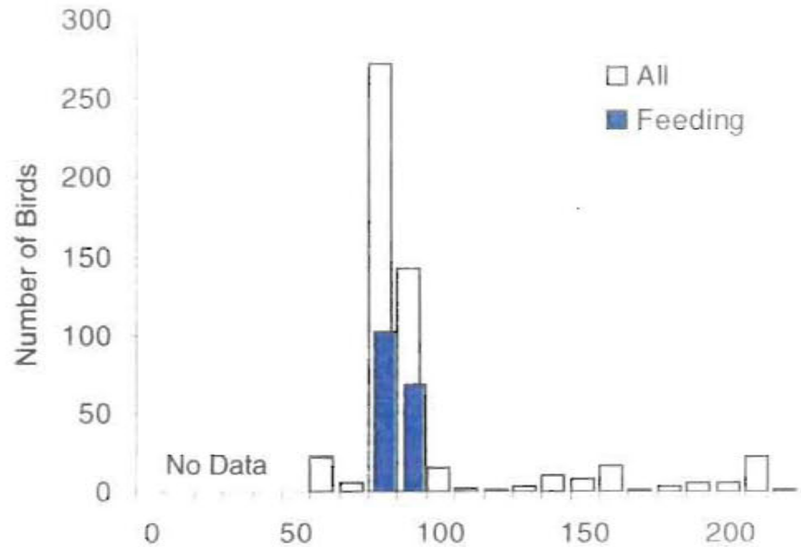


CAPE NEWENHAM (C Line), 5-6 August 1999, 7:34-6:51

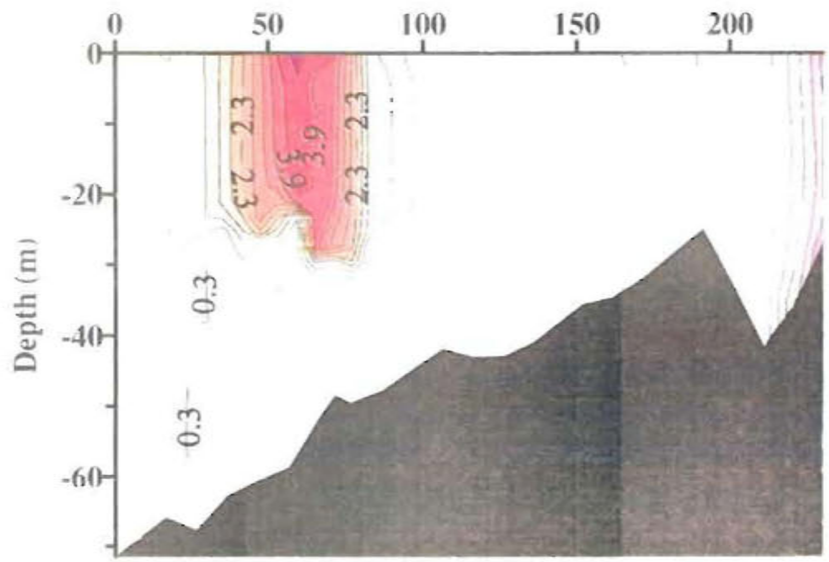
Temperature (°C)



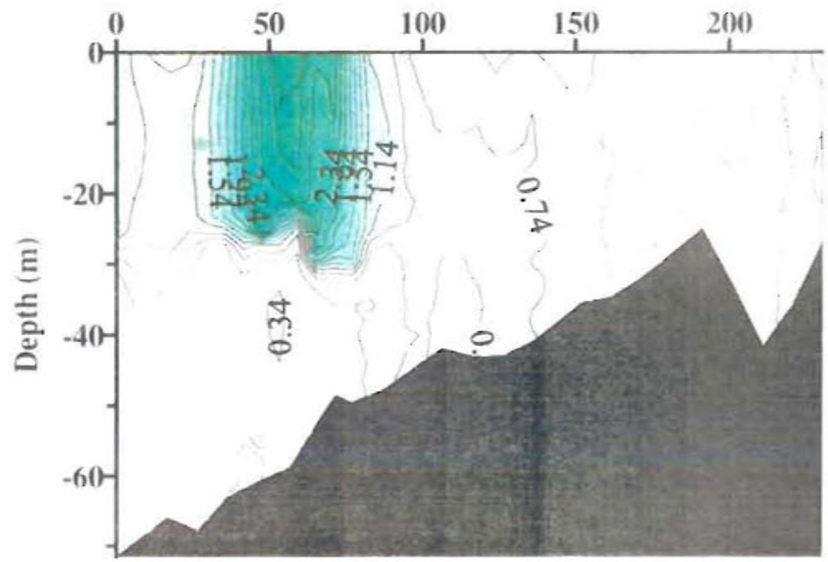
Dark Shearwaters, feeding and on the water, stations CNCX17 to CNC07, 7:34-22:30



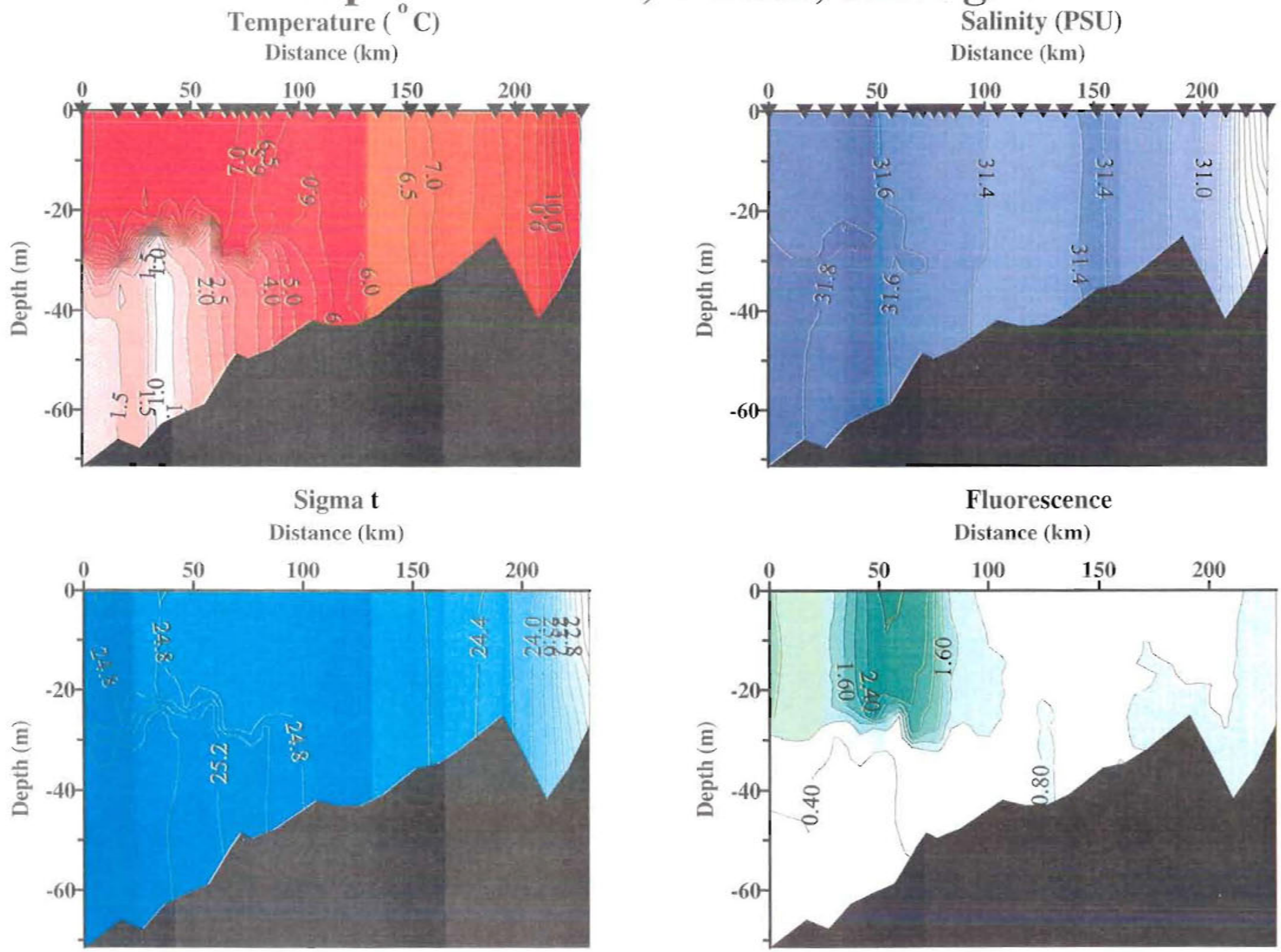
Extinction Coefficient



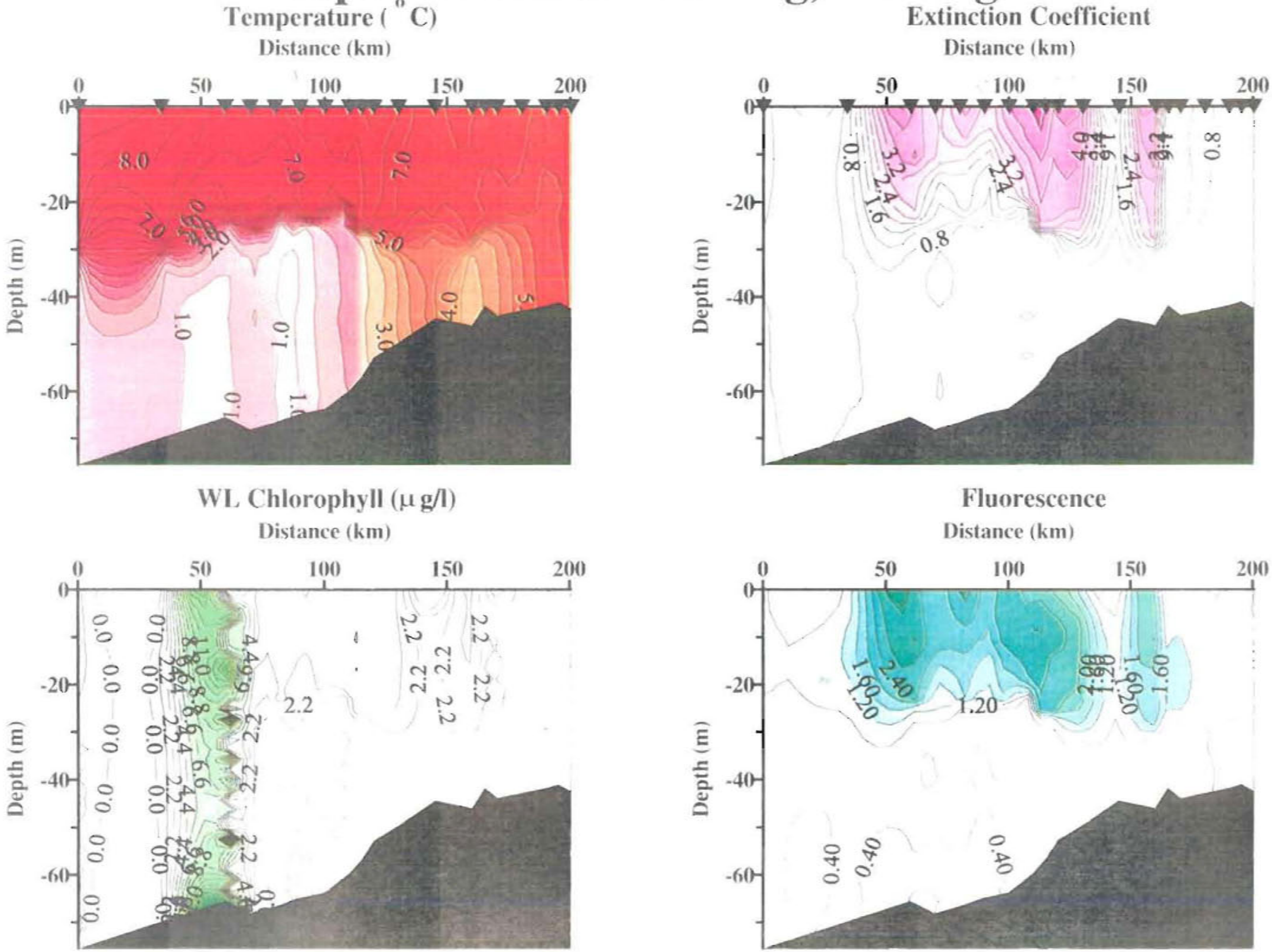
Fluorescence



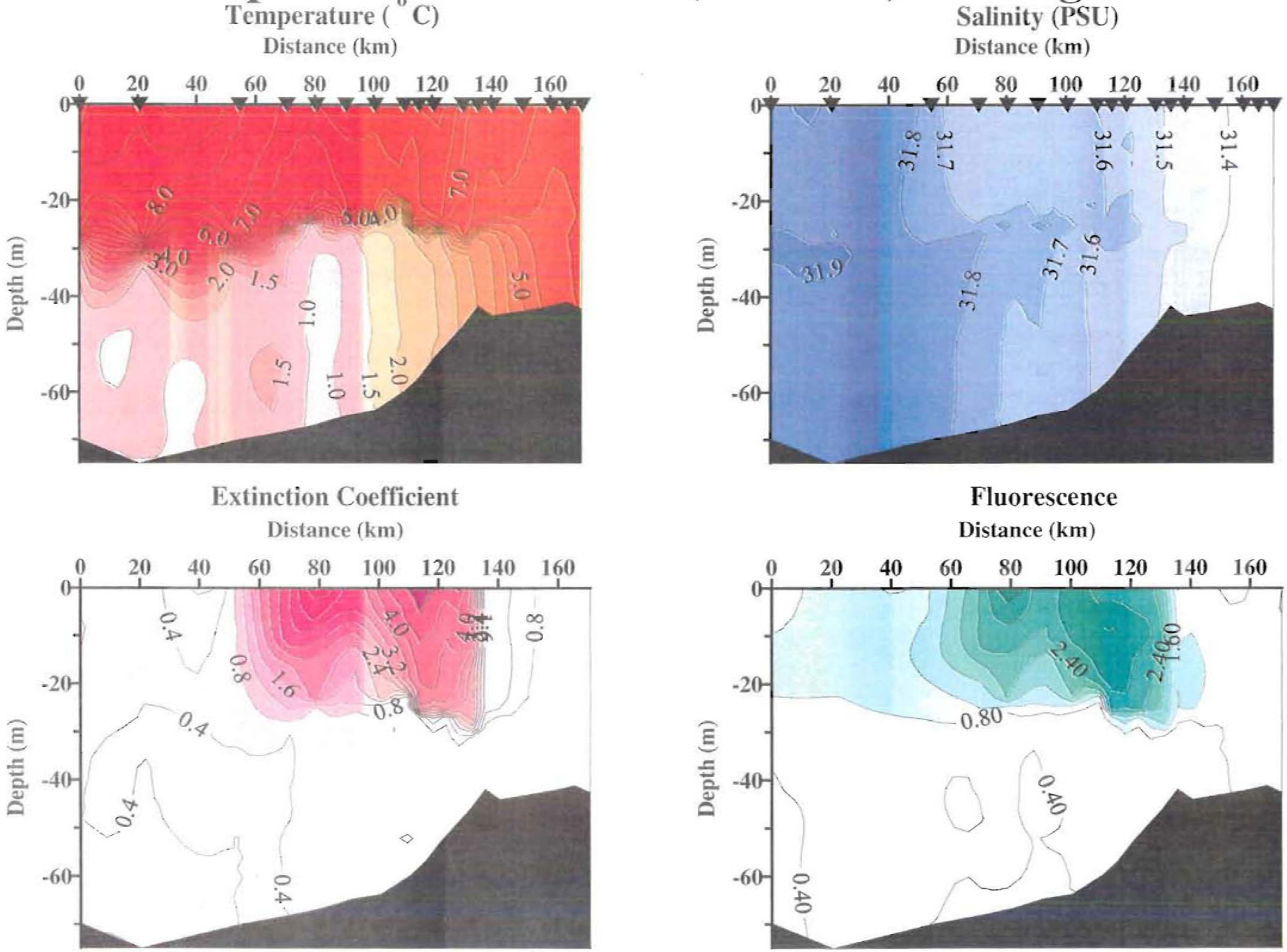
Cape Newenham, C-Line, 06 Aug. '99



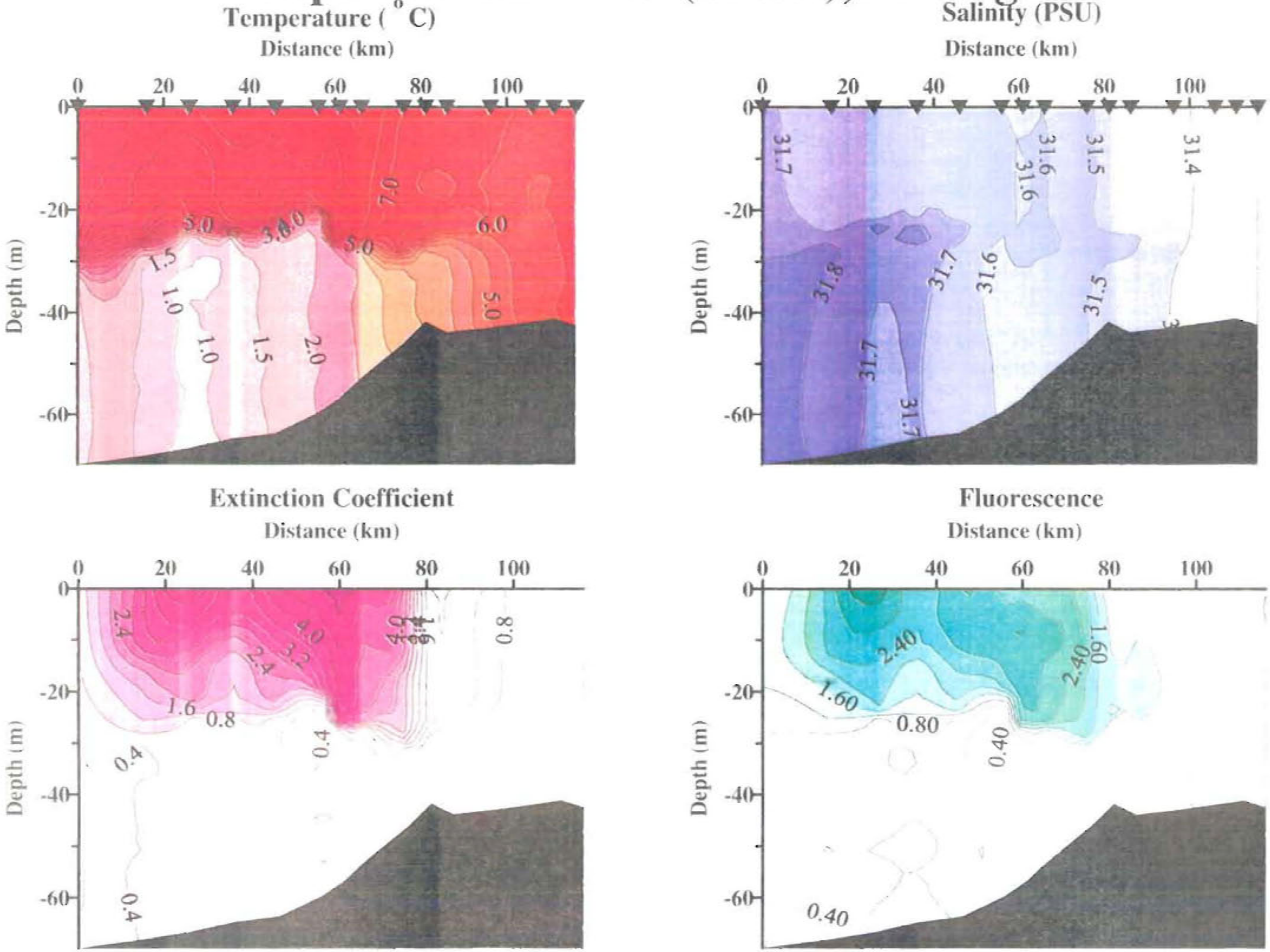
Cape Newenham C2-long, 7-8 Aug. '99



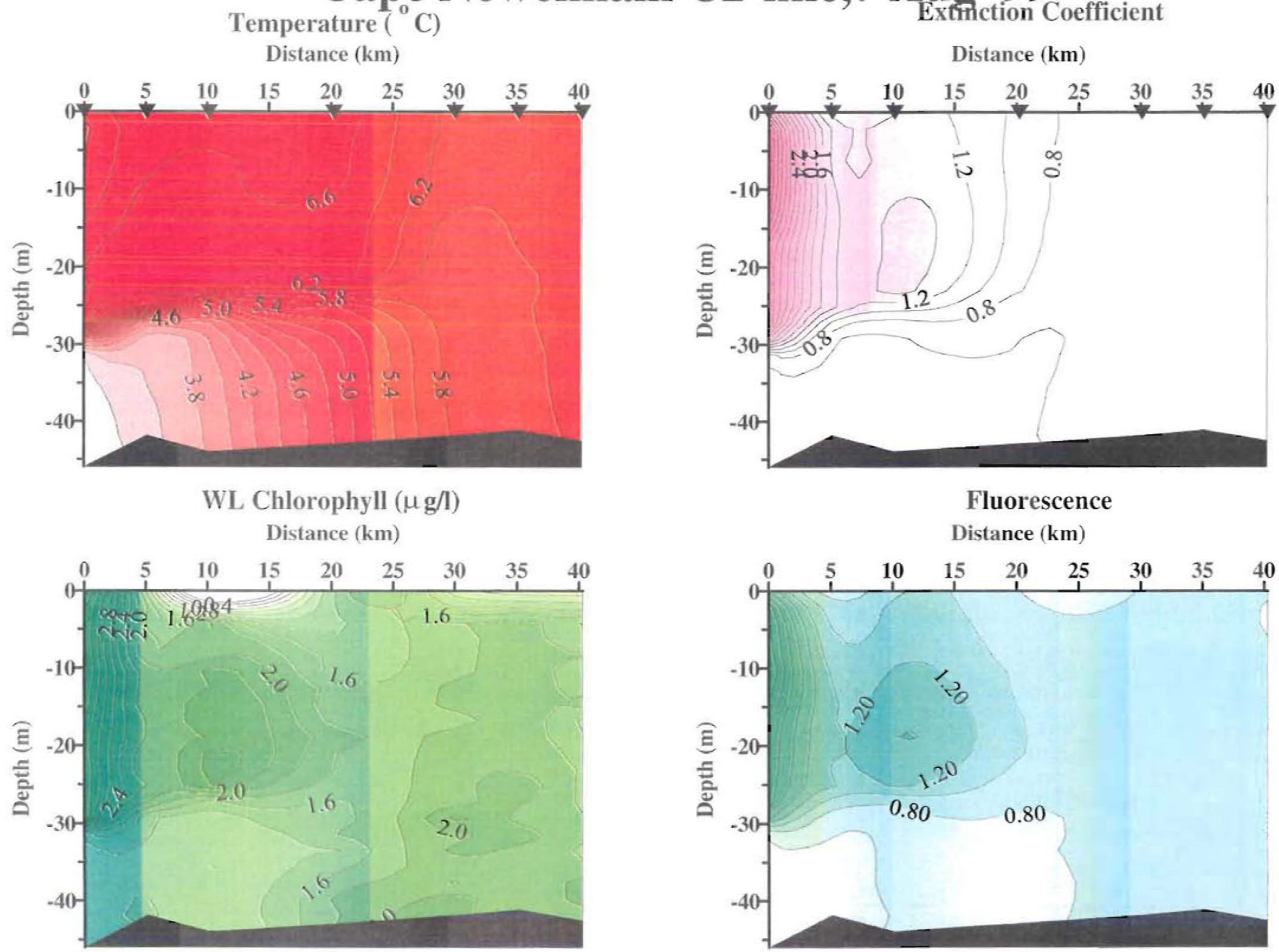
cape Newenham C2all (x1-wc5.5) 7-8 Aug. '99



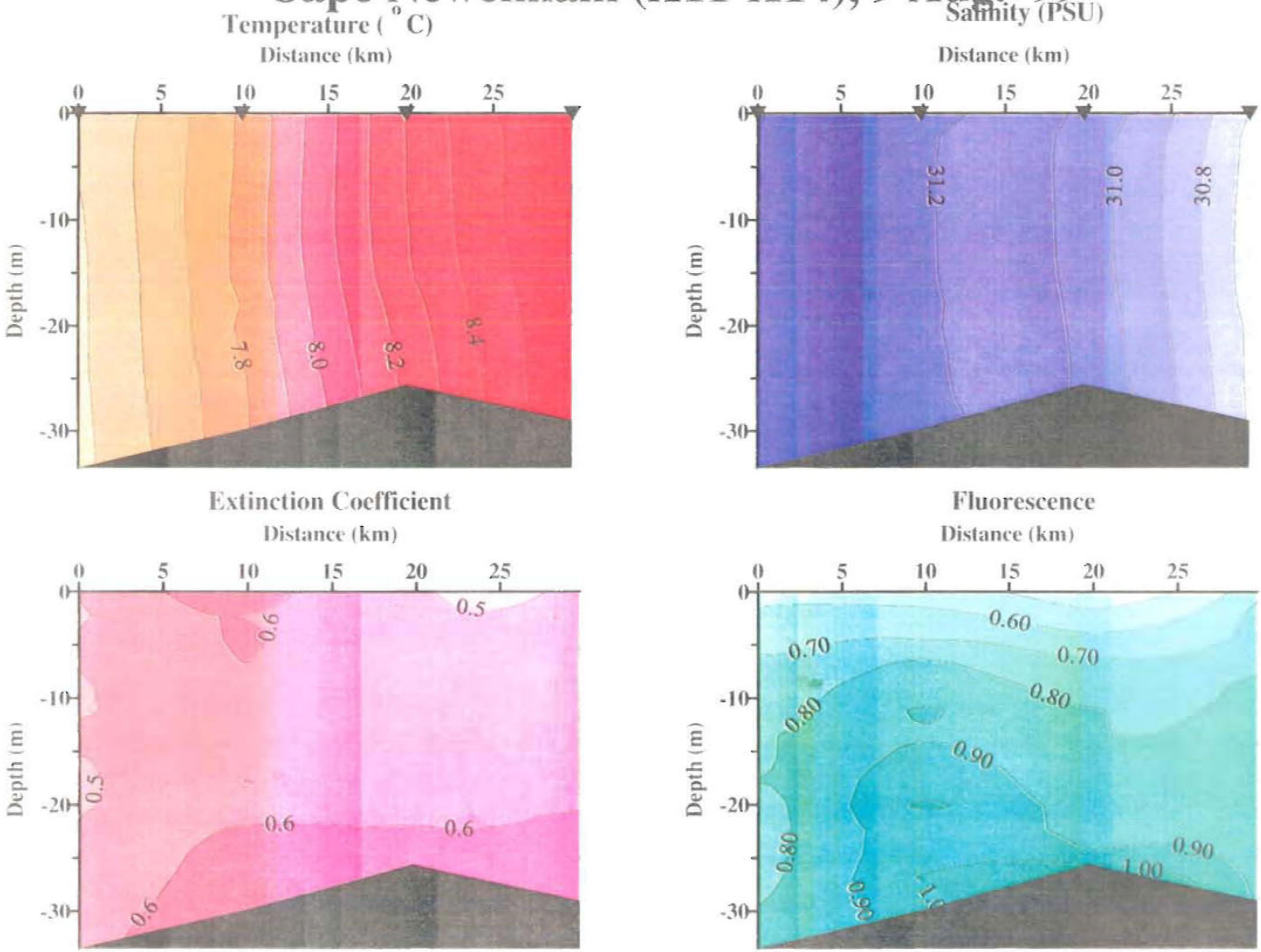
Cape Newenham C2(x1-m2),7-8 Aug. '99



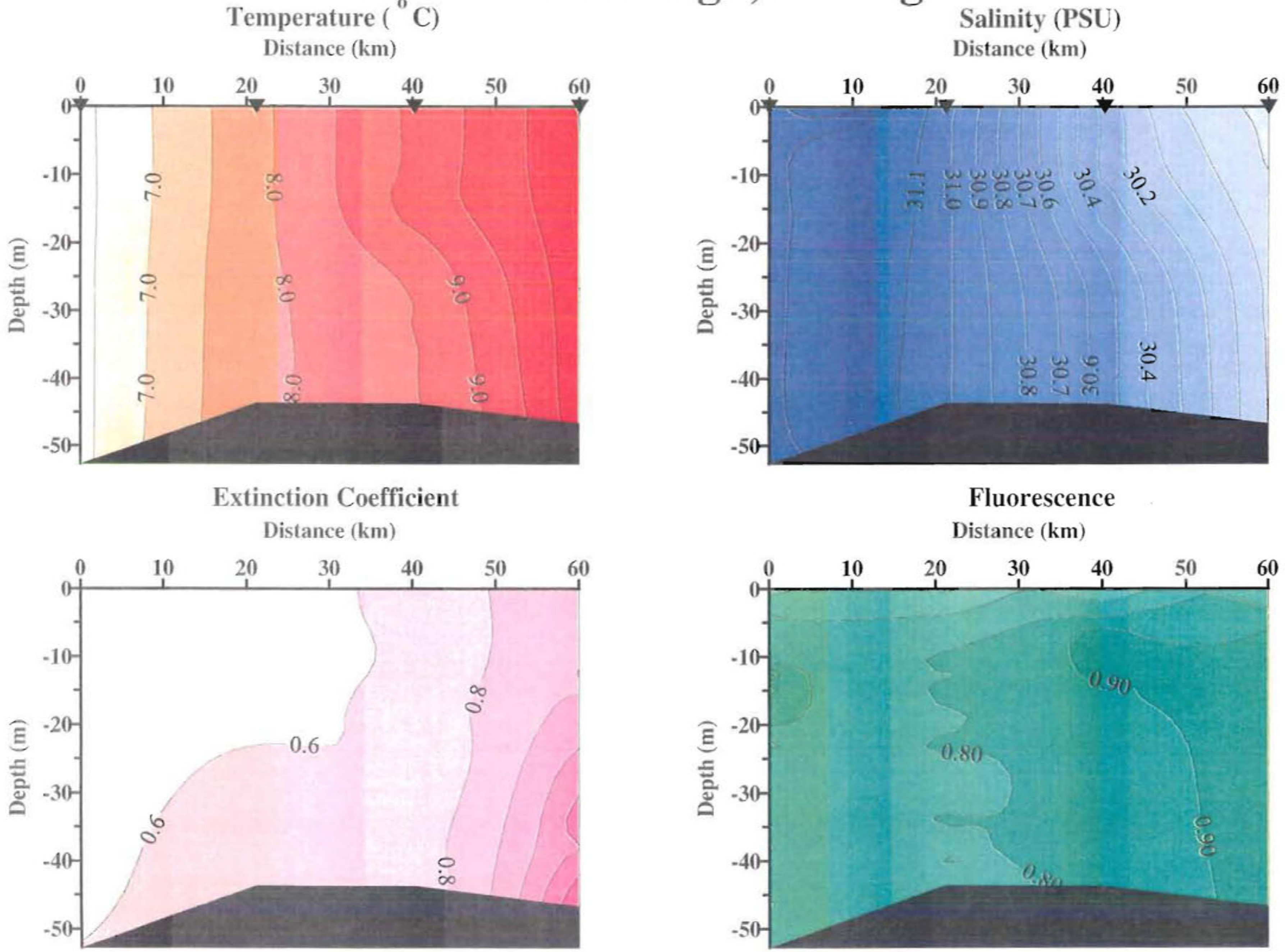
Cape Newenham C2-line, 7 Aug '99



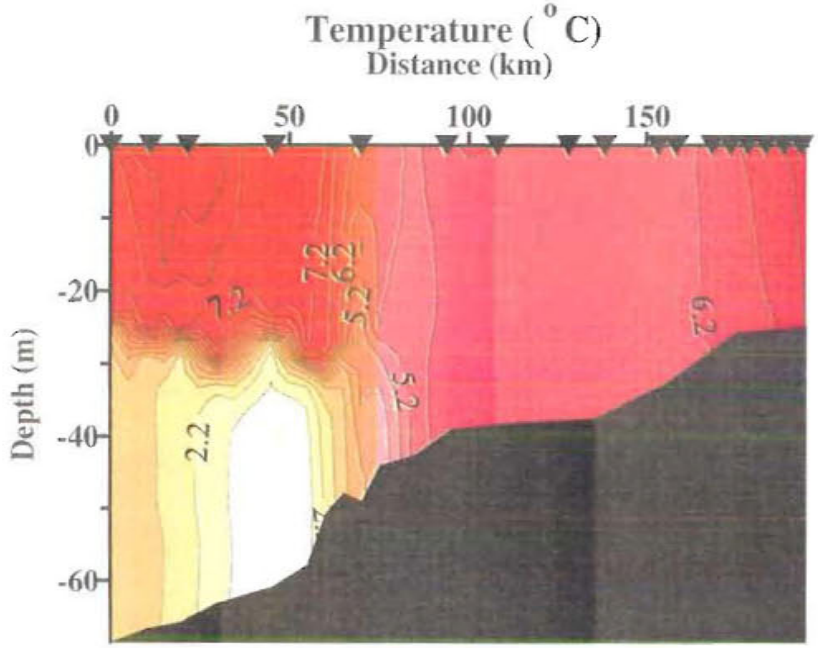
Cape Newenham (X11-X14), 9 Aug. '99

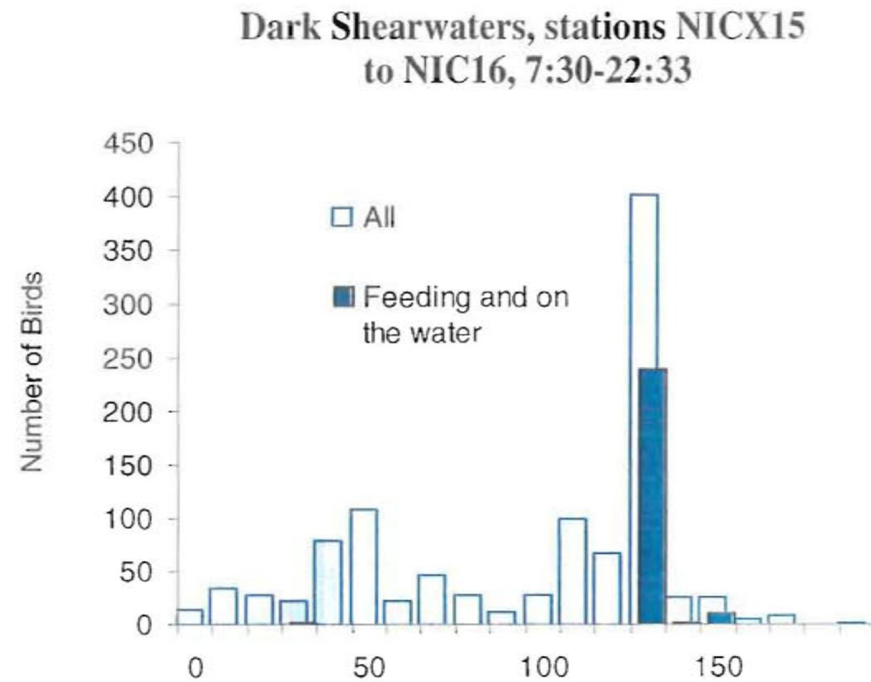


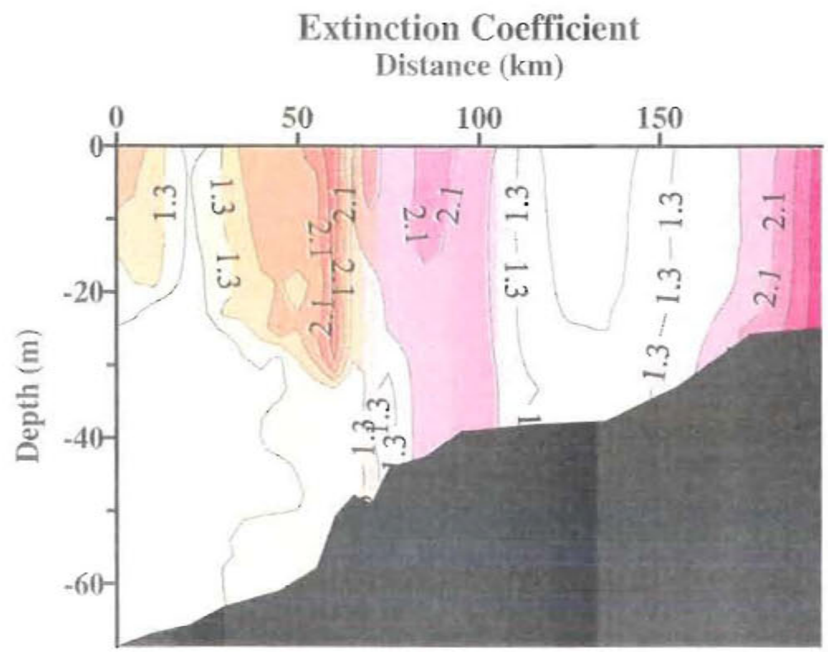
Newenham trough, 10 Aug. '99

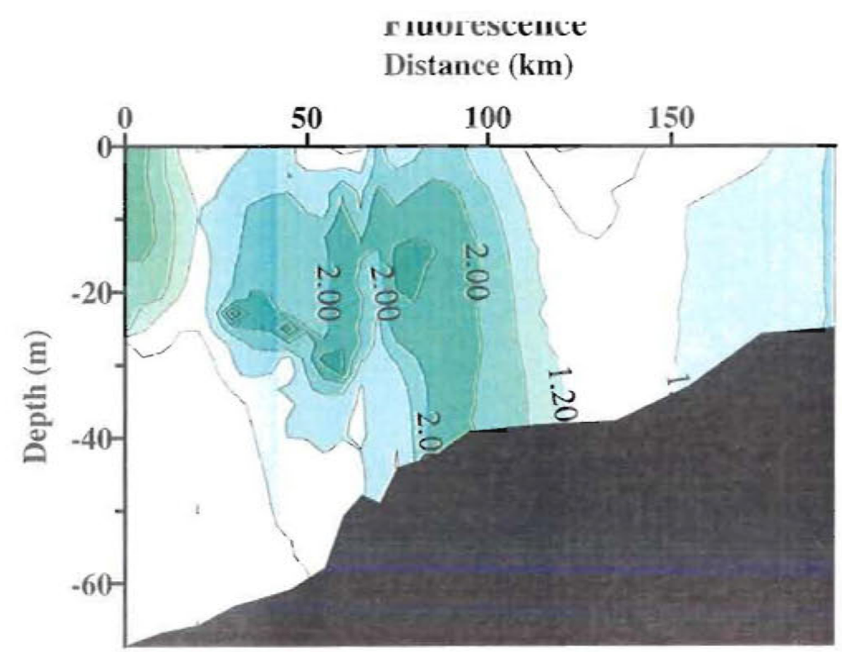


NUNIVAK ISLAND (C Line), 11 August 1999, 7:19-22:37

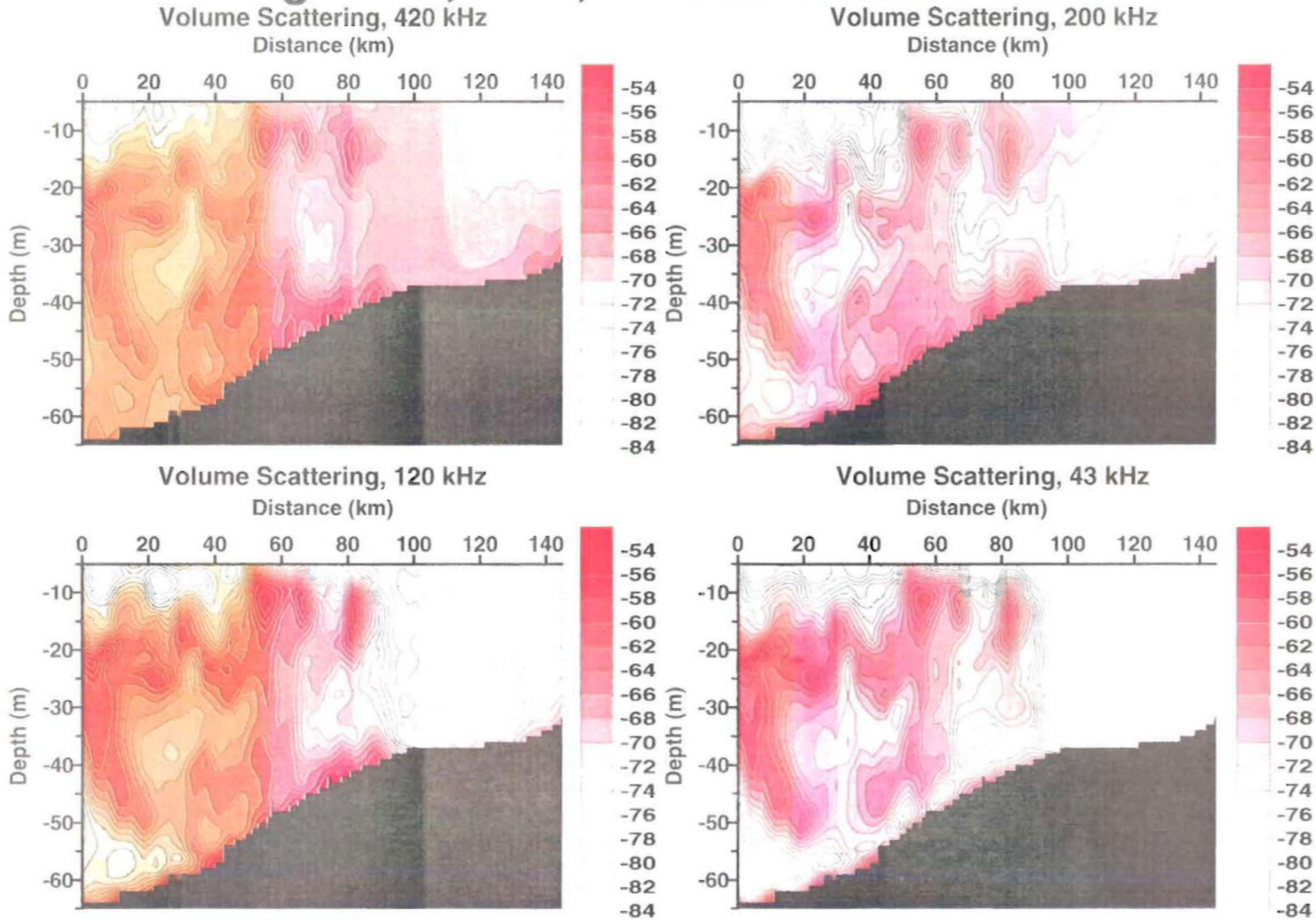




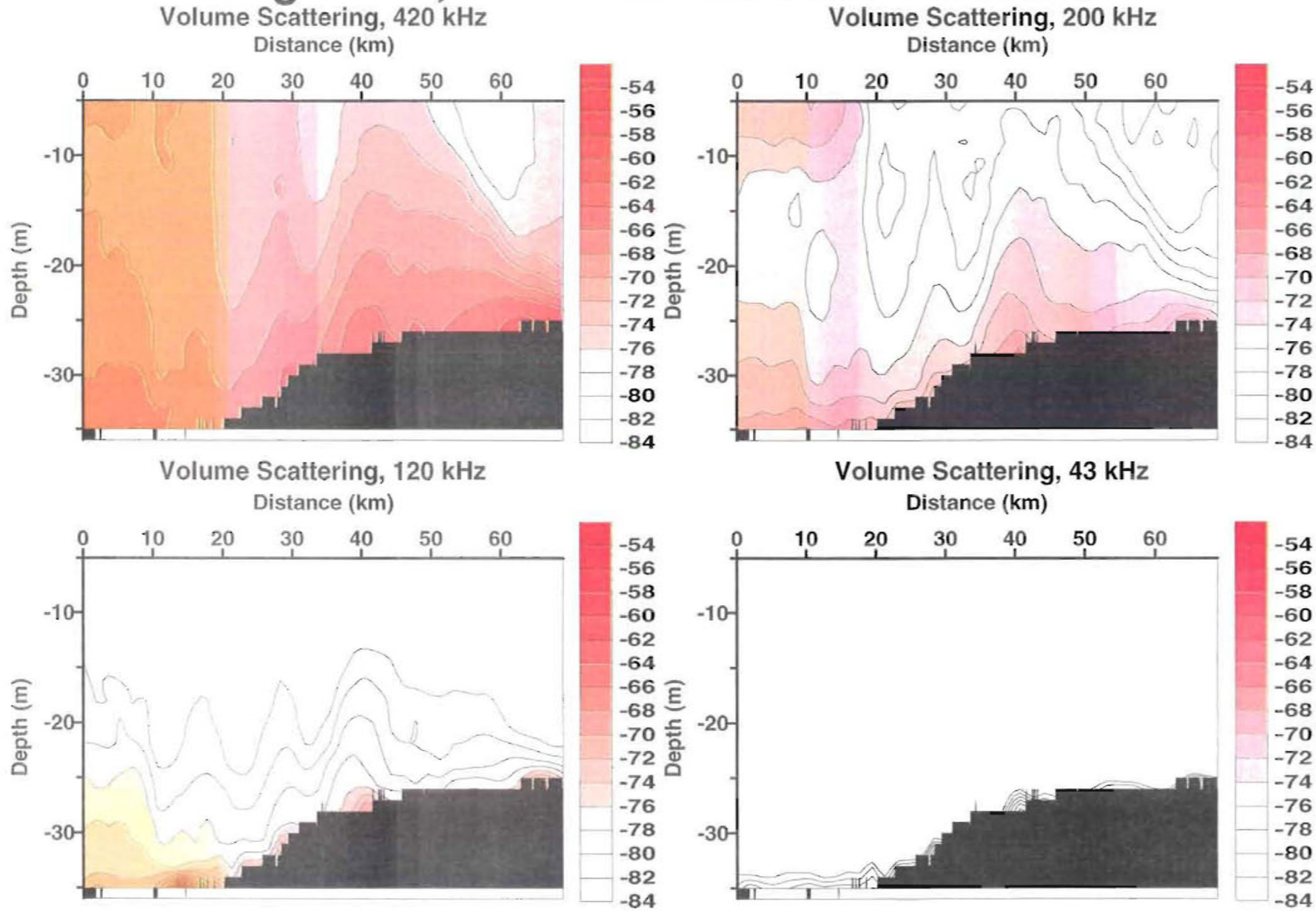




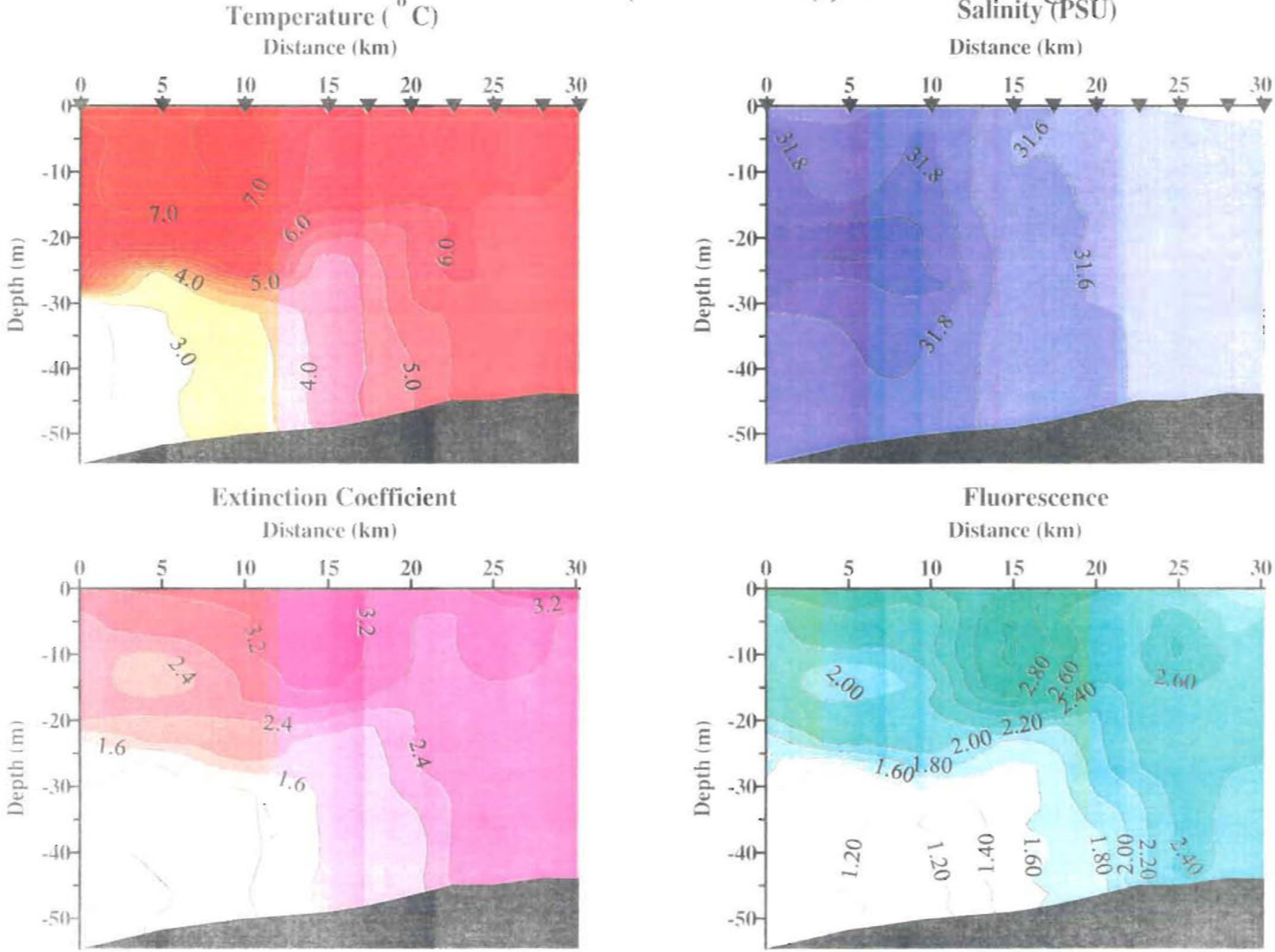
August 12, 1999, Nunivak island C Line



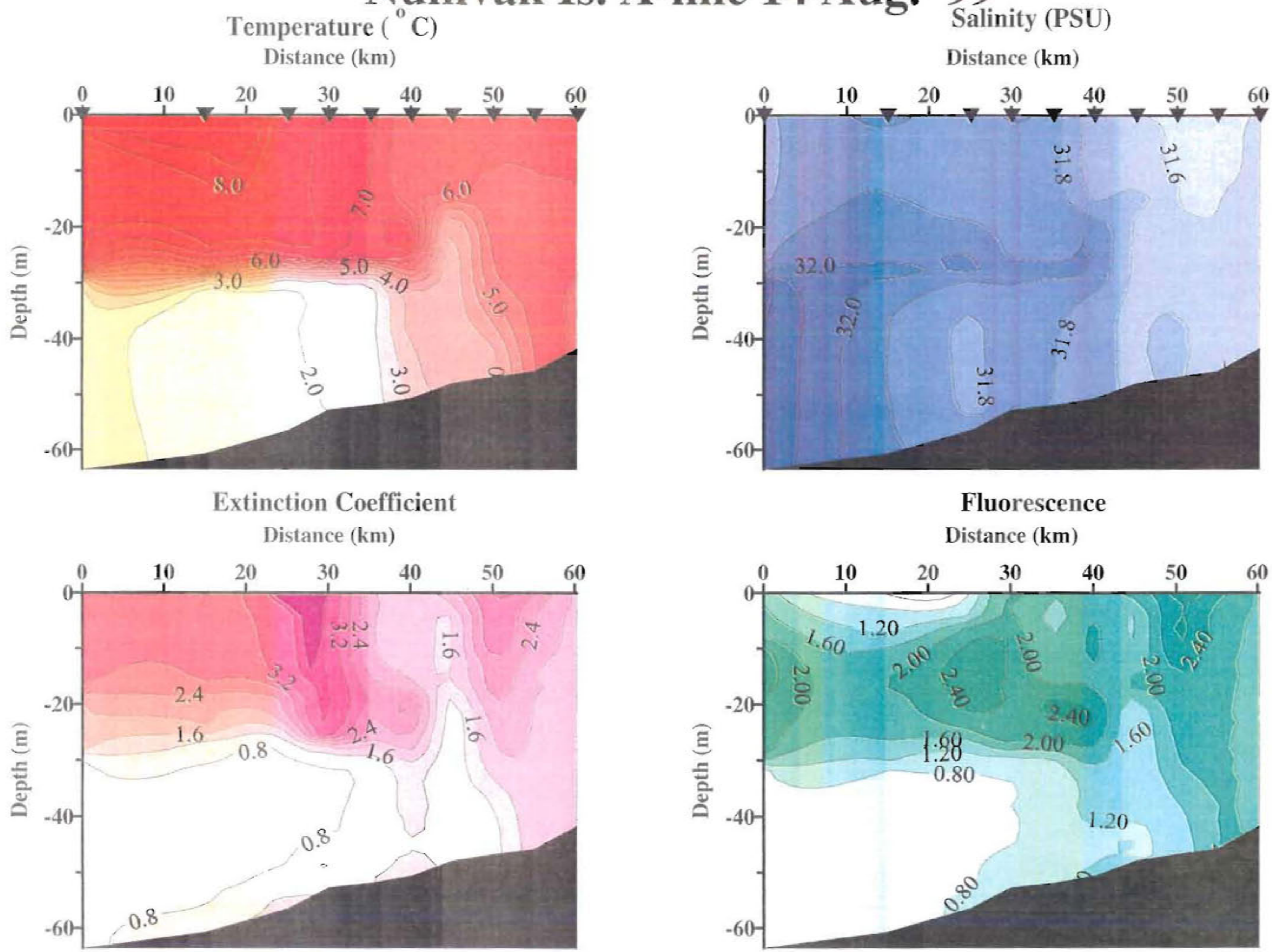
August 13, 1999 Nunivak Island CX Line



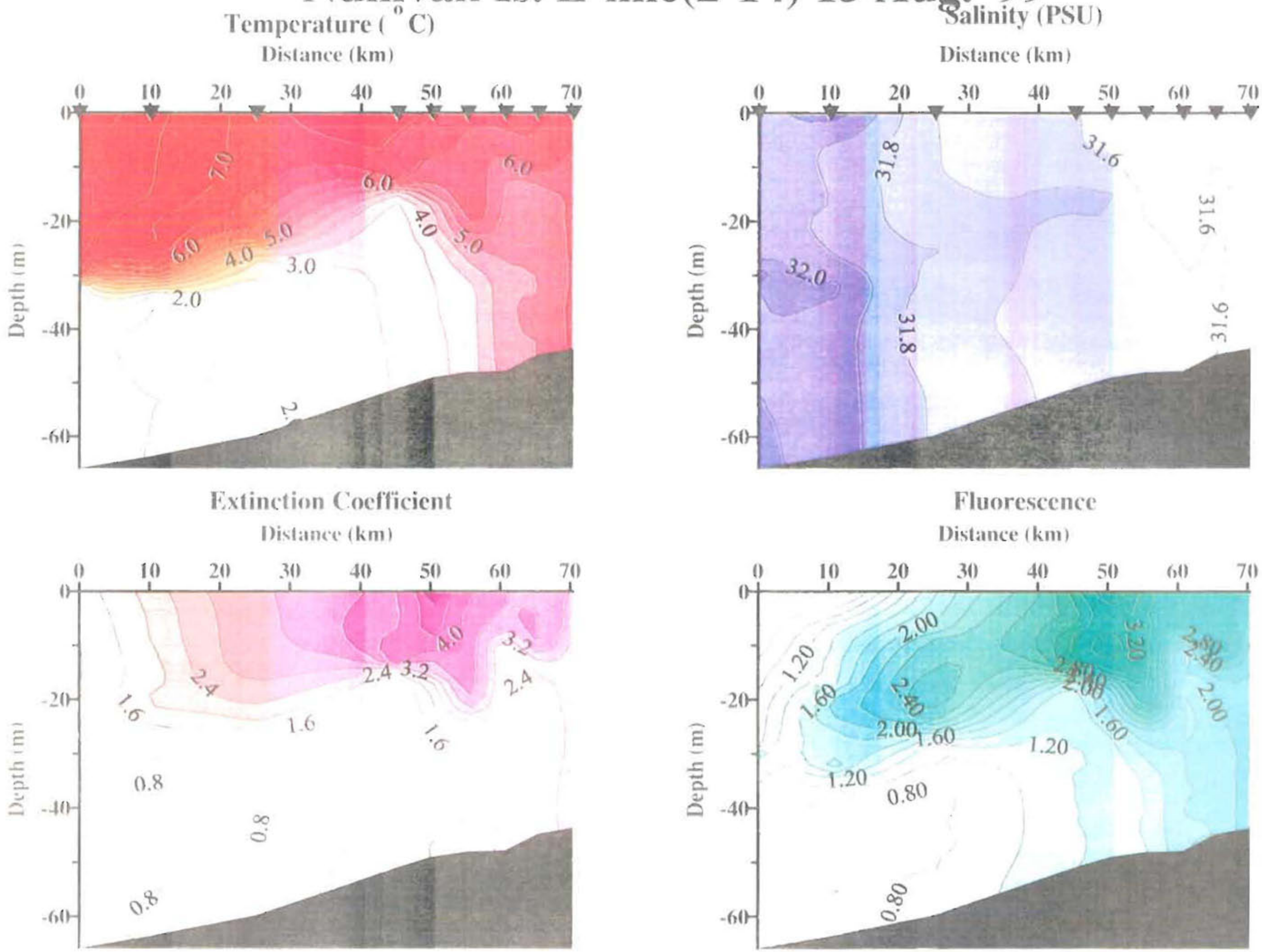
Nunivak Is C2-line (nic02-08), 13-14 Aug '99



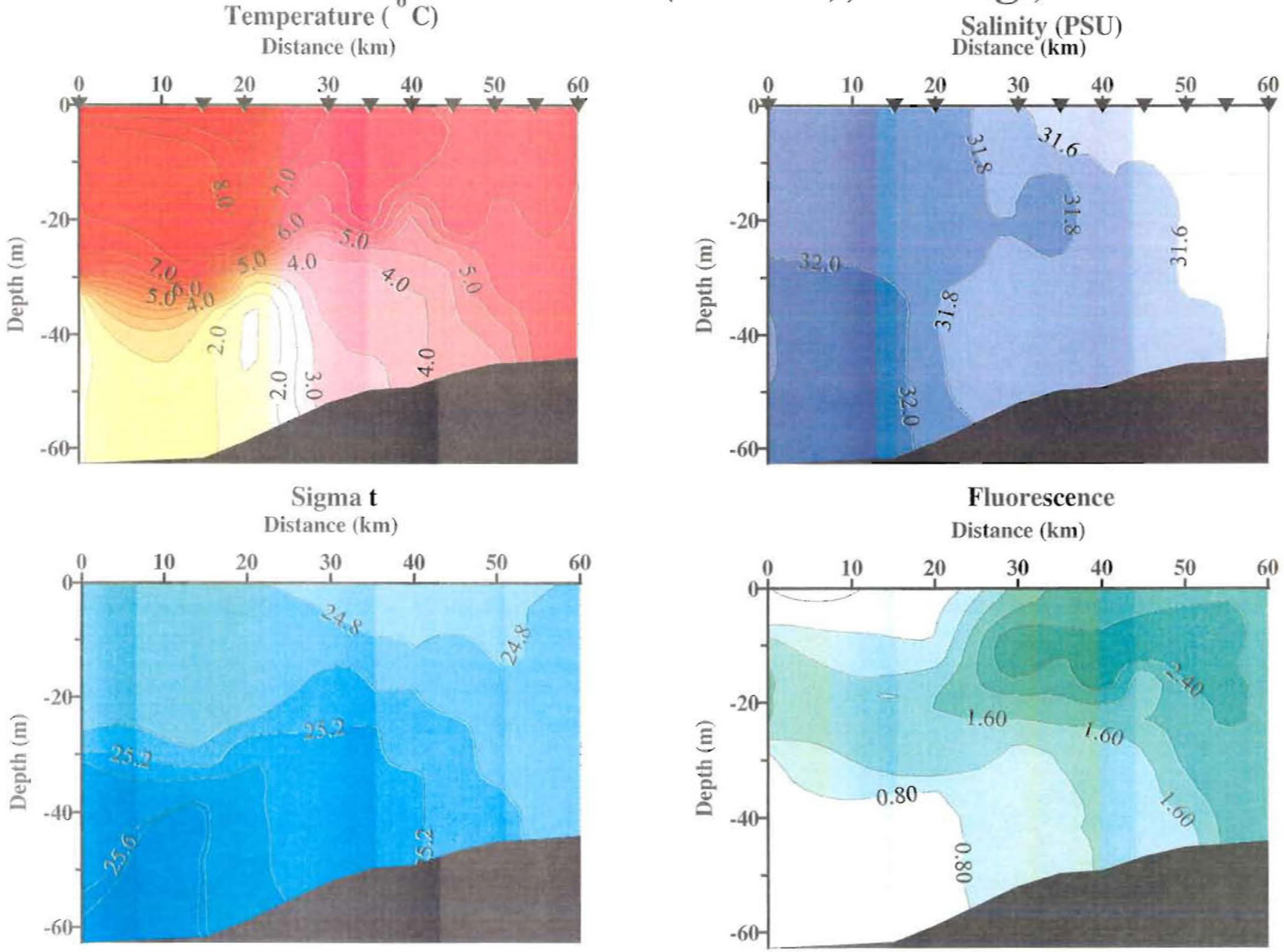
Nunivak Is. A-line 14 Aug. '99



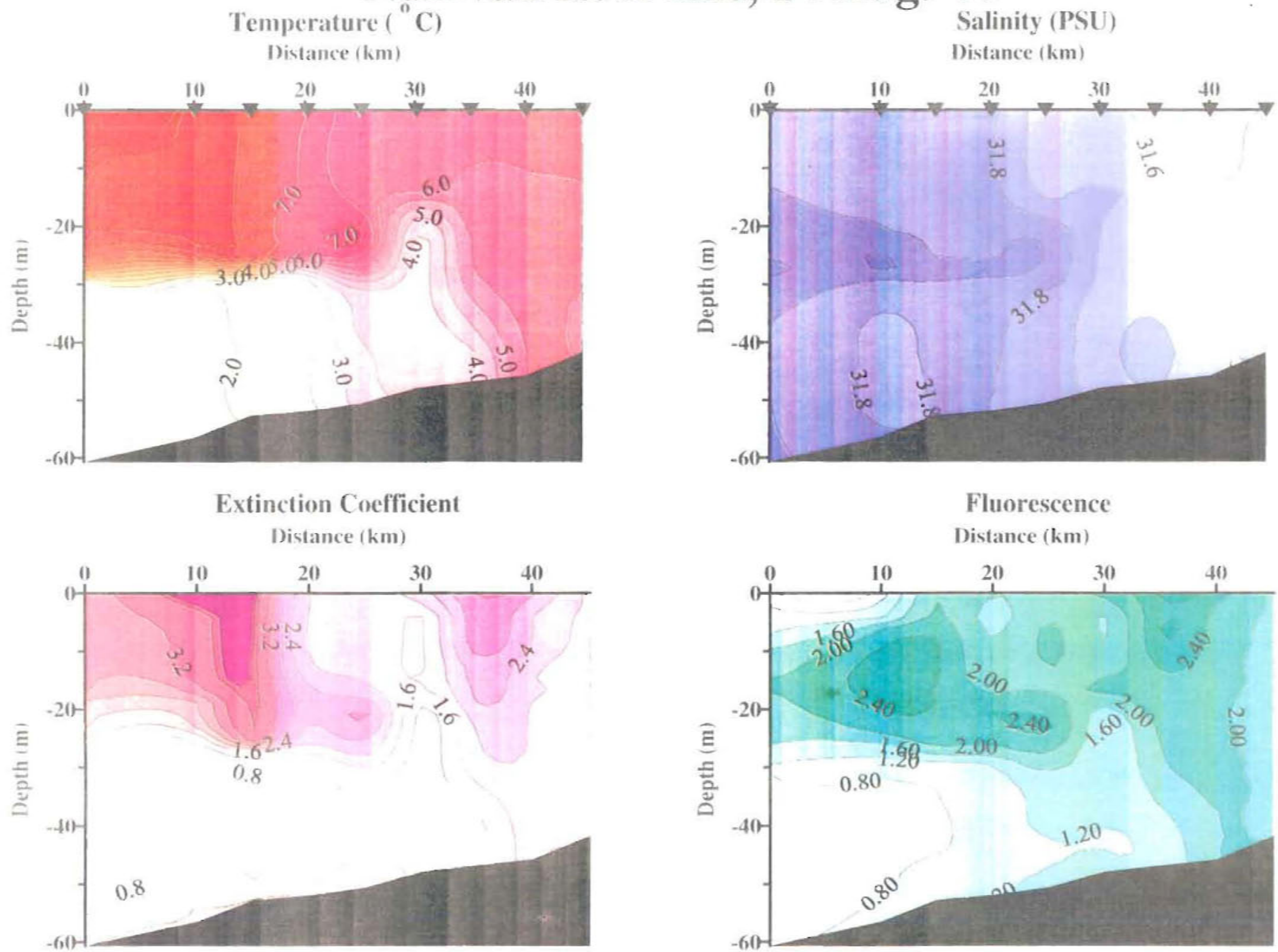
Nunivak Is. E-line(2-14) 15 Aug. '99



Ninivak Is. C3-line (nic2-13), 15 Aug., '99



Nunivak Is. A-line, 14 Aug. '99



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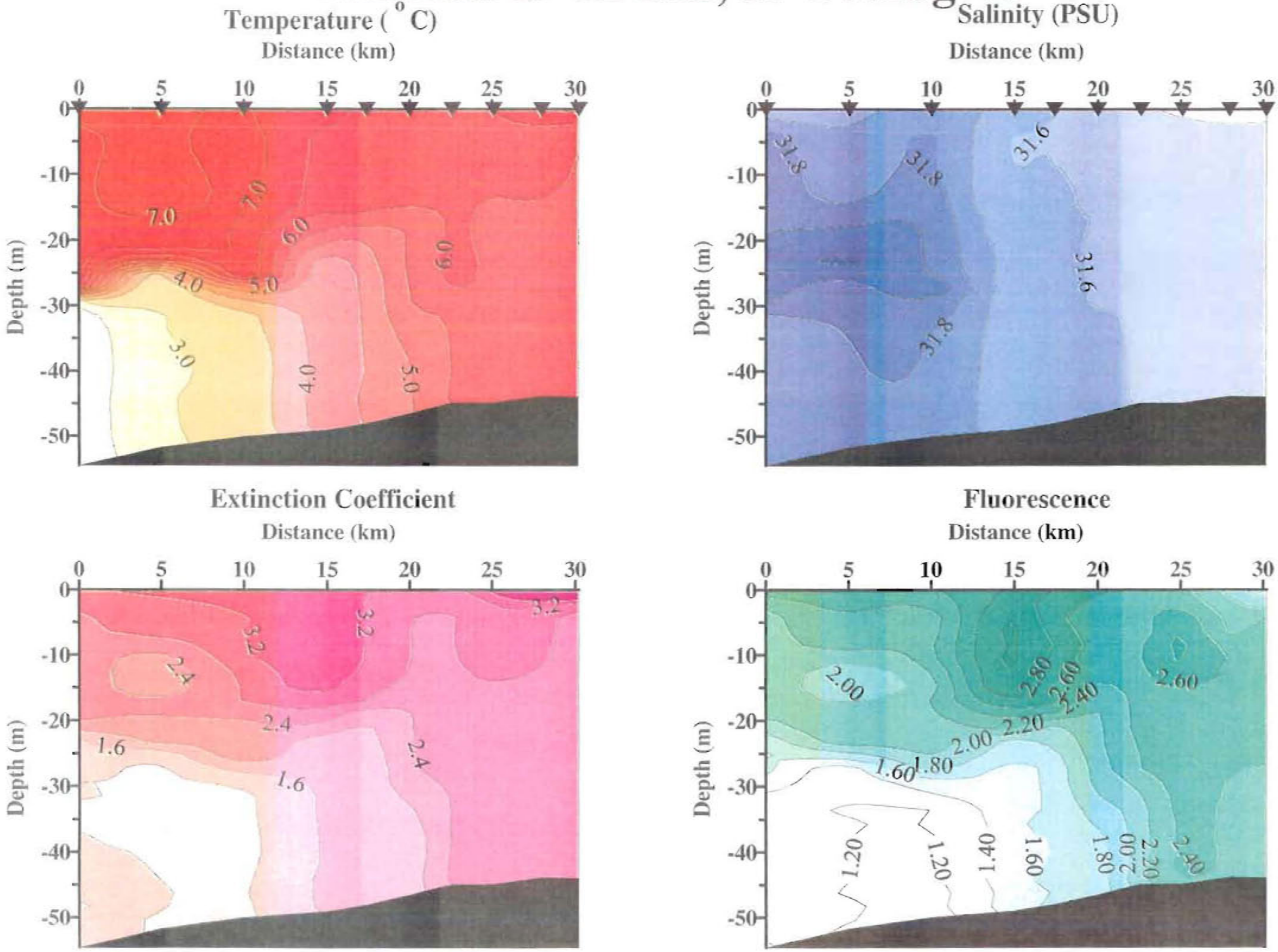
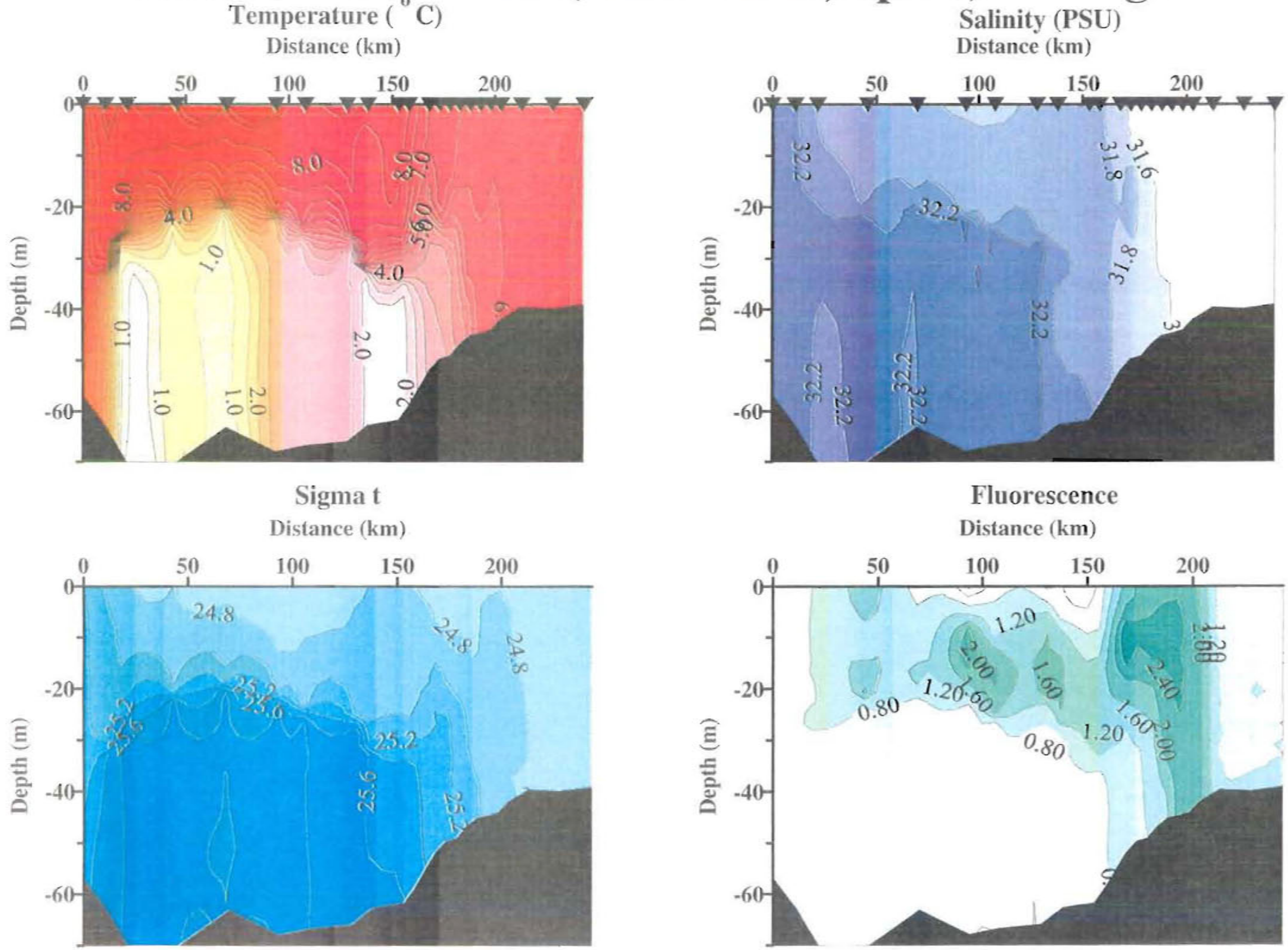
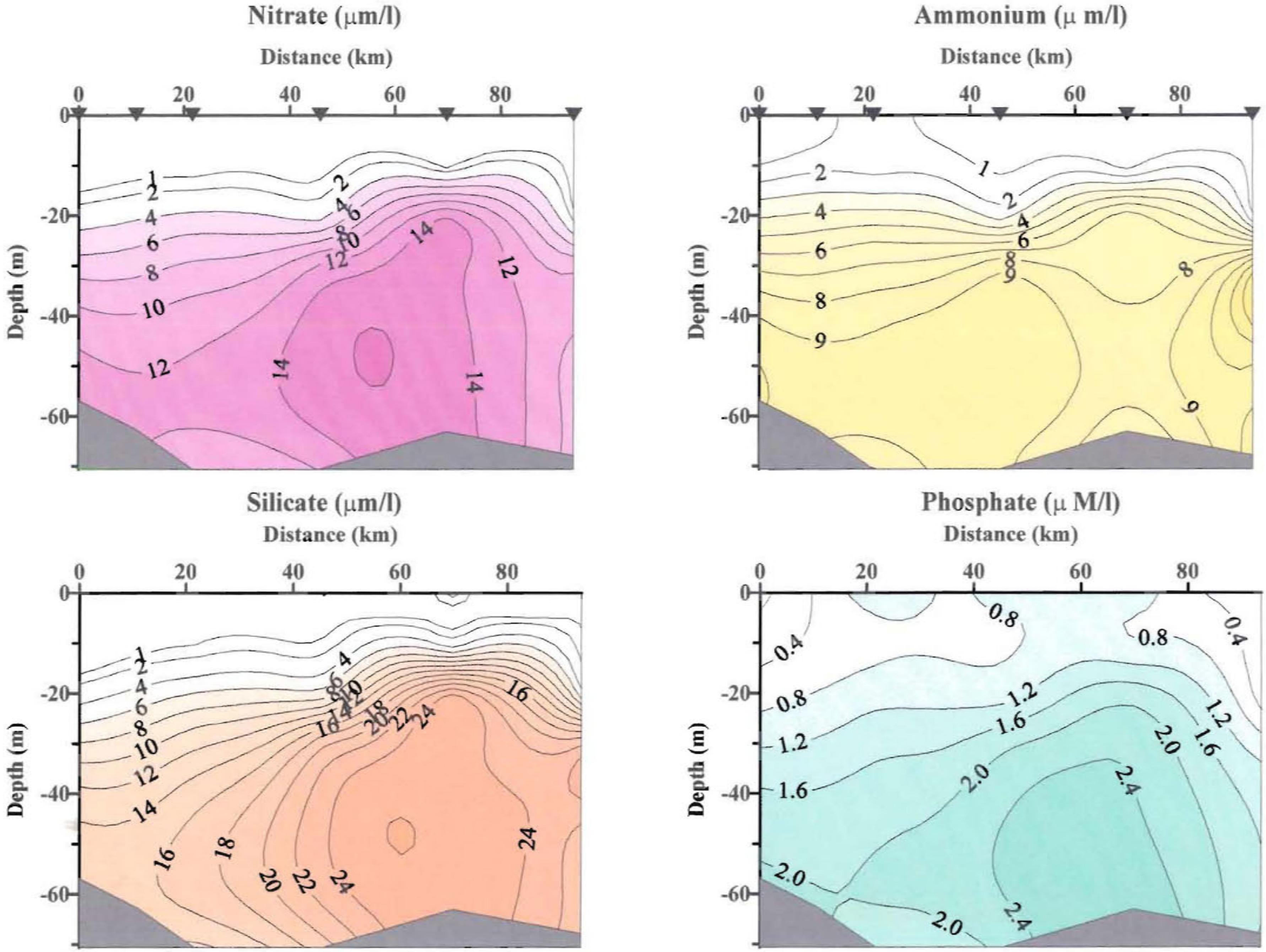


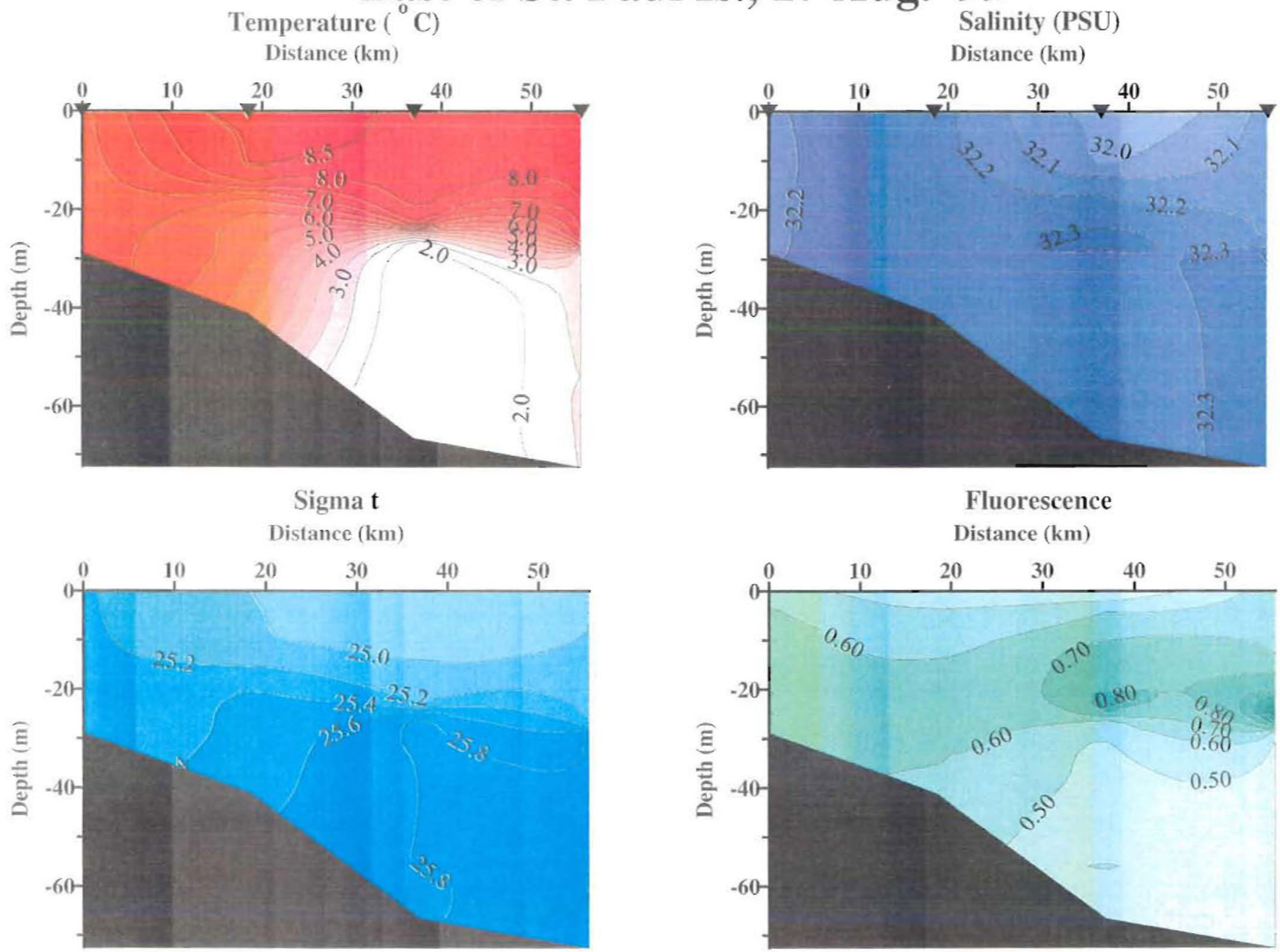
Nunivak to St. Paul (nicx8-nic16, np1-6) 15 Aug. '99



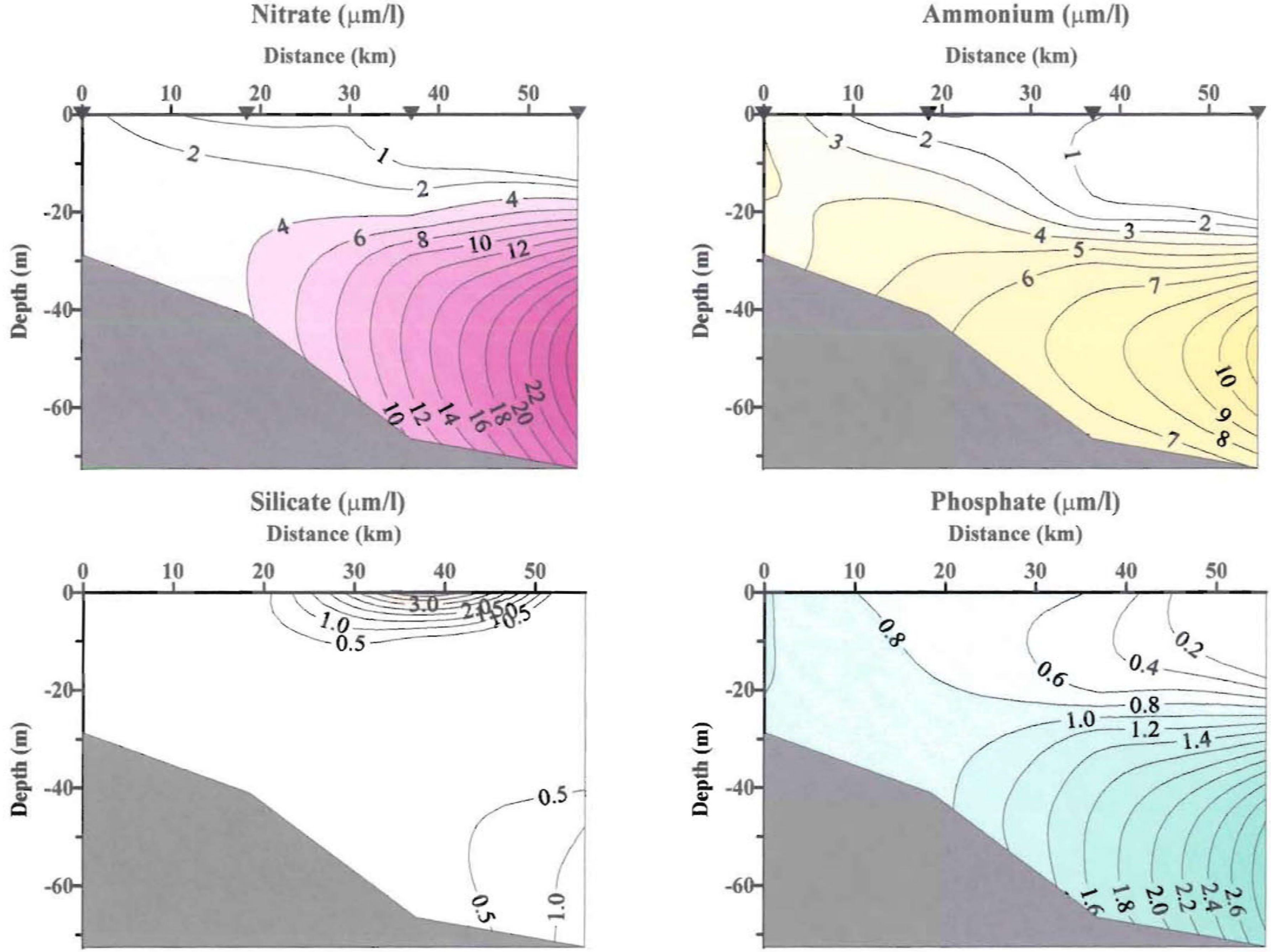
HX222; NP; 15 August 1999



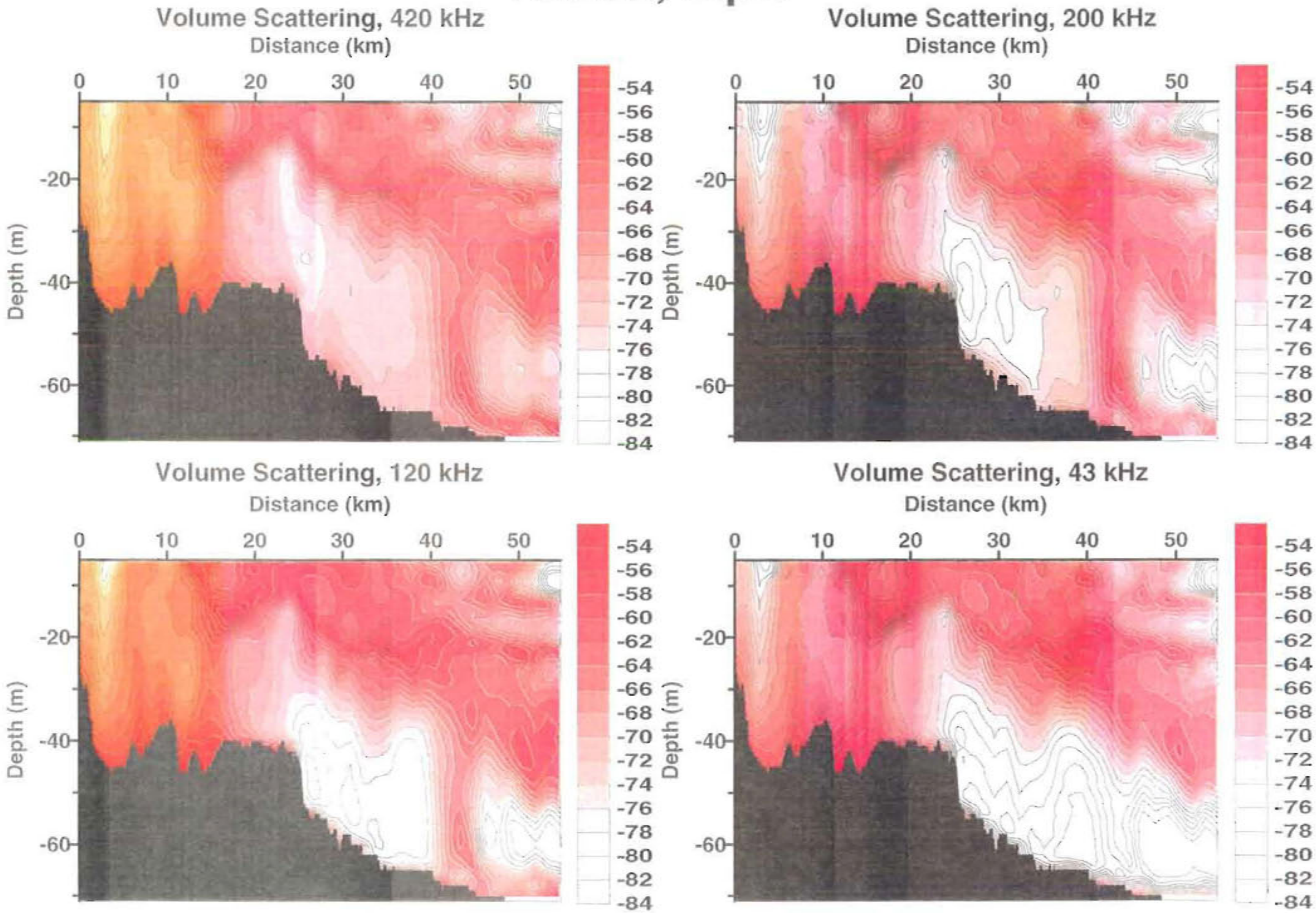
East of St. Paul Is., 17 Aug. '99



HX222 - St Paul East - 16 August 1999

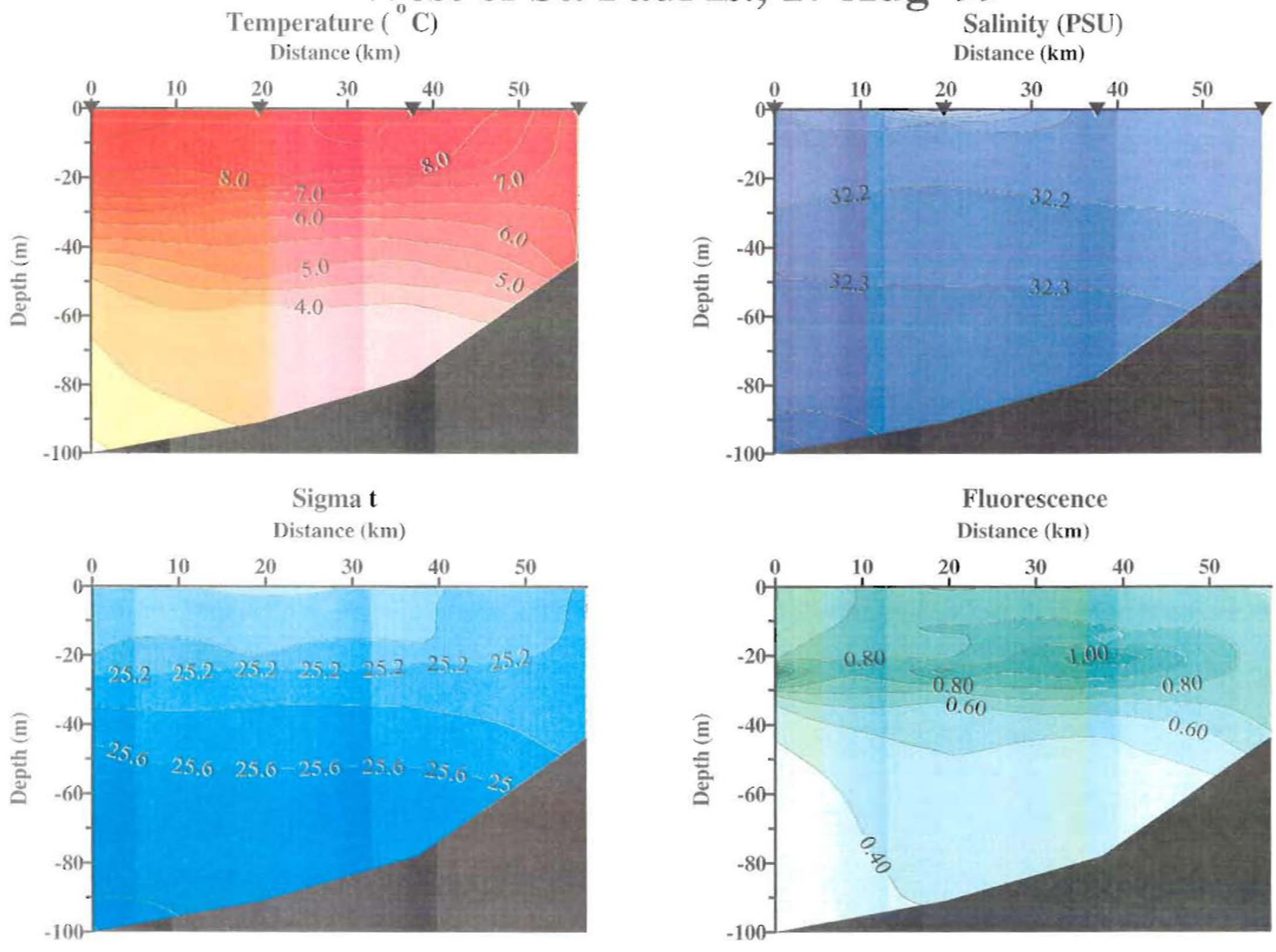


HX222; stple

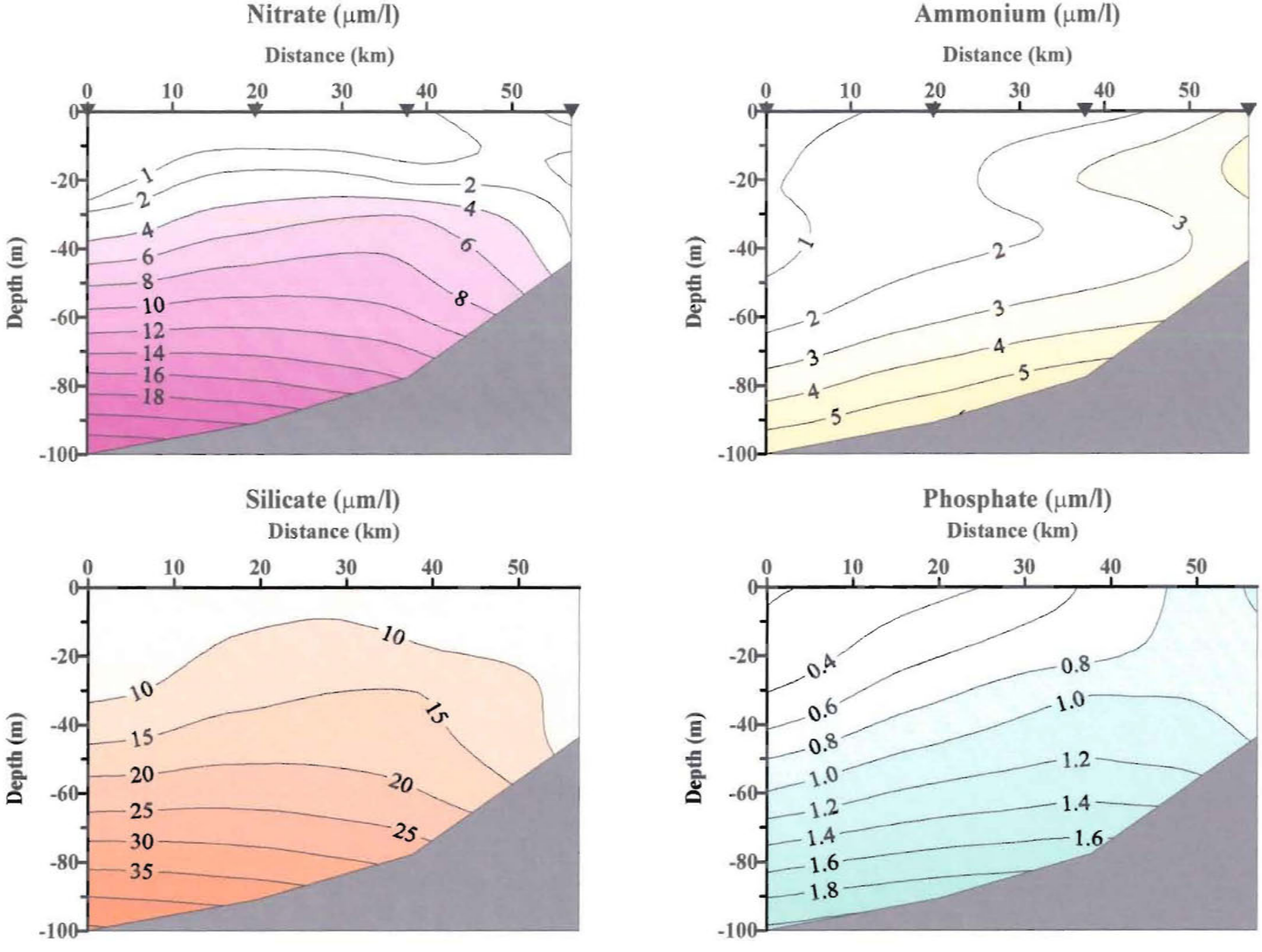


Volume Scattering, 420 kHz
Distance (km)
Depth (m)
Volume Scattering, 200 kHz
Distance (km)
Depth (m)
Volume Scattering, 120 kHz
Distance (km)
Depth (m)
Volume Scattering, 43 kHz
Distance (km)
Depth (m)

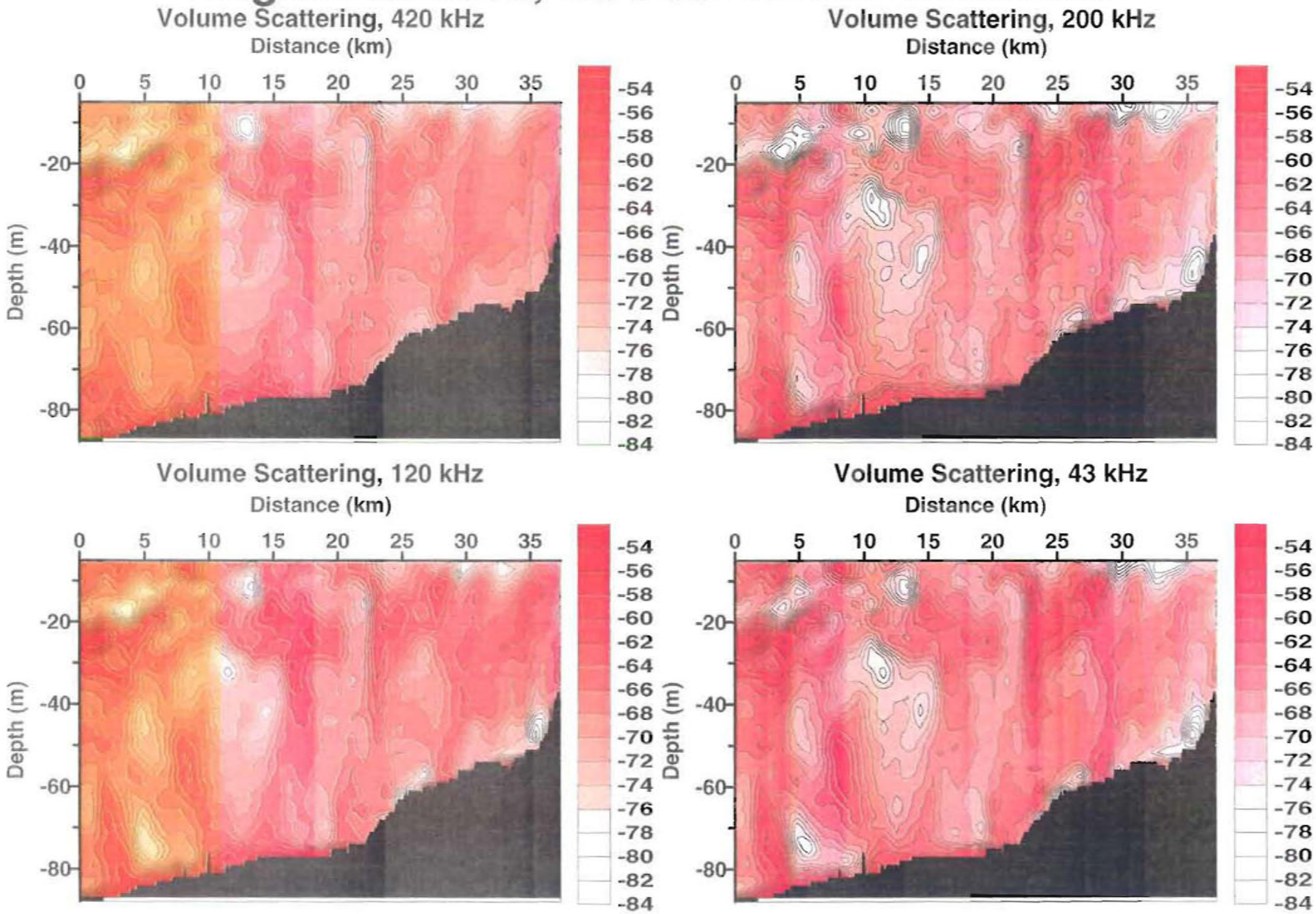
West of St. Paul Is., 17 Aug '99



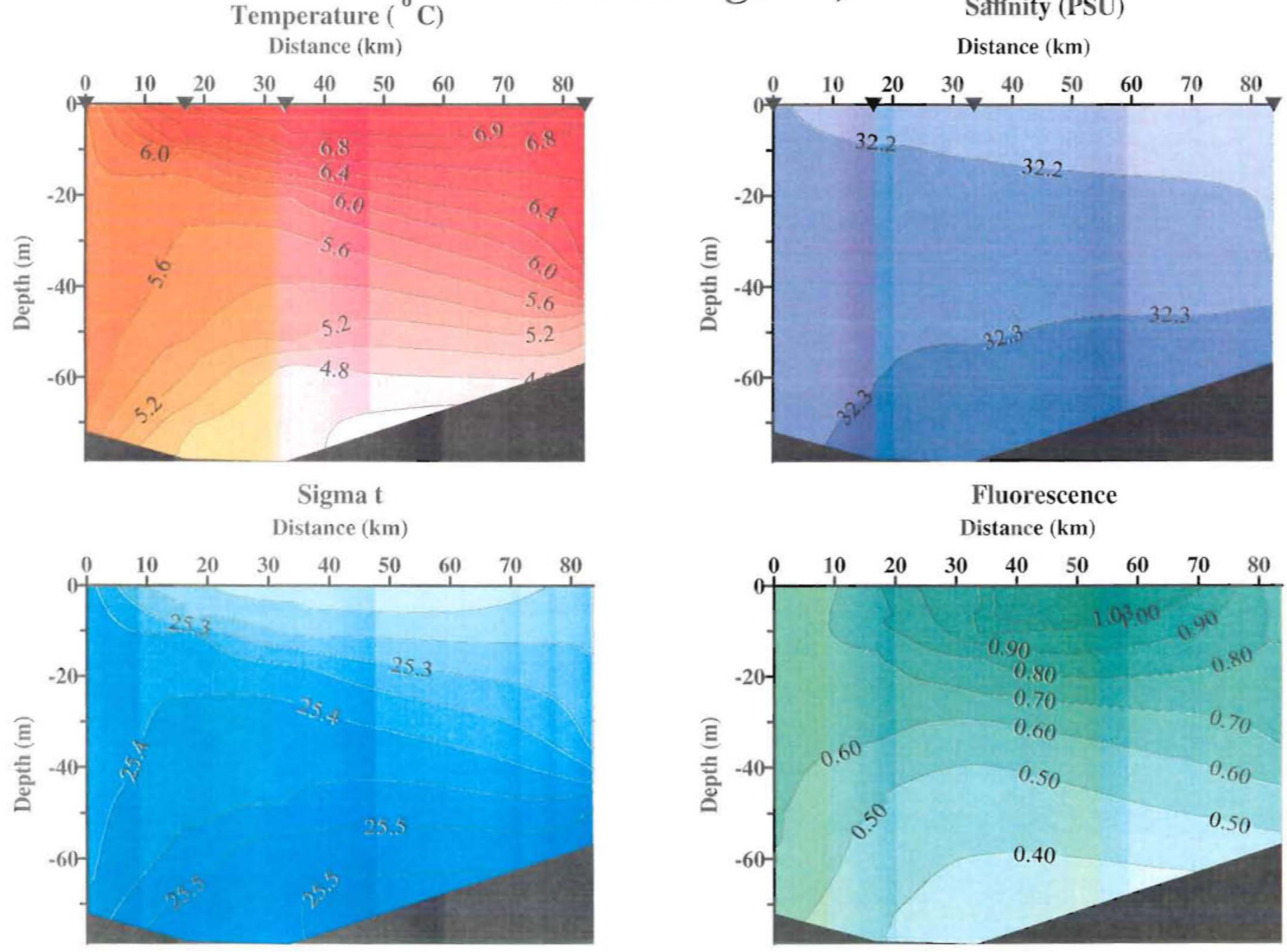
HX222 - St Paul West - 16 August 1999



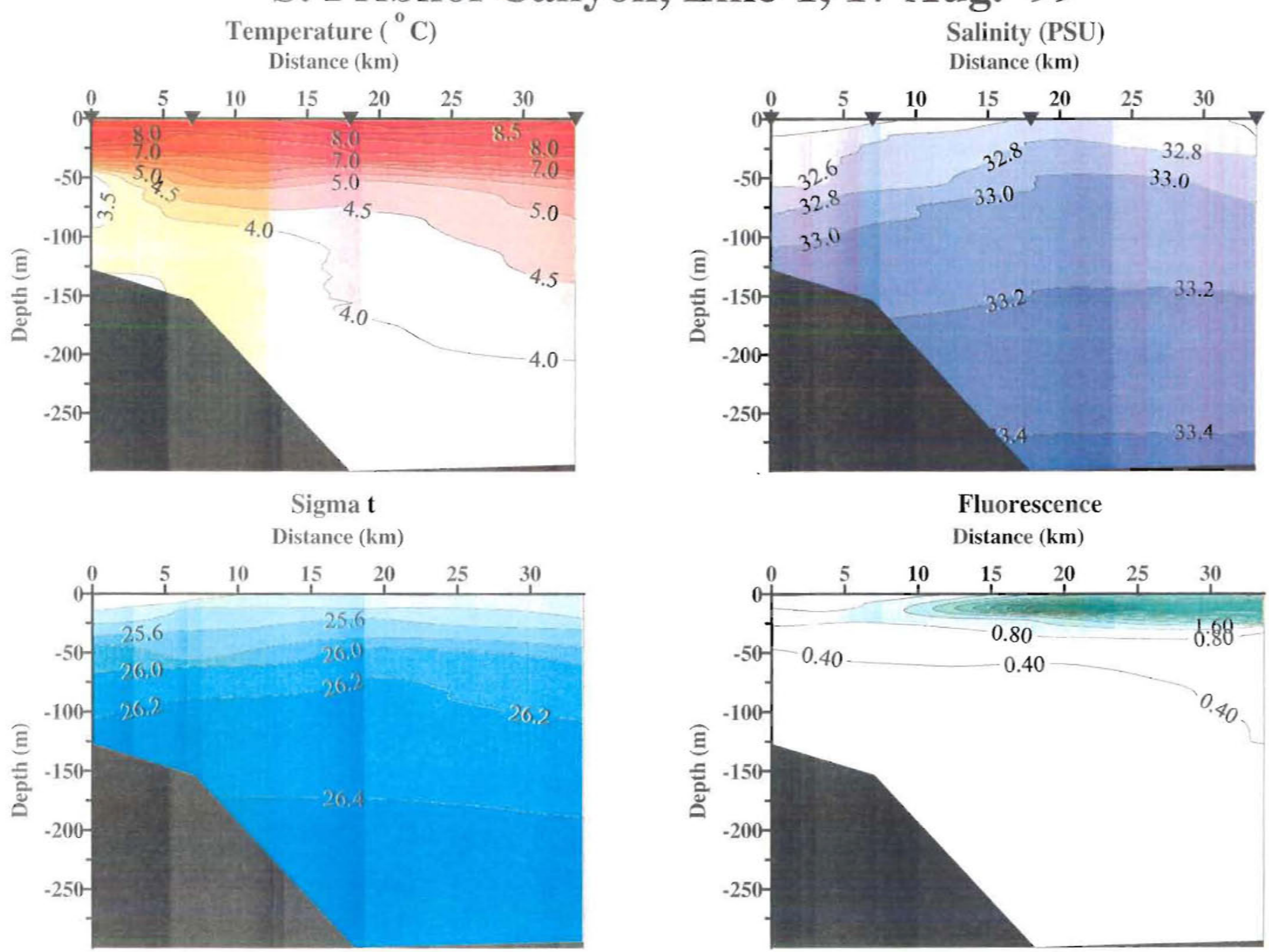
August 16 1999, St. Paul Island West Line



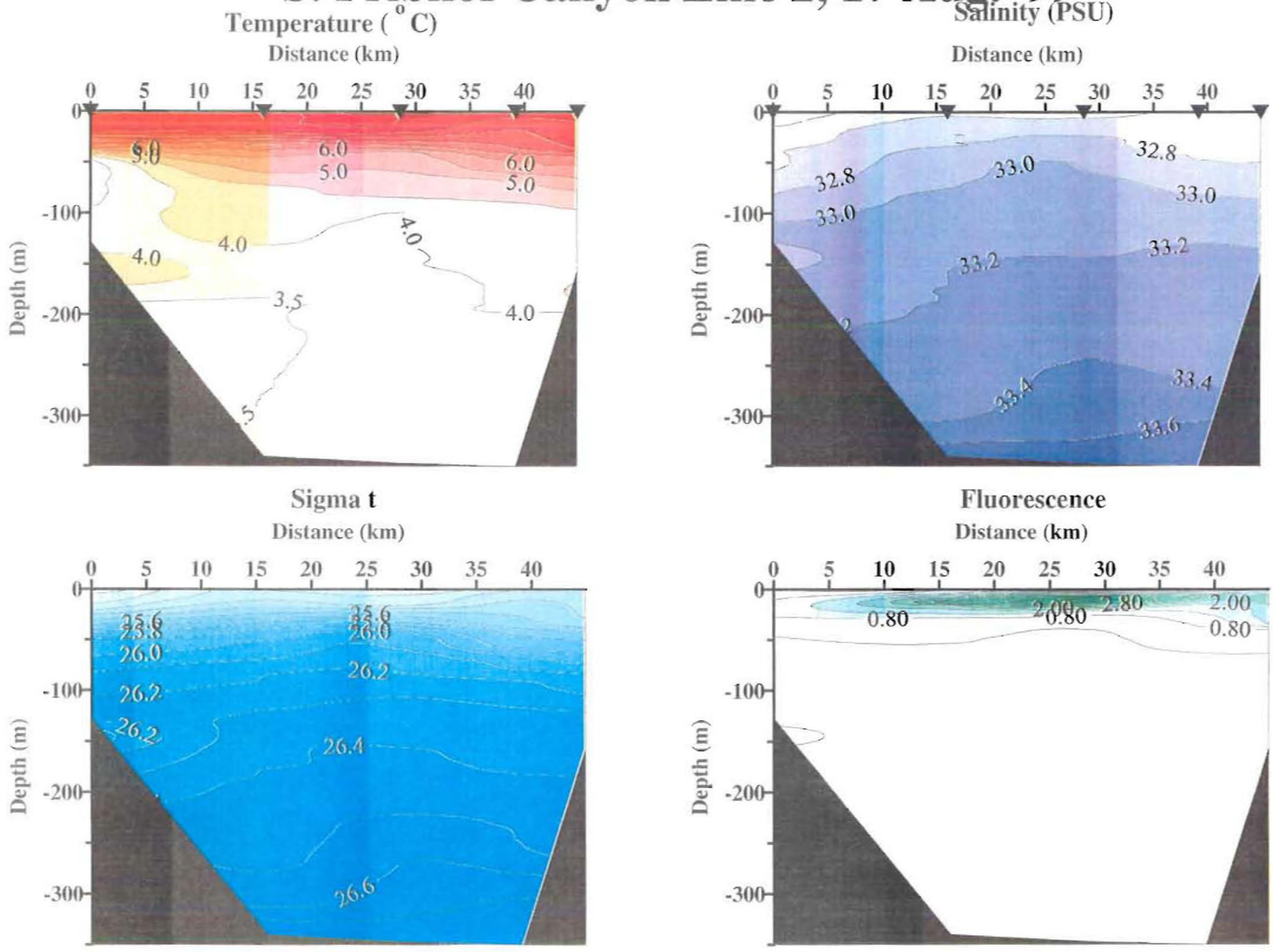
St. Paul Is.to St George Is., 17 Aug. '99



S. Pribilof Canyon, Line-1, 17 Aug. '99



S. Pribilof Canyon Line 2, 17 Aug. '99



16:55:24 Apr 12 2001
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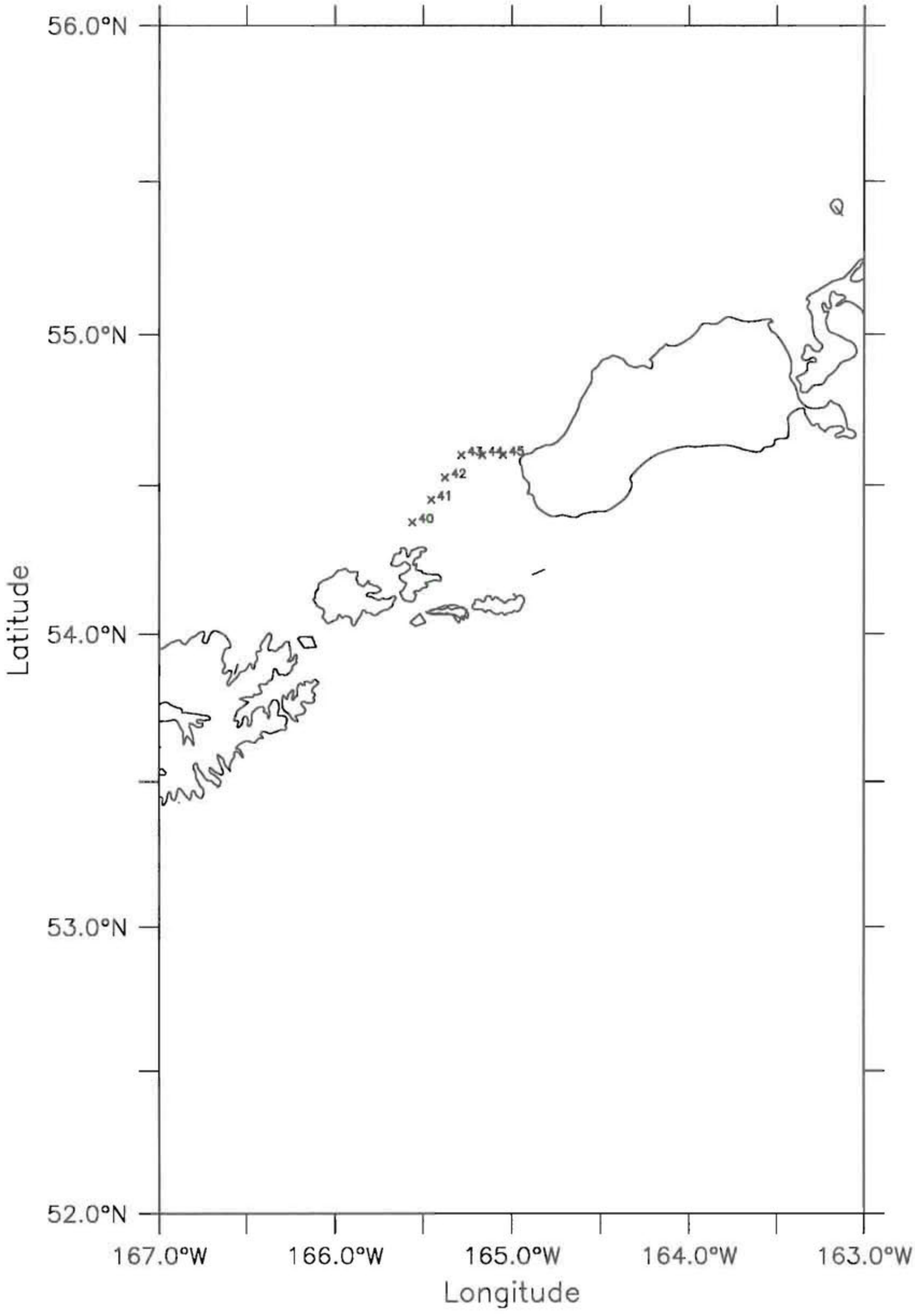

CTD Station Locations