CRUISE REPORT

ALPHA HELIX CRUISE 259

16 May to 19 June 2002

Foraging Habitats of Steller Sea Lions in the Aleutian Islands: Bottom-up Controls of Prey Availability and the Presence of Killer Whales

George L. Hunt, Jr., Chief Scientist

Ken Coyle, PI
Sue Moore, PI
Phyllis Stabeno, PI
Steve Zeeman, PI

G. Hunt
Department of Ecology and Evolutionary Biology
University of California, Irvine
Irvine CA 92697-2525
Phone: (949) 824-6322
824-6006 (message)
FAX: (949) 824-2181
25 June to 15 September: Phone (360) 378-6748
e-mail: glhunt@uci.edu

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Scientific Purpose:

Due to a continuing population decline, the western stock of the Steller sea lion (*Eumetopias jubatus*) is listed as endangered. The decline of Steller sea lions in the central and western areas of the North Pacific/Bering Sea has precipitated a number of research projects seeking to investigate possible causal factors. Hypotheses to explain declines in populations from Kodiak Island, the Alaskan Peninsula and the Aleutian Island Arc include: 1) Commercial fisheries are competitors for prey; 2) There is significant predation by killer whales (*Orcinus orca)*; and 3) Changes in climate have affected the productivity of sea-lion habitat, thus diminishing the abundance or availability of prey, particularly in the western portion of their range. Management actions necessary to mitigate the possible effects of fisheries have severely restricted the inshore portion of the commercial groundfish fishery. To improve the basis for future management decisions, more information is required about how killer whales and climate variations impact the ecosystem on which Steller sea lions depend. Our project, the Aleutians Passes Study, focused on two fundamental goals: (1) examination of productivity near sea lion rookeries and haul outs and (2) documentation of the number and ecotype of killer whales in waters between Unimak and Tanaga passes in the Aleutian chain.

To this end, we conducted investigations in seven passes through the Aleutian Islands that differed in physiography: Unimak Pass (about 19 km wide by 52 m deep), Akutan Pass (7 km by 30 m), Umnak Pass (6.7 km by 60 m), Samalga Pass (29 km by 200 m), Amukta Pass (68 km by 430 m), Seguam Pass (30 km by 165 m), and Tanaga Pass (32 km by 235 m) (Fig. 1). The passes border Steller sea lion rookeries and haul outs where populations are either in decline or holding steady; none are increasing. These passes provided the opportunity for a suite of comparisons of hydrography and productivity at dynamic centers of seawater exchange between the North Pacific and the Bering Sea. In each pass, we characterized and quantified: 1) the physical regime, 2) nutrient availability, 3) primary production, 4) the distribution and abundance of zooplankton and micro-nekton, 5) the foraging ecology of marine birds as indicators of prey availability, and 6) the distribution and relative abundance of killer whales, and where possible, obtained identification-quality photographs and biopsy samples from them. This study is the first multi-disciplinary, integrated examination of the ecosystem in the critical habitat of the western population of the Steller sea lion. It provides initial examinations of two of three hypotheses most likely to explain the decline of the sea lions, and has the potential to provide information of significant value for the future management of sea lion recovery and the fisheries of the region.

Personnel

George Hunt	Chief Sci.	UCI	USA	Ornithology
Steve Zeeman	Co-PI	U. New England	USA	Primary Production
Ken O. Coyle	Co-PI	U. AK, Fairbanks	USA	Zooplankton
Lori Mazzuca	Researcher	NMML	USA	Killer whales
Sigrid Salo	Res. Assoc.	PMEL	USA	Phys. Oceanogr.
Jaime Jahncke	Student	UCI	PERU	Ornithology
Sophie Webb	Technician	UCI	USA	Ornithology
Nancy Black	Technician	NMML	USA	Killer Whales
Bob Pitman	Researcher	SWFSC	USA	Killer Whales
Ruth Bolster	Technician	U. New England	USA	Primary production
Katie Strait	Student	U. New England	USA	Primary production
Amanda Byrd	Student	U. AK Fairbanks	USA	Zooplankton
Leandra DeSousa	Student	U. AK Fairbanks	USA	Zooplankton

Cruise Schedule and Activities

DATE	ACTIVITY
16-19 May	**In transit from Seward to the Dutch Harbor**
19-26 May	**Work in Akutan and Unimak Passes**

19 May: 09:30: Load science party at Dutch Harbor
10:30: Safety meetings and drills
11:30: Begin whale survey north side, Unalaska Island
22:00: End whale survey, north side, Unalaska Island
23:45: MOCNESS survey north end of Unimak Pass

20 May: 00:00: MOCNESS north end of Unimak Pass line (UNY-30, 28, 26, 23)
07:00: Productivity cast at UNY-28
07:30: Acoustic survey south through Unimak Pass with HTI, birds, and mammals
13:00: Productivity cast at UNY-19
14:00: Continue acoustic survey south
18:00: Failed productivity cast (CTD malfunction)
22:00: End bird survey
23:45: End acoustic survey at UNY-1

21 May: 00:30: MOCNESS at south end of Unimak Pass line (UNY-01, then weathered out; lost 3 tows)
07:00: Run for shelter with two sets of whale observations around south end of Akutan Pass and the Krenitzin Is.
18:00: Productivity station at AKY-14
18:30: Continue search for killer whales, north side of Akutan.
23:00: MOCNESS tows north end of Akutan Pass (AKY-14).

22 May: 00:00: MOCNESS sampling at AKY-16, 17, 18, 19
07:30: Productivity station at AKY-19
08:00: Start CTD and CalVET survey south along Akutan line with birds and mammals.
Stations at: AKY-19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 07, 04, 01
12:00: Productivity station at AKY-14
18:00: Productivity station at AKY-04
19:00: Ran back up line to position for MOCNESS tows.
23:30: MOCNESS AKY-10

23 May: 00:00: MOCNESS AKY-08, then weathered out.
09:00: At dock in Dutch harbor for pickup of parts, bad weather
15:30: Depart Dutch Harbor to search for whales north side of Unalaska Is.
19:38: On whales, launched small boat; secured at 20:45

24 May: 07:00: Productivity station at AKY-19
07:30: Begin acoustic survey with birds and mammals in Akutan Pass from AKY-19 to AKY-10 (rest of survey aborted due to heavy weather)
11:30: Run for lee and areas north of Akutan Is. without fog for mammal obs.
20:00: Encountered whales with a fishing boat hauling black cod traps.

25 May: 03:45: MOCNESS at UNY-11
07:00: Start CTD and CalVET survey south along Unimak Pass Y-line with bird and mammal observations. Stations: UNY-30, 28, 26, 23, 20, 18, 16, 14, 11, 08, 05, 03, and 01. Killer whales seen in passing mode only.
08:00: Productivity station at UNY-28
22:30: Grab water for a productivity experiment UNY-05
23:00: MOCNESS at UNY-05

26 May: 06:00: MOCNESS at AKY-04
07:00: Acoustic, seabird and mammal surveys in Akutan Pass between AKY-01 and AKY-09 then AKY-11- to AKY-09
13:30: Complete acoustic survey and head west for Tanaga Pass.

27-28 May Transit to Tanaga Pass

27 May: 00:00: Underway for Tanaga Pass.
12:56: Searching off-line for killer whale
17:45: Working killer whales
22:00: Secured from killer whale work.

28 May: 00:00: Underway to Tanaga Pass.
17:45: Arrive south end of Tanaga Pass: looking for whales in Delarof Is.

29-31 May Tanaga Pass

29 May: 00:01: MOCNESS Survey south end of Tanaga Pass (TNY-1, 4, 7, 10, 13)
07:30: Commence search for killer whales
09:55: End work on killer whales
12:30: Productivity station at TNY-01
12:50: Start acoustic, bird and mammal surveys of Tanaga Pass from TNY-01 to TNY-21
14:15: Deploy drifter on flood tide (TNY-4; 51° 28.69' N, 177° 44.75' W)
22:28: End acoustic survey
22:30: Underway for MOCNESS survey

30 May: 00:45: MOCNESS survey north end of Tanaga Pass (TNY-15, 17, 19, 21)
08:40: Productivity cast, TNY-21
09:00: Start CTD, CalVET, bird and mammal survey of Tanaga Pass at TNY-21 going south. Started south about half way through the ebb tide, and last half during flood. Stations at TNY-21, 18, 16, 14, 13, 12, 10, 08, 05, 02.
22:09: End CTD survey and head for Tanaga Bay for test of 38 kHz sounder.

31 May: 08:19: Commence CTD survey of Tanaga Pass X-line (TNX-05, 04, 03, 02 ,01)
11:00: Search for auklets to collect; break-off to look for whales
13:00: Deploy small boat to biopsy sperm whales
14:30: Retrieve small boat
15:25: Deploy small boat to work killer whales near Delarof Pass
17:20: Secure from whale work; continue survey through Delarof Is.
22:30: Collecting auklets
23:42: Underway to Tanaga Bay to anchor up for daylight travel eastward along north side.

1 June: 08:00: Underway for Seguam Pass, with whale survey along north side of Tanaga Is, Adak Is. etc.

2- 6 June **Seguam and Amukta Passes**

2 June: 08:00: Searching for killer whales in northern Seguam Pass
12:05: Begin CTD/CalVET survey of Seguam Pass with birds and mammal obs. Starting about ½ down from high tide and ending on rising tide. Stations: SGY-17, 15, 13, 12, 11, 10, 8, 6, 4, 2, and 00.
Productivity stations at SGY-17, SGY-10.

3 June: 00:30: MOCNESS survey southern Seguam Pass (SGY-00, 02, 04, 06, and 09)
09:00: Productivity cast at SGY-17
09:20: Begin acoustic survey of Seguam Pass with bird and mammal obs. from SGY-17 to SGY-00.
17:50: Productivity cast at SGY-00
18:15: Underway looking for birds to collect or killer whales
22:05: Working killer whales
23:40: Underway for MOCNESS survey

4 June: 02:00: MOCNESS survey north end of line (SGY-17, 15, 13, and 11).
08:00: Begin SGX survey at SGX-04
08:30: Abort line for whale studies
12:15: Small boat away for whale work
14:35: Small boat returned
15:23: Collected water for prod study
15:45: Underway for seabird collecting
16:30: Collected fulmars and short-tailed shearwaters from convergence slick near SGY-9.
17:45: Small boat on board, back to looking for whales
18:20: Small boat away for whale studies
22:30: Cast for productivity experiment in area of high chlorophyll; water held to next day for workup.
22:55: Small boat back from whale work

5 June: 00:01: CTD survey of Seguam X-line at night to beat weather: (SGX-04, 03, 02, 01); no bird or mammal observations
04:30: CTD Survey of the Amukta Pass X line (AMX-05, 04, 03, 02, 01); no mammal observations, bird obs. for last two segments only. End 09:00
11:44: Acoustic Survey with bird and mammal observations of Amukta Pass from AMY- 01 to AMY-17.
13:03: Deploy drifter # 36264 at AMY-04 (52° 02.66' N, 171° 41.80' W)
15:56: Break line for photos of killer whales
17:05: CTD cast for productivity study
17:30: Resume Acoustic Survey
19:58: Finish Acoustic Survey
20:01: CTD cast for Productivity station
20:24: Photos of Killer Whales
21:32: Begin CTD/CalVET survey south through Amukta Pass: (AMY-17, 15)

6 June: 00:38: Continue CTD/CalVET survey of Amukta Pass (AMY-13, 11, 09, 08, 06, 04) No bird or mammal observations; foul weather.
09:40: Complete CTD/CalVET survey and run for cover in Islands of Four Mountains
15:00: North side of Yunaska Island, Bird and Mammal surveys into Islands of Four Mountains
21:56: Anchor Up for weather

7 - 9 June Samalga Pass

7 June: 12:30: Begin CTD/CalVET survey of Samalga Y-line (SAY-16, 14, 12, 10)
17:24: Broke off because of bad weather went to anchor up.

8 June: 09:30: Complete CTD/CalVET survey of southern end of Samalga Pass on an ebb tide (SAY-02, 04, 06, 08 and 10)
12:46: Deploy drifter # 36265 at 52° 38.33'N 169° 28.22' W
15:00: Collecting birds near SAY-10 (Fulmars)
16:42: CTD Survey of Samalga X-line (SAX-05, 04, 03, 02, 01)
19:30: Searching for killer whales

9 June: 00:30: MOCNESS sampling of Samalga Pass (SAY-14, 10, 06, 02)
07:37: Commence Acoustic Survey of Samalga Pass against an ebbing tide (SAY-02 to SAY-14).
13:56: Abort Acoustic survey at SAY-11 to photograph and biopsy killer whales
18:20: Restart Acoustic survey at SAY-11 and run to SAY-14.
19:30: Complete Acoustic survey and underway to Umnak Pass

10 – 11 June **Umnak Pass**

10 June: 07:00: Brief look for whales, off effort
10:07: Begin CTD/CalVET survey of Umnak Pass (with ebbing tide) (Stations at UMY-08, 07, 06, 05, 04, 03, 02, 01); killer whales seen, passing mode only.
16:30: Start Acoustic survey of Umnak Pass from UMY- 01 to UMY-08
20:53: Abort Acoustic survey at UMY-07 to work killer whales

11 June: 07:00: Whale and bird observations from Umnak Pass to Unimak Pass.
12:52: Launch small boat for killer whale work
18:00: Working killer whales
20:00: Killer whales encountered, passing mode only

12-19 June **Unimak and Akutan Passes**

12 June: 01:30: MOCNESS Survey of north end of Unimak Pass (UNY-20, 23, 27)
06:00: CTD Cast for Productivity study (UNY-27)
06:22: Begin Acoustic Survey of Unimak Pass from UNY-27 to UNY-6
11:03: CTD for Productivity study at UNY-15
15:07: Begin CTD and CalVET Net survey of Unimak Pass (Stations at: UNY-6, 8, 12, 14, 16, 18, 20, 22, 24, 27).

13 June: 04:07: MOCNESS Survey north end of Akutan Pass (AKY-19, 17)
07:02: Begin time series of CTD casts at AKY-16 to document tidal incursions
22:00: End CTD series (16 casts, 1 /hr) and head for shelter.

14 June: 00:00: At anchor due to foul weather
10:28: Underway to Dutch for dental clinic and shelter

15 June: 12:00: Depart Dutch Harbor for AKY-line
13:49: CTD and CalVET Net survey of Akutan Line (AKY-19, 17, 15, 13, 11, 09, 07, 05, 03, 01)
22:30: Underway for MOCNESS stations

16 June: 00:30: MOCNESS Survey south end of Akutan Pass (AKY-07, 04, 01)
05:00: Acoustic survey of Akutan Y-line from AKY-01 to AKY-19 with bird and mammal observations.
13:25: Begin search for killer whales
17:00: Working killer whales
17:45: Broke off because of ship traffic
18:15: Collecting foraging seabirds
19:00: Looking for killer whales
19:30: Working killer whales
20:30: Shifted to working humpback whales
21:05: Deploy acoustic survey gear across an area where humpback whales and birds foraging.
21:40: Underway to MOCNESS deployment stations

17 June: 01:10: MOCNESS survey north end of Akutan Pass (AKY-14)
07:40: Drop G. Hunt at Dutch Harbor, K. Coyle Chief Scientist
08:00: Underway for Unimak Pass
11:30: Sighted and lost contact with killer whales
13:15: CTD survey along frontal feature where birds and humpback whales aggregated (KRX-07, 06, 05, 04, 03, 02, 01)
15:45: Acoustic survey across frontal feature from KRY-01 to KRY-09.
20:25: CTD survey across frontal feature with stations at KRY-09, 08, 07, 06, 04, 03, 02.

18 June: 00:30: MOCNESS survey (KRY-05.5, UNY-11)
07:00: Begin killer whale search near Unimak Island
07:15: Working killer whale group
09:15: Searching for killer whales
12:00: Working killer whale group
13:30: Searching for killer whales
14:15: Working killer whale groups
16:20: Underway for UNY-26
18:45: Bird survey through Unimak Pass from UNY-26 to UNY-11
23:10: Transect terminated prematurely because of darkness

19 June: 01:00: MOCNESS survey south end of Unimak Pass (UNY-6, UNY-01)
03:20: Calibration of HTI acoustic device
07:00: Underway to Dutch Harbor
14:00: Arrive Dutch Harbor

Summary Of Results

Overview

In 2002, we were in the eastern portion of our Aleutian Islands study area (Fig. 1) nearly a month earlier than we were in 2001. Therefore, in 2002, we began our sampling in Unimak and Akutan Passes on 20 May, before proceeding to Tanaga Pass, from which we worked our way eastward back to Unimak and Akutan Passes, where we finished up on 19 June. By visiting Unimak and Akutan Passes at both the beginning and the end of the cruise, we minimized aliasing our comparisons of eastern and western passes with a seasonal signal. This approach also allowed us to compare late spring and early summer conditions in the two eastern passes.

In 2002, we experienced considerable stormy weather, with low pressure systems moving through the Aleutians with intervals of one or two days of calm weather between two- to three-day periods of stormy weather. This high frequency of storms and the loss of several days of sampling because of poor weather necessitated a conservative approach to our cruise plan. Thus, to conserve potential weather days, we went no farther west than Tanaga Pass. As we managed to keep or exceed our planned work rate in the western passes, we added investigation of Umnak Pass and a more thorough study of Unimak Pass than was originally anticipated.

To accomplish our goals, we conducted transects through and across the passes to assess physical processes using CTD casts. Zooplankton distribution and abundance were assessed with acoustic surveys, and tows of CalVET and MOCNESS nets. Chlorophyll abundance was measured at each CTD station, and rates of primary production were measured at a subset of stations within the passes. The distributions and abundances of birds and marine mammals were assessed during each of the surveys along the fixed transects, and additional inshore surveys were conducted to search for killer whales. In 2002, we conducted 164 CTD casts for determination of hydrographic structure, nutrients (750 samples), and chlorophyll abundance (765 determinations), 35 ^{14}C-based studies of primary production, and collected 690 samples of phytoplankton for cell counts. Zooplankton sampling included 83 tows of a CalVET net for zooplankton community composition, 51 deployments of a MOCNESS multiple-opening-closing net for zooplankton abundance, and approximately 920 km of acoustic surveys. In addition, we conducted 1520 km of marine bird surveys, collected 10 short-tailed shearwaters, 18 northern fulmars and 5 least auklets for determination of food habits. We completed 350 hours of marine mammal surveys, conducted photo-ID encounters with 23 pods of killer whales and obtained 26 biopsy samples from killer whales in the study area.

This year's cruise yielded a number of exciting findings including: documentation of the westernmost pass with a significant northward flow of Alaska Coastal Current Water; a repeat of last year's finding of a strong east-west gradient in primary production and zooplankton abundance and species composition; a strong east-west shift in species composition of marine birds and their diets; and strong seasonal and east-west variations in the species composition and abundance of cetaceans. As was the case last year, we saw very few pinnipeds in the water anywhere in our study area. We had remarkable opportunities to observe foraging seabirds in a number of passes, but the most impressive

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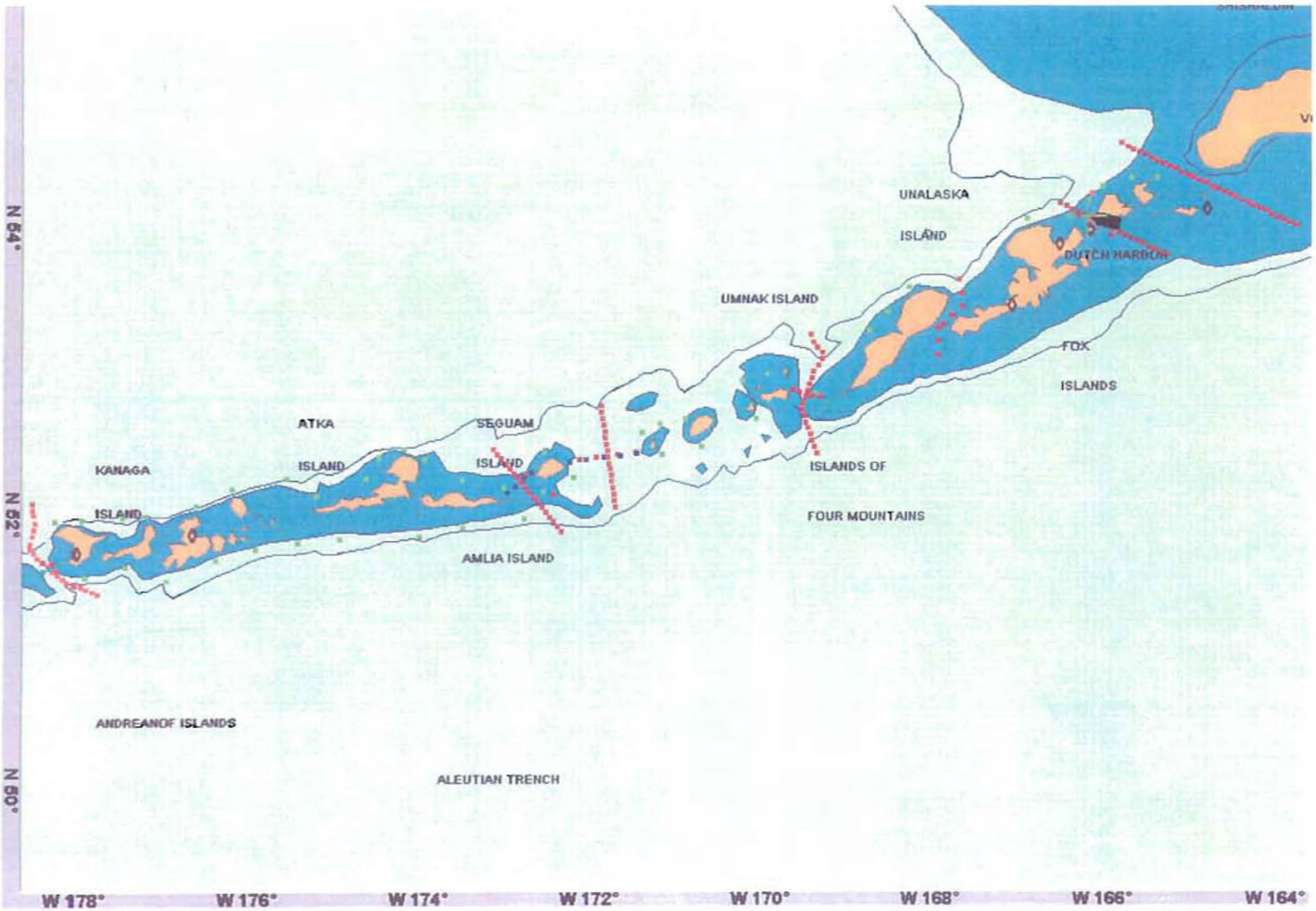

Fig. 1

were extraordinarily large aggregations of shearwaters foraging on euphausiids at frontal structures at the northwest corner of Unimak Pass. There were more than 100 humpback whales amongst the shearwaters. A remarkable concentration of killer whales was found foraging on fish (that appeared to be salmon) in Samalga Pass. Several groups of what were apparently transient-ecotype killer whales were encountered feeding on a gray whale calf in Unimak Pass.

We have begun to accrue the data necessary to show that there are striking step-functions in the physics, primary production, zooplankton types and biomass, and in the species composition and foraging ecology of marine birds as one goes from the eastern to central Aleutian Islands. These shifts in the marine ecosystem are at similar locations to those where sea lion diets change, and where regional population trajectories of sea lions may change. Our data also show that killer whales are numerous in the region, and that there are transient-ecotypes present that could be predators of sea lions. Given the numbers of resident-ecotype killer whales in the region and their foraging habits, it would be interesting to know whether they could be significant competitors with sea lions for Atka mackerel, salmon, herring and other forage fishes in the passes.

Unimak and Akutan Passes

In 2002, we visited the Unimak/Akutan study area between 19 and 26 May, and again between 12 June and 19 June (Fig.2, 3). In 2001, we were there between 14 and 20 June. As in 2001, in Unimak and Akutan passes in 2002, we found that cold, salty water was being pushed up into the passes from the north during ebb tides (Fig. 4-7). We expect that this water is a source of nutrient replenishment of the surface waters to the north of, and in the pass. Strong salinity and temperature fronts separated the fresher, warmer waters in the south from the colder, saltier water from the Bering Sea.

In May 2002, chlorophyll was abundant in the surface waters of both Unimak and Akutan passes, as well as to the north and south of the passes (Fig. 4a, 6a), suggesting that the spring phytoplankton bloom was still in progress. This was in marked contrast to the situation in June 2002 (and June 2001), when we found little chlorophyll present in the passes (Fig. 5a, 7a). In June 2001, but not in June 2002, we found elevated levels of chlorophyll in the stratified water just north of these passes, whereas in June 2002, the little chlorophyll that was present occurred south of the passes (Fig. 5a, 7a). A set of 16 CTD casts taken at hourly intervals on the shelf at the north end of Akutan Pass illustrated the intrusion of cold, salty water at depth, and the presence of a small patch of chlorophyll that was advected into the pass near the end of the ebb tide (Fig. 8).

Acoustic surveys in May 2002 showed that copepods were abundant in Unimak and Akutan passes, as well as to the north and the south of the passes (Fig. 9, 10). There was also a considerable biomass of euphausiids at the north end of Akutan Pass, with lesser amounts present at the north end of Unimak Pass. In May 2002, large biomasses of fish were detected in the north-central portion of Unimak Pass, and at the north end of Akutan Pass. By June 2002, there was comparatively little biomass present in Akutan Pass or in Unimak Pass with the exception of a large biomass of what were probably euphausiids at the north end of Unimak Pass (Fig. 11, 12).

In May 2002, seabirds were scarce in Unimak and Akutan passes when compared to what we encountered in June 2001 (Fig. 13, 14). On 12 June 2002, numbers of migrant shearwaters (*Puffinus* spp.) (Fig. 15) and puffins (*Fratercula* spp.) (Fig. 16) had increased compared to what we had found in May 2002 (Fig. 23, 24). However, visibility during these surveys was very poor, and we may have missed important concentrations. In May 2002, marine mammals in these passes were scarce compared to what we found in other passes, but humpback whales (*Megaptera novaeangliae*) were more prevalent here than elsewhere (Fig. 17). Few marine mammals were seen in the 12 June CTD and Acoustic surveys because viewing conditions were extremely poor (fog).

However, when we returned to Unimak Pass on 16 June, we encountered 100+ humpbacked whales (Fig. 18) and several million short-tailed shearwaters (*Puffinus tenuirostris*) foraging at the north end of the pass over dense concentrations of biomass (Fig. 19). The shearwaters and smaller numbers of northern fulmars (*Fulmarus glacialis*) were foraging on euphausiids that were concentrated in patches and long streaks that gave the sea surface a reddish color. In several instances, fish about 25 cm long were boiling at the surface, or could be seen swimming below the surface layers of euphausiids. They appeared similar to the herring (*Clupea pallasii*) caught in 2001 at the north end of Akutan Pass. The humpback whales were in pairs of adults, and were making short dives. There was no indication as to what prey they were eating. On 17 June we did a pair of transects along the frontal area and a pair of transects across the frontal area to take CTD measurements and to obtain acoustic profiles of the biomass in the water (Fig. 20). We also obtained MOCNESS tows to characterize the species composition of the biomass concentrations in the vicinity of the frontal system. The CTD profiles along the front revealed areas of strong convergence, possibly associated with a mesoscale meander, at which chlorophyll was concentrated (Fig. 21). The cross-shelf CTD transect showed evidence of on-shelf movement of water where tidal currents impinged on the bathymetry of the pass (Fig. 22). Acoustic data showed large amounts of biomass being forced up into the pass (Fig. 23), much of which was likely euphausiids, given the preliminary examination of the MOCNESS tows. This biomass was also patchily distributed along the frontal system (Fig. 24). Shearwaters were concentrated at the top of the shelf edge (Fig.25, 26), where the euphausiids were being concentrated (Fig. 23). A transect along the Unimak Pass Y-line on 18 June showed that shearwaters on this line were concentrated at the north end of the line (Fig. 27). This transect did not capture the highest concentrations of shearwaters as they were north of the point where the line had to be started. Neither the shearwaters nor the humpback whales were in evidence in May or at the beginning of our visit 11 or 12 June. Likewise, they were reported absent by R. Pitman (Pers. Com.) who transited Unimak Pass about 13 July. In this set of visits to Unimak Pass (16-18 June), several pods of killer whales were encountered, including three or four that were likely to have been residents and three that were eating a gray whale (*Eschrichtius robustus*) calf on the eastern side of Unimak Pass.

In summary, our three visits (May 2002 and June 2001 and 2002) to the Unimak/Akutan passes region suggest a strong seasonal shift in productivity and fauna between mid-May and mid-June. There is accumulating evidence that ebbing tides consistently result in the movement of cold, salty water from depth into the northern ends of the passes. However, it seems that flood tides do not bring similar cold, salty water into the southern ends of the passes, perhaps because of the wide expanse of shelf south of the passes. There also appears to be considerable inter-annual variation in the amounts of chlorophyll and zooplankton present in these passes. In May 2002, these passes did not appear to support high numbers of foraging marine birds or mammals. However, moderately high numbers of small auklets were present in the tide rips of Akutan Pass. In June 2002, there were modest numbers of alcids present in Akutan Pass and immense numbers of shearwaters concentrated in the Bering Sea side of Unimak Pass. In contrast, in June 2001, high numbers of seabirds foraged in Akutan Pass, with lower numbers found in Unimak Pass. Cetaceans were moderately abundant in these passes in June 2001, and in 2002, they were scarce in Akutan Pass and abundant in Unimak Pass.

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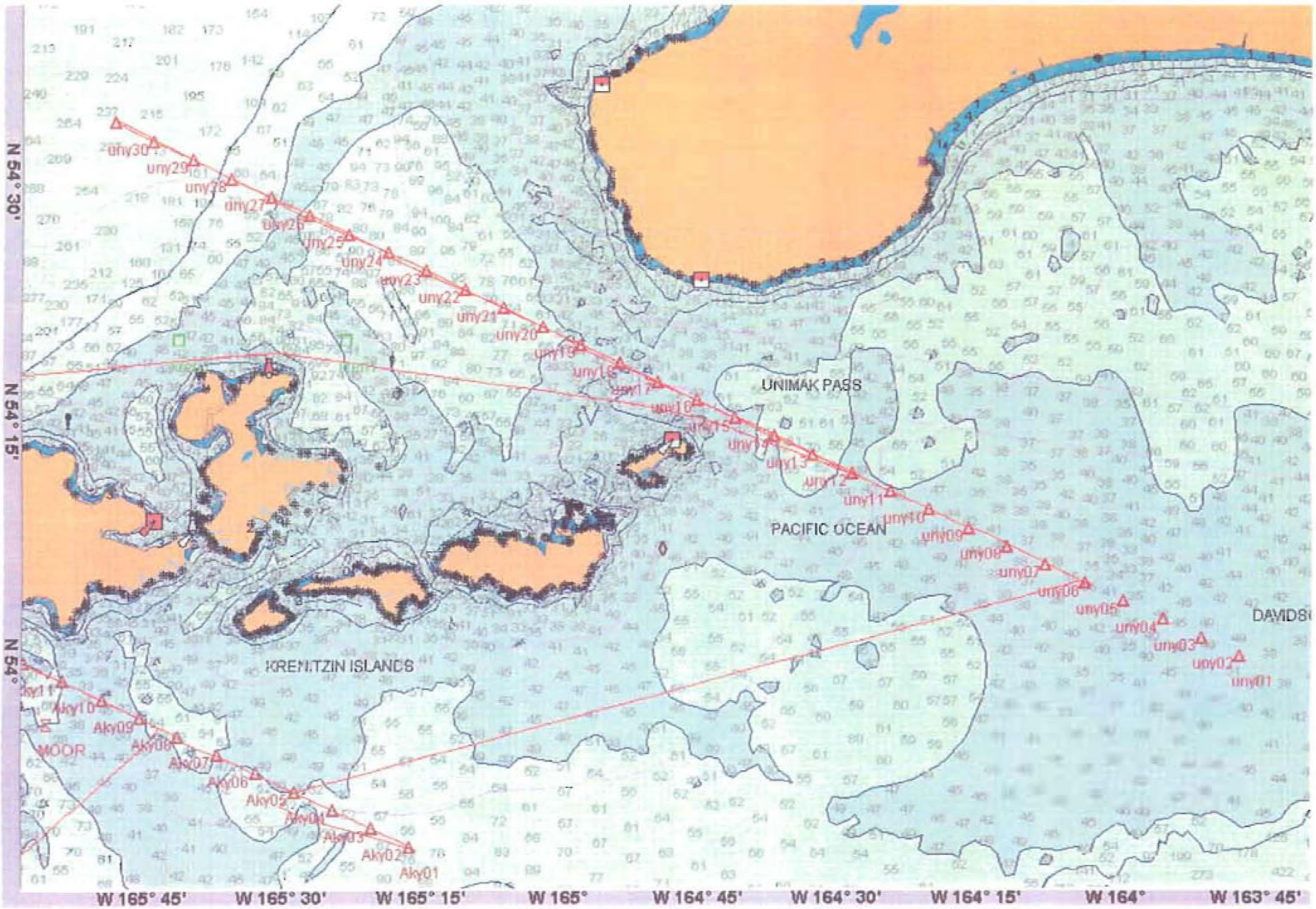

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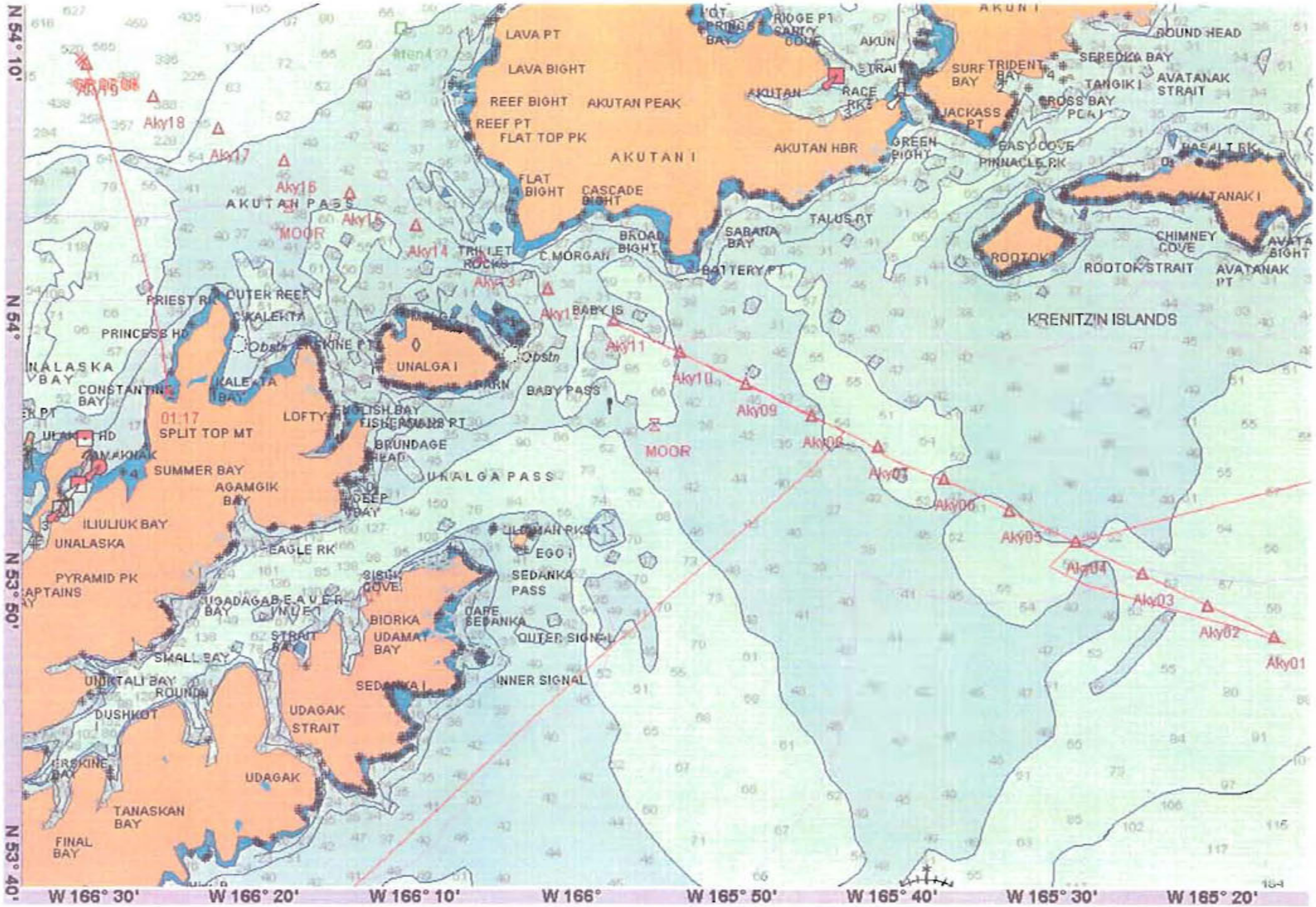

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Fig 3

HX259; Unimak Pass, 25-26 May 2002

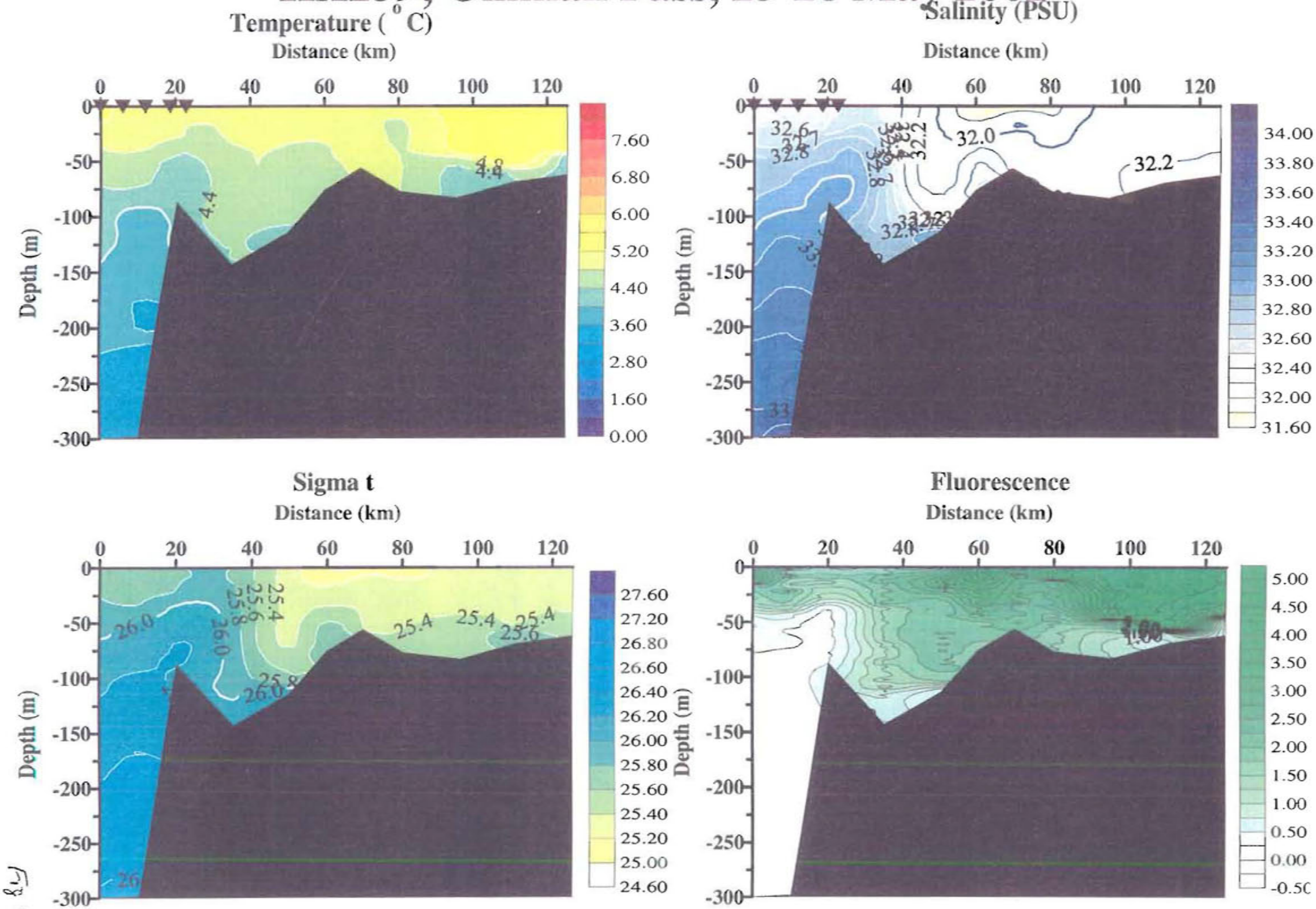

Fig 4a

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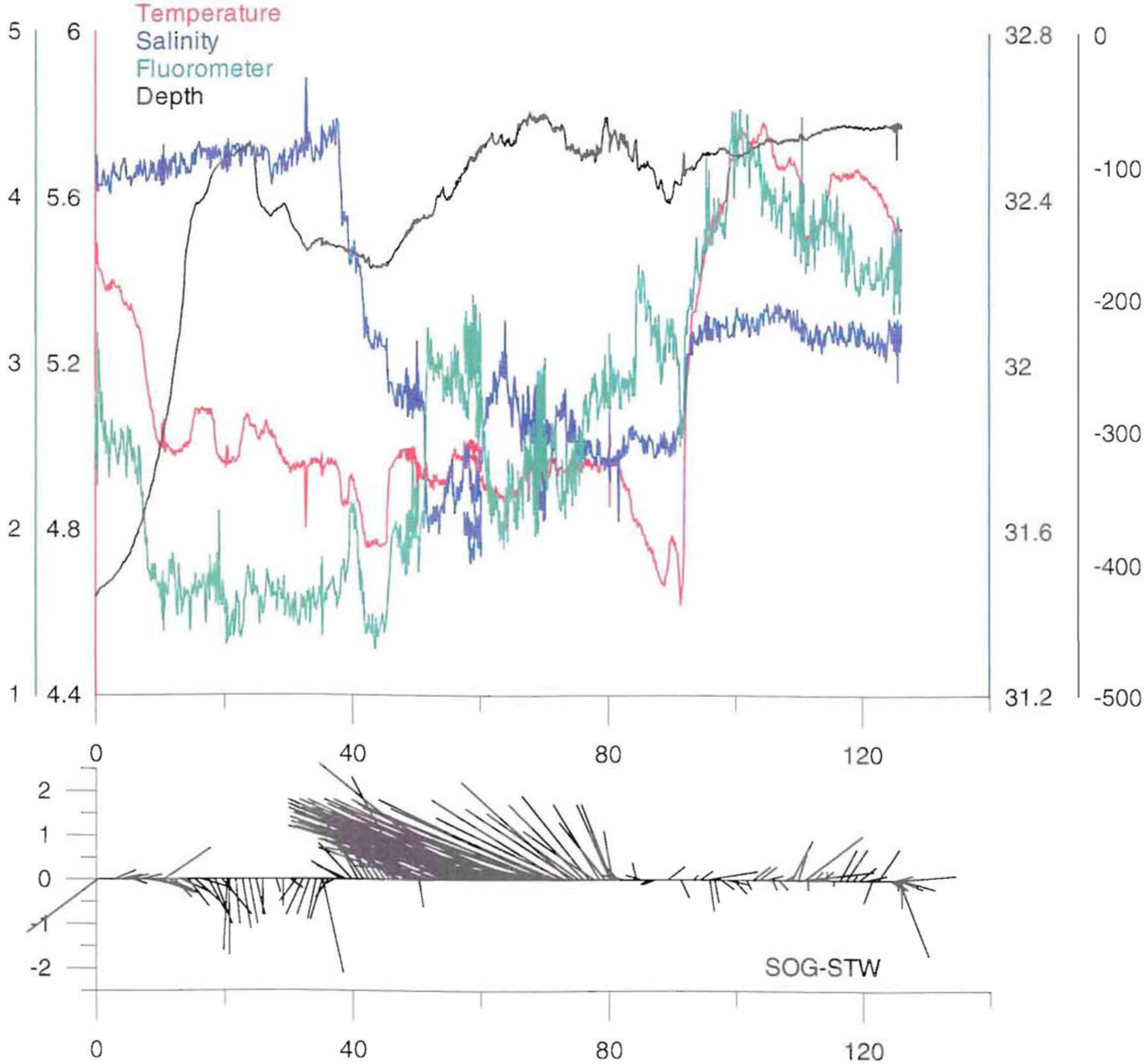
Fig. 4b

Unimak Pass, 25-26 May 2002



hx259; Unimak Pass2, 12 June 2002

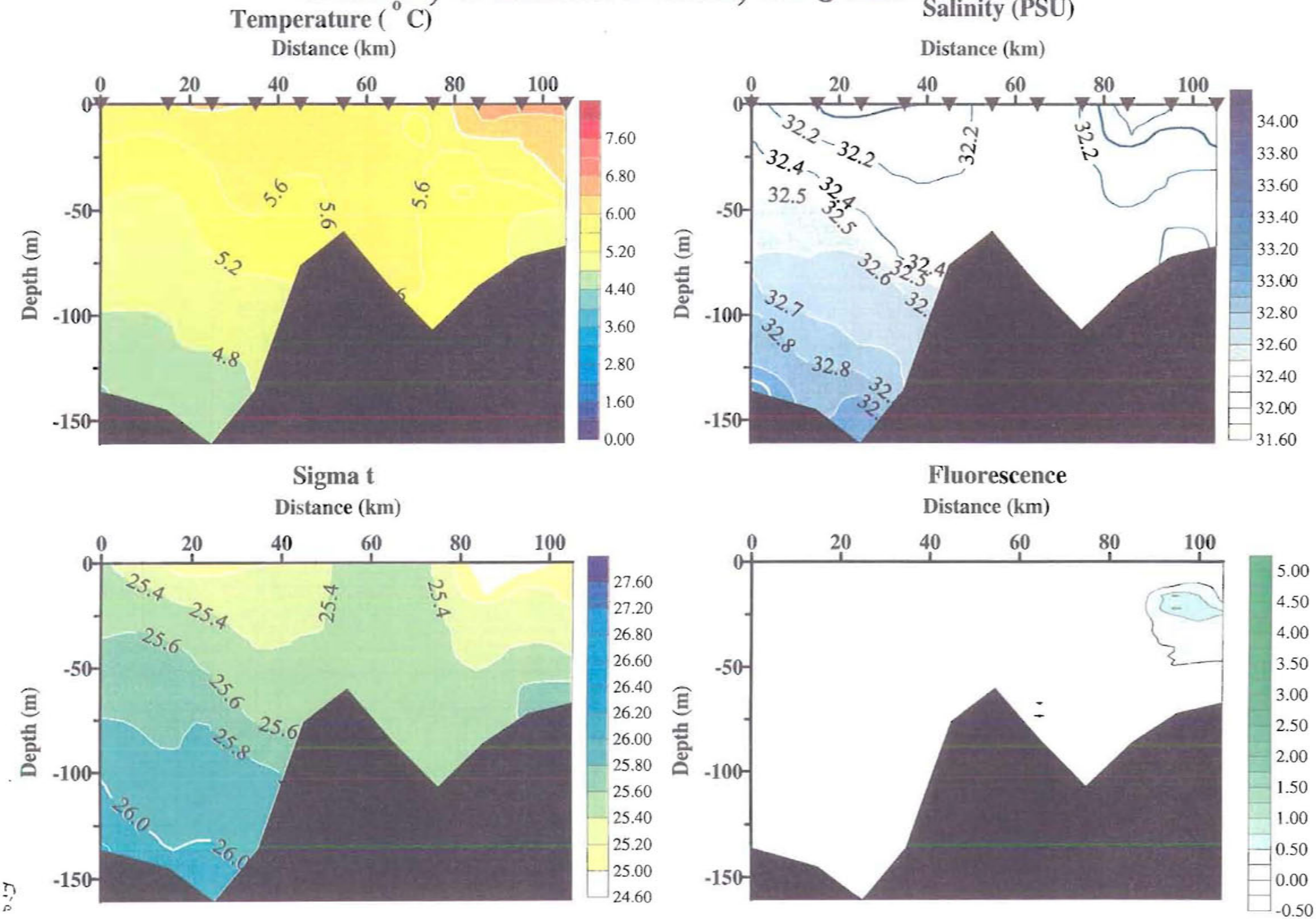
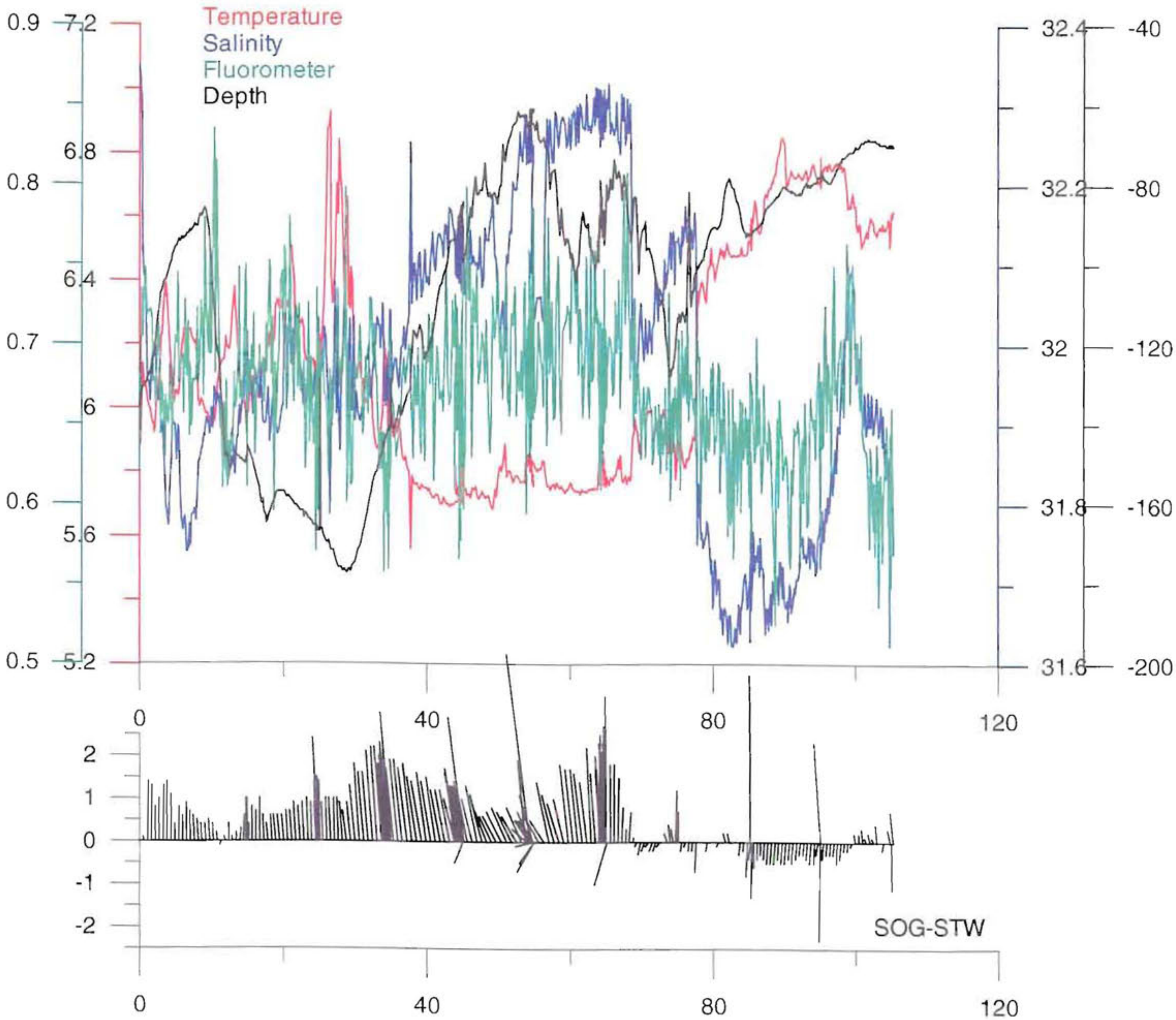


Fig 5a

Fig. 5b

Unimak Pass, 12 June 2002



p. 28

HX259 Akutan Pass, 22 May 2002

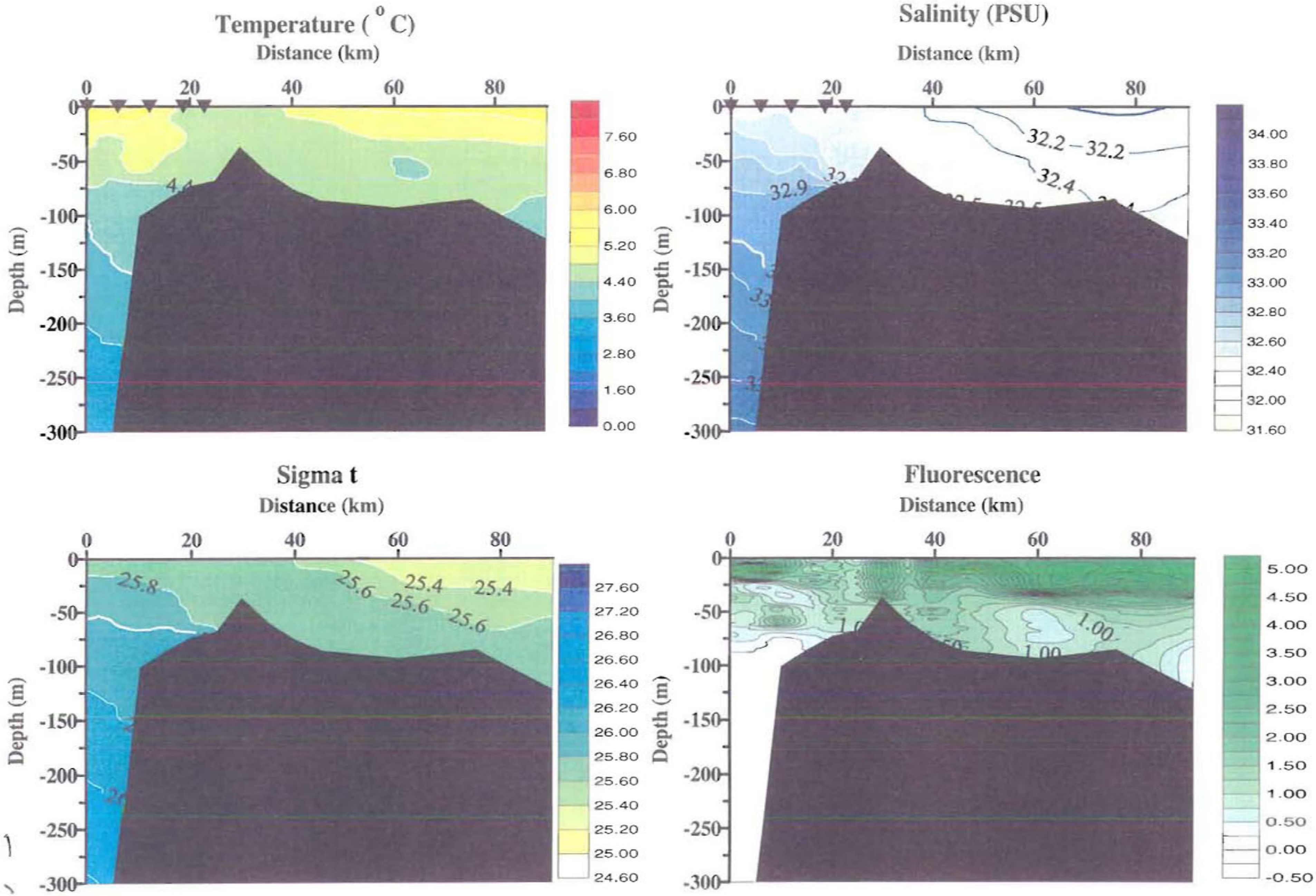
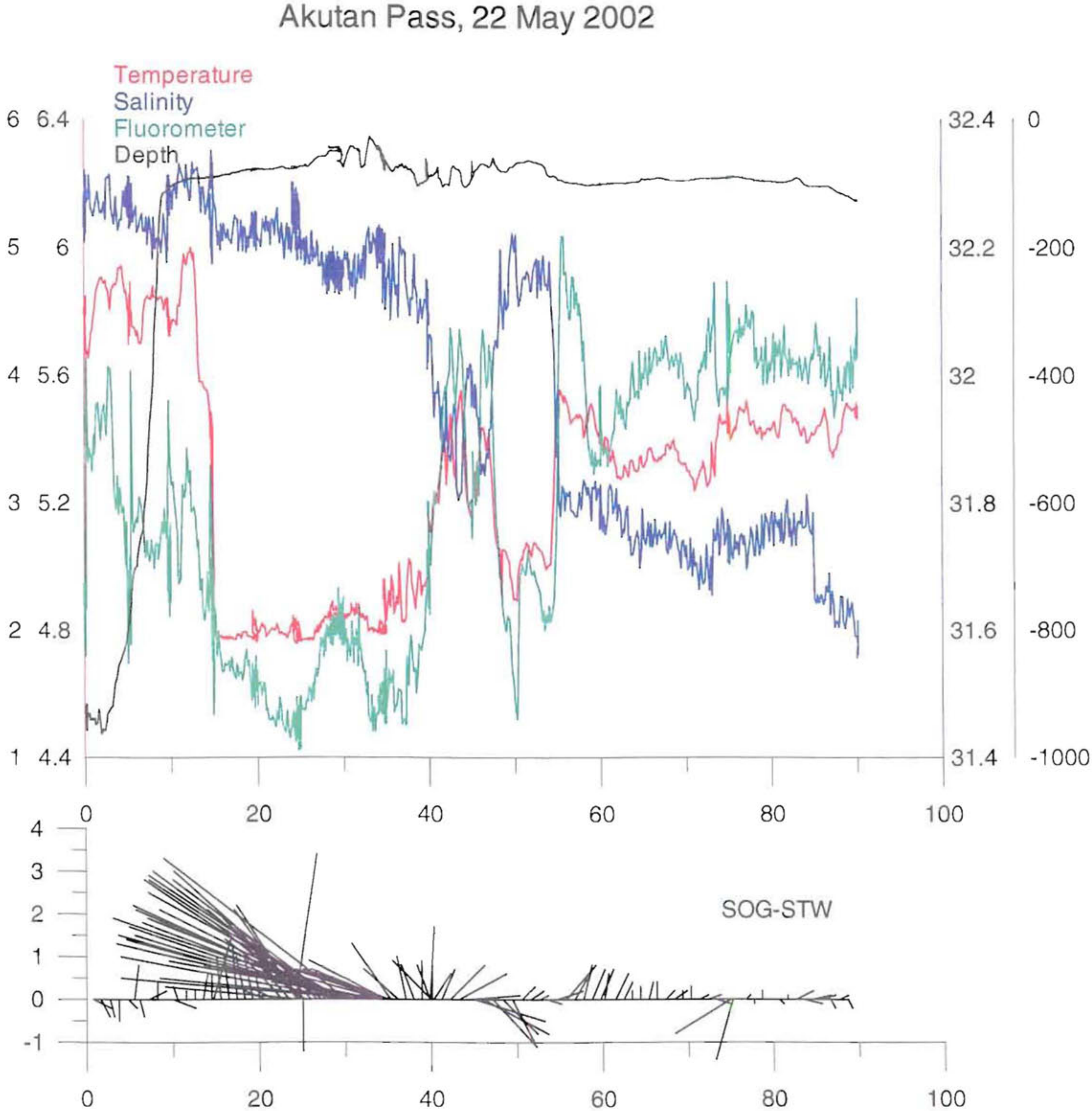


Fig. 6b


Akutan Pass, 22 May 2002
Temperature
Salinity
Fluorometer
Depth
6 6.4
5 6
4 5.6
3 5.2
2 4.8
1 4.4
32.4
32.2
32
31.8
31.6
31.4
0
-200
-400
-600
-800
-1000
0
20
40
60
80
100
4
3
2
1
0
-1
SOG-STW
0
20
40
60
80
100

hx259; Akutan Pass, 15 June 2002

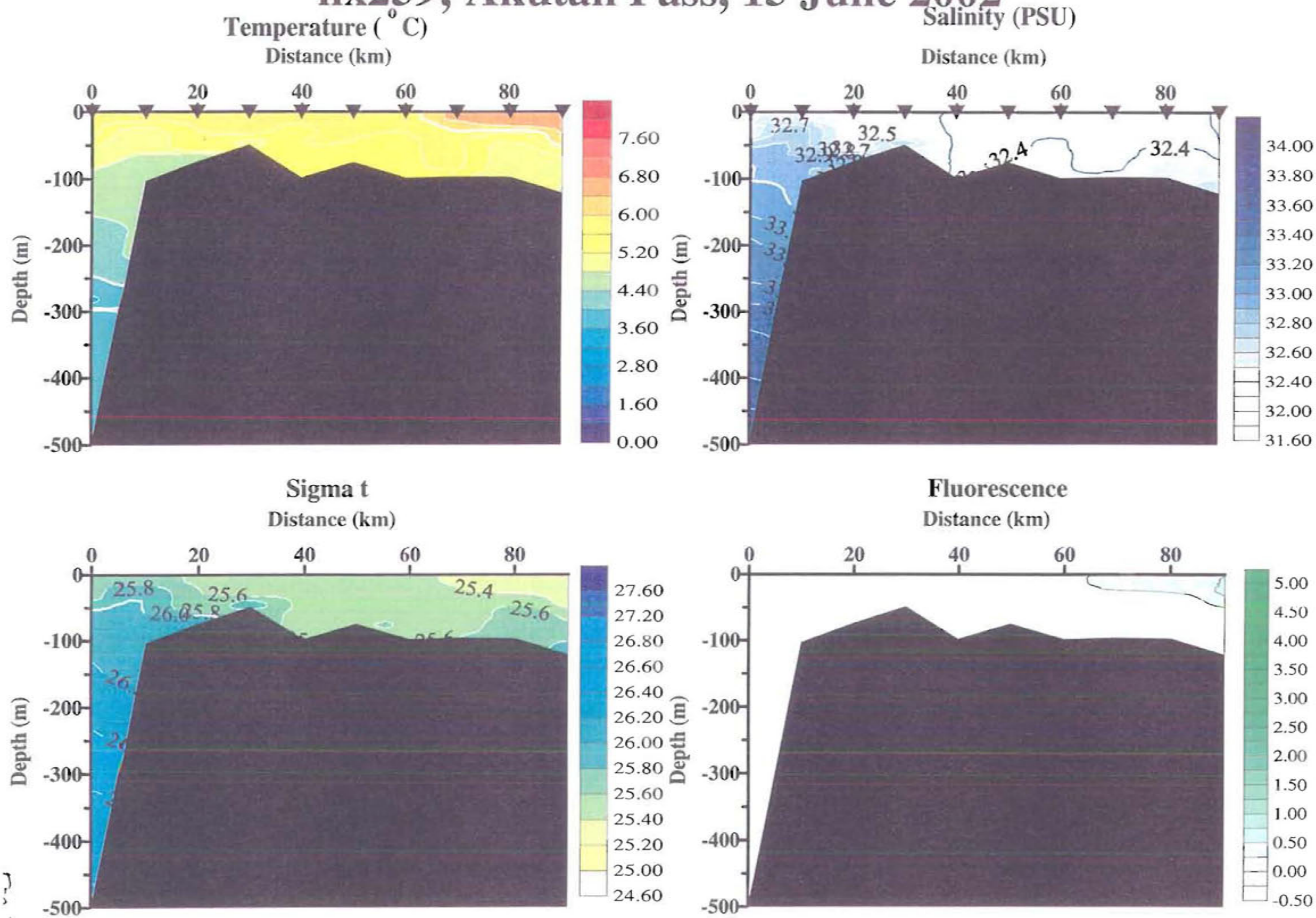
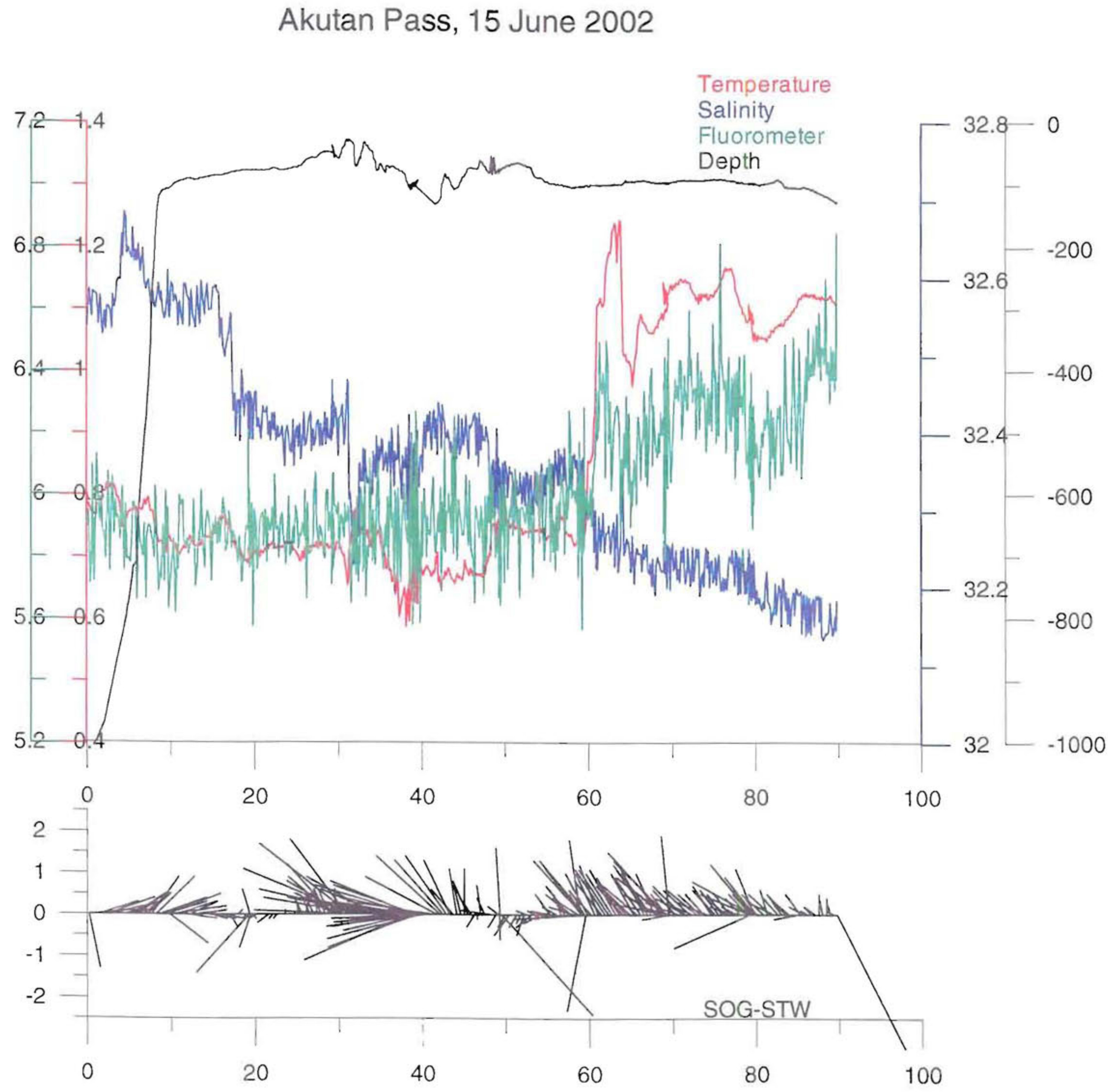


Fig 7b



Akutan Pass, 15 June 2002
Temperature
Salinity
Fluorometer
Depth
7.2
6.8
6.4
6
5.6
5.2
1.4
1.2
1
0.8
0.6
0.4
32.8
32.6
32.4
32.2
32
0
-200
-400
-600
-800
-1000
0
20
40
60
80
100
2
1
0
-1
-2
SOG-STW

HX259, 16-hr Station at Akutan Pass 13 June 2002

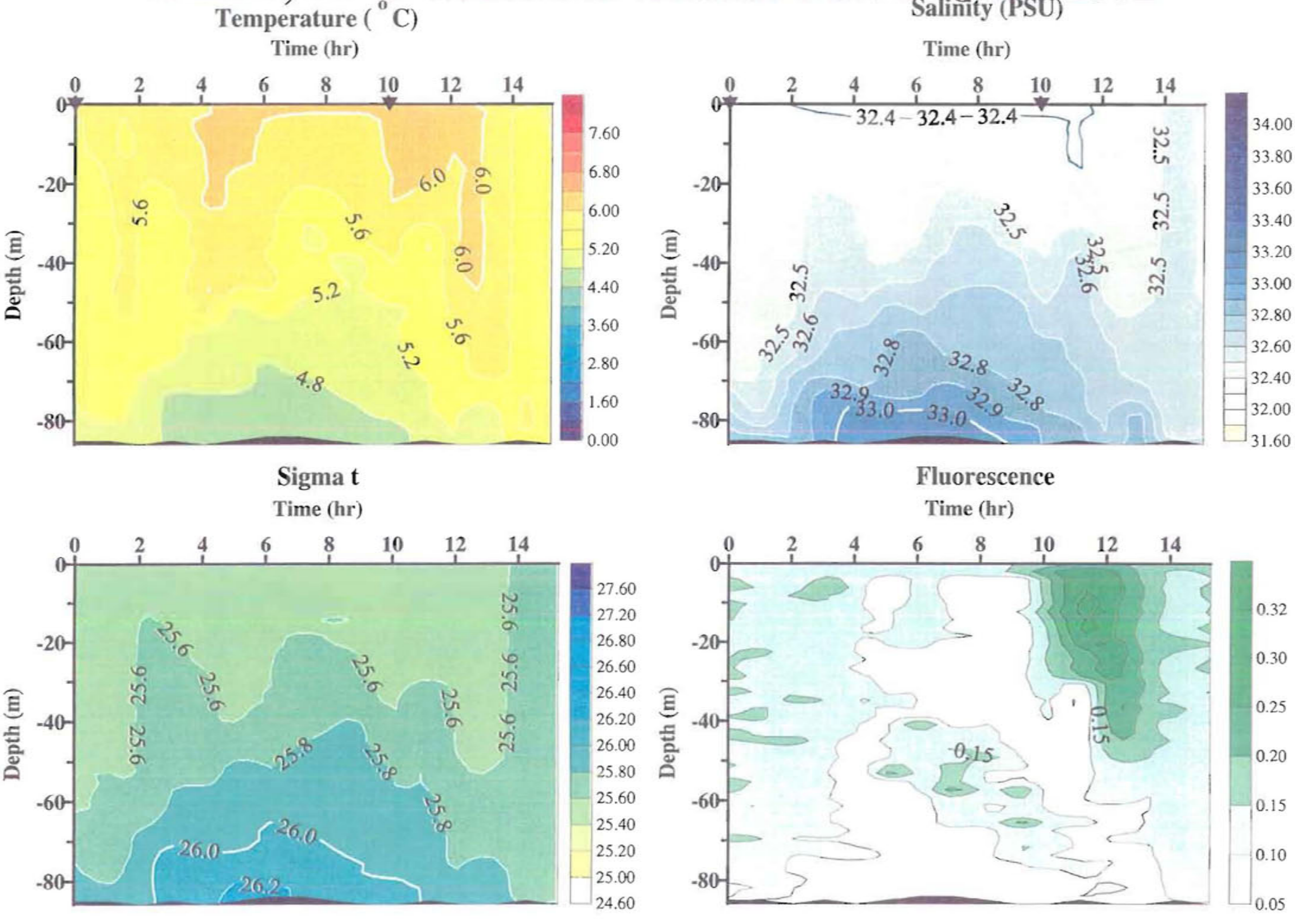
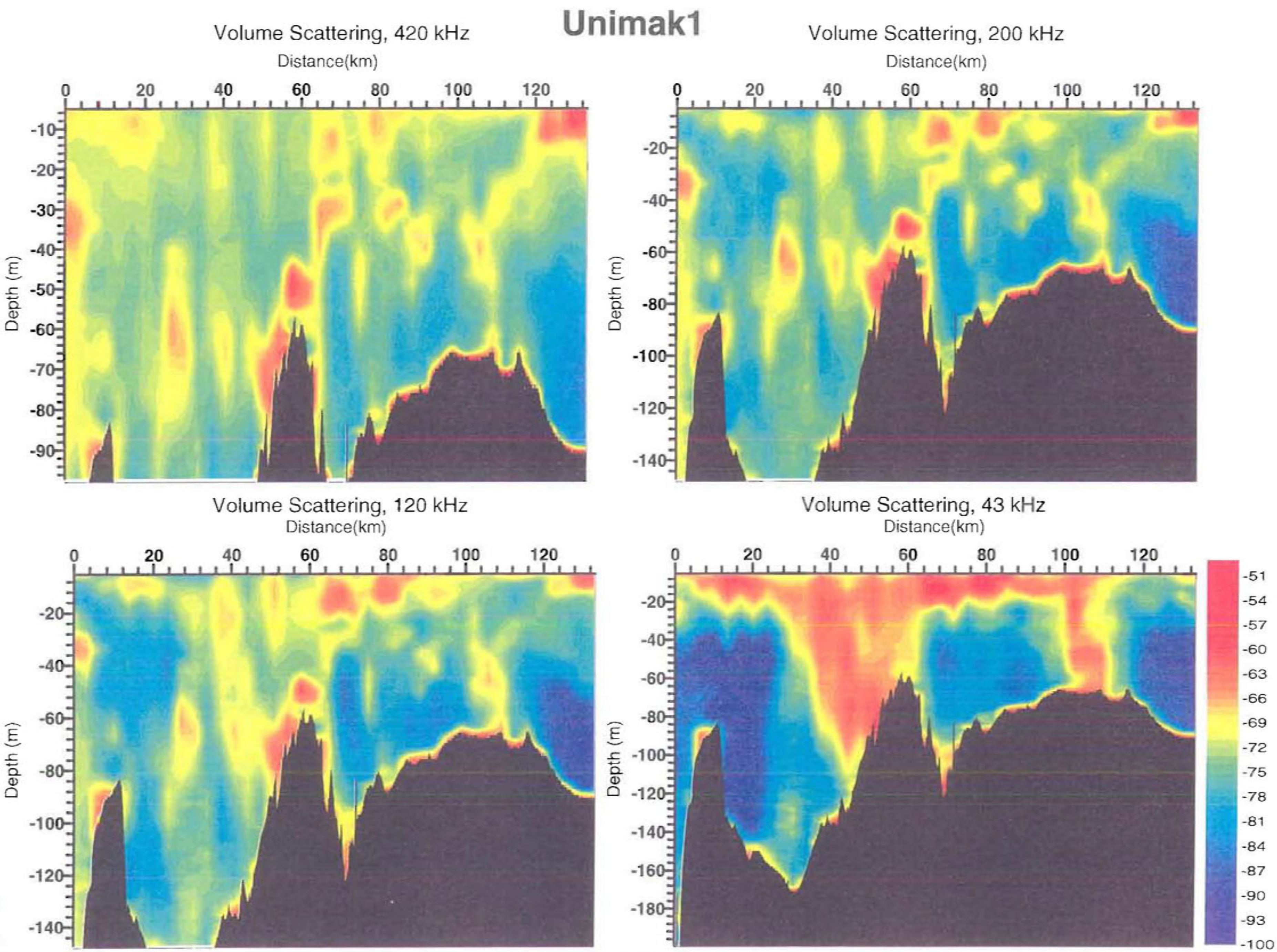


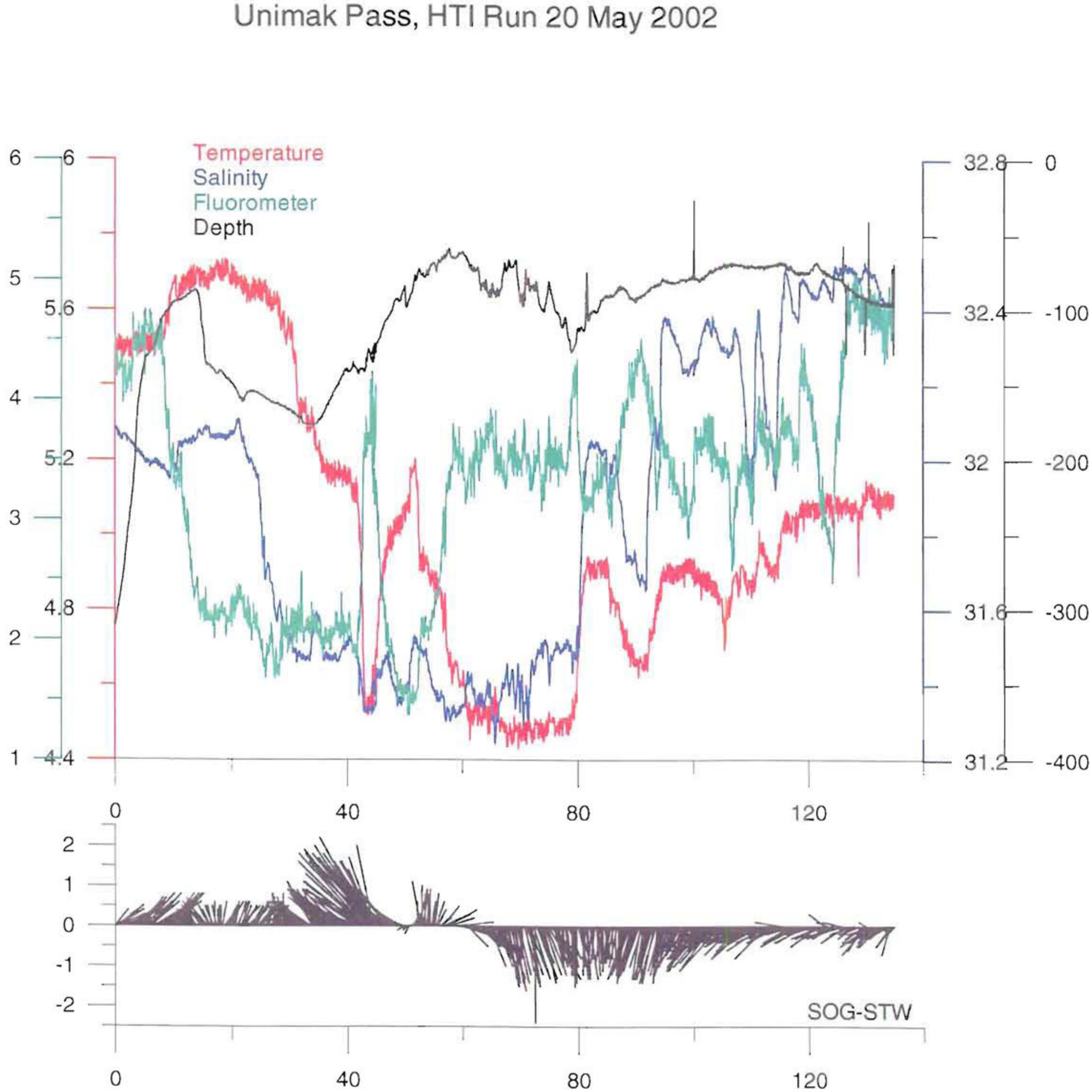
Fig 8



Unimak1
Volume Scattering, 420 kHz
Volume Scattering, 200 kHz
Volume Scattering, 120 kHz
Volume Scattering, 43 kHz
Distance(km)
Depth (m)
0
20
40
60
80
100
120
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180
-51
-54
-57
-60
-63
-66
-69
-72
-75
-78
-81
-84
-87
-90
-93
-100

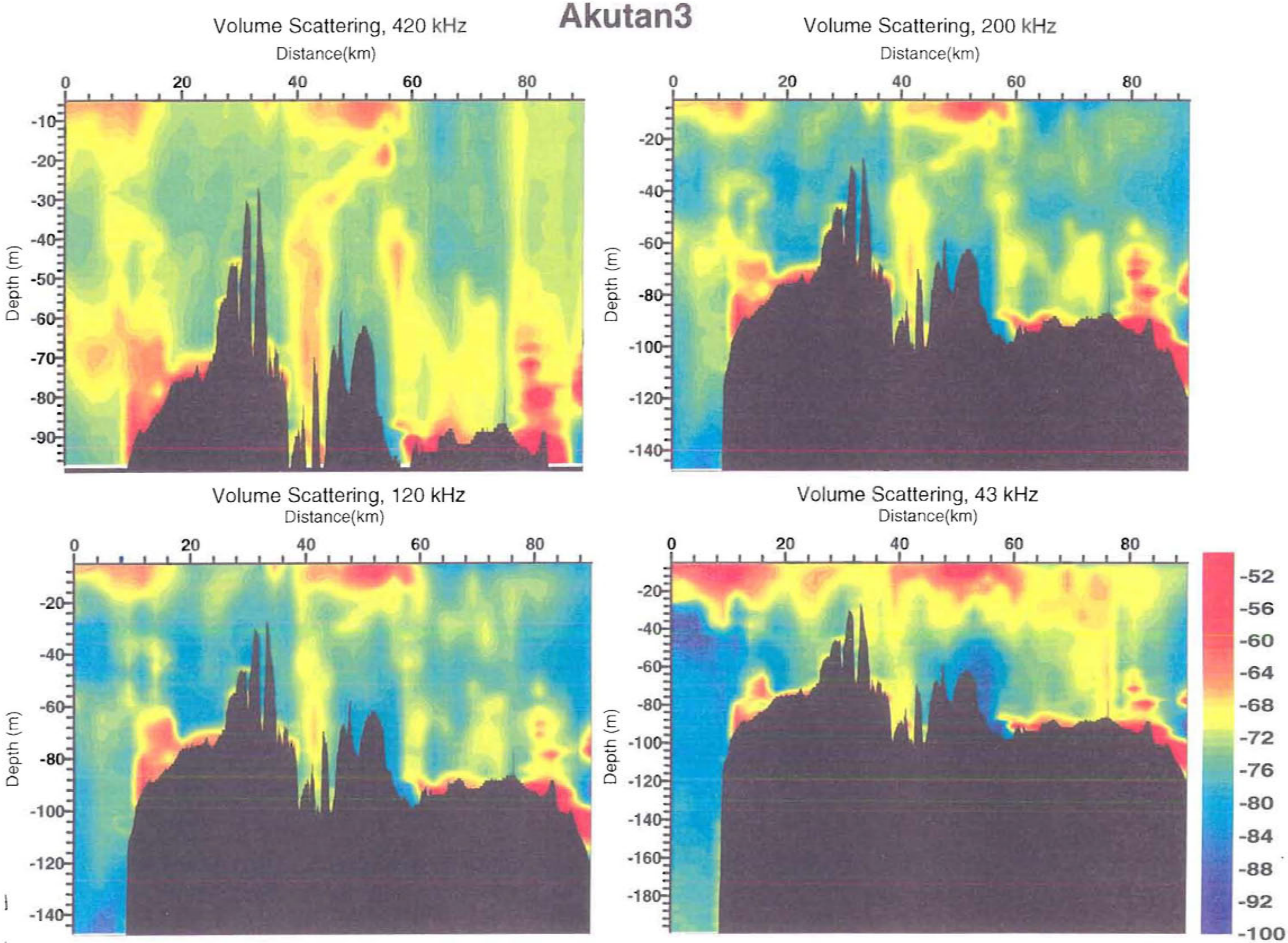
Fig 9a

Fig 9b



Unimak Pass, HTI Run 20 May 2002
Temperature
Salinity
Fluorometer
Depth
6
5
4
3
2
1
6
5.6
5.2
4.8
4.4
32.8
32.4
32
31.6
31.2
0
-100
-200
-300
-400
0
40
80
120
2
1
0
-1
-2
SOG-STW

Akutan3



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)
-52
-56
-60
-64
-68
-72
-76
-80
-84
-88
-92
-100

Fig. 10b

North Akutan Pass, HTI Run 24 May 2002

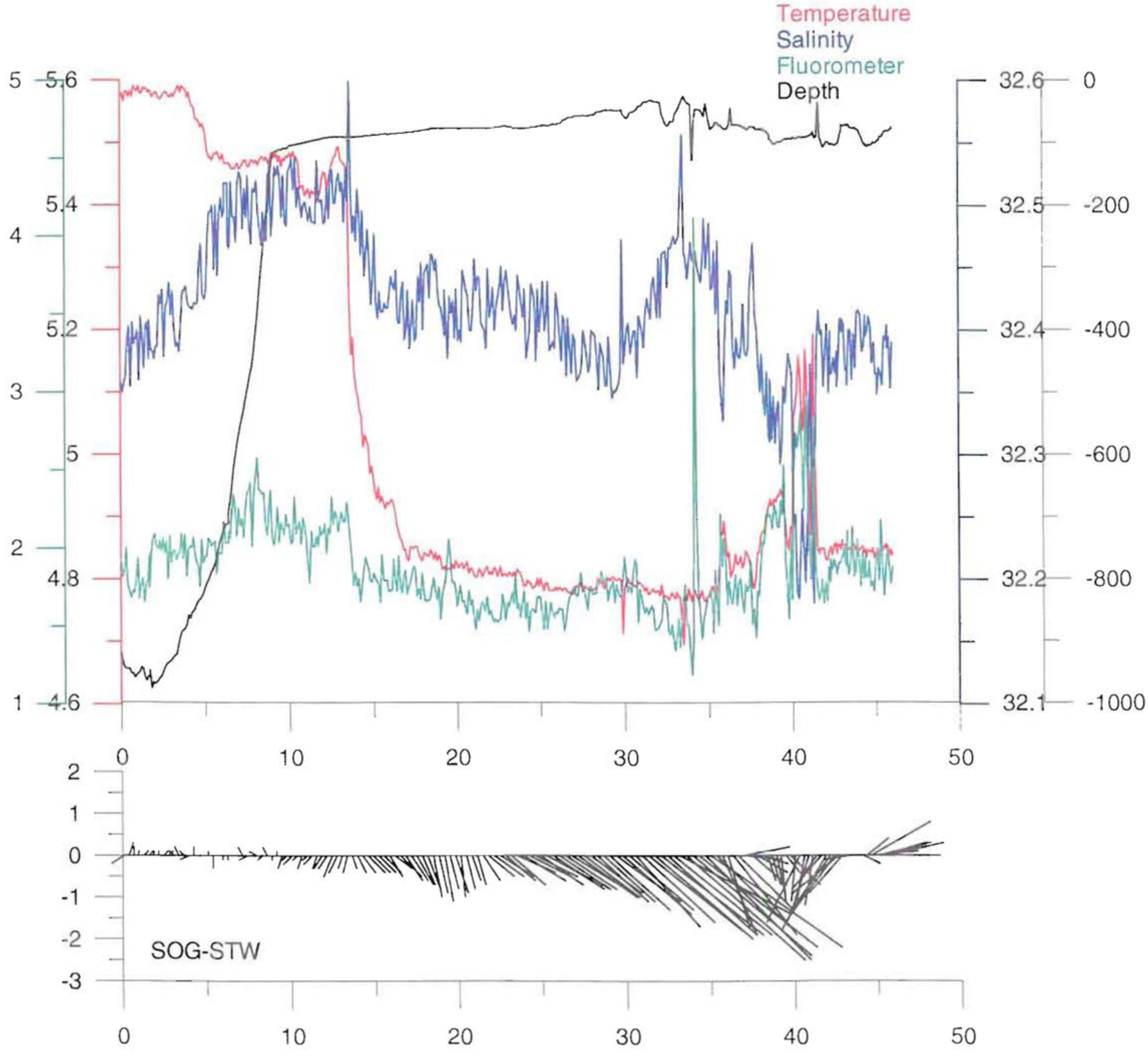
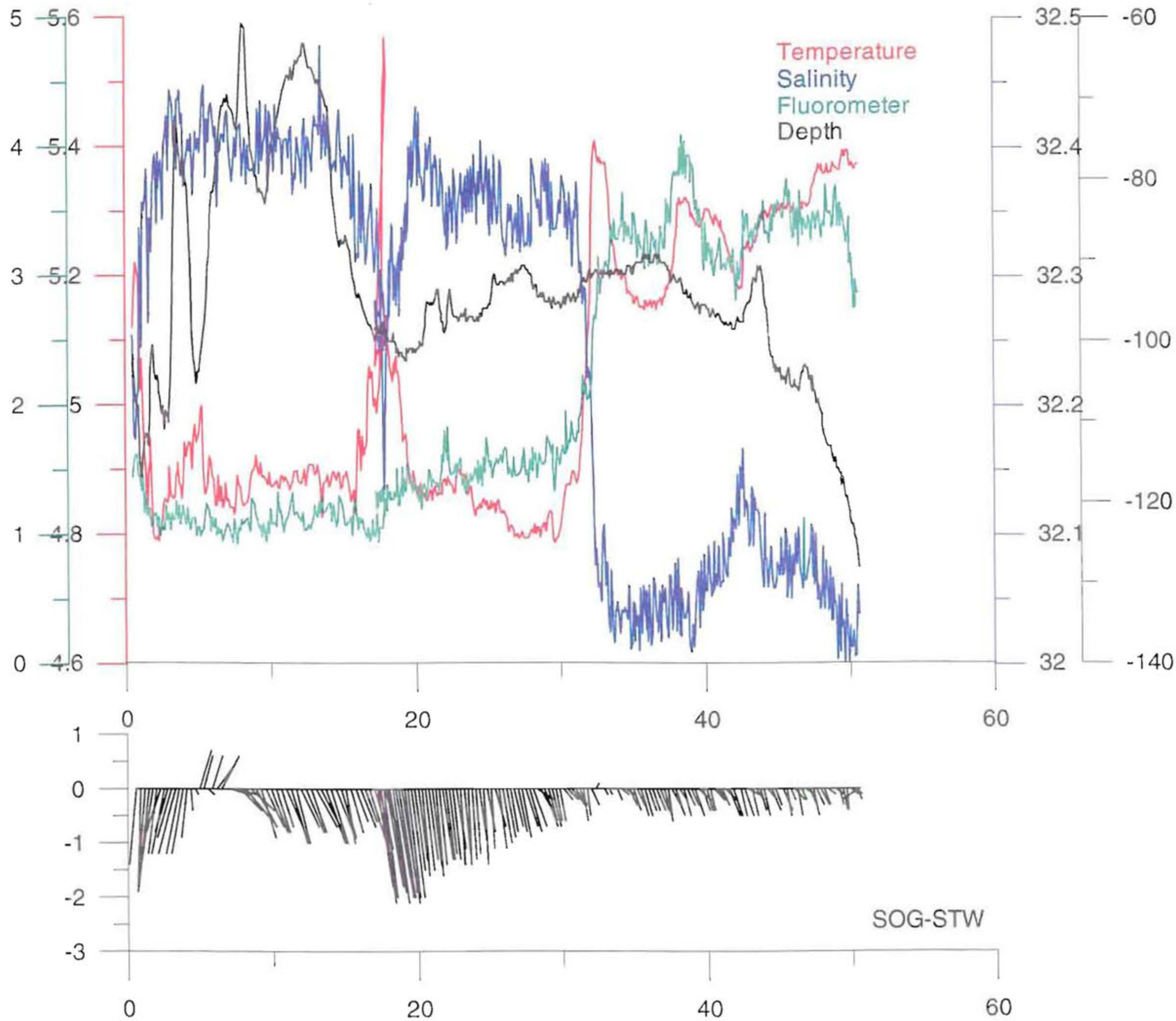
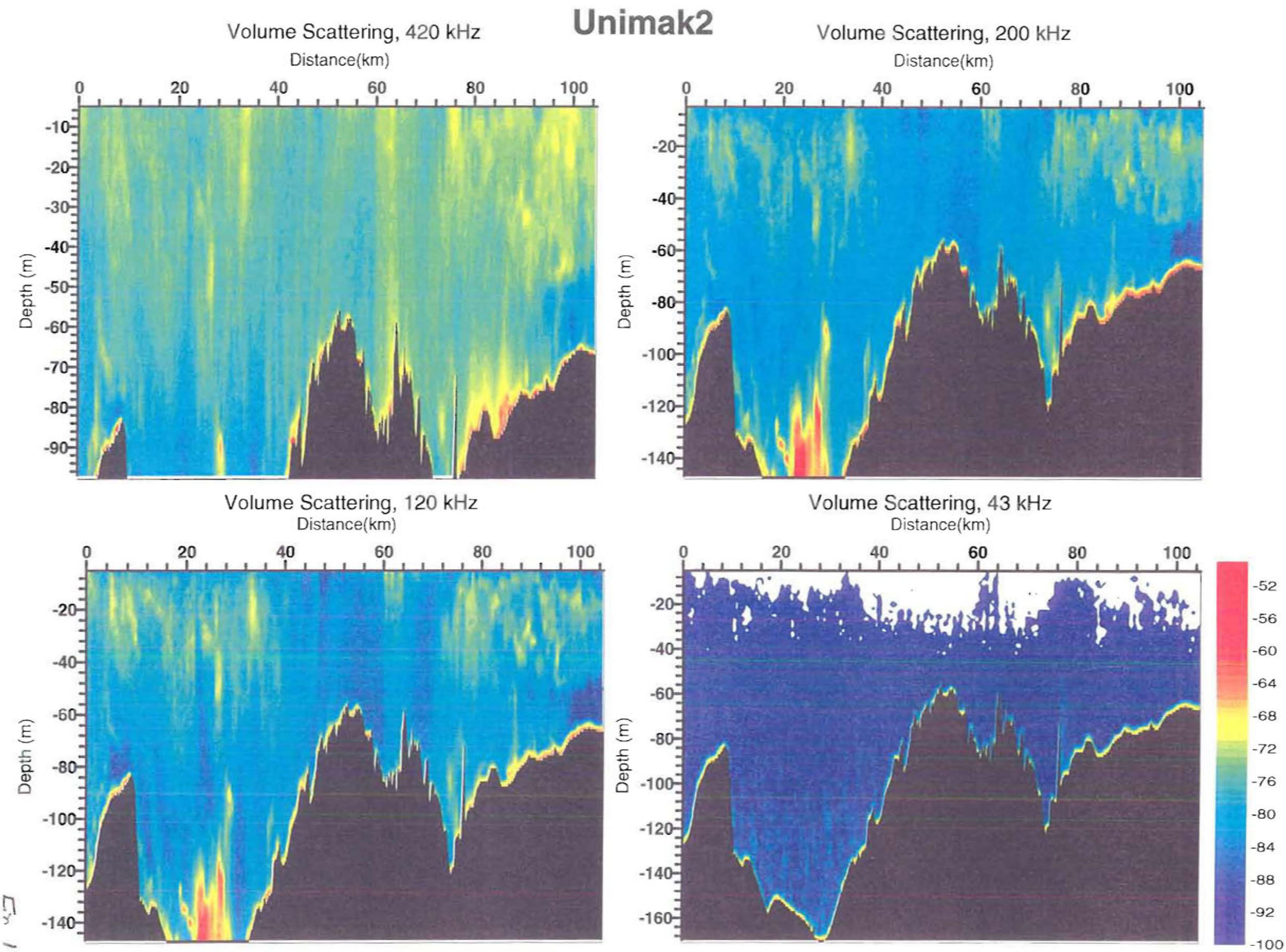


Fig. 10c

South side Akutan Pass HTI Run, 26 May 2002

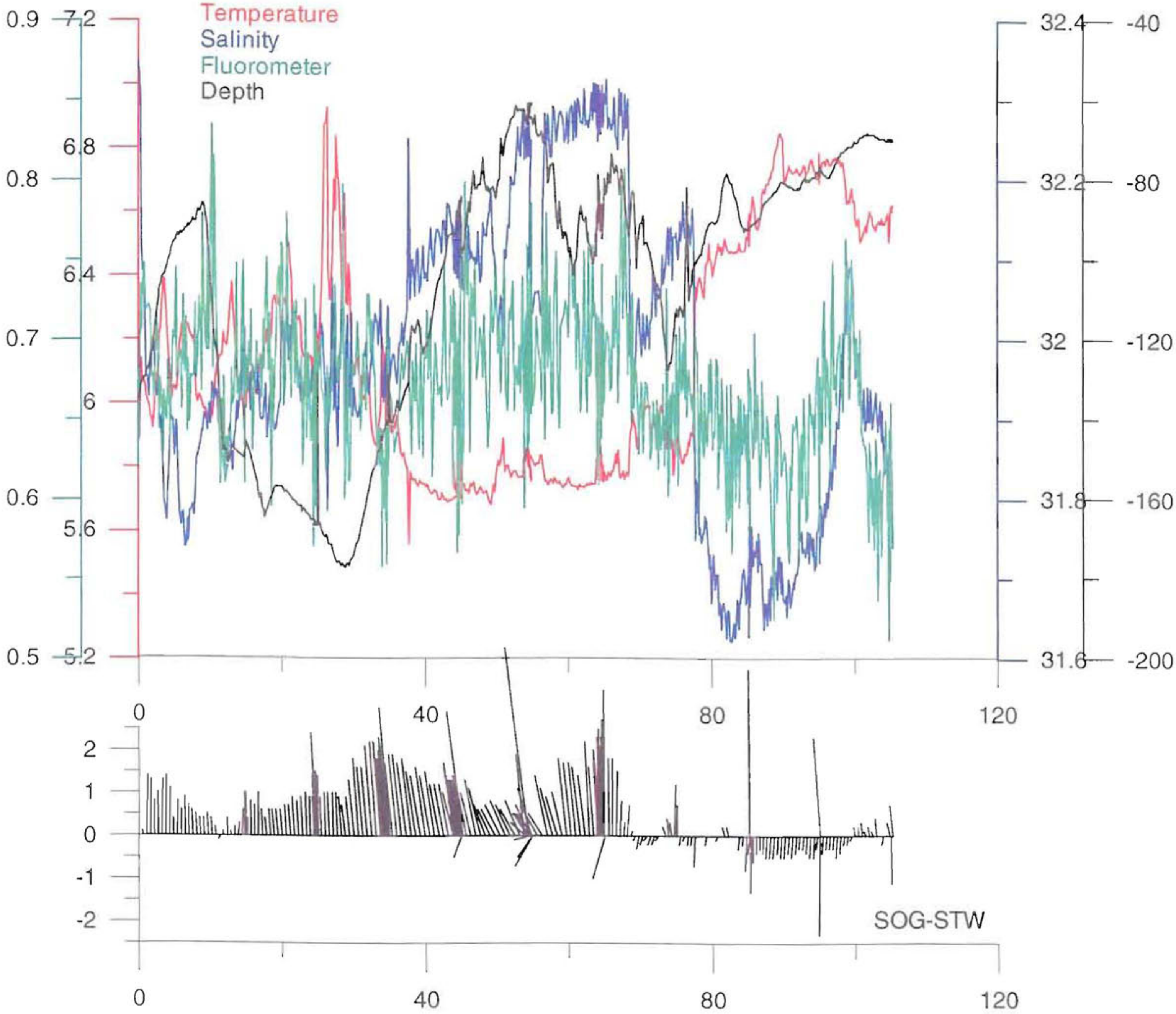



Unimak2
Volume Scattering, 420 kHz
Distance(km)
Depth (m)
Volume Scattering, 200 kHz
Distance(km)
Depth (m)
Volume Scattering, 120 kHz
Distance(km)
Depth (m)
Volume Scattering, 43 kHz
Distance(km)
Depth (m)
-52
-56
-60
-64
-68
-72
-76
-80
-84
-88
-92
-100

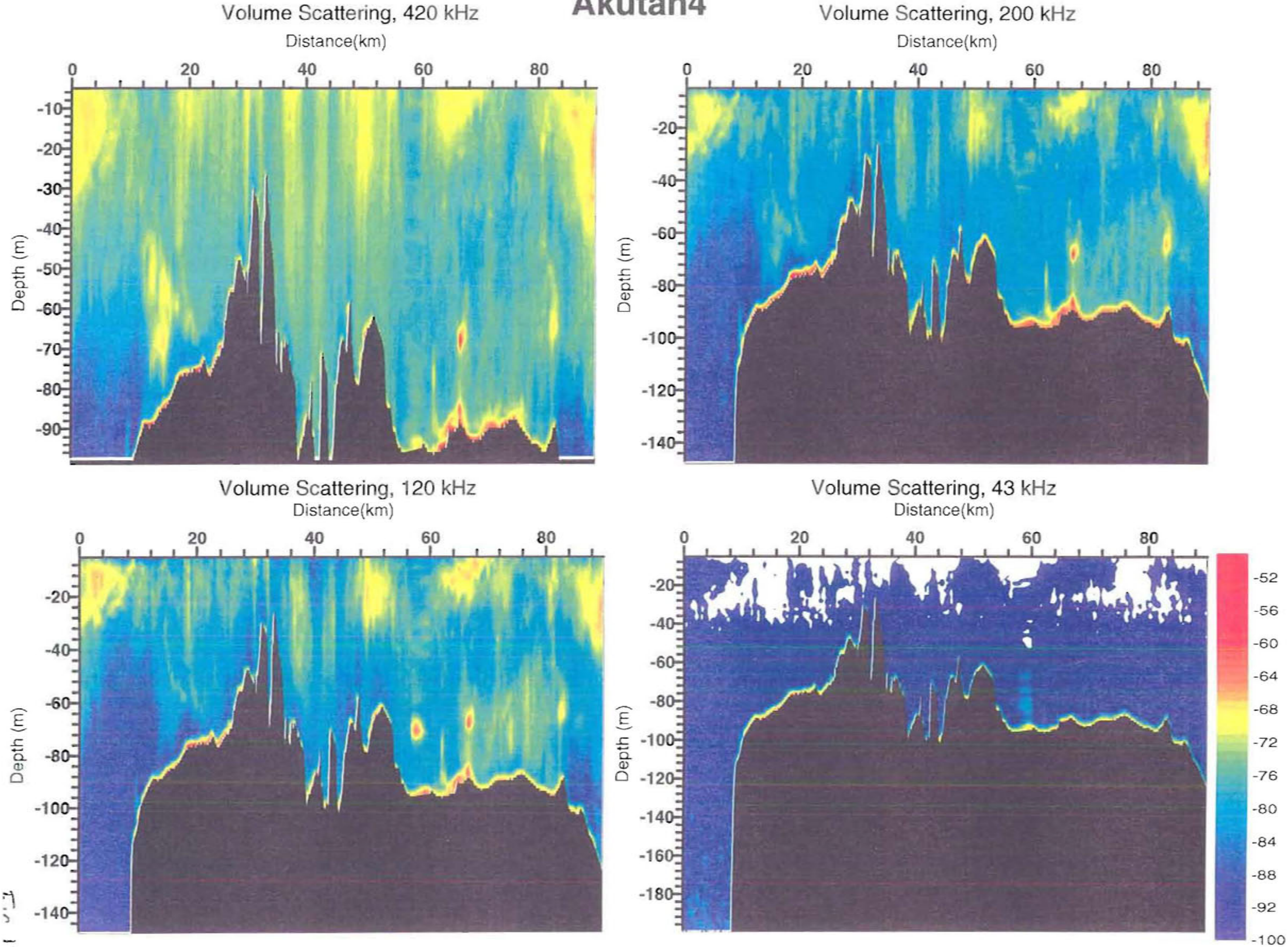
p. 39

Fig. 11b

Unimak Pass, 12 June 2002

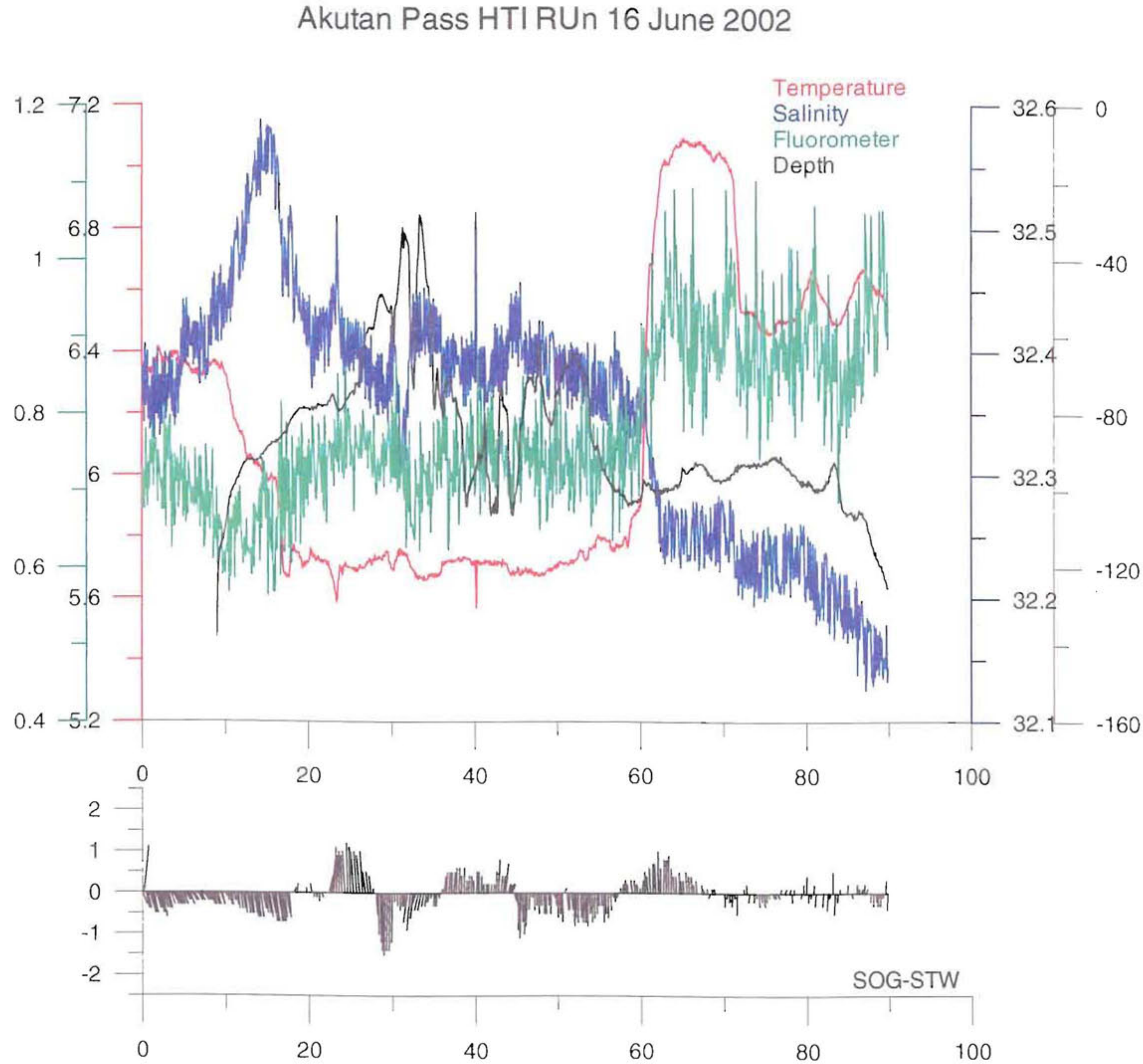


Akutan4



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)
-52
-56
-60
-64
-68
-72
-76
-80
-84
-88
-92
-100

Fig. 12b

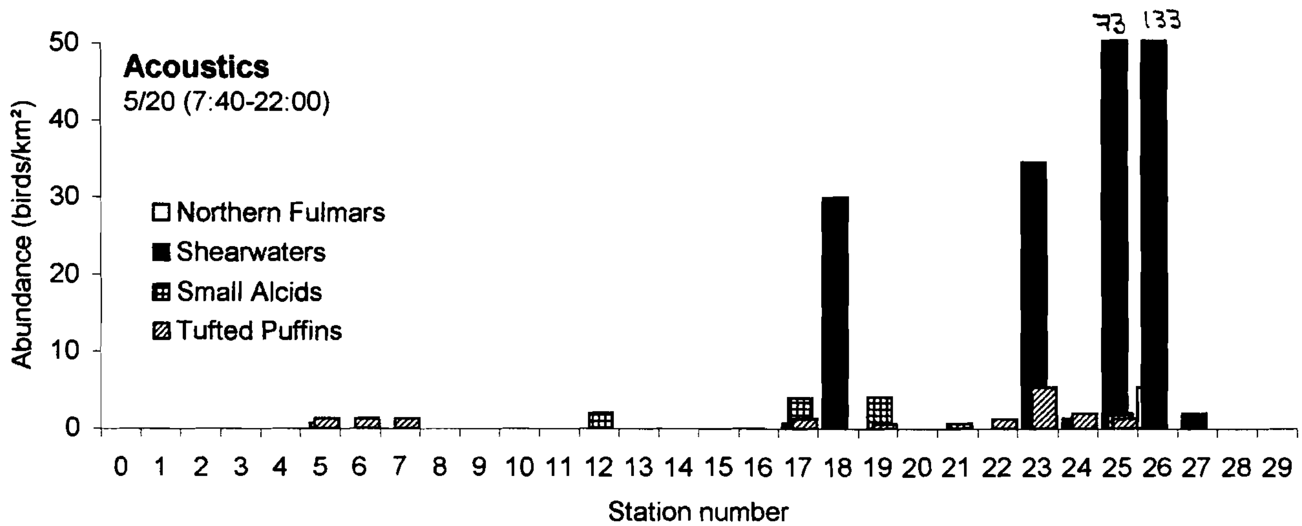


Akutan Pass HTI RUn 16 June 2002
Temperature
Salinity
Fluorometer
Depth
1.2
1
0.8
0.6
0.4
7.2
6.8
6.4
6
5.6
5.2
32.6
32.5
32.4
32.3
32.2
32.1
0
-40
-80
-120
-160
0
20
40
60
80
100
2
1
0
-1
-2
SOG-STW

Fig. 13

Abundance of birds along the Unimak Pass Y-line transect (May 20-25, 2002)

(only birds feeding and sitting on the water)



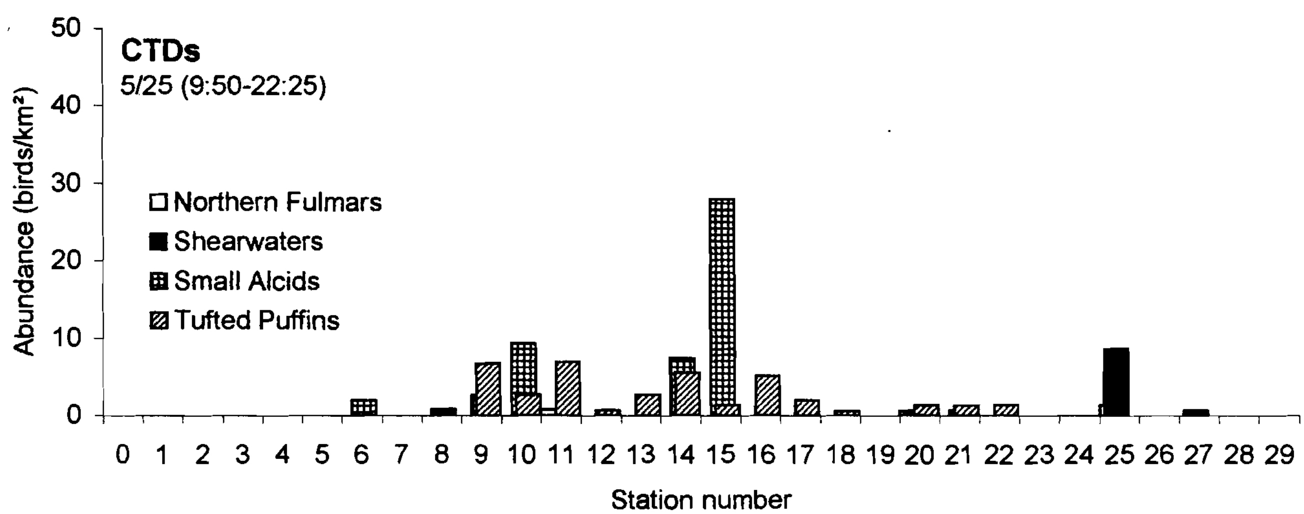


Fig. 14

Abundance of birds along the Akutan Pass Y-line transect (May 22-26, 2002)

(only birds feeding and sitting on the water)

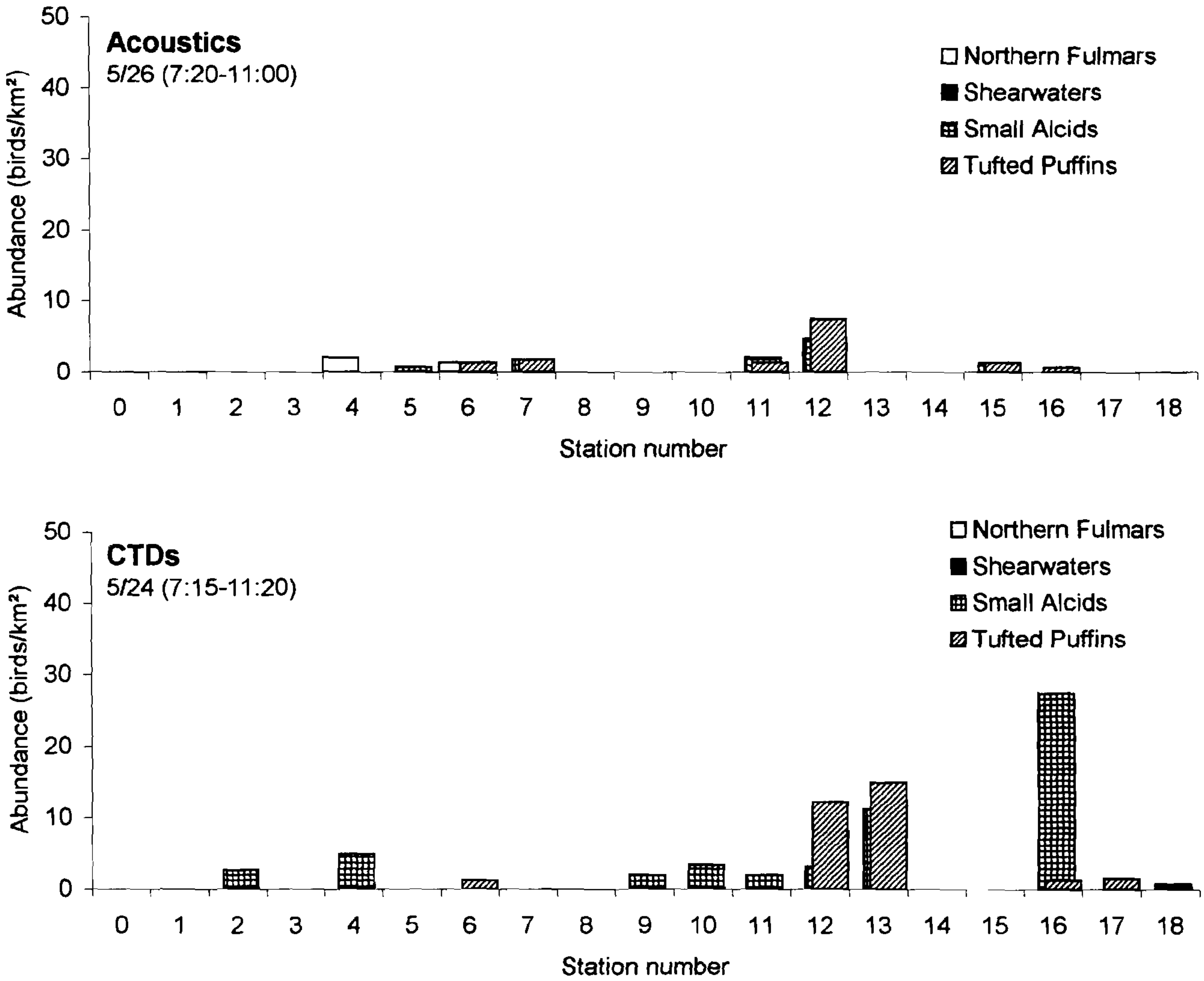
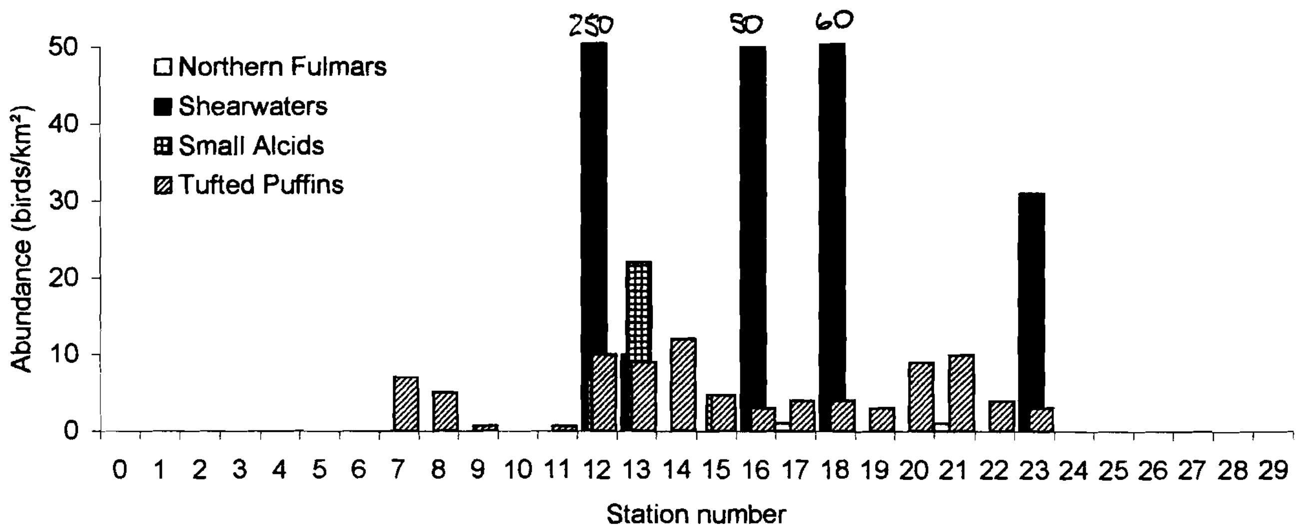


Fig. 15

Abundance of birds along the Unimak Pass Y-line transect (June 12, 2002)
(only birds feeding and sitting on the water)



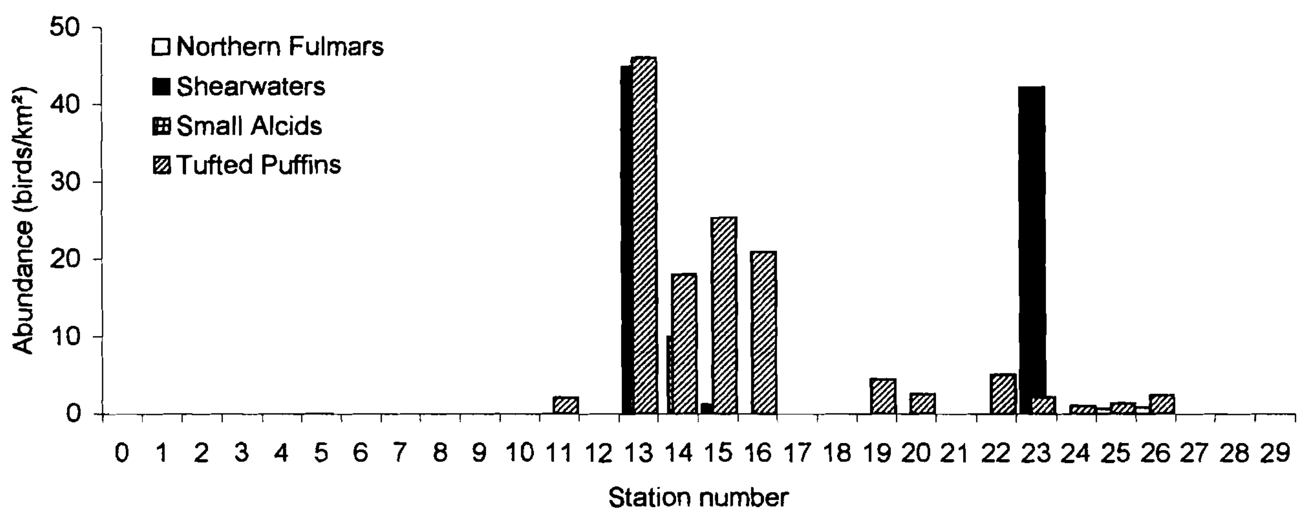
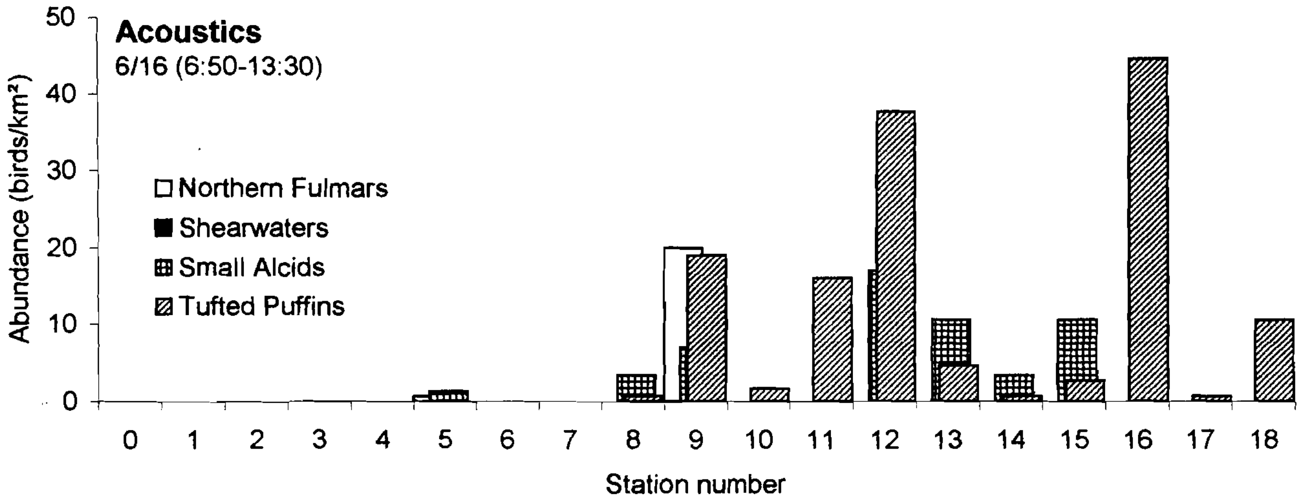
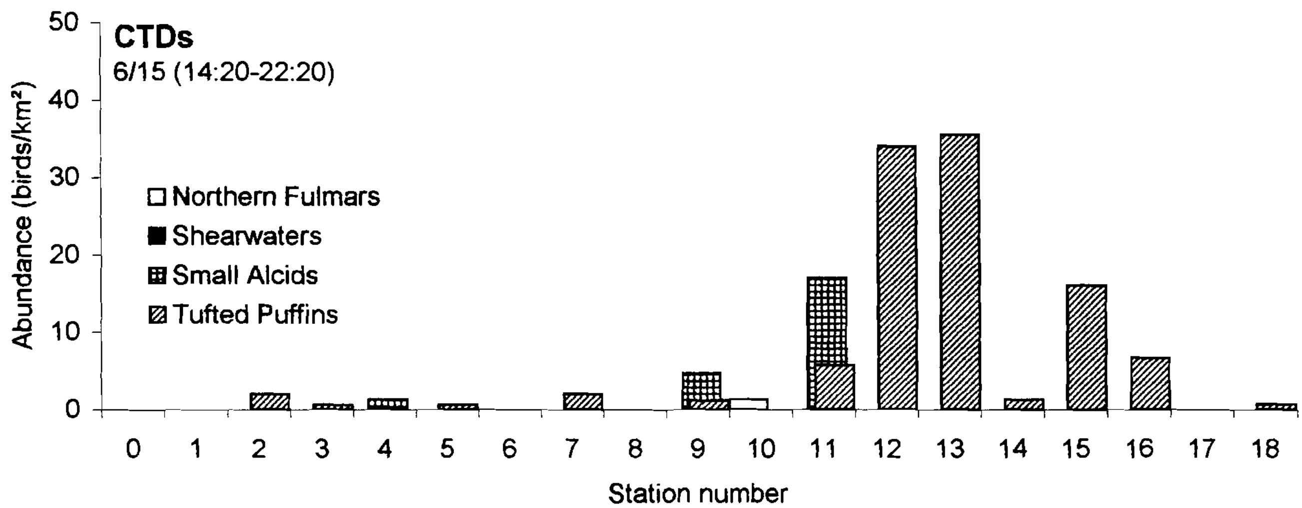


Fig. 16

Abundance of birds along the Akutan Pass Y-line transect (June 15-16, 2002)
(only birds feeding and sitting on the water)





Unimak/Akutan: 05/19/02 through 05/25/02

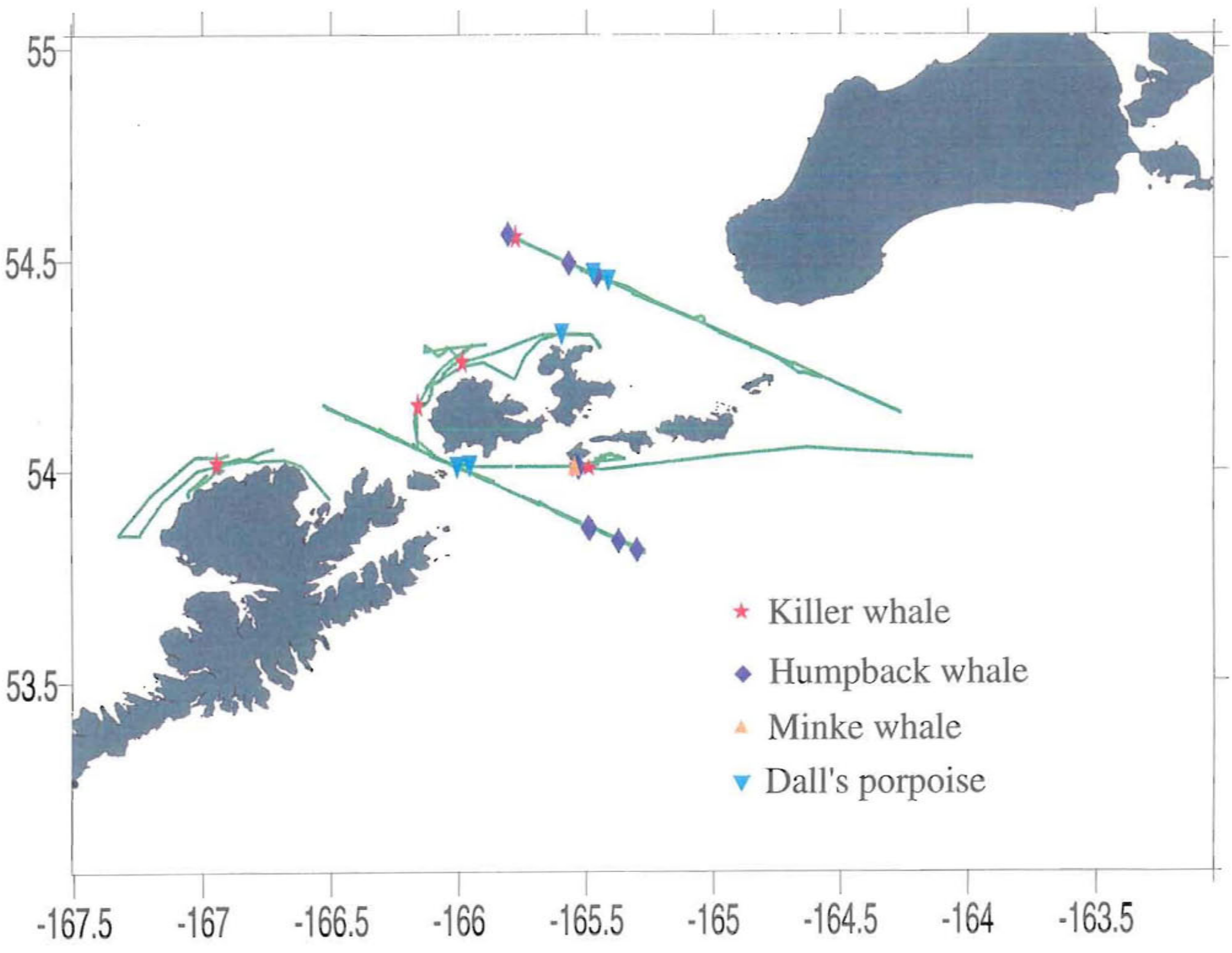


Fig. 17

Unimak/Akutan 06/15/02 through 06/18/02

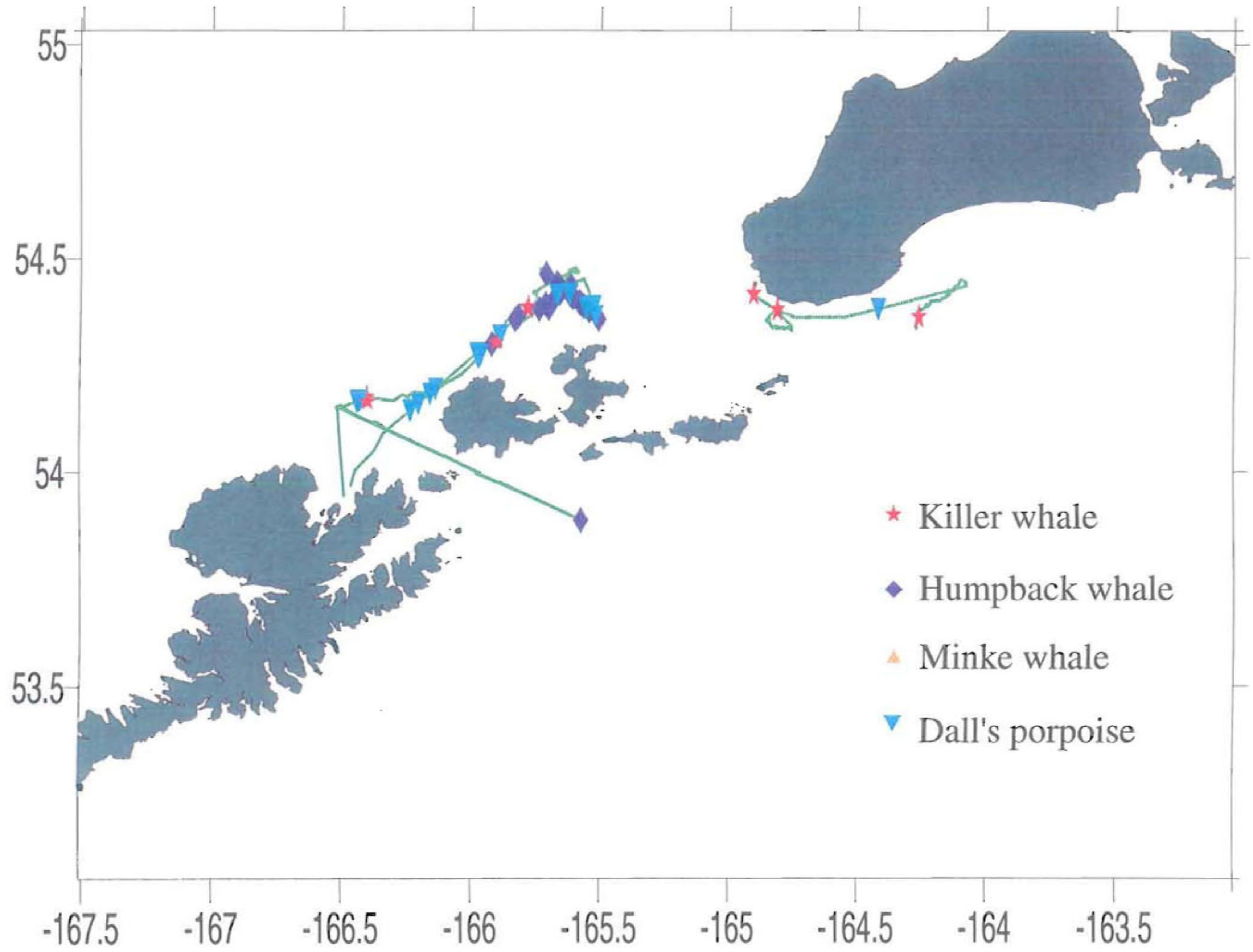
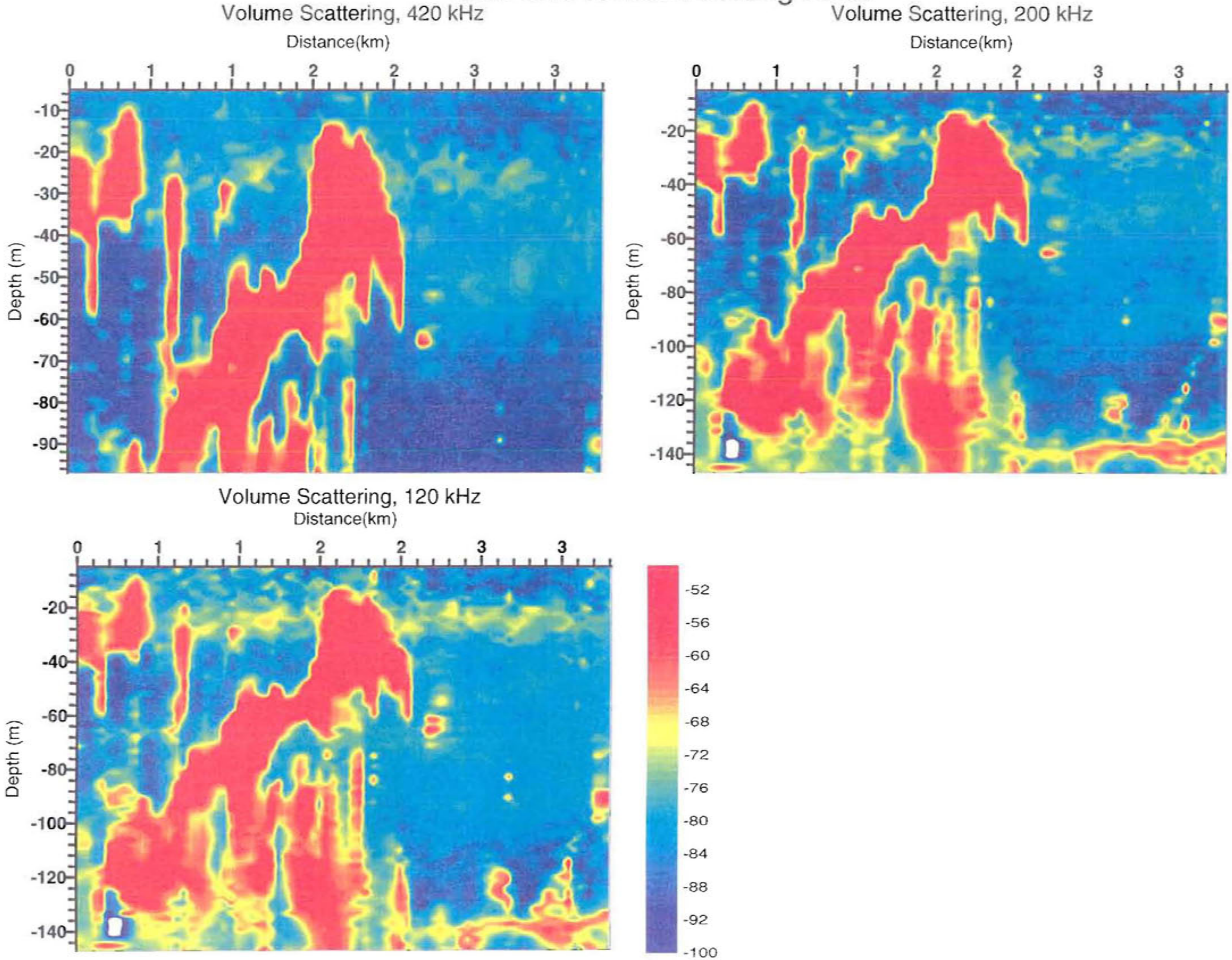


Fig. 18

Bird and Whale Feeding Area

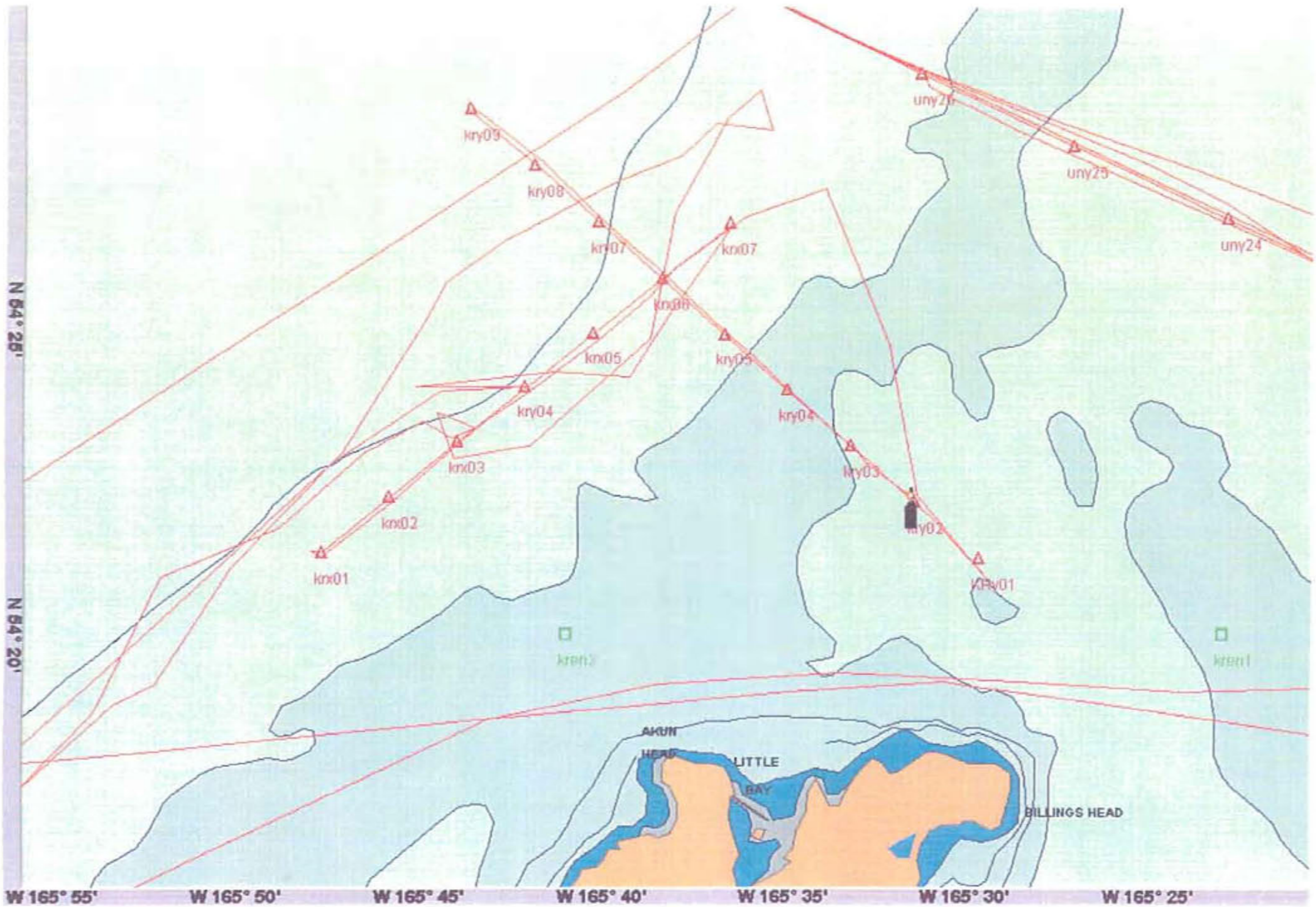


p. 49

Fig 19

Scale: 14.0NM 1:114000 Chart: Coastal UNDER

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



P. 50

hx259; Alongshore Krill Line, 17 June 2002

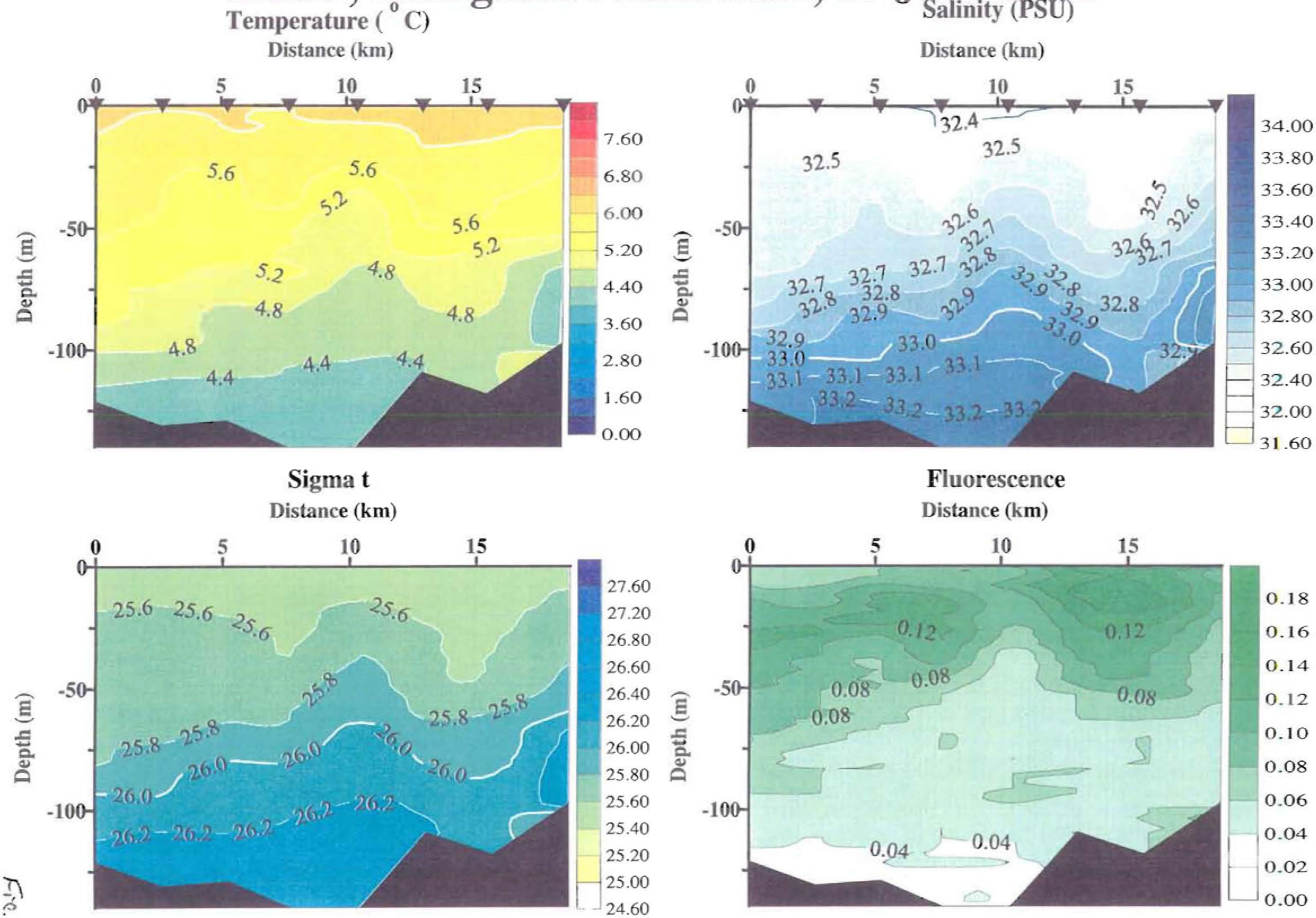


Fig. 21

P.51

hx259; Across-shelf Krill Line, 17 June 2002

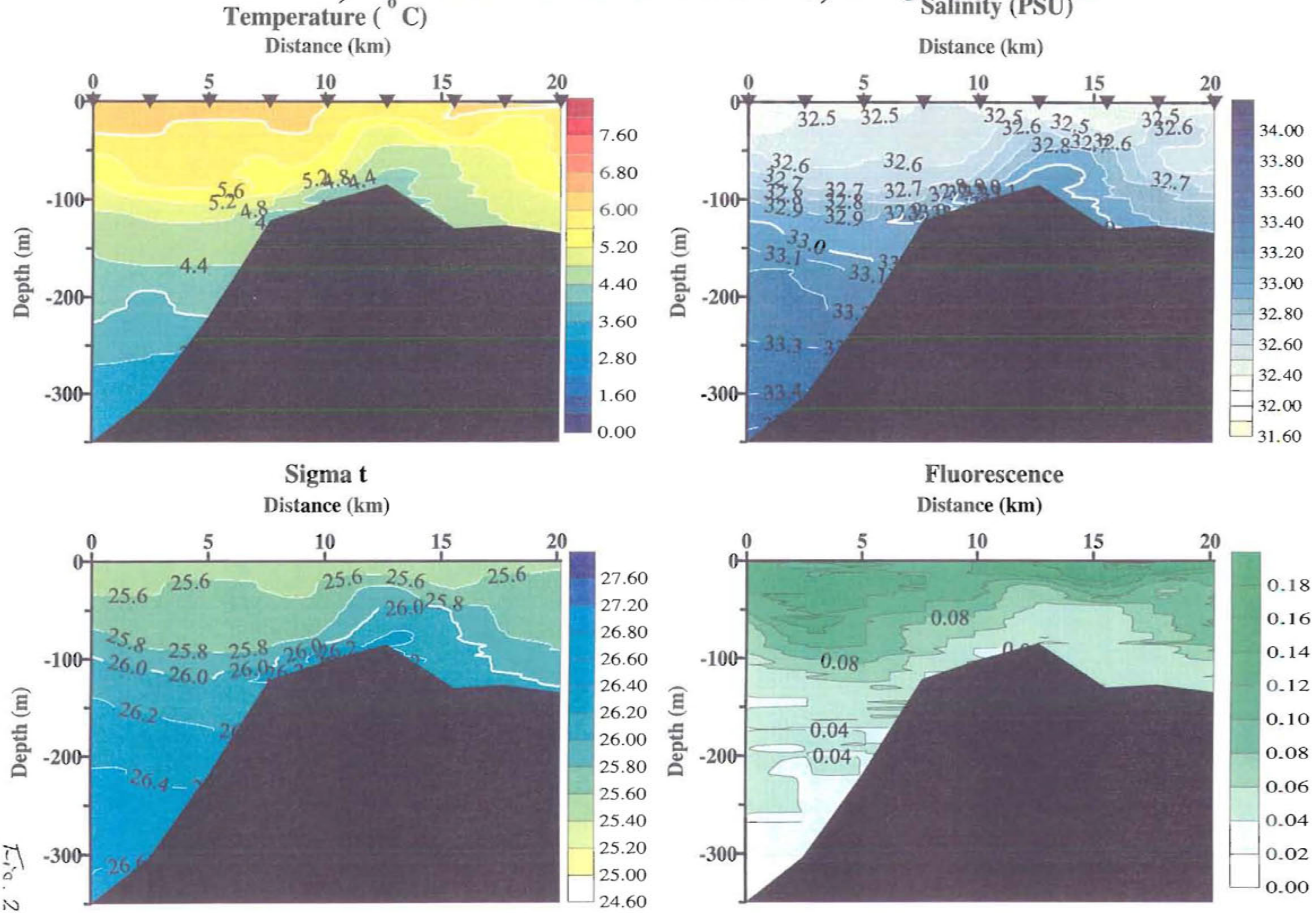
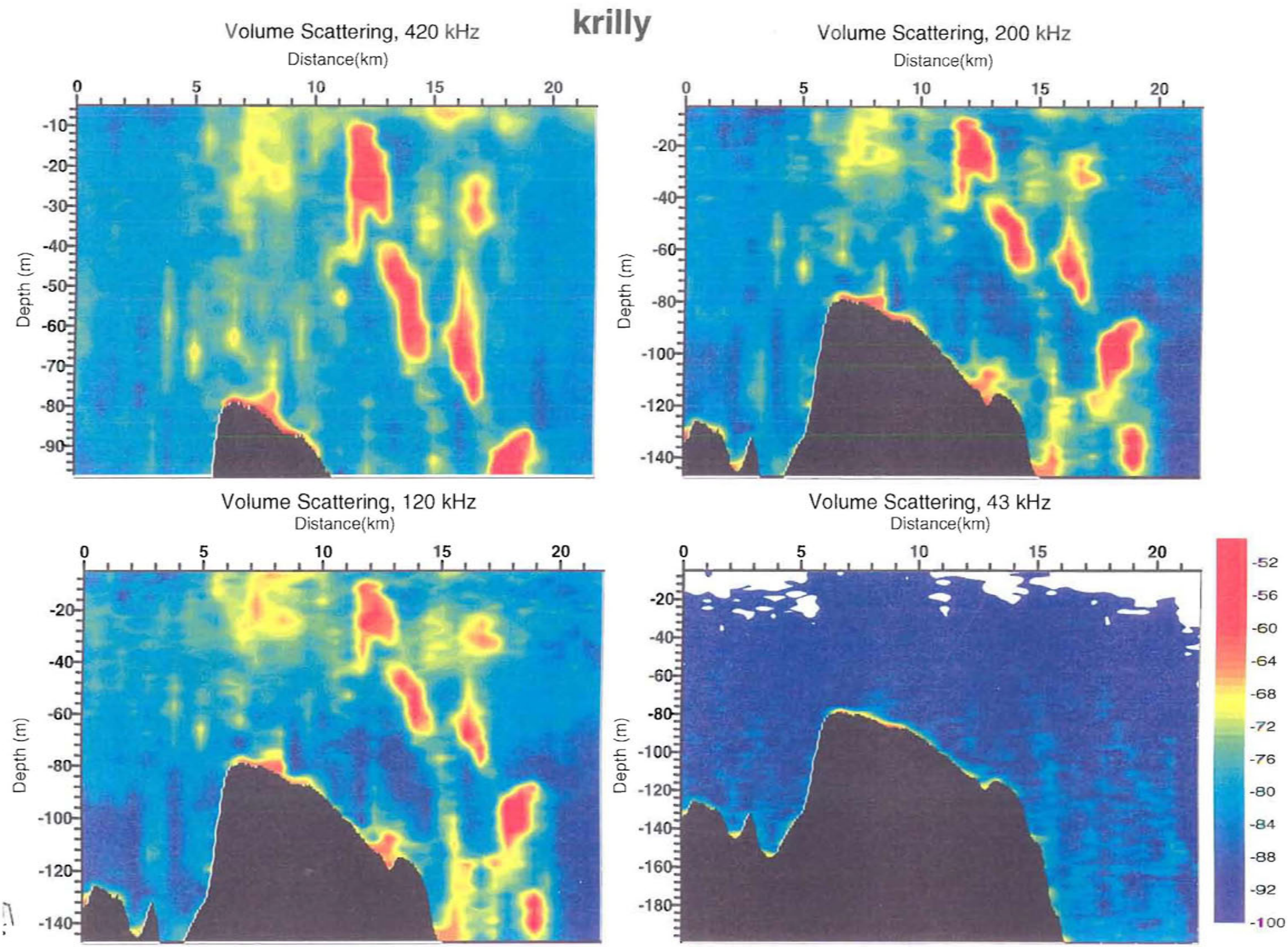
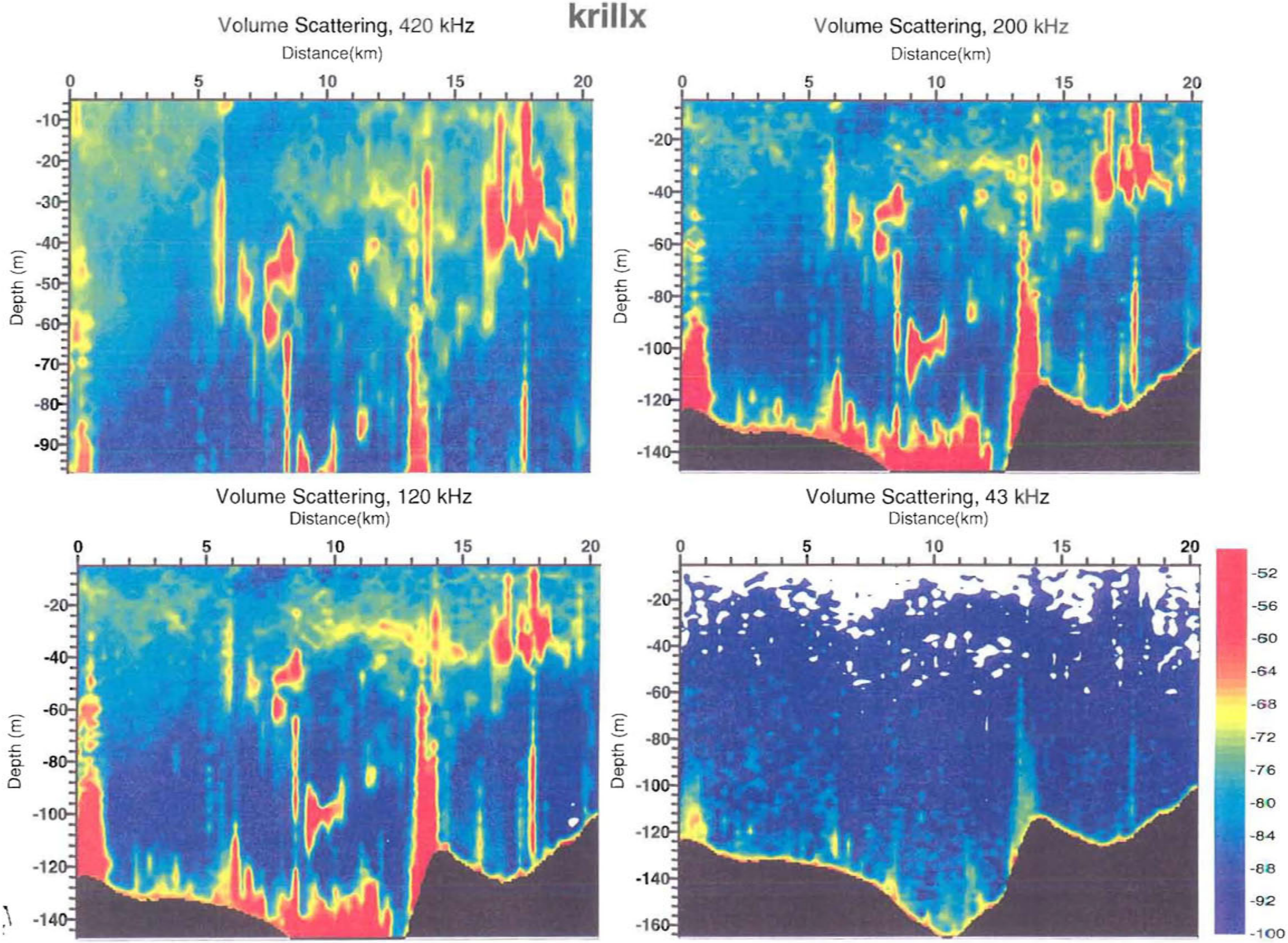


Fig. 22


krilly
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)
-52
-56
-60
-64
-68
-72
-76
-80
-84
-88
-92
-100

P. 53

krillx



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)
-52
-56
-60
-64
-68
-72
-76
-80
-84
-88
-92
-100

Fig. 25

Abundance of birds at frontal area, Y-line (Unimak Pass June 17, 2002)
(only birds feeding and sitting on the water)

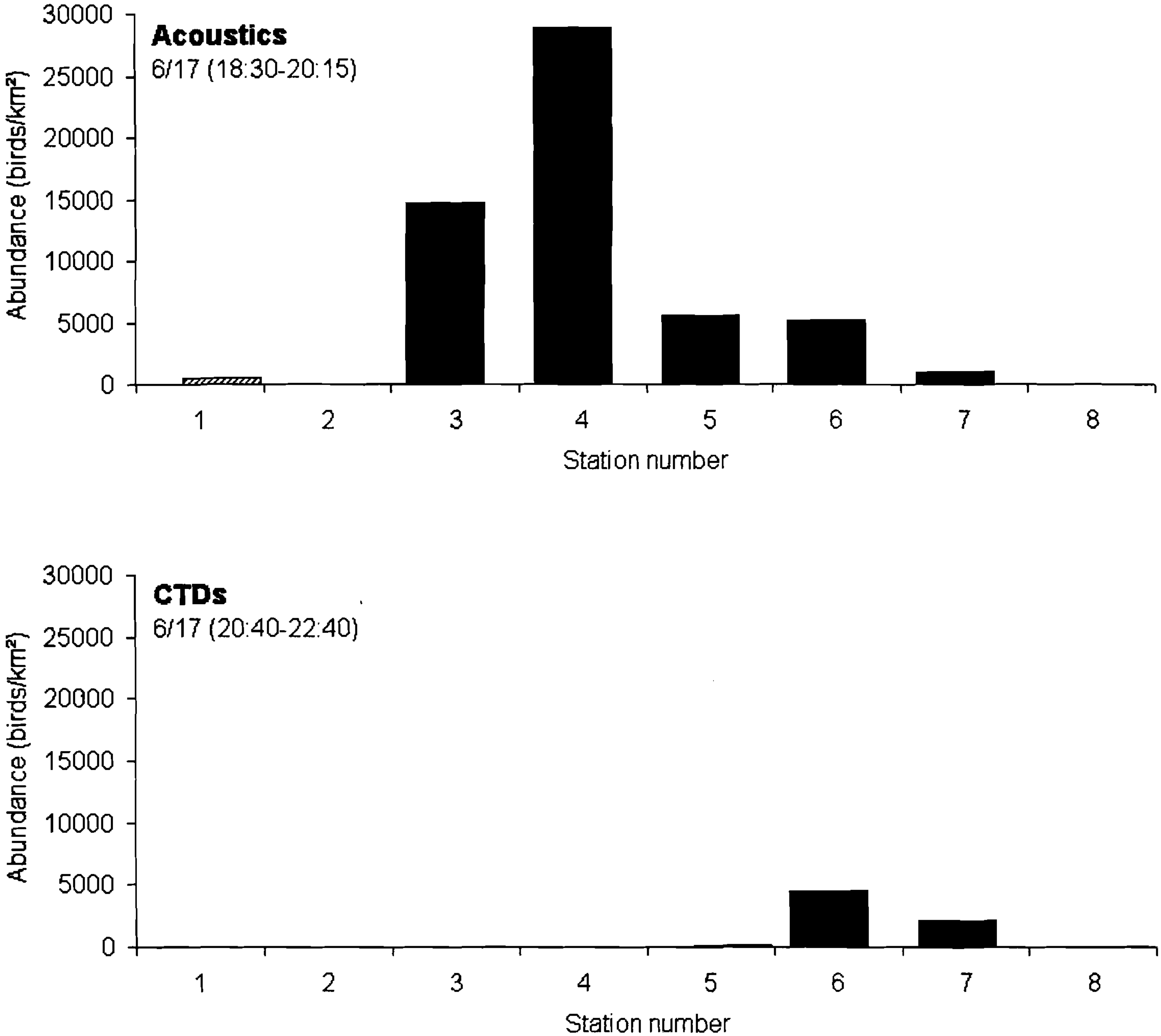


Fig. 26

Abundance of birds at frontal area, X-line (Unimak Pass June 17, 2002)
(only birds feeding and sitting on the water)

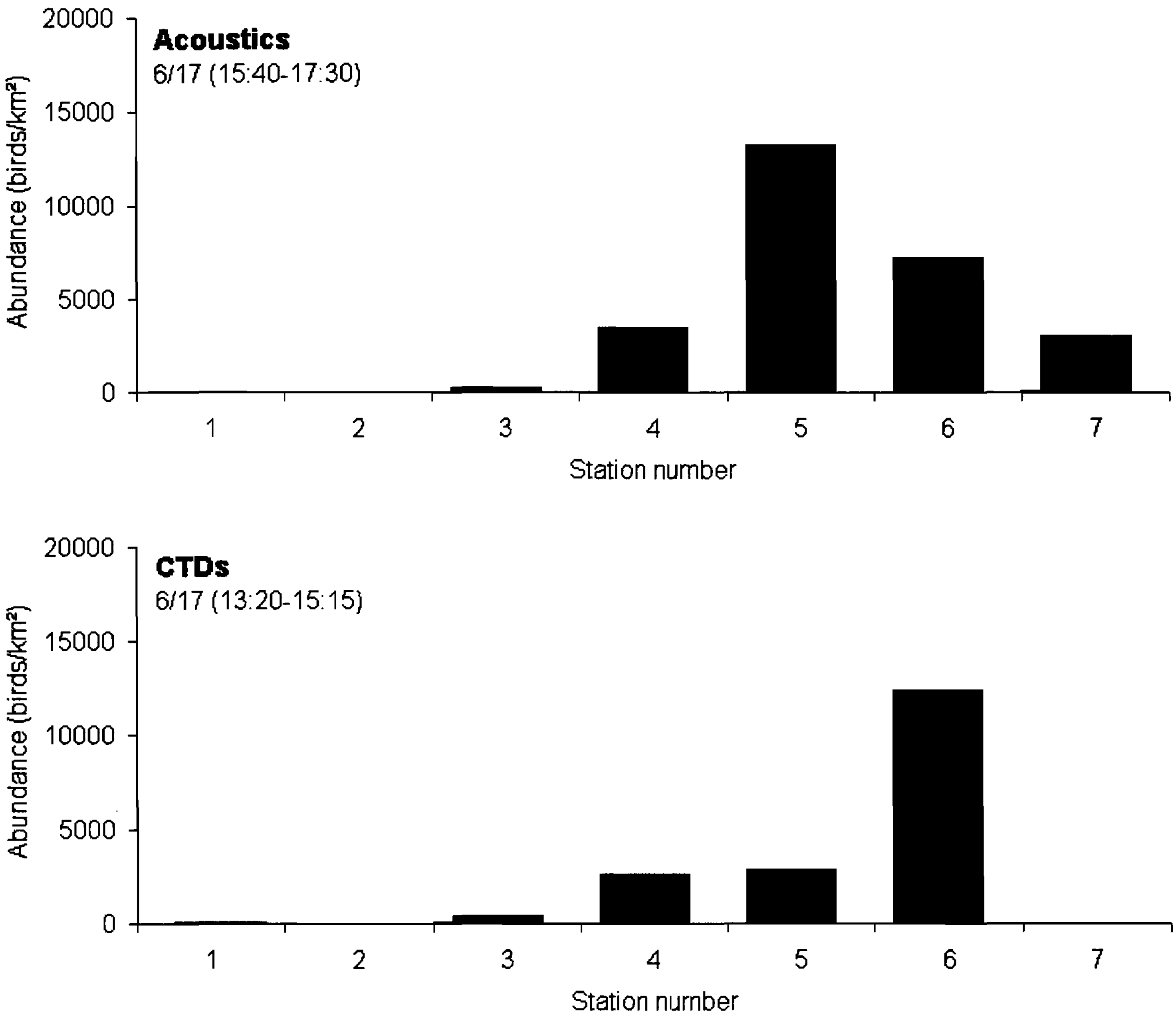
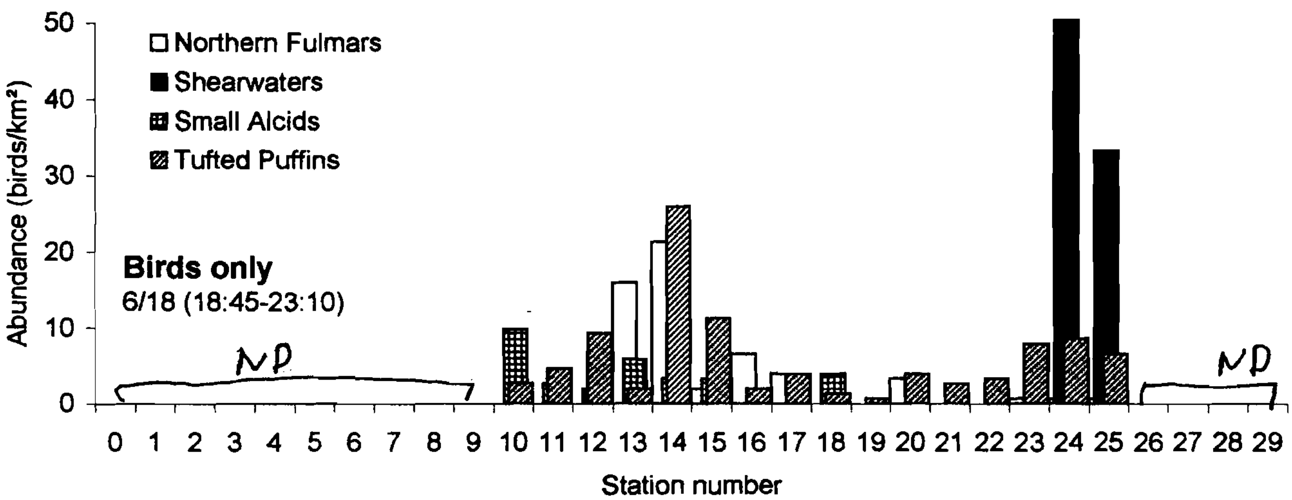


Fig. 27

Abundance of birds along the Unimak Pass Y-line transect (June 18, 2002)
(only birds feeding and sitting on the water)



Umnak Pass

We visited Umnak Pass on 10 June 2002 (Fig. 28). To facilitate sampling the pass, our CTD (Fig. 29a) and acoustic (Fig. 30a) surveys were timed to coincide with minimal tidal flow at the time of the CTD survey in the narrowest portion of the pass (Fig. 29b, 30b). This timing resulted in failure to determine if tidal flow would push cold, salty water from depth into the pass (Fig. 30a). Within the pass, little chlorophyll was present. Zooplankton (Fig. 30a) and seabirds (Fig. 31) were patchy. Additional analysis will be required to determine whether the strong acoustic signals were generated by bubbles in convergences, but a large flock of tufted puffins (*Fratercula cirrhata*) was encountered near a front during the CTD survey. Dall's porpoises (*Phocoenoides dalli*) were encountered in the pass. To the north of the pass, near the shelf edge, killer whales were encountered. This small, narrow pass was not an important foraging habitat for marine birds or mammals when we visited it.

06/09/02 INStar - 20:00:12

Scale: 37.2NM 1:303000 Chart: Coastal UNDER

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

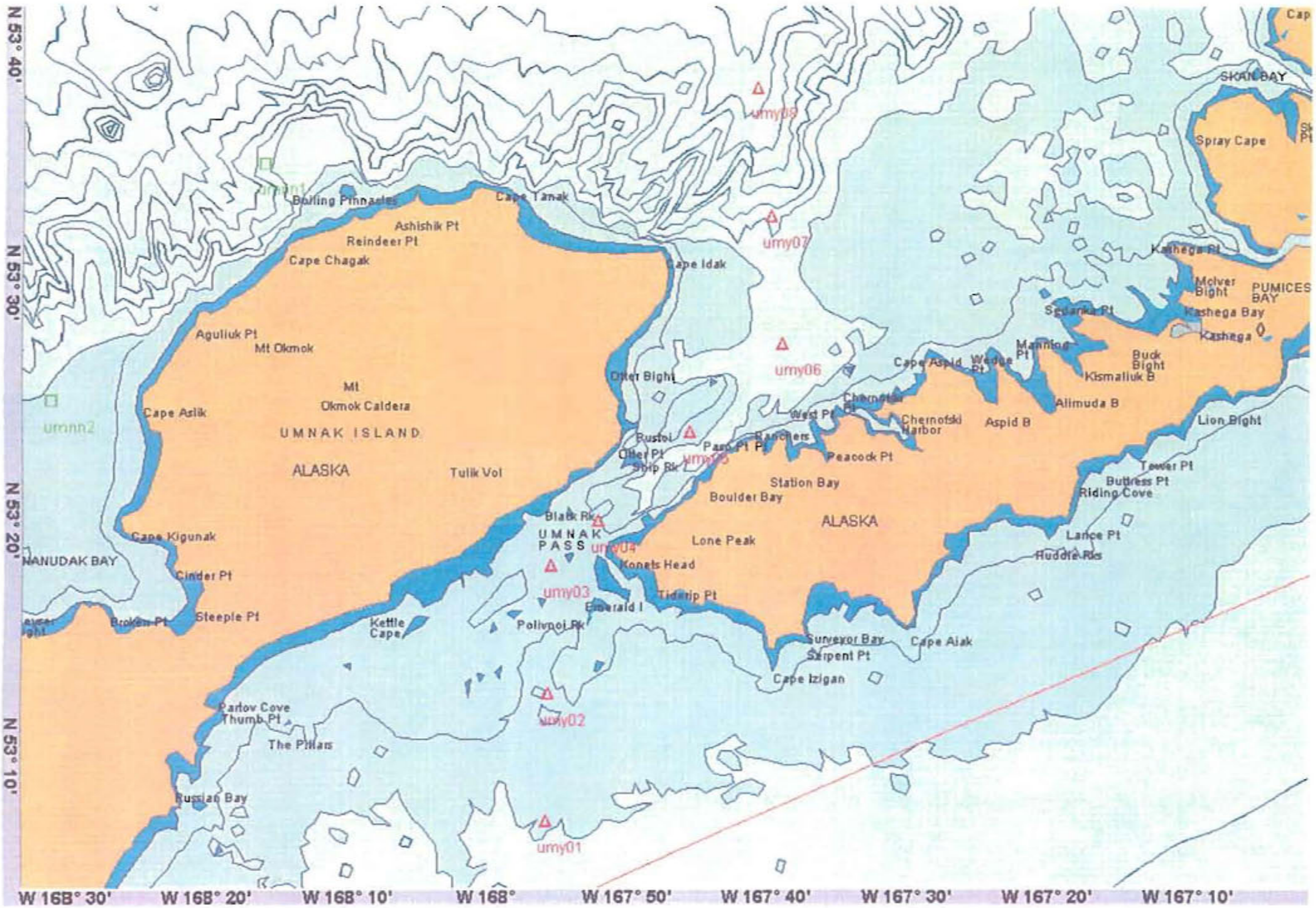


Fig. 28

hx259; Umnak Pass, 10 June 2002

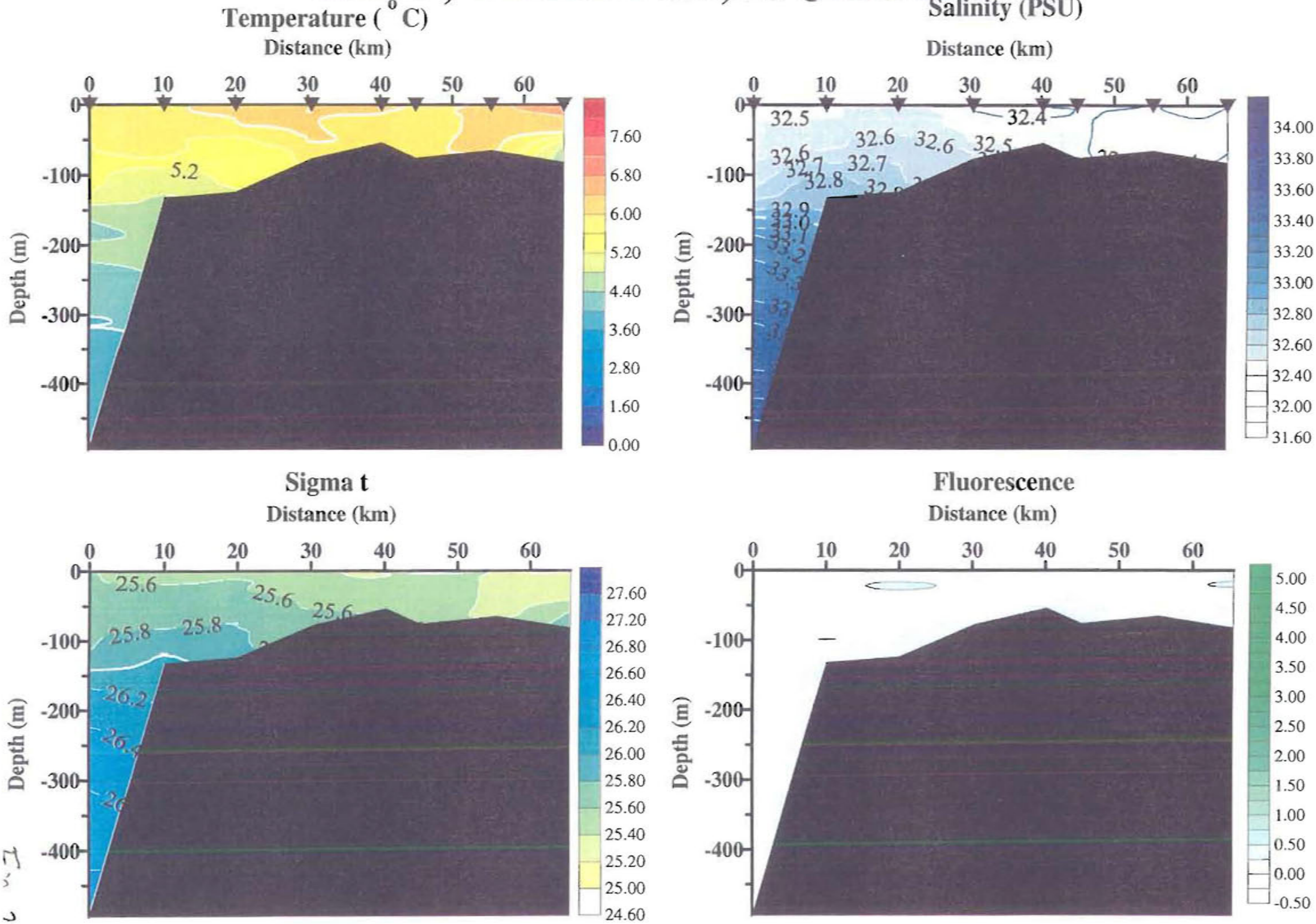
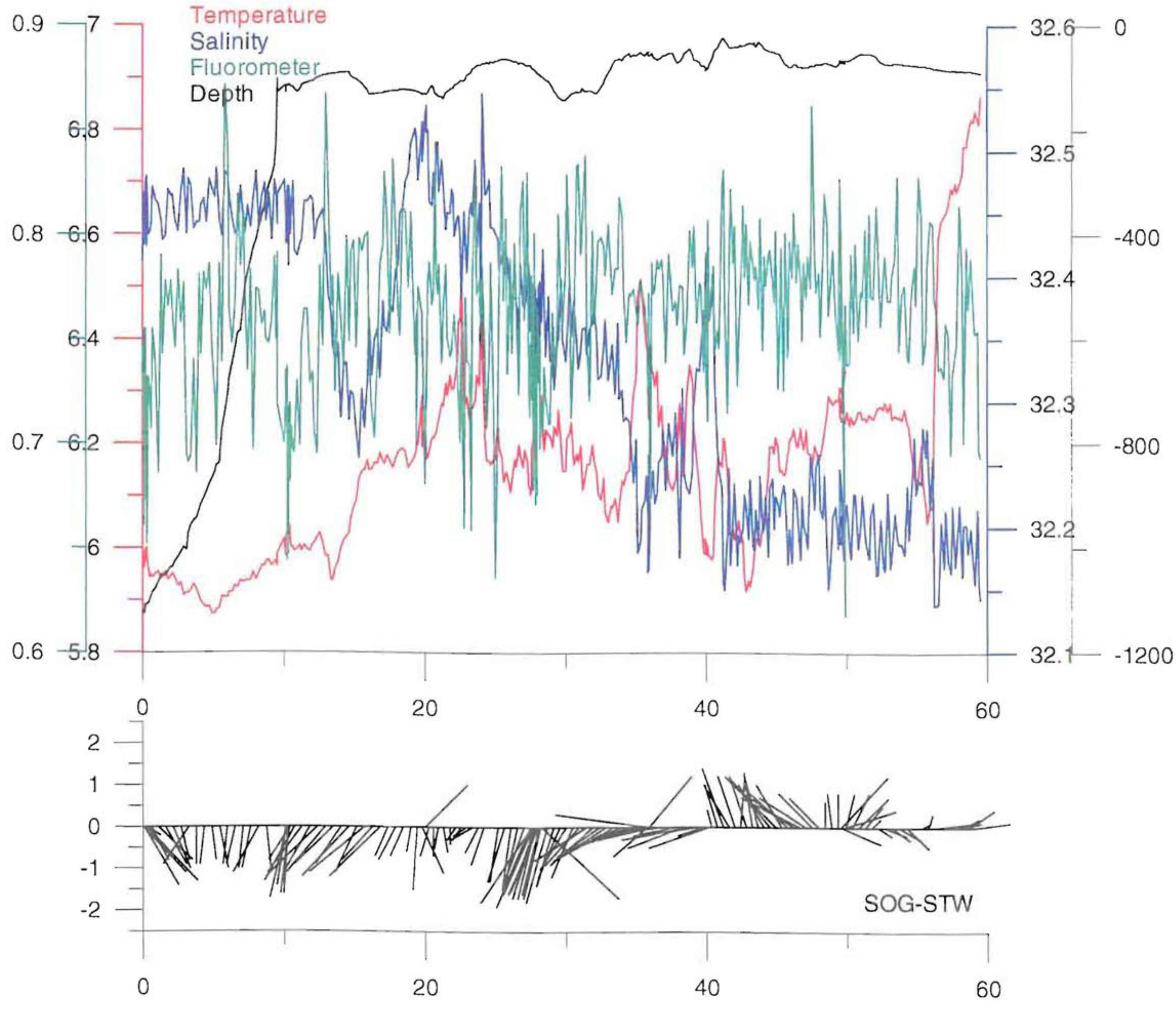


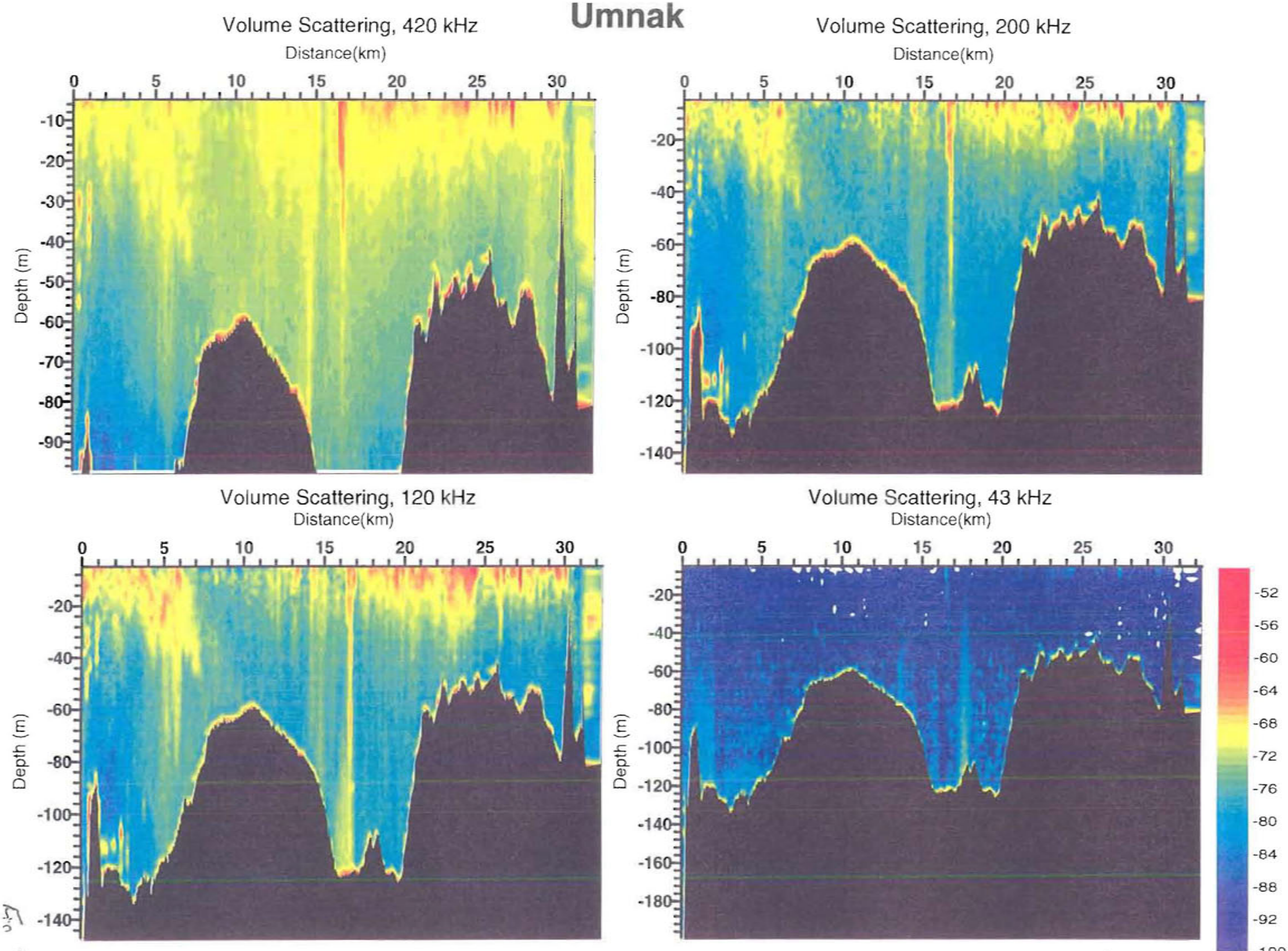
Fig. 29.

Fig. 29b

Umnak Pass, 10 June 2002



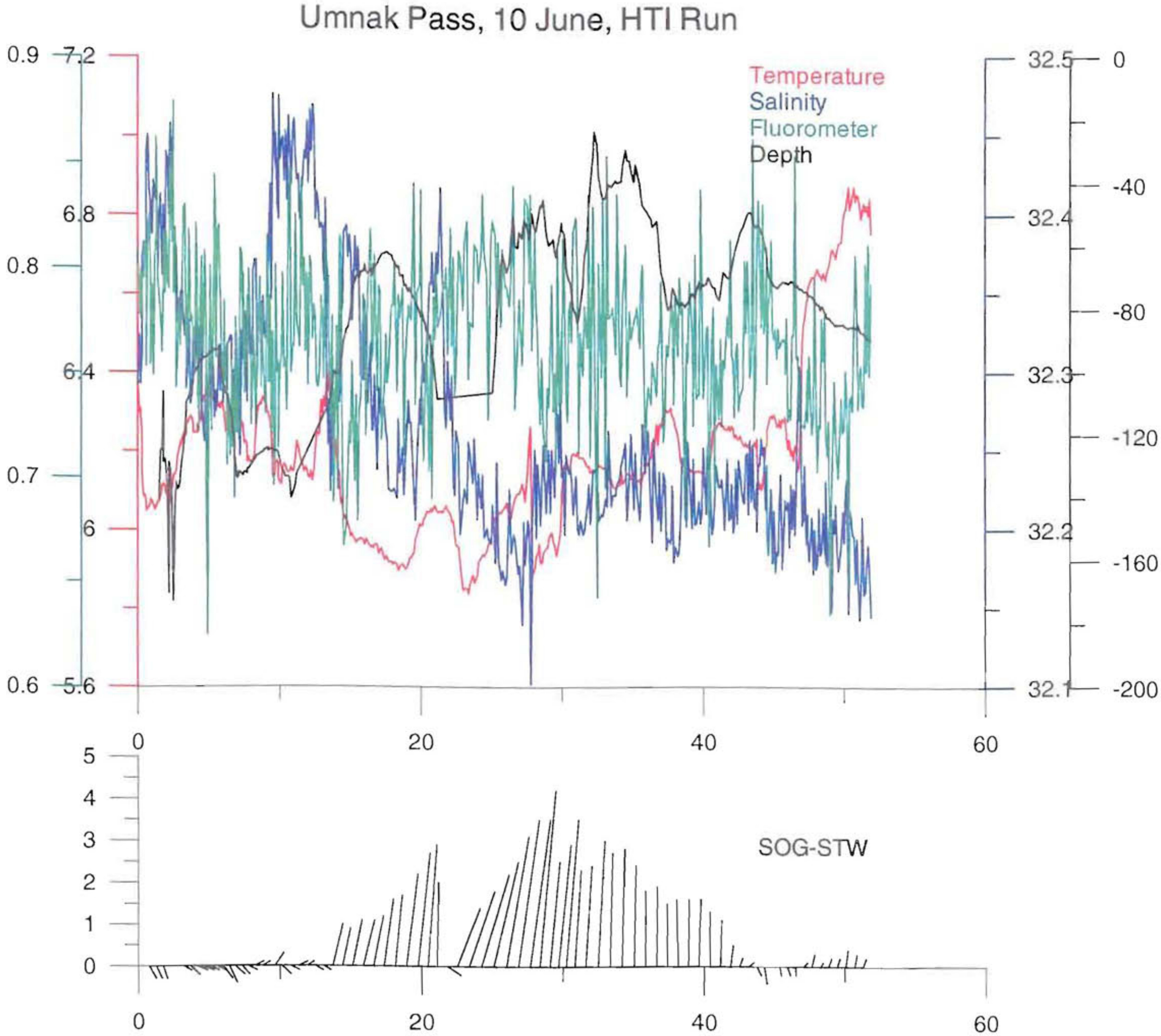
Umnak



P. 62

Fig 30a

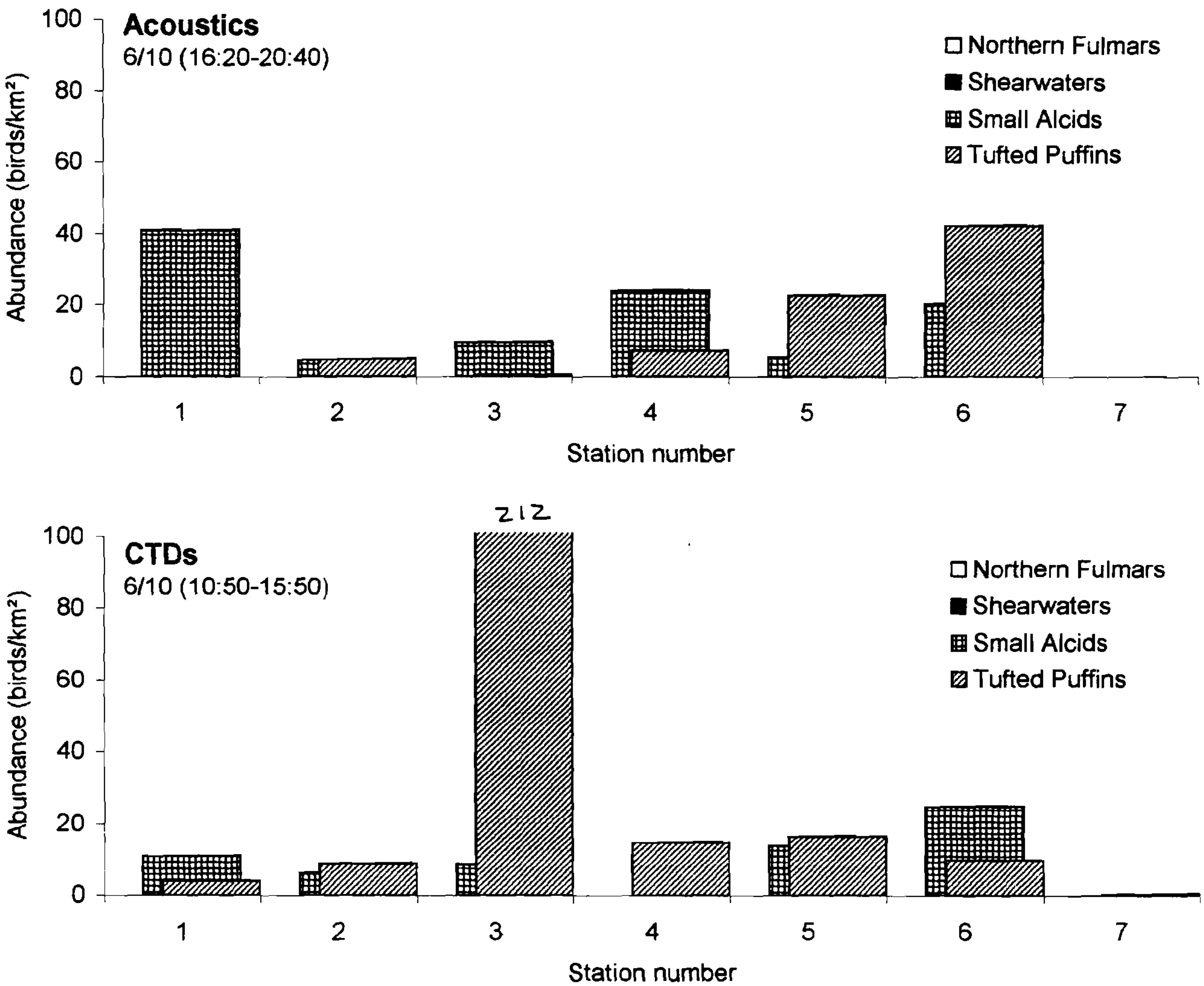
Fig. 306



Umnak Pass, 10 June, HTI Run
Temperature
Salinity
Fluorometer
Depth
0.9
0.8
0.7
0.6
7.2
6.8
6.4
6
5.6
32.5
32.4
32.3
32.2
32.1
0
-40
-80
-120
-160
-200
0
20
40
60
5
4
3
2
1
0
SOG-STW

Fig. 31

Abundance of birds along the Umnak Pass Y-line transect (June 10, 2002)
(only birds feeding and sitting on the water)



Samalga Pass

We visited Sarnalga Pass between 7 and 9 June 2002 (Fig. 32). Because of weather and timing considerations, our CTD survey of the pass was broken into two segments, both of which were run with the tide flowing from the pass to deeper water (Fig. 33, 34). Thus there was no opportunity to determine if cold, salty water from depth is mixed into the upper layers of the water column by tidal action (Fig. 33a, 34a). A transect across the pass showed northward flow of warm, relatively fresh water (Fig. 35a,b). This may be the farthest west that the Alaska Coastal Current penetrated in 2002. Chlorophyll levels were low within the pass, with the highest values seen at the southern extremity of the Y-line (Fig. 33a). Concentrations of zooplankton appeared to be low in this pass, with the highest concentrations occurring at the extreme southern end (Fig. 36). The pass had unusually conspicuous tide rips and fronts. Convergence slicks associated with the fronts supported high numbers of foraging fulmars that sat on the surface pecking (Fig. 37). Birds collected from these aggregations were foraging primarily on copepods. A remarkable concentration of killer whales was encountered a bit north of the center of the pass in an area of dimpled water next to a front. These animals were milling about and appeared to be chasing fish. One surfaced just in front of the boat with what looked like a salmon. These killer whales stayed in the same area for a couple of hours, with many spy-hopping, breaching, and riding the 1 to 2 m high breaking waves. This pass appeared to be an important foraging area for surface-foraging marine birds and possibly for killer whales.

06/16/02 INStar - 16:20:13

Scale: 57.6NM 1:469000 Chart: Coastal OVER

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

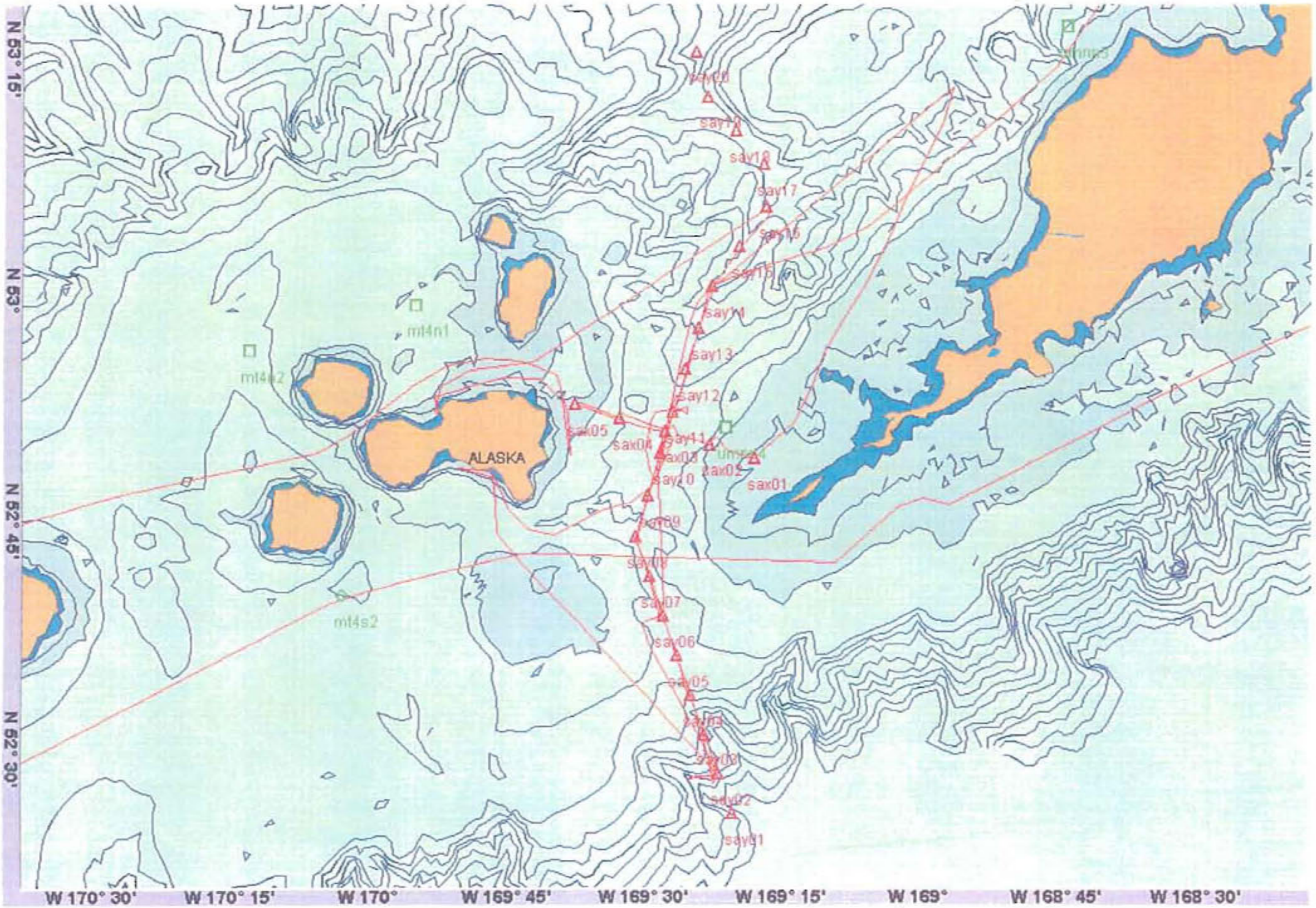


Fig. 32

hx259; Samalga Pass South, 8 June 2002

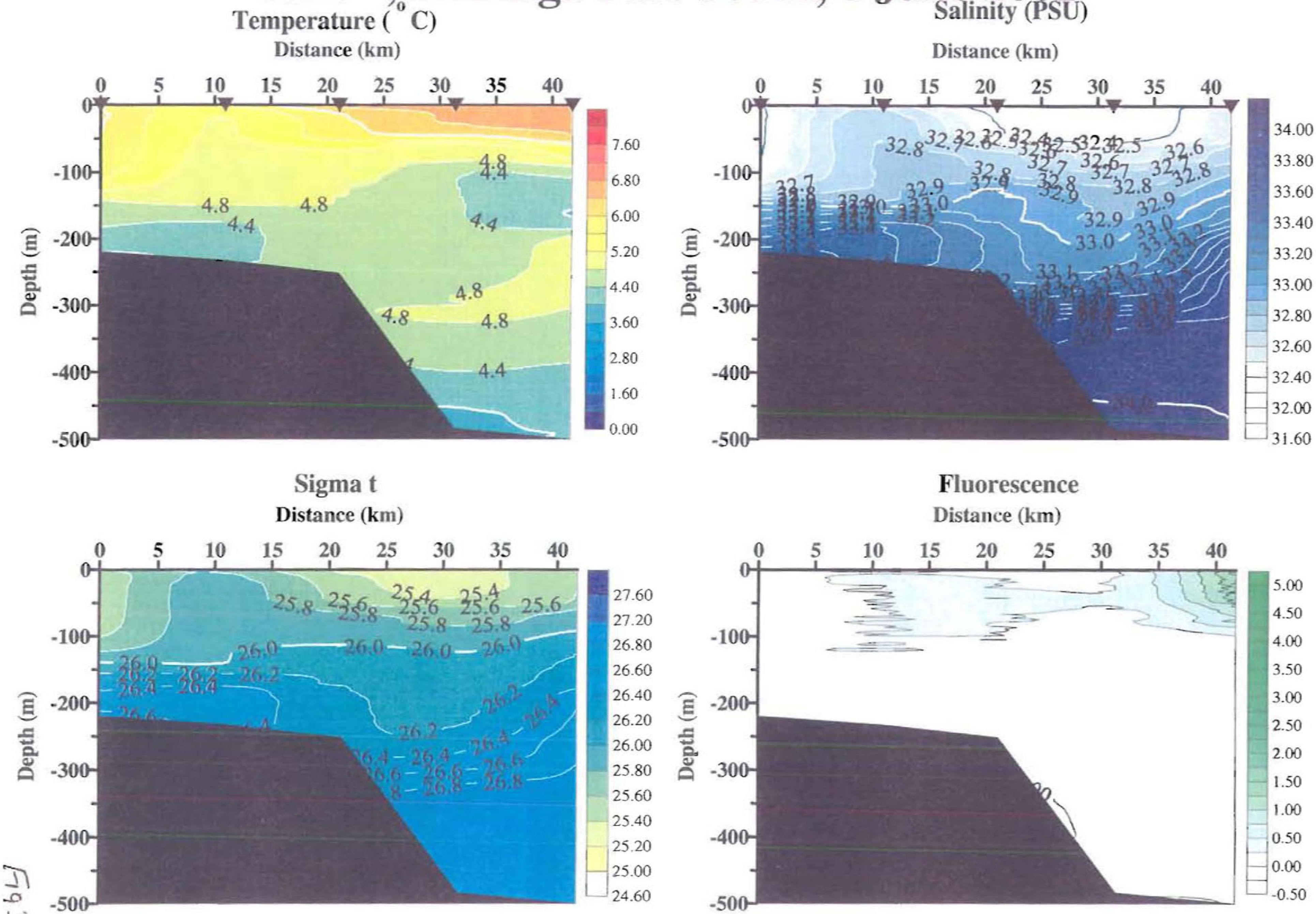
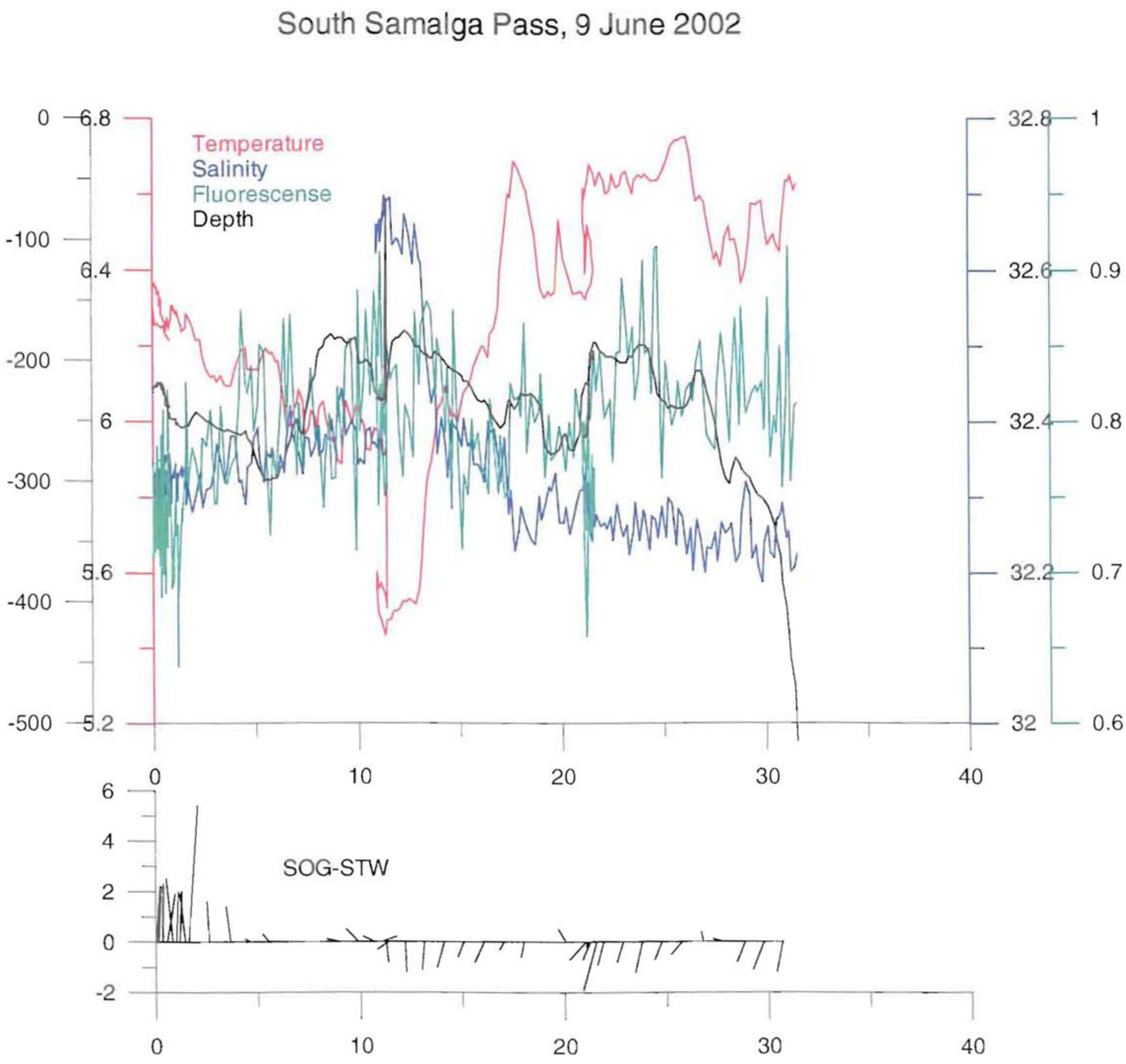


Fig 33a

p.67

Fig. 33b


South Samalga Pass, 9 June 2002
Temperature
Salinity
Fluorescense
Depth
0
-100
-200
-300
-400
-500
6.8
6.4
6
5.6
5.2
32.8
32.6
32.4
32.2
32
1
0.9
0.8
0.7
0.6
0
10
20
30
40
6
4
2
0
-2
SOG-STW
0
10
20
30
40

hx259; Samalga Pass North, 7-8 June 2002

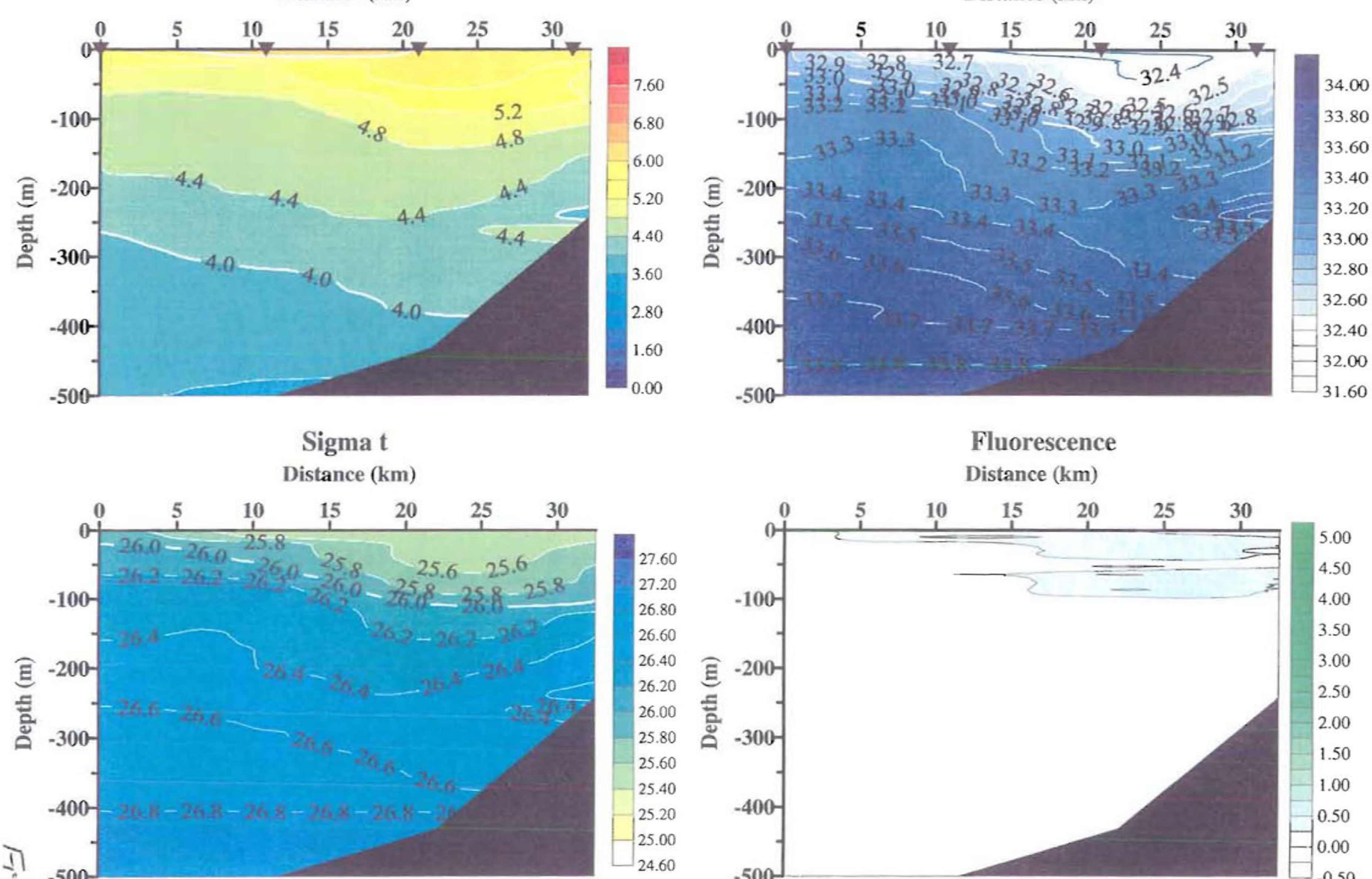
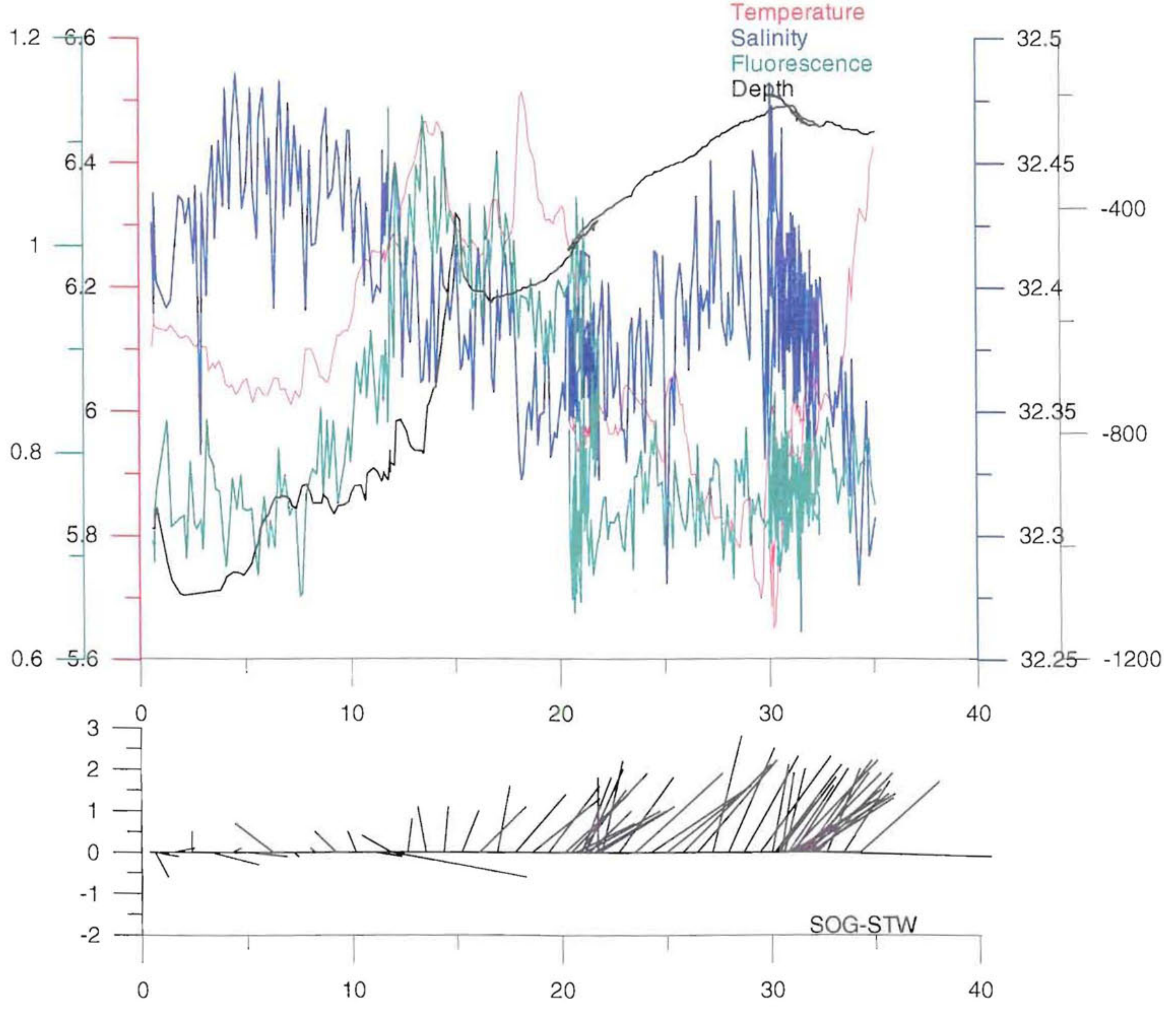


Fig. 34c

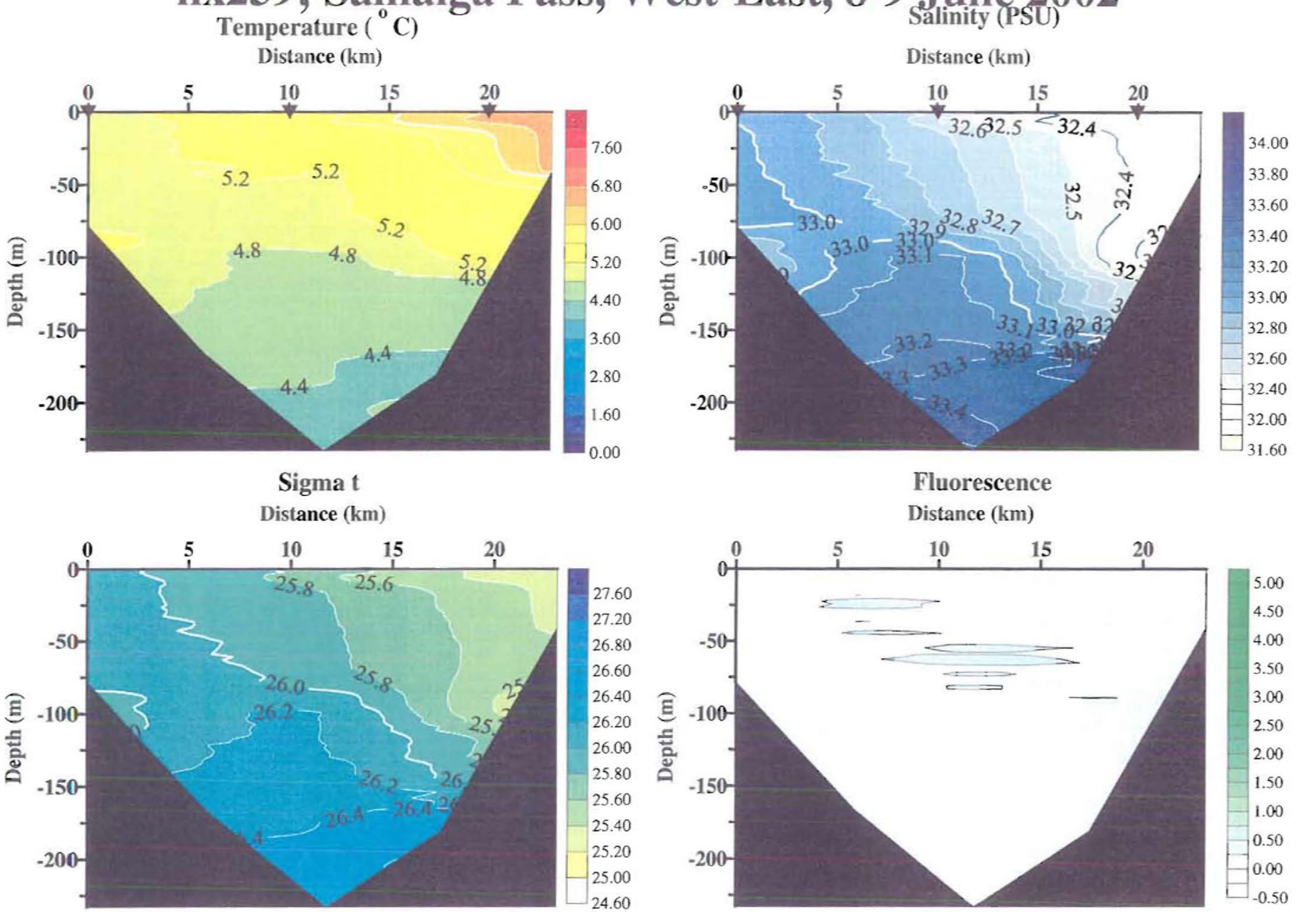
p. 69

Fig 34b

North End Samalga Pass, 7 June 2002



hx259; Samalga Pass, West-East, 8-9 June 2002

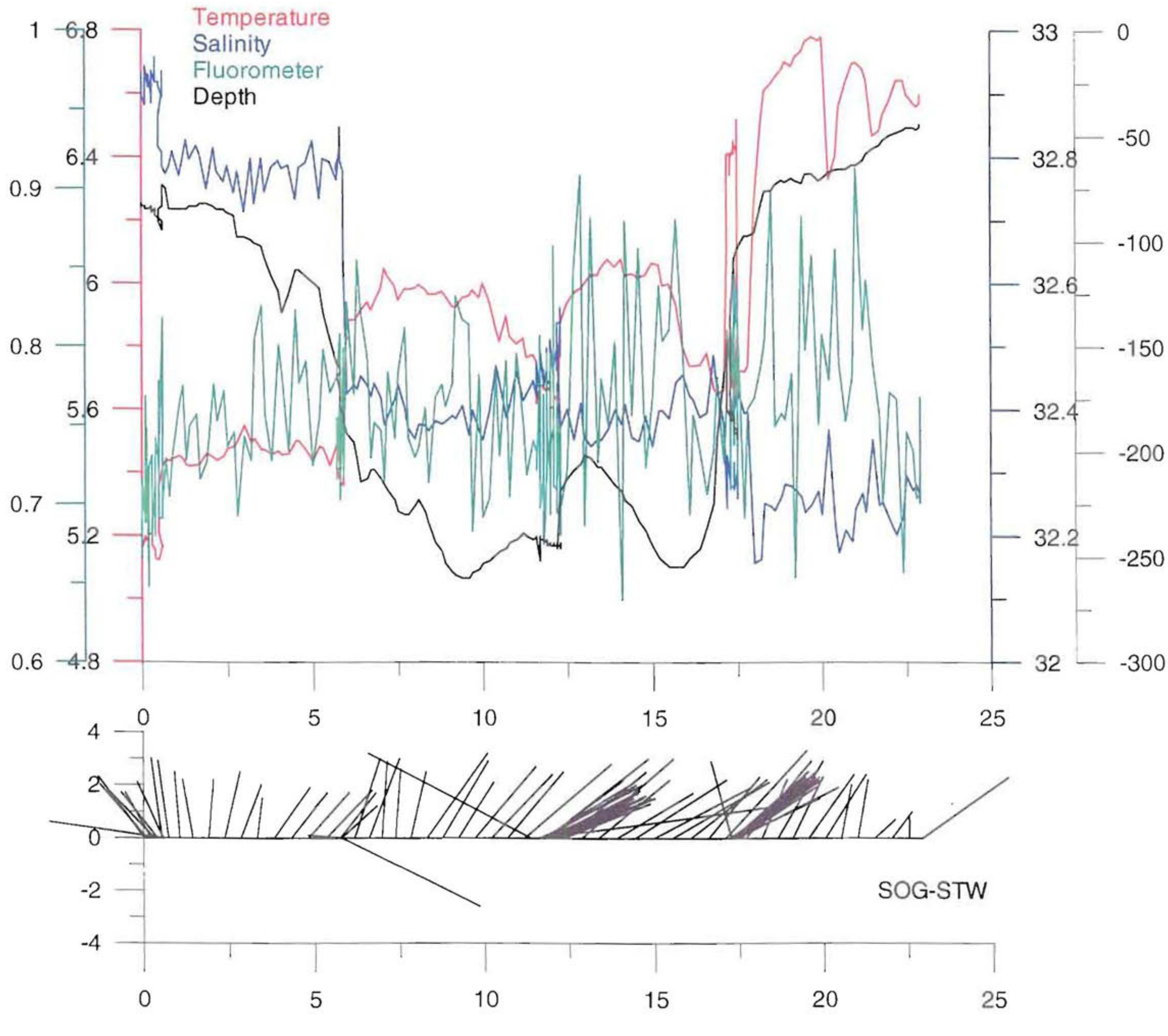


p. 71

Fig. 35a

Fig. 35b

Samalga Pass, West-East 8 June 2002



Samalga

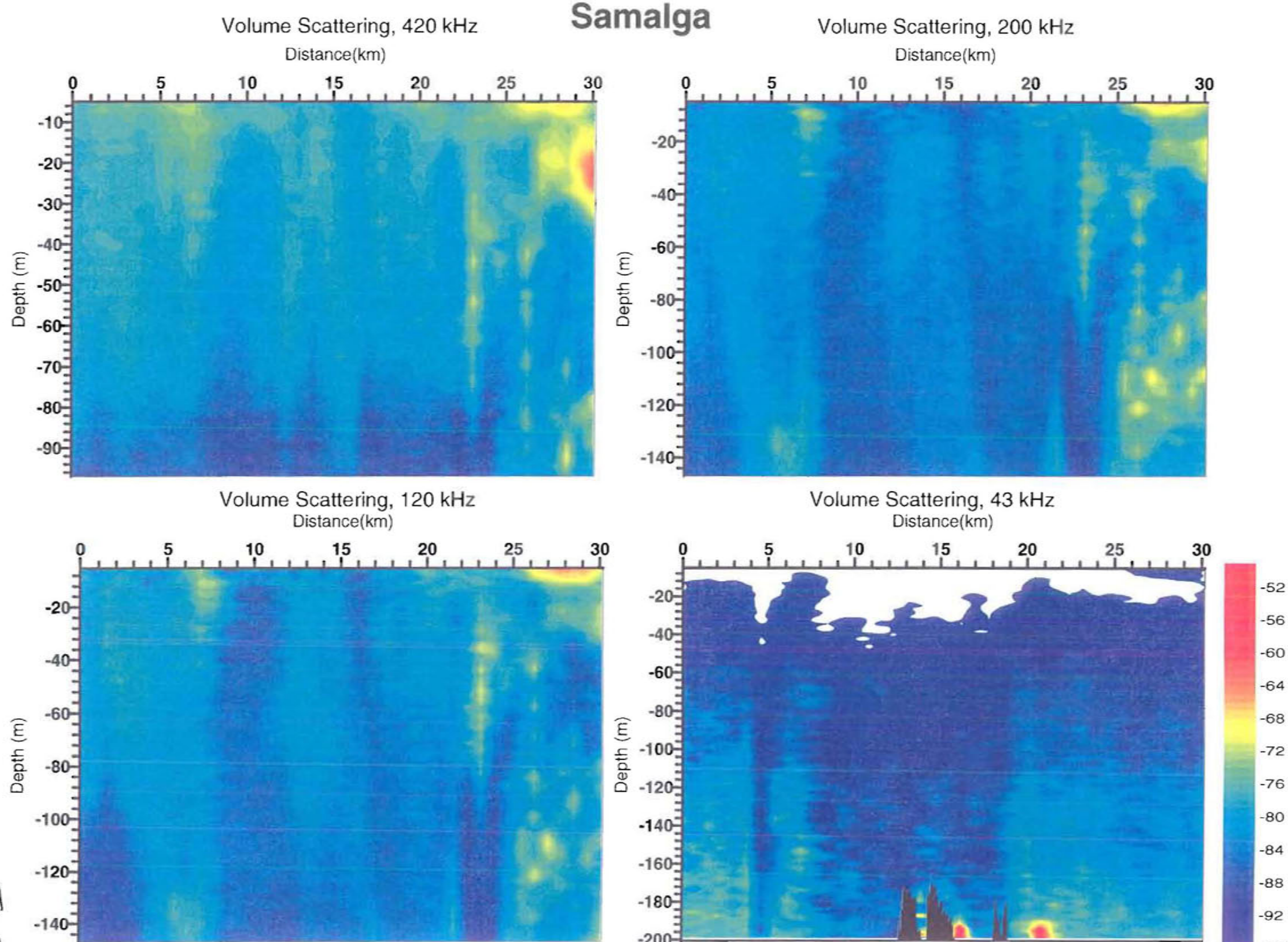
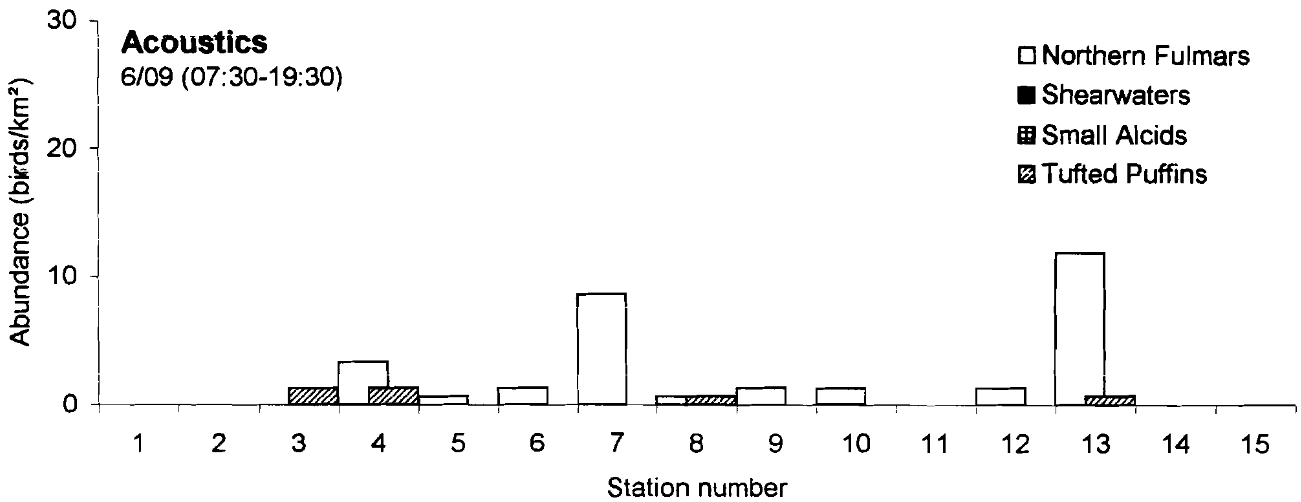


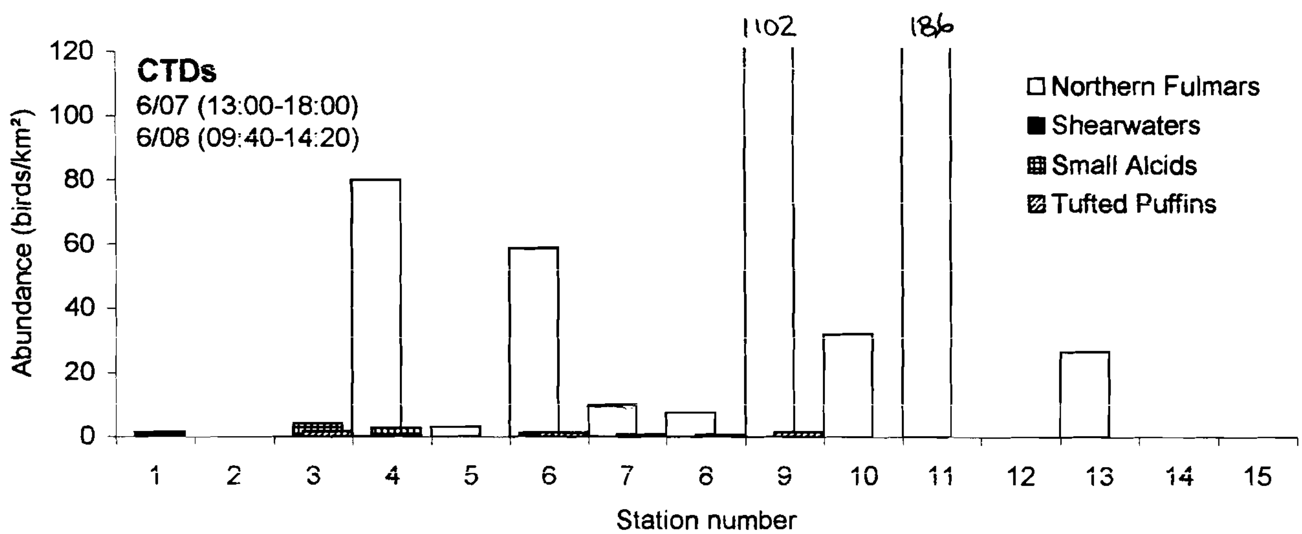
Fig. 3b

P. 73

Fig. 37

Abundance of birds along the Samalga Pass Y-line transect (June 7-9, 2002)
(only birds feeding and sitting on the water)





Amukta Pass

Amukta Pass was studied on 5 and 6 June under deteriorating weather conditions (Fig. 38). The X-line was run at night (Fig. 39), and immediately following its completion, we ran the acoustic survey from south to north (Fig. 40) and then the CTD/CalVET survey from north to south (Fig. 41). For most of the acoustic run, the tides were running north; during the CTD survey, were initially running north from the pass to deeper water, and then southward for the middle of the survey, and finally northward again (Fig. 40b). Much of the CTD survey was run at night. There was some evidence of cooler water coming from depth to 50 m north of and over the pass, but no evidence that this was contributing to elevated chlorophyll concentrations, which remained low throughout the pass (Fig. 41a). The little chlorophyll that was present was mostly in the extreme south. Physical data from the X-line suggested little geostrophic flow, and the possible presence of two eddies, one on the east side and one on the west (Fig. 39a). Zooplankton concentrations appeared low, with the possible exception of an area of elevated acoustic return just north of the pass (Fig. 40a). Birds and cetaceans were scarce throughout the pass during the acoustic survey Fig. 42 and 43). This pass did not appear to be an important habitat for supporting large concentrations of higher trophic level species in either 2001 or 2002.

06/02/02 INStar - 17:03:09

Scale: 46.4NM 1:399000 Chart:

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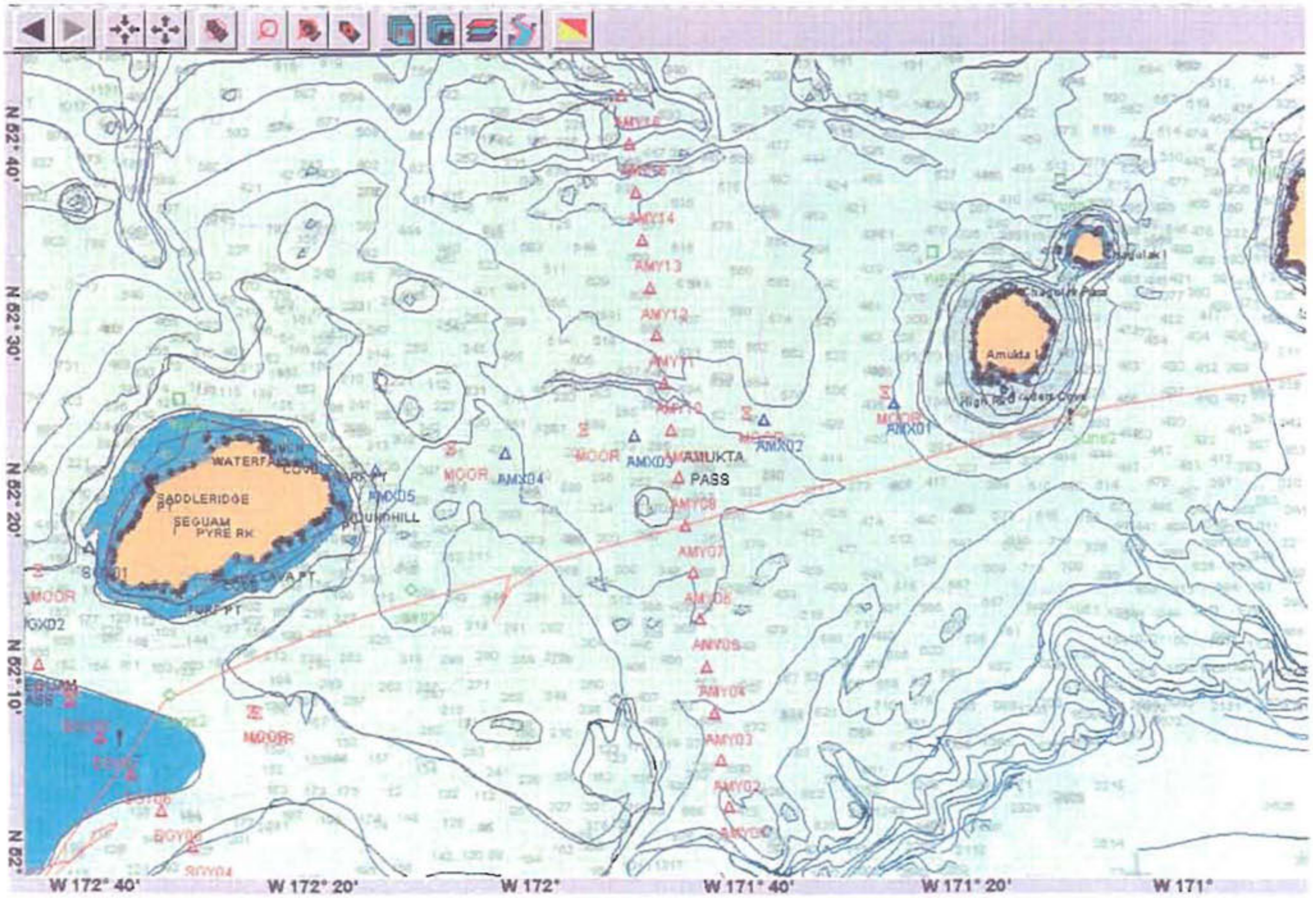
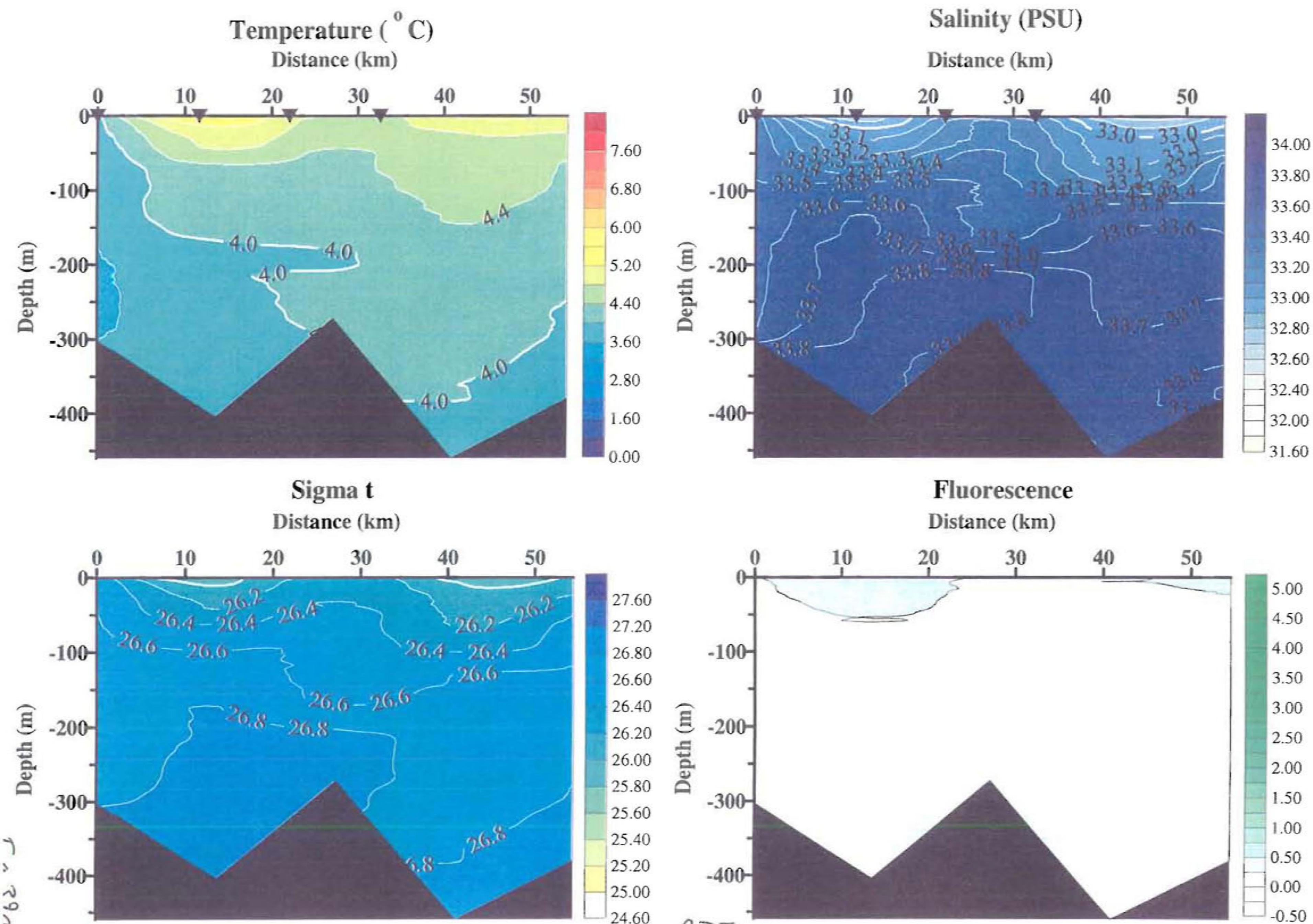


Fig. 38

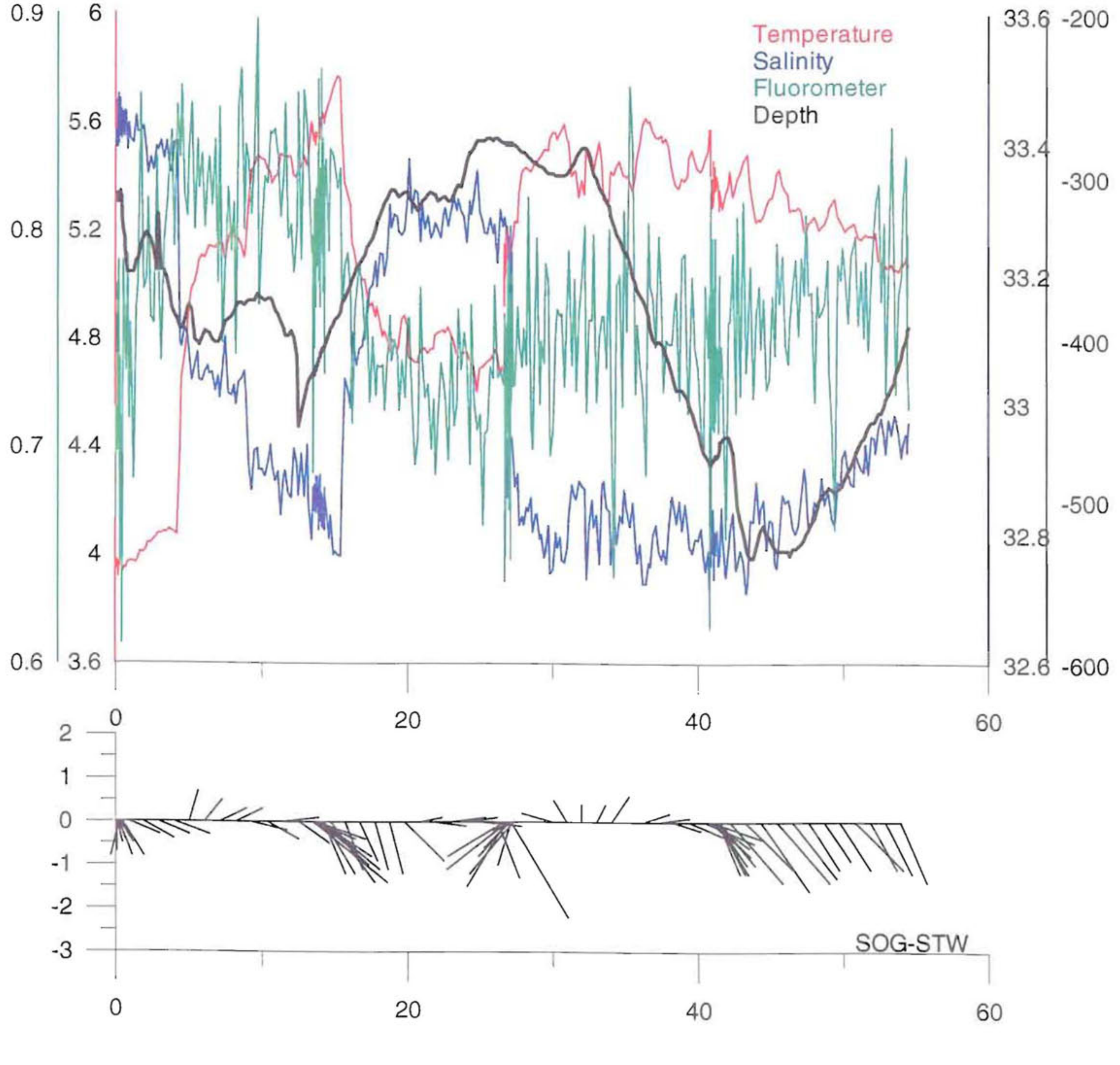
HX259; West-East Amukta Pass, 5 June 2002

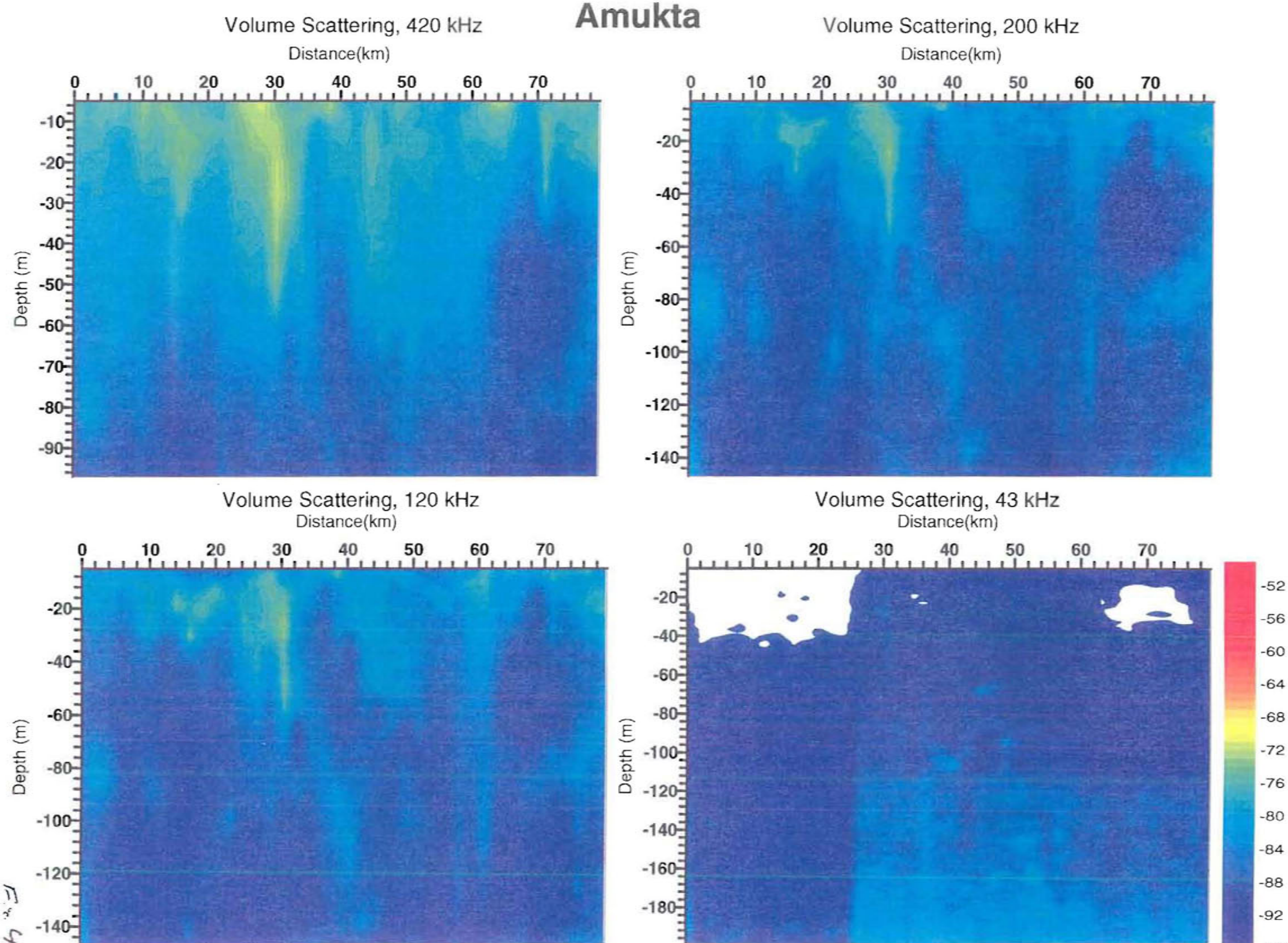


p.77

Fig. 39b

Amukta Pass, West-East 5 June 2002



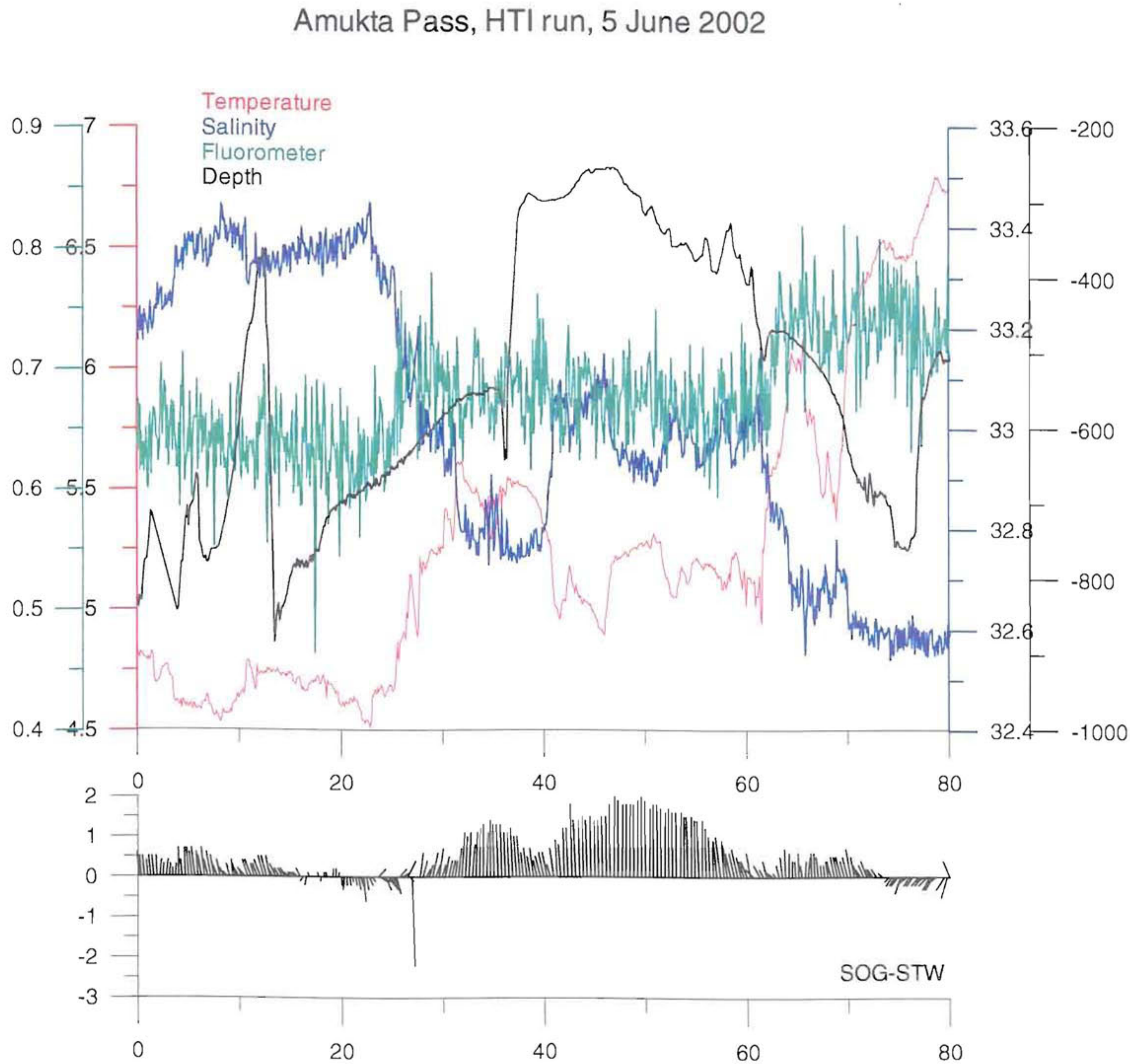


Amukta
Volume Scattering, 420 kHz
Distance(km)
Depth (m)
Volume Scattering, 200 kHz
Distance(km)
Depth (m)
Volume Scattering, 120 kHz
Distance(km)
Depth (m)
Volume Scattering, 43 kHz
Distance(km)
Depth (m)
-52
-56
-60
-64
-68
-72
-76
-80
-84
-88
-92
-100

Fx. 40a

p. 79

Fig. 40b


Amukta Pass, HTI run, 5 June 2002
Temperature
Salinity
Fluorometer
Depth
0.9
0.8
0.7
0.6
0.5
0.4
7
6.5
6
5.5
5
4.5
33.6
33.4
33.2
33
32.8
32.6
32.4
-200
-400
-600
-800
-1000
0
20
40
60
80
2
1
0
-1
-2
-3
SOG-STW
0
20
40
60
80

HX259; Amukta Pass, North-South, 6 June 2002

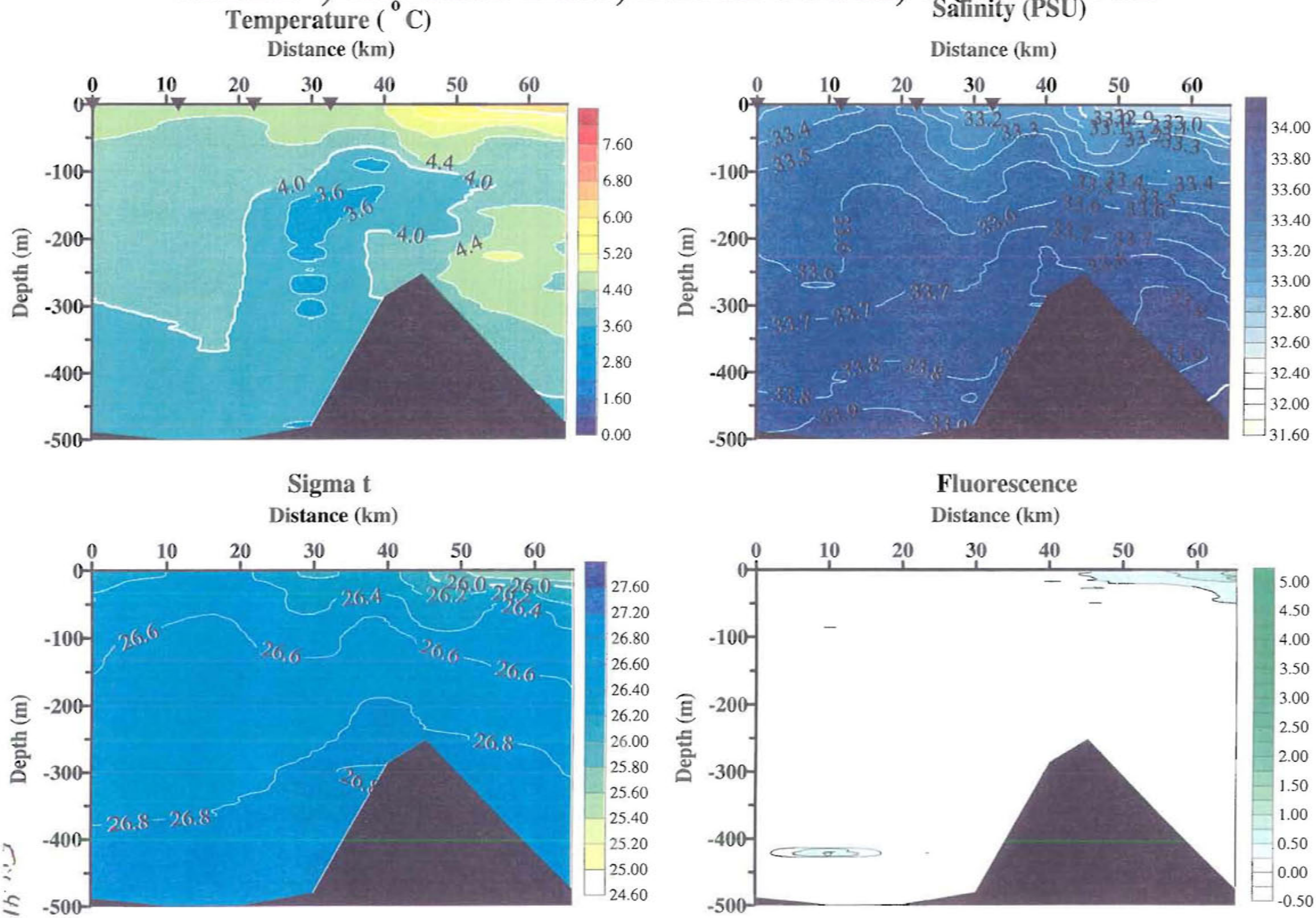


Fig. 41a

Fig. 41b

Amukta Pass, North-South,6 June 2002

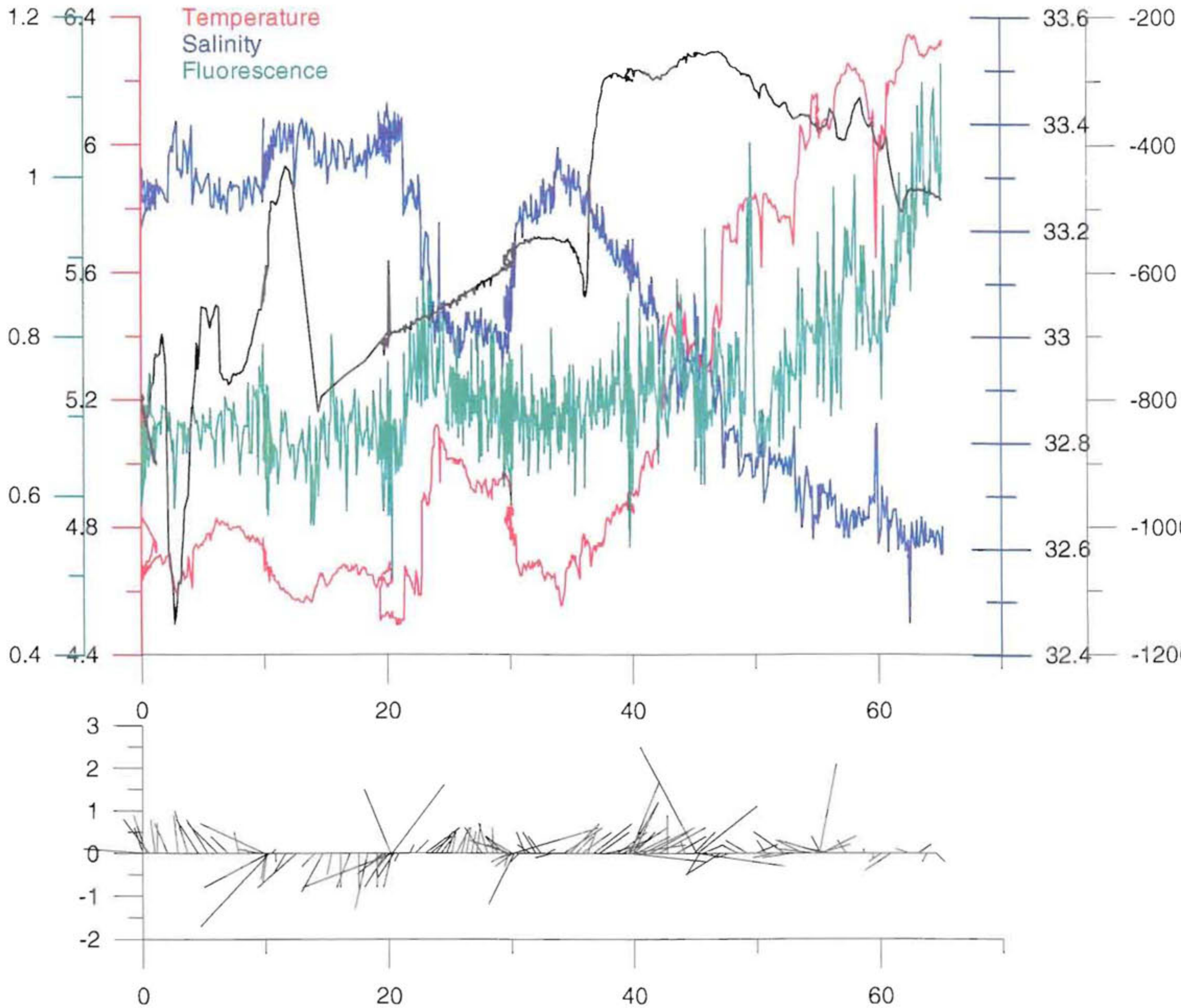
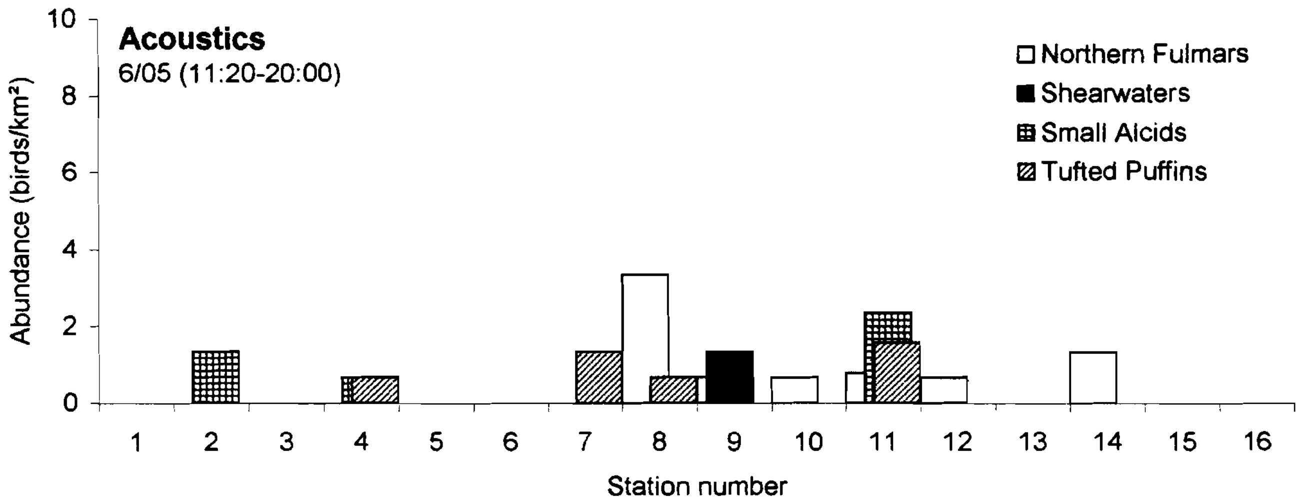


Fig. 42

Abundance of birds along the Amukta Pass Y-line transect (June 5, 2002)
(only birds feeding and sitting on the water)



Sequam/Amukta
05/27/02, and 06/03/02 through 06/05/02

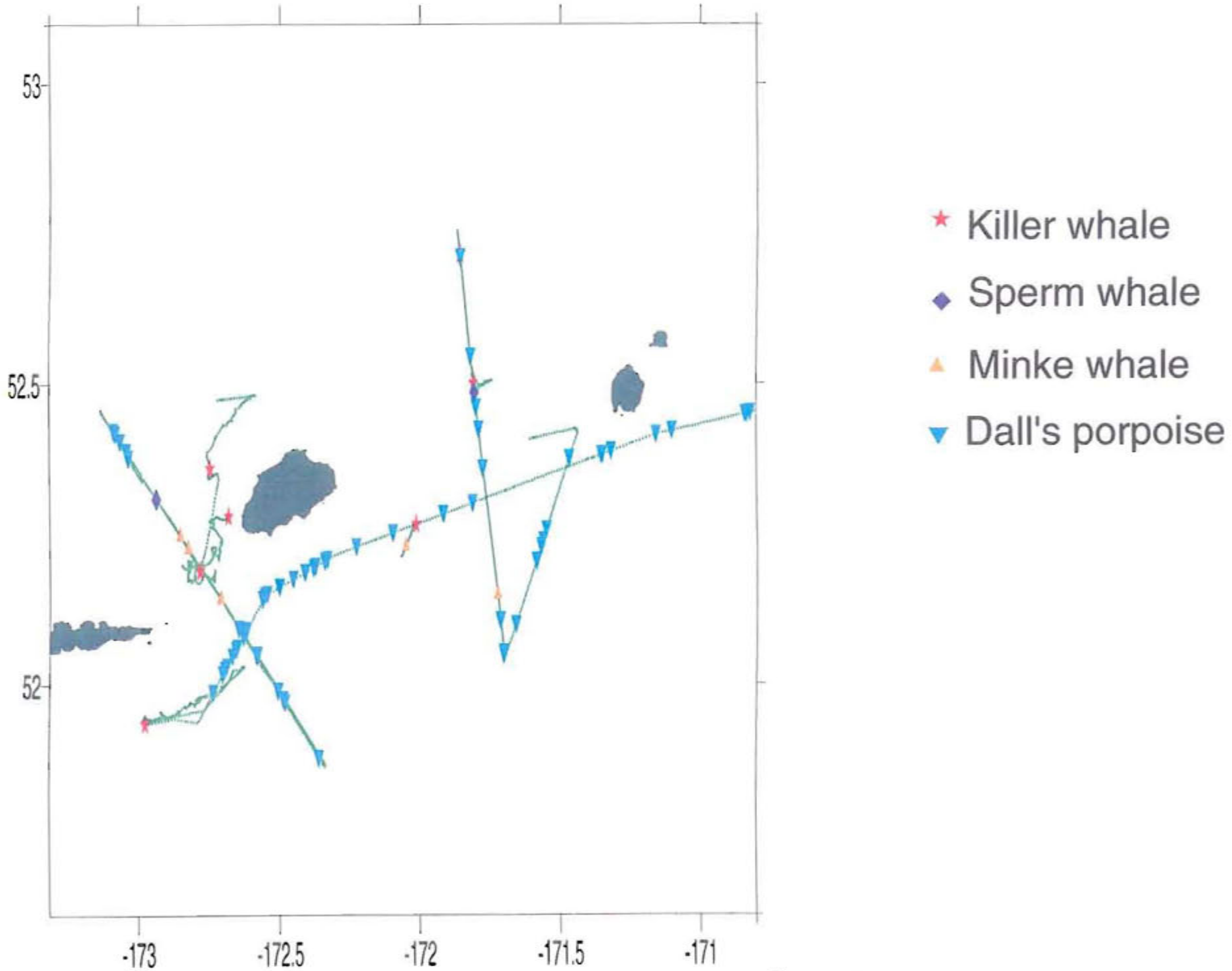


Fig. 43

Seguam Pass

Seguam Pass was studied from 2 to 5 June (Fig. 44). Our work was cut short by stormy weather. There was little evidence of cold, salty water being advected onto the pass (Fig. 45a), but the timing of our CTD line with respect to the tide may have resulted in a failure to capture this feature, if it was present (Fig. 45b). There was evidence of a current running eastward north of the pass and another moving westward south of the pass (Fig. 45a). Our cross-pass transect on 5 June showed evidence of flow through the pass (Fig. 46). At the northern end of the pass there a patch of chlorophyll-rich water (Fig. 45a) which was again encountered on our cross-pass line (Fig. 46a). Within the patch of high chlorophyll, potential primary production was high (See Productivity section, page 107). Otherwise little chlorophyll was present and primary production rates were low. Acoustic measures of zooplankton biomass showed that there was little zooplankton biomass in the pass (Fig. 47). High numbers of marine birds were present in the pass, dominated by northern fulmars that were feeding in convergence zones at frontal regions in the pass and along the sides of approaches to the pass (Fig. 48). Stomachs of fulmars collected in these large flocks contained primarily copepods and a few euphausiids. Some shearwaters were also present, and the few collected there had eaten euphausiids. Although a few minke, killer, and sperm whales were seen in the vicinity of this pass, the most common cetacean there was Dall's porpoise (Fig. 49).

06/02/02 INStar - 16:51:16

Scale: 53.3NM 1:459000 Chart: ˇ

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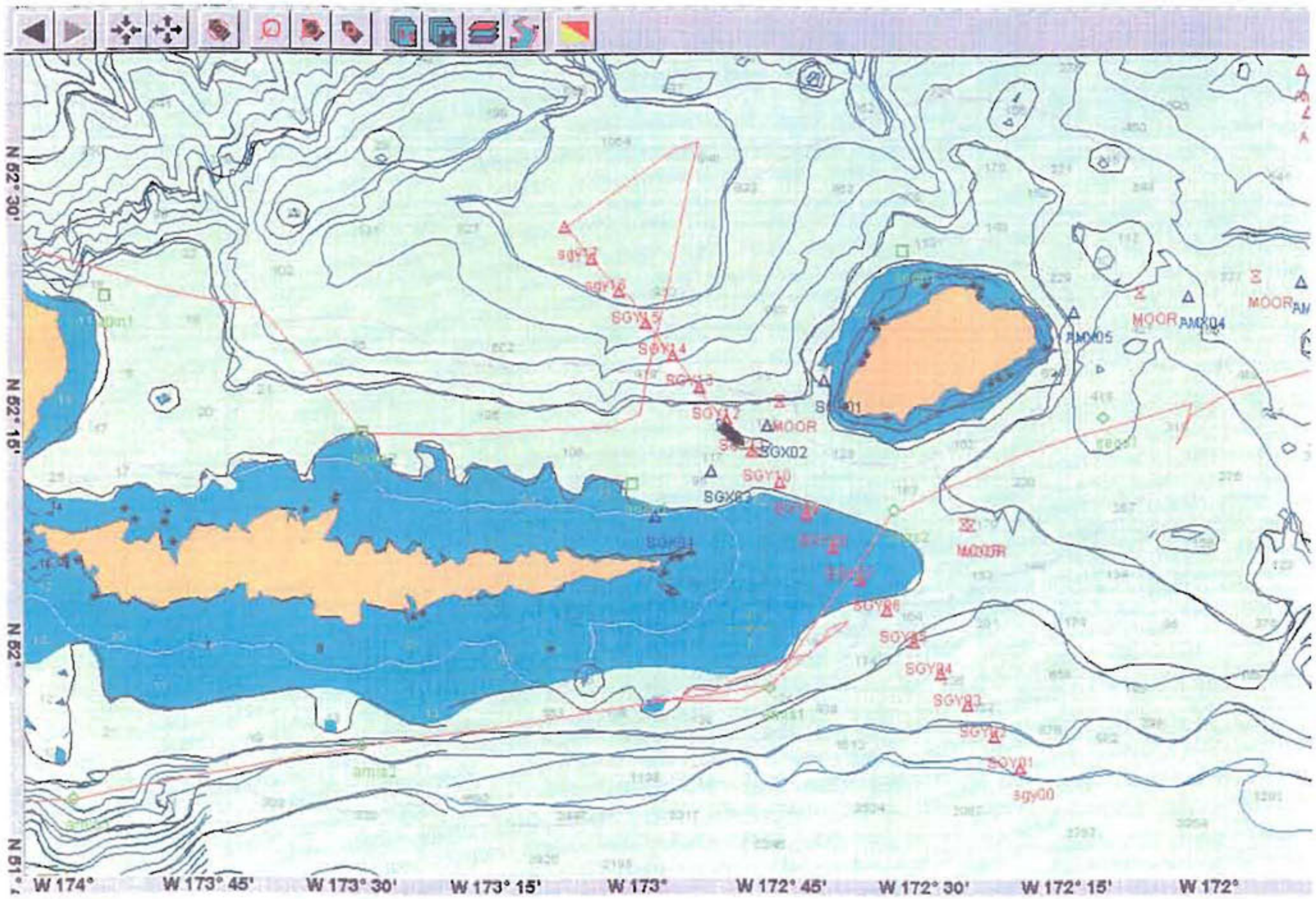


Fig. 44

HX259; Seguam Pass, 3 June 2002

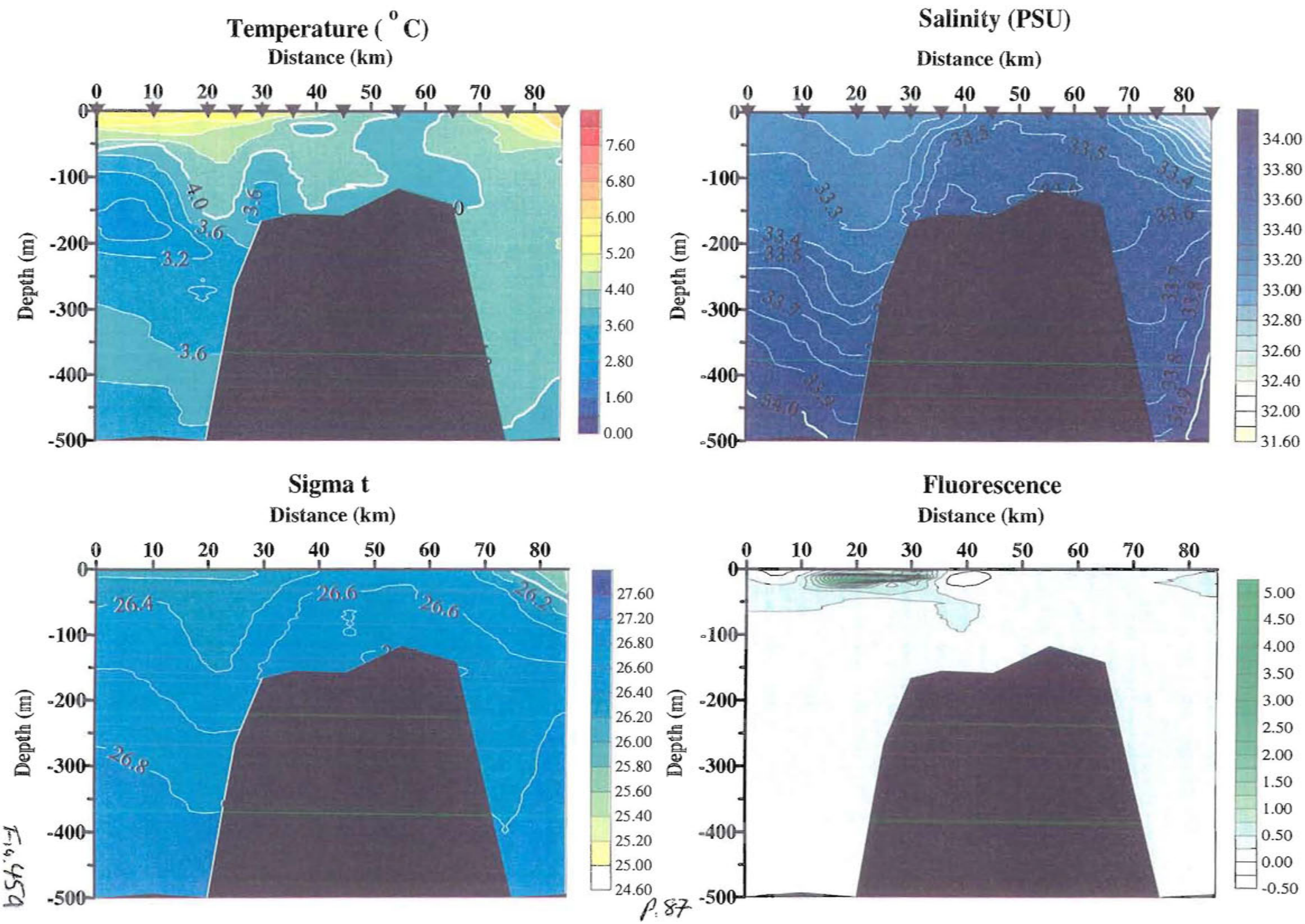
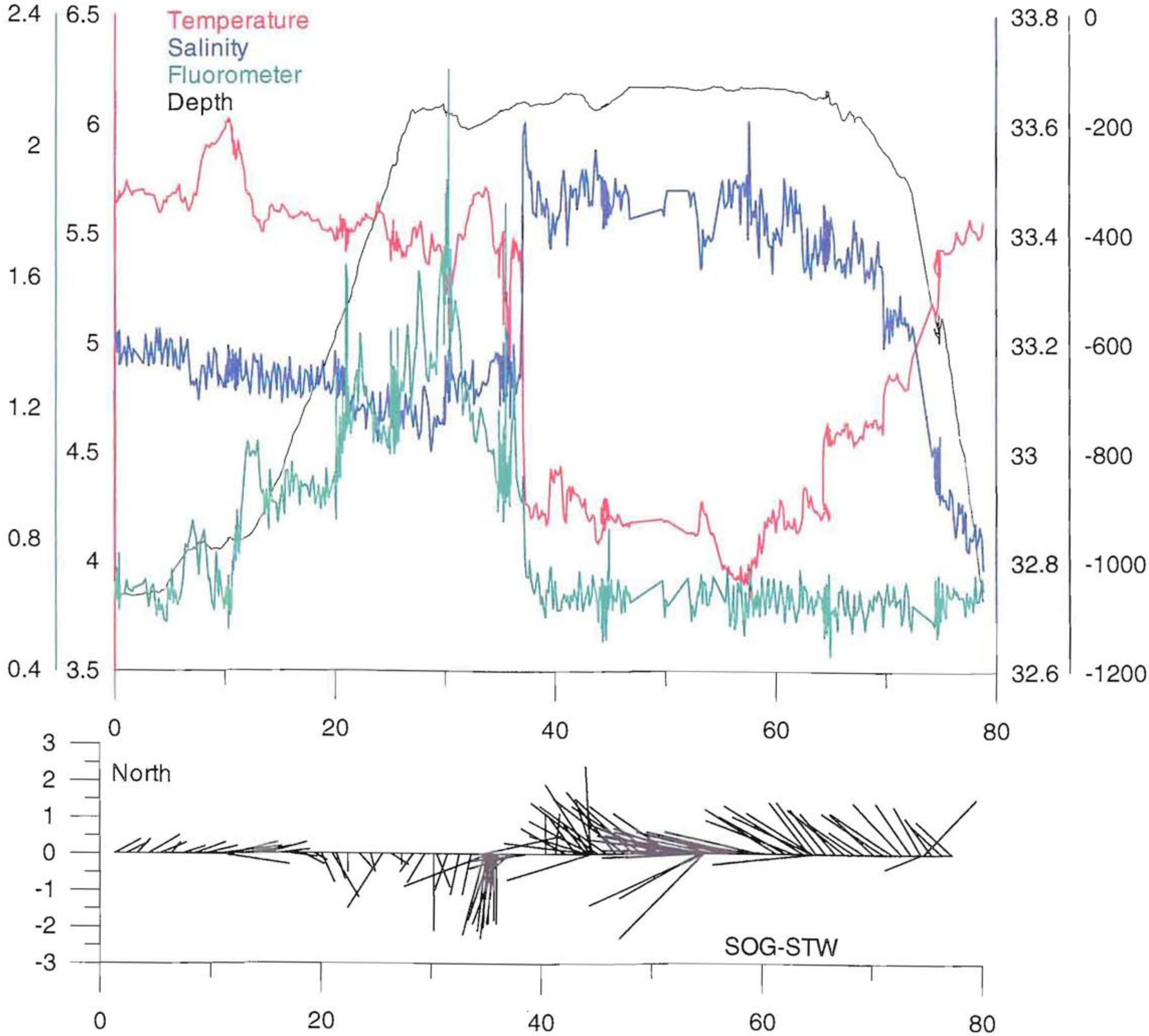


Fig. 459

p. 87

Fig 45b

Seguam Pass, 3 June 2002



p. 88

hx259; West-East Seguam Pass, 5 June 2002

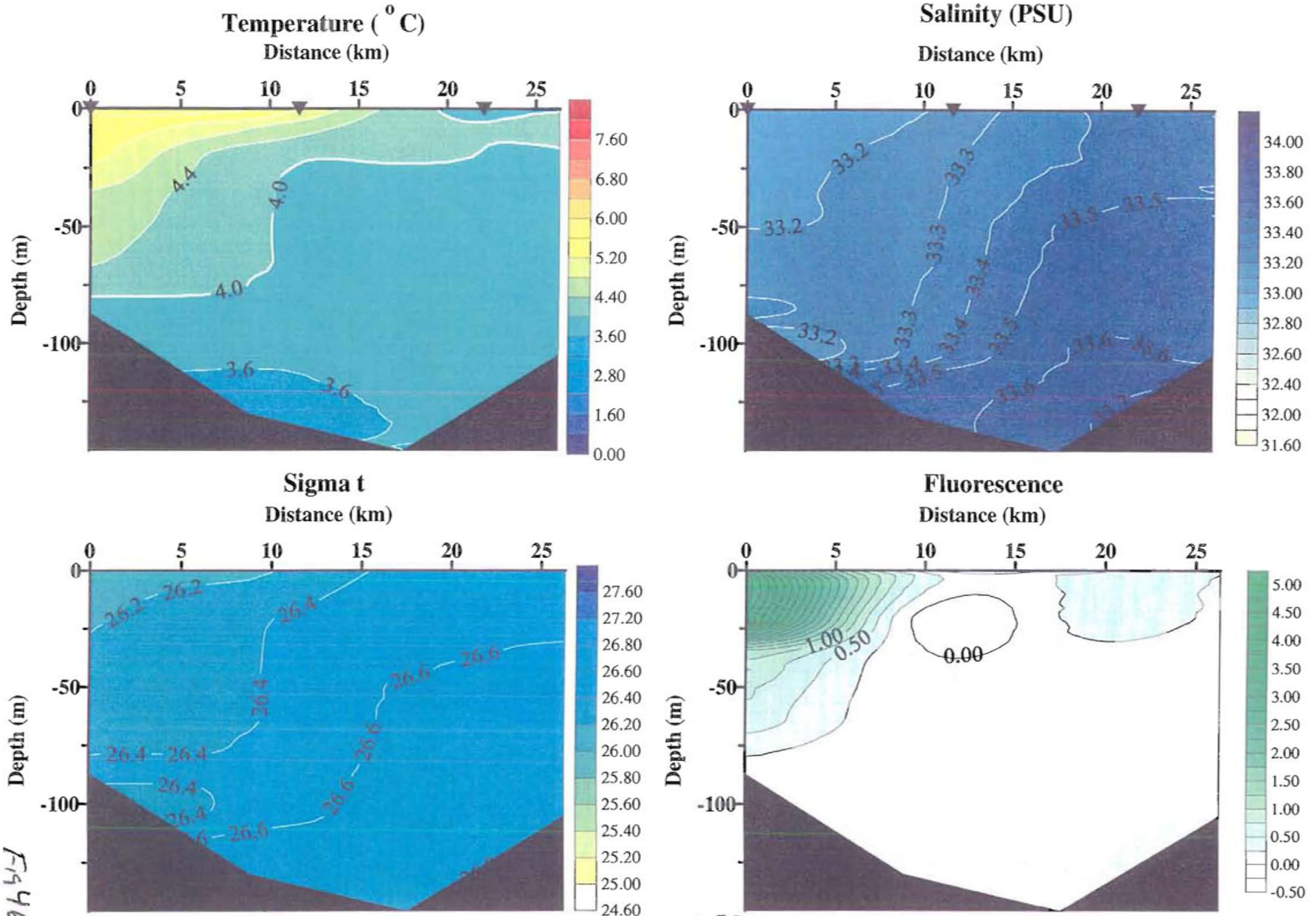
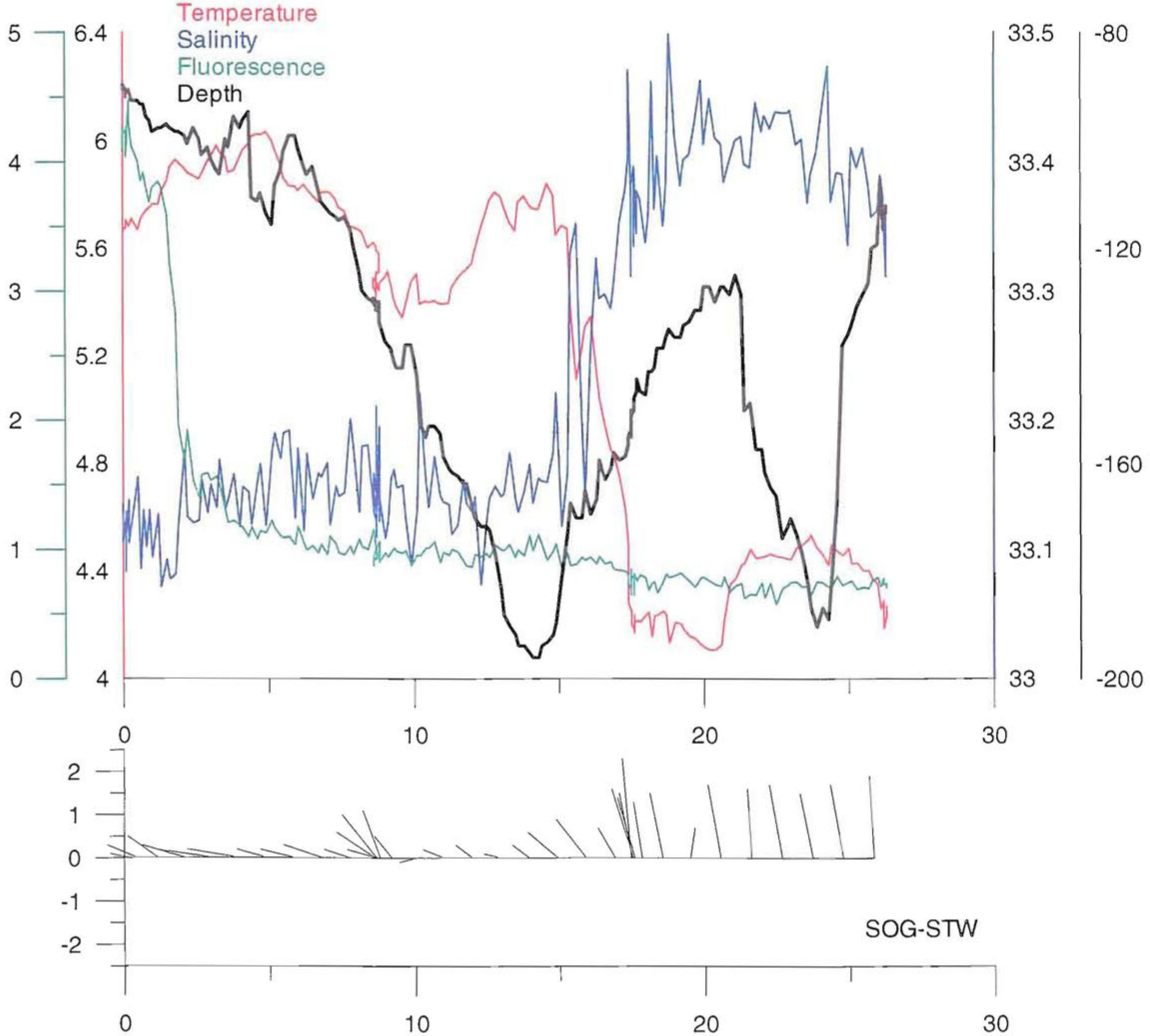


Fig 46a

p.89

Fig. 46b

Seguam Pass, West-East, 5 June 2002



Seguam

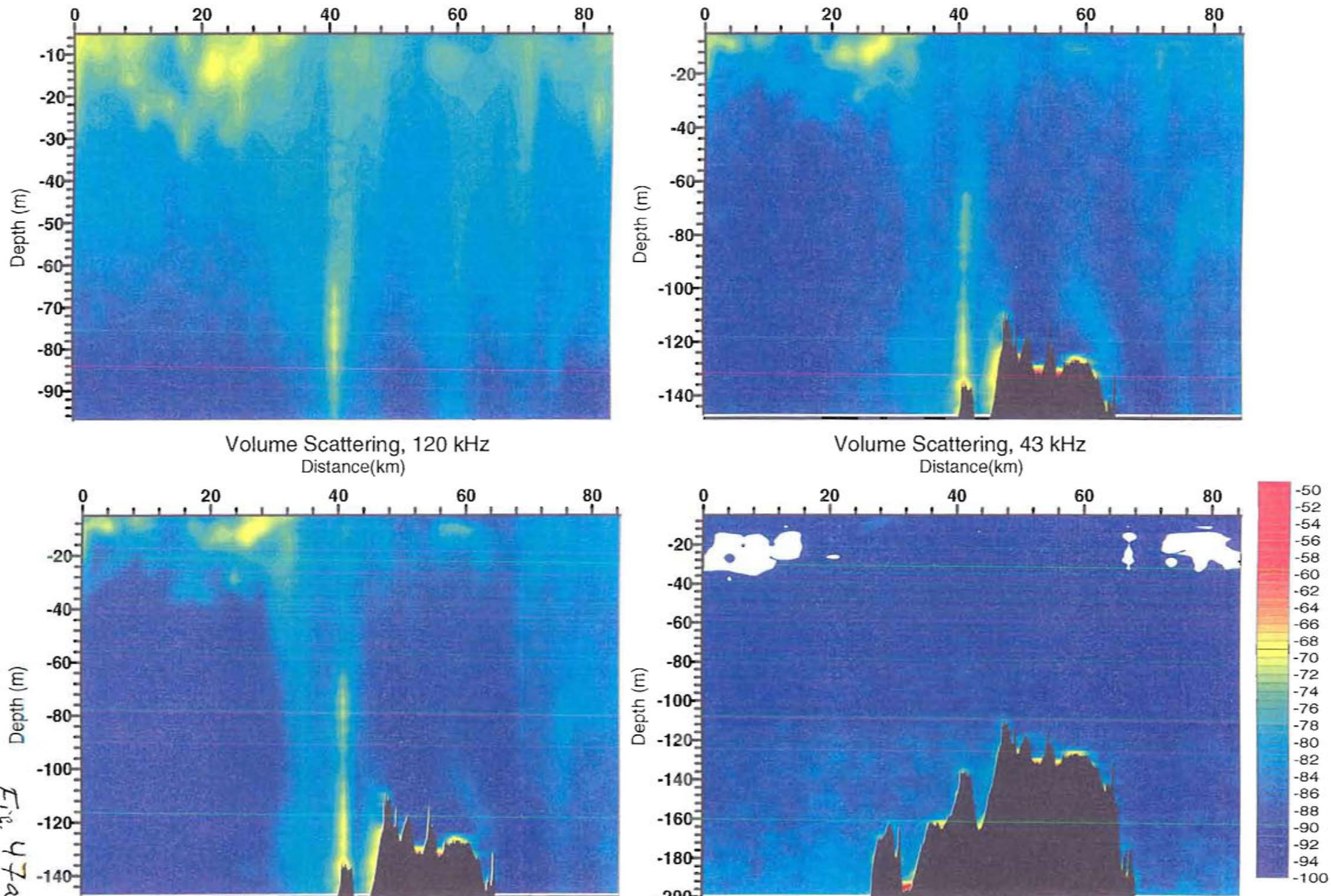


Fig. 47a

Fig. 47b

Seguam Pass, 3 June 2002

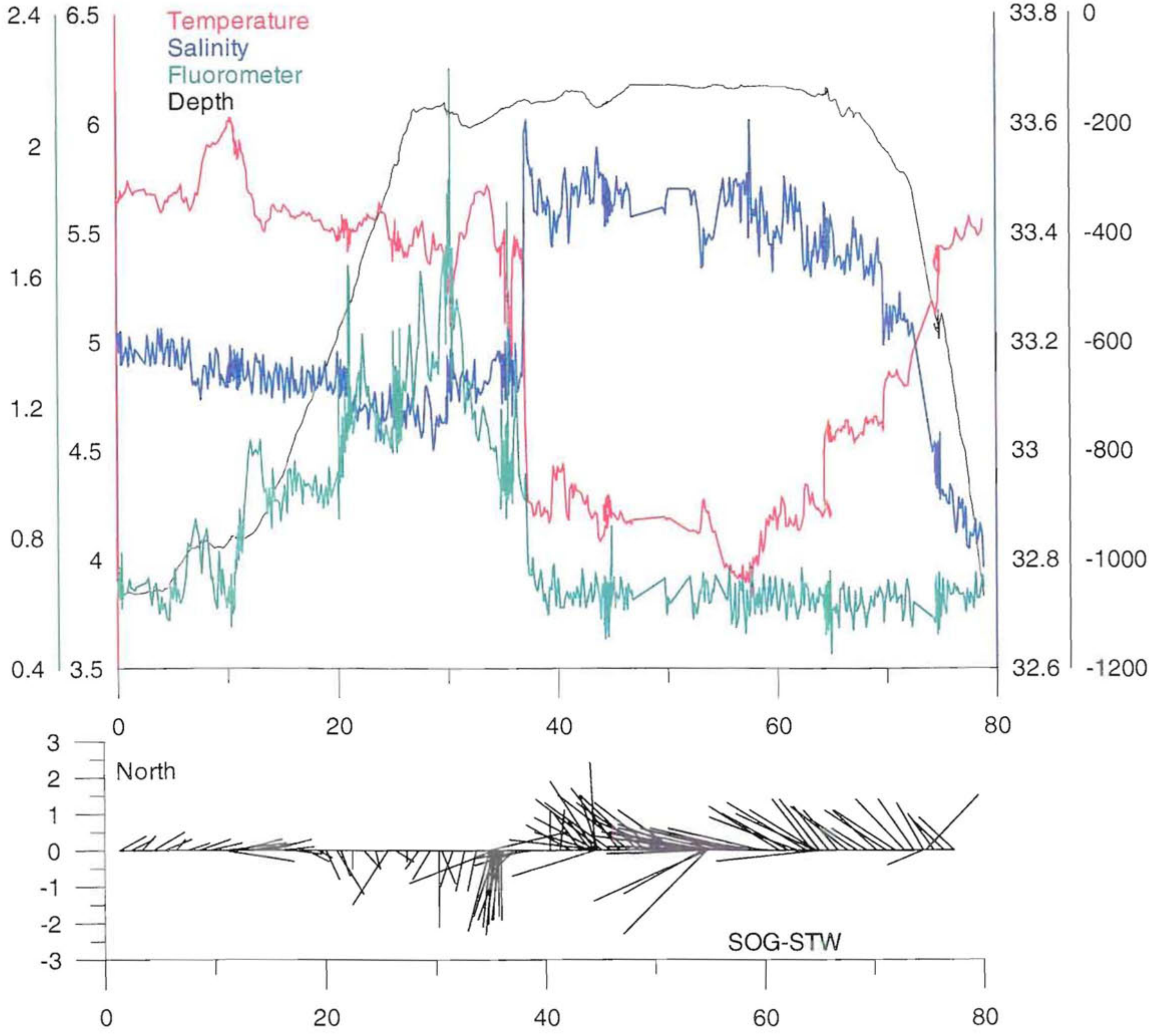
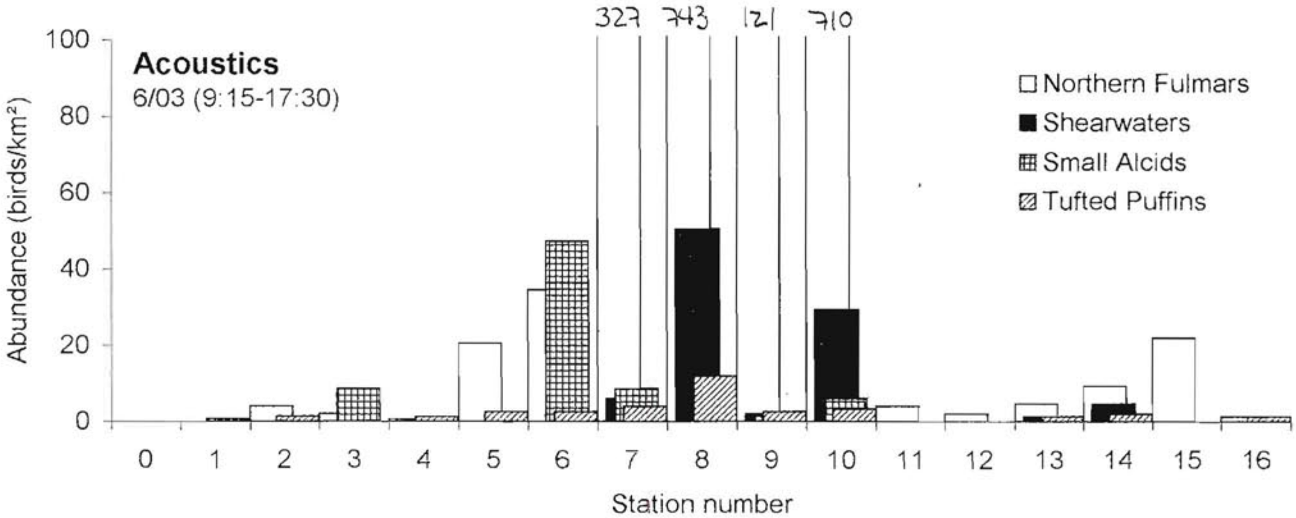
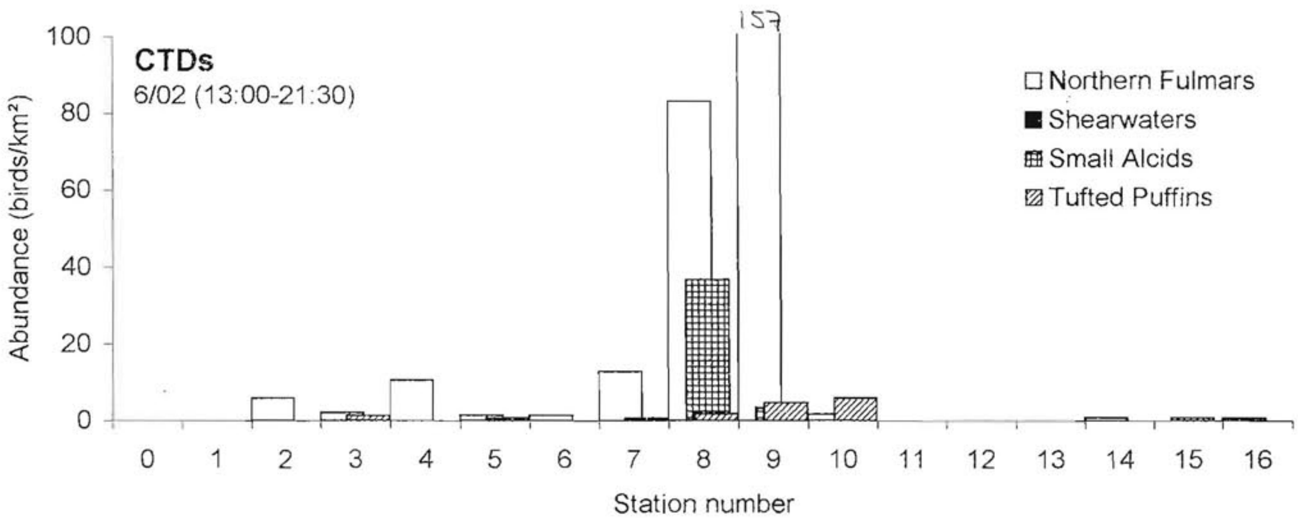


Fig. 48

Abundance of birds along the Seguam Pass Y-line transect (June 2-3, 2002)

(only birds feeding and sitting on the water)





Sequam/Amukta
05/27/02, and 06/03/02 through 06/05/02

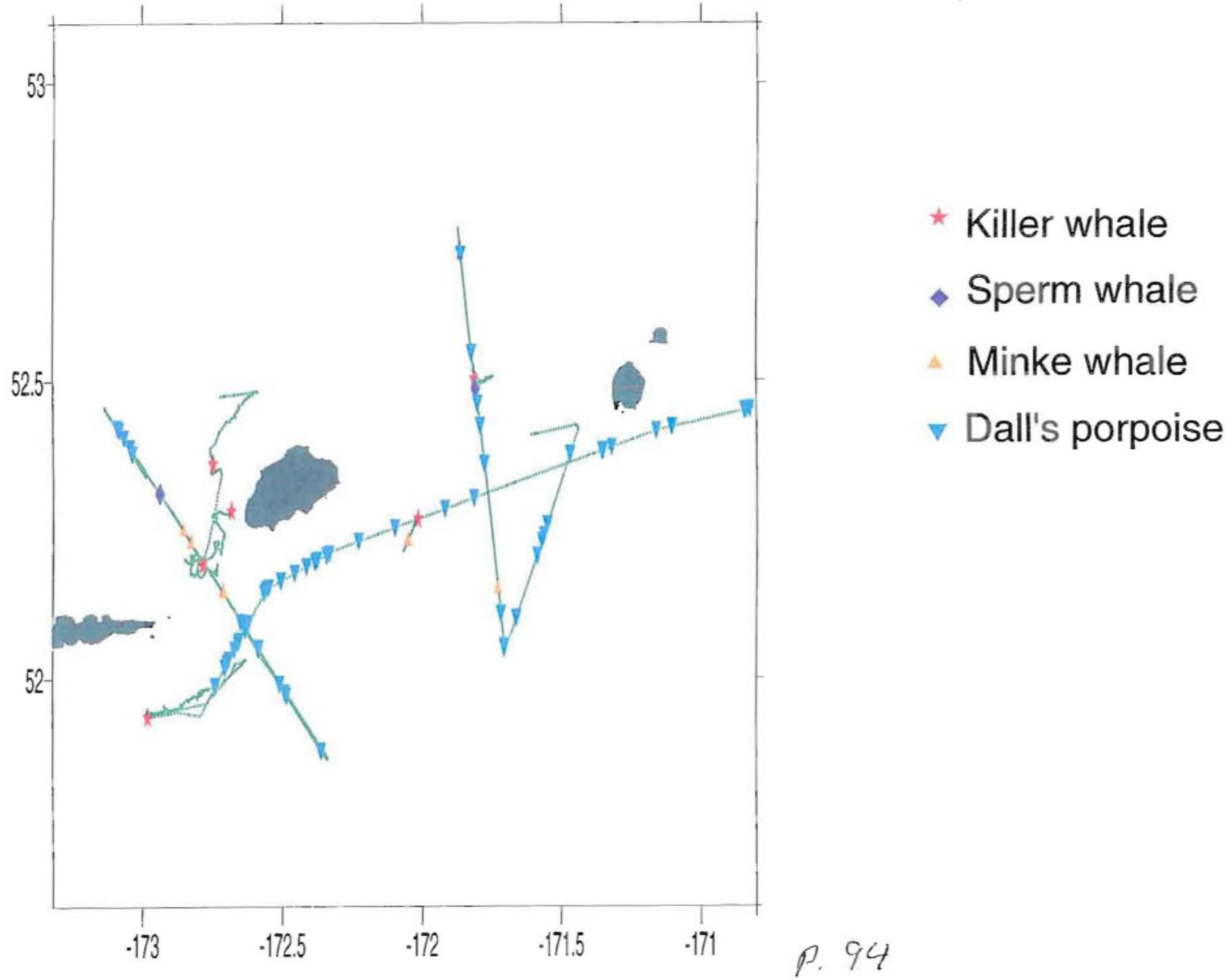


Fig. 49

Tanaga Pass

We visited Tanaga Pass from 29 to 31 May (Fig. 50). A CTD transect along the length of the pass provided evidence of salty water being pushed into the pass at depth from the north, and of a strong convergence over the center of the pass (Fig. 51a). Tidal flow at the time of the start of the transect was weak (Fig. 51b), and thus we may not have captured the full effect of advection of salty water from the north. Chlorophyll concentrations were generally very low, with an almost complete absence of detectable chlorophyll over the center of the pass. A cross-pass CTD transect showed little evidence of transport through the pass. (Fig. 52a, b). Acoustic surveys for zooplankton showed near-surface patches of small targets to the north of the pass, which were likely advected into the pass by the ebbing tide (Fig. 53a, b). In the vicinity of the convergence zones in the pass, high densities of least auklets and other small alcids were encountered foraging (Fig. 54). A small sample of least auklet stomachs showed them to be eating copepods and, in one case, amphipods. These observations of auklet feeding ecology are similar to those obtained in the nearby Delarof Islands (Hunt et al., 1996). Dall's porpoises were abundant throughout the Tanaga Pass region (Fig. 55). Sperm whales (*Physeter macrocephalus*) were also abundant, but primarily in the canyons and along the escarpment to the north of the pass and the Delarof Islands. Killer whales were also present on the north side of Tanaga Pass and north of the Delarofs (Fig. 55).

05/30/02 INStar - 19:44:37

Scale: 42.7NM 1:368000 Chart: Coastal UNDER

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

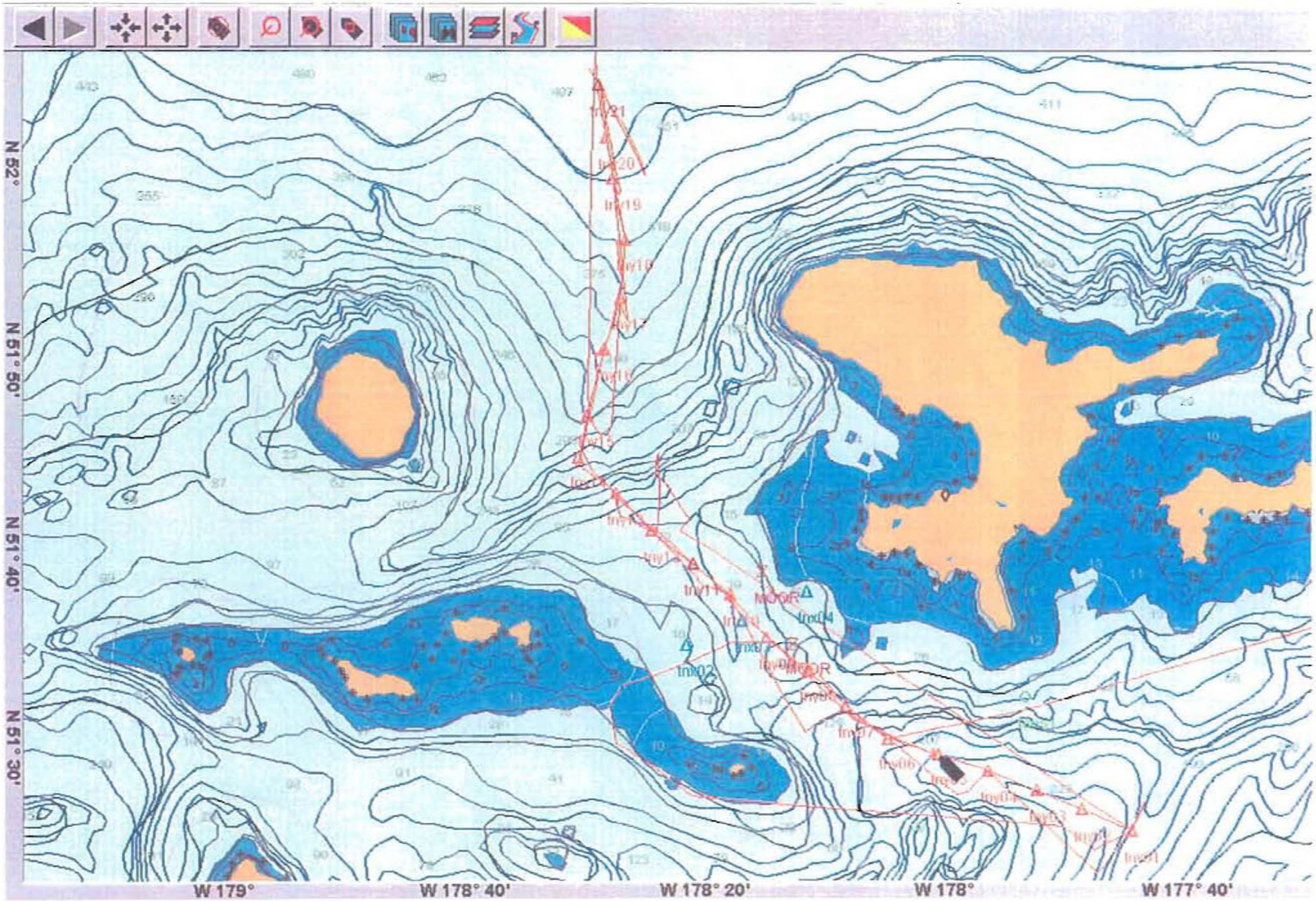


Fig. 50

p. 96

hx259; Tanaga Pass 30-31 May 2002

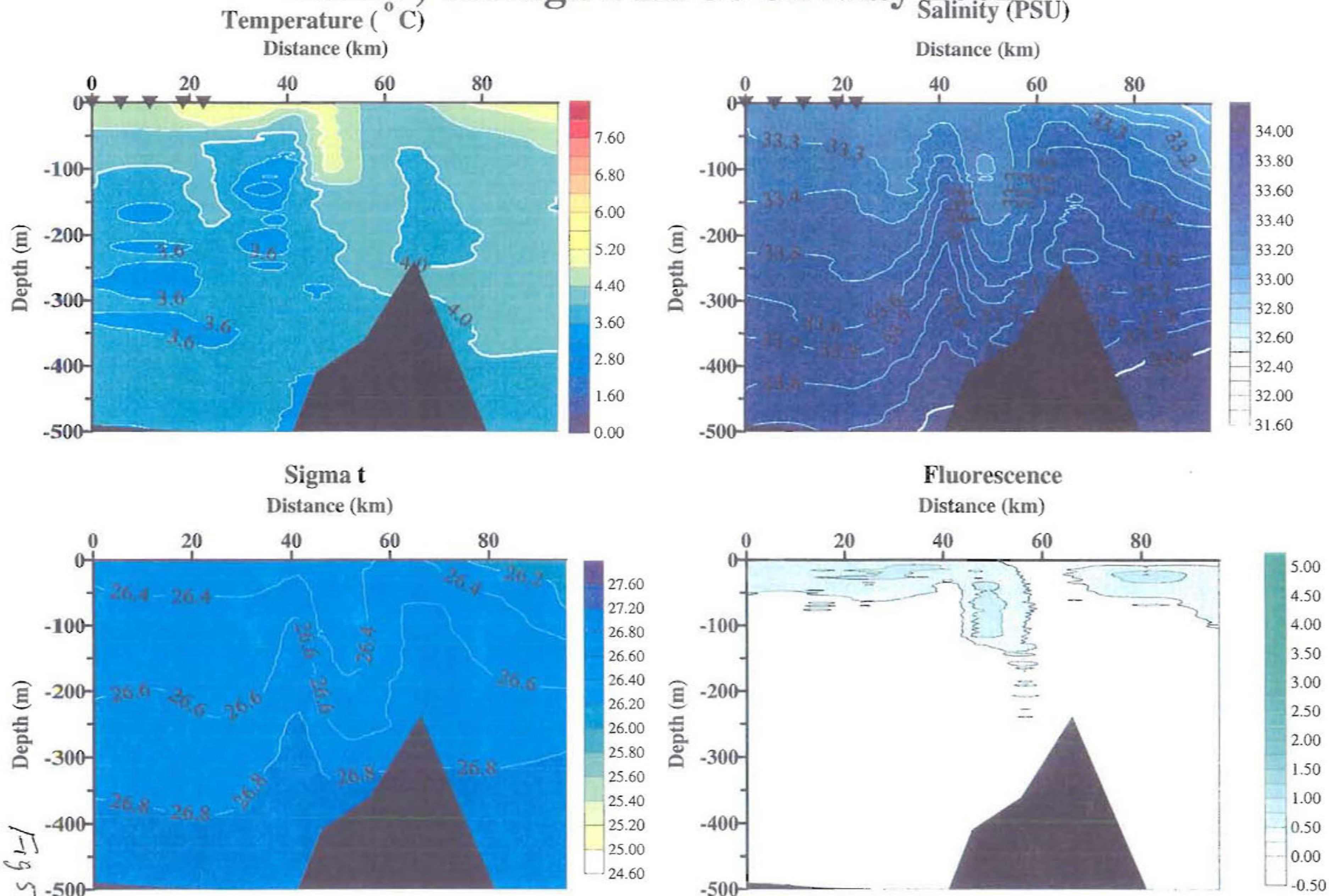
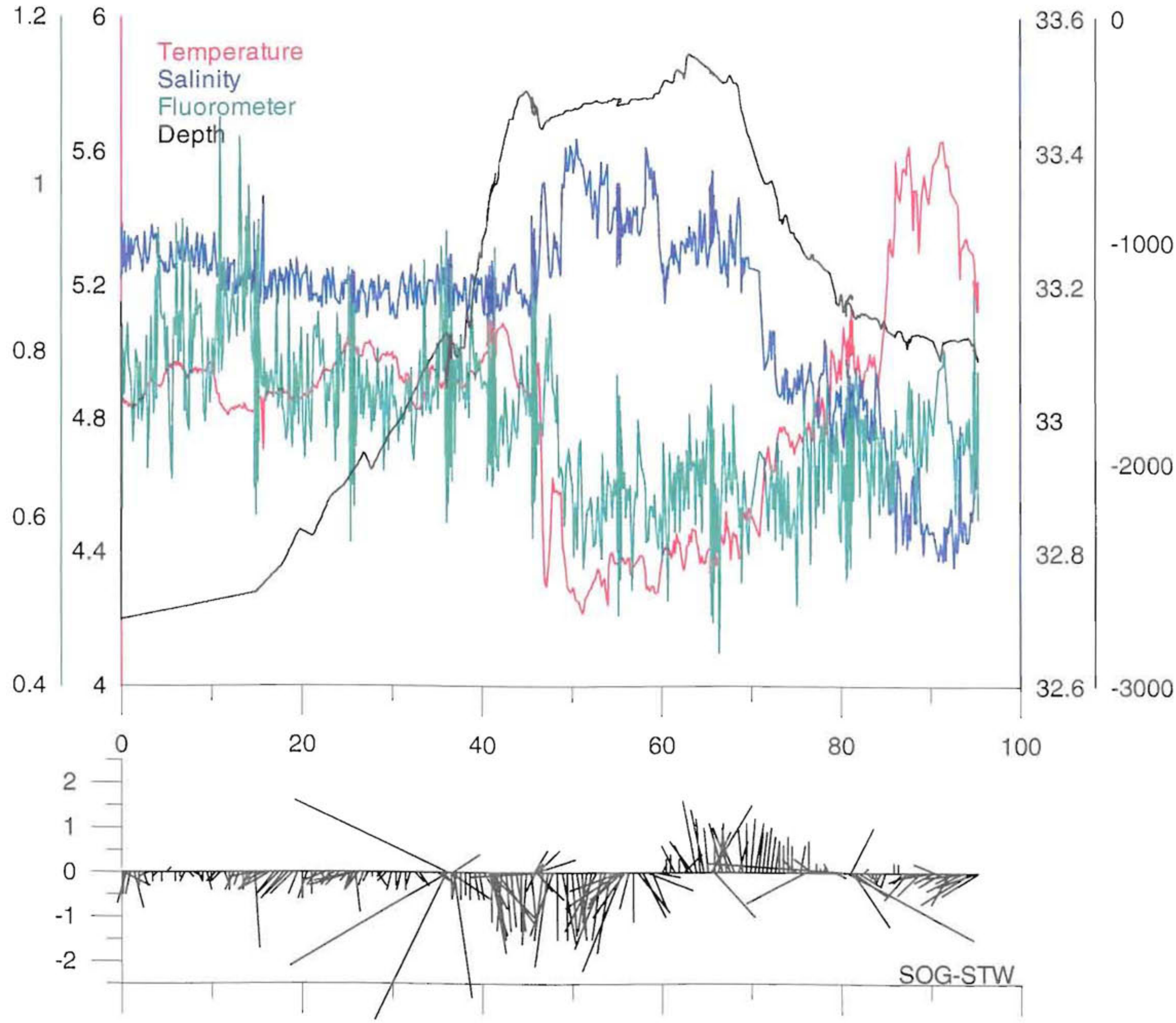


Fig 5/a

p. 97

Fig. 51b

Tanaga Pass, 30 May 2002



hx259; Across Tanaga Pass, 31 May 2002

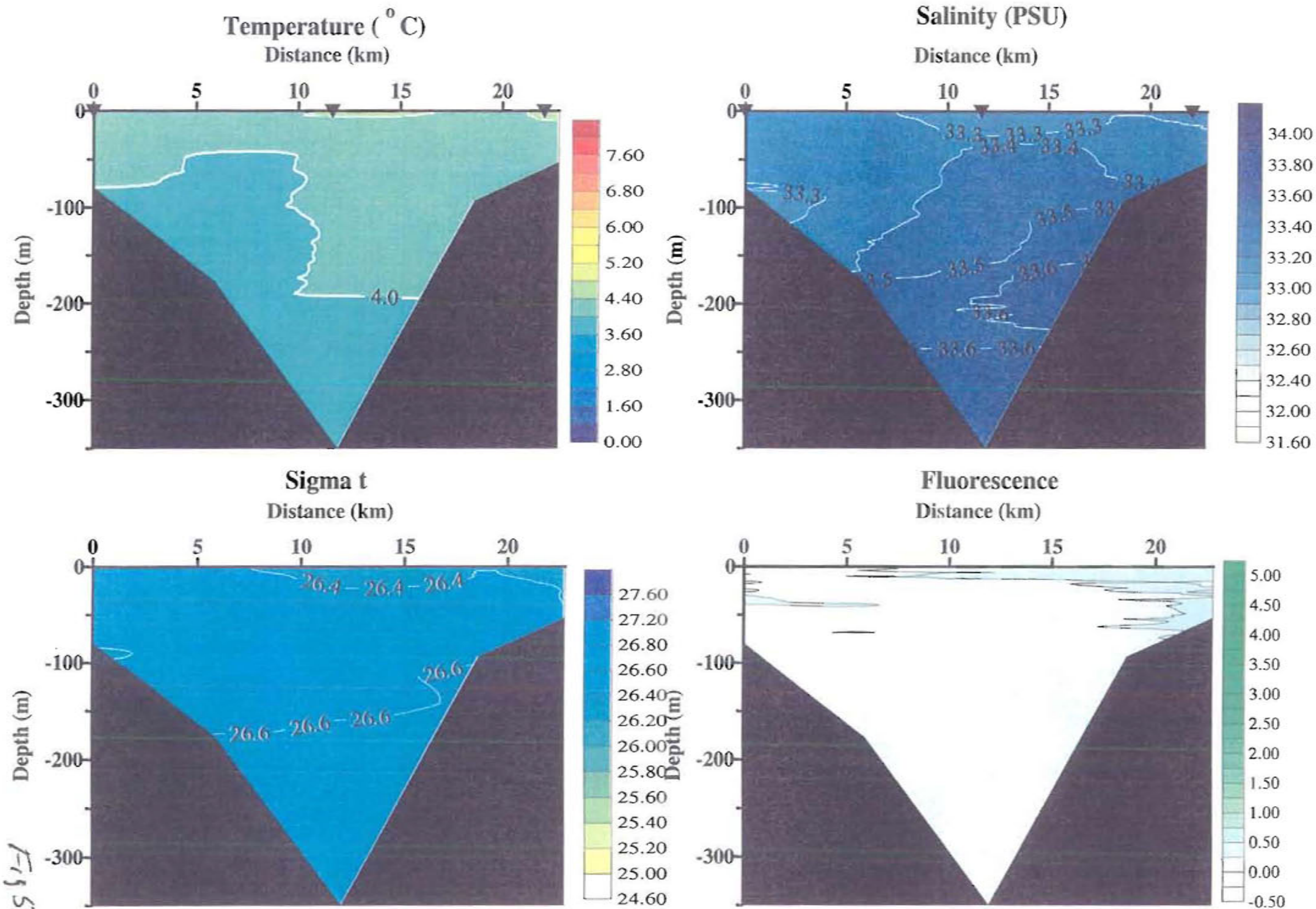
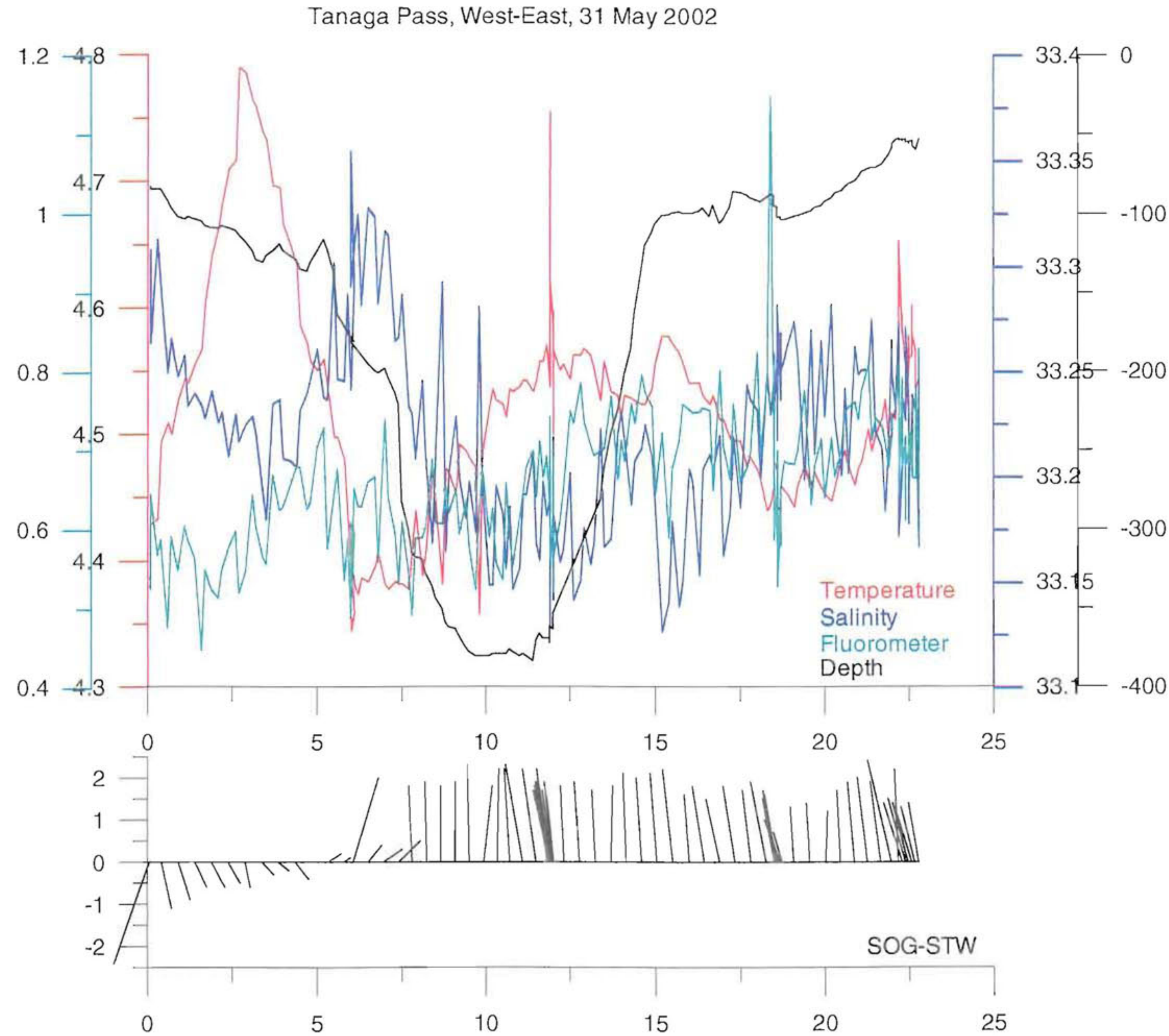


Fig 52a

p. 99

Fig. 52b


Tanaga Pass, West-East, 31 May 2002
Temperature
Salinity
Fluorometer
Depth
SOG-STW

Tananga

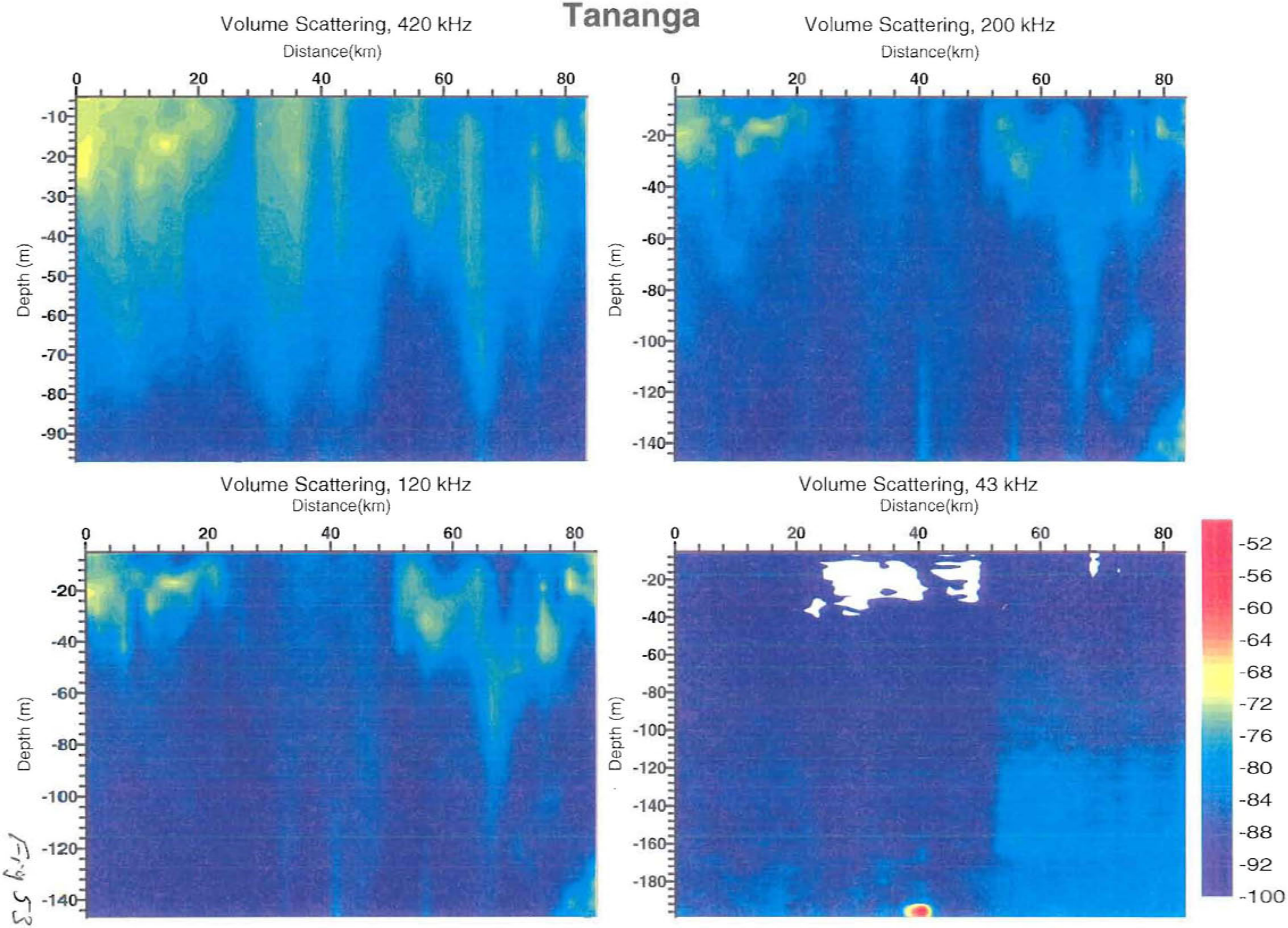


Fig 53a

p.101

Fig. 5-36

Tanaga Pass HTI Run, 29 May 2002

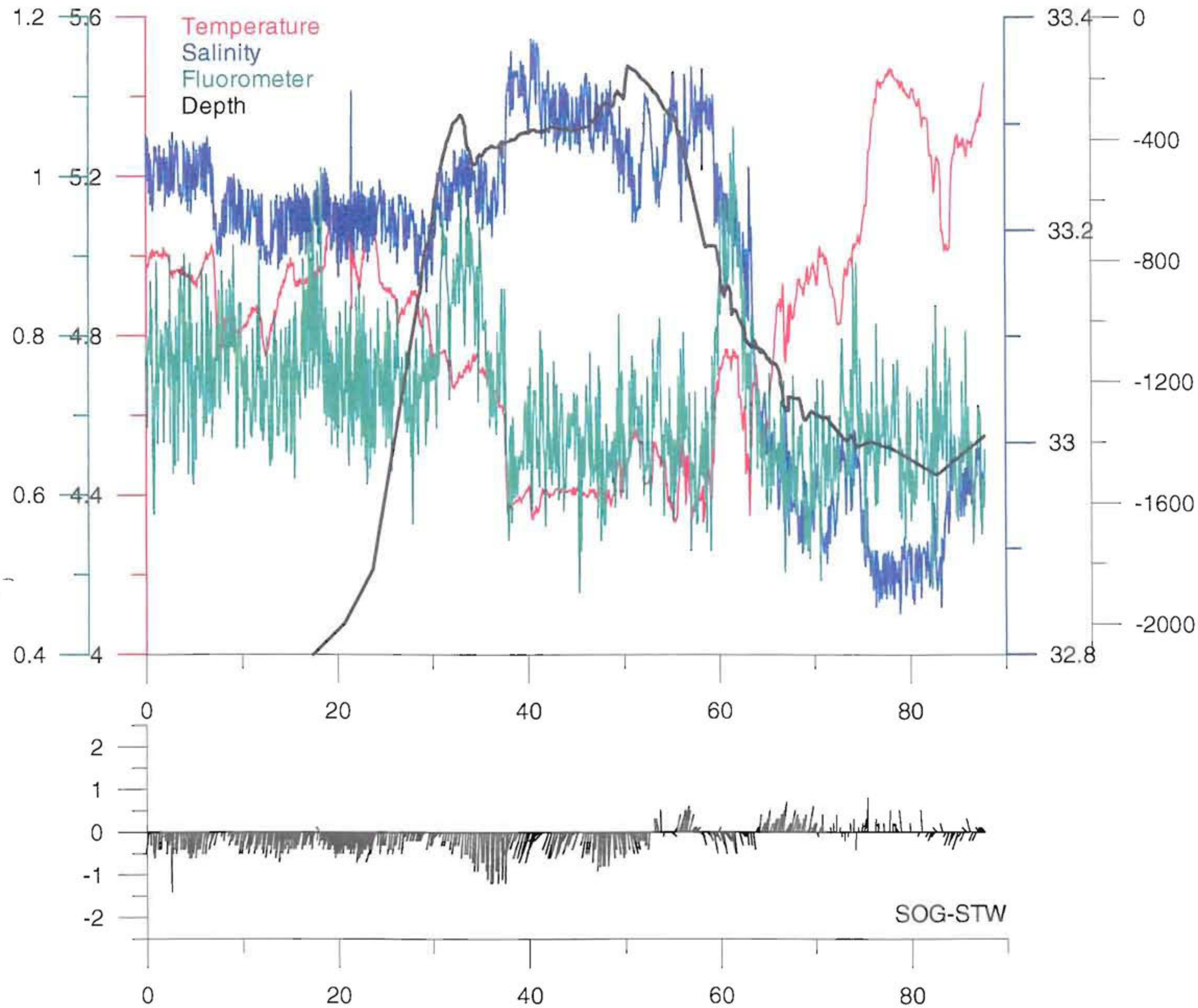
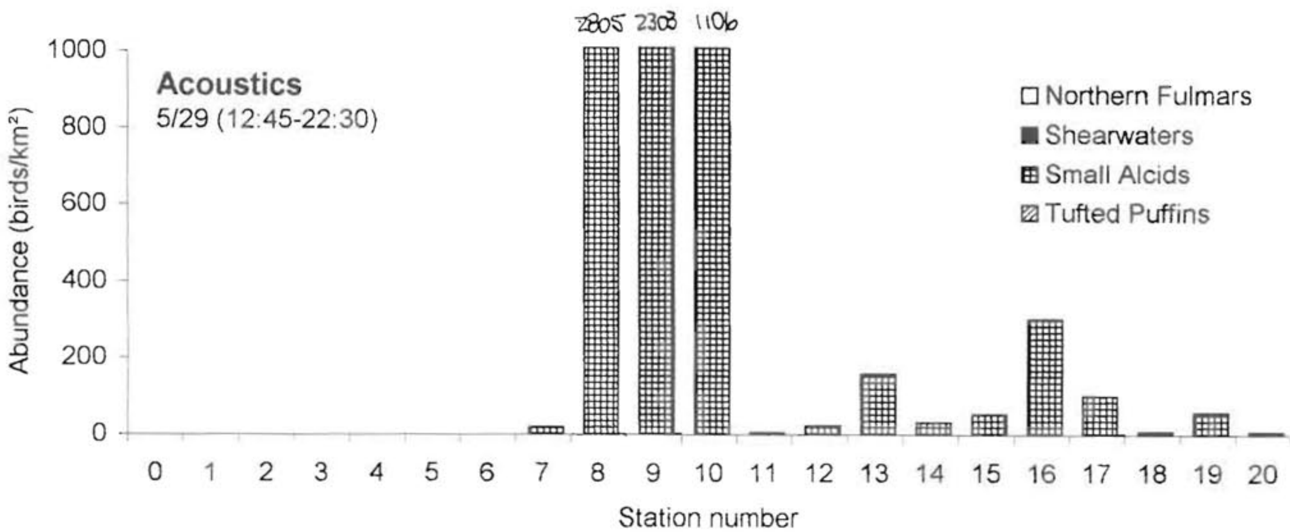


Fig. 54

Abundance of birds along the Tenaga Pass Y-line transect (May 29-30, 2002)

(only birds feeding and sitting on the water)



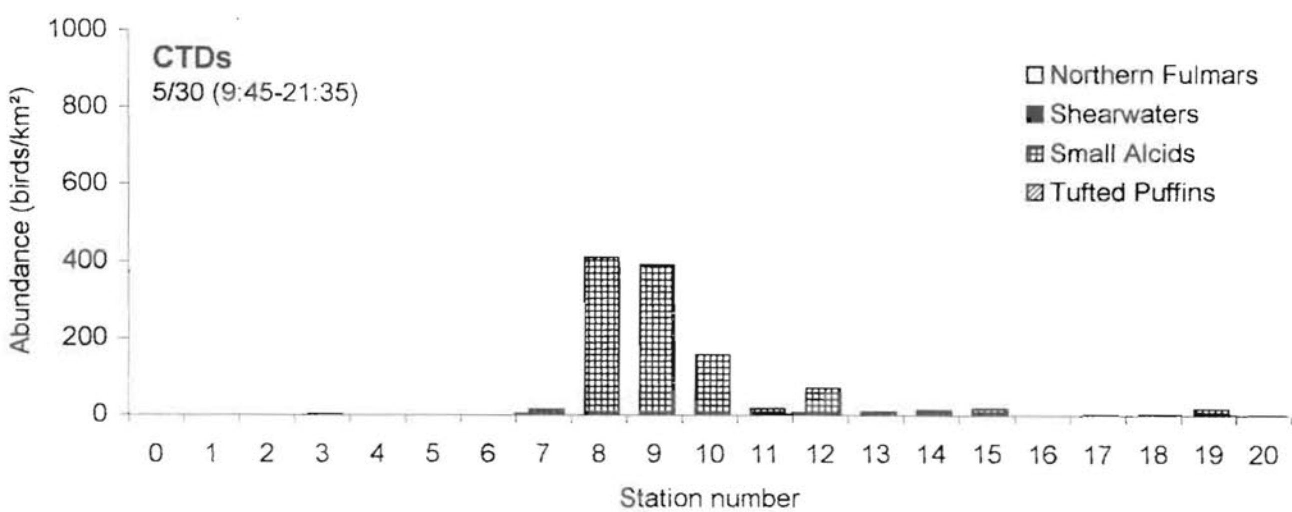
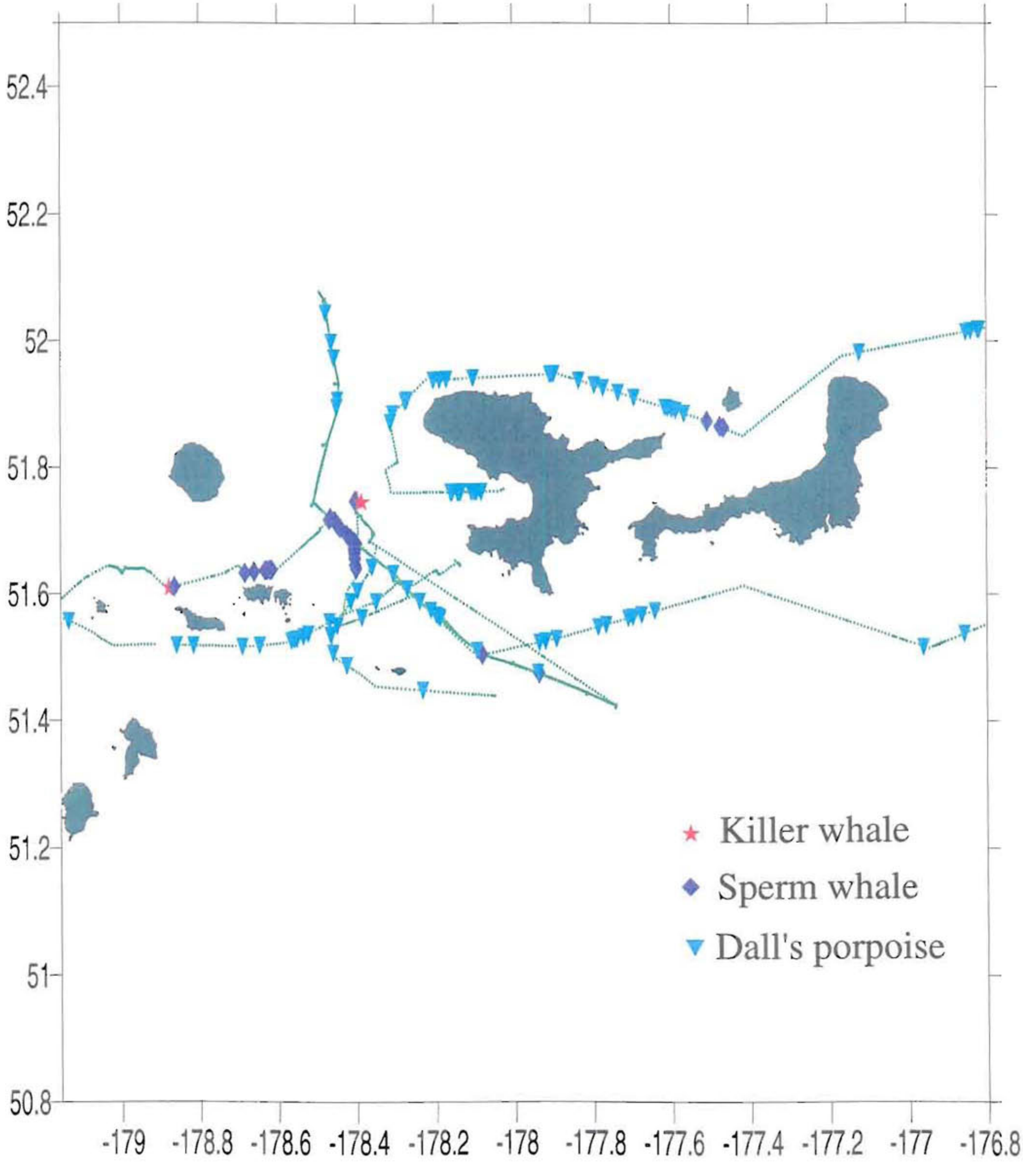


Fig. 55

Tananga: 05/28/02 through 06/01/02



Physical Oceanography

To quantify the differences in the physical habitats of Steller sea lions in the eastern and central Aleutian Islands, we conducted conductivity, temperature, depth (CTD) casts through seven passes (Fig. 1, p. 19) (Unimak [Fig. 2, p. 23; Fig. 4a, p. 25; Fig. 5a, p.27], Akutan [Fig. 3, p. 24; Fig. 6a, p. 29; Fig.7a, p. 31], Umnak [Fig. 28. p. 59; Fig. 29a, p. 60], Samalga [Fig. 32, p. 66; Fig. 33a, p. 67; Fig. 34a, p.69], Amukta [Fig. 38, p. 76; Fig 39a, p. 77], Seguam [Fig. 44, p. 86; Fig. 45a, p. 87], and Tanaga [Fig. 50, p. 96; Fig. 51a, p. 97]. To measure flow through the passes, we conducted CTD casts across four passes (Samalga [Fig. 35a, p. 71], Amukta [Fig. 39a, p. 77], Seguam [Fig. 46a, p. 89], and Tanaga [Fig. 52a, p. 99]). When possible, local tidal currents were taken into consideration in timing surveys through the passes (Fig. 4b, 5b, 6b, 7b, 9b, 10b, 10c, 12b, 29b, 40b, 46b, 51b, 41b, 45b,51b, 52b). In addition, we made a CTD cast every hour for a full ebb and flood tidal cycle at a site in northern Akutan Pass (Fig.8, p. 33).

The cross-pass density differences necessary to create geostrophic currents were greatest at Samalga Pass and Seguam Pass. In Amukta Pass, the transect appeared to contain two eddies affecting the upper 100m (Fig. 39a, p.77), and the reversal of flow associated with the eddies is apparent in the flow at the surface (Fig. 39b, p. 78).

The eastern passes (Unimak, Akutan, and Umnak Pass) are shallower and generally narrower than the western passes (Samalga, Amukta, Seguam, and Tanaga Pass). The shelf south of the eastern passes is broader than it is farther west. This isolates the eastern passes somewhat from "true" Pacific water, but exposes them to Alaska Coastal water flowing westward near the shore. We saw the low-salinity signature of Alaska Coastal water as far west as Samalga Pass, where it was diverted to flow northward through the eastern half of the pass (Fig. 35a, p. 71). Therefore, the minimum salinity at Unimak Pass was near 32 PSU, but west of Samalga Pass, it was near 33 PSU. The shelf to the north of all the passes is narrow and Bering Sea water is pulled up into all the passes during strong southward tides; this is especially visible at the Unimak Pass transect on 25 May (Fig. 4a, p.25). Many of the passes, like Unimak Pass and Amukta Pass, have a deeper "valley" in the northern part of the pass (Fig. 4a,b, p. 25, 26; Fig.41b, p. 82). It might be interesting to see if these valleys can store Bering Sea water deposited there during a strong tidal cycle, and if that storage would be of any importance to local conditions.

Temperature is affected by local heating or cooling, advection of colder or warmer water from elsewhere, upwelling of colder water from deeper in the ocean, mixing by wind, and mixing by tides in the passes. Temperature was cooler this year than last year. For example, the maximum temperature in Unimak Pass was greater than 7° C last year, and near 6° C in June of this year. The pass warmed by about a degree during the three weeks between late May and mid-June of this year. Temperature was warmer in the eastern passes than the western passes, probably because of the larger reservoir of cold subsurface water available to be mixed up to near the surface in the west. Surface temperatures were warmest south of the passes, decreased in the passes because of mixing there, and increased to intermediate values north of the passes.

The station that we occupied in Akutan Pass to monitor tidal conditions (Fig. 8, p. 33) was in roughly 90m of water, about 10 km south of the shelf break. Tides were ebbing during the first half of the period. The maximum ebb current, at about 5 hours, was predicted to be greater than 8 knots in the pass itself as was the maximum flood 6 hours later. During the ebb, colder more saline water was pulled in from farther north to occupy the lower 40 m of the water column (Fig. 8, p. 33). Since tidal currents out of the immediate pass are unlikely to be rectilinear, we need to examine the tidal patterns in northern Akutan Pass to determine how far the upwelled water may have progressed.

Productivity and Nutrient Studies

During the cruise, we determined primary production in the on-deck incubators at 32 stations through June 14. Some stations were visited twice to assess variability. Chlorophyll concentrations were determined at 137 stations, usually at standard depths of 0,10,20,30, and 50 meters, as well as at several at deeper depths. These samples were for calibrating the *in situ* fluorometer, although they will also be used in the production calculations. Samples for phytoplankton cell counts were taken at same stations and depths as the chlorophyll samples. In addition to the transect stations, we also sampled at the surface and bottom for chlorophyll and cell counts at the 16-hour station in Akutan pass. During the cruise, we employed a Pulse Amplitude Modulated (PAM) Fluorometer (Water-PAM, Heinz Walz GmbH) to investigate the physiological efficiency of the photosynthetic mechanism. We measured the maximal photochemical yield (Fv/Fm) and the apparent Electron Transport Rate (ETR) at 8 light intensities to generate a light curve, similar to the ^{14}C incubation experiments.

While primary production for the water column could not be calculated while on board, we were able to calculate P-I curves and the parameters of the equation. Using SYSTAT, we calculated P_{max}, alpha (Fig. 56), and the intercept for the Jasby and Platt hyperbolic tangent function. When applied to non-standardized uptake rates, P_{max} gives the potential maximal rate of photosynthesis (mg C m^{-3} hr^{-1}) in the water. If the uptake rates are standardized to chlorophyll concentration, they give the maximal photosynthetic uptake rate per unit chlorophyll (P^{b}_{max}), a measure of efficiency.

Results show that Akutan and Unimak as a whole had the highest rates of production, as well as chlorophyll concentrations (Fig. 57, 58). At the western passes, production and chlorophyll were much lower. The exception was Seguam Pass, where the potential for high production rates was found in the patch of high chlorophyll concentration at the start of the east-west transect (Fig. 59). Unlike last year, there was no distinct trend for higher production on the north or south side of the passes (Fig. 57, 59). The trends in P_{max} in both Unimak and Akutan were almost identical to the trends of Fv/Fm determined by PAM fluorometry (Fig. 60). Tanaga Pass was also very similar in both measures. Unimak, Seguam, and Amukta passes show differing trends in P_{max} and Fv/Fm. At this point it is unclear why the differences exist. One possible explanation is that we noticed instabilties in signals from the PAM at several points, but not consistently. We diagnosed part of the problem as a loose EPROM chip. Reseating the chip solved most of the instability, after which the results were much more consistent.

During the 16-hour station in Akutan, we were able to collect Fv/Fm measurements for both surface and bottom samples (Fig. 61). These show that phytoplankton in the bottom layer were not very efficient photosynthesizers. The Fv/Fm values ranged, on average, between 0.2 and 0.4. It is generally accepted that a maximum value for Fv/Fm is 0.8 - 0.835 in higher plants, and in phytoplankton it is probably close to 0.7. The surface values showed a changing trend during the 16 hours, which reflected the tidal change in the pass. The high values of Fv/Fm in the surface marked times when chlorophyll was also more abundant. At the surface these values ranged to 0.6 and higher, indicating that phytoplankton from surface waters were healthier than those in the bottom waters.

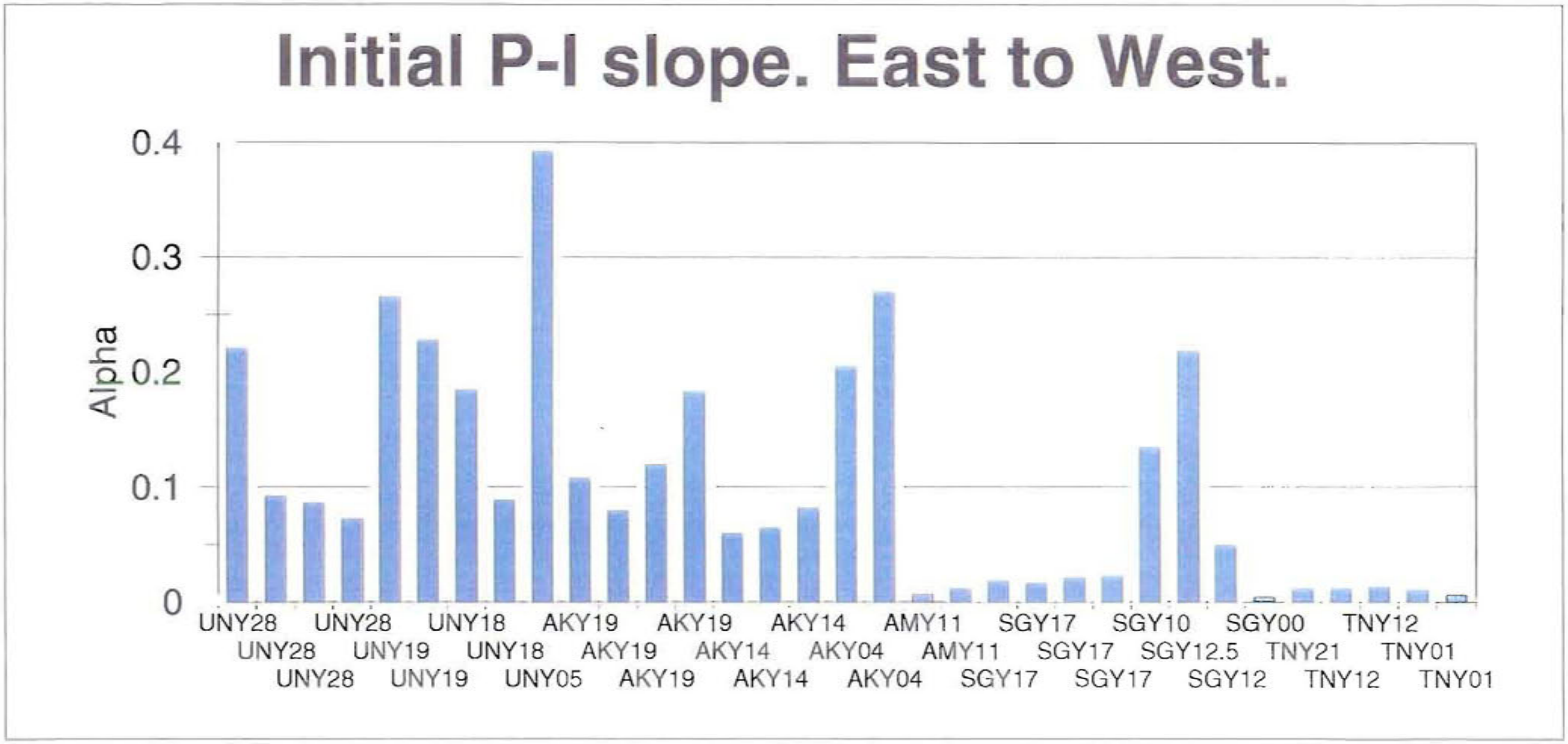
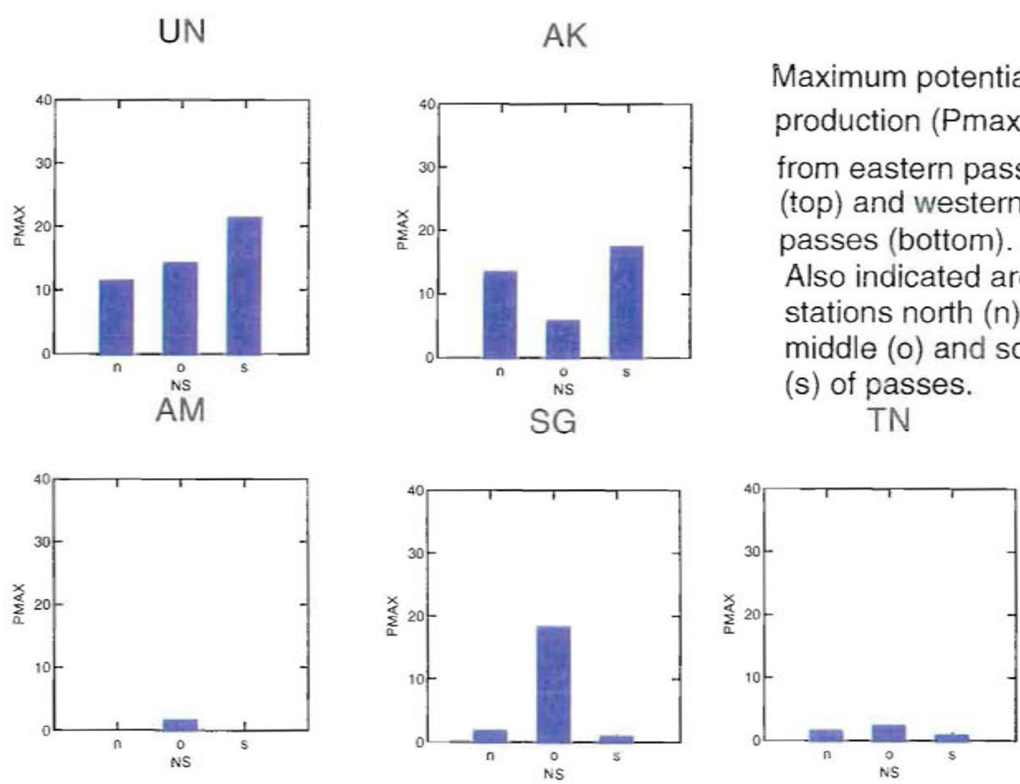

Initial P-I slope. East to West.
Alpha
0.4
0.3
0.2
0.1
0
UNY28
UNY28
UNY28
UNY28
UNY19
UNY19
UNY18
UNY18
UNY05
AKY19
AKY19
AKY19
AKY19
AKY14
AKY14
AKY14
AKY04
AKY04
AMY11
AMY11
SGY17
SGY17
SGY17
SGY17
SGY10
SGY12.5
SGY12
SGY00
TNY21
TNY12
TNY12
TNY01
TNY01

Fig. 56



Maximum potential production (Pmax) from eastern passes (top) and western passes (bottom). Also indicated are stations north (n), middle (o) and south (s) of passes.

Fig 57

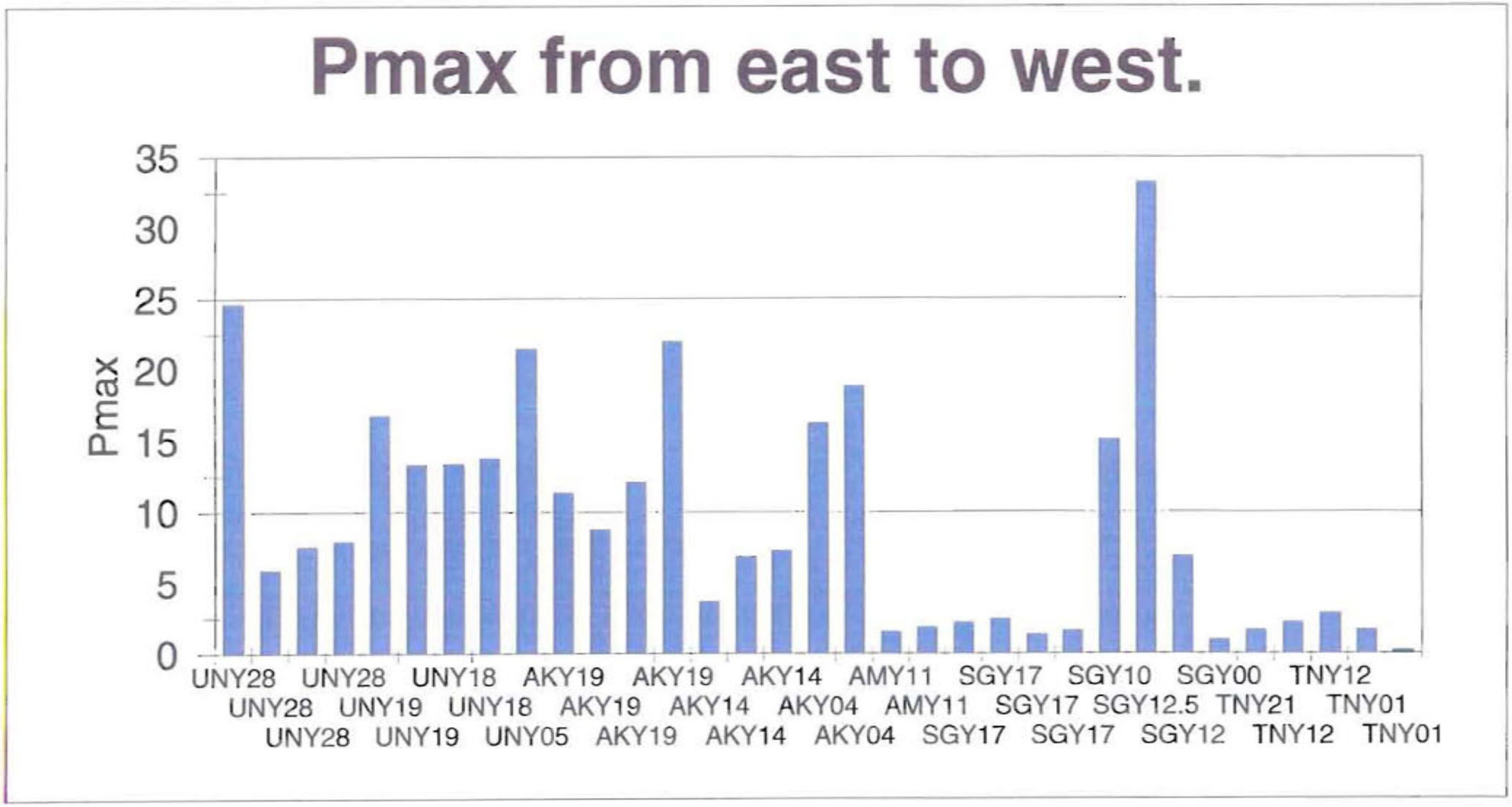
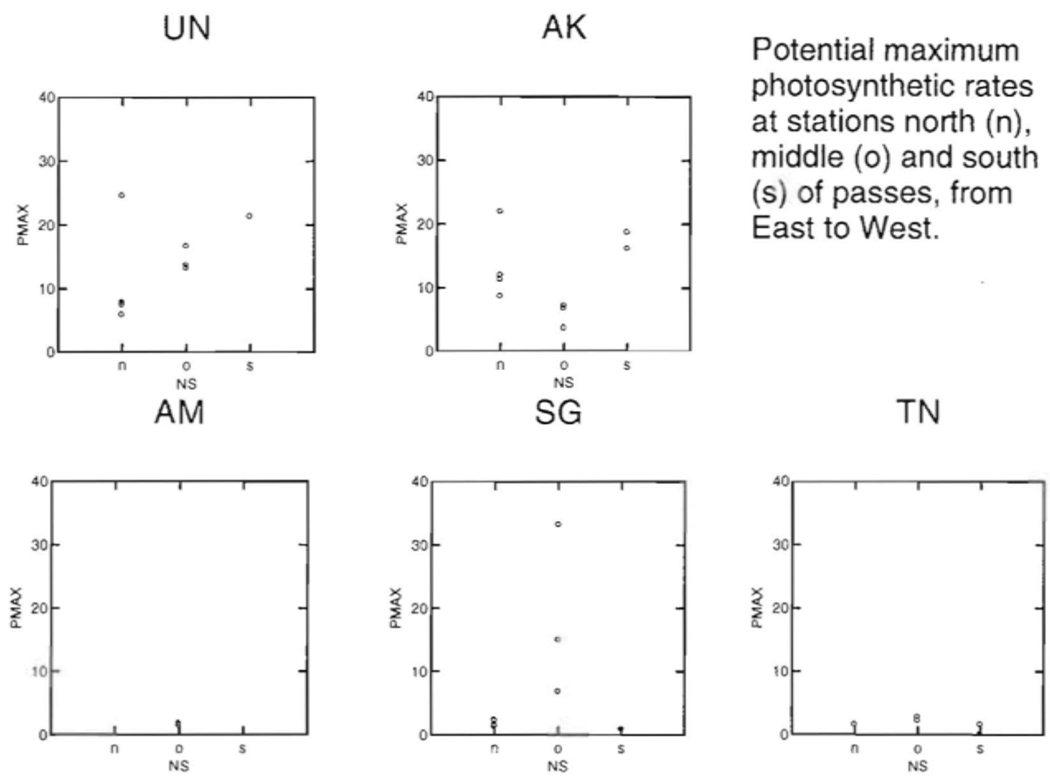
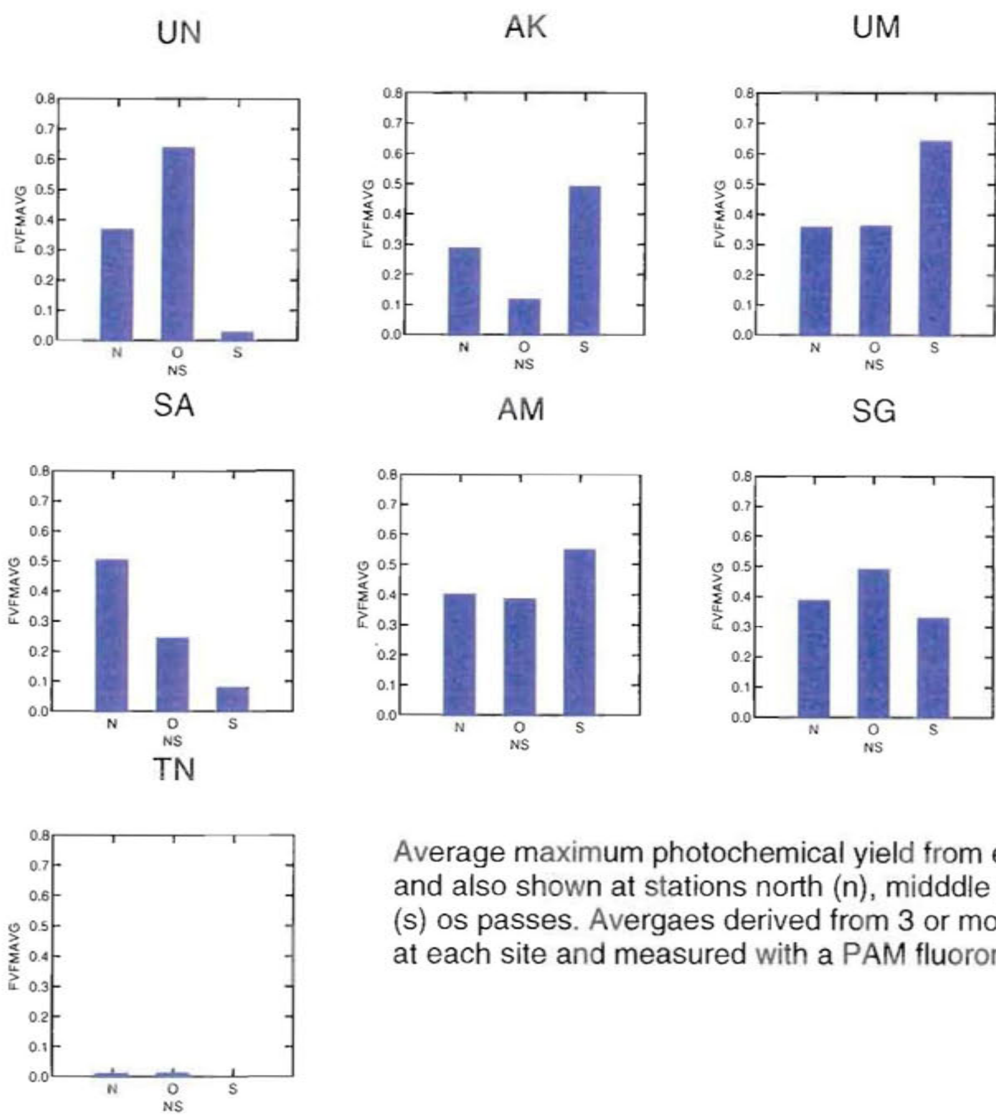

Pmax from east to west.
Pmax
35
30
25
20
15
10
5
0
UNY28 UNY28 UNY28 UNY28 UNY19 UNY19 UNY18 UNY18 UNY05 AKY19 AKY19 AKY19 AKY19 AKY14 AKY14 AKY14 AKY04 AKY04 AMY11 AMY11 SGY17 SGY17 SGY17 SGY17 SGY10 SGY12.5 SGY12 SGY00 TNY21 TNY12 TNY12 TNY01 TNY01

Fig. 58

Fig. 59



Potential maximum photosynthetic rates at stations north (n), middle (o) and south (s) of passes, from East to West.



Average maximum photochemical yield from east to west and also shown at stations north (n), midddle (o) and south (s) os passes. Avergaes derived from 3 or more samples at each site and measured with a PAM fluorometer.

Fig. 60

Least Squares Means

Maximum photochemical yield at 0 and 85 m in Akutan pass from 1000 hr to 2100 hr measured with PAM fluorometer.

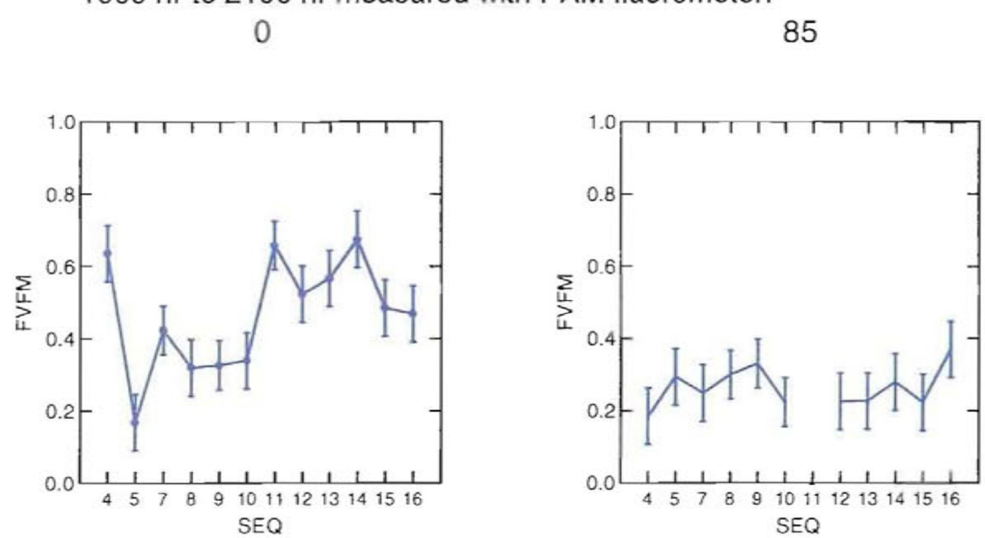


Fig. 61

Zooplankton

The goal of the zooplankton and acoustics component of the Aleutian Passes Project was to characterize the abundance, biomass, species composition and distribution of major zooplankton and micronekton taxa in the region around the Aleutian passes. Since zooplankton are the primary food of forage fishes, characterization of the zooplankton resources is central to understanding processes influencing the concentration, distribution and composition of Steller sea lion forage species in critical sea lion habitat. Samples were taken both north and south of the passes as well as in the passes.

Zooplankton samples were collected with a CalVET (CalCOFI vertical egg tow) net and a MOCNESS (Multiple Opening Closing Net and Environmental Sampling System) system. The CalVETs were equipped with 0.15 mm mesh nets and General Oceanics digital flow meters to monitor volume filtered. The nets were fished vertically from 100 m depth to the surface or from 5 m above the bottom to the surface in shallower regions. The MOCNESS sensors measured volume filtered, net angle, depth, salinity, temperature and fluorescence. The MOCNESS was equipped with nine 0.500 mm mesh nets, which were fished at discrete depths to obtain depth distributions of the major taxa.

The acoustic equipment consisted of an HTI (Hydroacoustics Technology Inc.) model 244 digital echosounder with transducer frequencies of 38, 120, 200 and 420 kHz. All of the transducers are split beam and therefore collected target strength data in addition to volume scattering. The transducer array was towed beside the vessel at 5-6 knots during surveys. In addition, acoustic data were taken during each MOCNESS tow to aid in scaling the acoustic data. Early in the cruise, the preamp in the 38 kHz transducer failed. Failure of the 38 kHz transducer will complicate interpretation of the data, since the 38 kHz data are important for distinguishing fish and plankton targets. In addition to the narrow-band HTI system, an experimental broad-band system was used. The broad-band system was multiplexed with the narrow-band HTI system to provide broad band target information for each depth interval and integration interval in the upper 200 m. Since the broad-band system characterizes the frequency response of targets between 110 and 190 kHz, it may provide a means of recovering some of the information lost by the failure of the HTI 38 kHz transducer.

CalVET samples were taken at CTD (Conductivity Temperature Depth) stations taken on transect lines through Unimak, Akutan, Samalga, Amukta, Seguam, and Tanaga passes. MOCNESS samples were taken at stations along the transect lines through Unimak, Akutan, Samalga, Seguam, and Tanaga passes. Acoustic transects were run through Unimak, Akutan, Umnak, Samalga, Amukta, Seguam, and Tanaga passes. The above sampling plan has generated sufficient material to allow us to characterize of the zooplankton resources in the passes and on either side of the passes.

Figures (Unimak Pass: Fig. 9a, 11a; Akutan Pass: Fig. 10a, 12a; Umnak Pass: 30a; Samalga Pass: Fig. 36; Amukta Pass: Fig. 40a; Seguam pass: Fig. 47a; Tanaga Pass: Fig. 53a) show the distribution of volume scattering through the passes for each of the four frequencies. Preliminary observation of volume scattering suggests that considerably higher densities of sound scattering organisms may occur in the eastern region (Unimak – Akutan) relative to the western area (Samalga, Amukta, Seguam and Tanaga passes). Much of the passes). Much of the scattering in the Unimak - Akutan area appeared to be from euphausiids, which were often the dominant organisms by weight in the MOCNESS samples. Additional scattering may have resulted from gadid fish larvae, which can dominate the acoustic return when they are present at high densities. Zooplankton in the western region seemed to be dominated by copepods. Zooplankton samples in the eastern region contained large amounts of phytoplankton in May, but phytoplankton was not observed in the June samples.

The zooplankton samples will be returned to the laboratory for analysis. Information from the samples will include the species composition, life history stages of the copepod taxa, the abundance and wet weight biomass of all the taxa and stages. The acoustic data will be analyzed using analytical and empirical sound scattering models and correlation techniques. Neural net software may aid in relating the acoustic signatures of both the narrow and broad-band data to sound scattering organisms collected by the MOCNESS. In addition, broad-band signatures from previous trawl studies may aid in identifying fish targets not sampled by the MOCNESS. Statistical comparisons of the distribution, composition, abundance and biomass of the zooplankton in each of the passes should help document any consistent differences in zooplankton resources between the eastern and western regions of the Aleutian archipelago.

Marine Birds

The goal of the marine ornithology component was to use seabirds as indicators of the potential of different regions to support upper trophic level organisms, including Steller sea lions. The rationale was that birds, depending upon species, forage on the prey of sea lion prey, or share the use of small fishes consumed by sea lions. Thus regions or processes that support high densities of seabirds might be expected to also be favorable foraging areas for sea lions. Thus, the objective of the seabird component of this study was to assess whether there were greater numbers of foraging seabirds in Pacific versus Bering Sea waters, and whether passes with certain characteristics, such as those with shallow sills, might support more birds. We also wished to determine whether there were certain physical oceanographic processes that might enhance the foraging opportunities of top predators within or near the passes.

Seabird observations were made during daylight when the ship was underway at speeds of 5 knots or greater within the study area. All birds within an arc of 90° from the bow to the side with the best visibility were counted from the bridge, and were recorded on a laptop computer for analysis. Behaviors of all birds were recorded

In Unimak, Samalga, Seguam and Tanaga passes, we sampled the abundant seabird species at foraging aggregations. Stomach contents were removed from birds within 1 hour of collection, and stored in 80% ETOH. Northern fulmars were collected in Unimak (1 bird) Seguam (9 birds) and Samalga Pass (8 birds). Five short-tailed shearwaters were collected in Seguam Pass and 5 in Unimak Pass. Four least auklets (*Aethia pusilla*) were collected in Tanaga Pass. Auklets were eating copepods, fulmars had been eating copepods and a mixture of copepods and euphausiids; shearwaters were eating exclusively euphausiids. Details of prey species and stage composition will be determined by microscopic examination in the laboratory.

During the cruise, we surveyed a total of 1,520 kilometers: 190.1 km on the northern side of the Aleutian Islands, 310 km on the southern side and 1011 km within the passes. We counted a total of 95,683 seabirds between Unimak Pass (eastern survey limit) and Tanaga Pass (western survey limit); 71,925 of them were feeding or sitting on the water. The most abundant seabirds were small alcids (least, crested [*A. cristatella*], parakeet [*Cyclorrhynchus psittacula*], and ancient murrelets [*Synthliboramphus antiquus*], with 28,539 individuals and 40% of birds observed feeding or on the water), short-tailed shearwaters (24,733 individuals, 34% feeding or on the water), northern fulmars (15,575 individuals, 22% feeding or on the water), and Tufted Puffins (2,661 individuals, 4% feeding or on the water).

Seabird abundance was greater (48.0 birds/km^2) on the Pacific Ocean side of the Aleutians than on the Bering Sea side (32.7 birds/km^2) (Fig. 62). On both sides of the Aleutian Archipelago, small alcids and northern fulmars were the most common birds. The biggest concentrations occurred as we crossed tiderips associated with nearby passes. Thus these averages do not reflect the densities of seabirds in the shelf waters away from the influence of passes.

Within the passes surveyed, seabird densities were higher in the relatively narrow, shallow passes (Unimak, Umnak, Samalga, Seguam and Tanaga) (Fig. 63). In these passes, large flocks of least auklets, shearwaters, or northern fulmars aggregated to forage at the frontal areas at the ends of the passes (e.g., Fig. 13, 16, 25, 26, 27, 31, 37, 48, 54). Mean seabird abundance was 406 birds/km^2 in Unimak Pass, 203 birds/km^2 in Tanaga Pass, 76 birds/km^2 in Seguam Pass, 51 birds/km^2 in Samalga Pass,) and 32 birds/km^2 in Umnak Pass. In comparison, Amukta Pass, which is wide and deep, supported only 1 bird/km^2.

There was a marked difference in the species composition of the seabirds encountered in the passes. In the eastern passes (Unimak, Akutan and Umnak), short-tailed shearwaters and tufted puffins were the dominant species, in the central passes (Samalga, Amukta and Seguam) fulmars were dominant, whereas in the west (Tanaga Pass), small alcids were dominant. In Unimak Pass, short-tailed shearwaters comprised 98% of the birds feeding or sitting on the water. In Akutan and Umnak passes, tufted puffins comprised 63%, and 57%, respecyively, of the birds feeding or sitting on the water. In Samalga, Amukta and Seguam passes, northern fulmars comprised respectively 98%, 44% and 90% of the birds feeding or sitting on the water. In Tanaga Pass, least auklets comprised 98% of the birds feeding or sitting on the water.

Within Unimak, Samalga, Seguam and Tanaga, passes, small alcids, northern fulmars and short-tailed shearwaters were observed foraging at frontal regions that crossed the ends of the passes. These were tidal fronts where either stratified Pacific Ocean or Bering Sea waters were interacting with the well-mixed water of the passes. At the northern end of Unimak Pass, short-tailed shearwaters were foraging on euphausiids. Similarly, northern fulmars and short-tailed shearwaters at Seguam Pass were foraging on adult euphausiids (mostly or all *Thysanoessa longipes*). Shearwaters and fulmars were also found foraging in patches along the sides of the passes with lines of foraging flocks parallel to the long axis of the pass. We were not able to determine if there was a physical mechanism that was organizing these foraging aggregations, although it seems possible that they may be the result of processes in a shear zone that could be separating the fast moving water in the center of the pass from the slower flowing water at the sides. Small alcids and northern fulmars collected at tidal fronts in Samalga, Seaguam and Tanaga passes were foraging mostly on copepods (probably *Neocalanus plumcrus/flemingerii).*

Fig. 62

Abundance of birds along the Aleutian Islands (May-June, 2002)

(only birds feeding and sitting on the water)

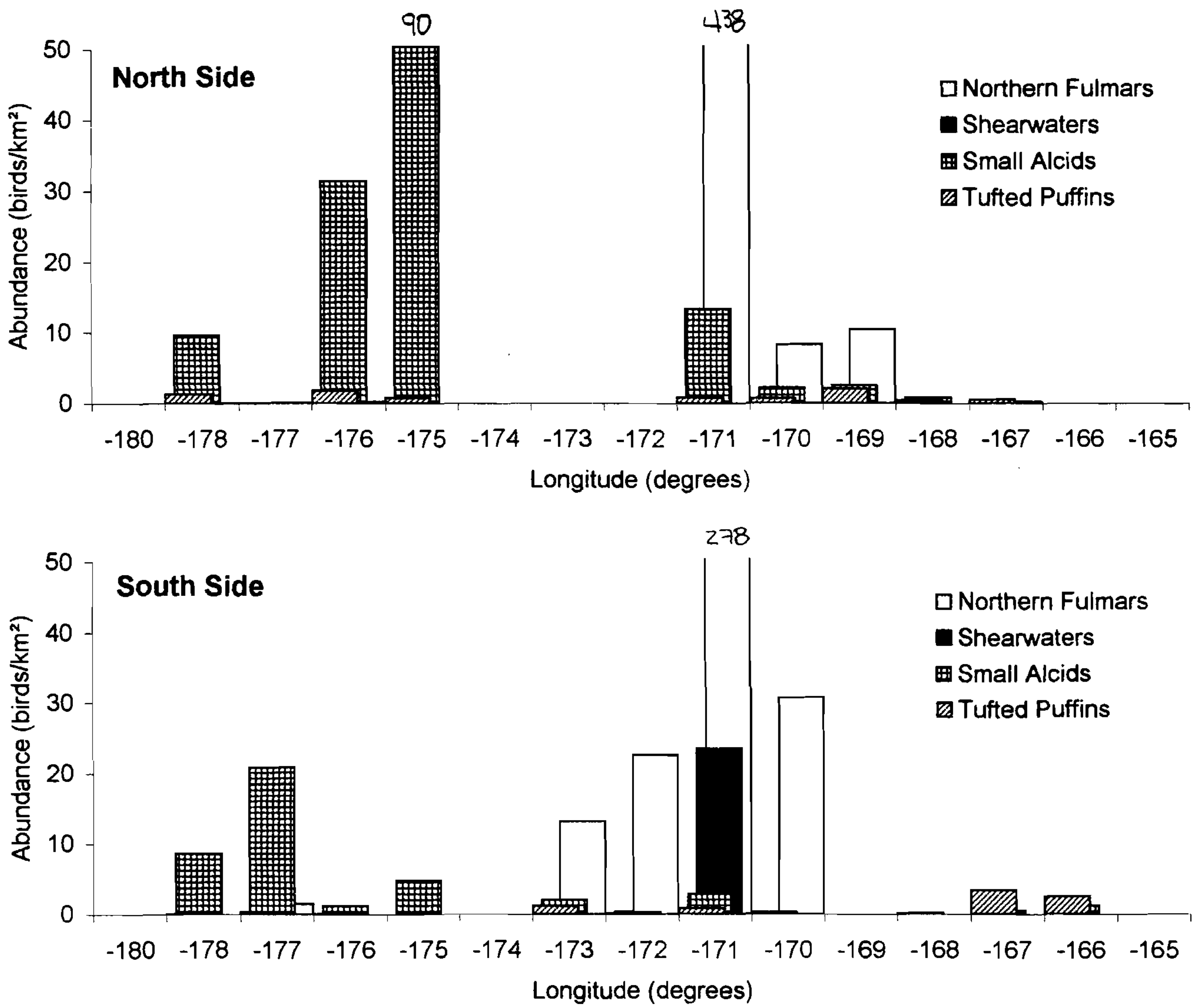
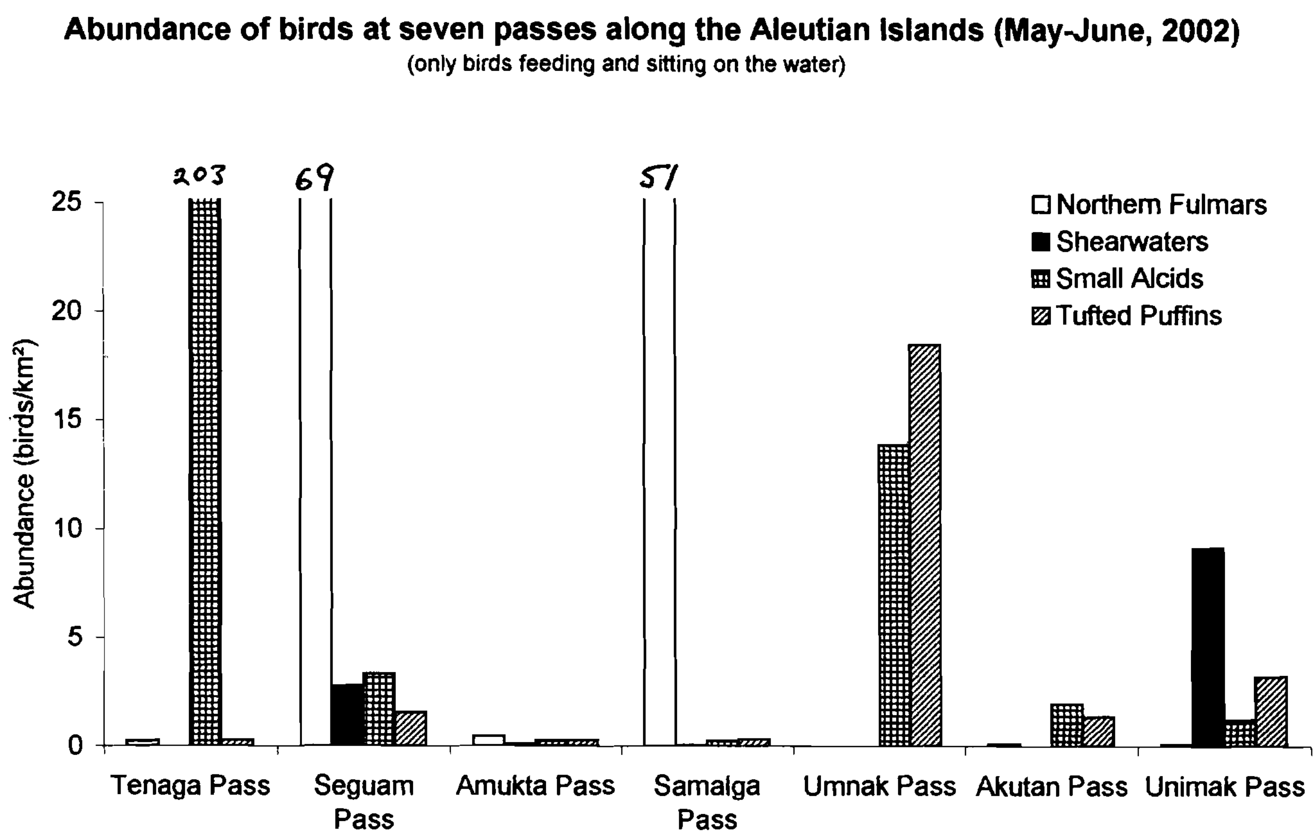


Fig 63



Abundance of birds at seven passes along the Aleutian Islands (May-June, 2002)
(only birds feeding and sitting on the water)
203
69
51
Northern Fulmars
Shearwaters
Small Alcids
Tufted Puffins
Abundance (birds/km²)
25
20
15
10
5
0
Tenaga Pass
Seguam Pass
Amukta Pass
Samalga Pass
Umnak Pass
Akutan Pass
Unimak Pass

Marine Mammal Studies

The decline of the Steller's sea lion (*Eumatopeas jubatus*) in the central and western areas of the North Pacific/Bering Sea has precipitated a number of research projects seeking to investigate possible causal factors. One of these is the Aleutian Passes project, focused on two fundamental goals: (1) examination of productivity near sea lion rookeries and haul outs and (2) documentation of the number and ecotype of killer whale (*Orcinus orca*) in waters between Unimak and Tanaga Passes in the central Aleutian chain. Preliminary results of the second field season of marine mammal observations are presented here.

Marine mammal surveys were conducted throughout the study area (Fig. 1, p. 19) and were focused on the occurrence of killer whales at seven Aleutian passes: Tanaga, Seguam, Amukta, Samalga, Umnak, Akutan, and Unimak (Fig. 64). The passes border Steller's sea lion rookeries and haul outs where populations are either in decline or holding steady, none are increasing.

Marine mammal observers maintained a watch from the port and starboard sides of the bridge (height 9.67 m) of the R/V ALPHA HELIX daily from early morning (0700-0800) to late evening (2100 to 2200; hours shifted depending on light conditions) when conditions were suitable (i.e., Beaufort <6; visibility <.5 km). Observers at port and starboard stations searched with naked eye and 7X (or higher) binoculars with reticules (some had no reticules). Observers scanned for one hour at each station, followed by a one-hour break. The two primary observers were assisted in finding marine mammals by seabird researchers conducting surveys from either the port or starboard side (depending on glare), and by the ship's crew. Data were recorded by the starboard observer using WinCruz software on a laptop interfaced directly to the ship's Global Positioning System (GPS). Positions along the cruise track were updated at 2-minute intervals. When marine mammals were seen, estimated bearing and reticule or distance to the sighting, species, and number (best/high/low) of animals were recorded. Sightings of cetaceans other than killer whales were recorded in passing mode, except in two instances when sperm whales (*Physter macrocephalus*) and humpback whales (*Megaptera novaeangliae*) were approached to obtain biopsies.

When killer whales were seen within the study area and time permitted, the marine mammal team moved to the bow of the ALPHA HELIX to photograph and biopsy whales as the ship maneuvered into the desired position. On 6 occasions, sea conditions permitted to launch a rigid-hull inflatable boat (RHIB) for additional and sometimes closer access to the whales. The RHIB was deployed with a driver and at least two team members (1 biopsy person and 1 photographer, and sometimes a combination of team members with a ride-a-long from another project). Whales were approached from behind on their left sides for both photographs and biopsies. Standard identification photographs of their dorsal fins and saddle patches were taken using two Nikon cameras with fixed 300mm lenses and black and white 1600ASA Fuji film (Dahlheim, 1997). Biopsy tissue samples were taken using either a Larsen gun or crossbow to deliver a hollow-tipped dart. Attempts to biopsy focused on distinctive individuals that were photographed during the encounter. Tissue samples were divided in two samples: a skin sample, stored in DMSO for DNA and isotopic analysis; and a blubber sample, frozen for analysis of contaminants.

Provisional Results

Approximately 350 hours of survey for marine mammals was completed in the study area (Fig. 1, p. 19). Roughly 135 of 350 (39%) survey hours were dedicated to search for killer whales and 58 of 135 (43%) hours were direct effort on sightings, or encounter groups (Table 1). Time allotted to search for killer whales was routinely given either: (1) at the beginning or end of an oceanographic work day (10 occasions—41 hrs—30%); (2) during transit time to the next pass (6 occasions—63 hrs—47 %); (3) seeking a lee during bad weather when other projects could not work (5 occasions—24 hrs—18%); and (4) when oceanographic lines were broken (3 occasions—07 hrs—05%) (Table 1). Weather and viewing conditions were usually poor compared to the 2001 survey with visibility often reduced to <1-3 nm due to fog, rain, wind, and increased Beaufort sea state to 4-5, and sometimes 6 (Table 1).

Ten marine mammal species were positively identified, three pinniped and seven cetacean. Steller's sea lions (Eumatopeas jubatus) were the most common pinniped seen (when animals hauled out on land were included). None were sighted in the water. Elephant seals (*Mirounga angustirostris*) and fur seals (*Callorhinus ursinus*) were also sighted several times each. Dall's porpoise (*Phocoenoides dalli*) were the cetacean seen most often (Fig. 65) and were abundant throughout the study area. Although ubiquitous, they were particularly common west of Unalaska Island and an order of magnitude higher in Tanaga, Seguam, Amukta, Samalga, and Umnak passes. However, they did not have similar densities in the Unimak/Akutan passes region where sightings were scarce by comparison. Sightings of Dall's porpoise were absent on the south side from Umnak pass to the easternmost region of the study area near the south end of Unimak pass (Fig. 65). Minke whales (*Balaenoptera acutorostrata*) were sighted 18 times throughout the study area with higher concentrations occurring in the western-most passes of the study area, Tanaga and Seguam (Fig. 66). All other minke whales sightings occurred on the south side of the island chain. Sperm whales (*Physeter macrocephalus*) were most prolific in the Tanaga pass region near the Delarof Islands where 35 sightings were recorded (Fig. 67). (It is important to note that most of these sightings were recorded over a 1.5-2.0 hrs duration while the ALPHA HELIX was either milling or transiting <4 knots while awaiting the return of the RHIB deployed for biopsy work.) The remaining five sightings of sperm whales occurred in Amukta pass and north of Seguam Island in Seguam pass (Fig. 67). Humpback whales (*Megaptera novaeangliae*) were sighted east of Amukta pass and occurred most often in the Unimak/Akutan passes region, either in the north end of Unimak pass (one event >100 spread over several miles) or the south end of Akutan pass (Fig. 68). Pacific white-sided dolphins (*Lagenorhynchus obliquidens*), harbor porpoise (*Phocoena phocoena*), and Baird's beaked whales (*Berardius bairdii*) were sighted one time each in the study area. Consistent with the 2001 survey, fin whales (*Balaenoptera physalus*) were not seen in the study area.

Killer Whale Encounters and Sightings:

There were 26 sightings of approximately 500 killer whales (summation of the best estimates of group size) seen in the study area from Tanaga Pass to Unimak Pass (Figs.64, 69; Table 1). These provisional counts likely under-represent the total number of animals present because (1) animals were often spread over a large area, (2) time allotted to tissue samples have not yet been analyzed to determine eco-type, we presume that at 15 of 26 (58%) groups of killer whales encountered are fish eaters (because open or fingers in saddle patches were seen in the group or they exhibited fish-foraging behaviors). With certainty, we conclude that at least one group (observed feeding on gray whale carcass) are mammal-eaters(Tables 1-2). With less certainty, we assume 2-4 additional groups may be mammal-eaters (group numbers were small, individuals had ragged dorsal fins, and other physical and behavioral characteristics of transients were noted) (Tables 1-2). The remaining groups are unknown eco-types because they were either seen in passing mode only, were never resighted, or they had no indicative physical or behavioral characteristics (Table 1-2).

Aleutians

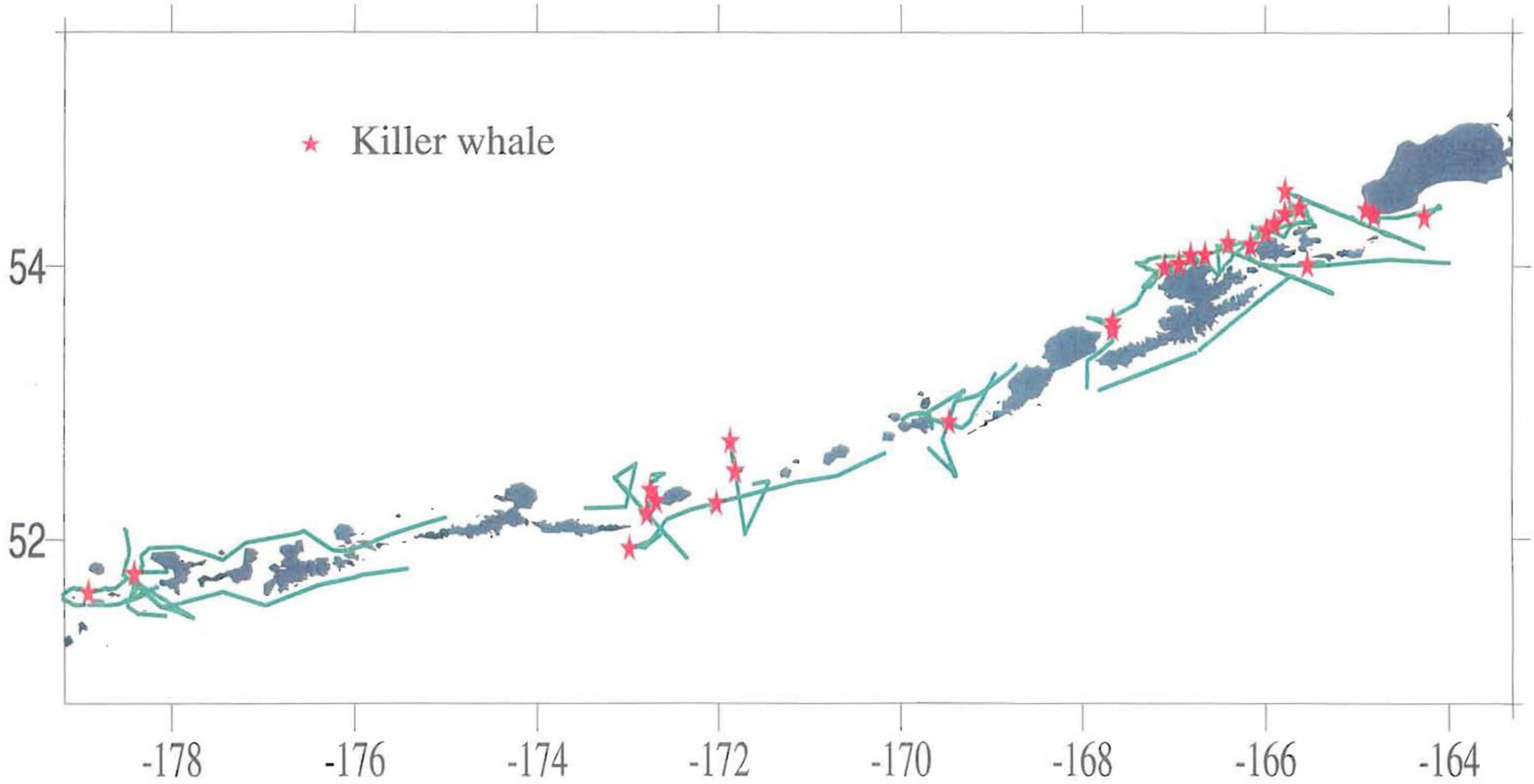


Fig 64

P. 124

Aleutians

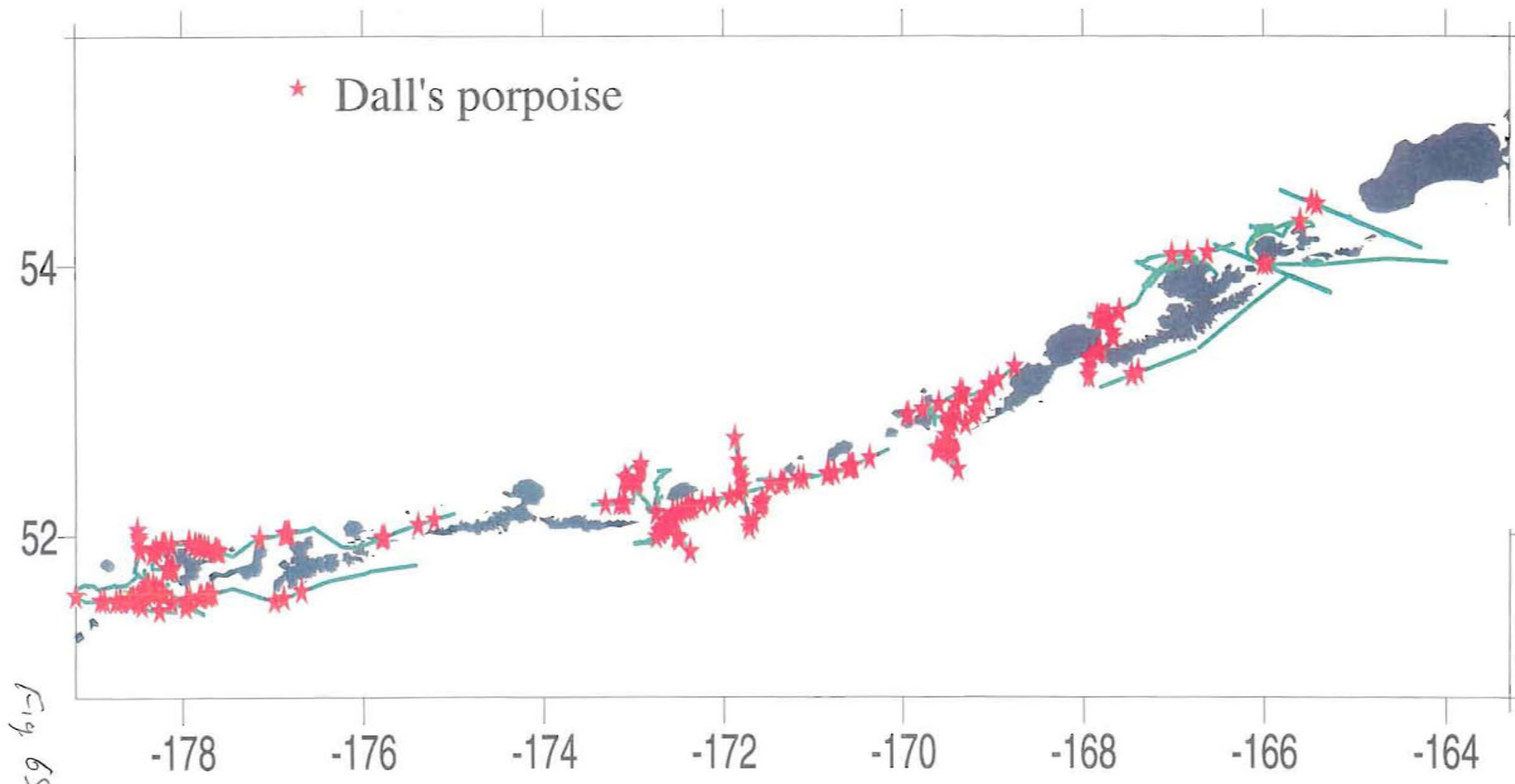


Fig 65

P.125

Aleutians

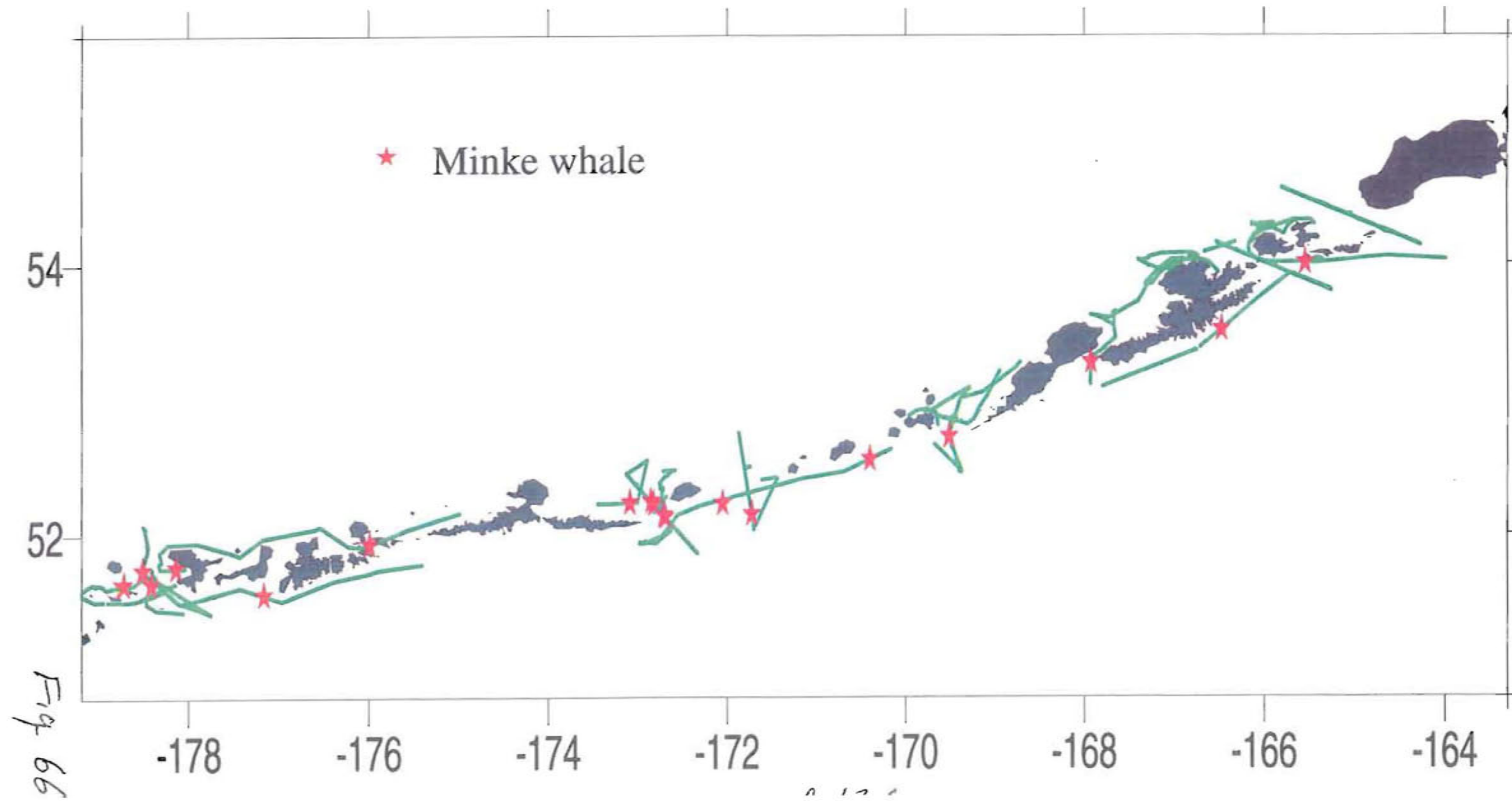


Fig 66

Aleutians

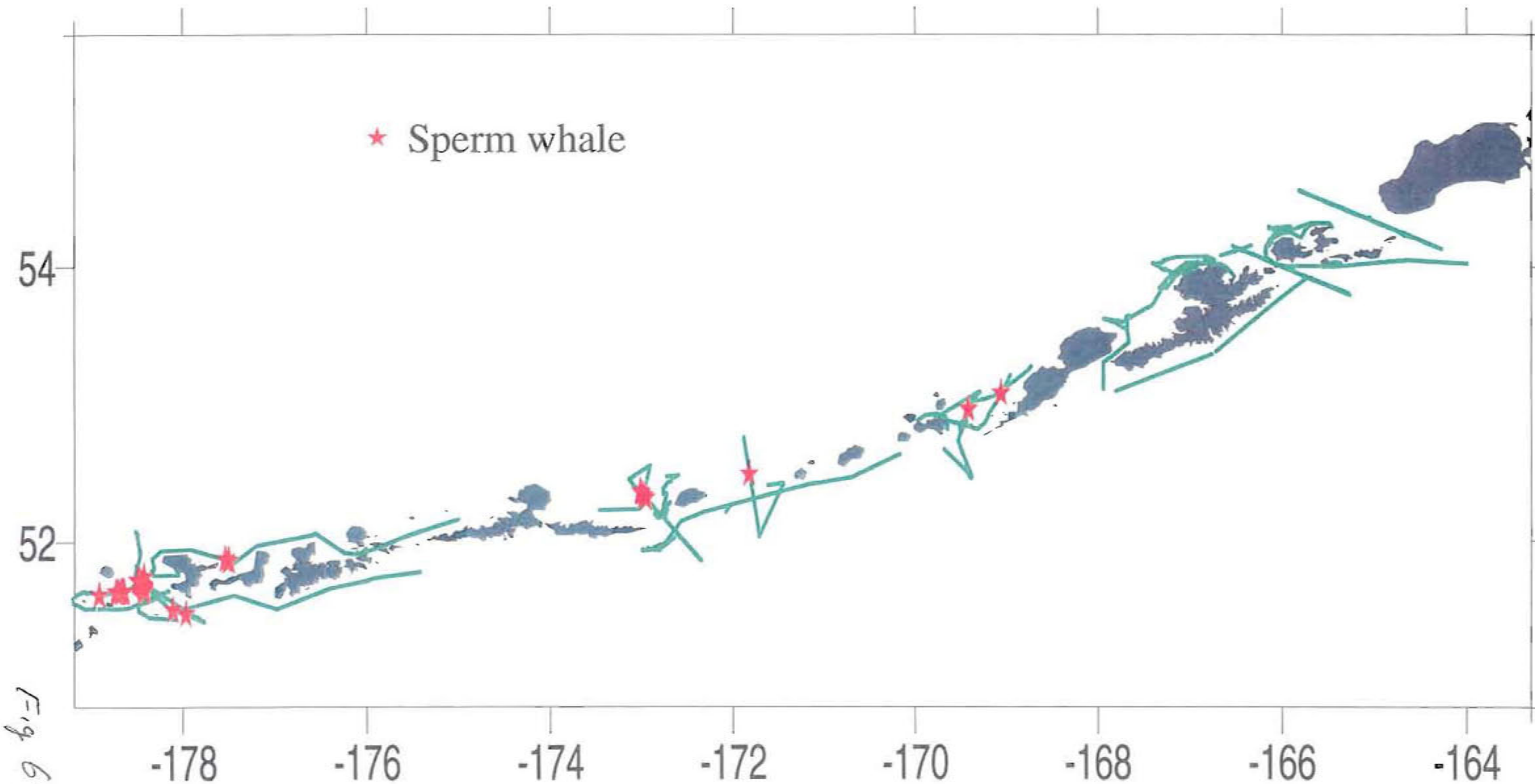
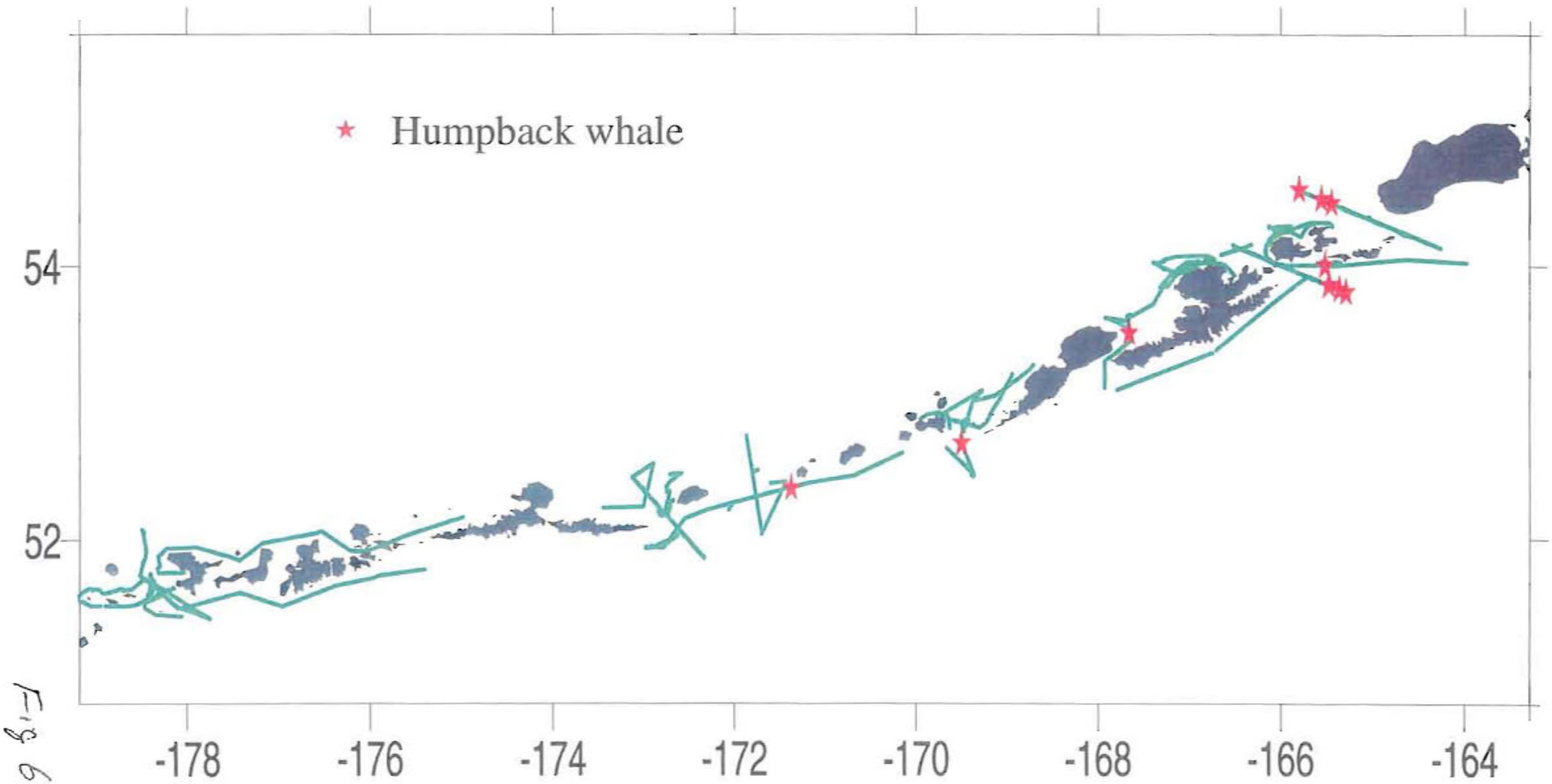


Fig 67

P. 127

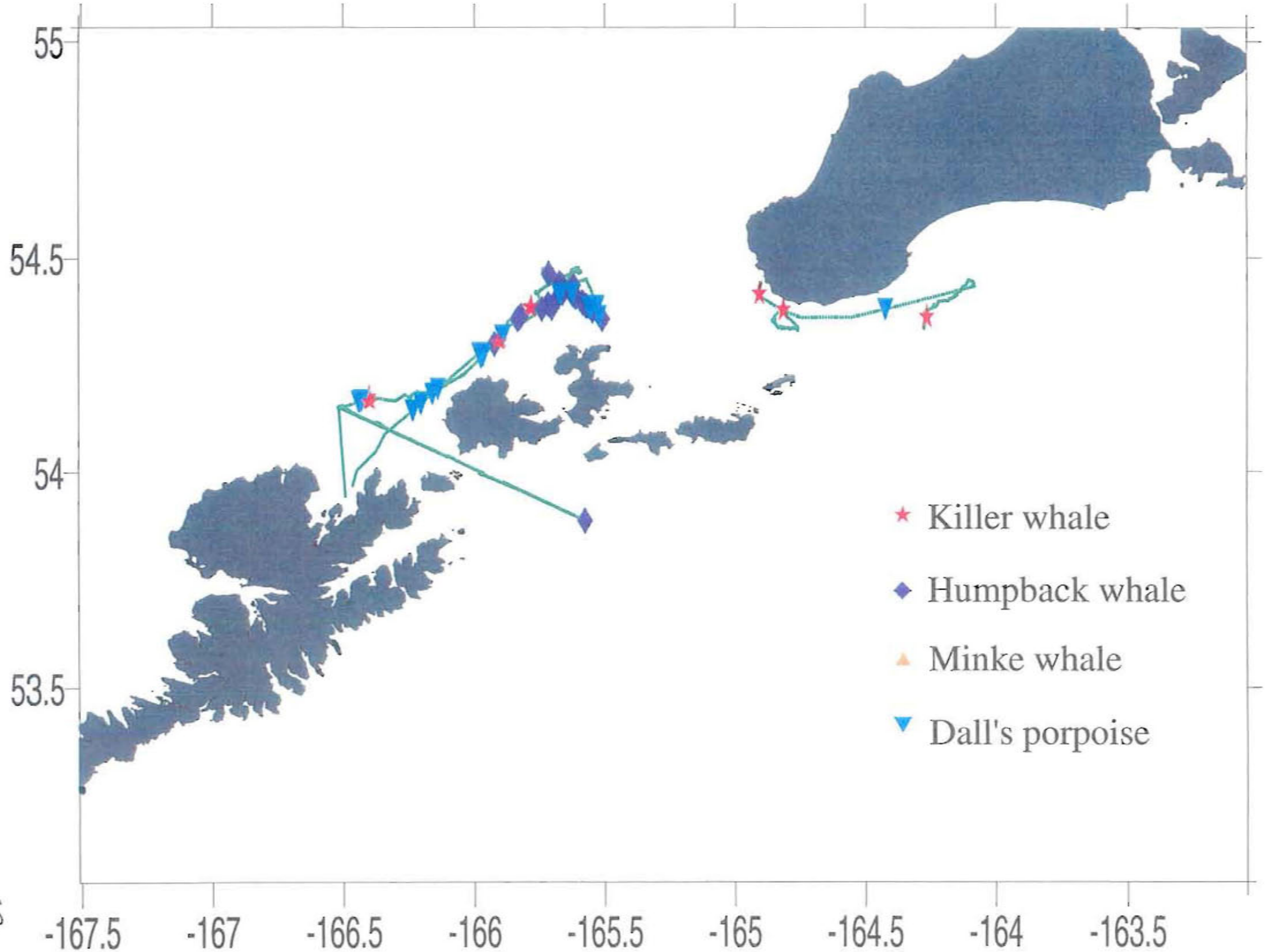
Aleutians



P. 128

Fig 68

Unimak/Akutan 06/15/02 through 06/18/02



p. 129

Fig. 69

Acknowledgments

We thank the Captain and crew of the R/V Alpha Helix for excellent support throughout the cruise. Their expertise and willingness to go the extra mile added greatly to the success of this research project. The marine technician, Steve Hartz was indispensable. We also thank the NOAA Coastal Ocean Program, through CIFAR and JIMO, and the NOAA Pacific Marine Environmental Laboratory for financial support of this study.

References Cited

Dahlheim, M.E. 1997. A photographic catalog of killer whales, *Orcinus orca*, from the central Gulf of Alaska to the Southeastern Bering Sea. NOAA Technical Report NMFS 131, 54 pp.

Hunt, G.L., Jr., Russell, R.W., Coyle, K.O., and Weingartner, T. 1998. Comparative foraging ecology of planktivorous auklets in relation to ocean physics and prey availability. Mar. Ecol. Prog. Ser.167: 241-259.

Table 1. Killer whale sighting data

ENCOUNTER NUMBER	DATE	LAT/LONG	LOCATION	NUMBER B/H/L	NUMBER SUB-GROUPS	NUMBER MALES	NUMBER CALVES	NUMBER BIOPSIES	*PRESUMED ECO-TYPE	TIME W/ GROUP	PHOTOS	WEATHER AT TIME OF SIGHTING
1	5/21/2002	N54:18.676 W166:03.25	Akutan Island (south of Rootok)	12-15-12	1	4	2 (min)	0	? (T?)	1200-1430 2.5 hrs	POOR (few if any id worthy)	Beaufort 4 5-7' seas; 10-20 kt winds clear visibility
2	5/21/2002	N54:13.29 W166:03.05	Akutan Island (lava point)	15-18-12	6	6	2 (1 calf/1 juv)	1	R	2011-2330 3 hrs 20 min	GOOD	Beaufort 3 5-6' seas; 10-15 kt winds 3-5 mi visibility fog and rain
3	5/23/2002	N51:54.34 W172:23.38	Unalaska (north side)	9-11-8	2-3	5 or 6	1	0	R	1740-1930 1 hr 50 min	FAIR	Beaufort 5 4-6' seas; rough 20 kt winds
4	5/24/2002	N54:17.14 W166:05.9	Akutan Island (north of Akutan)	30+	1 w/fishing boat	1 w/fishing boat others in area	2 w/mothers w/fishing boat others in area	1	R	1715-2130 3.75 hrs	GOOD (only of 6-9 individuals at most)	Beaufort 5 6' seas; 15-20 kt winds 2 mi visibility fog and rain
5	5/25/2002	N54:33.29 W165:46.48	Unimak	23-25-20		3	1	0	?	1030 0 hrs (pass)	NONE	Beaufort 4 6' seas; 20 kt winds 2 mi visibility
6	5/27/2002	N51:56.81 W172:58.36	Amlia Island (south side-east)	75-100-61	6 plus others in area	10	20	3	R	1725-2200 4.5 hrs	GOOD (only of several sub-groups)	Beaufort 2 6' seas; light winds clear visibility
7	5/29/2002	N51:45.22 W178:24.18	Tanaga pass	13-15-12	1	2	3	1	R	0800-1030 2.5 hrs	FAIR (some of all but shot in low light)	Beaufort 4 15 kt winds 5' seas; fog and rain 1.5-2.5 mi visibility fog and rain

Table 1. Killer whale sighting data

ENCOUNTER NUMBER	DATE	LAT/LONG	LOCATION	B/H/L	# SUB-GROUPS	# MALES	# CALVES	NUMBER BIOPSIES	*PRESUMED ECO-TYPE	ENCOUNTER TIME	PHOTOS	WEATHER AT TIME OF SIGHTING
8	5/31/2002	N51:36 W178:52	Delarof Islands	30	?	3	5	1	R	1500-1715 2.5 hrs	POOR (5--13% of group)	Beaufort 2 - 3 3-5' seas; 10 kt winds clear visibility
9	6/3/2002	N52:22.96 W172:45.09	Seguam Island 1	6-6-6	1	3	1	0	R	2150-2400 2 hrs	FAIR (some good too dark)	Beaufort 4 8' seas; 18 kt winds limited visibility
10	6/4/2002	N52:16.8 W172:42.86	Seguam Island 2	35-50-30	6-7	9-10	many	2	R	0800-1430 6.5 hrs	FAIR (lost 1 roll to camera malfunction)	Beaufort 2 4' seas; 15 kt variable clear visibility some fog/rain
11	6/4/2002	N52:15.83 W172:54.35	Seguam Island 3	12-15-10	1	3	1	0	R	1800-2300 5 hrs	POOR (distant)	Beaufort 1-3 4-6' seas 3-12 kt winds clear/ mostly hazy
12	6/5/2002	N52:29.89 W171:47.30	Amukta pass 1 (middle)	4-4-4	1	2	0	0	R	1600-1700 1 hr	EXCELLENT (good photos of all-100%)	Beaufort 5 8' seas 22 kt winds clear visibility
13	6/5/2002	N52:43.88 W171:52.20	Amukta pass 2 (south end)	12-11-10	1	2	3	0	R	2030-2130 1 hr	POOR (few and distant)	Beaufort 5 4-6' seas; 25 kt wind clear visibility
14	6/9/2002	N52:57.87 W169:26.88	Samalga pass (north end)	60-75-50	? (initially saw 2 subgroups--then other groups joined the mix)	15 (possibly more)	20 (calves + juv possibly more of both)	4	R	1400-1800 4 hrs	GOOD (25%-40% of group)	Beaufort 4-5 7-8' seas; 15-19 kt wind clear visibility

6/16/02

Table 1. Killer whale sighting data

ENCOUNTER NUMBER	DATE	LAT/LONG	LOCATION	B/H/L	# SUB-GROUPS	# MALES	# CALVES	NUMBER BIOPSIES	*PRESUMED ECO-TYPE	ENCOUNTER TIME	PHOTOS	WEATHER AT TIME OF SIGHTING
15	6/10/2002	N53:35.30 W167:39:8	Umnak pass (north end)	3-3-3	1	1	?	0	?	1100 0 hrs (pass)	NONE	Beaufort 6 6' seas; 23 kt winds clear visibility
16	6/10/2002	N53:33.23 W167:40.81	Umnak pass (north end)	14-?-14 (7-7-7) (5-?-5) (2-2-2)	3 (seen in area) (group 1) (group 2) (group 3)	2 (2) (0) (2)	0	1	R	2046-2300 2 hrs	POOR (few and most right sides)	Beaufort 6 5' seas; 30 kt winds clear visibility
17	6/11/2002	N53:59.59 W167:05.84	Unalaska Island (Koriga Pt) (3 mi offshore NE of Makushin Bay)	13-15-12	1	3	2	2	? (R?) (no open saddles seen)	1219-1630 3.5 hrs	GOOD (of those we got to)	Beaufort 3-4 4-5' seas; 10-15 kt winds intermittent fog
18	6/11/2002	N54:03.98 W166::46.11	Unalaska Island (Cape Wislow) (3 mi offshore NE of Makushin Bay)	35-?-30	2 (worked 2) (group 1) (group 2)	? (2) (0)	?	2	? (R?) (no open saddles seen)	1800-1930 1.5 hrs	FAIR (only few individuals--5%-10% of group)	Beaufort 3 3-4' seas; 12 kt winds clear visibility
19	6/11/2002	N54:05.23 W166:39.13	Unalaska Island (Reese Bay) (5 mi offshore NE of Makushin Bay)	5-5-5 (3-3-3) (2-2-2)	2 (seen in area) (group 1) (group 2)	2 (1) (2)	0	0	? (R?) (no open saddles seen)	2000 0 hrs (pass)	NONE	Beaufort 2 3' seas; 10 kt winds clear visibility
20	6/16/2002	N54:11.05 W166:13.55	Akutan Island (Lava Point)	3-3-3	1	2 (1 sprouter?)	0	1	?(T?) (no open saddles and ragged fins)	1400-1630 2.5 hrs	EXCELLENT (good photos of all animals)	Beaufort 2 3' seas; 10 kt wind clear visibility; some fog

6/18/02

Table 1. Killer whale sighting data

ENCOUNTER NUMBER	DATE	LAT/LONG	LOCATION	B/H/L	# SUB-GROUPS	# MALES	# CALVES	NUMBER BIOPSIES	*PRESUMED ECO-TYPE	ENCOUNTER TIME	PHOTOS	WEATHER AT TIME OF SIGHTING
21	6/16/2002	N54:18.92 W165:53.27	Akutan Island (north of North head)	25-30-20	? worked w/ 1 (group 1)	3 (in area) (2)	2 (minimum) (2)	1	R (fingers in saddles)	1700-1745 .75 hrs	FAIR (okay photos of 7 animals)	Beaufort 4 4' seas; 18 kt wind clear
22	6/16/2002	N54:25.69 W165:36.96	Unimak pass (northeast of Akutan Island)	20-25-20	? worked w/ 1 (group 1)	3 (others in area) (2)	2 (min) (2)	0	R (fingers in saddles)	1930-2030 1 hr	POOR (only a few frames)	Beaufort 5 4' seas; 20 kt wind clear
23	6/17/2002	N54:23.10 W165:46.93	Akutan Island (b/w Akutan pass and Unimak)	5-?-5	?	?	?	0	?	1130 0 hrs	NONE	Beaufort 4 4' seas; 16 kt wind 4 mi viz
24	6/18/2002	N54:21.71 W164:15.81	Unimak Island	4-5-4	1	1		1	T? (no open saddles/raggy dorsal fins)	0715-0915 2 hrs	GOOD (3 of 4)	Beaufort 3 3' seas; 10 kt wind <2 mi visibility; fog
25	6/18/2002	N54:22.73 W164:48.68	Unimak Island (SE side/coast)	9-10-8	1	1	3 (2 small-1 juv)	1	? (no open saddles)	1200-1330 1.5 hrs	GOOD (6-7 of 9)	Beaufort 3 3' seas; 10 kt wind 2-3 mi visibility; some fog
26	6/18/2002	N54:24.96 W164:54.20	Unimak Island (SE side/coast)	30 (min) (1) 12-15) (2) 5-6 (3) 4-5 (4) 5-6	4 (others coming into area but we could not stay :(	5 (min) (2) (1) (1) ?	4-5 (min)	4	T (feeding on gray whale carcass)	1415-1620 2 hrs	FAIR (time restricted good photos of first groups no look at incoming)	Beaufort 4 3' seas; 15 kt wind-choppy clear visibility; some haze
TOTALS				502				26		48		

6/18/02

Table 1. Killer whale sighting data

*Presumed Eco-Type

Resident: "R" was assigned if open saddle(s) were seen in a group and/or if animals appear to be foraging on fish.

Transient: "T" was assigned if observed predating on mammals

Offshore: "O" was not assigned to any group

? : "?" was assigned if open saddle(s) or fish foraging were absent.

TOTALS:

Number animals (best)	**502**
Number rolls of film	**74**
Number biopsies	**26**
Number groups biopsied	**15**
Hours working animals	**58**

PHOTO-ID TABLE

RATING		% of group identified in category	# groups in category	Encounter # in category	
NONE		0%	4	5, 15, 19, 23	
POOR		<10%	9	1, 4, 6, 8, 11, 13, 16, 18, 22	
FAIR		<25%	6	3, 7, 9, 10, 21, 26	
GOOD		>50%	5	2, 14, 17, 24, 25	
EXCELLENT		100%	2	12, 20	
			26		

ECO-TYPE KEY

*Presumed Eco-Type

Resident: "R" assigned if open or fingers in saddle(s) were seen in a group or if animals appeared to be foraging on fish.

Transient: "T" was assigned if observed predating on mammals

Offshore: "O" was not assigned to any group

? : "?" assigned if there were no physical or behavioral characteristics, or other indicators typical of known eco-types observed.

Table 2

ENCOUNTER NUMBER/DATE	NOTES
1 5/21/2002	Encountered during time given for bad weather. Poor photos (<10% of group photo-identified); no biopsy; ecotype unknown. Weather rolled in and they gave us the slip. Few if any id worthy photos. Minke whale seen with this group where several animals shadowed the whale for several minutes then broke off. Possible transients? Animals were elusive and difficult to work. We were unable to relocate the minke after several surfacings. Animals located in the Krenitzen Islands/south of Rootok and Avatanak Islands--between the two islands.
2 5/21/2002	Encountered during time given for bad weather. Good photos (>50% of group photo-identified); 1 biopsy; ecotype presumed resident. Animals seen in the Krenitzen Islands/north of Akutan Island near Lava Point & north of North Head Bite (1 mile offshore & spread out)
3 5/23/2002	Encountered during time given for bad weather. Fair photos (<25%% of group photo-identified); no biopsy; ecotype presumed resident. Launched small boat; difficult to work; fair photos and only a few per roll. Saw male with round scar (about the size of a bullet) on the upper one-third trailing edge of dorsal fin (refer to biopsy photo catalogue Whale #6 from 2001 Aleutian Mariner cruise--possibly same animal). Two Pacific white-sided dolphins were seen bow-riding KW's. Overall, an unsuccessful mission working 2 males--fair photos of 1 animal and poor photos of the other--again, no biopsy. Strong winds limited the workable area-- on north side of Unalaska Island west of Dutch Harbor we were contained to work within an approximate 5 mile area.
4 5/24/2002	Encountered during time given for bad weather. Poor photos (<10% of group photo-identified); 1 biopsy; ecotype presumed resident. Group associated w/ black cod/sable fishing vessel pulling in longline pots. KW female w/ calf feeding on small bycatch thrown overboard. Vessel "Guiding Star" (Captain Jose Castillo--Westward Sea Foods 581-1660) conveyed that KW's have learned to open pots! Good photos of biopsied animal and the 2 m/c pairs behind the boat-- 6-9 individuals maximum were photo identified. Many KW's were seen in the area spread out for miles, but did not approach fishing vessel during our 3.75 hrs observation.
5 5/25/2002	Killer whales were seen in passing mode due to non-stop CTD & CalVET line. Saw 2-3 subgroups, more may have been present; whales passed w/in 50m of vessel. No photos; no biopsy; no time to get group size estimate; ecotype unknown.
6 5/27/2002	Encountered during transit time to Tanaga pass off of the southeast side of Amlia Island. Poor photos (<10% of group photo-identified) but good photos of several sub-groups; 3 biopsies (1 skin only) Obtained a large number of photos--most good, as we were able to work from large and small boat simultaneously. Worked 6 sub-groups but never got to all groups. Many distinct animals. Individuals sometimes following closely behind the boat. Dart shot from bow and stuck in lower right side of female w/calf; both seen several times throughout the encounter with the dart still in tact. *See MR #13 LM1 frames 1-4; female right side during darting. KW01 biopsy had no blubber--skin sample only (must have hit base of dorsal).

ENCOUNTER NUMBER/DATE	NOTES (CONT'D)
7 5/29/2002	Encountered prior to CTD line early morning. Fair photos (<25% of group photo-identified--low light); 1 biopsy; presumed ecotype resident. Some photos of all animals but best opportunities shot in very low light (best as low as 400 @ F4). One young, orange-colored calf spy-hopped frequently.
8 5/31/2002	Encountered 20 minutes under survey after having spent 1.5-2.0 hrs obtaining biopsies from sperm whales. Poor photos (<10%) of group photo-identified); 1 biopsy (grazed the animal @ dorsal base and is skin only--no contaminant sample); ecotype presumed resident. Worked from small boat after unsuccessful from the large boat. Difficult animals to work and sea conditions became unfavorable as time progressed.
9 6/3/2002	Encountered after extended HTI/bird collection; seen at end of day near Seguam. Fair photos (<25% of group photo-identified--low light); no biopsy; presumed ecotype resident. One adult male had a very distinct dorsal curled all the way over on left side and an open saddle on the right side. *Same or similar-looking curled-fin adult male was seen again the next morning (6/4/02) in the vicinity of this larger scattered group. (See Encounter #10.) We never got to that subgroup to positively identify. We worked them until dark; 1 hr 45 minutes (2100-2330).
10 6/4/2002	Encountered prior to start of CTD line (line delayed). Fair photos (<25% of group photo-identified); 2 biopsies; ecotype presumed resident. Large group spread over 1.5-2 miles. Worked 6-7 sub groups but there were others scattered around; at least 9-10 males; many calves. Worked 4 hrs from big boat and 2 hrs from small boat; had better luck w/ small boat. Biopsied 1 male/1 female. Also, saw same or similar curled to the left dorsal on male from last night's encounter (Encounter #9), but did not appear to be associated with same animals as previous sighting. Nancy had malfunction w/ older camera and lost entire first roll of film (first 4.5 hrs of encounter).
11 6/4/2002	Encountered after prod/bird collection and prior to CTD line. Poor photos (<10% of group photo-identified--distant); no biopsy; ecotype presumed resident. Open saddle male; distinct female with cut in top of dorsal that looked like sideways and rounded "M" (profile/side view). Only distant photos. Uncooperative animals; worked for 5 hrs from small boat; no biopsy after 1 attempt
12 6/5/2002	Encountered duriing HTI line @1600. Line broken near end for 50 minute "intermission" and then resumed the line. Excellent photos (100% of group photo-identified); no biopsy after attempts; ecotype presumed resident. Two females, 1 w/ open saddle--1 w/ yellow saddle/eye patch (diatoms?) Distinct male w/ open saddle and wide fin--canted to left w/ notch in middle.
13 6/5/2002	HTI (acoustic line) was broken with 1 station left to finish. Initial sighting was post-poned 30 mins to finish CTD line--we went back to find these animals. Poor photos (<10% of group photo-identified--few distant frames; no biopsy attempt; ecotype resident. Initially, frequent tail-slapping by one of the adult males and spyhopping. Very evasive group that was either milling or traveling slowly in Amukta Pass (north end). We spent 50 minutes with this group because they were being uncooperative and had a CTD line to do.

ENCOUNTER NUMBER/DATE	NOTES (CONT'D)
14 6/9/2002	Encountered group 1/2 hr prior to end of HTI line through Samalga pass. Line broken with 1 station remaining. Good photos (>50% of group photo-identified); 4 biopsies; ecotype presumed resident. Initially worked 1 larger group (about 15 animals) and some other smaller groups and males in the area unsuccessfully for 1.5 hrs. A front passed through and KW's appeared from all around in the convergence. Animals exhibited an array of behaviors over the next 3 hrs including an abundance of social play, spyhopping, breaching; tail-slapping; sexual play/display between 2-3 males throughout the encounter; and fishing (saw a KW bring up a large salmon off the bow).
15 6/10/2002	Encountered at the beginning of a CTD-CalVET line through Umnak pass. No photos; no biopsy; ecotype unknown. Saw 3 animals (1 male + 2 female types) at the beginning Animals appeared to be traveling.
16 6/10/2002	Encountered during HTI line (near end) with 1 station remaining. Poor photos (<10% of group photo-identified); 1 biopsy; ecotype presumed resident. Beaufort 6; 30 kt winds; 5' seas left us with poor photos and 1 biopsy of male with forward canted fin. Saw 3 groups in area, minimum 14 animals. Although no open saddles were seen, animals were milling and diving over a confined area where HTI had shown strong fish sign prior to breaking the transect--suggesting these animals may have been foraging. Bottom topography drops off quickly in the north end of Umnak pass. Numerous Laysan Albatross and other bird species were observed feeding on dead, floating rock fish--presumably bycatch from fishery tossed overboard (fishing gear seen in the area).
17 6/11/2002	Encountered during transit from Umnak to Unimak. Good photos (>50% of group photo-identified); 2 biopsies; ecotype presumed resident. Killer whales were seen North east of Makushin Bay and worked from both boats. Good photos of biopsied whales (2 males with distinct fins). Dart tip broke off with crossbow attempt in adult female (pictured during darting on MR #55 LM1 frames 5-9, plus others frames on the roll). Although no open saddles were seen, these animals may be residents, as they appeared to be diving over an area for a time before moving, suggesting foraging.
18 6/11/2002	Encountered during transit from Umnak to Unimak pass. Poor photos (<10% of group photo-identified); 2 biopsies; ecotype presumed resident. Killer whales encountered were spread over miles--all traveling west. Transiting on a schedule for MOCNESS in Unimak--had only 1.5 hrs to get some photos and biopsies to represent the passing sub groups. Limited time and scattered distribution of made it difficult to estimate number of animals but we roughly estimate a minimum of 30-35 animals. We worked with 2 sub- groups (only) before continuing our transit. These animals were encountered 1.5 hrs and 10 miles east of previous encounter (#17).
19 6/11/2002	Encountered during transit to Unimak for MOCNESS. Passed. No photos; no biopsy; ecotype unknown. No time to stop; possibly part of larger, spread out group from previous encounter(s)? In passing-mode, rough estimate: 2 groups of 5 animals. These animals were seen approximately 30 minutes and 5 mi east of previous encounter (#18).

ENCOUNTER NUMBER/DATE	NOTES (CONT'D)
20 6/16/02	Encountered after just having completed HTI in transit through Akutan pass and on the way to Unimak for MOCNESS tonight. Excellent photos (100% of group photo-identified); 1 biopsy (adult male); ecotype presumed transient? Initially saw 3 individuals, lost them, then resighted. All had ragged dorsal fins on the trailing edges and closed saddles. Possible transients. At least 1 male; possible 2nd male as sprouter and 1 smaller female-type. Whales were following the 100m contour along Akutan Island.
21 6/16/02	Encountered in transit through Akutan pass and on the way to Unimak for MOCNESS tonight. Fair photos (<25% of group photo-identified); 1 biopsy; ecotype presumed resident. Not long after Encounter 20 we came upon KW's and much of the food chain! Large euphausiid bloom made the water red from a distance; minimum 50 humpback whales; dalls porpoise; flocks of shear waters and fulmars; fulmars & Laysan albatross eating on what appeared to be mammalian intenstines; and a lot of activity above and below the water...in some areas water was "boiling" with krill and fish. After only 1 pass of photos on 7-9 animals and 1 biopsy of an adult male, we had to stop due to shipping traffic and the shipping channel. Not a good enough look to estimate group size and composition of sub-groups.
22 6/16/02	Encountered in transit through Akutan pass and on the way to Unimak for MOCNESS tonight. Poor photos (<10% of group photo-identified); no biopsy; ecotype presumed resident. After Encounter 21 bird collecting was underway and we waited for shipping traffic to pass. Water was rougher, winds and sea state picked up, whales elusive. Shot several frames of an animal that looked 99% certain to be from the Encounter 21 group. Possible same group of animals. Worked humpbacks instead.
23 6/17/2002	Encountered on a day dedicated to whales. No photos; no biopsy; ecotype unknown. Hail from NOAA ship Miller Freeman and other circumstances cost losing animals and never resighted. Sighted and lost animals near feature of biomass observed previous day. Losing the animals became an "opening" to began a "1.5 hr" CTD line that became 11 hrs of CTD/HTI lines in a criss-cross pattern at the north end of Unimak pass through the feature. Millions of shearwaters and minimum 100 humpacks in the area.
24 6/18/02	Encountered on a day dedicated to whales. Good photos (>50% of group photo-identified); 1 biopsy; ecotype presumed to be transient. Sighted animals on the way to southeast side of Unimak Island. Transient-looking, no open saddles, 4-5 animals. Good photos of 3 animals; biopsy of adult male.
25 6/18/02	Encountered on a day dedicated to whales. Good photos (>50% of group photo-identified); 1 biopsy; ecotype presumed to be transient. Sighted animals on the southeast coast of Unimak Island--2 miles offshore. Transient-looking, no open saddles, good photos of at least 6 individuals; 1 biopsy adult male.

ENCOUNTER NUMBER/DATE	NOTES (CONT'D)
26 6/18/02	Encountered on a day dedicated to whales. Fair photos (<25% of group photo-identified); 4 biopsies; ecotype presumed transient. Sighted animals on the southeast coast of Unimak Island--2 miles offshore. Milling and social behavior with pod members and often approached RHIB. Huge oil slick, smell, and chunks of flesh. KW's were feeding on gray whale carcass, presumably a calf taken the previous day; repeatedly dragging it under. Appeared that other groups were coming to join but we had to leave before we could get a look or group size estimate. At least 4 subgroups; 4-5 males; many calves; minimum of 30 whales and possibly others on the way. Feeding/socializing made them very easy to work. Unfortunate and untimely restriction was hailed over the radio by grad student and we had to leave this encounter to do a duplicate "bird" line through Unimak pass.

Appendix I: List of stations and Activities

Station	Date	Time	Lat.	Long.	Depth (m)	Activity
UNY30	5/19	2349	54 33.80	165 48.42	422	Deploy MOCNESS 1
	5/20	0028	54 34.60	165 50.23	425	Recover MOCNESS
UNY28	5/20	0128	54 31.53	165 39.90	320	Deploy MOCNESS 2
	5/20	0156	54 32.39	165 41.40	364	Recover MOCNESS
UNY26	5/20	0330	54 29.39	165 30.93	94	Deploy MOCNESS 3
	5/20	0356	54 30.18	165 31.63	99	Recover MOCNESS
UNY23	5/20	0509	54 25.67	165 18.80	156	Deploy MOCNESS 4
	5/20	0535	54 26.39	165 19.71	150	Recover MOCNESS
UNY28	5/20	0708	54 31.17	165 39.68	307	CTD 001 (Prod Station)
UNY28	5/20	0744	54 31.18	165 39.60	320	Start HTI run
UNY19	5/20	1233	54 20.91	165 02.04	123	Recover HTI for CTD
UNY19	5/20	1255	54 20.90	165 02.10	123	CTD 002 (Prod Station)
UNY19	5/20	1317	54 20.88	165 01.93	115	Re-deploy HTI
UNY08	5/20	1840	54 08.21	164 15.78	78	Recover HTI for CTD
CTD						failed, bad slip rings
UNY08	5/20	1931	54 08.20	164 16.12	77	Re-deploy HTI
UNY01	5/20	2346	54 00.29	163 46.79	96	Recover HTI
UNY01	5/21	0037	54 00.55	163 46.17	94	Deploy MOCNESS 5
	5/21	0108	54 01.25	163 45.00	87	Recover MOCNESS
Operations stopped, weather						
AKY14	5/21	1808	54 03.33	166 09.94	74	CTD 003 (Prod station)
AKY14	5/21	2330	54 03.46	166 09.76	74	Deploy MOCNESS 6
	5/21	2355	54 04.40	166 09.44	45	Recover MOCNESS
AKY16	5/22	0044	54 05.61	166 17.94	87	Deploy MOCNESS 7
	5/22	0106	54 05.49	166 16.72	86	Recover MOCNESS
AKY17	5/22	0145	54 06.77	166 22.24	105	Deploy MOCNESS 8
	5/22	0211	54 06.42	166 20.71	94	Recover MOCNESS
AKY18	5/22	0254	54 07.90	166 26.22	783	Deploy MOCNESS 9
	5/22	0322	54 07.46	166 24.60	509	Recover MOCNESS
AKY19	5/22	0404	54 09.09	166 30.40	938	Deploy MOCNESS 10
	5/22	0426	54 08.77	166 29.05	971	Recover MOCNESS
AKY19	5/22	0729	54 09.15	166 30.62	930	CTD 004 (Prod station)
	5/22	0752	54 09.06	166 30.64	923	CalVET 1
	5/22	0805	54 09.21	166 30.67	942	CTD 005
AKY18	5/22	0855	54 07.98	166 26.43	792	CTD 006
	5/22	0929	54 07.74	166 26.27	745	CalVET 2
AKY17	5/22	1000	54 06.85	166 22.57	108	CTD 007
	5/22	1010	54 06.86	166 22.54	108	CalVET 3
AKY16	5/22	1035	54 05.72	166 18.21	88	CTD 008
	5/22	1049	54 05.95	166 18.32	88	CalVET 4
AKY15	5/22	1119	54 04.53	166 14.04	78	CTD 009
	5/22	1132	54 04.71	166 14.32	78	CalVET 5

Station	Date	Time	Lat.	Long.	Depth	Activity
AKY14	5/22	1200	54 03.44	166 09.93	74	CTD 010
	5/22	1219	54 03.33	166 09.98	74	CalVET 6
AKY13	5/22	1258	54 02.28	166 05.91	48	CTD 011
	5/22	1313	54 02.17	166 05.99	64	CalVET 7
AKY12	5/22	1358	54 01.10	166 01.67	70	CTD 012
	5/22	1416	54 00.99	166 01.73	77	CalVET 8
AKY11	5/22	1442	53 59.97	165 57.41	87	CTD 013
	5/22	1457	53 59.88	165 57.49	87	CalVET 9
AKY10	5/22	1521	53 58.72	165 53.24	97	CTD 014
	5/22	1535	53 58.69	165 52.94	81	CalVET 10
AKY07	5/22	1616	53 55.23	165 40.86	99	CTD 015
	5/22	1640	53 55.46	165 40.78	99	CalVET 11
AKY04	5/22	1738	53 51.72	165 28.46	90	CTD 016
	5/22	1754	53 51.91	165 28.59	90	CalVET 12
AKY01	5/22	1852	53 48.28	165 16.28	126	CTD 017
	5/22	1907	53 48.33	165 38.79	99	CalVET 13
AKY10	5/22	2339	53 58.46	165 53.03	87	Deploy MOCNESS 11
	5/23	0003	53 57.70	165 52.12	70	Recover MOCNESS
AKY08	5/23	0054	53 56.36	165 45.09	90	Deploy MOCNESS 12
	5/23	0122	53 56.20	165 43.81	100	Recover MOCNESS
	5/23	0221	53 54.98	165 39.49	100	Stopped ops: winds
	5/23	1938	54 00.33	166 56.11	132	Whales/ small boat
AKY19	5/24	0700	54 09.23	166 30.67	926	CTD 018 (Prod)
	5/24	0729	54 09.19	166 30.65	926	HTI deployed
Acoustics, seabird, whale transect						
AKY10	5/24	1126	53 58.45	165 52.35	87	Abort transect
	5/24	1500	53 15.98	165 44.55		Whale obs, Akutan Bay
	5/24	2000	54 17.65	166 02.71		Chasing Whales
UNY11	5/25	0401	54 11.73	164 28.54	91	Deploy MOCNESS 13
	5/25	0425	54 11.59	164 27.81	91	Recover MOCNESS
UNY30	5/25	0940	54 33.63	165 48.19	422	CTD 019
	5/25	1017	54 33.78	165 48.12	420	CalVET 14
UNY28	5/25	1059	54 31.24	165 39.55	307	CTD 020
	5/25	1103	54 31.24	165 39.55	307	CalVET 15
UNY26	5/25	1203	54 28.89	165 31.16	94	CTD 021
	5/25	1216	54 28.69	165 31.10	94	CalVET 16
UNY23	5/25	1309	54 25.47	165 18.61	156	CTD 022
	5/25	1328	54 25.32	154 18.86	156	CalVET 17
UNY20	5/25	1434	54 22.03	165 06.06	141	CTD 023
	5/25	1454	54 22.34	165 07.30	141	CalVET 18
UNY18	5/25	1602	54 19.78	165 57.87	84	CTD 024
	5/25	1637	54 19.60	164 57.87	88	CalVET 19
UNY16	5/25	1748	54 17.53	164 49.63	62	CTD 025
	5/25	1812	54 17.40	164 49.48	62	CalVET 20

Station	Date	Time	Lat.	Long.	Depth	Activity
UNY14	5/25	1906	54 15.08	164 40.95	78	CTD 026
	5/25	1920	54 15.24	164 40.94	78	CalVET 21
UNY11	5/25	2017	54 11.63	164 28.36	89	CTD 027
	5/25	2028	54 11.64	164 28.06	89	CalVET 22
UNY08	5/25	2122	54 08.24	164 15.88	76	CTD 028
	5/25	2133	54 08.32	164 15.53	76	CalVET 23
UNY05	5/25	2226	54 04.83	164 03.40	69	CTD 029
	5/25	2237	54 04.92	164 03.15	69	CalVET 24
	5/25	2326	54 05.05	164 03.40	69	Deploy MOCNESS 14
	5/25	2345	54 04.97	164 04.30	70	Recover MOCNESS
AKY04	5/26	0532	53 51.69	165 28.72	91	Deploy MOCNESS 15
	5/26	0556	53 51.32	165 29.46	94	Recover MOCNESS
AKY01	5/26	0721	53 48.27	165 16.18	295	Deploy HTI
Acoustics, birds, whales transect, AKY01-10						
	5/26	1049	53 56.05	165 43.90	97	Abort transect, tides
AKY11	5/26	1203	53 59.75	165 43.00	104	Deploy HTI
Acoustics, birds, whales transect, AKY11-7,						
	5/26	1332	53 55.79	165 43.00	100	Recover HTI
Underway to Tanaga Pass, bird and whale observations en route						
	5/27	1256	52 15.95	172 01.16		Killer Whales
	5/27	1840	51 57.25	172 54.85	111	Small boat ops, whales
	5/27	2205	52 01.88	172 37.67	120	Small boat returned
TNY01	5/29	0005	51 25.23	177 45.25	1400	Deploy MOCNESS 16
	5/29	0042	51 24.03	177 46.71	1400	Recover MOCNESS
TNY04	5/29	0151	51 28.60	177 56.79	1300	Deploy MOCNESS 17
	5/29	0225	51 27.80	177 57.95	1300	Recover MOCNESS
TNY07	5/29	0331	51 31.94	178 08.67		Deploy MOCNESS 18
	5/29	0401	51 31.27	178 10.71	721	Recover MOCNESS
TNY10	5/29	0503	51 37.93	178 18.24		Deploy MOCNESS 19
	5/29	0535	51 38.28	178 19.76	390	Recover MOCNESS
TNY13	5/29	0630	51 42.84	178 27.38	761	Deploy MOCNESS 20
	5/29	0658	51 41.99	178 27.18		Recover MOCNESS
TNY12	5/29	0719	51 41.07	178 28.31	426	CTD 030 (Prod)
	5/29	0738	51 41.23	178 23.86		Start Bird, whale obs
	5/29	0955	51 40.88	178 21.15		Killer whales sighted
TNY01	5/29	1233	51 25.58	177 44.55		CTD 031 (Prod)
	5/29	1256	51 25.64	177 44.75		Deploy HTI
Acoustics, birds, whales obs TNY 01-21						
TNY04	5/29	1413	51 28.69	177 56.49		ARGOS drifter 36266
TNY21	5/29	2228	52 04.26	178 29.08		Recover HTI
TNY15	5/30	0047	51 46.90	178 29.73	2300	Deploy MOCNESS 21
	5/30	0118	51 46.06	178 28.79		Recover MOCNESS
TNY17	5/30	0217	51 52.91	178 27.17	2300	Deploy MOCNESS 22

Station	Date	Time	Lat.	Long.	Depth	Activity
	5/30	0241	51 52.13	178 26.76		Recover MOCNESS
TNY19	5/30	0339	51 59.10	178 27.70	>2000	Deploy MOCNESS 23
	5/30	0402	51 58.29	178 27.09		Recover MOCNESS
TNY21	5/30	0455	52 03.83	178 28.84		Deploy MOCNESS 24
	5/30	0516	52 03.06	178 28.06		Recover MOCNESS
TNY21	5/30	0840	52 04.03	178 28.78	>2000	CTD 032 (Prod)
	5/30	0903	52 04.07	178 28.88		CalVET 25
	5/30	0914	52 03.97	178 28.81		CTD 033
					>2000	
TNY18	5/30	1034	51 56.09	178 26.69		CTD 034
	5/30	1108	51 56.07	178 27.30		CalVET 26
TNY16	5/30	1154	51 50.46	178 28.42	2100	CTD 035
	5/30	1239	51 50.26	178 29.15		CalVET 27
TNY14	5/30	1325	51 44.86	178 30.49	1414	CTD 036
	5/30	1408	51 44.57	178 30.89		CalVET 28
TNY13	5/30	1437	51 43.06	178 27.36	816	CTD 037
	5/30	1523	51 43.17	178 27.33		CalVET 29
TNY12	5/30	1547	51 41.09	178 24.30	426	CTD 038 (Prod)
	5/30	1559	51 41.11	178 24.11		CalVET 30
	5/30	1610	51 41.16	178 24.49		CTD 039
TNY10	5/30	1716	51 37.83	178 17.81	357	CTD 040
	5/30	1747	51 37.69	178 18.36		CalVET 31
TNY08	5/30	1832	51 33.93	178 11.51	245	CTD 041
	5/30	1851	51 34.15	178 11.54	245	CalVET 32
TNY05	5/30	1953	51 29.52	178 00.63	1269	CTD 042
	5/30	2039	51 29.50	178 00.45		CalVET 33
TNY02	5/30	2138	51 26.71	177 48.74	1519	CTD 043
	5/30	2209	51 26.64	177 49.20		CalVET 34
TNX05	5/31	0819	51 38.89	178 08.18	60	CTD 044
TNX04	5/31	0847	51 38.14	178 12.00	100	CTD 045
TNX03	5/31	0925	51 36.73	178 16.90	360	CTD 046
TNX02	5/31	1014	51 35.27	178 21.57	177	CTD 047
TNX01	5/31	1051	51 34.10	178 26.31	82	CTD 048
	5/31	1300	51 42.28	178 29.59		Deploy small boat-sperm whales
	5/31	1430				Recover small boat
	5/31	1525	51 38.36	178 56.16		Deploy small boat (killer whales)
	5/31	1720				Recover small boat
SGY17	6/02	1205	52 27.25	173 07.48	1050	CTD 049 (Prod)
	6/02	1218	52 27.27	173 07.39	1050	CalVET 35
	6/02	1229	52 27.73	173 07.48	1047	CTD 050
SGY15	6/02	1336	52 22.97	173 01.81	959	CTD 051
	6/02	1409	52 22.84	173 00.78	959	CalVET 36

Station	Date	Time	Lat.	Long.	Depth	Activity
	6/04	0831				line abandoned- whales
	6/04	1212	52 10.62	172 48.09		Deploy small boat
	6/04	1437	52 11.67	172 47.01		Recover small boat
SGY12	6/04	1523	52 16.85	172 53.47	297	CTD 065 (prod)
	6/04	1636	52 10.52	172 44.90	151	Deploy small boat(birds)
	6/04	1748	52 10.54	172 43.75		Recover small boat
	6/04	1820	52 12.01	172 47.80	167	Deploy small boat (whales)
	6/04	2233	52 15.77	172 54.33	272	CTD 066 (prod)
	6/04	2258	52 16.80	172 54.65	272	Recover small boat
SGX04	6/05	0001	52 08.50	172 58.25	90	CTD 067
SGX03	6/05	0045	52 11.44	172 52.17	130	CTD 068
SGX02	6/05	0128	52 14.42	172 46.29	153	CTD 069
SGX01	6/05	0209	52 17.39	172 40.34	112	CTD 070
AMX05	6/05	0424	52 21.77	172 14.00	308	CTD 071
AMX04	6/05	0528	52 22.72	172 02.13	418	CTD 072
AMX03	6/05	0636	52 23.69	171 50.25	278	CTD 073
AMX02	6/05	0743	52 24.66	171 38.24	472	CTD 074
AMX01	6/05	0851	52 25.52	171 26.35	394	CTD 075
AMY01	6/05	1144	52 02.66	171 41.80	507	Deploy HTI
Acoustics, Bird, whale obs AMY01-AMY17						
AMY04	6/05	1303	52 10.67	171 43.70	480	Drifter 36264
	6/05	1556	52 30.76	171 48.48	620	Abandon transect, whales
AMY11	6/05	1705	52 29.29	171 48.06	580	CTD 076 (prod)
	6/05	1730	52 30.98	171 48.38	620	Restart transect
AMY17	6/05	1958	52 45.26	171 51.96		Recover HTI
AMY17	6/05	2001	52 43.98	171 52.20	804	CTD 077 (prod)
	6/05	2024	52 43.98	171 52.20		Whales
AMY17	6/05	2132	52 45.33	171 52.02	797	CTD 078
	6/05	2213	52 45.33	171 52.03	807	CalVET 46
AMY15	6/05	2306	52 40.06	171 50.72	616	CTD 079
	6/05	2339	52 39.94	171 50.71	588	CalVET 47
AMY13	6/06	0038	52 34.69	171 49.34	830	CTD 080
	6/06	0109	52 34.52	171 49.69	692	CalVET 48
AMY11	6/06	0245	52 29.36	171 48.06	585	CTD 081
	6/06	0324	52 29.28	171 48.20	585	CalVET 49
AMY09	6/06	0453	52 24.02	171 46.93	295	CTD 082
	6/06	0514	52 24.20	171 46.80	295	CalVET 50
AMY08	6/06	0556	52 21.30	171 46.15	257	CTD 083
	6/06	0620	52 21.27	171 46.42	257	CalVET 51
AMY06	6/06	0717	52 15.98	171 44.90	372	CTD 084
	6/06	0746	52 15.93	171 45.39	372	CalVET 52
AMY04	6/06	0844	52 10.65	171 43.64	480	CTD 085

Station	Date	Time	Lat.	Long.	Depth	Activity
SGY13	6/02	1445	52 18.85	172 56.21	578	CTD 052
	6/02	1519	52 18.48	172 55.64	578	CalVET 37
SGY12	6/02	1541	52 16.78	172 53.44	285	CTD 053
	6/02	1603	52 16.48	172 53.23	285	CalVET 38
SGY11	6/02	1625	52 14.76	172 50.72	171	CTD 054
	6/02	1642	52 14.53	172 50.68	171	CalVET 39
SGY10	6/02	1705	52 12.66	172 48.02	174	CTD 055 (Prod)
	6/02	1716	52 12.40	172 48.16	174	CalVET 40
	6/02	1726	52 12.15	172 48.22	169	CTD 056
SGY08	6/02	1816	52 08.65	172 42.35	163	CTD 057
	6/02	1834	52 08.68	172 42.18	163	CalVET 41
SGY06	6/02	1922	52 04.47	172 36.68	124	CTD 058
	6/02	1940	52 04.53	172 36.77	124	CalVET 42
SGY04	6/02	2028	52 00.35	172 31.07	139	CTD 059
	6/02	2046	52 00.40	172 30.95	139	CalVET 43
SGY02	6/02	2133	51 56.23	172 25.37	588	CTD 060
	6/02	2207	51 56.29	172 25.34	588	CalVET 44
SGY00	6/02	2250	51 52.07	172 19.87		CTD 061
	6/02	2321	51 51.98	172 19.80		CalVET 45
SGY00	6/03	0029	51 52.20	172 20.08		Deploy MOCNESS 25
	6/03	0100	51 53.26	172 21.50		Recover MOCNESS
SGY02	6/03	0136	51 56.34	172 25.48	561	Deploy MOCNESS 26
	6/03	0204	51 57.60	172 26.80	276	Recover MOCNESS
SGY04	6/03	0242	52 00.61	172 31.07	150	Deploy MOCNESS 27
	6/03	0308	52 01.91	172 31.32	150	Recover MOCNESS
SGY06	6/03	0352	52 04.57	172 36.39	126	Deploy MOCNESS 28
	6/03	0419	52 05.67	172 35.50	143	Recover MOCNESS
SGY09	6/03	0544	52 10.51	172 44.96	154	Deploy MOCNESS 29
	6/03	0614	52 09.81	172 45.42	137	Recover MOCNESS
SGY17	6/03	0856	52 27.25	173 07.52	1050	CTD 062(Prod)
	6/03	0918	52 27.20	173 07.44	1050	Deploy HTI
Acoustics, birds, whales observations, SGY17-00						
SGY00	6/03	1733	51 52.03	172 19.88		Recover HTI
SGY00	6/03	1754	51 51.95	172 19.84		CTD 063(Prod)
	6/03	2204	52 22.96	172 45.09	190	Whales Whales
SGY17	6/04	0148	52 27.29	173 07.54		Deploy MOCNESS 30
	6/04	0216	52 27.95	173 08.43		Recover MOCNESS
SGY15	6/04	0309	52 23.22	173 01.82	966	Deploy MOCNESS 31
	6/04	0325	52 23.97	173 02.17	1004	Recover MOCNESS
SGY13	6/04	0424	52 19.07	172 56.20	600	Deploy MOCNESS 32
	6/04	0450	52 19.60	172 56.53	666	Recover MOCNESS
SGY11	6/04	0543	52 14.63	172 50.93	176	Deploy MOCNESS 33
	6/04	0611	52 13.91	172 51.96	160	Recover MOCNESS
SGX01	6/04	0803	52 17.29	172 40.52	120	CTD 064

Station	Date	Time	Lat.	Long.	Depth	Activity
	6/06	0916	52 10.47	171 44.33	480	CalVET 53
	6/06	0937	52 10.62	171 43.76	480	CTD 086(prod)
Transect truncated/ weather						
SAY16	6/07	1236	53 05.36	169 16.71	1050	CTD 087
	6/07	1310	53 05.06	169 16.44	1050	CalVET 54
SAY14	6/07	1400	53 00.19	169 22.69	866	CTD 088
	6/07	1431	53 00.11	169 22.84	860	CalVET 55
SAY12	6/07	1517	52 54.77	169 25.45	419	CTD 089
	6/07	1550	52 55.36	169 24.91	419	CalVET 56
SAY10	6/07	1649	52 49.37	169 28.17	252	CTD 090
	6/07	1716	52 49.96	169 27.00	252	CalVET 57
	6/07	1724	52 50.15	169 26.85	252	CalVET redo
Transect stopped/weather						
SAY02	6/08	0934	52 28.18	169 21.83	1252	CTD 091
	6/08	1007	52 27.71	169 22.25	1252	CalVET 58
SAY04	6/08	1054	52 33.43	169 24.98	454	CTD 092
	6/08	1124	52 33.02	169 25.12	454	CalVET 59
SAY06	6/08	1219	52 38.69	169 27.92	260	CTD 093
	6/08	1239	52 38.38	169 28.14	260	CalVET 60
	6/08	1246	52 38.33	169 28.22	200	Deploy drifter 36265
SAY08	6/08	1324	52 43.81	169 31.05	230	CTD 094
	6/08	1345	52 43.61	169 30.87	230	CalVET 61
SAY10	6/08	1447	52 50.00	169 28.31	252	CalVET 62
	6/08	1504	52 49.36	169 28.08	252	CTD 095
	6/08	1530				Bird collecting
SAX05	6/08	1642	52 52.50	169 37.56	78	CTD 096
SAX04	6/08	1715	52 51.73	169 32.55	162	CTD 097
SAX03	6/08	1753	52 50.73	169 27.57	241	CTD 098
SAX02	6/08	1840	52 49.90	169 22.79	179	CTD 099
SAX01	6/08	1924	52 48.97	169 17.90	45	CTD 100
SAY14	6/09	0039	53 00.06	169 22.98	833	Deploy MOCNESS 34
	6/09	0110	52 59.17	169 24.22	747	Recover MOCNESS
SAY10	6/09	0237	52 49.25	169 28.19	252	Deploy MOCNESS 35
	6/09	0305	52 49.05	169 28.47	244	Recover MOCNESS
SAY06	6/09	0434	52 38.60	169 28.24	254	Deploy MOCNESS 36
	6/09	0502	52 38.33	169 29.79	202	Recover MOCNESS
SAY02	6/09	0632	52 28.20	169 28.20	270	Deploy MOCNESS 37
	6/09	0700	52 28.02	169 24.89	270	Recover MOCNESS
SAY02	6/09	0737	52 28.33	169 21.79	340	Deploy HTI
Acoustics birds, whales transect, SAY02-SAY14						
SAY11	6/09	1356	52 51.87	169 26.88	278	Break off line, whales
	6/09	1757	52 48.03	169 28.56	261	End whale chase
	6/09	1818	52 51.00	169 26.73	282	Re-deploy HTI
SAY14	6/09	1929	53 00.42	169 22.41	854	Recover HTI

Station	Date	Time	Lat.	Long.	Depth	Activity
UMY08	6/10	1007	53 38.13	167 40.88	1183	CTD 101
	6/10	1043	53 37.80	167 40.02	1187	CalVET 63
UMY07	6/10	1118	53 32.70	167 39.93	117	CTD 102
	6/10	1135	53 32.37	167 40.02	115	CalVET 64
UMY06	6/10	1210	53 27.34	167 39.00	124	CTD 103
	6/10	1224	53 27.17	167 39.03	124	CalVET 65
UMY05	6/10	1301	53 23.38	167 45.62	75	CTD 104
	6/10	1312	53 23.12	167 45.76	86	CalVET 66
UMY04	6/10	1345	53 19.95	167 52.28	57	CTD 105
	6/10	1357	53 19.98	167 52.54	57	CalVET 67
UMY03	6/10	1412	53 18.27	167 55.47	80	CTD 106
	6/10	1421	53 18.35	167 55.50	80	CalVET 68
UMY02	6/10	1500	53 12.62	167 55.68	69	CTD 107
	6/10	1516	53 12.72	167 55.40	69	CalVET 69
UMY01	6/10	1555	53 07.19	167 55.94	88	CTD 108
	6/10	1607	53 07.13	167 55.76	88	CalVET 70
	6/10	1628	53 07.18	167 55.83	88	Deploy HTI
Acoustics, birds, whales transect UMY01-08						
UMY07+	6/10	2053	53 33.44	167 39.94	400	Recover HTI
	6/10	2138	53 33.23	167 40.81	437	whales
UMY07	6/11	0710				Start bird, whale obs.
	6/11	1252	53 59.27	167 01.23		Small boat ops, whales
UNY20	6/12	0119	54 22.27	165 06.18	140	Deploy MOCNESS 38
	6/12	0148	54 23.47	165 06.71	150	Recover MOCNESS
UNY23	6/12	0249	54 25.62	165 18.72	155	Deploy MOCNESS 39
	6/12	0318	54 26.37	165 19.82	150	Recover MOCNESS
UNY27	6/12	0429	54 30.16	165 35.68	139	Deploy MOCNESS 40
	6/12	0455	54 30.90	165 36.89	219	Recover MOCNESS
UNY27	6/12	0601	54 30.00	165 35.39	133	CTD 109 (prod)
UNY27	6/12	0622	54 30.04	165 35.43	139	Deploy HTI
Acoustics, bird, whale obs, UNY27-6						
UNY15	6/12	1103	54 16.27	165 45.04	92	Recover HTI for CTD
UNY15	6/12	1114	54 16.22	164 45.06	86	CTD 110 (prod)
UNY15	6/12	1136	54 16.18	164 44.87	80	Redeploy HTI
UNY06	6/12	1500	54 05.97	164 07.54	69	Recover HTI
UNY06	6/12	1504	54 05.98	164 07.64	69	CTD 111 (prod)
	6/12	1518	54 05.99	164 07.78	70	CalVET 71
UNY08	6/12	1558	54 08.23	164 16.04	76	CTD 112
UNY10	6/12	1642	54 10.47	164 24.29	91	CTD 113
	6/12	1656	54 10.33	164 24.19	91	CalVET 72
UNY12	6/12	1737	54 12.82	164 32.79	113	CTD 114
UNY14	6/12	1822	54 15.26	164 41.04	85	CTD 115
	6/12	1831	54 15.65	164 41.33	85	CalVET 73
UNY16	6/12	1910	54 17.41	164 49.65	60	CTD 116

Station	Date	Time	Lat.	Long.	Depth	Activity
UNY18	6/12	1941	54 19.77	164 57.74	85	CTD 117
	6/12	1958	54 19.70	164 57.81	85	CalVET 74
UNY20	6/12	2029	54 22.05	165 06.23	140	CTD 118
UNY22	6/12	2108	54 24.35	165 14.47	165	CTD 119
	6/12	2129	54 24.28	165 14.57	165	CalVET 75
UNY24	6/12	2207	54 26.66	165 22.88	146	CTD 120
UNY27	6/12	2305	54 30.09	165 35.44	136	CTD 121
	6/12	2318	54 30.19	165 35.66	136	CalVET 76
AKY19	6/13	0411	54 09.12	166 30.36	942	Deploy MOCNESS 41
	6/13	0443	54 08.63	166 28.33	938	Recover MOCNESS
AKY17	6/13	0525	54 06.86	166 22.14	106	Deploy MOCNESS 42
	6/13	0555	54 06.31	166 20.87	93	Recover MOCNESS
AKY16	6/13	0702	54 05.66	166 18.12	88	CTD 122
	6/13	0801	54 05.78	166 18.30	89	CTD 123
	6/13	0859	54 05.74	166 18.08	88	CTD 124
	6/13	1000	54 05.73	166 18.12	88	CTD 125
	6/13	1059	54 05.73	166 18.11	88	CTD 126
	6/13	1159	54 05.69	166 18.10	88	CTD 127
	6/13	1301	54 05.73	166 18.12	88	CTD 128
	6/13	1359	54 05.65	166 18.18	88	CTD 129
	6/13	1500	54 05.67	166 18.21	88	CTD 130
	6/13	1600	54 05.69	166 18.24	88	CTD 131
	6/13	1700	54 05.69	166 18.23	88	CTD 132
	6/13	1800	54 05.74	166 18.17	88	CTD 133
	6/13	1902	54 05.78	166 18.16	88	CTD 134
	6/13	2001	54 05.71	166 18.20	88	CTD 135
	6/13	2101	54 05.68	166 18.17	88	CTD 136
	6/13	2200	54 05.72	166 18.18	88	CTD 137
Break off operations, winds up to 40 knots						
AKY19	6/15	1349	54 09.25	166 30.59	940	CTD 138
	6/15	1420	54 09.31	166 30.05	940	CalVET 77
AKY17	6/15	1458	54 06.82	166 22.33	108	CTD 139
	6/15	1510	54 06.96	166 22.11	100	CalVET 78
AKY15	6/15	1549	54 04.56	166 14.02	77	CTD 140
	6/15	1600	54 04.61	166 14.19	77	CalVET 79
AKY13	6/15	1642	54 02.24	166 05.77	58	CTD 141
AKY11	6/15	1734	53 59.87	165 57.52	92	CTD 142
	6/15	1747	53 59.91	165 58.24	104	CalVET 80
AKY09	6/15	1840	53 57.52	165 49.35	79	CTD 143
AKY07	6/15	1930	53 56.28	165 40.92	101	CTD 144
	6/15	1958	53 55.38	165 41.15	101	CalVET 81
AKY05	6/15	2035	53 53.02	165 32.79	97	CTD 145
AKY03	6/15	2127	53 50.58	165 24.23	97	CTD 146
	6/15	2139	53 50.70	165 24.55	97	CalVET 82

Station	Date	Time	Lat.	Long.	Depth	Activity
AKY01	6/15	2227	53 48.34	165 15.92	125	CTD 147
AKY07	6/16	0032	53 55.12	165 40.76	99	Deploy MOCNESS
	6/16	0055	53 54.75	165 39.47	99	Recover MOCNESS
AKY04	6/16	0152	53 51.71	165 28.44	91	Deploy MOCNESS
	6/16	0217	53 51.30	165 26.94	92	MOCNESS
AKY01	6/16	0322	53 48.18	165 15.92	127	Deploy MOCNESS
	6/16	0350	53 47.49	165 14.46	139	Recover MOCNESS
	6/16	0435	53 48.29	165 16.27	149	CTD 148 (prod)
	6/16	0500	53 48.14	165 15.55		Deploy HTI
Acoustics, birds, whales transect AKY01-AKY19						
AKY19	6/16	1325	54 09.16	166 30.68		Recover HTI
Krill	6/16	2105	54 26.93	165 40.28	234	Deploy HTI
Acoustics line, patch of krill with birds, whales						
	6/16	2139	54 26.00	165 43.40	300	Recover HTI
AKY14	6/17	0107	54 03.30	166 09.97	75	Deploy MOCNESS
	6/17	0135	54 02.77	166 09.83	70	Recover MOCNESS
Dropped George off in Dutch Harbor						
KRX07	6/17	1313	54 26.51	165 36.48	127	CTD 149
KRX06	6/17	1334	54 25.60	165 38.26	150	CTD 150
KRX05	6/17	1354	54 24.74	165 40.17	155	CTD 151
KRX04	6/17	1415	54 23.84	165 42.10	152	CTD 152
KRX03	6/17	1436	54 23.00	165 43.87	110	CTD 153
KRX02	6/17	1456	54 22.13	165 45.74	134	CTD 154
KRX01	6/17	1517	54 21.25	165 47.69	124	CTD 155
	6/17	1546	54 21.30	165 47.69	125	Deploy HTI
Acoustics, birds, whales line, KR01-KR07+						
KRX07+	6/17	1731	54 27.06	165 33.92	102	Recover HTI
	6/17	1734	54 27.07	165 33.78	100	CTD 156
KRY01	6/17	1830	54 20.88	165 29.52	139	Deploy HTI
Acoustics, birds, whales line, KRY01-KRY09						
KRY09	6/17	2016	54 28.33	165 43.74		Recover HTI
	6/17	2023	54 28.39	165 43.59	364	CTD 157
KRY08	6/17	2056	54 27.53	165 41.86	312	CTD 158
KRY07	6/17	2127	54 26.60	165 40.12	212	CTD 159
KRY06	6/17	2154	54 25.69	165 38.31	123	CTD 160
KRY05	6/17	2219	54 24.83	165 36.66	104	CTD 161
KRY04	6/17	2241	54 23.92	165 34.90	87	CTD 162
KRY03	6/17	2303	54 22.88	165 32.86	121	CTD 163
KRY02	6/17	2325	54 22.12	165 31.34	164	CTD 164
KRY01	6/17	2350	54 21.30	165 29.66	140	CTD 165