# Coastal Circulation and Sediment Dynamics along West Maui, Hawaii

## PART II:

### 2003 Hydrographic Survey Cruises A-3-03-HW and A-4-03-HW Report on the spatial structure of currents, temperature, salinity and turbidity along Western Maui.

U.S. Department of the Interior
U.S. Geological Survey

**Open-File Report 03-430**

# Coastal Circulation and Sediment Dynamics along West Maui, Hawaii

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### 2003 Hydrographic Survey Cruises A-3-03-HW and A-4-03-HW Report on the spatial structure of currents, temperature, salinity and turbidity along Western Maui.

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U.S. GEOLOGICAL SURVEY

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## ADDITIONAL DIGITAL INFORMATION

For additional information on the February, 2003 cruises, please see:
http://walrus.wr.usgs.gov/infobank/a/a303hw/html/a-3-03-hw.meta.html

For additional information on the June/July, 2003 cruises, please see:
http://walrus.wr.usgs.gov/infobank/a/a403hw/html/a-4-03-hw.meta.html

For an online PDF version of this report, please see:
http://geopubs.wr.usgs.gov/open-file/of03-430/

For more information on the U.S. Geological Survey Western Region's Coastal and Marine Geology Team, please see:
http://walrus.wr.usgs.gov/

For more information on the U.S. Geological Survey's Coral Reef Project, please see:
http://coralreefs.wr.usgs.gov/

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## REPORT REFERENCE

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# INTRODUCTION

Two multi-day hydrographic survey cruises were conducted to acquire spatially-extensive, high-resolution three-dimensional measurements of currents, temperature, salinity and turbidity were made off West Maui in the winter and summer of 2003 to better understand coastal dynamics in coral reef habitats. The studies were conducted in support of the U.S. Geological Survey (USGS) Coastal and Marine Geology Program's Coral Reef Project. The purpose of these cruises was to collect hydrographic data to better constrain the nature of how currents and water column properties such as water temperature, salinity and turbidity in the vicinity of nearshore coral reef systems vary over relatively large (~ 20 km) spatial scales. These measurements support the ongoing process studies being conducted under the Coral Reef Project; the ultimate goal is to better understand the transport mechanisms of sediment, larvae, pollutants and other particles in coral reef settings. This report, the second in a series of three, describes data acquisition, processing and analysis. Previous and subsequent reports will provide data and results on: Long-term measurements of currents, temperature, salinity and turbidity off Kahana (PART I), and Flow and coral larvae and sediment dynamics during the 2003 summer spawning season (PART III)

**Project Objectives:**

The objective of these cruises was to understand how currents, temperature, salinity and turbidity vary both horizontally and vertically along northwest Maui during 2003. These data were collected to support the ongoing process studies being conducted off northwest Maui as part of the multi-disciplinary USGS Coral Reef Project that focuses on the geologic processes that affect coral reef systems. To meet these objectives, the direction and intensity of current flow along northwest Maui were investigated. These data will provide insight into the impact of terrestrial sediment, nutrient or contaminant delivery and coral larval transport on nearshore coral reefs. The first set of cruises, A-3-03-HW, were collected over a spring-neap tidal cycle during the winter season (February, 2003) while the second, A-4-03-HW, were collected in late June/early July, 2003, during the spawning of the Hawaiian reef-building coral *Montipora capitata*. Data collected during these cruises supplement 15 months of benthic boundary layer and water column measurements made by a tripod deployed in roughly 10 m of water off Kahana, Maui as part of the USGS Coral Reef Project (see PART 1 of this report).

**Study Area:**

These two cruises were conducted off Western Maui, Hawaii, USA, in the Pailolo and Auau Channels between the Hawaiian Islands of Maui, Lanai and Molokai. The data collection extended from Honolua Bay south to Lahaina (FIGURE 1). All of the surveys were collected on the inner shelf, inshore of the 50 m isobath. These surveys extended inshore as shallow as possible, usually between the 4 m and 10 m isobaths depending on the oceanographic conditions (primarily ocean surface waves). All vessel operations, including mobilization and demobilization, were based out of Lahaina Harbor, West Maui, Hawaii.

## OPERATIONS

This section provides information about the vessel, personnel and equipment used during the cruises. See TABLE 1 for a list of personnel and TABLES 2 through 5 for complete listings of cruise operational information.

**Scientific Party:**

The scientific party for A-3-03-HW included two scientists from the USGS Coral Reef Project and three cooperating scientists from the University of California at Santa Cruz (UCSC). At any one time, however, there were only three to four scientists on board the vessel: two USGS and one or two UCSC scientists. There was one vessel captain in addition to these scientists on board.

**Equipment and Data Review:**

Two primary instruments were used to acquire data during these surveys. The first instrument was a 600 kHz downward-looking Acoustic Doppler Current Profiler (ADCP), which was used to collect vertical profiles of current velocity and acoustic backscatter data. The second instrument employed was a Conductivity/Temperature/Depth (CTD) Profiler with an Optical Backscatter Sensor (OBS) to collect vertical profiles of water temperature, salinity, density and optical backscatter (a measure of turbidity).

ADCP profile data were collected continuously along 18 shore-normal transects and one shore-parallel transect while the vessel was traveling at approximately 2-3 knots. Over the 11 days of surveying we collected roughly 110 km of ADCP data down to a maximum depth of 40 m. CTD/OBS casts were collected at the beginning and end of each ADCP profiling line (one on the inshore end of each line and one at the offshore end of each line). Other CTD/OBS casts were collected at points along the line when interesting hydrographic features were observed. Thus two CTD/OBS casts were collected at each ADCP profiling line in order to relate water column structure to current velocities. In all, 211 CTD/OBS casts were collected over the 11 days of surveying. The log of ADCP profiler data acquisition is presented in TABLES 2 and 3 while the CTD/OBS data acquisition log is presented in TABLES 4 and 5. The instrument specifics and sampling schemes are listed in APPENDIX 1 and APPENDIX 2 for the ADCP profiler and CTD/OBS profiler, respectively.

Navigation equipment included two hand-held WAAS-equipped GPS units, a computer with positioning and mapping software and an external LCD monitor. The positioning and mapping software enabled real-time GPS position data to be combined with images of previously collected high-resolution SHOALS lidar color-coded, shaded-relief bathymetry, 5 m isobaths and aerial photographs of terrestrial portions of the maps. Fifteen planned data collection transects were entered into the software before the cruise departed and overlaid on the bathymetry; four more were added during the course of the cruises (FIGURE 2).

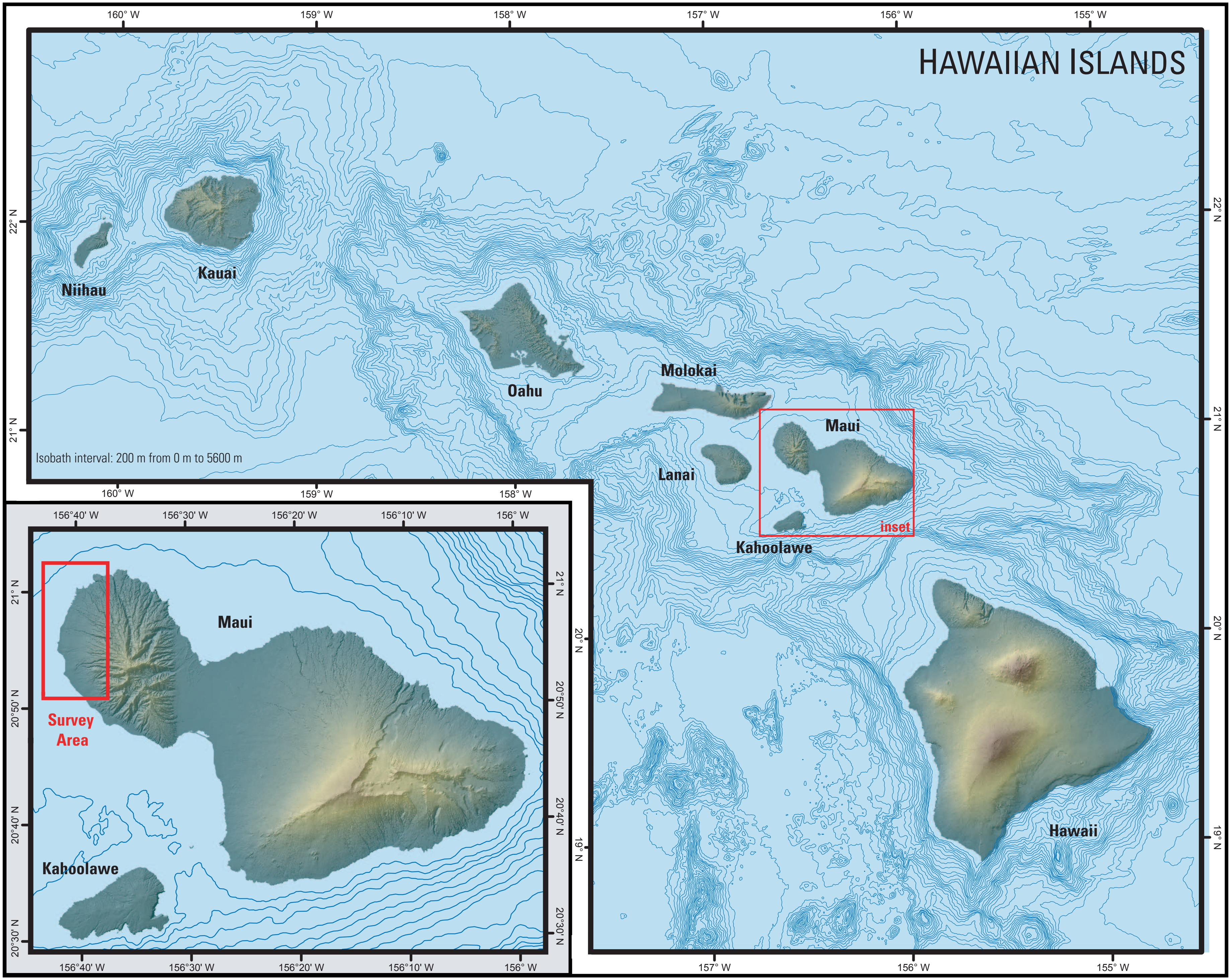



***FIGURE 1.*** *Map of the study area location in the main Hawaiian Island chain.*

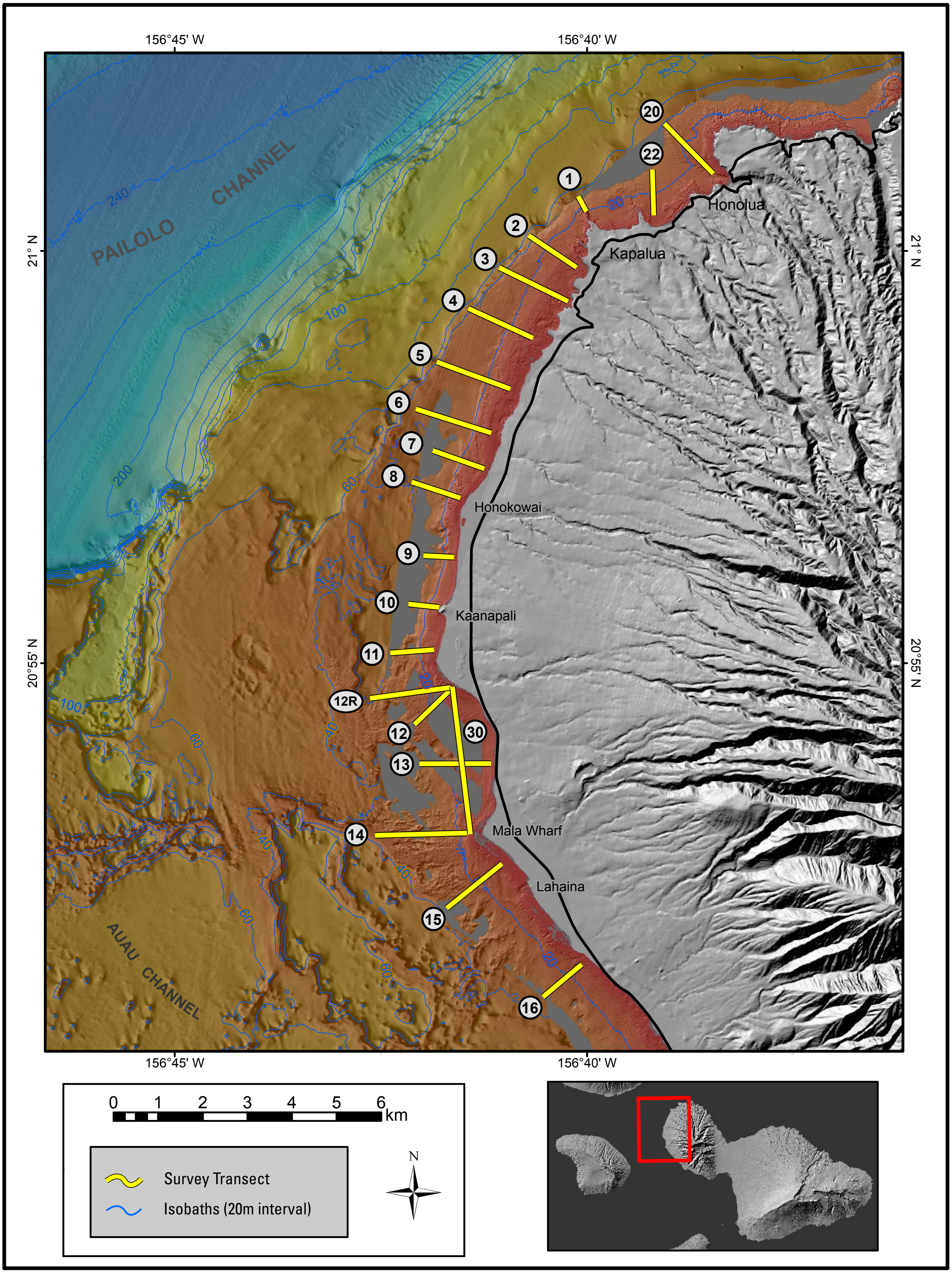



***FIGURE 2.*** *Location of planned ADCP transects shown with USGS digital elevation model (DEM) and bathymetry from SHOALS lidar and multibeam data. The bathymetric contour interval is 20 meters.*

**Research Platform:**

The cruises were conducted using a chartered vessel, the 28-ft-long *R/V Alyce C.*, owned and operated by Alyce C. Sport Fishing (FIGURE 3a). The *R/V Alyce C.*, which was designed as a sport-fishing boat, was modified for scientific studies. The space under the bridge was allocated for data acquisition and processing, which took place on two laptop computers (FIGURE 3f). The port beam was allocated for CTD/OBS profiler operations (FIGURE 3b), which included the use of a hydraulic winch and an overhead davit. The starboard quarterdeck was allocated for the attachment of a specialized bracket used to deploy the ADCP profiler (FIGURE 3c-d). The driver's station was outfitted with a LCD display (FIGURE 3e) to provide the vessel captain with a graphic display of position information, speed, heading and distance to the next transect line.

## DATA ACQUISITION AND QUALITY

Eleven days of data were acquired over two three-day periods (02/18/2003 - 02/20/2003 and 02/24/2003 – 02/26/2003) and one five-day period (06/30/2003 – 07/04/2003). The tidal stages for the three periods are shown in FIGURE 4. The vessel tracks, along with the location and time of CTD casts, are shown in FIGURES 5-10.

Although some of the ADCP data were affected by the heave, pitch and roll of the vessel when large ocean surface waves were encountered, we had greater than 99% data recovery for both the ADCP and CTD/OBS profilers. Data quality was generally very high, with some problems near the surface and near the bed. The ADCP data near the surface displayed slightly lower correlation due to bubble interference with the transducers, while most of the near-bed data showed low beam correlation due to beam spreading and vessel roll. Beam spreading caused the beam footprint to be large while vessel roll caused substantial Doppler offsets from the bed that could not be post-processed out of the data. This loss of data from the bins closest to the bed is common to most mobile, downward-looking ADCP surveys and was expected.

The raw ADCP data were archived and copies of the data were post-processed to remove all "ghost" data from below the bed, averaged over 10 sec windows to reduce the effects of wave-induced motions. All data for which the beam correlation dropped below 70% were discarded for visualization and analysis. After post-processing, spatially heterogeneous features such as sediment plumes were identifiable in the acoustic backscatter data while coastal jets and eddies were visible in the velocity data. An example of the post-processed ADCP data collected along survey line #14 off Mala Wharf on 02/20/2003 is shown in FIGURE 11.

The CTD/OBS data near the bed often displayed spikes in the OBS data due to interaction of the optical beam with the bed. The raw CTD/OBS data were archived and copies of the data were post-processed by calculating the average over 0.5 m depth windows to reduce high-frequency noise. These 0.5 m bin-averaged data were then used for visualization and analysis. The CTD/OBS data were very high in quality, with features such as low-salinity (fresh water) surface plumes visible in the salinity data, multi-layered structures (water masses) identified by density contrasts, and turbid layers identifiable in the OBS data. Co-located laser in-situ scattering and transmissometry

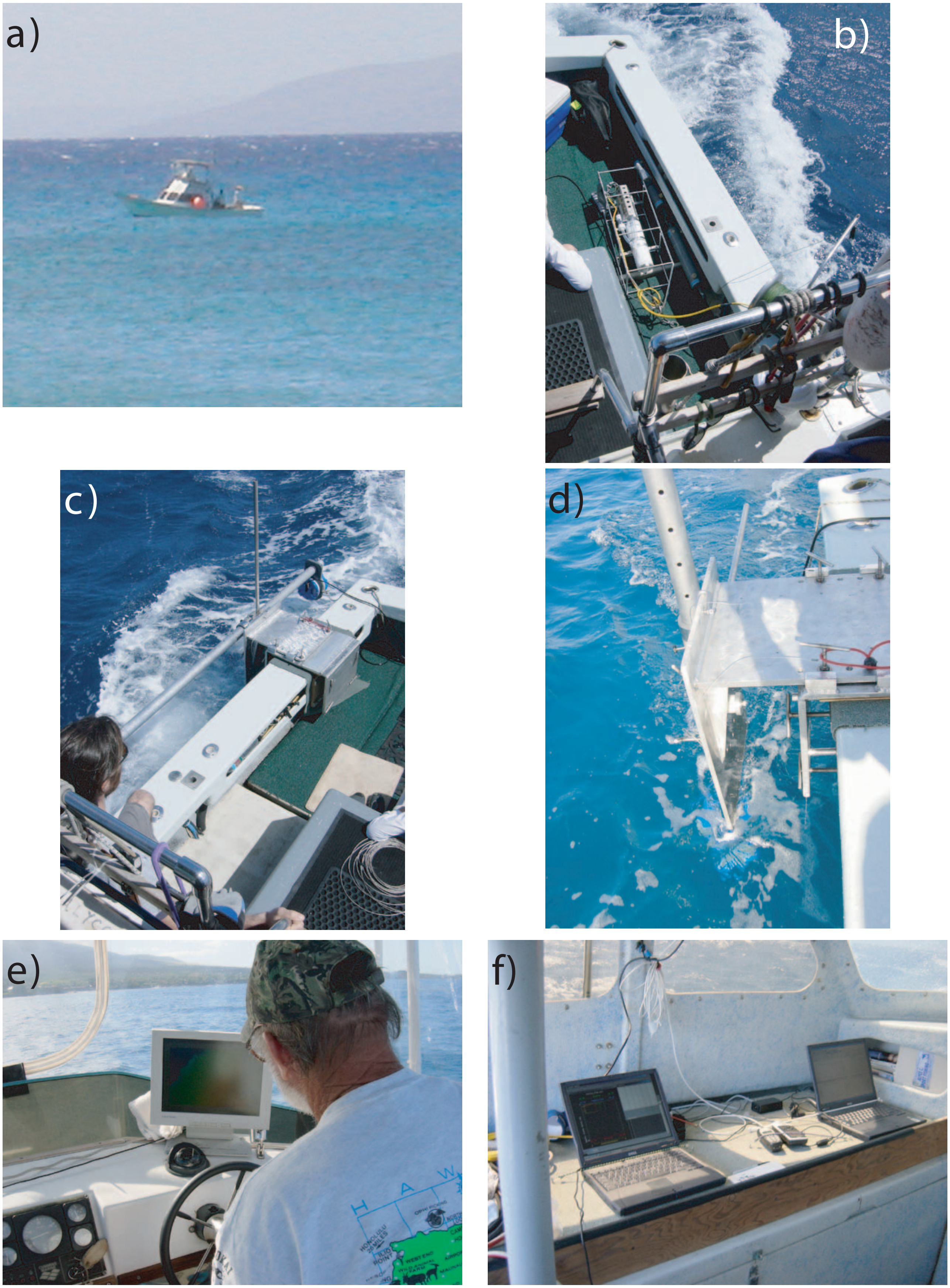



***FIGURE 3.*** *Photographs of equipment placement on the R/V Alyce C. (a) View of the Alyce C from shore as she proceeds onshore along Line #2 on 02/24/2003. (b) View of the port beam showing the CTD/OBS profiler. (c) View of the starboard quarter showing the ADCP profiler and mount up in the travel position. (d) View of the starboard quarter showing the ADCP profiler and mount down in the data acquisition position. (e) View of the driver's LCD screen on the bridge that provided the vessel captain with position and navigation information. (f) View of the space under the bridge where ADCP, CTD/OBS and GPS data acquisition and pre-processing took place.*

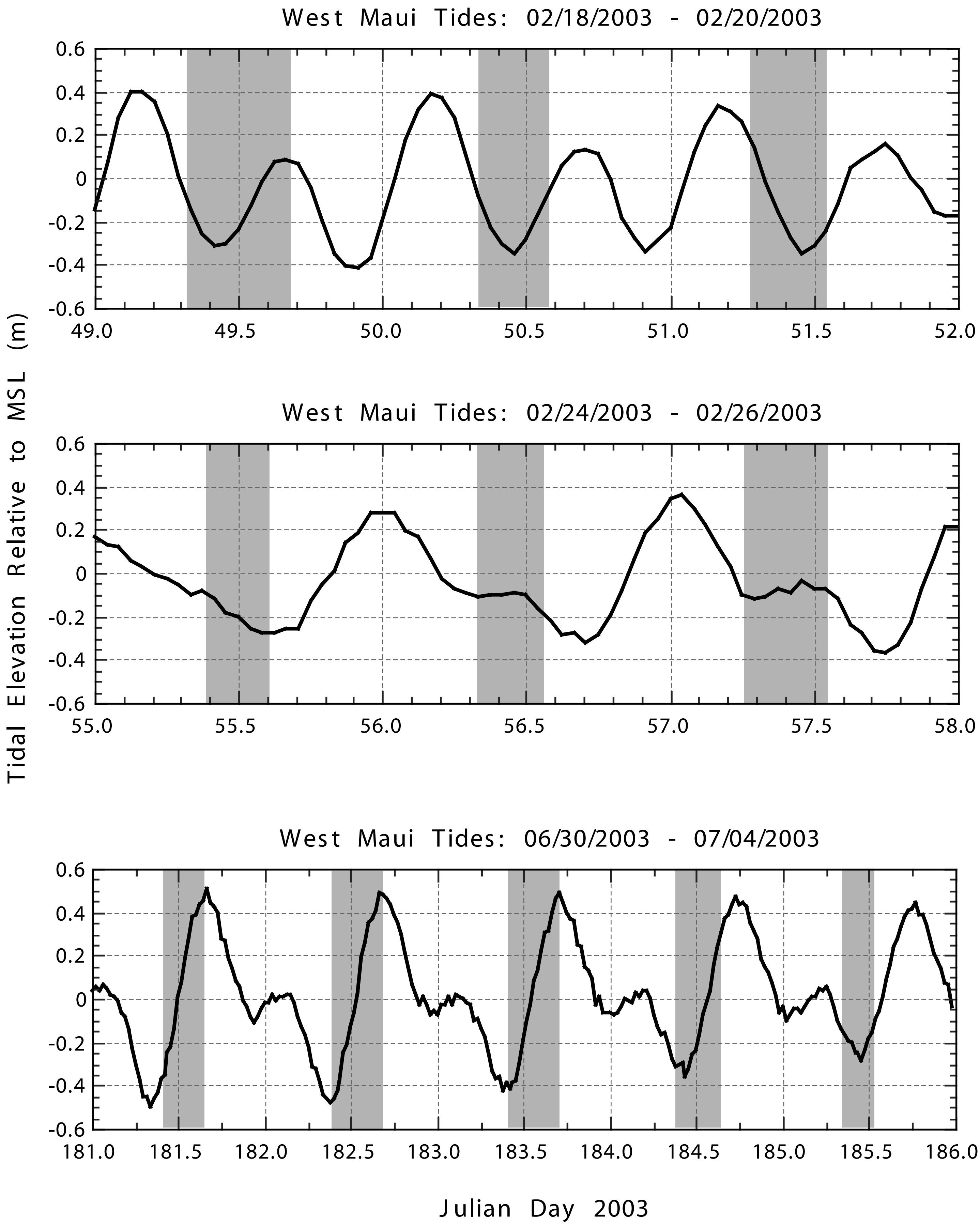



***FIGURE 4.*** *Tidal data from Lahaina Harbor for the three surveying periods showing the periods of data acquisition relative to the tidal elevation. The gray bands denote times of data acquisition.*

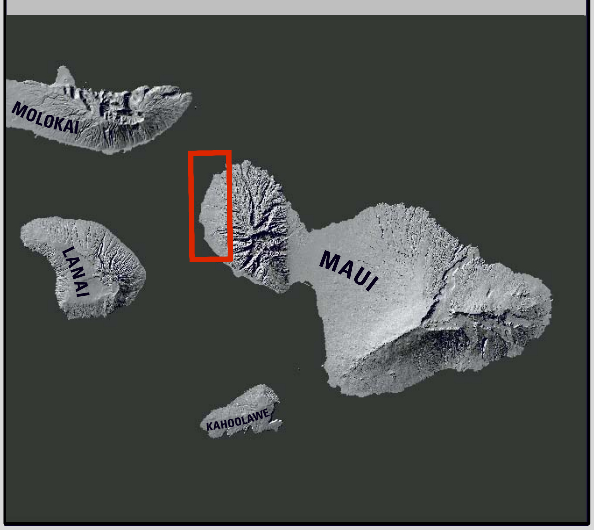
# Navigation Track Maps

Tracklines are shown for the route taken during data acquisition each day. CTD/OBS casts were done at the beginning and end of each ADCP transect.
Each CTD/OBS cast is labelled by the time of acquisition.

## Legend for figures 5-10

Navigation track
Isobaths (20m interval)
CTD cast

## Area of Surveys

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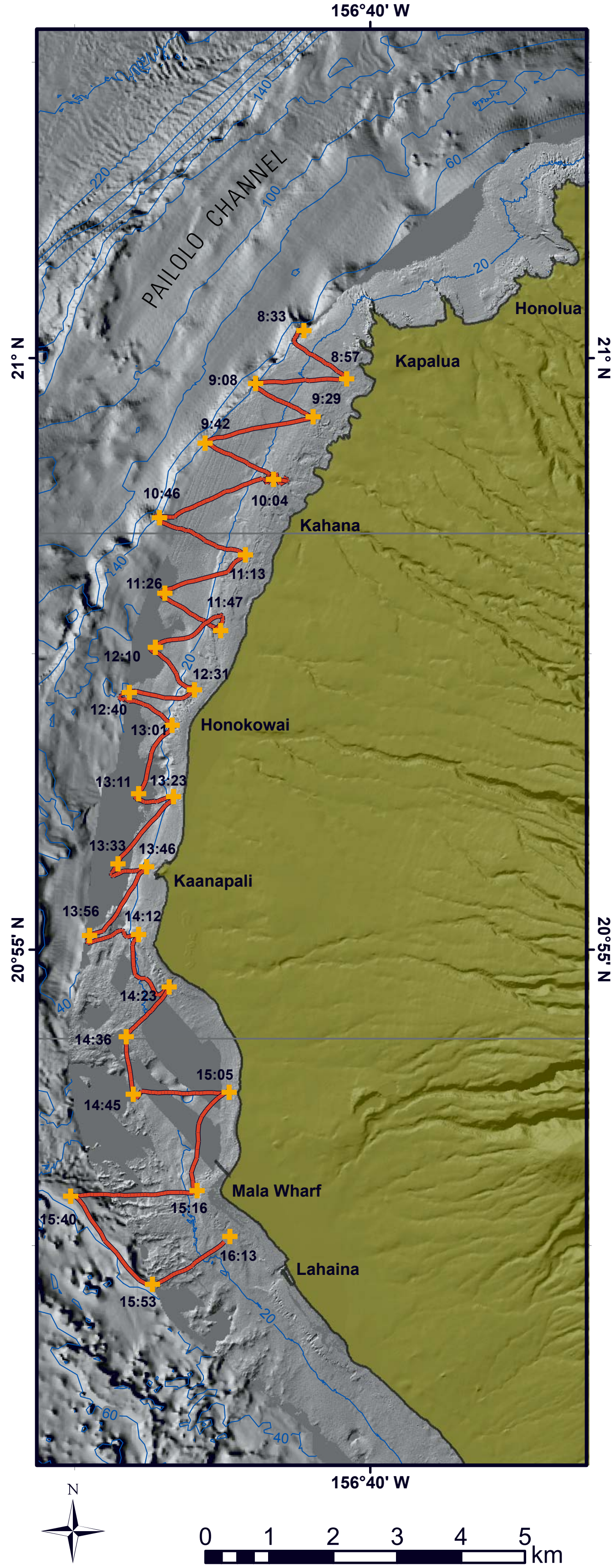


Isobath interval: 20m

***FIGURE 5.*** *Maps showing the vessel tracklines and location of CTD/OBS casts. Spring tide conditions trackline from Tuesday 02/18/2003. ADCP profiler data were collected along the shore-normal sections of the tracklines between CTD/OBS casts. Cruise A-3-03-HW metadata is available at* http:walrus.wr.usgs.gov/infobank/a/a303hw/html/a-3-03-hw.meta.html

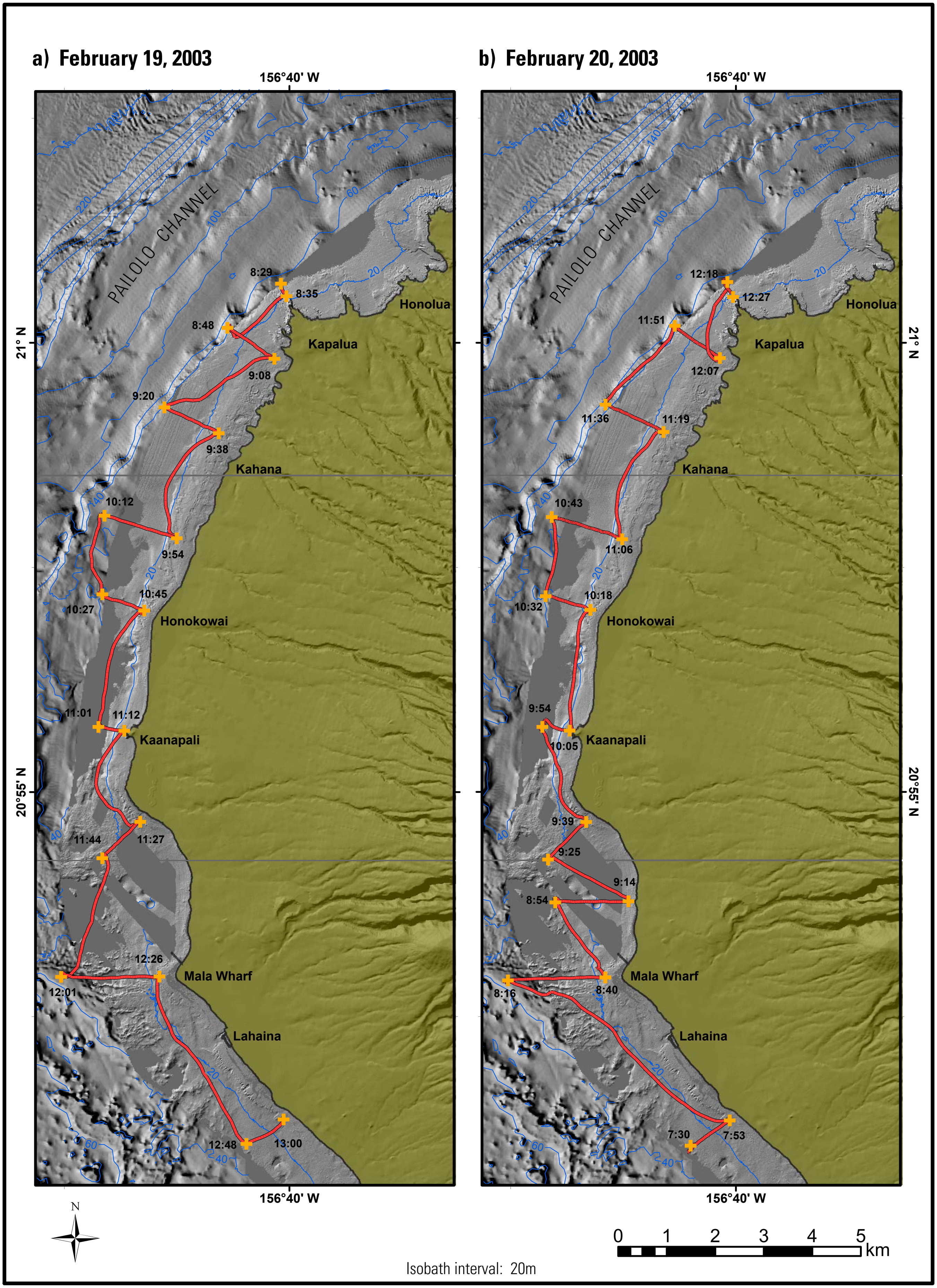


***FIGURE 6.*** *Maps showing the vessel tracklines and location of CTD/OBS casts. (a) Spring tide conditions trackline from Wednesday 02/19/2003. (b) Spring tide conditions trackline from Thursday 02/20/2003. ADCP profiler data were collected along the shore-normal sections of the tracklines between CTD/OBS casts. Cruise A-3-03-HW metadata is available at*
http:walrus.wr.usgs.gov/infobank/a/a303hw/html/a-3-03-hw.meta.html

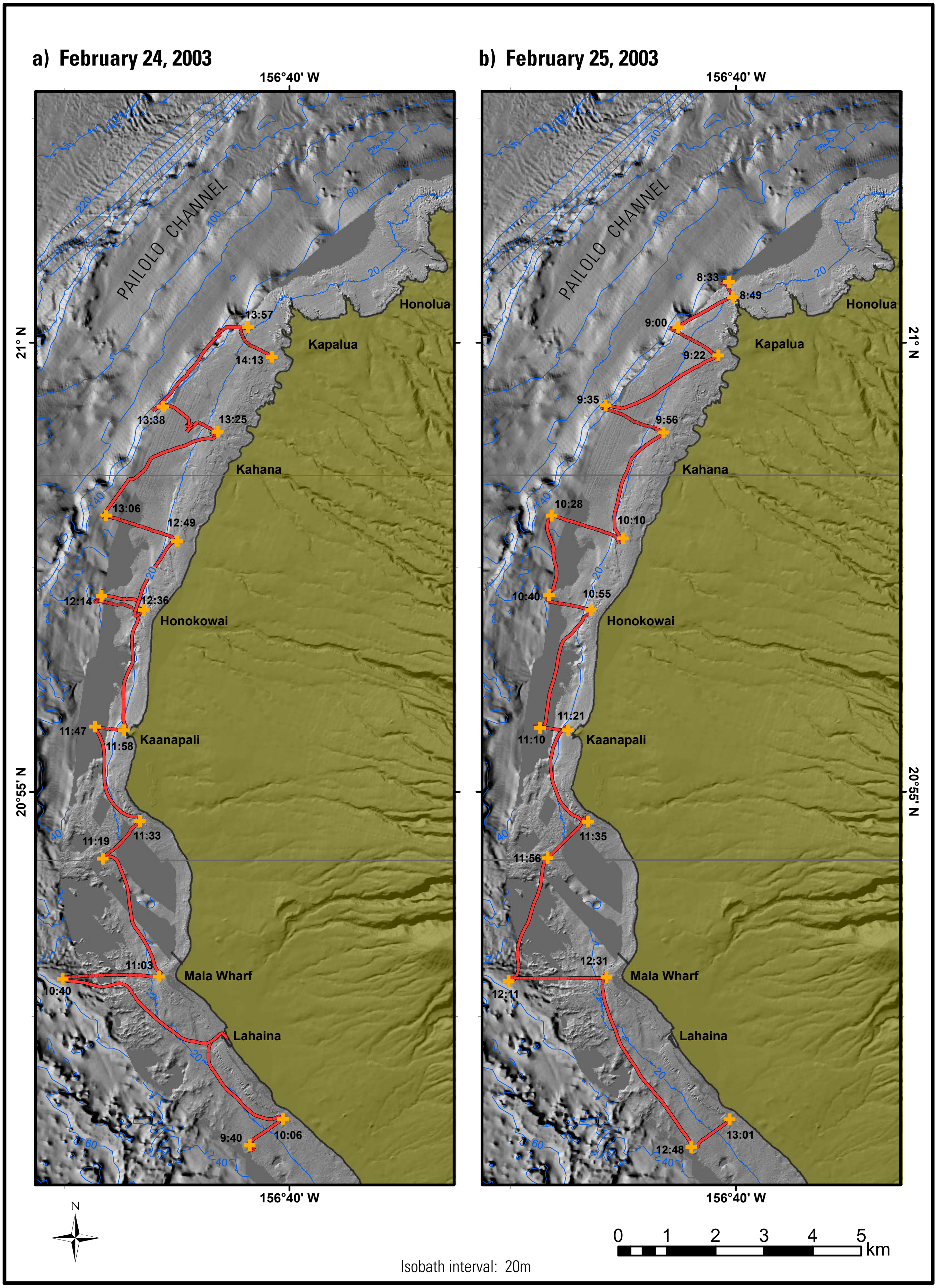


***FIGURE 7.*** *Maps showing the vessel tracklines and location of CTD/OBS casts. (a) Neap tide conditions trackline from Monday 02/24/2003. (b) Neap tide conditions trackline from Tuesday 02/25/2003. ADCP profiler data were collected along the shore-normal sections of the tracklines between CTD/OBS casts. Cruise A-3-03-HW metadata is available at* http:walrus.wr.usgs.gov/infobank/a/a303hw/html/a-3-03-hw.meta.html

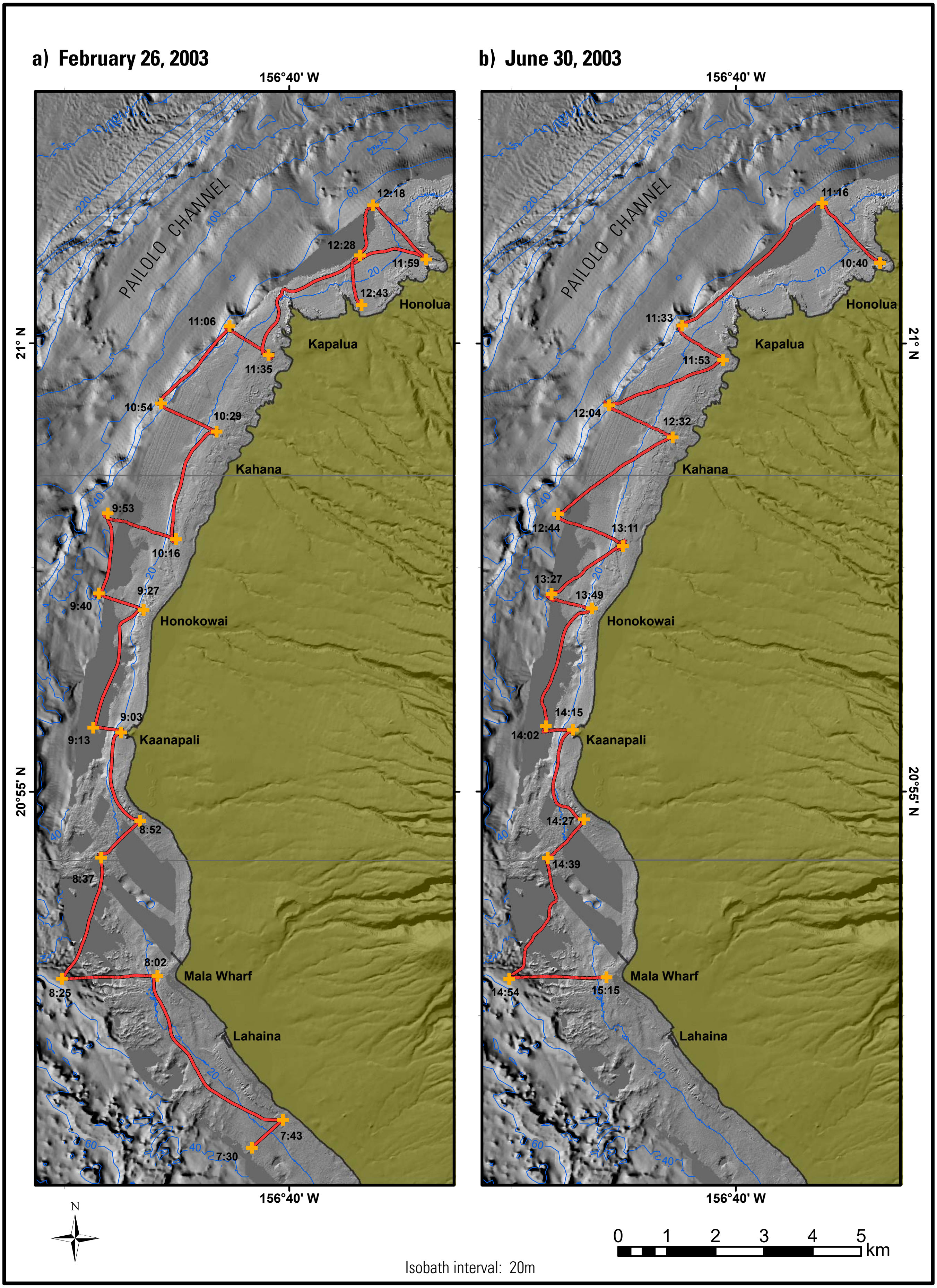


***FIGURE 8.*** *Maps showing the vessel tracklines and location of CTD/OBS casts. (a) Neap tide conditions trackline from Wednesday 02/26/2003. (b) Trackline from Monday 06/30/2003 during the coral spawning event. ADCP profiler data were collected along the shore-normal sections of the tracklines between CTD/OBS casts. Cruise A-3-03-HW metadata is available at* http:walrus.wr.usgs.gov/infobank/a/a303hw/html/a-3-03-hw.meta.html *and cruise A-4-03-HW metadata is available at* http:walrus.wr.usgs.gov/infobank/a/a403hw/html/a-4-03-hw.meta.html

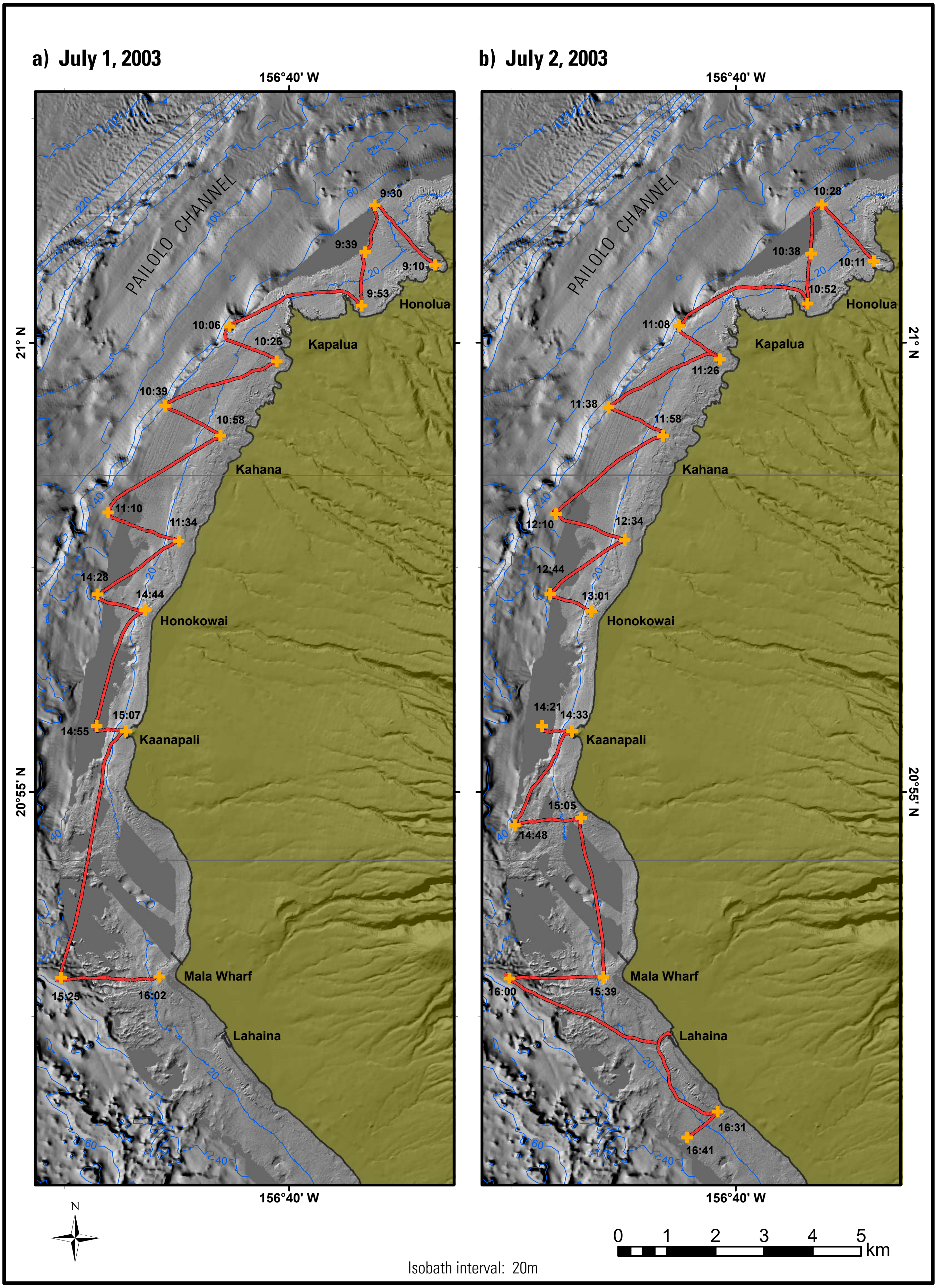


***FIGURE 9.*** *Maps showing the vessel tracklines and location of CTD/OBS casts. (a) Trackline from Tuesday 07/01/2003 during the coral spawning event. (a) Trackline from Wednesday 07/02/2003 during the coral spawning event. ADCP profiler data were collected along the shore-normal sections of the tracklines between CTD/OBS casts. Cruise A-4-03-HW metadata is available at* http:walrus.wr.usgs.gov/infobank/a/a403hw/html/a-4-03-hw.meta.html

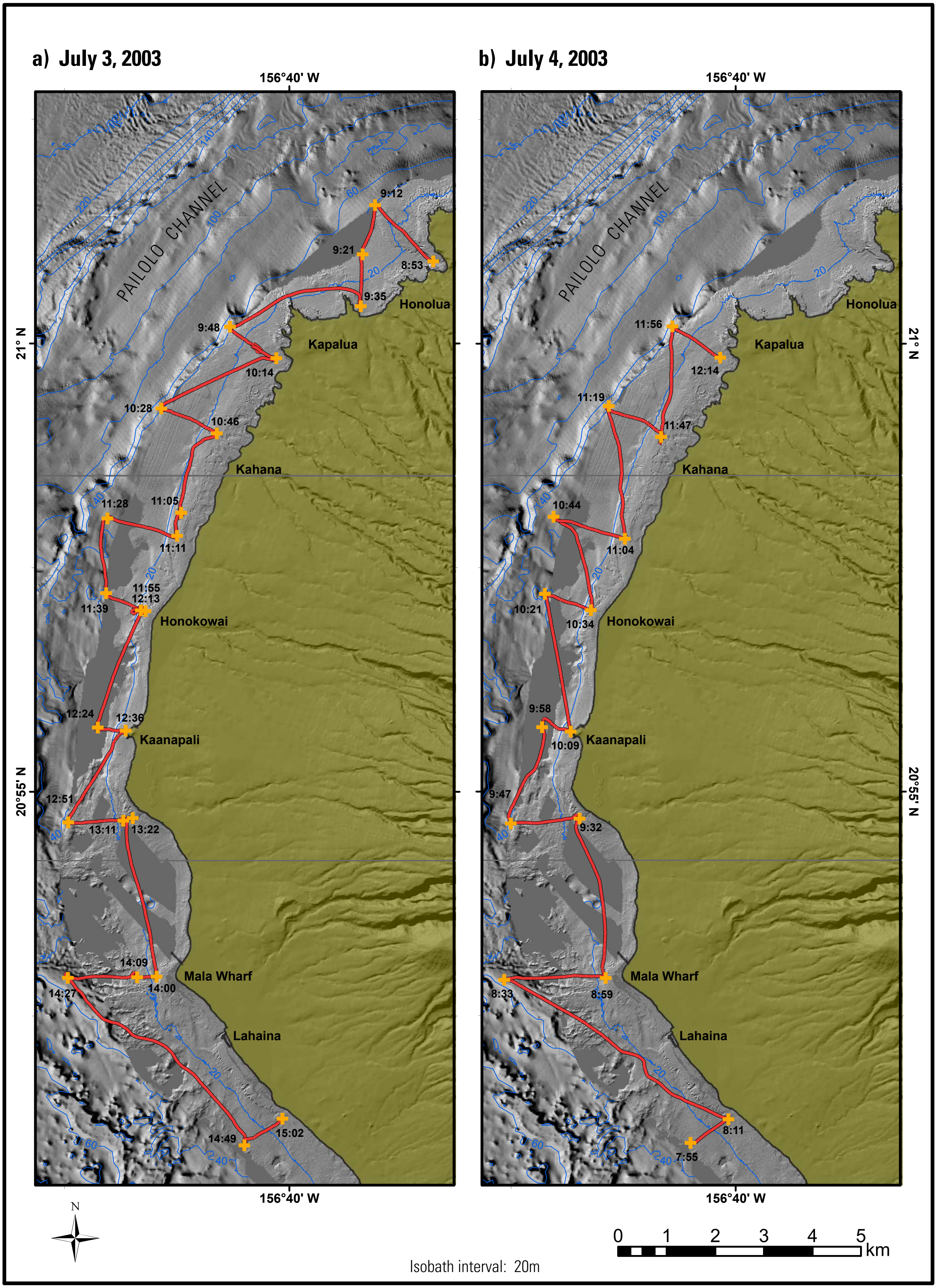


***FIGURE 10.*** *Map showing the vessel tracklines and location of CTD/OBS casts. (a) Trackline from Thursday 07/03/2003 during the coral spawning event. (b) Friday 07/04/2003 during the coral spawning event. ADCP profiler data were collected along the shore-normal sections of the tracklines between CTD/OBS casts. Cruise A-4-03-HW metadata is available at*
http:walrus.wr.usgs.gov/infobank/a/a403hw/html/a-4-03-hw.meta.html

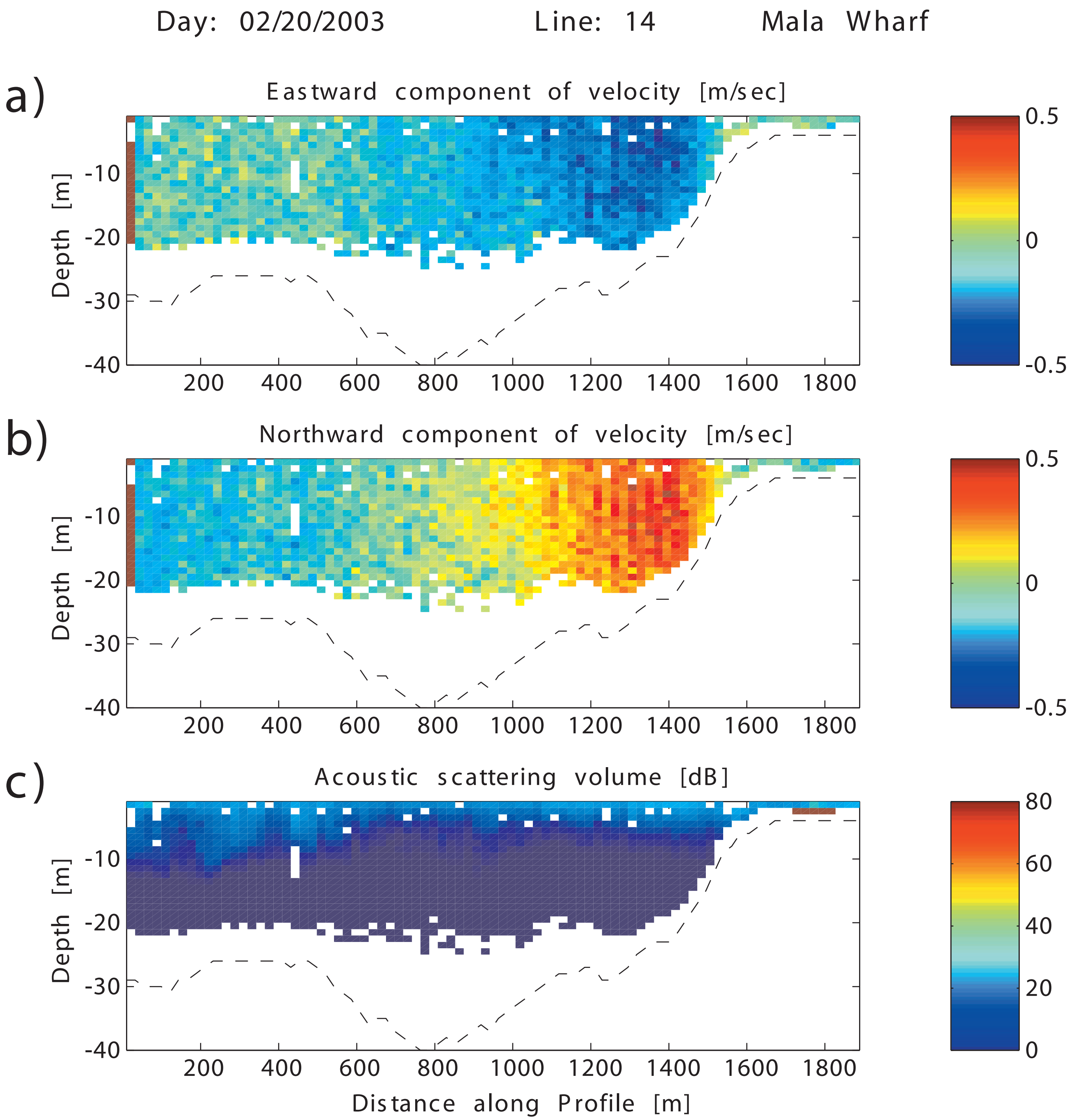


***FIGURE 11.*** *Example of ADCP profile data collected off Mala Wharf (Line #14) on Thursday 02/20/2003 during a falling Spring tide. (a) Eastward component of current velocity. (b) Northward component of current velocity. (c) Acoustic scattering volume. These data show an approximately 800 m-wide northwestward flowing jet on the fore reef with southwestward flow both to the inshore and offshore of the jet. The low acoustic scattering corresponded with visually and optically (from the OBS; not shown) clear water*

(LISST) data showed wide spatial and temporal variability in the size of the material that was imaged by the OBS (J.Harney, personal communication). Due to this variability, we were unable to calculate valid regression that would allow us to accurately determine suspended sediment concentrations by mass (i.e- mg/l) and thus only present raw OBS voltages instead. An example of data from a single CTD/OBS cast collected along line # 20 in Honolua Bay on 02/26/2003 is shown in FIGURE 12.

## RESULTS AND DISCUSSION

This section reviews the data collected by both systems during the surveys and addresses the significance of the findings to better understanding the local oceanographic conditions in the study area and their implication for larval, nutrient or pollutant dynamics.

### Currents

Current speeds in the study area ranged between < 0.01 m/sec to 1.96 m/sec, with a mean ± one standard deviation of 0.24 ± 0.23 m/sec (~0.9 km/hr or 0.5 knots). The alongshore current speeds were typically on the order of a magnitude larger than the cross-shore current speeds except in locations where recirculating eddies were observed. Assuming flow remained constant alongshore, the mean alongshore current speed measured along the 20 m isobath of 0.25 m/sec (0.10 m/sec along the 5 m isobath) would result in a total replacement of water along the 22 km length of the study area between Honolua Bay and southern Lahaina in just over 24 hours (3 days for flow along the 5 m isobath). Seeing that oscillatory tidal flows enhance these mean flow speeds, the actual replenishment time would typically be shorter, as discussed by P.Flament (personal communication). Since it took on more than 5 hours to survey the entire study area each day, it was not possible to constrain a single phase of tidal flow, such as flooding or rising tide, at each survey line in one day. It was thus necessary to create synthetic maps of tidal current end-members using survey lines acquired during different days to constrain the flow at the same tidal stage at each survey line. Four synthetic tidal current maps were made for the following tidal end-members: Rising Spring tide, Falling Spring tide, Rising Neap tide and Falling Neap Tide. The dates and lines used for each of these four synthetic tidal current maps are listed in TABLE 6.

***Rising Spring Tide*:**

The synthetic map of Rising Spring tidal currents displays a three-part flow pattern (FIGURE 13a). An inshore jet heading south was observed between Napili and Mala Wharf. Just off northern Lahaina the jet separated from the shoreline and while it headed further offshore, it continued to the south. Further inshore off northern Lahaina, an inshore jet heading north was observed, suggesting a front between the southerly offshore flow and the northerly inshore flow. The directions and magnitudes of flow might suggest the presence of a cyclonic eddy off northern Lahaina; similar features have been observed in the area over the previous 15 months during tripod deployment and recovery operations. The alongshore extent of this front could not be constrained further to the north or south due to lack of data. From Honokawai north to Napili, the

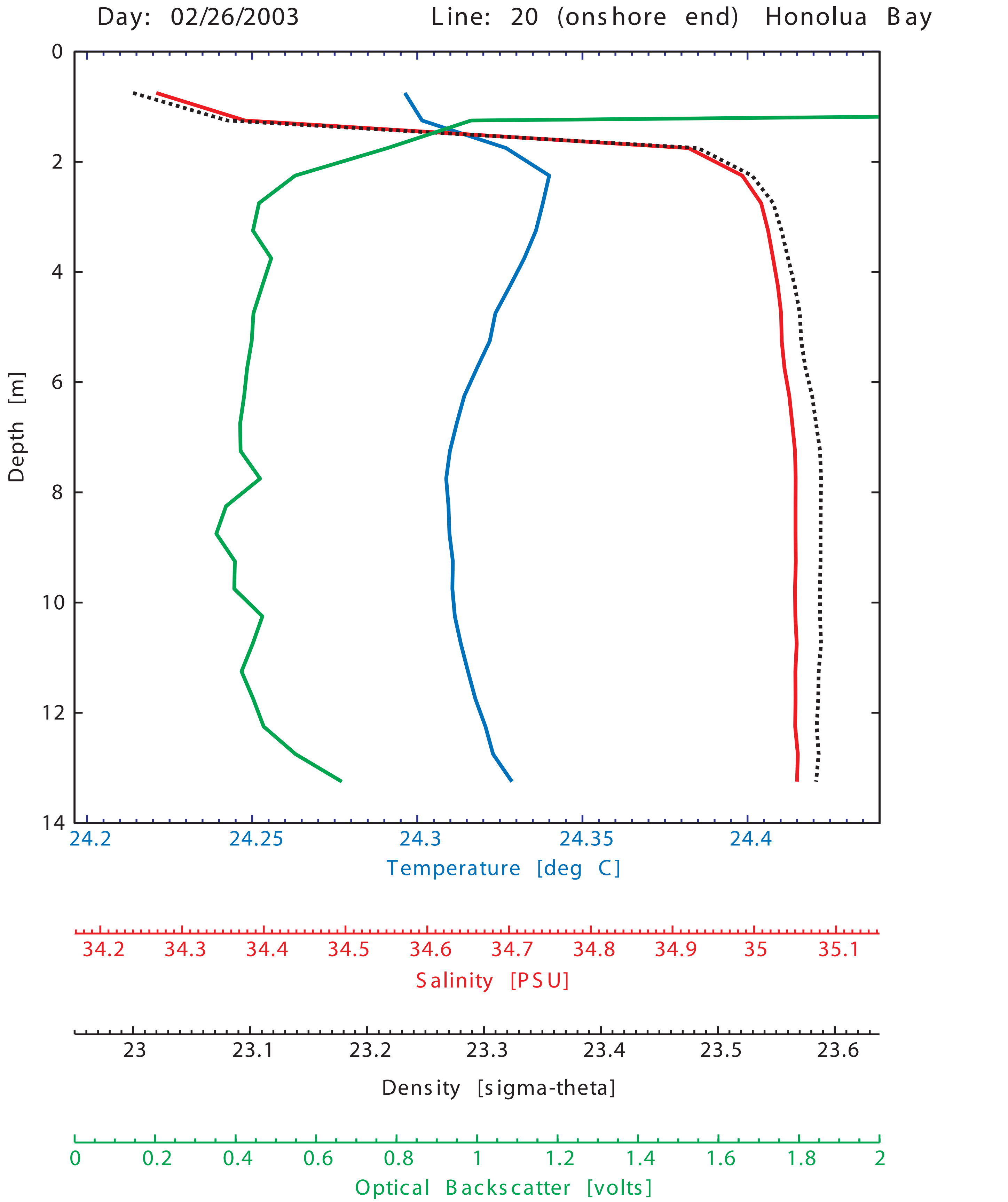


***FIGURE 12.*** *Example of CTD/OBS cast data collected in Honolua Bay (inshore end of Line #20) on Wednesday 02/26/2003 during a flooding Neap tide. Although this cast was taken four days after a rainstorm, a turbid, low-salinity and temperature freshwater surface plume is clearly identifiable in the data due to continued stream discharge. This plume was clear visible to the naked eye and was also identifiable in the ADCP's acoustic scattering data (not shown).*

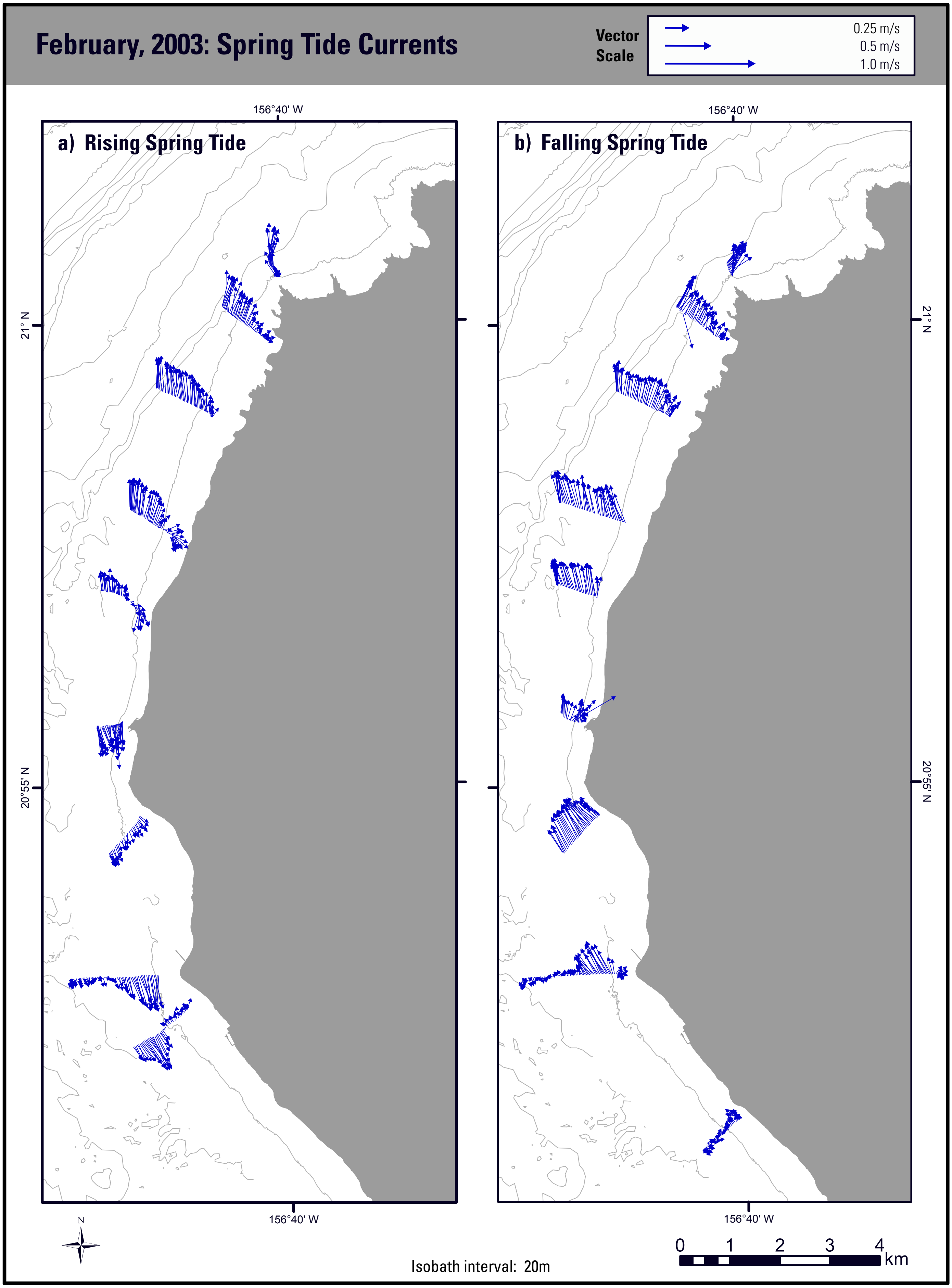


***FIGURE 13.*** *The map of synthetic Spring tidal currents in the study area. (a) rising Spring tide. (b) falling Spring tide.*

flow offshore of the 15 m isobath headed to the north, suggesting a front between the inshore, southerly flow and the offshore, northerly flow.

***Falling Spring Tide*:**
The synthetic map of Falling Spring tidal currents shown in FIGURE 13b displays a much less complex flow pattern than observed during the Rising Spring Tide. All of the inshore flow along the entire study area headed towards the north, and the flow all the way across the inner shelf (< 50 m water depth) north of Kaanapali headed north. The very western-most flow measured along the lines off Mala Wharf and Lahaina headed south, suggesting a front between the inshore northerly flow and the offshore southerly flow. The slow rotation in the direction of the currents, along with their variation in magnitude along the line off Mala Wharf suggest the presence of a cyclonic eddy northwest of Mala Wharf over a region of complex bathymetry, as seen in FIGURE 2.

***Rising Neap Tide*:**
The synthetic map of Rising Neap tidal currents displays a three-part flow pattern (FIGURE 14a), similar to that observed during the Rising Spring Tide. Overall, while the flows are generally similar in flow direction, their magnitudes are much lower and the cohesiveness along specific tracklines is much less than during the Rising Spring Tide. The southerly heading inshore jet was again observed between Napili and Kaanapali; this inshore jet, however, does not stretch south down into the embayment between Kaanapali and Mala Wharf as observed during the Rising Spring Tide (FIGURE 13). This inshore southerly jet separated from the shoreline near southern Kaanapali, further to the north than observed during the Rising Spring Tide. The inshore jet heading north off northern Lahaina was observed again but stretched further to the north, up to southern Kaanapali. Again, this cross-shore shear suggests that a front had developed between the southerly flow offshore and the northerly flow inshore. The directions and magnitudes of flow might suggest the presence of a cyclonic eddy off southern Kaanapali, similar to the features observed in the vicinity of this embayment as discussed previously. From northern Honokawai north to Napili, the flow offshore of the 15 m isobath headed to the north, again implying some type of front had developed between the inshore, southerly flow and the offshore, northerly flow.

***Falling Neap Tide*:**
The synthetic map of Falling Neap tidal currents is shown in FIGURE 14b and displays a similar pattern to that observed during the Falling Spring Tide. The lower current speeds and cohesiveness along specific tracklines observed between the Rising Spring and Neap Tides are also observed between the Falling Spring and Neap Tides. Similar to the Rising Spring Tides, all of the flow between southern Kaanapali and Napili heads to the north. The cross-shore shear observed offshore Mala Wharf and Lahaina during the Falling Spring Tides was not observed during the Falling Neap Tides. Instead, flow was seen to diverge from the region off northern Lahaina, with all of the flow off Mala Wharf headed north while all of the flow off Lahaina headed south.

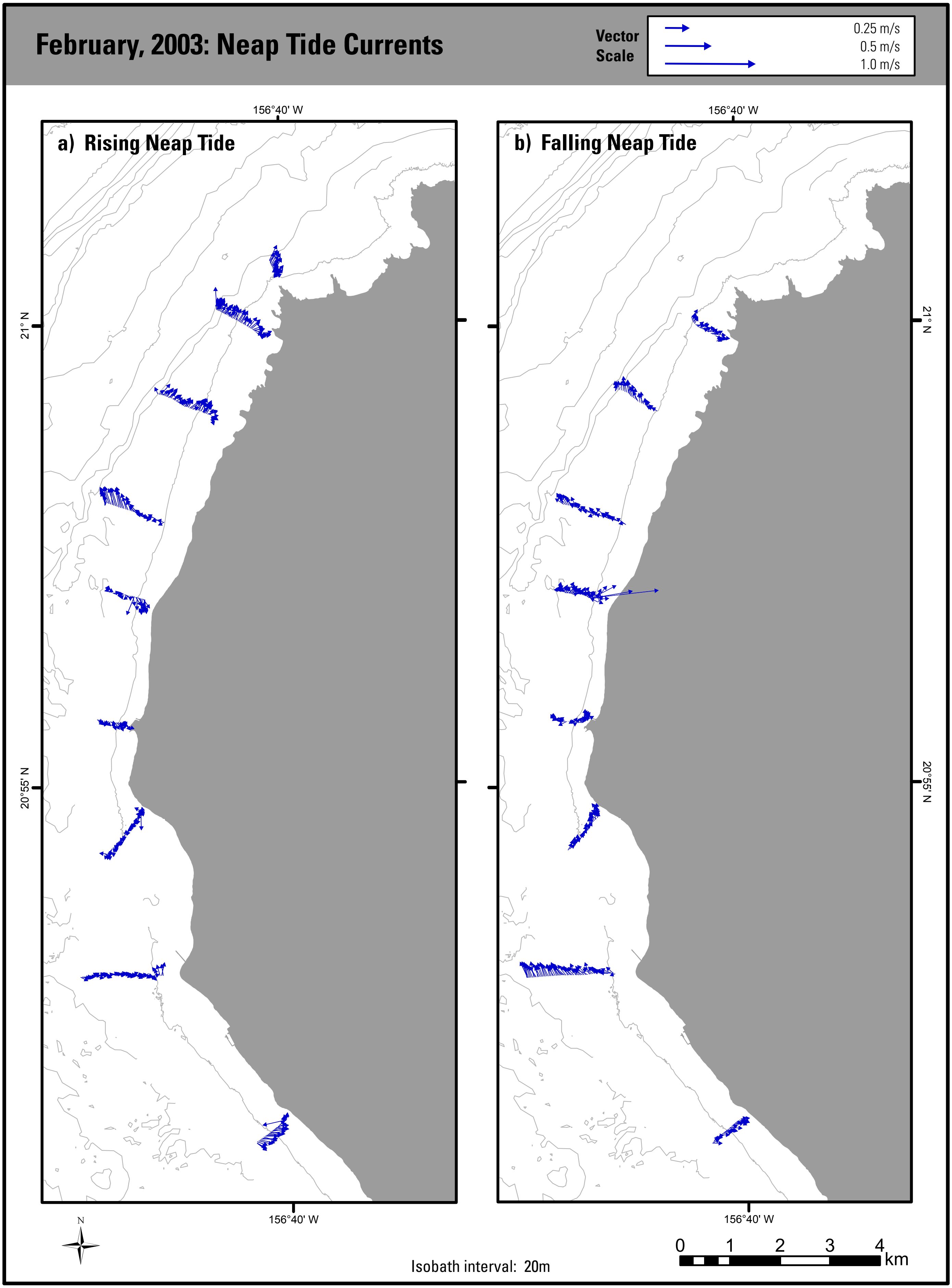


***FIGURE 14.*** *The map of synthetic Neap tidal currents in the study area. (a) rising Neap tide. (b) falling Neap tide.*

**Water Column Properties**

The water column properties that were collected included variations in temperature (ºC), salinity (PSU) and raw optical backscatter (volts) with depth; from these data we were able to also compute density (sigma-theta) and the speed of sound in the water column (m/sec). See TABLE 7 for the mean, minimum, maximum and standard deviation in temperature, salinity, optical backscatter and density at both the inshore, shallow end and deep, offshore end of each survey line for both sets of cruises. Only temperature, salinity and raw optical backscatter will be addressed here.

***Temperature*:**

The maps of depth-averaged mean temperature for each cast in the study area display a general 0.5 to 1.5 ºC decrease in temperature from north to south as shown in FIGURES 15 and 16. In the northern half of the study area, warmer water was typically observed further from shore; these near-shore low temperatures are likely related to cool, fresh (very low-salinity) groundwater flowing out of streams or percolating out of the reef, which was often observed in the field during snorkeling and scuba dives. The uplands along the northwestern section Maui above Napili and Kahana typically receives higher precipitation than the uplands further to the south and thus infiltration and groundwater effluence on the reef are more likely to occur along the northern section of the study area. In the southern half of the study area, however, the warmest water temperatures were typically observed onshore, which would be consistent with greater warming of the shallower water column onshore due to solar heating during the daytime and its mixing with cooler water further offshore.

The maps of temperature stratification, computed as the near-surface (0.5-1.5 m below the surface) temperature minus the near-bed temperature (0.5-1.5 m above the bed) for each cast in the study area are shown in FIGURES 17 and 18. Temperature stratification is generally relatively small (typically < 0.5 ºC) and is greater further offshore, which agrees with the typical observed depth of the thermocline at 10-25 m. The absence of a thermocline further inshore is likely due to two factors: shallow depth (less than 20 m) and increased mixing by very short period Trade wind-driven surface waves. Often, as shown in many of the casts taken during February (FIGURES 17), the water column close to shore had cool surface water overlying warm near-bed water. This thermal inversion was probably related to freshwater discharge from the adjacent stream mouths.

***Salinity*:**

The maps of mean, depth-averaged salinity for each cast in the study area displays are shown in FIGURES 19 and 20. Overall, the salinity along West Maui varies relatively little (< 0.25 PSU) except at the mouths of streams. Even though the variability is low, some interesting phenomena can be identified in the salinity data. The low salinity observed off Kahana on 02/18/2003 (FIGURE 19) occurred concurrently with very low temperature readings (FIGURE 15), suggesting that this feature was related to freshwater discharge out of the well-developed drainage directly onshore. Similar features can be identified off Napili and Honolua in the June data (FIGURES 16 and 20). The low nearshore salinities observed all along the study area on 02/25/2003-02/26/2003 may be related to the light rainfall event on the night of 02/22/2003-

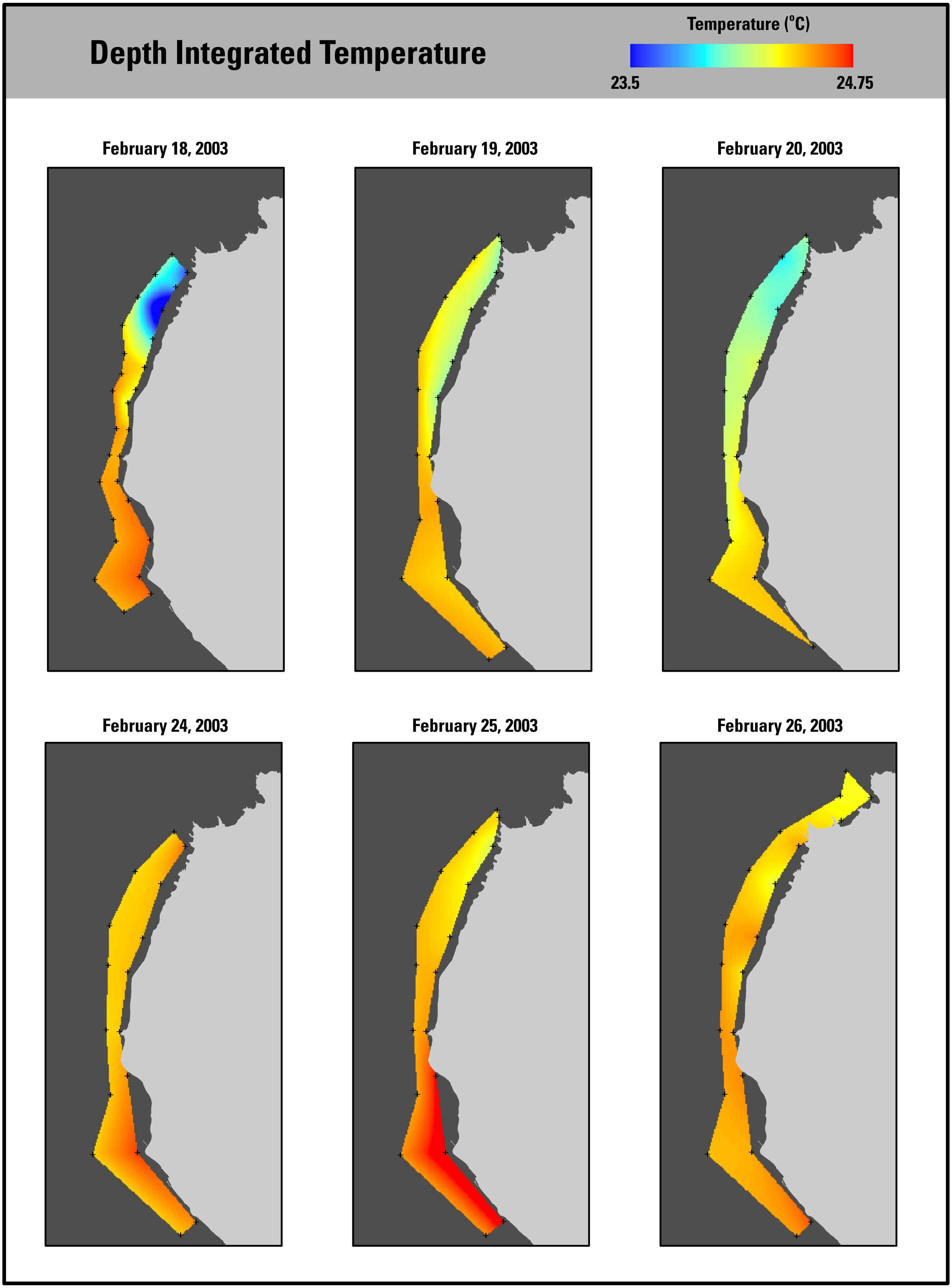


***FIGURE 15.*** *Maps of depth-averaged temperature for each cast in the study area during the February cruises. These maps display the very localized influence of cold freshwater runoff and the general lack of alongshore variability in temperature likely caused by wave-induced mixing. Note these temperatures are 1-2 ºC cooler than during the summer (see FIGURE 16).*

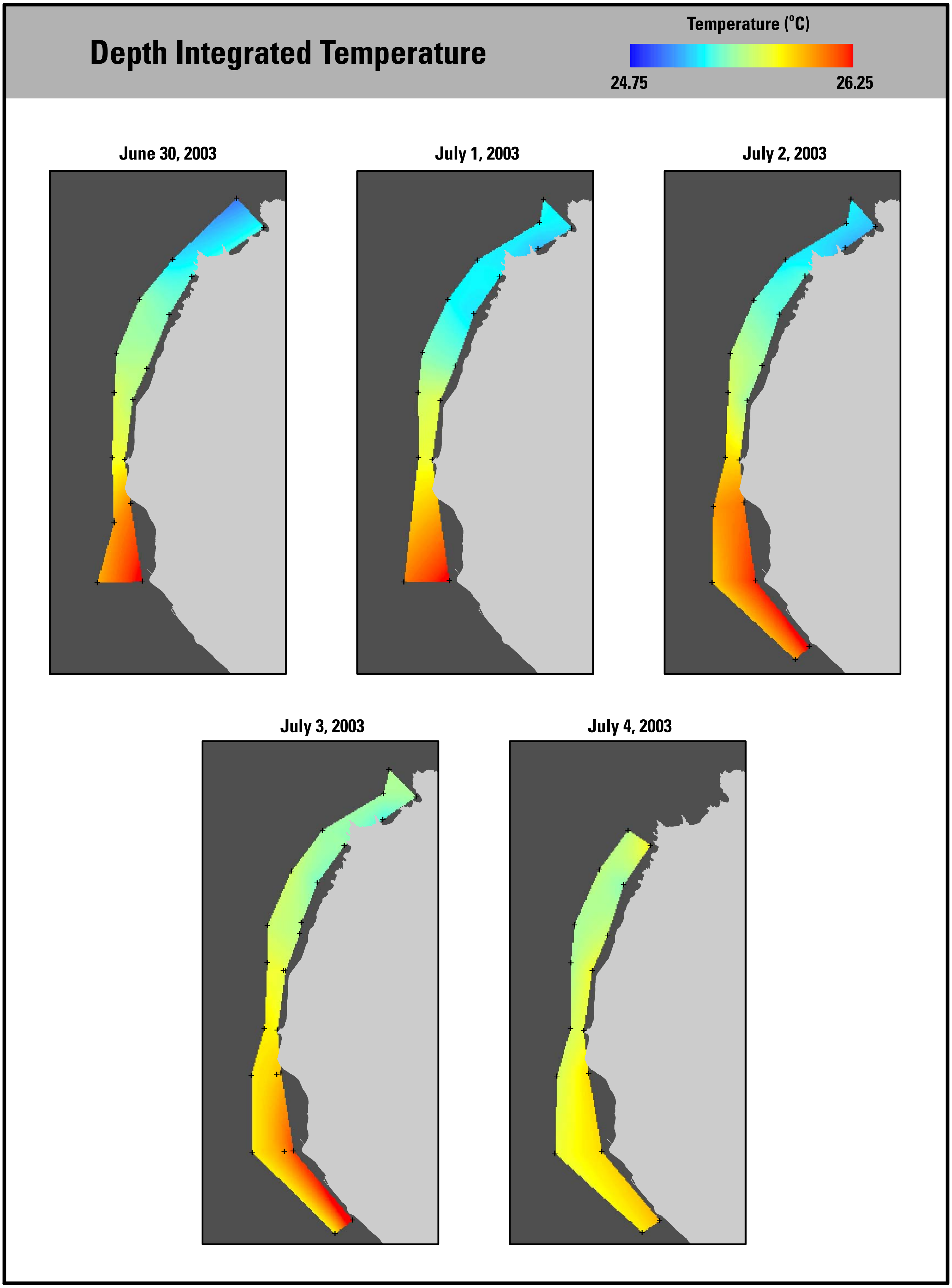


***FIGURE 16.*** *Maps of depth-averaged temperature for each cast in the study area during the June/July cruises. These maps display an alongshore temperature gradient on the order 1-2 °C which is likely caused by insolation and Trade wind-driven surface flow to the south and southwest.*

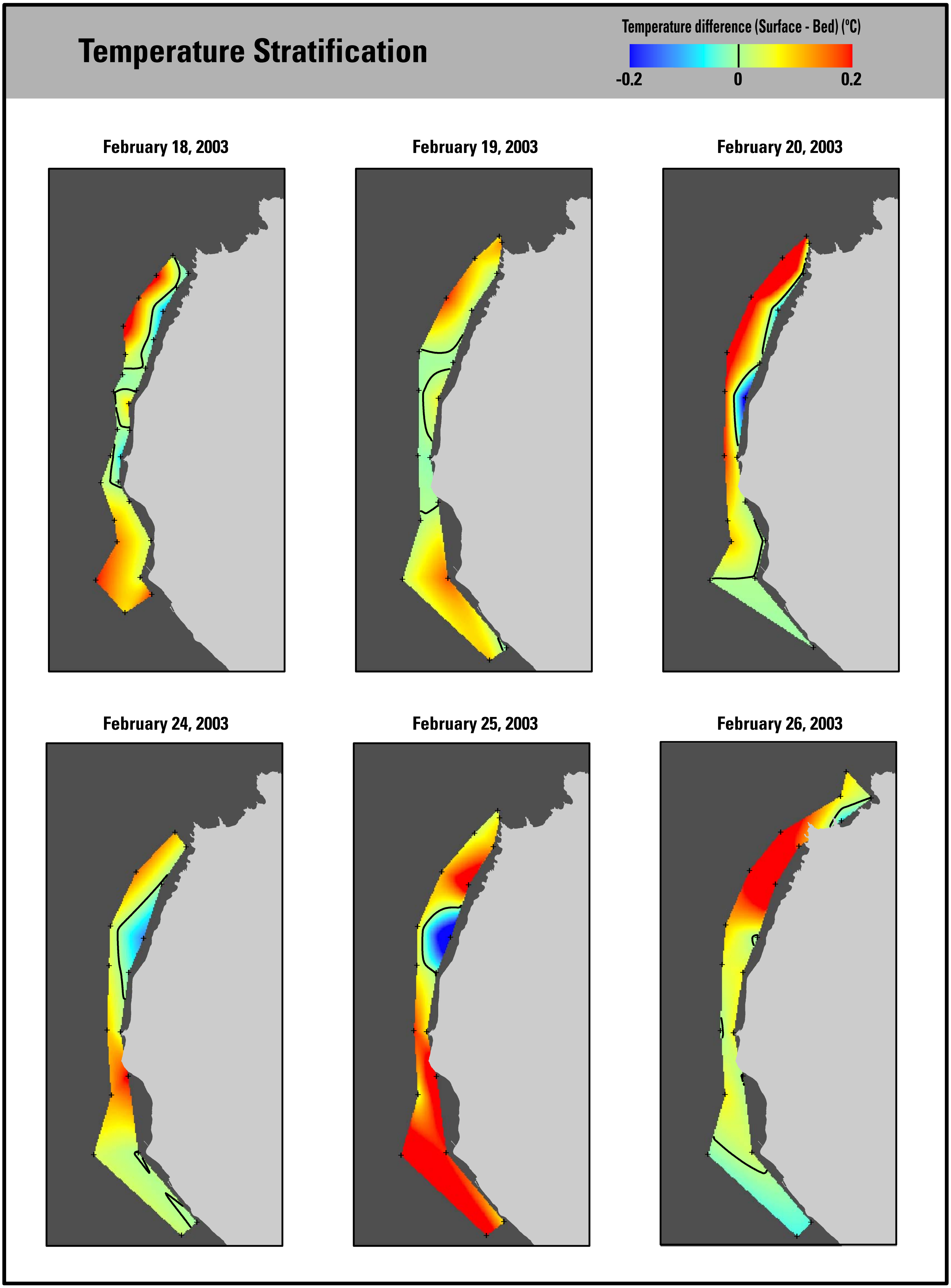


***FIGURE 17***. *Maps of temperature stratification, computed as the near-surface temperature minus the near-bed temperature for each cast in the study area during the February cruises. Near-surface temperatures are typically higher close to shore due to greater mixing and insolation except where cold freshwater runoff from streams lower the surface water temperature.*

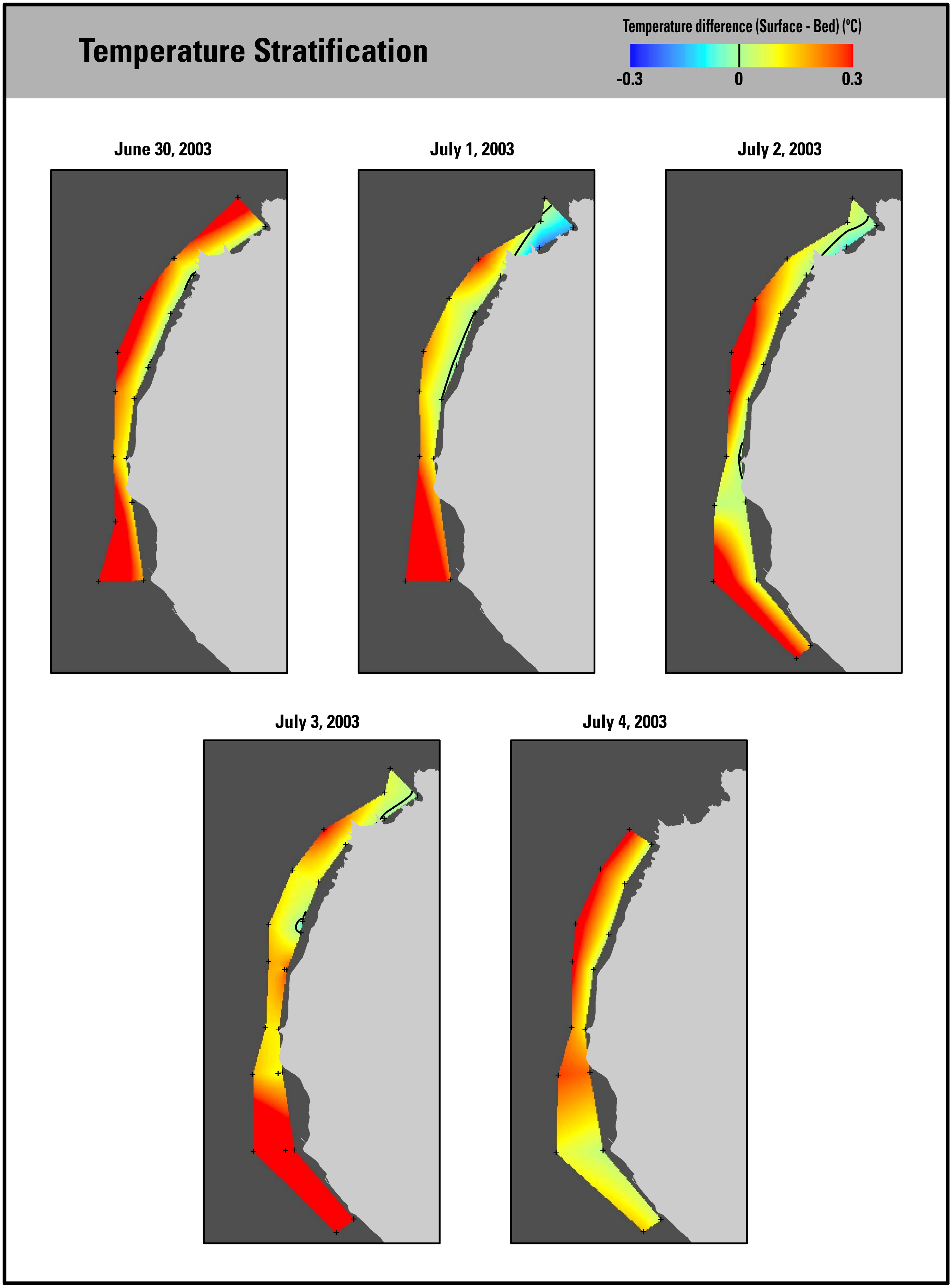


***FIGURE 18.*** *Maps of temperature stratification, computed as the near-surface temperature minus the near-bed temperature for each cast in the study area during the June/July cruises. The lack of precipitation and less wave-induced mixing are likely responsible for the greater homogeneity in the temperature stratification during these surveys as compared to those made earlier in the year (see FIGURE 17).*

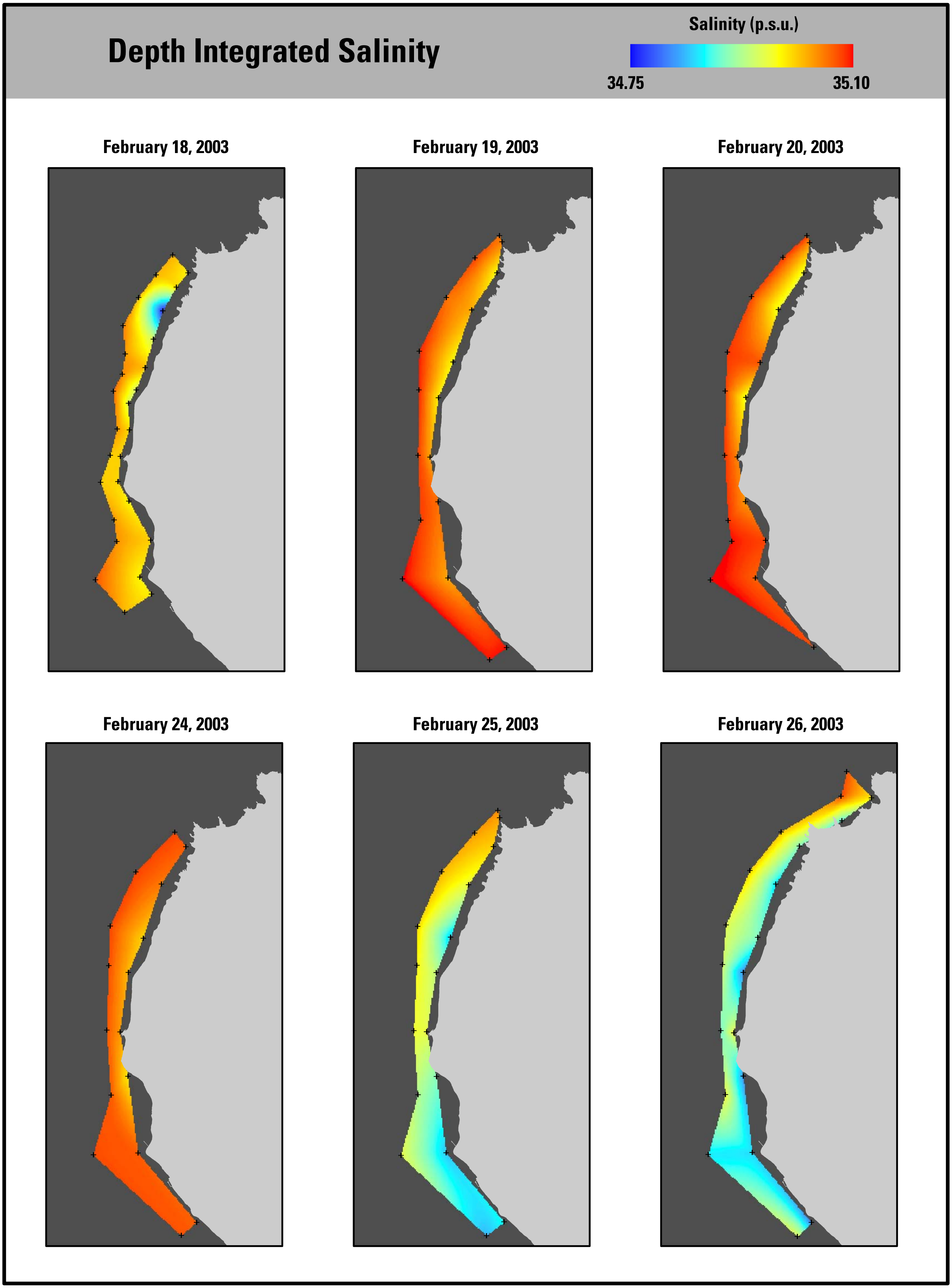


***FIGURE 19.*** *Maps of depth-averaged salinity for each cast in the study area during the February cruises. Salinity is typically lower closer to shore due to freshwater runoff from streams and groundwater effluence through the reef. Wave-induced mixing likely reduces heterogeneity in the data.*

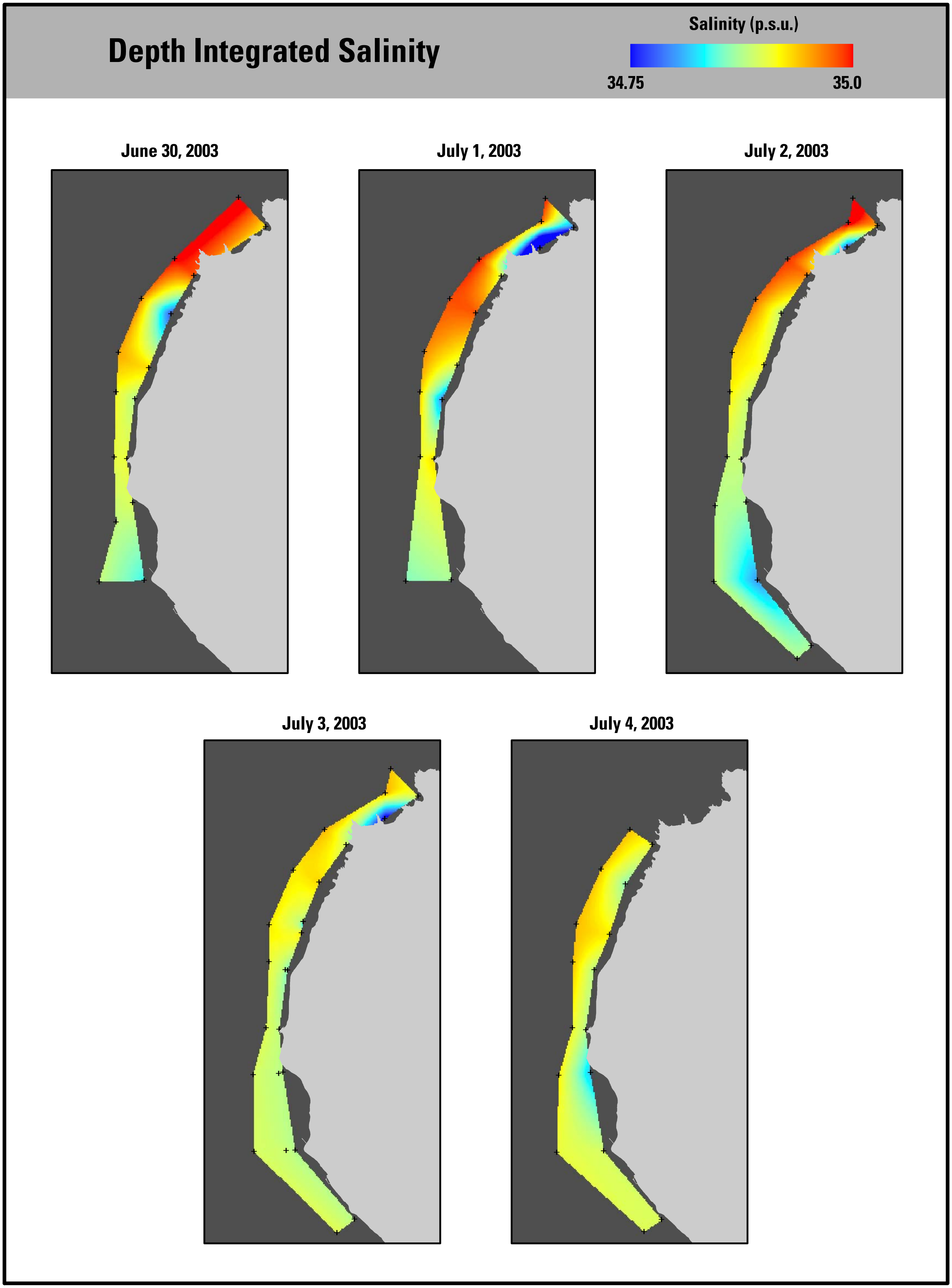


***FIGURE 20.*** *Maps of mean, depth-averaged salinity for each cast in the study area during the June/July cruises. Salinity is typically lower closer to shore due to freshwater runoff from streams and groundwater effluence through the reef. Less wave-induced mixing likely causes the greater heterogeneity in these data as compared to the data collected earlier in the year (see FIGURE 19).*

02/23/2003, and the 2 day lag between the rainfall and it subsequent effluence on the reef might be able to provide some information on hydraulic conductivities of the volcanic bedrock.

The map of salinity stratification shows the near-surface salinity (0.5-1.5 m below the surface) minus the near-bed salinity (0.5-1.5 m above the bed) for each cast in the study area. These maps typically display a stable water column, with lower salinity surface waters overlying more dense, higher salinity near-bed waters as shown in FIGURE 21 and 22. In a number of casts however, the near-bed salinity was lower than the near-surface salinity as shown by the positive stratification at the near shore Kahana and Kaanapali casts on 02/25/2003-02/26/2003 (FIGURE 21) and the offshore Kahana cast on 07/04/2003. These inverted profiles with more saline and thus more dense surface waters overlying less saline and thus less dense near-bed waters are likely due to the effluence of fresh water from the shoreface; this conclusion is supported by the positive temperature stratification observed at the same time in these locations.

The variability in salinity as a function of temperature for both sets of cruises is shown in FIGURE 23. The data from the deeper casts measured during the June/July cruises displays the typical decrease in temperature with increasing salinity. This trend is indicative of colder, more saline waters at depth being overlaid by lower salinity, warmer surface waters that form a stable water column. The cooler, more saline values are likely due to either weak wind-driven upwelling or tidal pumping. The greater scatter in the shallower casts is likely due to two different water masses, likely due to the influence of freshwater effluence through the reef or direct runoff from streams. The higher variability in salinity with temperature during the February cruises is likely due to the higher precipitation that occurs during the winter season, causing more fresh water to be in the system.

***Optical Backscatter*:**

The maps showing the distribution of optical backscatter in the study area display high spatial and temporal heterogeneity, as shown in FIGURES 24 and 25. While some high optical backscatter features were clearly caused by high suspended sediment loads related to stream discharge (i.e.- close to shore off Kahana gulch on 02/18/2003 and all along the coast on 02/25/2003-02/26/2003; FIGURE 24), other regions of observed high optical backscatter (i.e.- far offshore Kahana/Napili on 02/24/2003; FIGURE 24) were unrelated to suspended sediment and were likely due to high plankton concentrations in the water column. Long-period waves out of the south during 07/02/2003 and tapering off into 07/03/2003 resuspended fine-grained bed sediment, causing high optical backscatter at numerous locations along the coast (FIGURE 25).

***Variability in Water Column Properties with Depth:***

The overall trends for the variation in water column properties with depth over both survey periods display two dominant modes: turbid buoyant freshwater surface plumes inshore and two-layer structure offshore (FIGURES 26 and 27). Overall, temperature and optical backscatter decreased with depth while salinity and density increased with depth. At the shallow ends of the survey lines at the very surface, the higher backscatter but lower temperature, salinity and density at the surface are

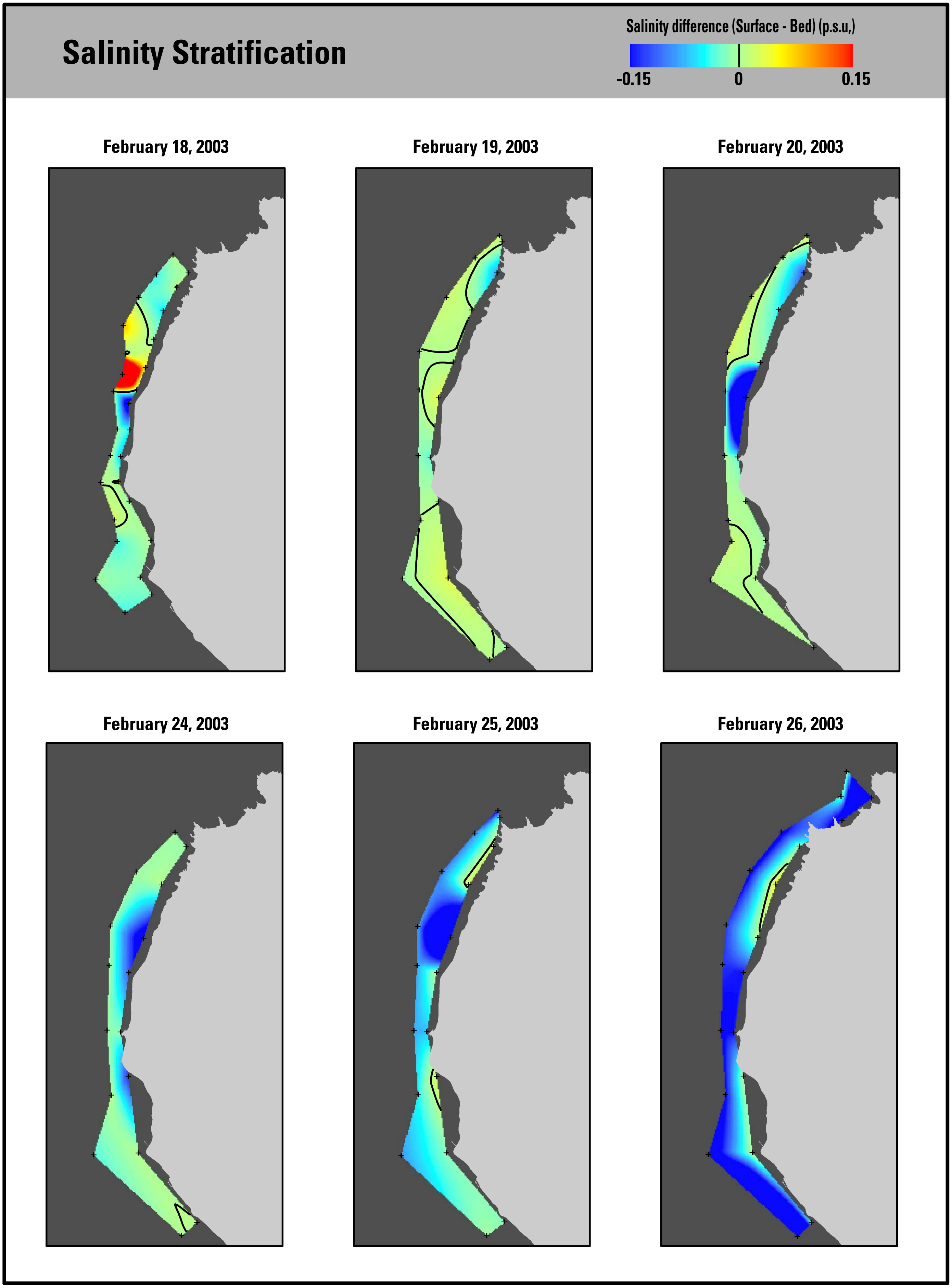


***FIGURE 21.*** *Maps of salinity stratification, computed as the near-surface salinity minus the near-bed salinity for each cast in the study area during the February cruises. The high variability in salinity stratification is likely caused by greater volumes of fresh water being released into the coastal waters through stream runoff or effluence through the reef.*

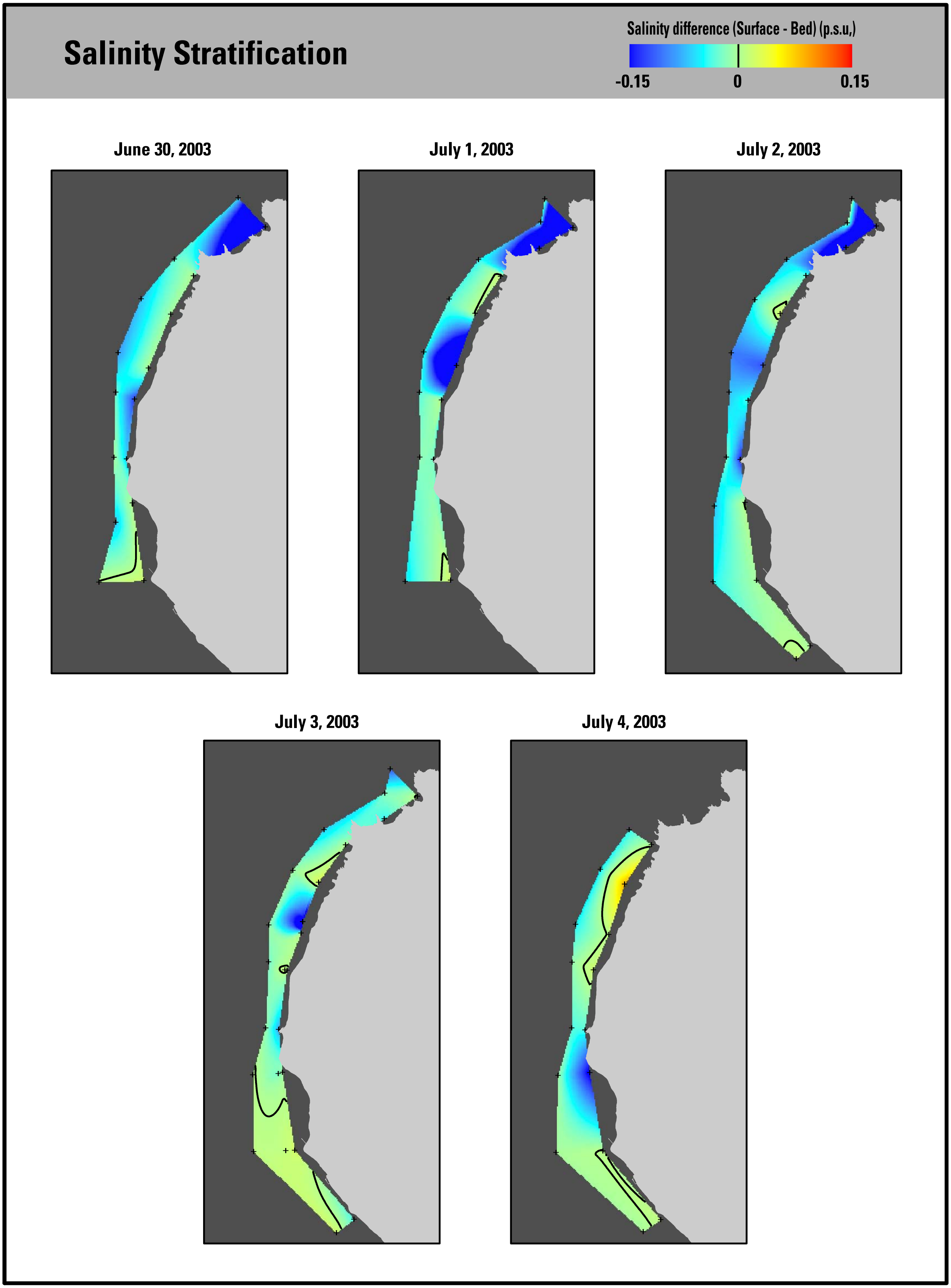


***FIGURE 22.*** *Maps of salinity stratification, computed as the near-surface salinity minus the near-bed salinity for each cast in the study area during the June/July cruises. The lower variability is these data as compared to earlier in the year (see FIGURE 21) is likely caused by the much smaller volumes of fresh water being released into the coastal waters during the drier summer season.*

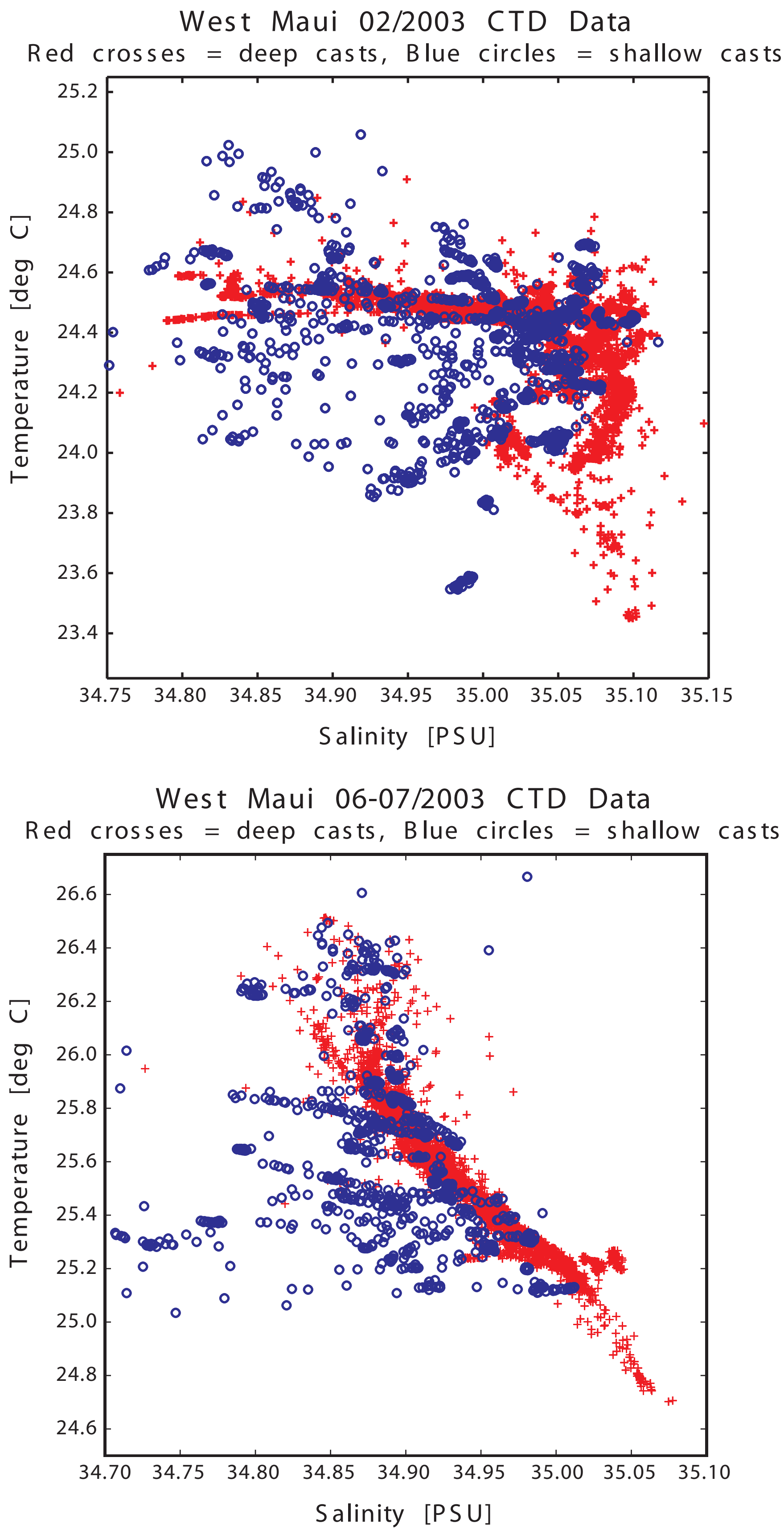


***FIGURE 23.*** *Plots of variation in salinity as a function of temperature. (a) Data collected during the February cruises. (b) Data collected during the June/July cruises. Deeper casts were those taken at the offshore ends of the ADCP transects; conversely, the shallow casts were those taken at the inshore ends of the transect lines. The data from February display more than one distinct water mass in the study area: one high salinity water mass with a wide range of temperatures and another with a small temperature range but with high temperature variability. These distinct signatures in the February data are likely heavily influenced by freshwater runoff from streams and/or effluence through the reef. The data from June/July show a more common temperature-salinity relationship. Overall, the shallower data typically show greater scatter due to more influence from terrestrial freshwater, insolation and wave-induced mixing.*

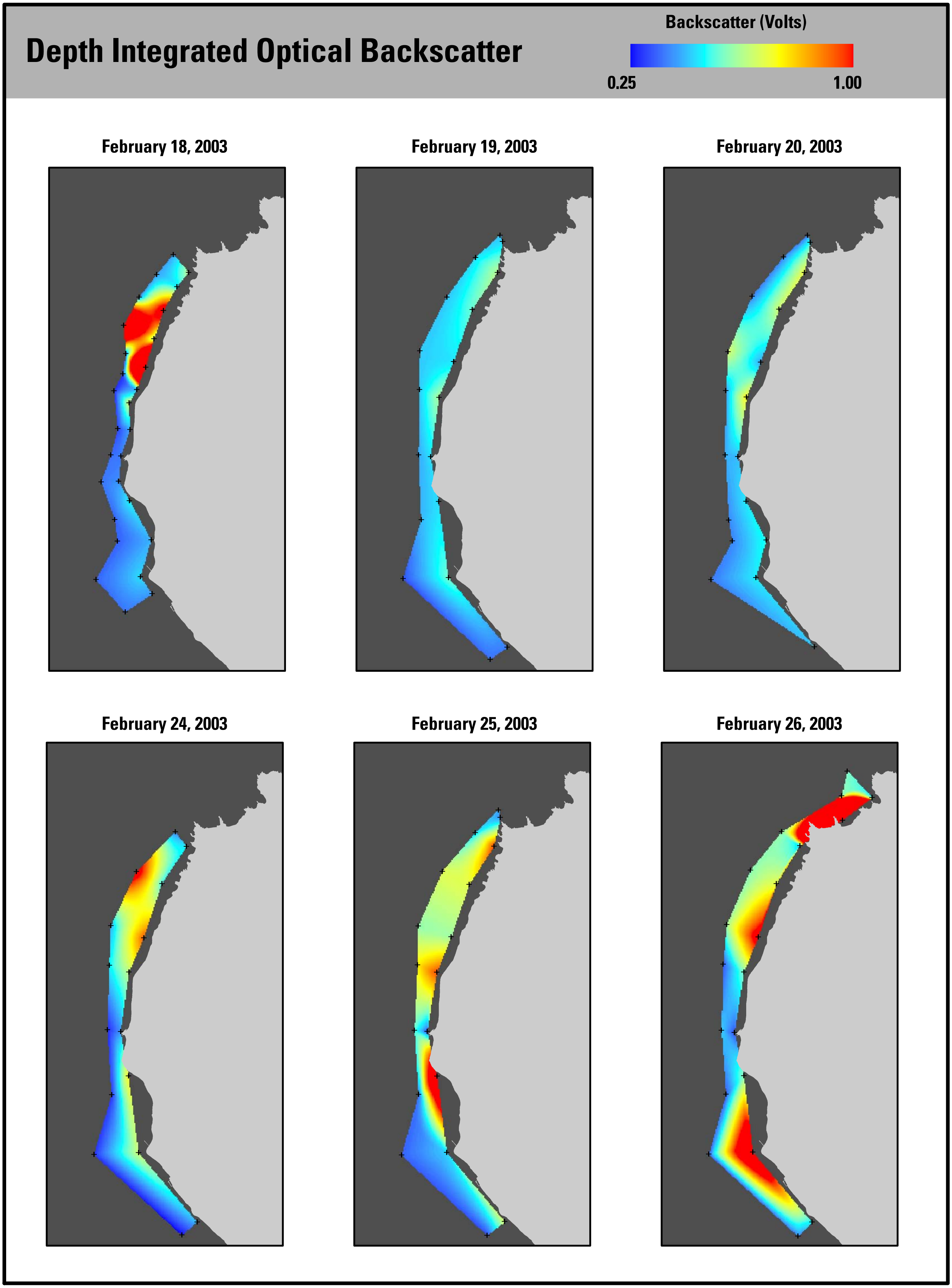


***FIGURE 24.*** *Maps of optical backscatter in the study area during the February cruises. Overall, optical backscatter is typically quite low except in areas affected by turbid stream discharge or wave-induced re-suspension of seafloor sediment. Most of the regions where high turbidity is typically observed are correlated with significant terrestrial drainages.*

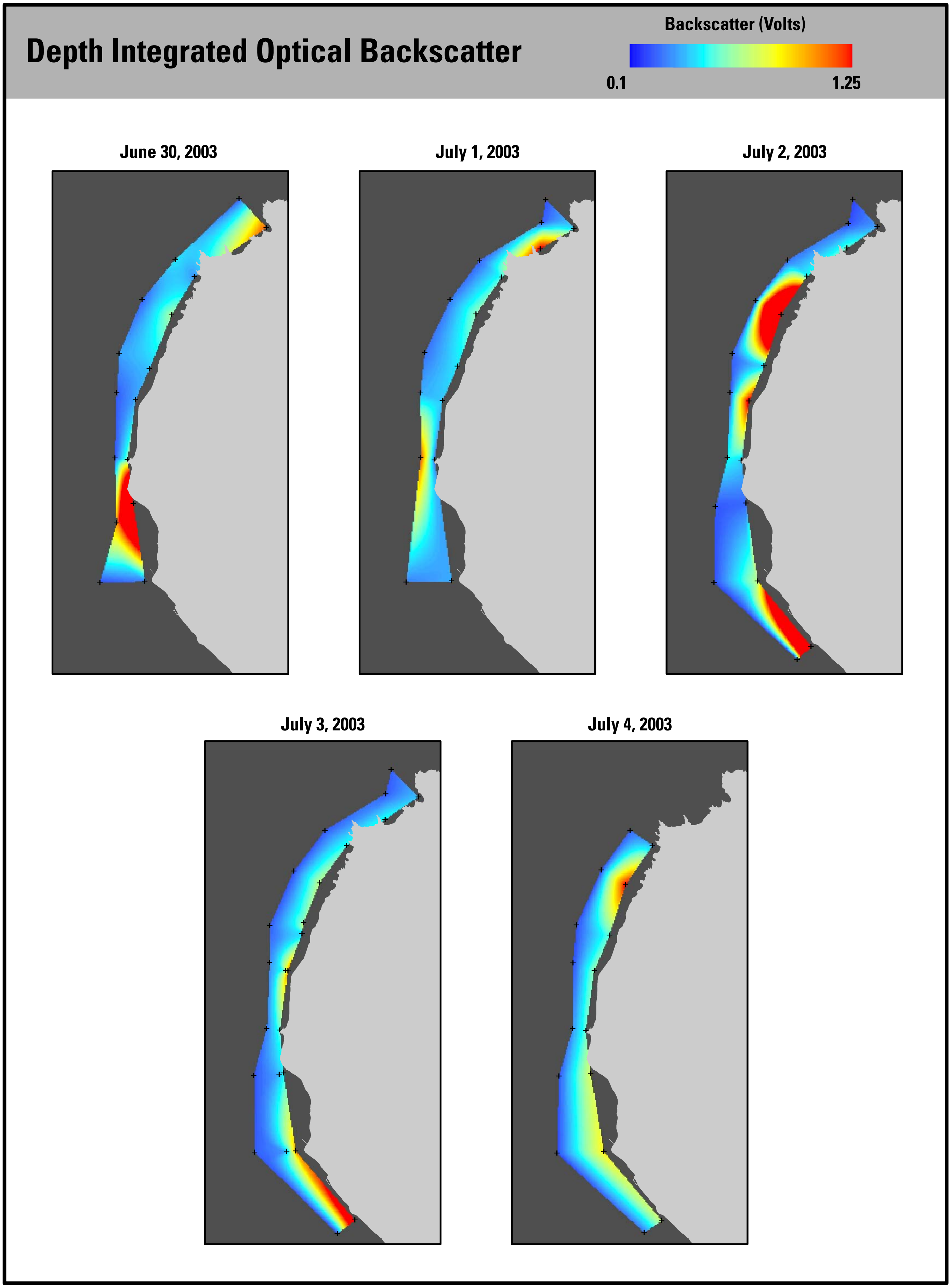


***FIGURE 25.*** *Maps of optical backscatter in the study area during the June/July cruises. Overall, optical backscatter is typically quite low except in areas affected by turbid stream discharge or wave-induced re-suspension of seafloor sediment. Most of the regions where high turbidity is typically observed are correlated with significant terrestrial drainages.*

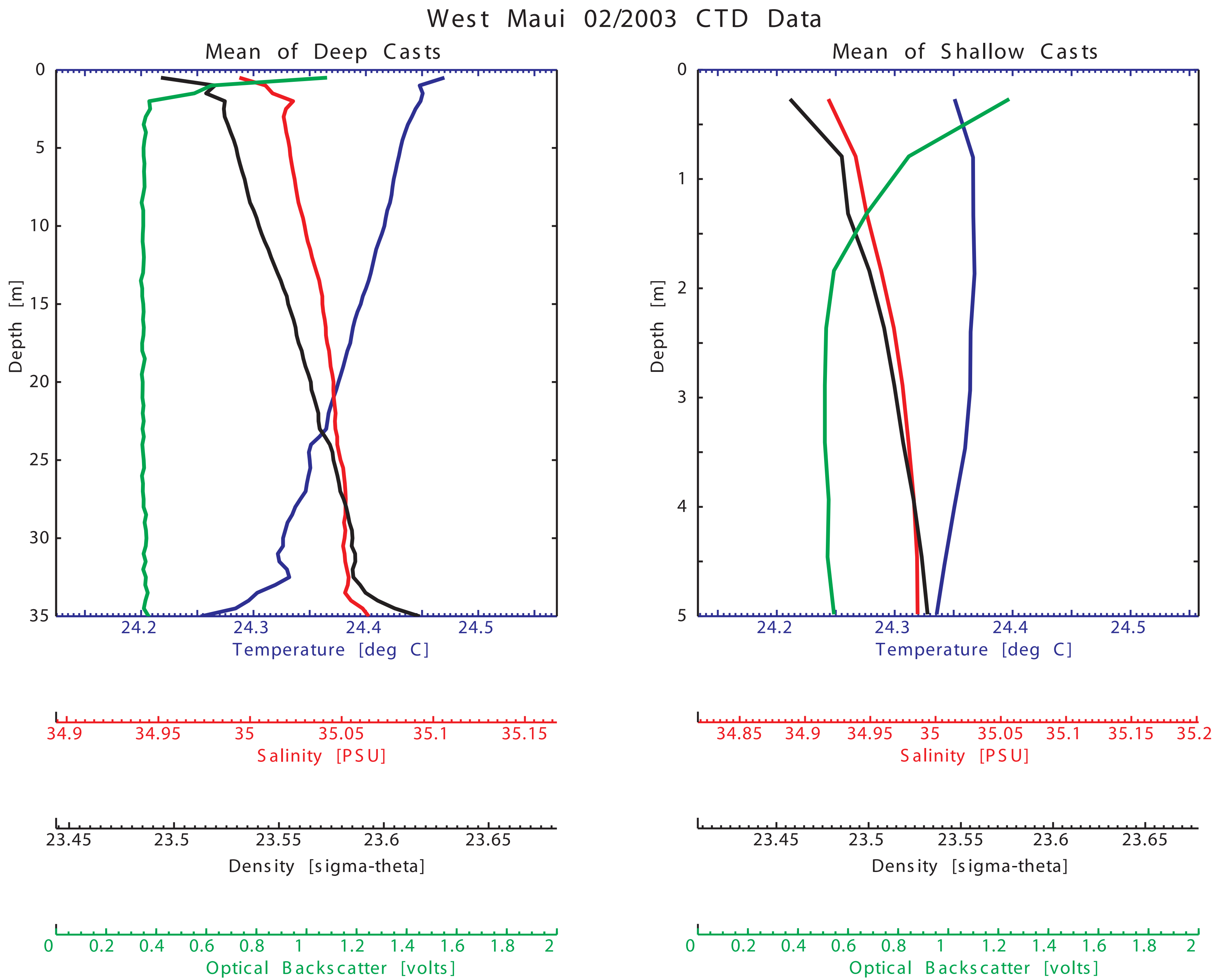


***FIGURE 26.*** *Plots of mean variation in CTD/OBS profiler data with depth during the February cruises. Turbidity is typically higher and salinity and temperature are lower right at the surface due to freshwater runoff close to shore. Turbidity and temperature then decrease with depth as salinity increases closer to the bed.*

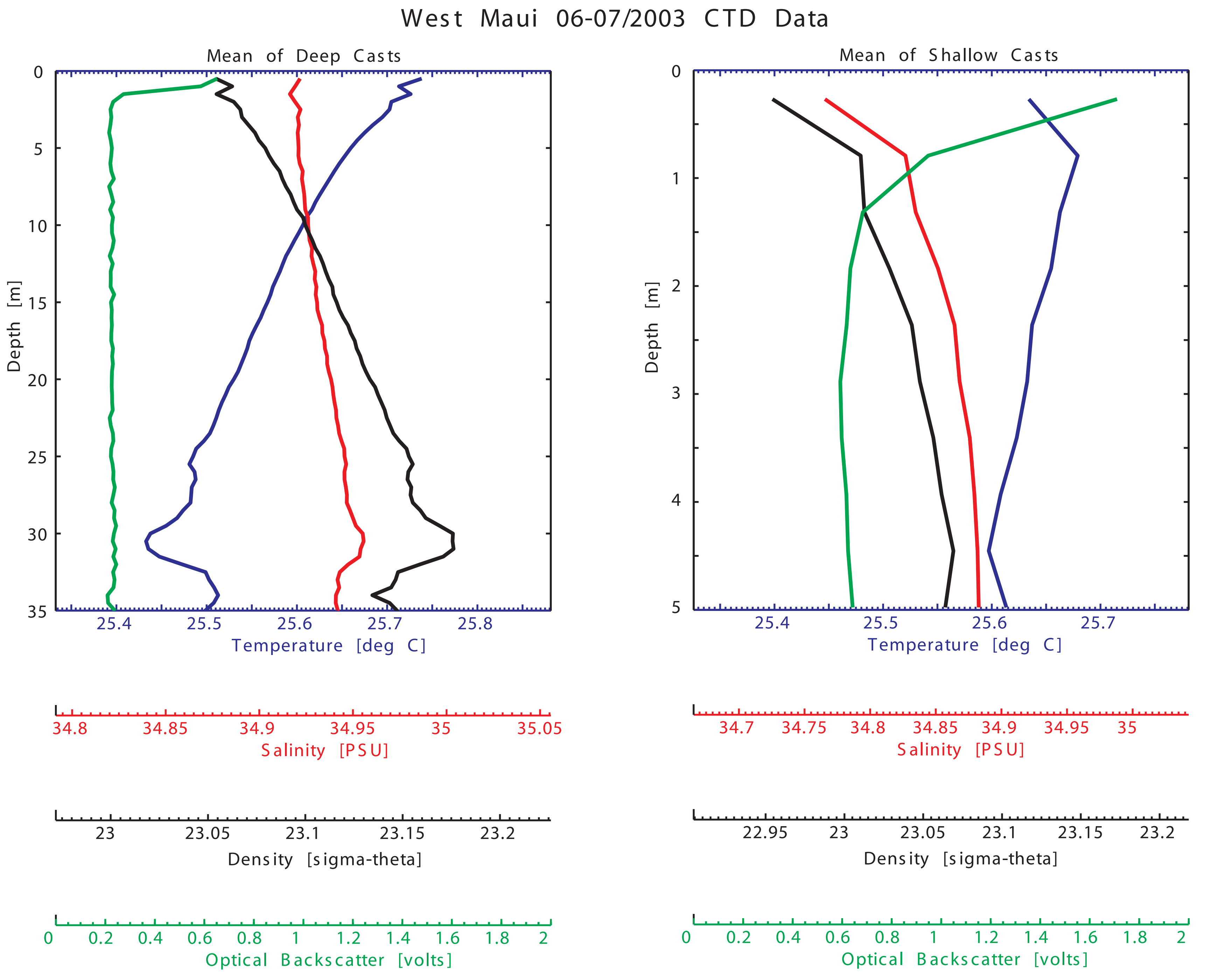


***FIGURE 27.*** *Plots of mean variation in CTD/OBS profiler data with depth during the June/July cruises. Turbidity is typically higher and salinity and temperature are lower right at the surface due to freshwater runoff close to shore. Turbidity and temperature then decrease with depth as salinity increases closer to the bed.*

indicative of the influence of turbid freshwater runoff plume. The temperature typically quickly rose to its maximum, then decreased slowly towards the bed. Optical backscatter generally decreased logarithmically towards the bed, typically reaching base levels 2 m below the water's surface; this suggests the slow settling of scattering material from the surface plume. The low salinity and density near the surface also support the presence of a buoyant freshwater surface plume.

Further offshore, the effects of the turbid buoyant freshwater surface plumes can still be identified by their lower salinity and density along with the higher optical backscatter. More import, however, were the presence of two-layer structures in the water column that were clearly identified in the individual casts but are manifested in the mean profiles as a general decrease in temperature and increase in salinity and density with depth. The differences between the overlying warmer, less saline water mass and the cooler, more saline water mass were often on the order of 0.25 ºC and 0.15 PSU. Numerous times during the surveys large, rapid displacements in the temperature, salinity and density profiles were observed at depths between 10-25 m, suggesting the presence of internal waves or non-linear internal tidal bores, similar to those observed in the long-term instrument package deployed off Kahana from the fall of 2001 through the spring of 2003 (see PART I of this report).

**Overall Trends**

These analyses, in conjunction with numerous field observations evoke the following conceptual model of water and turbidity flux along West Maui. The strong north-south gradient in precipitation along West Maui causes on average more fresh water and sediment to be discharged from streams in the northern part of the study area between Honolua Bay and Honokawai (FIGURE 28). This causes lower than normal salinities close to shore as more fresh water is discharged from streams and percolates out of the reef. Most of this turbid, lower salinity water close to shore is driven to the south due to Trade wind wave-induced breaking and the resulting wave-driven currents. This often turbid southward nearshore jet veers offshore at Kaanapali. The flow close to shore offshore of Lahaina heads north past Mala Wharf, causing a zone of convergence and eddy formation in the region between Mala Wharf and Kaanapali. These eddies likely help to retain turbid water in this area; similar retention of turbid water likely does not occur in Honolua Bay due to the higher wave energy that would dissipate the turbid fresh water plumes. The high cross-shore shear zone typically observed between the 10 m and 20 m isobaths along the study area might help to retain contaminants, nutrients or larvae along the region, which could affect local coral reefs in this depth range.

## CONCLUSIONS

In all, more than 110 km of high-resolution ADCP profile data and 211 CTD/OBS casts were collected off northwestern Maui, Hawaii, USA. All of the data were collected along shore-normal and shore-parallel transects between the 50 m and 4 m isobaths and included CTD/OBS casts at the offshore and inshore ends of each transect line

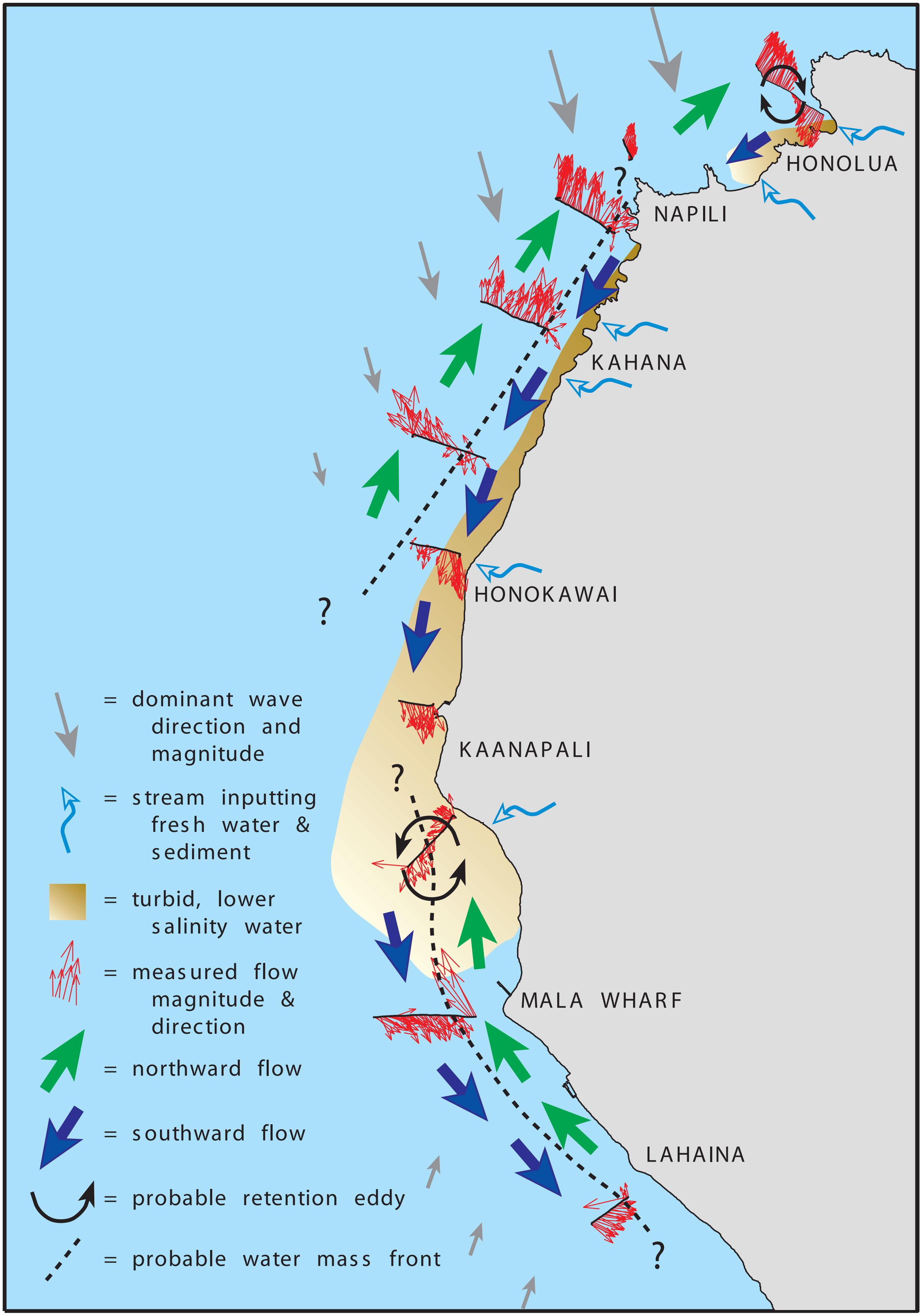


***FIGURE 28.*** *Schematic diagram of the dynamics of flow and turbidity in the study area. Higher turbidity and freshwater effluence or runoff is typically found close to shore. Net wave-driven flow close to shore is to the south in the northern part of the study area and to the north in then southern portions of the study area, causing convergence in the region between Mala Wharf and Kaanapali. Flow further offshore is typically the opposite of that observed inshore, with offshore flow to the north in the northern portion of the study area and to the south in the southern portion of the study area.*

over which ADCP profile data were collected. Critical findings from these measurements and analyses include:

(1) There is a persistent eddy in Honolua Bay, which is also often affected by turbid freshwater runoff. High wave action causes these turbid freshwater plumes to dissipate rapidly with distance from the stream mouth.

(2) From Kapalua to Black Rock at Kaanapali there is a relatively weak but consistent flow to the southwest close to shore that is likely wave-driven, while further offshore the net flow is to the northeast. There is evidence of turbid freshwater runoff from streams and fresh groundwater effluence from the nearshore reef in this region.

(3) There is a persistent eddy in the region between Kaanapali and Mala Wharf that, along with the absence of large waves, helps to maintain the high levels of turbidity typically observed in the area.

(4) From Mala Wharf to south of Lahaina there is a relatively weak but consistent flow to the northwest close to shore, while further offshore the net flow is to the southwest. Flow velocities are generally much weaker than observed further north. High turbidity was typically observed off southern Lahaina and the temperature and salinity data suggest it might be due to freshwater runoff.

(5) High turbidity was generally correlated with one of two processes: large wave events that tend to resuspend fine-grained bed sediment and cause elevated turbidity levels over long stretches of coastline, and turbid freshwater runoff that has a tendency to be more isolated along the coast in the area of stream mouths.

(6) The waters off West Maui are generally more saline and cooler further offshore, further to the north and with increasing depth. These overall trends, however, are greatly influenced by the presence of fresh water either from stream discharge or groundwater effluence through the shoreface.

These data provide us with a much clearer picture of the nature of and controls on flow and water column properties such as temperature, salinity and turbidity in the study area. A number of interesting phenomena were observed that indicate complex coastal circulation off West Maui.

## ACKNOWLEDGEMENTS

This work was carried out as part of the USGS's Coral Reef Project as part of an effort in the U.S. and its trust territories to better understand the affect of geologic processes on coral reef systems. Margaret McManus, Brian McLaughlin and Olivia Cheriton contributed as part of the ongoing USGS/University of California at Santa Cruz's Cooperative Studies Program. Project Chief Michael Field deserves thanks for providing us with the patience, opportunity and support to carry out these cruises. We would like to thank Joe Reich, the captain of the *R/V Alyce C.*, who piloted and navigated during the coral coverage surveys and during our numerous dive transects and instrument deployments. We would also like to thank Greg Piniak (USGS) and Amy Draut (USGS), who contributed numerous excellent suggestions and a timely review of our work.

## TABLE 1. Cruise personnel

| Crew Person | Crew Affiliation | Crew Responsibilities |
| --- | --- | --- |
| Curt Storlazzi | USGS | Chief scientist, oversaw CTD/OBS operations |
| Joshua Logan | USGS | Led navigation and CTD/OBS data acquisition |
| Margaret McManus | UCSC | Co-chief scientist, oversaw ADCP operations |
| Brian McLaughlin | UCSC | Led ADCP data acquisition |
| Olivia Cheriton | UCSC | Helped ADCP data acquisition |
| Joe Reich | | Captain, *R/V Alyce C.* |

**TABLE 2. ADCP profiler log: 02/18/2003 - 02/26/2003**

| Cruise ID | Island ID | Local Date | Local Time | UTC Date | UTC Time | Line ID |
|---|---|---|---|---|---|---|
| A-3-03-HW | MA | 2/18/2003 | 8:45 | 2/18/2003 | 18:45 | 030218_02 |
| A-3-03-HW | MA | 2/18/2003 | 9:20 | 2/18/2003 | 19:20 | 030218_03 |
| A-3-03-HW | MA | 2/18/2003 | 9:50 | 2/18/2003 | 19:50 | 030218_04 |
| A-3-03-HW | MA | 2/18/2003 | 11:00 | 2/18/2003 | 21:00 | 030218_05 |
| A-3-03-HW | MA | 2/18/2003 | 11:35 | 2/18/2003 | 21:35 | 030218_06 |
| A-3-03-HW | MA | 2/18/2003 | 12:20 | 2/18/2003 | 22:20 | 030218_07 |
| A-3-03-HW | MA | 2/18/2003 | 12:50 | 2/18/2003 | 22:50 | 030218_08 |
| A-3-03-HW | MA | 2/18/2003 | 13:15 | 2/18/2003 | 23:15 | 030218_09 |
| A-3-03-HW | MA | 2/18/2003 | 13:40 | 2/18/2003 | 23:40 | 030218_10 |
| A-3-03-HW | MA | 2/18/2003 | 14:10 | 2/19/2003 | 0:10 | 030218_11 |
| A-3-03-HW | MA | 2/18/2003 | 14:30 | 2/19/2003 | 0:30 | 030218_12 |
| A-3-03-HW | MA | 2/18/2003 | 14:55 | 2/19/2003 | 0:55 | 030218_13 |
| A-3-03-HW | MA | 2/18/2003 | 15:30 | 2/19/2003 | 1:30 | 030218_14 |
| A-3-03-HW | MA | 2/18/2003 | 16:05 | 2/19/2003 | 2:05 | 030218_15 |
| | | | | | | |
| A-3-03-HW | MA | 2/19/2003 | 8:30 | 2/19/2003 | 18:30 | 030219_01 |
| A-3-03-HW | MA | 2/19/2003 | 9:00 | 2/19/2003 | 19:00 | 030219_02 |
| A-3-03-HW | MA | 2/19/2003 | 9:30 | 2/19/2003 | 19:30 | 030219_04 |
| A-3-03-HW | MA | 2/19/2003 | 10:05 | 2/19/2003 | 20:05 | 030219_06 |
| A-3-03-HW | MA | 2/19/2003 | 10:40 | 2/19/2003 | 20:40 | 030219_08 |
| A-3-03-HW | MA | 2/19/2003 | 11:10 | 2/19/2003 | 21:10 | 030219_10 |
| A-3-03-HW | MA | 2/19/2003 | 11:35 | 2/19/2003 | 21:35 | 030219_12 |
| A-3-03-HW | MA | 2/19/2003 | 12:15 | 2/19/2003 | 22:15 | 030219_14 |
| A-3-03-HW | MA | 2/19/2003 | 12:55 | 2/19/2003 | 22:55 | 030219_16 |
| | | | | | | |
| A-3-03-HW | MA | 2/20/2003 | 7:45 | 2/20/2003 | 17:45 | 030220_16 |
| A-3-03-HW | MA | 2/20/2003 | 8:30 | 2/20/2003 | 18:30 | 030220_14 |
| A-3-03-HW | MA | 2/20/2003 | 9:05 | 2/20/2003 | 19:05 | 030220_13 |
| A-3-03-HW | MA | 2/20/2003 | 9:30 | 2/20/2003 | 19:30 | 030220_12 |
| A-3-03-HW | MA | 2/20/2003 | 10:00 | 2/20/2003 | 20:00 | 030220_10 |
| A-3-03-HW | MA | 2/20/2003 | 10:25 | 2/20/2003 | 20:25 | 030220_08 |
| A-3-03-HW | MA | 2/20/2003 | 11:00 | 2/20/2003 | 21:00 | 030220_06 |
| A-3-03-HW | MA | 2/20/2003 | 11:30 | 2/20/2003 | 21:30 | 030220_04 |
| A-3-03-HW | MA | 2/20/2003 | 12:00 | 2/20/2003 | 22:00 | 030220_02 |
| A-3-03-HW | MA | 2/20/2003 | 12:25 | 2/20/2003 | 22:25 | 030220_01 |
| | | | | | | |
| A-3-03-HW | MA | 2/24/2003 | 9:50 | 2/24/2003 | 19:50 | 030224_16 |
| A-3-03-HW | MA | 2/24/2003 | 10:50 | 2/24/2003 | 20:50 | 030224_14 |
| A-3-03-HW | MA | 2/24/2003 | 11:25 | 2/24/2003 | 21:25 | 030224_12 |
| A-3-03-HW | MA | 2/24/2003 | 11:55 | 2/24/2003 | 21:55 | 030224_10 |
| A-3-03-HW | MA | 2/24/2003 | 12:35 | 2/24/2003 | 22:35 | 030224_08 |
| A-3-03-HW | MA | 2/24/2003 | 13:00 | 2/24/2003 | 23:00 | 030224_06 |
| A-3-03-HW | MA | 2/24/2003 | 13:30 | 2/24/2003 | 23:30 | 030224_04 |
| A-3-03-HW | MA | 2/24/2003 | 14:05 | 2/25/2003 | 0:05 | 030224_02 |
| | | | | | | |
| A-3-03-HW | MA | 2/25/2003 | 8:40 | 2/25/2003 | 18:40 | 030225_01 |
| A-3-03-HW | MA | 2/25/2003 | 9:10 | 2/25/2003 | 19:10 | 030225_02 |
| A-3-03-HW | MA | 2/25/2003 | 9:45 | 2/25/2003 | 19:45 | 030225_04 |
| A-3-03-HW | MA | 2/25/2003 | 10:20 | 2/25/2003 | 20:20 | 030225_06 |
| A-3-03-HW | MA | 2/25/2003 | 10:45 | 2/25/2003 | 20:45 | 030225_08 |
| A-3-03-HW | MA | 2/25/2003 | 11:15 | 2/25/2003 | 21:15 | 030225_10 |
| A-3-03-HW | MA | 2/25/2003 | 11:45 | 2/25/2003 | 21:45 | 030225_12 |
| A-3-03-HW | MA | 2/25/2003 | 12:20 | 2/25/2003 | 22:20 | 030225_14 |
| A-3-03-HW | MA | 2/25/2003 | 12:55 | 2/25/2003 | 22:55 | 030225_16 |
| | | | | | | |
| A-3-03-HW | MA | 2/26/2003 | 7:30 | 2/26/2003 | 17:30 | 030226_16 |
| A-3-03-HW | MA | 2/26/2003 | 8:15 | 2/26/2003 | 18:15 | 030226_14 |
| A-3-03-HW | MA | 2/26/2003 | 8:45 | 2/26/2003 | 18:45 | 030226_12 |
| A-3-03-HW | MA | 2/26/2003 | 9:10 | 2/26/2003 | 19:10 | 030226_10 |
| A-3-03-HW | MA | 2/26/2003 | 9:35 | 2/26/2003 | 19:35 | 030226_08 |
| A-3-03-HW | MA | 2/26/2003 | 10:05 | 2/26/2003 | 20:05 | 030226_06 |
| A-3-03-HW | MA | 2/26/2003 | 10:40 | 2/26/2003 | 20:40 | 030226_04 |
| A-3-03-HW | MA | 2/26/2003 | 11:20 | 2/26/2003 | 21:20 | 030226_02 |
| A-3-03-HW | MA | 2/26/2003 | 12:10 | 2/26/2003 | 22:10 | 030226_20 |
| A-3-03-HW | MA | 2/26/2003 | 12:35 | 2/26/2003 | 22:35 | 030226_22 |

## TABLE 3. ADCP profiler log: 06/30/2003 - 07/04/2003

| Cruise ID | Island ID | Local Date | Local Time | UTC Date | UTC Time | Line ID |
|---|---|---|---|---|---|---|
| A-4-03-HW | MA | 6/30/2003 | 10:55 | 6/30/2003 | 20:55 | 030630_20 |
| A-4-03-HW | MA | 6/30/2003 | 11:45 | 6/30/2003 | 21:45 | 030630_02 |
| A-4-03-HW | MA | 6/30/2003 | 12:20 | 6/30/2003 | 22:20 | 030630_04 |
| A-4-03-HW | MA | 6/30/2003 | 13:00 | 6/30/2003 | 23:00 | 030630_06 |
| A-4-03-HW | MA | 6/30/2003 | 13:40 | 6/30/2003 | 23:40 | 030630_08 |
| A-4-03-HW | MA | 6/30/2003 | 14:10 | 7/1/2003 | 0:10 | 030630_10 |
| A-4-03-HW | MA | 6/30/2003 | 14:35 | 7/1/2003 | 0:35 | 030630_12 |
| A-4-03-HW | MA | 6/30/2003 | 15:05 | 7/1/2003 | 1:05 | 030630_14 |
| | | | | | | |
| A-4-03-HW | MA | 7/1/2003 | 9:20 | 7/1/2003 | 19:20 | 030701_20 |
| A-4-03-HW | MA | 7/1/2003 | 9:45 | 7/1/2003 | 19:45 | 030701_22 |
| A-4-03-HW | MA | 7/1/2003 | 10:15 | 7/1/2003 | 20:15 | 030701_02 |
| A-4-03-HW | MA | 7/1/2003 | 10:50 | 7/1/2003 | 20:50 | 030701_04 |
| A-4-03-HW | MA | 7/1/2003 | 11:20 | 7/1/2003 | 21:20 | 030701_06 |
| A-4-03-HW | MA | 7/1/2003 | 14:35 | 7/2/2003 | 0:35 | 030701_08 |
| A-4-03-HW | MA | 7/1/2003 | 15:00 | 7/2/2003 | 1:00 | 030701_10 |
| A-4-03-HW | MA | 7/1/2003 | 15:45 | 7/2/2003 | 1:45 | 030701_14 |
| | | | | | | |
| A-4-03-HW | MA | 7/2/2003 | 10:20 | 7/2/2003 | 20:20 | 030702_20 |
| A-4-03-HW | MA | 7/2/2003 | 10:45 | 7/2/2003 | 20:45 | 030702_22 |
| A-4-03-HW | MA | 7/2/2003 | 11:20 | 7/2/2003 | 21:20 | 030702_02 |
| A-4-03-HW | MA | 7/2/2003 | 11:50 | 7/2/2003 | 21:50 | 030702_04 |
| A-4-03-HW | MA | 7/2/2003 | 12:20 | 7/2/2003 | 22:20 | 030702_06 |
| A-4-03-HW | MA | 7/2/2003 | 12:55 | 7/2/2003 | 22:55 | 030702_08 |
| A-4-03-HW | MA | 7/2/2003 | 14:25 | 7/3/2003 | 0:25 | 030702_10 |
| A-4-03-HW | MA | 7/2/2003 | 14:55 | 7/3/2003 | 0:55 | 030702_12R |
| A-4-03-HW | MA | 7/2/2003 | 15:25 | 7/3/2003 | 1:25 | 030702_30 |
| A-4-03-HW | MA | 7/2/2003 | 15:50 | 7/3/2003 | 1:50 | 030702_14 |
| A-4-03-HW | MA | 7/2/2003 | 16:35 | 7/3/2003 | 2:35 | 030702_16 |
| | | | | | | |
| A-4-03-HW | MA | 7/3/2003 | 9:05 | 7/3/2003 | 19:05 | 030703_20 |
| A-4-03-HW | MA | 7/3/2003 | 9:30 | 7/3/2003 | 19:30 | 030703_22 |
| A-4-03-HW | MA | 7/3/2003 | 10:00 | 7/3/2003 | 20:00 | 030703_02 |
| A-4-03-HW | MA | 7/3/2003 | 10:40 | 7/3/2003 | 20:40 | 030703_04 |
| A-4-03-HW | MA | 7/3/2003 | 11:20 | 7/3/2003 | 21:20 | 030703_06 |
| A-4-03-HW | MA | 7/3/2003 | 11:55 | 7/3/2003 | 21:55 | 030703_08 |
| A-4-03-HW | MA | 7/3/2003 | 12:30 | 7/3/2003 | 22:30 | 030703_10 |
| A-4-03-HW | MA | 7/3/2003 | 13:05 | 7/3/2003 | 23:05 | 030703_12R |
| A-4-03-HW | MA | 7/3/2003 | 13:45 | 7/3/2003 | 23:45 | 030703_30 |
| A-4-03-HW | MA | 7/3/2003 | 14:15 | 7/4/2003 | 0:15 | 030703_14 |
| A-4-03-HW | MA | 7/3/2003 | 14:55 | 7/4/2003 | 0:55 | 030703_16 |
| | | | | | | |
| A-4-03-HW | MA | 7/4/2003 | 8:05 | 7/4/2003 | 18:05 | 030704_16 |
| A-4-03-HW | MA | 7/4/2003 | 8:45 | 7/4/2003 | 18:45 | 030704_14 |
| A-4-03-HW | MA | 7/4/2003 | 9:15 | 7/4/2003 | 19:15 | 030704_30 |
| A-4-03-HW | MA | 7/4/2003 | 9:40 | 7/4/2003 | 19:40 | 030704_12R |
| A-4-03-HW | MA | 7/4/2003 | 10:05 | 7/4/2003 | 20:05 | 030704_10 |
| A-4-03-HW | MA | 7/4/2003 | 10:25 | 7/4/2003 | 20:25 | 030704_08 |
| A-4-03-HW | MA | 7/4/2003 | 10:55 | 7/4/2003 | 20:55 | 030704_06 |
| A-4-03-HW | MA | 7/4/2003 | 11:30 | 7/4/2003 | 21:30 | 030704_04 |
| A-4-03-HW | MA | 7/4/2003 | 12:05 | 7/4/2003 | 22:05 | 030704_02 |

**TABLE 4. CTD/OBS profiler log: 02/18/2003 - 02/26/2003**

| Cruise ID | Island ID | Local Date | Local Time | UTC Date | UTC Time | Site/Line ID | Depth [ft] | Depth [m] | Latitude [dd] | Longitude [dd] | Conditions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A-3-03-HW | MA | 02/18/2003 | 8:33 | 02/18/2003 | 18:33 | 030218_02F | 110 | 33.5 | 21.0039105 | -156.6759889 | 3m swell |
| A-3-03-HW | MA | 02/18/2003 | 8:57 | 02/18/2003 | 18:57 | 030218_02N | 18 | 5.5 | 20.9970825 | -156.6699737 | |
| A-3-03-HW | MA | 02/18/2003 | 9:08 | 02/18/2003 | 19:08 | 030218_03F | 100 | 30.5 | 20.9964623 | -156.6828074 | |
| A-3-03-HW | MA | 02/18/2003 | 9:29 | 02/18/2003 | 19:29 | 030218_03N | 20 | 6.1 | 20.9917561 | -156.6746923 | |
| A-3-03-HW | MA | 02/18/2003 | 9:42 | 02/18/2003 | 19:42 | 030218_04F | 105 | 32.0 | 20.9880244 | -156.6899239 | |
| A-3-03-HW | MA | 02/18/2003 | 10:04 | 02/18/2003 | 20:04 | 030218_04N | 20 | 6.1 | 20.9829376 | -156.6802703 | |
| A-3-03-HW | MA | 02/18/2003 | 10:46 | 02/18/2003 | 20:46 | 030218_05F | 95 | 29.0 | 20.9775425 | -156.6963405 | 2m swell |
| A-3-03-HW | MA | 02/18/2003 | 11:13 | 02/18/2003 | 21:13 | 030218_05N | 18 | 5.5 | 20.9722899 | -156.6842550 | |
| A-3-03-HW | MA | 02/18/2003 | 11:26 | 02/18/2003 | 21:26 | 030218_06F | 120 | 36.6 | 20.9668828 | -156.6955958 | |
| A-3-03-HW | MA | 02/18/2003 | 11:47 | 02/18/2003 | 21:47 | 030218_06N | 18 | 5.5 | 20.9616344 | -156.6877363 | |
| A-3-03-HW | MA | 02/18/2003 | 12:10 | 02/18/2003 | 22:10 | 030218_07F | 115 | 35.1 | 20.9592712 | -156.6969371 | |
| A-3-03-HW | MA | 02/18/2003 | 12:31 | 02/18/2003 | 22:31 | 030218_07N | 20 | 6.1 | 20.9532929 | -156.6914120 | |
| A-3-03-HW | MA | 02/18/2003 | 12:40 | 02/18/2003 | 22:40 | 030218_08F | 110 | 33.5 | 20.9529071 | -156.7005905 | |
| A-3-03-HW | MA | 02/18/2003 | 13:01 | 02/18/2003 | 23:01 | 030218_08N | 20 | 6.1 | 20.9482908 | -156.6945832 | |
| A-3-03-HW | MA | 02/18/2003 | 13:11 | 02/18/2003 | 23:11 | 030218_09F | 120 | 36.6 | 20.9386418 | -156.6992926 | |
| A-3-03-HW | MA | 02/18/2003 | 13:23 | 02/18/2003 | 23:23 | 030218_09N | 30 | 9.1 | 20.9382226 | -156.6943729 | 1m swell |
| A-3-03-HW | MA | 02/18/2003 | 13:33 | 02/18/2003 | 23:33 | 030218_10F | 120 | 36.6 | 20.9287587 | -156.7022018 | |
| A-3-03-HW | MA | 02/18/2003 | 13:46 | 02/18/2003 | 23:46 | 030218_10N | 40 | 12.2 | 20.9283378 | -156.6981509 | |
| A-3-03-HW | MA | 02/18/2003 | 13:56 | 02/18/2003 | 23:56 | 030218_11F | 120 | 36.6 | 20.9186667 | -156.7062010 | |
| A-3-03-HW | MA | 02/18/2003 | 14:12 | 02/19/2003 | 0:12 | 030218_11N | 25 | 7.6 | 20.9188103 | -156.6992781 | |
| A-3-03-HW | MA | 02/18/2003 | 14:23 | 02/19/2003 | 0:23 | 030218_12N | 20 | 6.1 | 20.9114216 | -156.6949707 | |
| A-3-03-HW | MA | 02/18/2003 | 14:36 | 02/19/2003 | 0:36 | 030218_12F | 70 | 21.3 | 20.9044152 | -156.7010312 | |
| A-3-03-HW | MA | 02/18/2003 | 14:45 | 02/19/2003 | 0:45 | 030218_13F | 115 | 35.1 | 20.8962953 | -156.7000322 | |
| A-3-03-HW | MA | 02/18/2003 | 15:05 | 02/19/2003 | 1:05 | 030218_13N | 20 | 6.1 | 20.8965644 | -156.6865303 | |
| A-3-03-HW | MA | 02/18/2003 | 15:16 | 02/19/2003 | 1:16 | 030218_14N | 20 | 6.1 | 20.8827119 | -156.6910482 | |
| A-3-03-HW | MA | 02/18/2003 | 15:40 | 02/19/2003 | 1:40 | 030218_14F | 90 | 27.4 | 20.8819472 | -156.7088719 | |
| A-3-03-HW | MA | 02/18/2003 | 15:53 | 02/19/2003 | 1:53 | 030218_15F | 120 | 36.6 | 20.8695161 | -156.6973537 | |
| A-3-03-HW | MA | 02/18/2003 | 16:13 | 02/19/2003 | 2:13 | 030218_15N | 25 | 7.6 | 20.8762544 | -156.6864325 | |
| | | | | | | | | | | | |
| A-3-03-HW | MA | 02/19/2003 | 8:29 | 02/19/2003 | 18:29 | 030219_01F | 125 | 38.1 | 21.0110062 | -156.6681672 | 3m swell |
| A-3-03-HW | MA | 02/19/2003 | 8:35 | 02/19/2003 | 18:35 | 030219_01N | 75 | 22.9 | 21.0086518 | -156.6671982 | |
| A-3-03-HW | MA | 02/19/2003 | 8:48 | 02/19/2003 | 18:48 | 030219_02F | 130 | 39.6 | 21.0027789 | -156.6781371 | |
| A-3-03-HW | MA | 02/19/2003 | 9:08 | 02/19/2003 | 19:08 | 030219_02N | 20 | 6.1 | 20.9970532 | -156.6694259 | |
| A-3-03-HW | MA | 02/19/2003 | 9:20 | 02/19/2003 | 19:20 | 030219_04F | 105 | 32.0 | 20.9880397 | -156.6898369 | |
| A-3-03-HW | MA | 02/19/2003 | 9:38 | 02/19/2003 | 19:38 | 030219_04N | 20 | 6.1 | 20.9832353 | -156.6797268 | |
| A-3-03-HW | MA | 02/19/2003 | 9:54 | 02/19/2003 | 19:54 | 030219_06N | 20 | 6.1 | 20.9637450 | -156.6875156 | 1m swell |
| A-3-03-HW | MA | 02/19/2003 | 10:12 | 02/19/2003 | 20:12 | 030219_06F | 120 | 36.6 | 20.9679572 | -156.7009282 | |
| A-3-03-HW | MA | 02/19/2003 | 10:27 | 02/19/2003 | 20:27 | 030219_08F | 120 | 36.6 | 20.9533587 | -156.7013413 | |
| A-3-03-HW | MA | 02/19/2003 | 10:45 | 02/19/2003 | 20:45 | 030219_08N | 20 | 6.1 | 20.9503384 | -156.6935654 | |
| A-3-03-HW | MA | 02/19/2003 | 11:01 | 02/19/2003 | 21:01 | 030219_10F | 120 | 36.6 | 20.9287786 | -156.7020857 | |
| A-3-03-HW | MA | 02/19/2003 | 11:12 | 02/19/2003 | 21:12 | 030219_10N | 30 | 9.1 | 20.9280492 | -156.6972542 | |
| A-3-03-HW | MA | 02/19/2003 | 11:27 | 02/19/2003 | 21:27 | 030219_12N | 20 | 6.1 | 20.9111699 | -156.6943192 | |
| A-3-03-HW | MA | 02/19/2003 | 11:44 | 02/19/2003 | 21:44 | 030219_12F | 75 | 22.9 | 20.9043970 | -156.7013521 | |
| A-3-03-HW | MA | 02/19/2003 | 12:01 | 02/19/2003 | 22:01 | 030219_14F | 85 | 25.9 | 20.8823677 | -156.7089959 | |
| A-3-03-HW | MA | 02/19/2003 | 12:26 | 02/19/2003 | 22:26 | 030219_14N | 20 | 6.1 | 20.8824392 | -156.6907684 | |
| A-3-03-HW | MA | 02/19/2003 | 12:48 | 02/19/2003 | 22:48 | 030219_16F | 105 | 32.0 | 20.8513933 | -156.6746079 | |
| A-3-03-HW | MA | 02/19/2003 | 13:00 | 02/19/2003 | 23:00 | 030219_16N | 20 | 6.1 | 20.8559235 | -156.6676910 | |
| | | | | | | | | | | | |
| A-3-03-HW | MA | 02/20/2003 | 7:30 | 02/20/2003 | 17:30 | 030220_16F | 105 | 32.0 | 20.8512823 | -156.6750387 | calm |
| A-3-03-HW | MA | 02/20/2003 | 7:53 | 02/20/2003 | 17:53 | 030220_16N | 20 | 6.1 | 20.8559746 | -156.6677857 | |
| A-3-03-HW | MA | 02/20/2003 | 8:16 | 02/20/2003 | 18:16 | 030220_14F | 90 | 27.4 | 20.8818774 | -156.7088262 | |
| A-3-03-HW | MA | 02/20/2003 | 8:40 | 02/20/2003 | 18:40 | 030220_14N | 20 | 6.1 | 20.8824173 | -156.6907958 | |
| A-3-03-HW | MA | 02/20/2003 | 8:40 | 02/20/2003 | 18:40 | 030220_14N2 | 20 | 6.1 | 20.8824173 | -156.6907958 | |
| A-3-03-HW | MA | 02/20/2003 | 8:54 | 02/20/2003 | 18:54 | 030220_13F | 115 | 35.1 | 20.8963155 | -156.7000757 | |
| A-3-03-HW | MA | 02/20/2003 | 9:14 | 02/20/2003 | 19:14 | 030220_13N | 20 | 6.1 | 20.8965185 | -156.6865356 | |
| A-3-03-HW | MA | 02/20/2003 | 9:25 | 02/20/2003 | 19:25 | 030220_12F | 75 | 22.9 | 20.9042409 | -156.7014106 | |
| A-3-03-HW | MA | 02/20/2003 | 9:39 | 02/20/2003 | 19:39 | 030220_12N | 20 | 6.1 | 20.9112100 | -156.6943505 | |
| A-3-03-HW | MA | 02/20/2003 | 9:54 | 02/20/2003 | 19:54 | 030220_10F | 135 | 41.2 | 20.9287787 | -156.7024556 | |
| A-3-03-HW | MA | 02/20/2003 | 10:05 | 02/20/2003 | 20:05 | 030220_10N | 30 | 9.1 | 20.9281075 | -156.6974050 | |
| A-3-03-HW | MA | 02/20/2003 | 10:18 | 02/20/2003 | 20:18 | 030220_08N | 20 | 6.1 | 20.9504465 | -156.6935759 | 1m swell |
| A-3-03-HW | MA | 02/20/2003 | 10:32 | 02/20/2003 | 20:32 | 030220_08F | 125 | 38.1 | 20.9529853 | -156.7018404 | |
| A-3-03-HW | MA | 02/20/2003 | 10:43 | 02/20/2003 | 20:43 | 030220_06F | 120 | 36.6 | 20.9676314 | -156.7007298 | |
| A-3-03-HW | MA | 02/20/2003 | 11:06 | 02/20/2003 | 21:06 | 030220_06N | 20 | 6.1 | 20.9635266 | -156.6876792 | |
| A-3-03-HW | MA | 02/20/2003 | 11:19 | 02/20/2003 | 21:19 | 030220_04N | 20 | 6.1 | 20.9833658 | -156.6800161 | |
| A-3-03-HW | MA | 02/20/2003 | 11:36 | 02/20/2003 | 21:36 | 030220_04F | 140 | 42.7 | 20.9884363 | -156.6907509 | |
| A-3-03-HW | MA | 02/20/2003 | 11:51 | 02/20/2003 | 21:51 | 030220_02F | 135 | 41.2 | 21.0030022 | -156.6779284 | |
| A-3-03-HW | MA | 02/20/2003 | 12:07 | 02/20/2003 | 22:07 | 030220_02N | 20 | 6.1 | 20.9970595 | -156.6695920 | |
| A-3-03-HW | MA | 02/20/2003 | 12:18 | 02/20/2003 | 22:18 | 030220_01F | 130 | 39.6 | 21.0111157 | -156.6682176 | |
| A-3-03-HW | MA | 02/20/2003 | 12:27 | 02/20/2003 | 22:27 | 030220_01N | 40 | 12.2 | 21.0083599 | -156.6671670 | |
| | | | | | | | | | | | |
| A-3-03-HW | MA | 02/24/2003 | 9:40 | 02/24/2003 | 19:40 | 030224_16F | 105 | 32.0 | 20.8511613 | -156.6740186 | calm |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A-3-03-HW | MA | 02/24/2003 | 10:06 | 02/24/2003 | 20:06 | 030224_16N | 20 | 6.1 | 20.8559921 | -156.6677874 | |
| A-3-03-HW | MA | 02/24/2003 | 10:40 | 02/24/2003 | 20:40 | 030224_14F | 90 | 27.4 | 20.8819913 | -156.7087193 | |
| A-3-03-HW | MA | 02/24/2003 | 11:03 | 02/24/2003 | 21:03 | 030224_14N | 20 | 6.1 | 20.8824253 | -156.6908511 | |
| A-3-03-HW | MA | 02/24/2003 | 11:19 | 02/24/2003 | 21:19 | 030224_12F | 75 | 22.9 | 20.9043221 | -156.7012936 | |
| A-3-03-HW | MA | 02/24/2003 | 11:33 | 02/24/2003 | 21:33 | 030224_12N | 20 | 6.1 | 20.9113152 | -156.6944047 | |
| A-3-03-HW | MA | 02/24/2003 | 11:47 | 02/24/2003 | 21:47 | 030224_10F | 140 | 42.7 | 20.9288003 | -156.7026849 | 0.5m swell |
| A-3-03-HW | MA | 02/24/2003 | 11:58 | 02/24/2003 | 21:58 | 030224_10N | 30 | 9.1 | 20.9281014 | -156.6973491 | |
| A-3-03-HW | MA | 02/24/2003 | 12:14 | 02/24/2003 | 22:14 | 030224_08F | 120 | 36.6 | 20.9530699 | -156.7015149 | 1m swell |
| A-3-03-HW | MA | 02/24/2003 | 12:36 | 02/24/2003 | 22:36 | 030224_08N | 25 | 7.6 | 20.9504199 | -156.6936769 | |
| A-3-03-HW | MA | 02/24/2003 | 12:49 | 02/24/2003 | 22:49 | 030224_06N | 20 | 6.1 | 20.9631959 | -156.6875334 | |
| A-3-03-HW | MA | 02/24/2003 | 13:06 | 02/24/2003 | 23:06 | 030224_06F | 120 | 36.6 | 20.9679720 | -156.7006490 | |
| A-3-03-HW | MA | 02/24/2003 | 13:25 | 02/24/2003 | 23:25 | 030224_04N | 20 | 6.1 | 20.9835154 | -156.6799408 | |
| A-3-03-HW | MA | 02/24/2003 | 13:38 | 02/24/2003 | 23:38 | 030224_04F | 120 | 36.6 | 20.9881865 | -156.6901087 | |
| A-3-03-HW | MA | 02/24/2003 | 13:57 | 02/24/2003 | 23:57 | 030224_02F | 70 | 21.3 | 21.0029573 | -156.6743245 | |
| A-3-03-HW | MA | 02/24/2003 | 14:13 | 02/25/2003 | 0:13 | 030224_02N | 20 | 6.1 | 20.9973971 | -156.6698989 | |
| | | | | | | | | | | | |
| A-3-03-HW | MA | 02/25/2003 | 8:33 | 02/25/2003 | 18:33 | 030225_01F | 125 | 38.1 | 21.0111320 | -156.6679053 | calm |
| A-3-03-HW | MA | 02/25/2003 | 8:49 | 02/25/2003 | 18:49 | 030225_01N | 40 | 12.2 | 21.0083302 | -156.6672356 | |
| A-3-03-HW | MA | 02/25/2003 | 9:00 | 02/25/2003 | 19:00 | 030225_02F | 125 | 38.1 | 21.0027463 | -156.6773189 | |
| A-3-03-HW | MA | 02/25/2003 | 9:22 | 02/25/2003 | 19:22 | 030225_02N | 20 | 6.1 | 20.9975270 | -156.6698750 | |
| A-3-03-HW | MA | 02/25/2003 | 9:35 | 02/25/2003 | 19:35 | 030225_04F | 140 | 42.7 | 20.9882840 | -156.6907775 | |
| A-3-03-HW | MA | 02/25/2003 | 9:56 | 02/25/2003 | 19:56 | 030225_04N | 20 | 6.1 | 20.9832479 | -156.6800412 | |
| A-3-03-HW | MA | 02/25/2003 | 10:10 | 02/25/2003 | 20:10 | 030225_06N | 20 | 6.1 | 20.9636532 | -156.6875883 | |
| A-3-03-HW | MA | 02/25/2003 | 10:28 | 02/25/2003 | 20:28 | 030225_06F | 120 | 36.6 | 20.9678521 | -156.7007492 | |
| A-3-03-HW | MA | 02/25/2003 | 10:40 | 02/25/2003 | 20:40 | 030225_08F | 120 | 36.6 | 20.9532025 | -156.7012232 | 1m swell |
| A-3-03-HW | MA | 02/25/2003 | 10:55 | 02/25/2003 | 20:55 | 030225_08N | 20 | 6.1 | 20.9503382 | -156.6935189 | |
| A-3-03-HW | MA | 02/25/2003 | 11:10 | 02/25/2003 | 21:10 | 030225_10F | 135 | 41.2 | 20.9285922 | -156.7028805 | |
| A-3-03-HW | MA | 02/25/2003 | 11:21 | 02/25/2003 | 21:21 | 030225_10N | 35 | 10.7 | 20.9281390 | -156.6977375 | |
| A-3-03-HW | MA | 02/25/2003 | 11:35 | 02/25/2003 | 21:35 | 030225_12N | 15 | 4.6 | 20.9112234 | -156.6940263 | |
| A-3-03-HW | MA | 02/25/2003 | 11:56 | 02/25/2003 | 21:56 | 030225_12F | 75 | 22.9 | 20.9044446 | -156.7015221 | |
| A-3-03-HW | MA | 02/25/2003 | 12:11 | 02/25/2003 | 22:11 | 030225_14F | 90 | 27.4 | 20.8817044 | -156.7087333 | |
| A-3-03-HW | MA | 02/25/2003 | 12:31 | 02/25/2003 | 22:31 | 030225_14N | 15 | 4.6 | 20.8824277 | -156.6906076 | |
| A-3-03-HW | MA | 02/25/2003 | 12:48 | 02/25/2003 | 22:48 | 030225_16F | 110 | 33.5 | 20.8509805 | -156.6748972 | |
| A-3-03-HW | MA | 02/25/2003 | 13:01 | 02/25/2003 | 23:01 | 030225_16N | 18 | 5.5 | 20.8561324 | -156.6677881 | |
| | | | | | | | | | | | |
| A-3-03-HW | MA | 02/26/2003 | 7:30 | 02/26/2003 | 17:30 | 030226_16F | 105 | 32.0 | 20.8506891 | -156.6735619 | calm |
| A-3-03-HW | MA | 02/26/2003 | 7:43 | 02/26/2003 | 17:43 | 030226_16N | 20 | 6.1 | 20.8558765 | -156.6678025 | |
| A-3-03-HW | MA | 02/26/2003 | 8:02 | 02/26/2003 | 18:02 | 030226_14N | 20 | 6.1 | 20.8825514 | -156.6910948 | |
| A-3-03-HW | MA | 02/26/2003 | 8:25 | 02/26/2003 | 18:25 | 030226_14F | 85 | 25.9 | 20.8820299 | -156.7087815 | |
| A-3-03-HW | MA | 02/26/2003 | 8:37 | 02/26/2003 | 18:37 | 030226_12F | 75 | 22.9 | 20.9045097 | -156.7015402 | |
| A-3-03-HW | MA | 02/26/2003 | 8:52 | 02/26/2003 | 18:52 | 030226_12N | 15 | 4.6 | 20.9113382 | -156.6942928 | |
| A-3-03-HW | MA | 02/26/2003 | 9:03 | 02/26/2003 | 19:03 | 030226_10N | 30 | 9.1 | 20.9277466 | -156.6978103 | |
| A-3-03-HW | MA | 02/26/2003 | 9:13 | 02/26/2003 | 19:13 | 030226_10F | 140 | 42.7 | 20.9286245 | -156.7029901 | |
| A-3-03-HW | MA | 02/26/2003 | 9:27 | 02/26/2003 | 19:27 | 030226_08N | 20 | 6.1 | 20.9504660 | -156.6936674 | 1m swell |
| A-3-03-HW | MA | 02/26/2003 | 9:40 | 02/26/2003 | 19:40 | 030226_08F | 130 | 39.6 | 20.9535239 | -156.7019529 | |
| A-3-03-HW | MA | 02/26/2003 | 9:53 | 02/26/2003 | 19:53 | 030226_06F | 115 | 35.1 | 20.9683972 | -156.7003093 | |
| A-3-03-HW | MA | 02/26/2003 | 10:16 | 02/26/2003 | 20:16 | 030226_06N | 20 | 6.1 | 20.9636020 | -156.6876697 | |
| A-3-03-HW | MA | 02/26/2003 | 10:29 | 02/26/2003 | 20:29 | 030226_04N | 20 | 6.1 | 20.9835399 | -156.6801150 | |
| A-3-03-HW | MA | 02/26/2003 | 10:54 | 02/26/2003 | 20:54 | 030226_04F | 140 | 42.7 | 20.9887672 | -156.6904565 | |
| A-3-03-HW | MA | 02/26/2003 | 11:06 | 02/26/2003 | 21:06 | 030226_02F | 135 | 41.2 | 21.0031035 | -156.6777090 | |
| A-3-03-HW | MA | 02/26/2003 | 11:35 | 02/26/2003 | 21:35 | 030226_02N | 20 | 6.1 | 20.9977428 | -156.6704609 | |
| A-3-03-HW | MA | 02/26/2003 | 11:59 | 02/26/2003 | 21:59 | 030226_20N | 40 | 12.2 | 21.0154780 | -156.6412026 | |
| A-3-03-HW | MA | 02/26/2003 | 12:18 | 02/26/2003 | 22:18 | 030226_20F | 115 | 35.1 | 21.0255229 | -156.6510495 | |
| A-3-03-HW | MA | 02/26/2003 | 12:28 | 02/26/2003 | 22:28 | 030226_22F | 105 | 32.0 | 21.0162588 | -156.6534886 | |
| A-3-03-HW | MA | 02/26/2003 | 12:43 | 02/26/2003 | 22:43 | 030226_22N | 20 | 6.1 | 21.0070593 | -156.6532318 | |

**TABLE 5. CTD/OBS profiler log: 06/30/2003 - 07/04/2003**

| Cruise ID | Island ID | Local Date | Local Time | UTC Date | UTC Time | Site/Line ID | Depth [ft] | Depth [m] | Latitude [dd | Longitude [dd | Conditions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A-4-03-HW | MA | 06/30/2003 | 10:40 | 06/30/2003 | 20:40 | 030630_20N | 30 | 9.9 | 21.0148203 | -156.6398803 | calm |
| A-4-03-HW | MA | 06/30/2003 | 11:16 | 06/30/2003 | 21:16 | 030630_20F | 110 | 36.3 | 21.0259276 | -156.6506077 | 2m swell |
| A-4-03-HW | MA | 06/30/2003 | 11:33 | 06/30/2003 | 21:33 | 030630_02F | 110 | 36.3 | 21.0032327 | -156.6765834 | |
| A-4-03-HW | MA | 06/30/2003 | 11:53 | 06/30/2003 | 21:53 | 030630_02N | 15 | 5.0 | 20.9968055 | -156.6689823 | |
| A-4-03-HW | MA | 06/30/2003 | 12:04 | 06/30/2003 | 22:04 | 030630_04F | 125 | 41.3 | 20.9884061 | -156.6901276 | |
| A-4-03-HW | MA | 06/30/2003 | 12:32 | 06/30/2003 | 22:32 | 030630_04N | 15 | 5.0 | 20.9824548 | -156.6783546 | |
| A-4-03-HW | MA | 06/30/2003 | 12:44 | 06/30/2003 | 22:44 | 030630_06F | 115 | 38.0 | 20.9682228 | -156.6996644 | 1m swell |
| A-4-03-HW | MA | 06/30/2003 | 13:11 | 06/30/2003 | 23:11 | 030630_06N | 15 | 5.0 | 20.9622846 | -156.6875709 | |
| A-4-03-HW | MA | 06/30/2003 | 13:27 | 06/30/2003 | 23:27 | 030630_08F | 120 | 39.6 | 20.9534286 | -156.7008249 | |
| A-4-03-HW | MA | 06/30/2003 | 13:49 | 06/30/2003 | 23:49 | 030630_08N | 25 | 8.3 | 20.9507381 | -156.6933548 | |
| A-4-03-HW | MA | 06/30/2003 | 14:02 | 07/01/2003 | 0:02 | 030630_10F | 120 | 39.6 | 20.9288880 | -156.7018940 | |
| A-4-03-HW | MA | 06/30/2003 | 14:15 | 07/01/2003 | 0:15 | 030630_10N | 30 | 9.9 | 20.9282238 | -156.6968631 | |
| A-4-03-HW | MA | 06/30/2003 | 14:27 | 07/01/2003 | 0:27 | 030630_12N | 20 | 6.6 | 20.9116053 | -156.6948073 | calm |
| A-4-03-HW | MA | 06/30/2003 | 14:39 | 07/01/2003 | 0:39 | 030630_12F | 75 | 24.8 | 20.9044131 | -156.7015406 | |
| A-4-03-HW | MA | 06/30/2003 | 14:54 | 07/01/2003 | 0:54 | 030630_14F | 90 | 29.7 | 20.8819852 | -156.7086695 | |
| A-4-03-HW | MA | 06/30/2003 | 15:15 | 07/01/2003 | 1:15 | 030630_14N | 20 | 6.6 | 20.8823171 | -156.6906252 | |
| | | | | | | | | | | | |
| A-4-03-HW | MA | 07/01/2003 | 9:10 | 07/01/2003 | 19:10 | 030701_20N | 25 | 8.3 | 21.0145430 | -156.6395307 | calm |
| A-4-03-HW | MA | 07/01/2003 | 9:30 | 07/01/2003 | 19:30 | 030701_20F | 110 | 36.3 | 21.0255856 | -156.6507807 | 2m swell |
| A-4-03-HW | MA | 07/01/2003 | 9:39 | 07/01/2003 | 19:39 | 030701_22F | 100 | 33.0 | 21.0168610 | -156.6525243 | |
| A-4-03-HW | MA | 07/01/2003 | 9:53 | 07/01/2003 | 19:53 | 030701_22N | 20 | 6.6 | 21.0069603 | -156.6532327 | |
| A-4-03-HW | MA | 07/01/2003 | 10:06 | 07/01/2003 | 20:06 | 030701_02F | 135 | 44.6 | 21.0030820 | -156.6777140 | |
| A-4-03-HW | MA | 07/01/2003 | 10:26 | 07/01/2003 | 20:26 | 030701_02N | 15 | 5.0 | 20.9966117 | -156.6689616 | |
| A-4-03-HW | MA | 07/01/2003 | 10:39 | 07/01/2003 | 20:39 | 030701_04F | 110 | 36.3 | 20.9883470 | -156.6897386 | 1m swell |
| A-4-03-HW | MA | 07/01/2003 | 10:58 | 07/01/2003 | 20:58 | 030701_04N | 15 | 5.0 | 20.9828304 | -156.6793934 | |
| A-4-03-HW | MA | 07/01/2003 | 11:10 | 07/01/2003 | 21:10 | 030701_06F | 115 | 38.0 | 20.9685643 | -156.7002083 | |
| A-4-03-HW | MA | 07/01/2003 | 11:34 | 07/01/2003 | 21:34 | 030701_06N | 15 | 5.0 | 20.9633124 | -156.6871469 | |
| A-4-03-HW | MA | 07/01/2003 | 14:28 | 07/02/2003 | 0:28 | 030701_08F | 130 | 42.9 | 20.9533782 | -156.7021956 | |
| A-4-03-HW | MA | 07/01/2003 | 14:44 | 07/02/2003 | 0:44 | 030701_08N | 20 | 6.6 | 20.9503973 | -156.6933720 | |
| A-4-03-HW | MA | 07/01/2003 | 14:55 | 07/02/2003 | 0:55 | 030701_10F | 130 | 42.9 | 20.9289422 | -156.7023943 | |
| A-4-03-HW | MA | 07/01/2003 | 15:07 | 07/02/2003 | 1:07 | 030701_10N | 30 | 9.9 | 20.9280316 | -156.6969111 | |
| A-4-03-HW | MA | 07/01/2003 | 15:25 | 07/02/2003 | 1:25 | 030701_14F | 90 | 29.7 | 20.8822151 | -156.7089826 | |
| A-4-03-HW | MA | 07/01/2003 | 16:02 | 07/02/2003 | 2:02 | 030701_14N | 20 | 6.6 | 20.8824186 | -156.6907425 | |
| | | | | | | | | | | | |
| A-4-03-HW | MA | 07/02/2003 | 10:11 | 07/02/2003 | 20:11 | 030702_20N | 30 | 9.9 | 21.0152151 | -156.6409875 | calm |
| A-4-03-HW | MA | 07/02/2003 | 10:28 | 07/02/2003 | 20:28 | 030702_20F | 110 | 36.3 | 21.0256831 | -156.6506794 | 1m swell |
| A-4-03-HW | MA | 07/02/2003 | 10:38 | 07/02/2003 | 20:38 | 030702_22F | 100 | 33.0 | 21.0165465 | -156.6526536 | |
| A-4-03-HW | MA | 07/02/2003 | 10:52 | 07/02/2003 | 20:52 | 030702_22N | 25 | 8.3 | 21.0073063 | -156.6533309 | |
| A-4-03-HW | MA | 07/02/2003 | 11:08 | 07/02/2003 | 21:08 | 030702_02F | 120 | 39.6 | 21.0031218 | -156.6771560 | 2m swell |
| A-4-03-HW | MA | 07/02/2003 | 11:26 | 07/02/2003 | 21:26 | 030702_02N | 20 | 6.6 | 20.9969608 | -156.6695703 | |
| A-4-03-HW | MA | 07/02/2003 | 11:38 | 07/02/2003 | 21:38 | 030702_04F | 120 | 39.6 | 20.9880746 | -156.6902477 | |
| A-4-03-HW | MA | 07/02/2003 | 11:58 | 07/02/2003 | 21:58 | 030702_04N | 20 | 6.6 | 20.9827574 | -156.6801483 | |
| A-4-03-HW | MA | 07/02/2003 | 12:10 | 07/02/2003 | 22:10 | 030702_06F | 115 | 38.0 | 20.9682280 | -156.6999707 | |
| A-4-03-HW | MA | 07/02/2003 | 12:34 | 07/02/2003 | 22:34 | 030702_06N | 15 | 5.0 | 20.9634204 | -156.6872858 | |
| A-4-03-HW | MA | 07/02/2003 | 12:44 | 07/02/2003 | 22:44 | 030702_08F | 120 | 39.6 | 20.9534249 | -156.7010633 | 1m swell |
| A-4-03-HW | MA | 07/02/2003 | 13:01 | 07/02/2003 | 23:01 | 030702_08N | 20 | 6.6 | 20.9502364 | -156.6934897 | |
| A-4-03-HW | MA | 07/02/2003 | 14:21 | 07/03/2003 | 0:21 | 030702_10F | 140 | 46.2 | 20.9289242 | -156.7025561 | |
| A-4-03-HW | MA | 07/02/2003 | 14:33 | 07/03/2003 | 0:33 | 030702_10N | 30 | 9.9 | 20.9279892 | -156.6969999 | |
| A-4-03-HW | MA | 07/02/2003 | 14:48 | 07/03/2003 | 0:48 | 030702_12F | 90 | 29.7 | 20.9105620 | -156.7076480 | |
| A-4-03-HW | MA | 07/02/2003 | 15:05 | 07/03/2003 | 1:05 | 030702_12N | 20 | 6.6 | 20.9118169 | -156.6953378 | calm |
| A-4-03-HW | MA | 07/02/2003 | 15:39 | 07/03/2003 | 1:39 | 030702_14N | 25 | 8.3 | 20.8823836 | -156.6912081 | |
| A-4-03-HW | MA | 07/02/2003 | 16:00 | 07/03/2003 | 2:00 | 030702_14F | 85 | 28.1 | 20.8820602 | -156.7086275 | |
| A-4-03-HW | MA | 07/02/2003 | 16:31 | 07/03/2003 | 2:31 | 030702_16N | 20 | 6.6 | 20.8573706 | -156.6700296 | |
| A-4-03-HW | MA | 07/02/2003 | 16:41 | 07/03/2003 | 2:41 | 030702_16F | 110 | 36.3 | 20.8525761 | -156.6756787 | |
| | | | | | | | | | | | |
| A-4-03-HW | MA | 07/03/2003 | 8:53 | 07/03/2003 | 18:53 | 030703_20N | 30 | 9.9 | 21.0151628 | -156.6399215 | calm |
| A-4-03-HW | MA | 07/03/2003 | 9:12 | 07/03/2003 | 19:12 | 030703_20F | 110 | 36.3 | 21.0256001 | -156.6507058 | 1m swell |
| A-4-03-HW | MA | 07/03/2003 | 9:21 | 07/03/2003 | 19:21 | 030703_22F | 105 | 34.7 | 21.0164661 | -156.6530177 | |
| A-4-03-HW | MA | 07/03/2003 | 9:35 | 07/03/2003 | 19:35 | 030703_22N | 20 | 6.6 | 21.0068487 | -156.6533558 | |
| A-4-03-HW | MA | 07/03/2003 | 9:48 | 07/03/2003 | 19:48 | 030703_02F | 135 | 44.6 | 21.0030408 | -156.6776501 | |
| A-4-03-HW | MA | 07/03/2003 | 10:14 | 07/03/2003 | 20:14 | 030703_02N | 15 | 5.0 | 20.9972139 | -156.6690472 | |
| A-4-03-HW | MA | 07/03/2003 | 10:28 | 07/03/2003 | 20:28 | 030703_04F | 120 | 39.6 | 20.9878629 | -156.6904170 | |
| A-4-03-HW | MA | 07/03/2003 | 10:46 | 07/03/2003 | 20:46 | 030703_04N | 20 | 6.6 | 20.9832553 | -156.6800963 | |
| A-4-03-HW | MA | 07/03/2003 | 11:05 | 07/03/2003 | 21:05 | 030703_05M | 20 | 6.6 | 20.9685246 | -156.6866915 | |
| A-4-03-HW | MA | 07/03/2003 | 11:05 | 07/03/2003 | 21:05 | 030703_05O | 25 | 8.3 | 20.9684888 | -156.6866972 | |
| A-4-03-HW | MA | 07/03/2003 | 11:11 | 07/03/2003 | 21:11 | 030703_06N | 20 | 6.6 | 20.9642486 | -156.6874636 | |
| A-4-03-HW | MA | 07/03/2003 | 11:28 | 07/03/2003 | 21:28 | 030703_06F | 120 | 39.6 | 20.9674590 | -156.7004017 | |
| A-4-03-HW | MA | 07/03/2003 | 11:39 | 07/03/2003 | 21:39 | 030703_08F | 120 | 39.6 | 20.9535878 | -156.7006303 | |
| A-4-03-HW | MA | 07/03/2003 | 11:55 | 07/03/2003 | 21:55 | 030703_08M | 30 | 9.9 | 20.9504232 | -156.6941782 | |
| A-4-03-HW | MA | 07/03/2003 | 12:13 | 07/03/2003 | 22:13 | 030703_08N | 15 | 5.0 | 20.9502812 | -156.6933386 | |
| A-4-03-HW | MA | 07/03/2003 | 12:24 | 07/03/2003 | 22:24 | 030703_10F | 120 | 39.6 | 20.9286667 | -156.7021877 | |
| A-4-03-HW | MA | 07/03/2003 | 12:36 | 07/03/2003 | 22:36 | 030703_10N | 30 | 9.9 | 20.9280700 | -156.6970071 | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A-4-03-HW | MA | 07/03/2003 | 12:51 | 07/03/2003 | 22:51 | 030703_12F | 95 | 31.4 | 20.9110797 | -156.7076667 | |
| A-4-03-HW | MA | 07/03/2003 | 13:11 | 07/03/2003 | 23:11 | 030703_12M | 50 | 16.5 | 20.9113798 | -156.6974407 | |
| A-4-03-HW | MA | 07/03/2003 | 13:22 | 07/03/2003 | 23:22 | 030703_12N | 30 | 9.9 | 20.9118536 | -156.6956966 | |
| A-4-03-HW | MA | 07/03/2003 | 14:00 | 07/04/2003 | 0:00 | 030703_14N | 25 | 8.3 | 20.8824117 | -156.6912591 | |
| A-4-03-HW | MA | 07/03/2003 | 14:09 | 07/04/2003 | 0:09 | 030703_14M | 90 | 29.7 | 20.8823205 | -156.6948777 | |
| A-4-03-HW | MA | 07/03/2003 | 14:27 | 07/04/2003 | 0:27 | 030703_14F | 80 | 26.4 | 20.8822087 | -156.7077419 | |
| A-4-03-HW | MA | 07/03/2003 | 14:49 | 07/04/2003 | 0:49 | 030703_16F | 110 | 36.3 | 20.8511477 | -156.6749762 | |
| A-4-03-HW | MA | 07/03/2003 | 15:02 | 07/04/2003 | 1:02 | 030703_16N | 20 | 6.6 | 20.8560799 | -156.6679096 | |
| | | | | | | | | | | | |
| A-4-03-HW | MA | 07/04/2003 | 7:55 | 07/04/2003 | 17:55 | 030704_16F | 110 | 36.3 | 20.8515552 | -156.6750199 | calm |
| A-4-03-HW | MA | 07/04/2003 | 8:11 | 07/04/2003 | 18:11 | 030704_16N | 20 | 6.6 | 20.8559564 | -156.6679898 | |
| A-4-03-HW | MA | 07/04/2003 | 8:33 | 07/04/2003 | 18:33 | 030704_14F | 95 | 31.4 | 20.8818244 | -156.7096033 | |
| A-4-03-HW | MA | 07/04/2003 | 8:59 | 07/04/2003 | 18:59 | 030704_14N | 15 | 5.0 | 20.8821806 | -156.6907510 | |
| A-4-03-HW | MA | 07/04/2003 | 9:32 | 07/04/2003 | 19:32 | 030704_12N | 30 | 9.9 | 20.9117412 | -156.6956092 | |
| A-4-03-HW | MA | 07/04/2003 | 9:47 | 07/04/2003 | 19:47 | 030704_12F | 100 | 33.0 | 20.9108554 | -156.7083591 | |
| A-4-03-HW | MA | 07/04/2003 | 9:58 | 07/04/2003 | 19:58 | 030704_10F | 130 | 42.9 | 20.9287047 | -156.7025632 | 1m swell |
| A-4-03-HW | MA | 07/04/2003 | 10:09 | 07/04/2003 | 20:09 | 030704_10N | 30 | 9.9 | 20.9278888 | -156.6972608 | |
| A-4-03-HW | MA | 07/04/2003 | 10:21 | 07/04/2003 | 20:21 | 030704_08F | 130 | 42.9 | 20.9534374 | -156.7020545 | |
| A-4-03-HW | MA | 07/04/2003 | 10:34 | 07/04/2003 | 20:34 | 030704_08N | 20 | 6.6 | 20.9504174 | -156.6935206 | |
| A-4-03-HW | MA | 07/04/2003 | 10:44 | 07/04/2003 | 20:44 | 030704_06F | 120 | 39.6 | 20.9677452 | -156.7004307 | |
| A-4-03-HW | MA | 07/04/2003 | 11:04 | 07/04/2003 | 21:04 | 030704_06N | 15 | 5.0 | 20.9636855 | -156.6871981 | |
| A-4-03-HW | MA | 07/04/2003 | 11:19 | 07/04/2003 | 21:19 | 030704_04F | 115 | 38.0 | 20.9882806 | -156.6901860 | |
| A-4-03-HW | MA | 07/04/2003 | 11:47 | 07/04/2003 | 21:47 | 030704_04N | 15 | 5.0 | 20.9825730 | -156.6804866 | |
| A-4-03-HW | MA | 07/04/2003 | 11:56 | 07/04/2003 | 21:56 | 030704_02F | 145 | 47.9 | 21.0030860 | -156.6783750 | |
| A-4-03-HW | MA | 07/04/2003 | 12:14 | 07/04/2003 | 22:14 | 030704_02N | 15 | 5.0 | 20.9972983 | -156.6695079 | |

## TABLE 6. Synthetic Current Field Lines and Dates/Times

**Falling Spring Tide**

| Line | Day | Month | Year | File |
|---|---|---|---|---|
| 1 | 19 | 2 | 3 | 030219_01 |
| 2 | 19 | 2 | 3 | 030219_02 |
| 4 | 19 | 2 | 3 | 030219_04 |
| 6 | 19 | 2 | 3 | 030219_06 |
| 8 | 20 | 2 | 3 | 030220_08 |
| 10 | 20 | 2 | 3 | 030220_10 |
| 12 | 20 | 2 | 3 | 030220_12 |
| 14 | 20 | 2 | 3 | 030220_14 |
| 16 | 20 | 2 | 3 | 030220_16 |

**Rising Spring Tide**

| Line | Day | Month | Year | File |
|---|---|---|---|---|
| 1 | 20 | 2 | 3 | 030220_01 |
| 2 | 20 | 2 | 3 | 030220_02 |
| 4 | 20 | 2 | 3 | 030220_04 |
| 6 | 18 | 2 | 3 | 030218_06 |
| 8 | 18 | 2 | 3 | 030218_08 |
| 10 | 18 | 2 | 3 | 030218_10 |
| 12 | 18 | 2 | 3 | 030218_12 |
| 14 | 18 | 2 | 3 | 030218_14 |
| 16 | 18 | 2 | 3 | 030218_16 |

**Falling Neap Tide**

| Line | Day | Month | Year | File |
|---|---|---|---|---|
| 1 | ND | 2 | 3 | ND |
| 2 | 24 | 2 | 3 | 030224_02 |
| 4 | 24 | 2 | 3 | 030224_04 |
| 6 | 24 | 2 | 3 | 030224_06 |
| 8 | 24 | 2 | 3 | 030224_08 |
| 10 | 24 | 2 | 3 | 030224_10 |
| 12 | 24 | 2 | 3 | 030224_12 |
| 14 | 26 | 2 | 3 | 030226_14 |
| 16 | 26 | 2 | 3 | 030226_16 |

**Rising Neap Tide**

| Line | Day | Month | Year | File |
|---|---|---|---|---|
| 1 | 25 | 2 | 3 | 030225_01 |
| 2 | 25 | 2 | 3 | 030225_02 |
| 4 | 25 | 2 | 3 | 030225_04 |
| 6 | 25 | 2 | 3 | 030225_06 |
| 8 | 25 | 2 | 3 | 030225_08 |
| 10 | 25 | 2 | 3 | 030225_10 |
| 12 | 25 | 2 | 3 | 030225_12 |
| 14 | 24 | 2 | 3 | 030224_14 |
| 16 | 24 | 2 | 3 | 030224_16 |

ND = no data exists for this end-member because it was not able to be sampled due to weather conditions

## TABLE 7: CTD Profiler Statistics

| Parameter | Statistic | 02/2003 Deep | 02/2003 Shallow | 06/2003 Deep | 06/2003 Shallow | ALL |
|---|---|---|---|---|---|---|
| **Temperature** | mean | 24.386 | 24.348 | 25.566 | 25.635 | 24.984 |
| **(deg C)** | minimum | 23.450 | 22.918 | 24.702 | 24.993 | 22.918 |
| | maximum | 24.910 | 25.059 | 26.513 | 27.557 | 27.557 |
| | standard deviation | 0.163 | 0.278 | 0.263 | 0.360 | 0.266 |
| | | | | | | |
| **Salinity** | mean | 35.038 | 34.987 | 34.934 | 34.870 | 34.957 |
| **(PSU)** | minimum | 34.117 | 34.213 | 34.727 | 33.572 | 33.572 |
| | maximum | 36.296 | 35.116 | 35.078 | 35.012 | 36.296 |
| | standard deviation | 0.068 | 0.096 | 0.048 | 0.111 | 0.081 |
| | | | | | | |
| **Density** | mean | 23.556 | 23.528 | 23.119 | 23.049 | 23.313 |
| **(sigma-theta)** | minimum | 22.890 | 22.953 | 22.737 | 22.258 | 22.258 |
| | maximum | 24.475 | 23.775 | 23.490 | 23.312 | 24.475 |
| | standard deviation | 0.082 | 0.105 | 0.115 | 0.135 | 0.109 |
| | | | | | | |
| **OBS** | mean | 0.360 | 0.534 | 0.234 | 0.646 | 0.444 |
| **(volts)** | minimum | 0.000 | 0.000 | 0.000 | 0.111 | 0.000 |
| | maximum | 4.557 | 4.291 | 3.349 | 4.705 | 4.705 |
| | standard deviation | 0.174 | 0.313 | 0.108 | 0.580 | 0.294 |

Deep = Deeper casts at offshore end of survey lines

Shallow = Shallower casts at inshore end of survey lines

## APPENDIX 1

Acoustic Doppler Current Profiler (ADCP) information

Instrument:

RD Instruments 600 kHz Workhorse Monitor; s/n: 3098

| | |
|---|---|
| Transmitting Frequency: | 614 kHz |
| Depth of Transducer: | 1 m |
| Blanking Distance: | 0.5 m |
| Depth of First Bin: | 1.5 m |
| Bin size: | 1.0 m |
| Number of Bins: | 40 |
| Operating Mode: | High-resolution, broad bandwidth |
| Bottom-track: | enabled |
| Sampling Frequency: | 4 Hz |
| Beam Angle: | 20 deg |
| Time per Ping: | 00:00:00.30 |
| Pings per Ensemble: | 1 |
| Time per Ensemble: | 00:00:02.00 |
| Sound Speed Calculation: | Set salinity, updating temperature via sensor |

Position Information:

Garmin GPS-76 GPS; s/n: 80207465; USGS/CRP unit#1
RDI internal compass/gyroscope, set to –10 deg magnetic offset

Data Log File Name: “0302_CRP_ADCPprofiler_log.xls”

Total Profiles: 110

| | | | | |
|---|---|---|---|---|
| Profile Lengths: | Minimum: | 253 m | Maximum: | 1897 m |
| | Mean: | 997 m | | |

ADCP Profile Naming Convention: “YYMMDD_LL”, with:

YY = year (03)
MM = month (02)
DD = day (18-26)
LL = line number (1-22)

Thus, “030218_02” was taken on 02/18/2003 on line #2

Navigation File Name: Navigation data are embedded in the ADCP data files.

Data Processing:

The data were averaged over 10-bin (10 sec) ensembles, all of the spurious data below the seafloor were removed and all of the data in bins where the beam correlation dropped below 70% were removed for visualization and analysis.

# APPENDIX 2

Conductivity/Temperature/Depth (CTD) Profiler with
Optical Backscatter Sensor (OBS) information

Instruments:

Seabird 19plus CTD; s/n: 4299; calibrated 10/08/2002
D&A Instruments OBS-3; s/n: 1983; calibrated 10/24/2002
Sampling Frequency: 4 Hz

Position Information:

Garmin GPS-76 GPS; s/n: 80207465; USGS/CRP unit#1

Data Log File Name: "0302_CRP_CTDprofiler_log.xls"

Total Casts: 211

| | | | | |
|---|---|---|---|---|
| Cast Depths: | Minimum: | 4 m | Maximum: | 43 m |
| | Mean: | 15 m | | |

CTD Cast Naming Convention: "YYMMDD_LLP", with:

YY = year (03)
MM = month (02)
DD = day (18-26)
LL = line number (1-22)
PP = position on line ("F" for offshore end of line, "N" for onshore end of line)

Thus, "030630_02F" was taken on 06/30/2003 at the offshore end line #2

Navigation File Names: embedded in Data Log File

Data Processing:

The data were averaged into 0.5 m vertical bins and all of the spurious data marked by a flag in the raw data were removed for visualization and analysis. Stratification were measured as the difference between the mean of the top three bins (0.5-1.5 m below the surface) and the bottom three bins (0.5-1.5 m above the bed).