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Southern California Beach Processes Study - Torrey Pines Beach Nourishment Study 4th Quarterly Report to California Resources Agency and California Department of Boating and Waterways

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The data associated with this publication are available upon request.

Southern California Beach Processes Study

Torrey Pines Field Site



**4th Quarterly Report
28 February 2002**

to

*California Resources Agency
and
California Department of Boating and Waterways*

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BACKGROUND:

The objective of the Southern California Beach Processes Study is to develop an improved understanding of how sand is transported by nearshore waves and currents, thus improving the technical basis for the design of beach nourishment projects. The first project in this study, funded by the State of California, involves the simultaneous observations of nearshore waves and sand level changes at the SANDAG-sponsored beach nourishment project at Torrey Pines State Beach. These observations will be used to calibrate and evaluate existing computer models for the wave-driven evolution of a nourished beach, and eventually for the development and testing for new models. Torrey Pines Beach, located at the border between the cities of San Diego and Del Mar, was nourished during late April 2001 with nominally 191,000 cubic m of sand. The sand was deposited on the beach above the low tide level and over a 500 m alongshore span, forming an elevated pad of sand (Figure 1b). This study was described in a presentation at the California Shore and Beach Preservation/California Coastal Coalition 2001 Annual Conference Restoring the Beach, Science, Policy and Funding, held in San Diego on 8-10 November.

A description of the Torrey Pines Beach Nourishment Project may be accessed through the <http://cdip.ucsd.edu/SCBPS/homepage.shtml> website. In addition to a Project Overview and Field Operations section, examples of survey ranges and bathymetry are displayed. A section has been added under Survey Results including photos and bathymetry plots of the November 2001 storm described below. Following publication, the Quarterly Reports are included on this site.

SAND LEVEL SURVEYS:

Since the last quarterly report, 6 additional surveys of sand levels have been acquired that span the same region as in the first 16 surveys. Cross-shore survey transects extend from the base of the Torrey Pines cliffs or Highway 101 onshore to about the 8 m depth contour offshore. The alongshore spacing between cross-shore survey lines is 20 m for a 700 m-long stretch of beach centered on the originally nourished site, and 100 m for additional 1 km-long stretches of beach up and down coast of the original nourishment. Additionally, in the 6 most recent surveys, 8 additional cross-shore transects were added to decrease the alongshore spacing from 100 m to 25 m, over a 40 m long reach of beach located immediately south of the original nourishment region. The surveying-ATV has been an effective complement to the jetski and dolly. Tracks for each of these 6 surveys are shown in the (a) panels of Figures 1-6, and indicate the surveys had generally good spatial coverage including overlap between the high-tide jetski surveys and the low tide beach-dolly surveys. Occasionally, a few jetski transects are lost owing to poor satellite coverage, or overlap is lacking owing to rough wave conditions. Bathymetry for the entire surveyed region, and for the closely (20 m) spaced alongshore lines near the nourishment site, are shown in the (b) panels of Figures 1-6. Changes in sand level near the nourishment site, relative to the first post-nourishment survey (27 April 01), and relative to the preceding survey are shown in the (c) panels of Figures 1-6. Prior to the surveys described in this report, the beach face adjacent to the nourishment pile had accreted in response to the relatively mild spring and summer wave conditions. Reversing this trend, moderate erosion of the beach face occurred between the surveys of 31 October (described in the previous quarterly report) and 17 November (the first survey in this report). The beach face erosion (pale blue in Figure 1c, right panel) was accompanied by accretion in slightly deeper water (yellow in Figure 1c, right panel). More significant erosion of both the nourishment pad and the adjacent beach face occurred in late November during the first major storm of the winter season (the offshore wave height reached 3 m, Figure 9a). Most of the original nourishment pad was eroded (e.g. there was 3 m of erosion in the region of the original nourishment, Figure 2c, right panel, dark purple within the dashed black area). Some of the eroded sand was apparently deposited immediately offshore in a few m water depth, as indicated by up to 1.5 m of accretion (orange in Figure 2c, right panel). A partial survey, conducted on 23 November during the storm, is discussed below. Waves were energetic often during December and early January (Figure 9b and 9c, top), and the pattern of beach face erosion

(blue) and offshore accretion (yellow) continued (Figures 3c and 4c, right panels). Waves were less energetic with just a few storms during late January and February (Figure 9c and 9d, top) and the pattern reversed with beach face accretion (yellow) and offshore erosion (blue) (Figures 5c and 6c, right panels). As of 28 February, the last survey in this report, changes since the first post-nourishment survey (27 April 01) include approximately complete erosion of the original nourishment pad, and development of a zone of accretion offshore of the original nourishment (Figure 6c, left panel).

WAVE MEASUREMENTS AND MODELING:

Wave data was collected continuously during the last quarter at the Torrey Pines Outer Buoy site (550 m depth), the Torrey Pines Buoy Inner site (20 m), and outside the surf zone of the nourishment site (7.5 m). Wave parameters from the two buoys are shown in Figures 9a-d. The data at the 7.5m site are being collected by a self-contained pressure gauge (continuous, but non-directional). In addition, directional wave data was collected at the 7.5 m site from December 20, 2001- January 4, 2002 using a Nortek AquaDopp acoustic wave and current sensor. The data from all 7.5 m sensors are currently being analyzed, with an initial review indicating nearly 100% data return. November-January are energetic winter wave months in Southern California. The first large, westerly wave event of the season occurred November 20-23, 2001, with significant wave heights exceeding 3 m at both the inner and outer buoys. This event remains the largest of the winter season at the study site to date and it eroded much of the nourishment sand from the beach as described in the previous sand level surveys section. Numerous additional erosive wave events occurred in December, with 5 events exceeding significant wave heights of 2.5 m and an additional 3 events exceeding 2 m. Wave conditions subsided considerably after mid-January, coinciding with the relatively benign winter weather conditions seen throughout the State for the last 2 months.

BEACH RESPONSE MODELING:

Discussions have been held with Dr. Kraus (one of the creators of the GENESIS software) over difficulties encountered with actually exercising the model and he has agreed to provide assistance. He feels that the diffusion phase that the Torrey Pines nourishment site is undergoing will probably not be modeled by GENESIS as well as the translation during winter storms. Efforts continue to take existing profile, wave and tide data and translate it into the very restrictive formats demanded by GENESIS.

Collaboration with scientists at the Naval Postgraduate School (Monterey, California) and Delft University (Netherlands) is planned. The observed changes in beach morphology will be compared with predictions of DELFT3D (a numerical model widely used in Europe). Funding for the modeling effort has been provided by the Mellon Foundation, and this work has begun.

SAND FINGERS:

Between the completion of the nourishment and 20 November 2001, significant wave heights measured about 1 km offshore of the study site were less than 1.5 m. The beach face adjacent to the nourishment site accreted, while most of the nourishment pad remained unchanged. (The most significant change was an approximately 20 m shoreward retreat of the steep seawards-facing edge of the nourishment pad.) During the 3 day period 22-24 November 2001, when offshore wave heights reached 3 m (Figure 9a, top), the nourishment pad and the adjacent beach face both eroded substantially. The erosion of the unnourished region was approximately alongshore uniform. In contrast, erosion in the nourished region was alongshore non-uniform. At high tide, wave uprushes reached the relatively flat, elevated pad and flowed alongshore to initially small depressions that channeled the flow seawards. The offshore flow rapidly deepened and widened the channels. Midway through the storm, the shoreward end of the eroded channels reached the riprap at the shoreward limit of the nourished beach. The beach face region was surveyed 23 November,

2001 to quantify the 3-dimensionality of the actively eroding nourishment pad (Figure 7). Sand peninsulas, located between the channels, were elevated roughly 1.5 m above the surrounding beach and protruded seawards roughly 25 m from the riprap at the landward edge of the beach. The average alongshore spacing of the peninsulas was about 50 m. On 30 November 2001, the next full survey, the sand fingers were smaller (Figure 3b, right panel) and by 16 January 2002 the fingers were essentially gone. Photographs of the sand peninsulas are included in the Survey Results section at:

<http://cdip.ucsd.edu/SCBPS/homepage.shtml>

DREDGING OF LOS PENASQUITOS LAGOON:

To improve water quality in the lagoon near the nourishment site, sand was moved with bulldozers from the lagoon onto the beach face during the period 29 January to 9 February 2002. Based on surveys of the lagoon before and after dredging, the estimated dredged volume is 16,820 cubic m (Elwany, personal communication). A special survey of the beach face was conducted on 7 February 2002 (Figure 8a, b). The new sand formed an elevated narrow strip, about 200 m long and 30 m wide. The small area of erosion located north of the newly placed sand (blue in Figure 8c, left panel) is owing to dredging of the lagoon mouth. The volume of the new nourishment, placed between 1 February 2002 and 7 February 2002 was estimated as 13,000 cubic m, based on the differences between these surveys (Figure 8c, right panel). Sand was placed on the beach for a few days prior to the 1 February survey, and after the 7 February survey, so the volume based on this time period is expected to be lower than that based on the lagoon surveys.

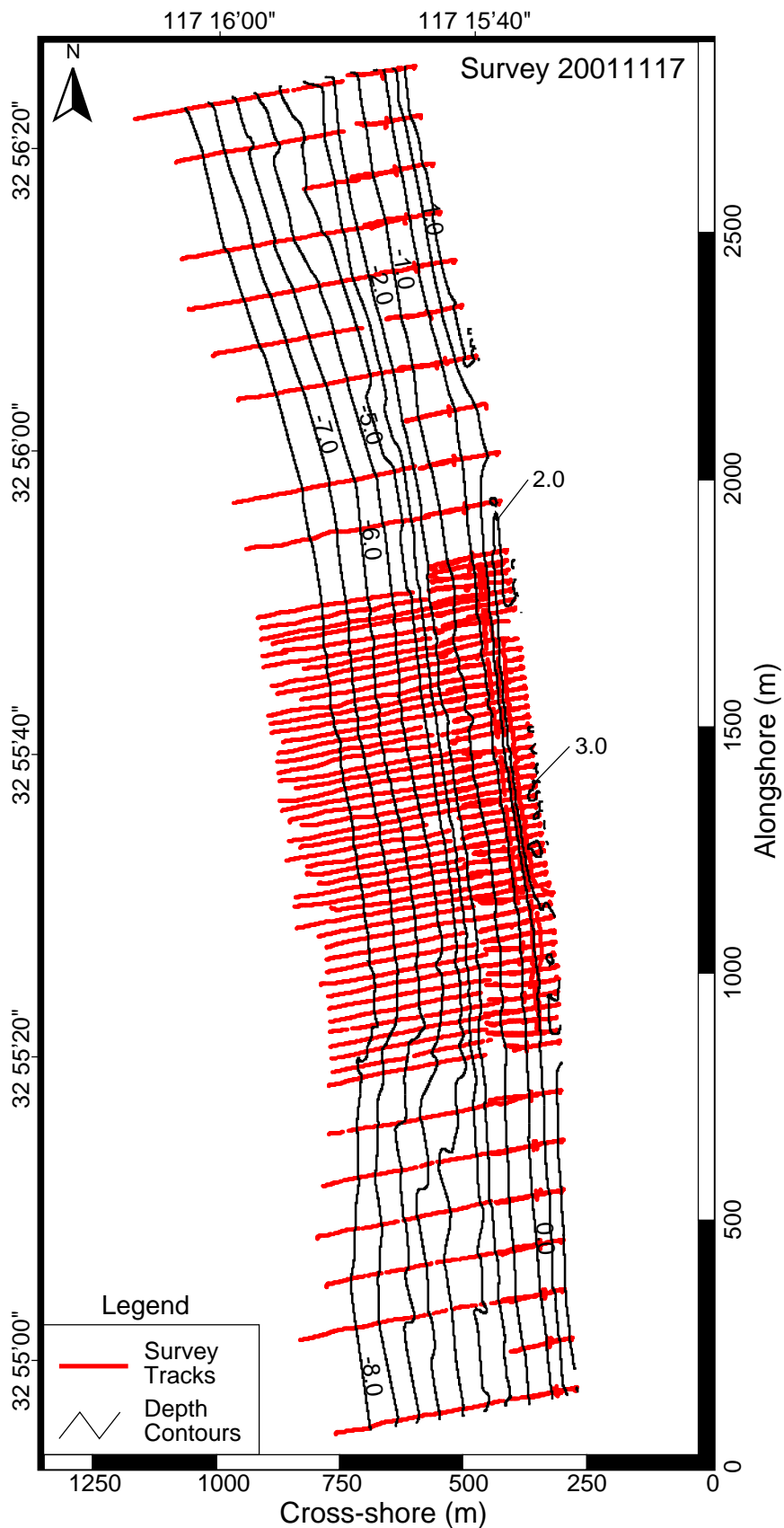


FIGURE 1a.

Survey starting 17 November 01. Red lines are survey tracks. Black lines are depth contours in meters (relative to mean sea level).

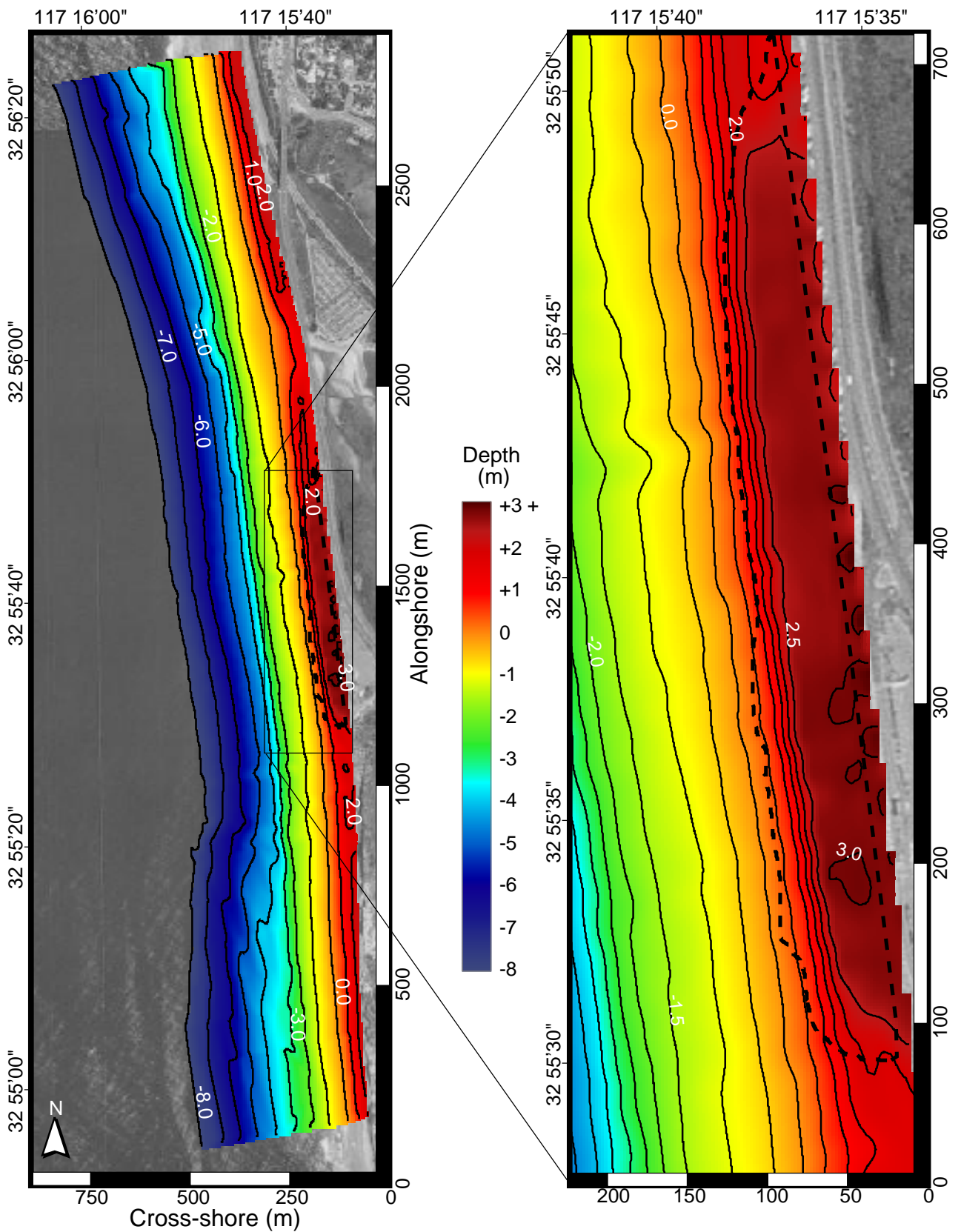


FIGURE 1b.

Left: Bathymetry measured 17 November 01 in a 3-km long strip centered on the initially nourished region (bounded by the black dashed line). The contour interval is 1.0 meters.

Right: Nourishment zone enlarged. The contour interval is 0.5 meters.

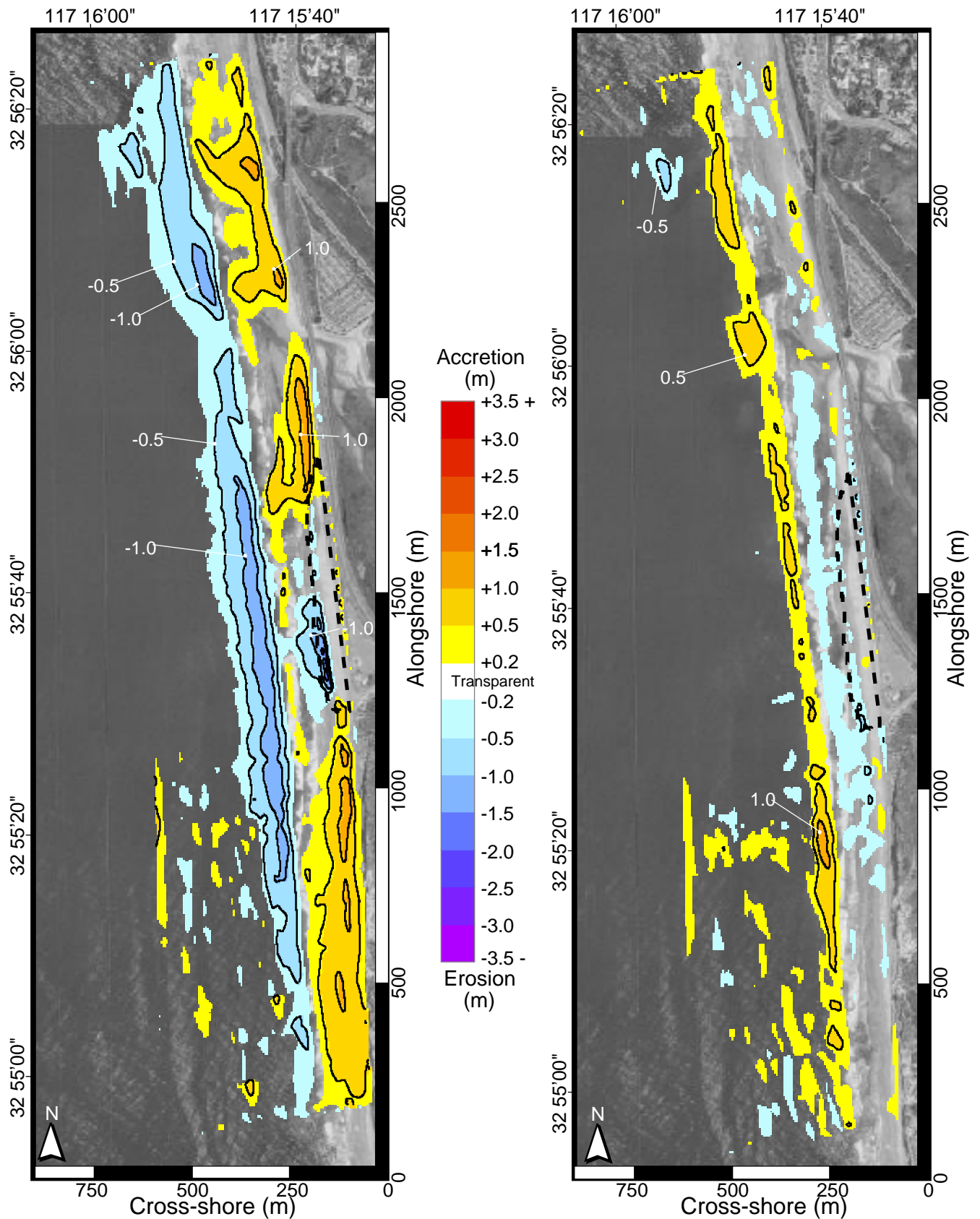


FIGURE 1c.

Left: Changes in sand level on 17 November 01 relative to 27 April 01 (the first post-nourishment survey). The contour interval is 0.5 meters (changes less than +/- 0.2 meters are not shown).

Right: Changes in sand level on 17 November 01 relative to 31 October 01 (the previous survey).

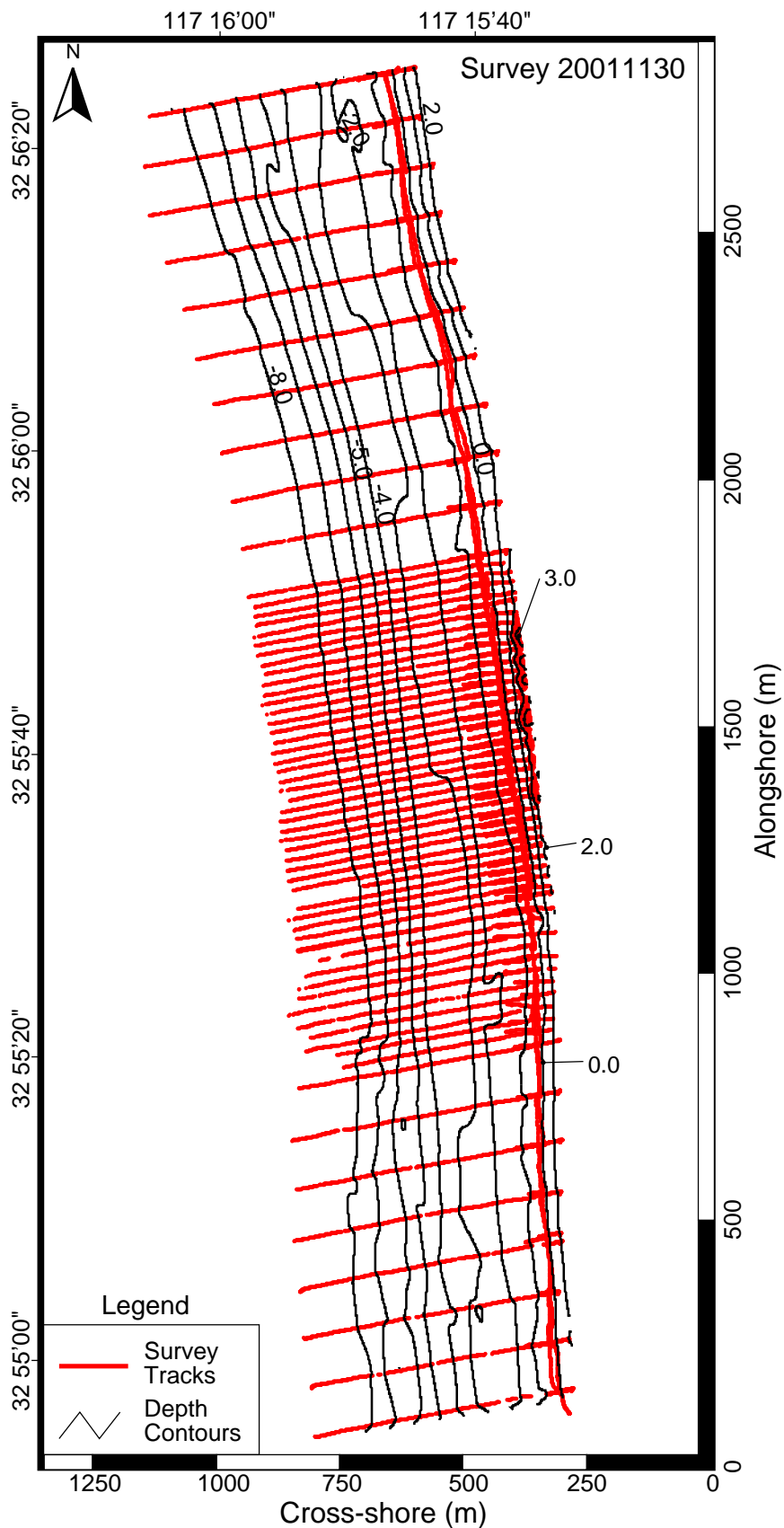


FIGURE 2a.

Survey starting 30 November 01. Red lines are survey tracks. Black lines are depth contours in meters (relative to mean sea level).

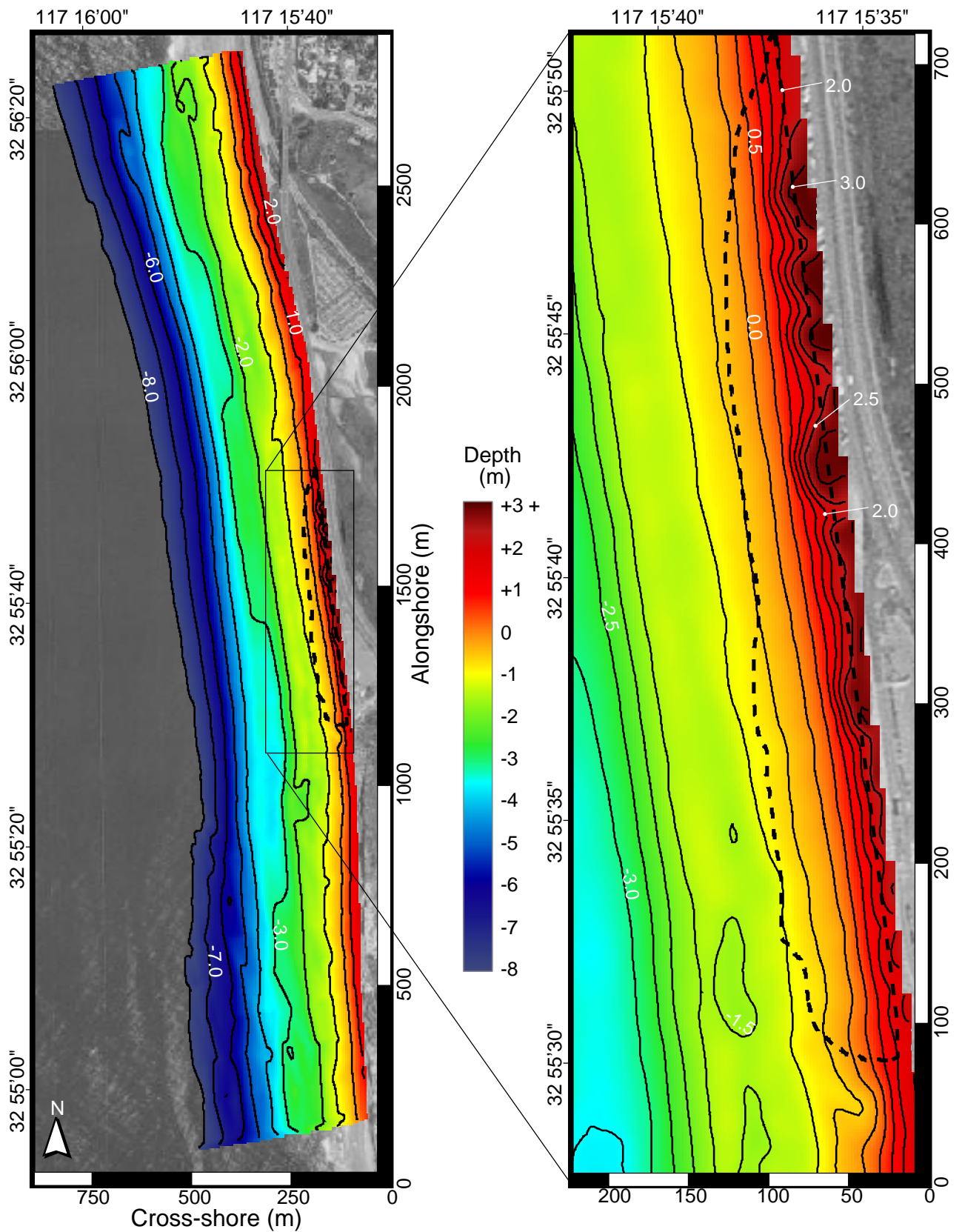


FIGURE 2b.

Left: Bathymetry measured 30 November 01 in a 3-km long strip centered on the initially nourished region (bounded by the black dashed line). The contour interval is 1.0 meters.

Right: Nourishment zone enlarged. The contour interval is 0.5 meters.

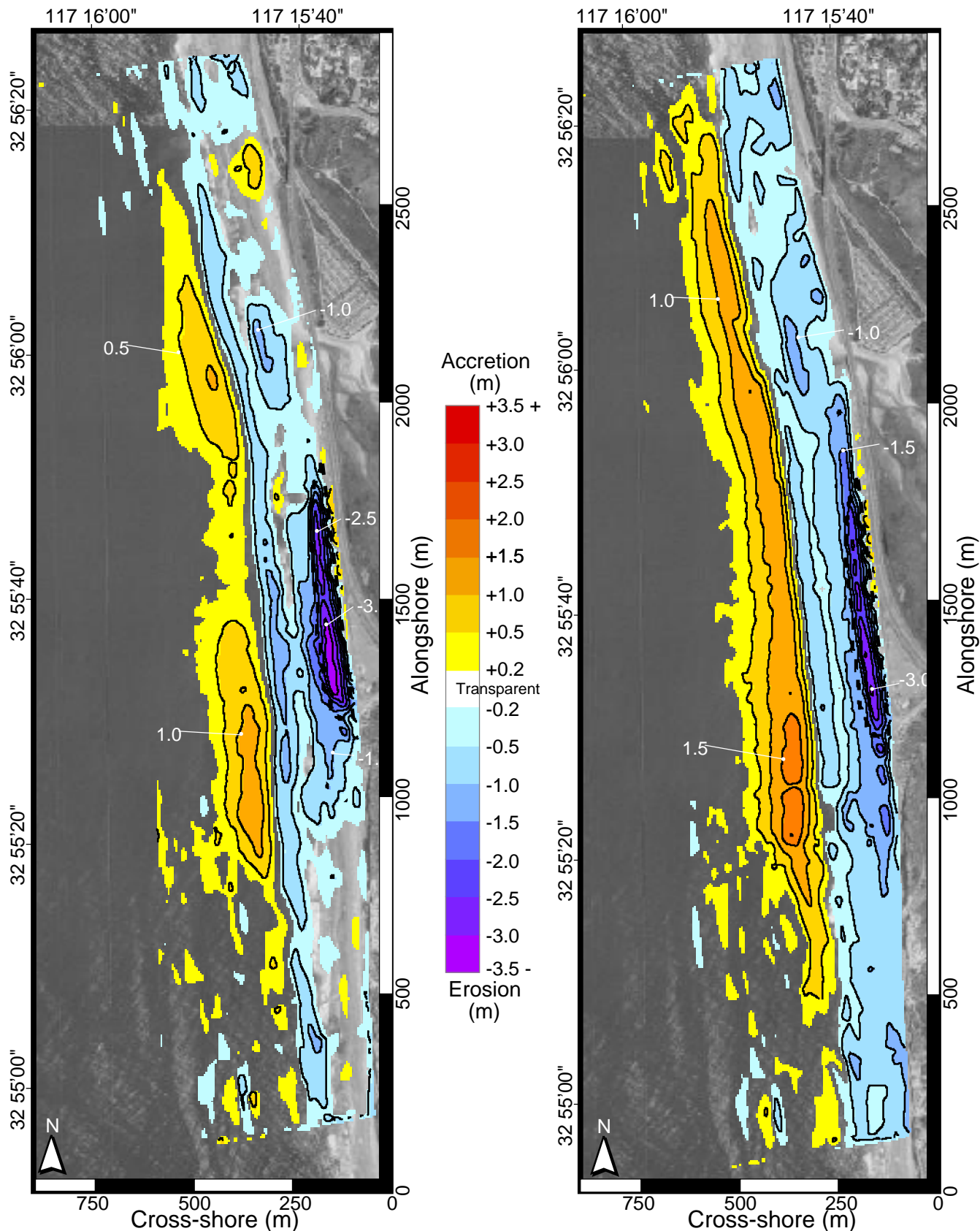


FIGURE 2c.

Left: Changes in sand level on 30 November 01 relative to 27 April 01 (the first post-nourishment survey). The contour interval is 0.5 meters (changes less than +/- 0.2 meters are not shown).

Right: Changes in sand level on 30 November 01 relative to 17 November 01 (the previous survey).

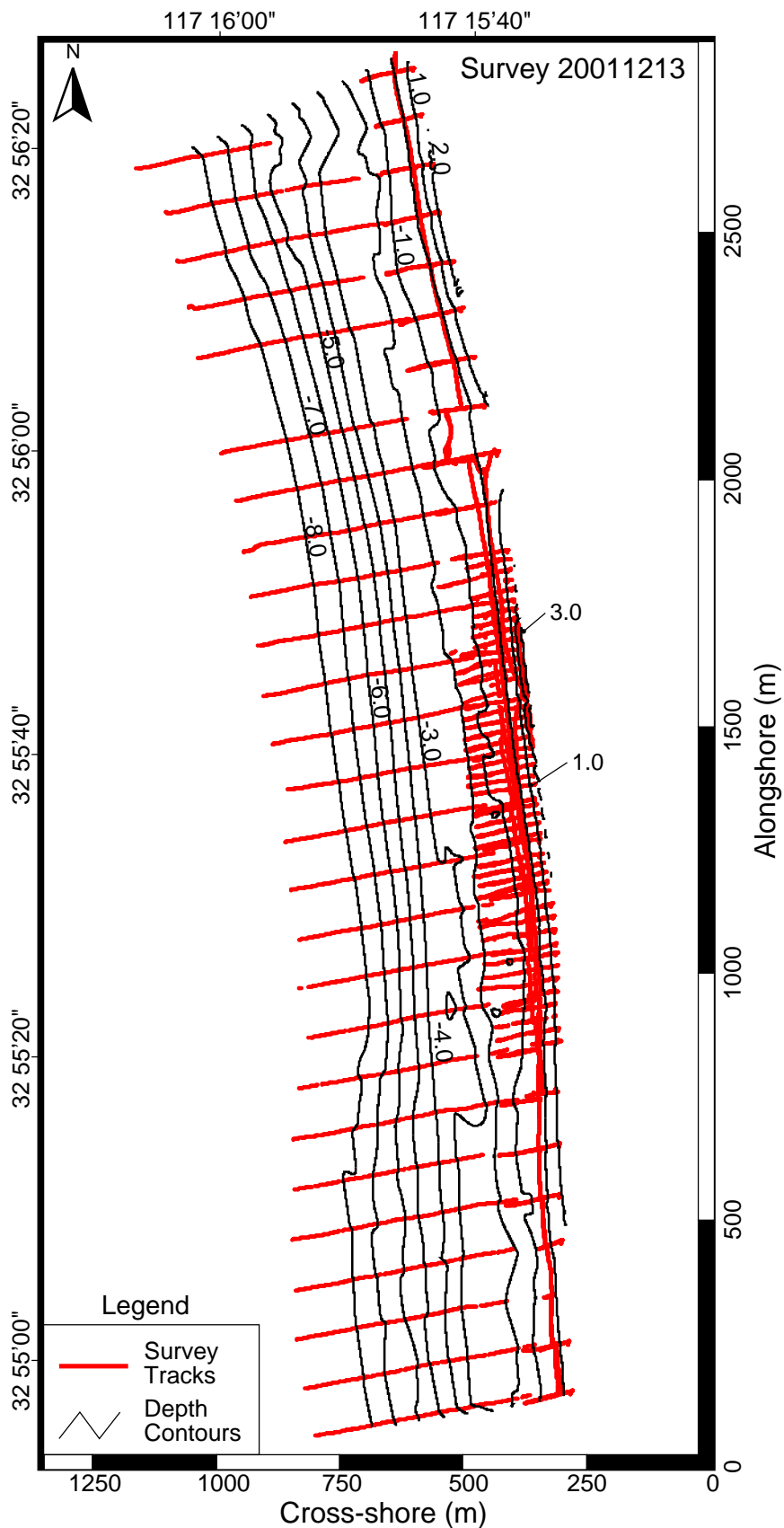


FIGURE 3a. Survey starting 13 December 01. Red lines are survey tracks. Black lines are depth contours in meters (relative to mean sea level).

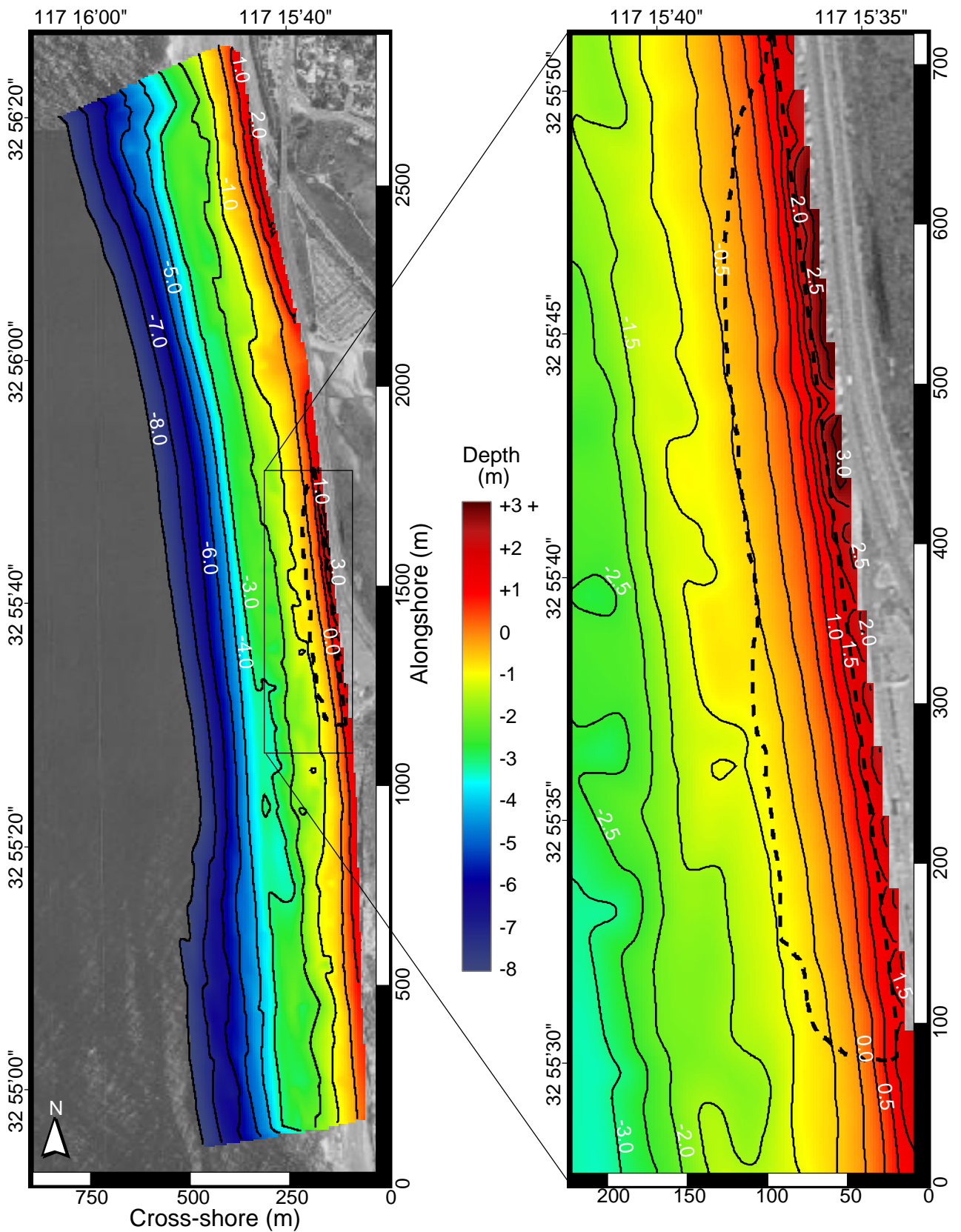


FIGURE 3b.

Left: Bathymetry measured 13 December 01 in a 3-km long strip centered on the initially nourished region (bounded by the black dashed line). The contour interval is 1.0 meters.

Right: Nourishment zone enlarged. The contour interval is 0.5 meters.

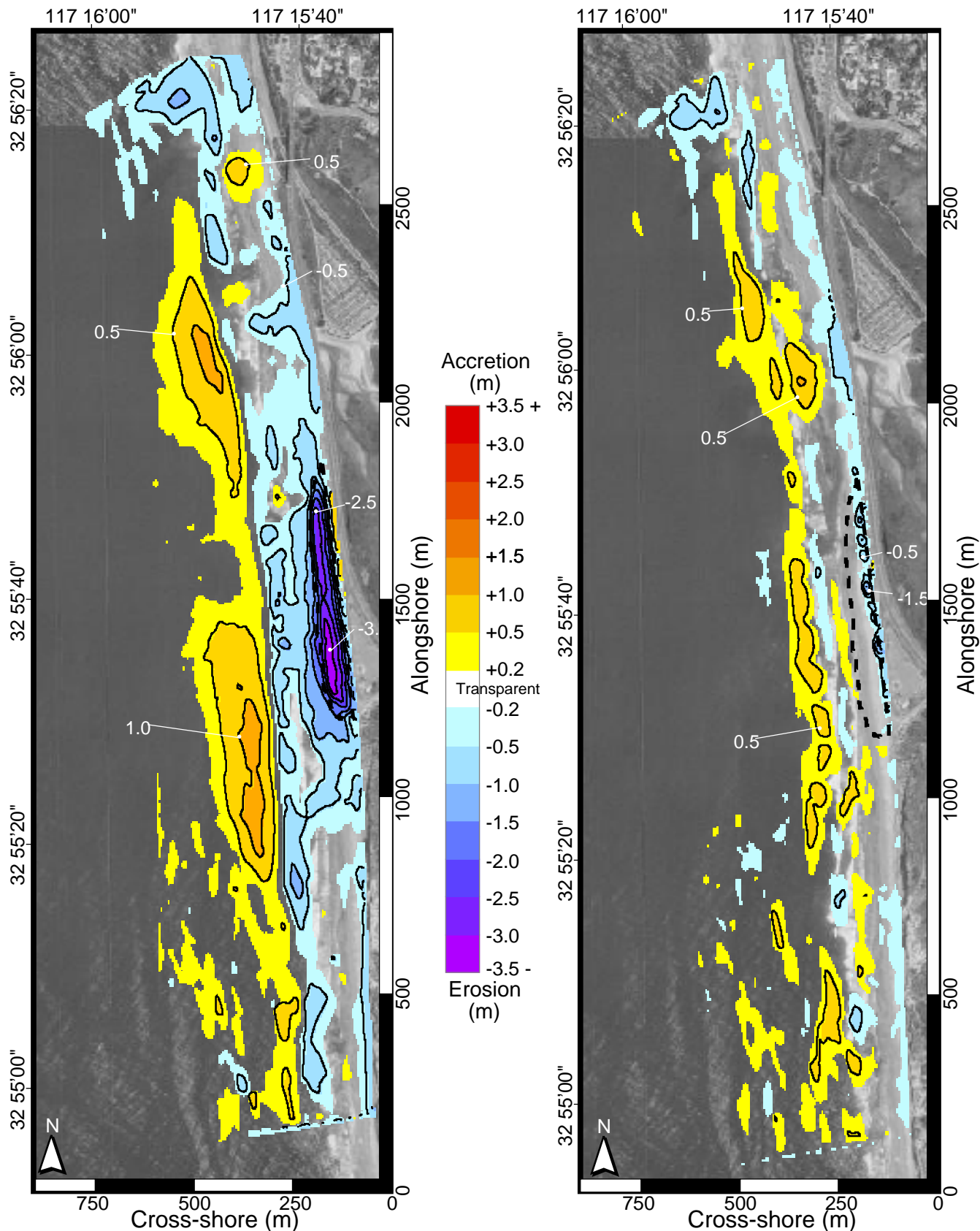


FIGURE 3c.

Left: Changes in sand level on 13 December 01 relative to 27 April 01 (the first post-nourishment survey). The contour interval is 0.5 meters (changes less than +/- 0.2 meters are not shown).

Right: Changes in sand level on 13 December 01 relative to 30 November 01 (the previous survey).

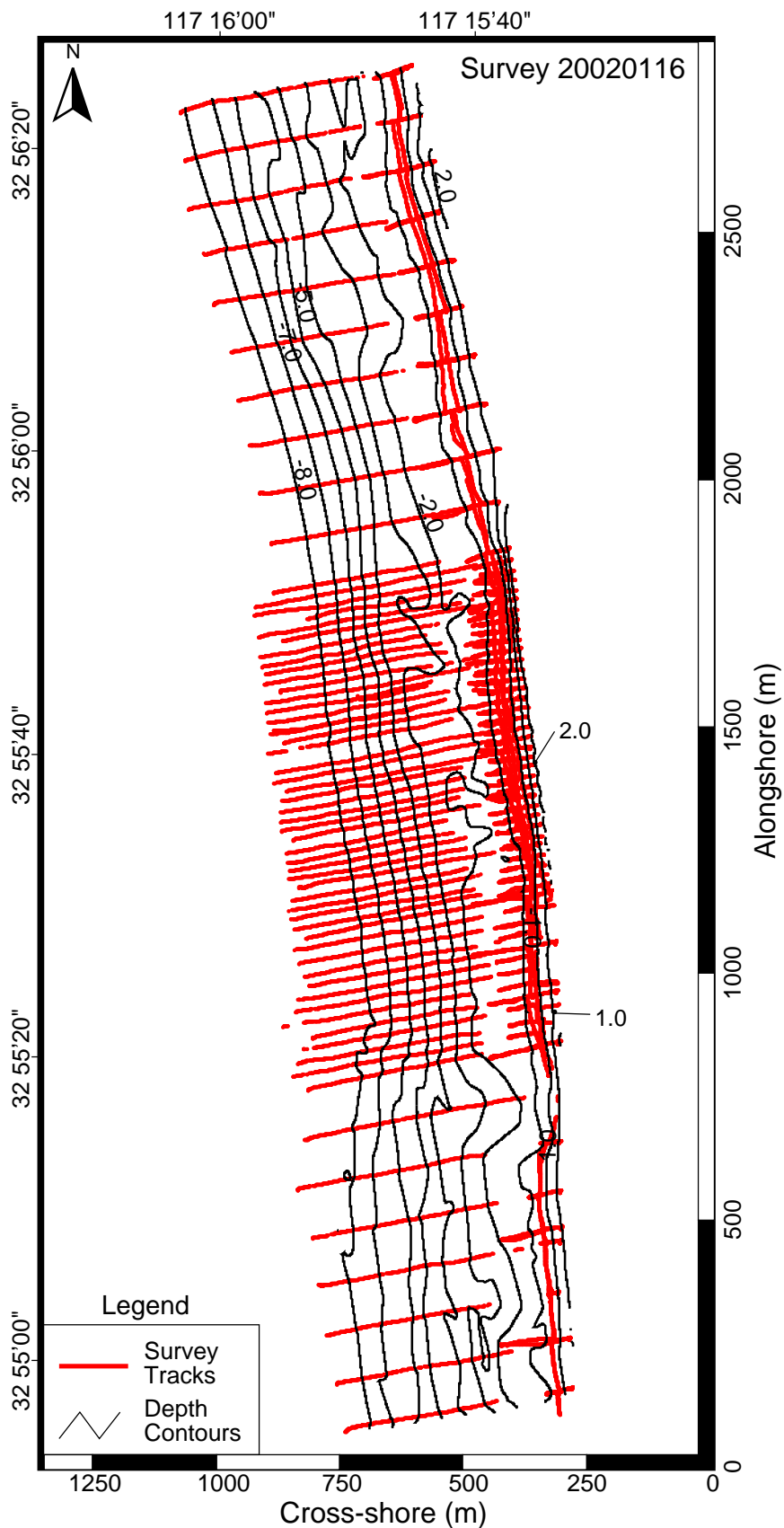


FIGURE 4a. Survey starting 16 January 02. Red lines are survey tracks. Black lines are depth contours in meters (relative to mean sea level).

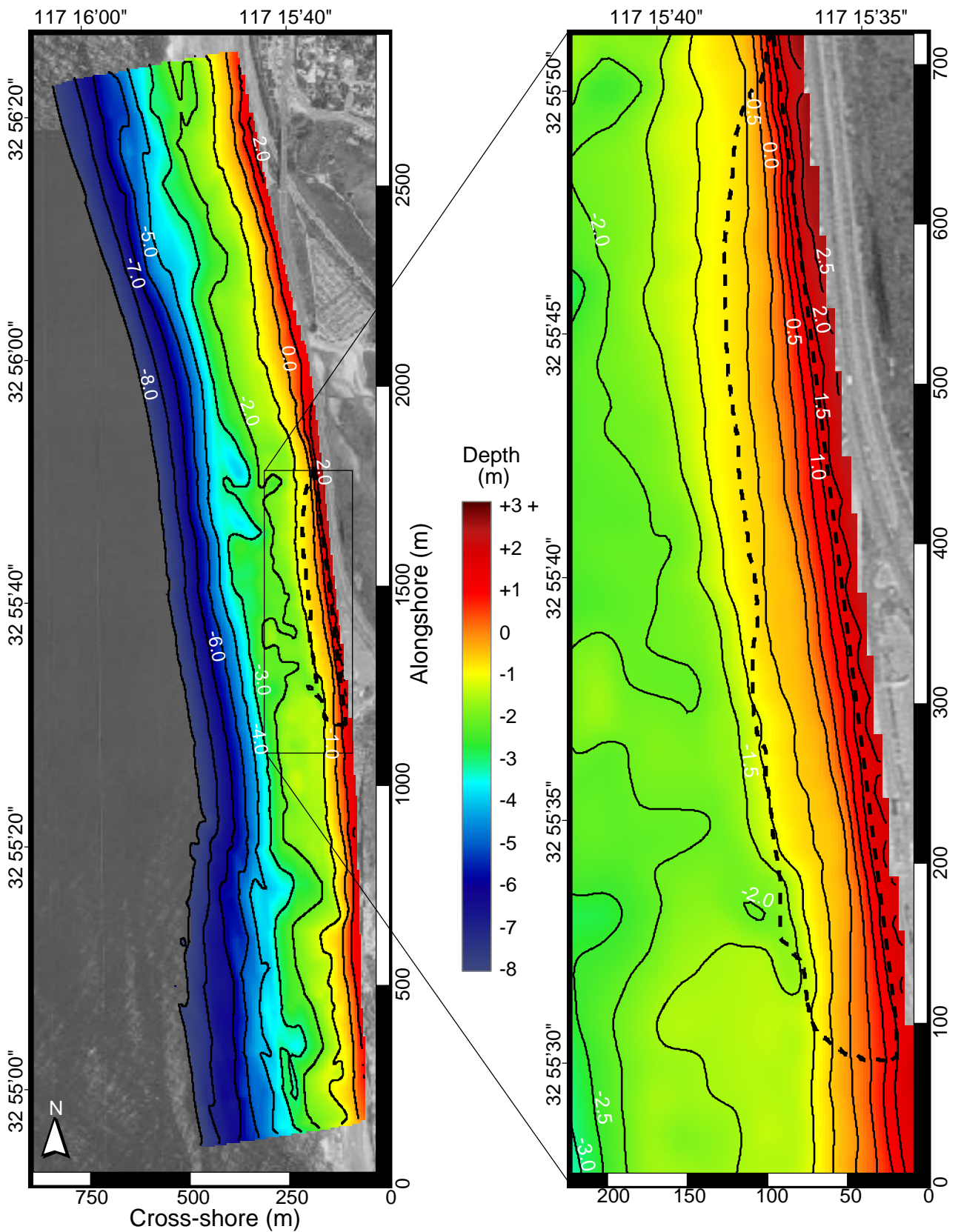


FIGURE 4b.

Left: Bathymetry measured 16 January 02 in a 3-km long strip centered on the initially nourished region (bounded by the black dashed line). The contour interval is 1.0 meters.

Right: Nourishment zone enlarged. The contour interval is 0.5 meters.

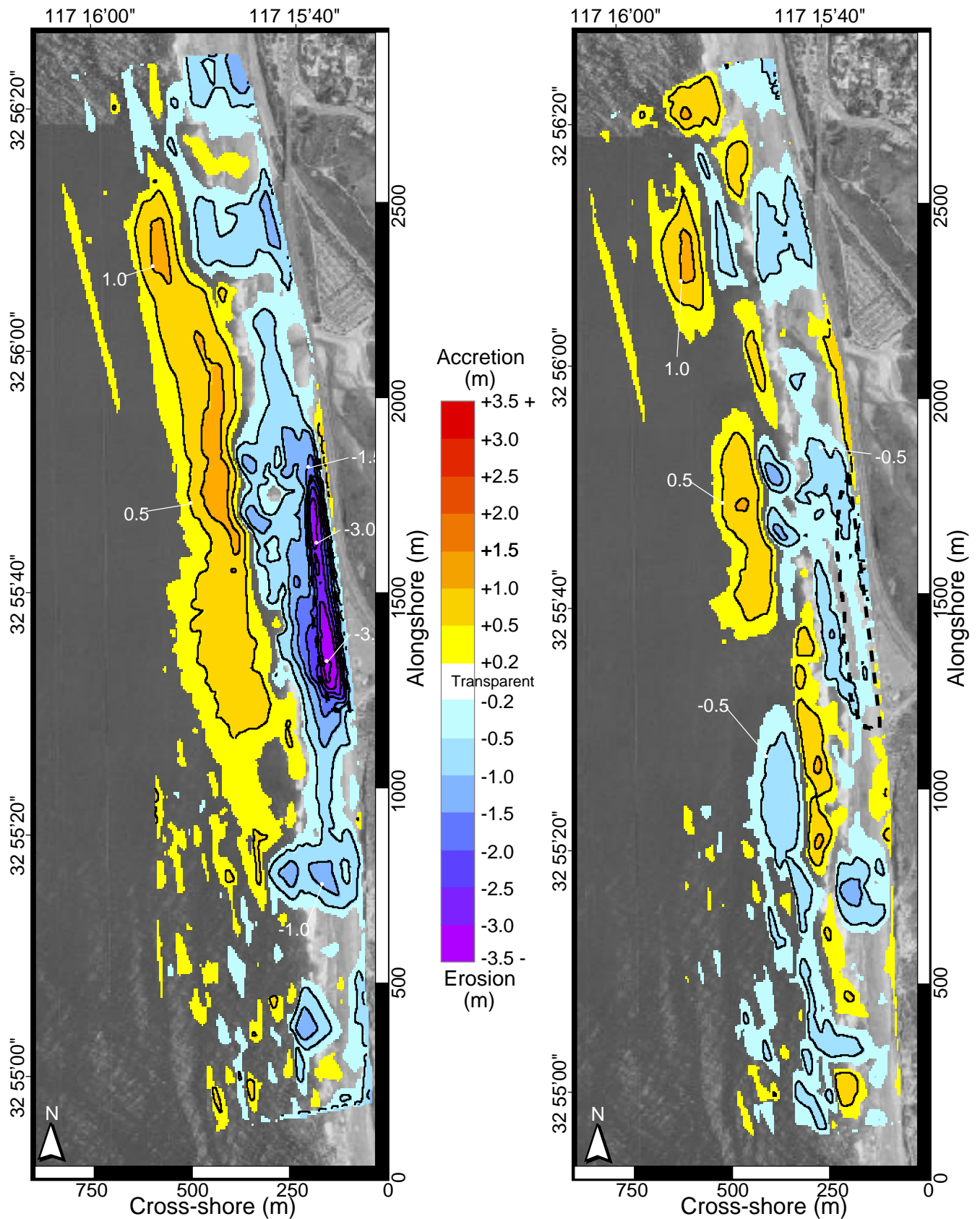


FIGURE 4c.

Left: Changes in sand level on 16 January 02 relative to 27 April 01 (the first post-nourishment survey). The contour interval is 0.5 meters (changes less than +/- 0.2 meters are not shown).

Right: Changes in sand level on 16 January 02 relative to 13 December 01 (the previous survey).

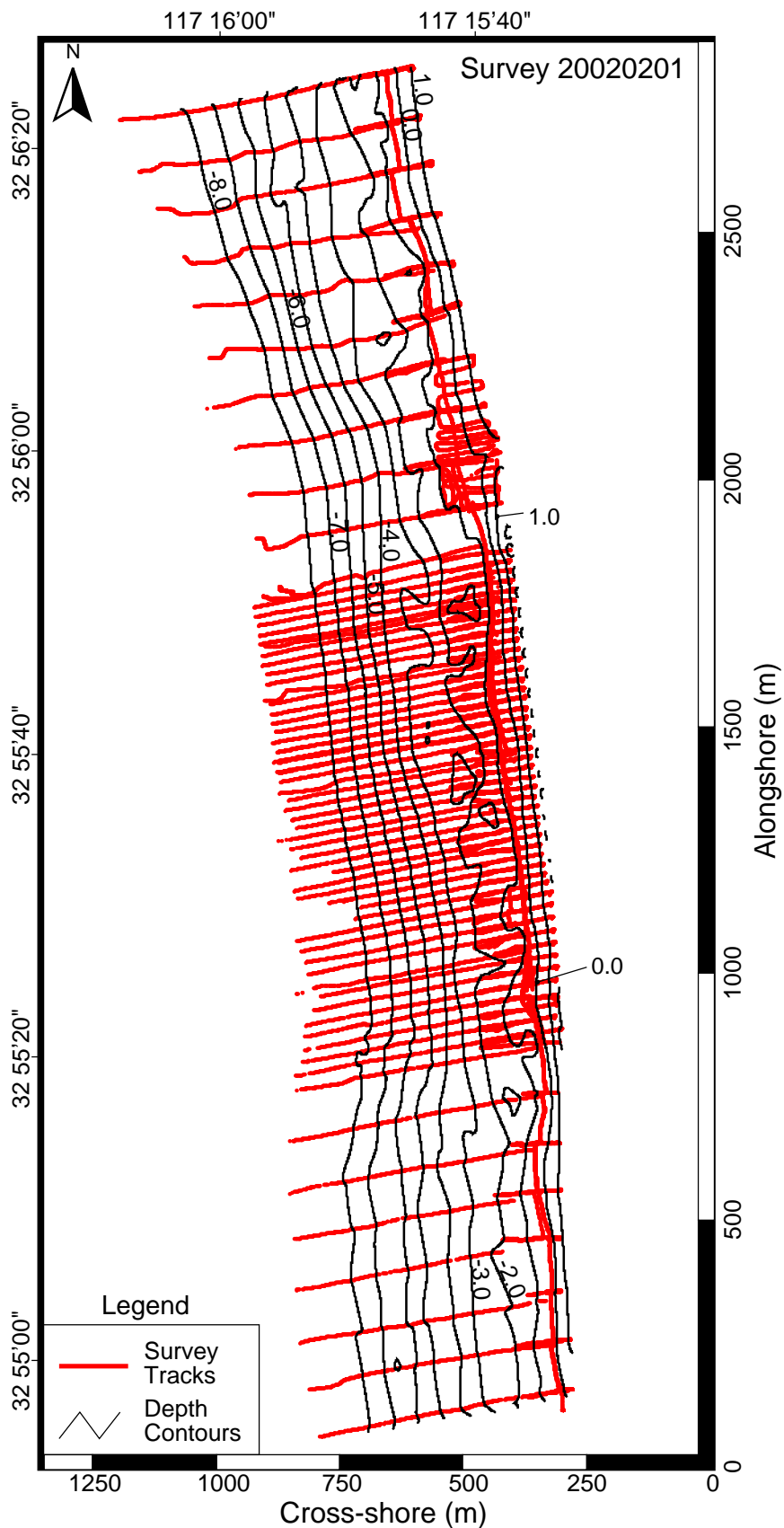


FIGURE 5a.

Survey starting 01 February 02. Red lines are survey tracks. Black lines are depth contours in meters (relative to mean sea level).

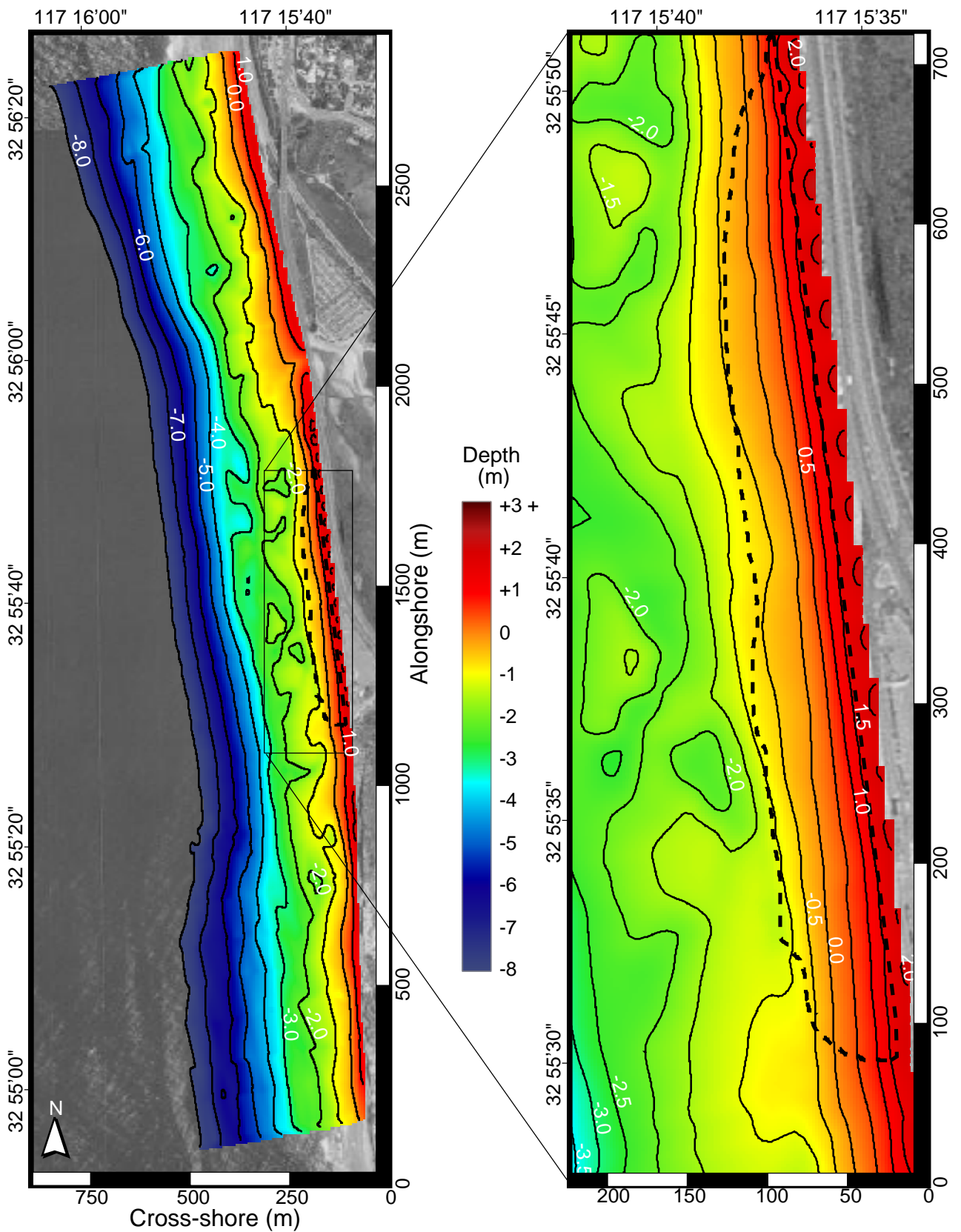


FIGURE 5b.

Left: Bathymetry measured 01 February 02 in a 3-km long strip centered on the initially nourished region (bounded by the black dashed line). The contour interval is 1.0 meters.

Right: Nourishment zone enlarged. The contour interval is 0.5 meters.

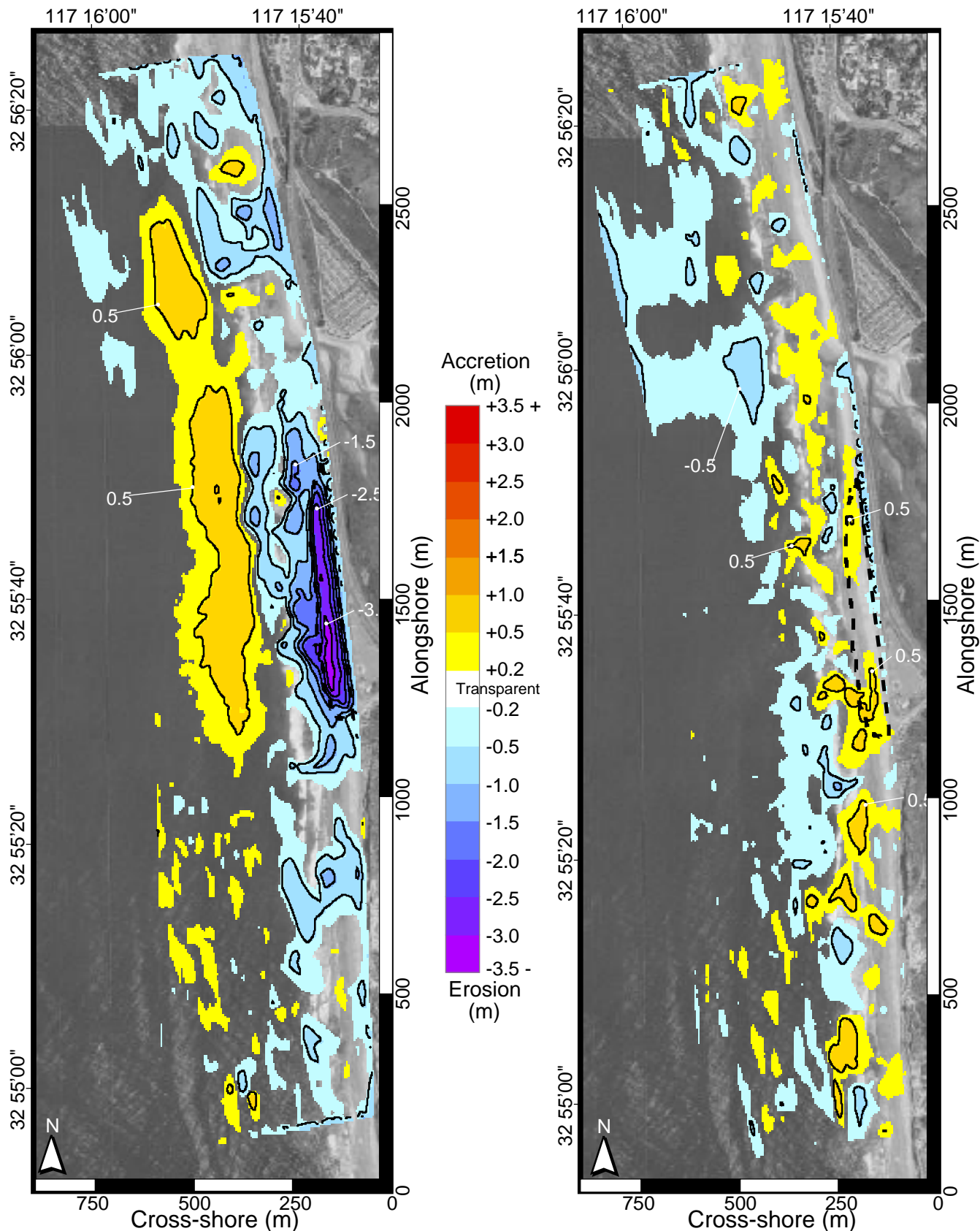


FIGURE 5c.

Left: Changes in sand level on 01 February 02 relative to 27 April 01 (the first post-nourishment survey). The contour interval is 0.5 meters (changes less than +/- 0.2 meters are not shown).

Right: Changes in sand level on 01 February 02 relative to 16 January 02 (the previous survey).

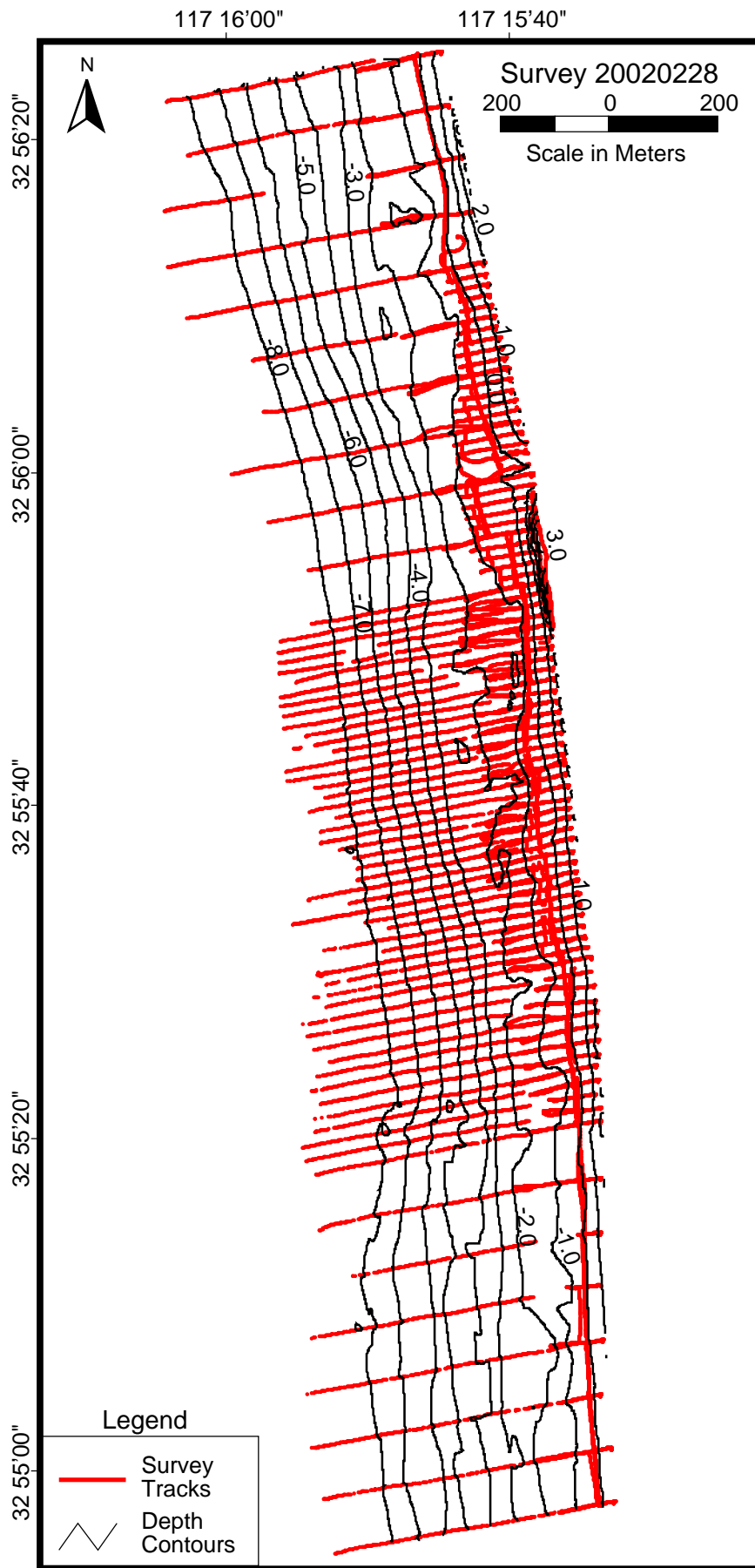


FIGURE 6a : Survey starting 28 February 02. Red lines are survey tracks. Black lines are depth contours in meters (relative to mean sea level).

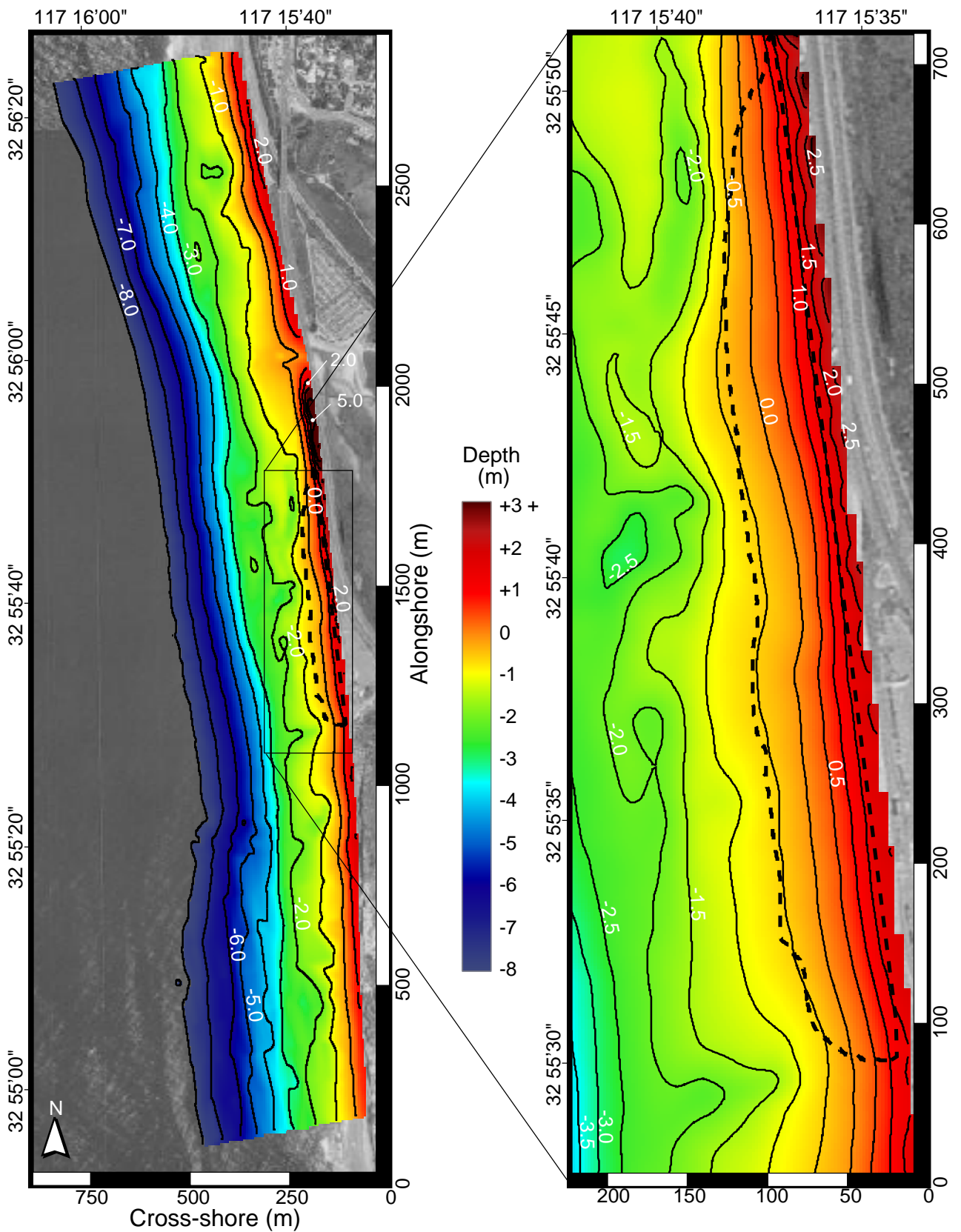


FIGURE 6b.

Left: Bathymetry measured 28 February 02 in a 3-km long strip centered on the initially nourished region (bounded by the black dashed line). The contour interval is 1.0 meters.

Right: Nourishment zone enlarged. The contour interval is 0.5 meters.

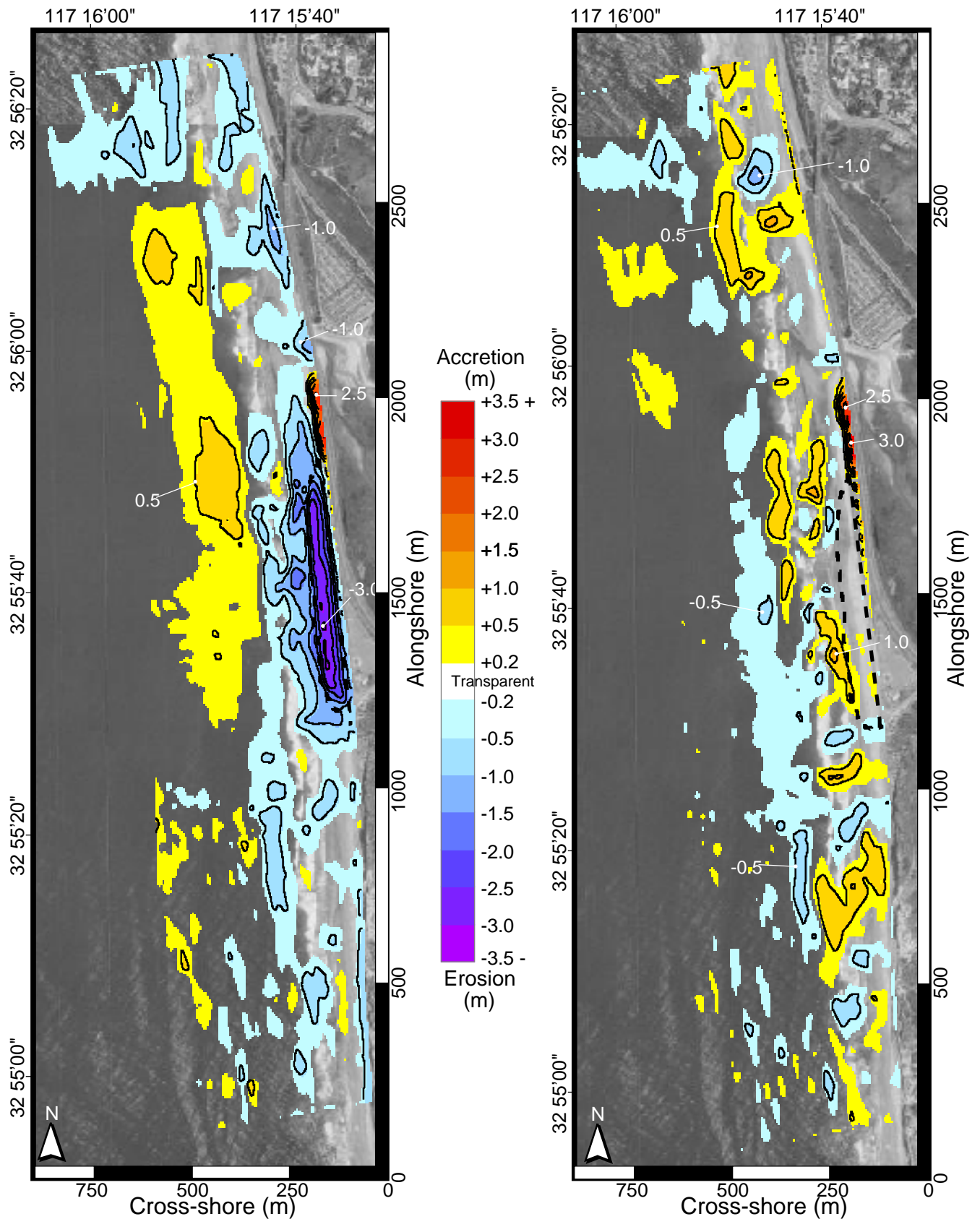


FIGURE 6c.

Left: Changes in sand level on 28 February 02 relative to 27 April 01 (the first post-nourishment survey). The contour interval is 0.5 meters (changes less than +/- 0.2 meters are not shown).

Right: Changes in sand level on 28 February 02 relative to 01 February 02 (the previous survey).

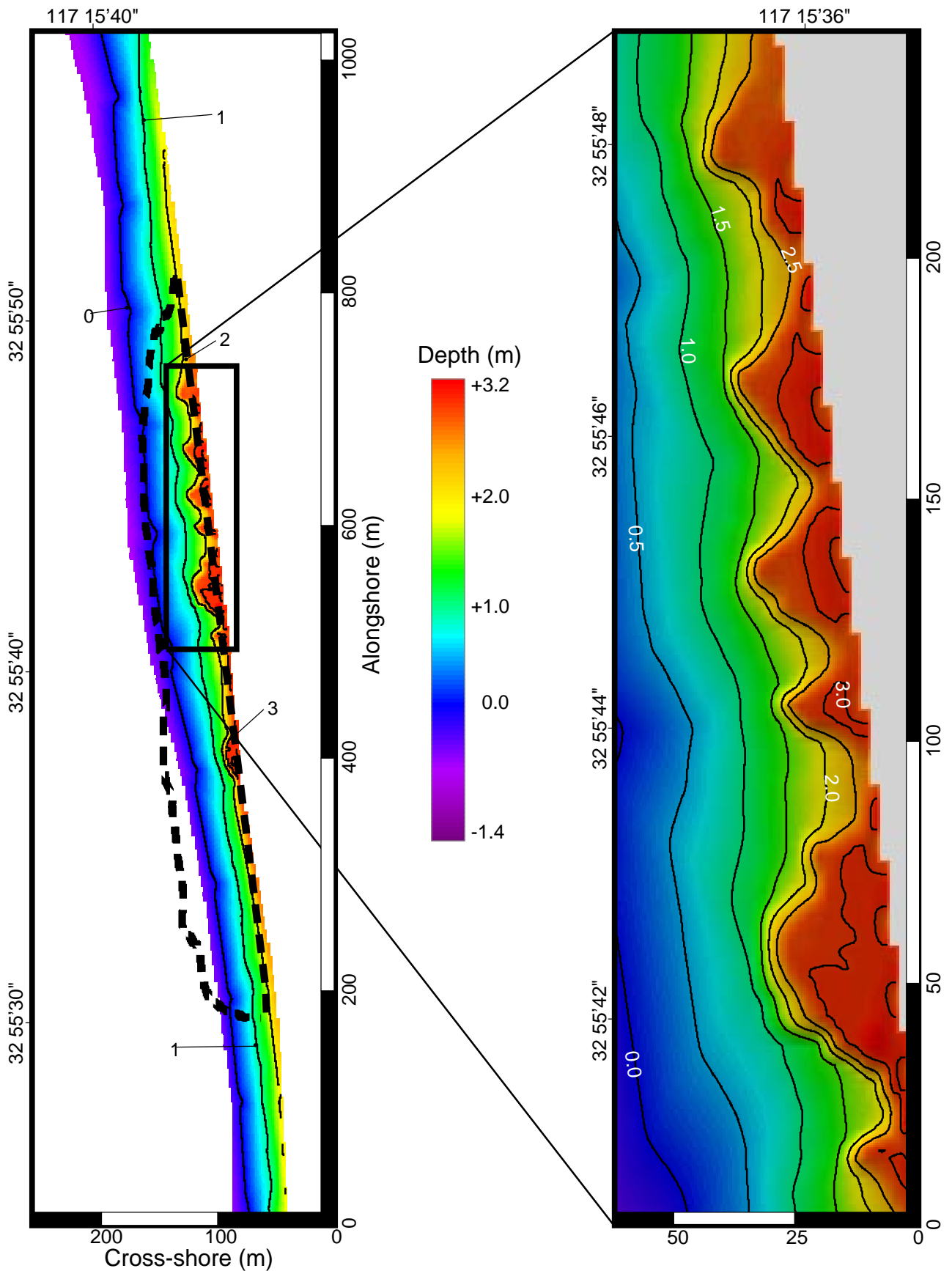


FIGURE 7.

Left: Bathymetry measured 23 November 01. Black dashed line marks original nourishment region.

Right: Sand peninsula region enlarged. Contour interval is 0.5 meters.

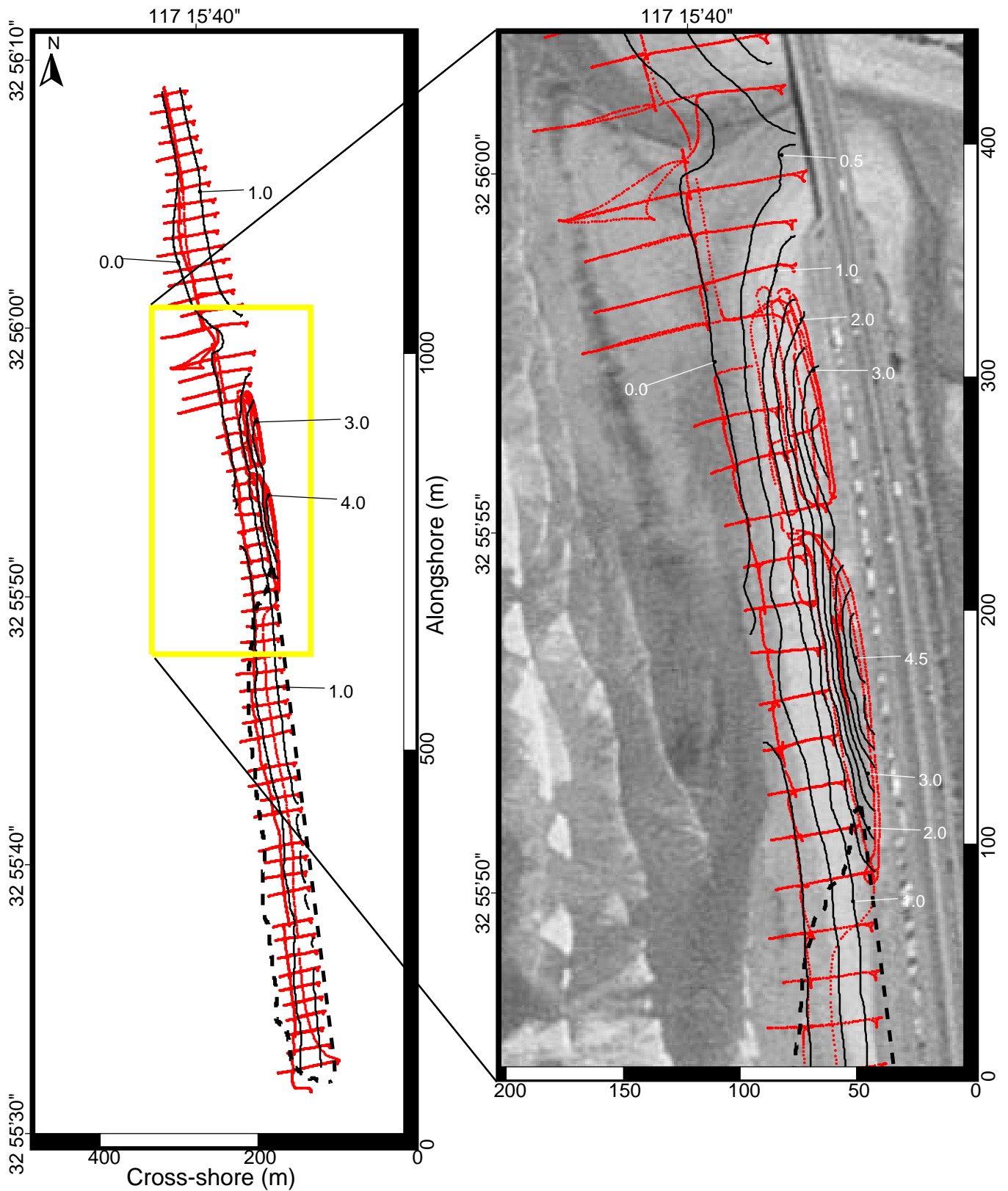


FIGURE 8a.

Left: Survey tracks collected 07 February 02. Contour interval is 1.0 meters. Right: Survey tracks covering the deposition of dredged material from Los Penasquitos lagoon. Contour interval is 0.5 meters. Dotted black line marks the northern boundary of the original nourishment region.

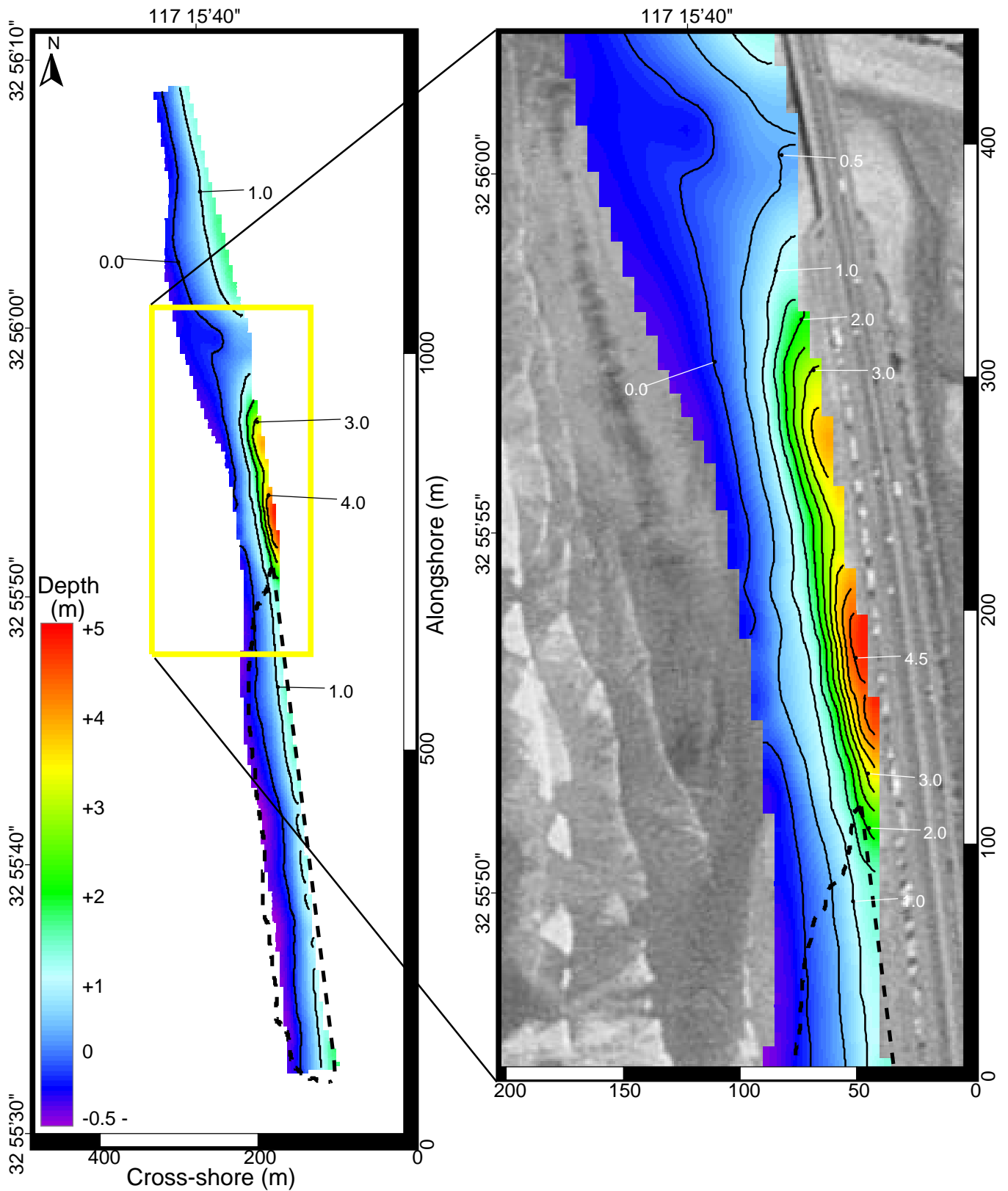


FIGURE 8b.

Left: Bathymetry measured 07 February 02. Contour interval is 1.0 meters. Right: Enlarged view of newly deposited dredge material. Contour interval is 0.5 meters. Dotted black line marks the northern boundary of the original nourishment region.

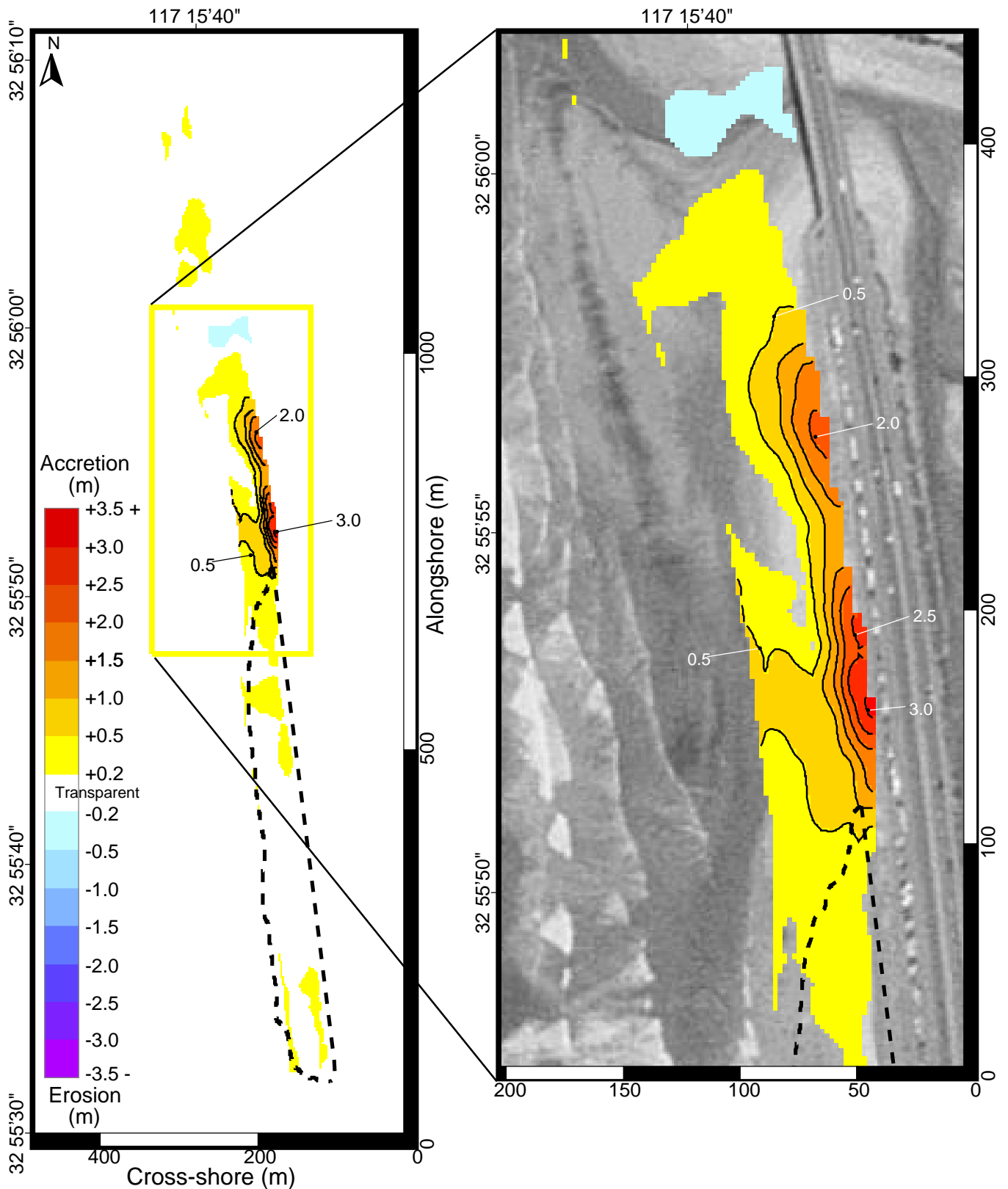
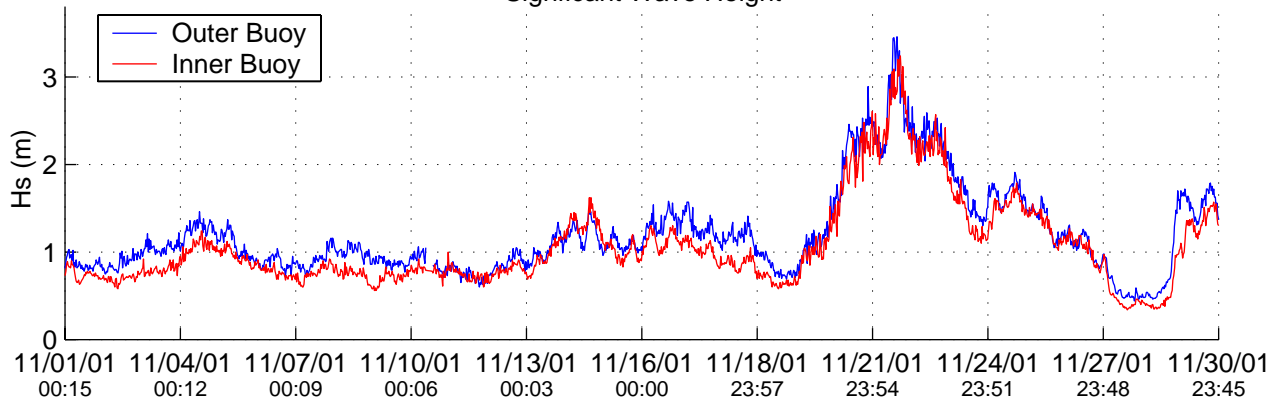


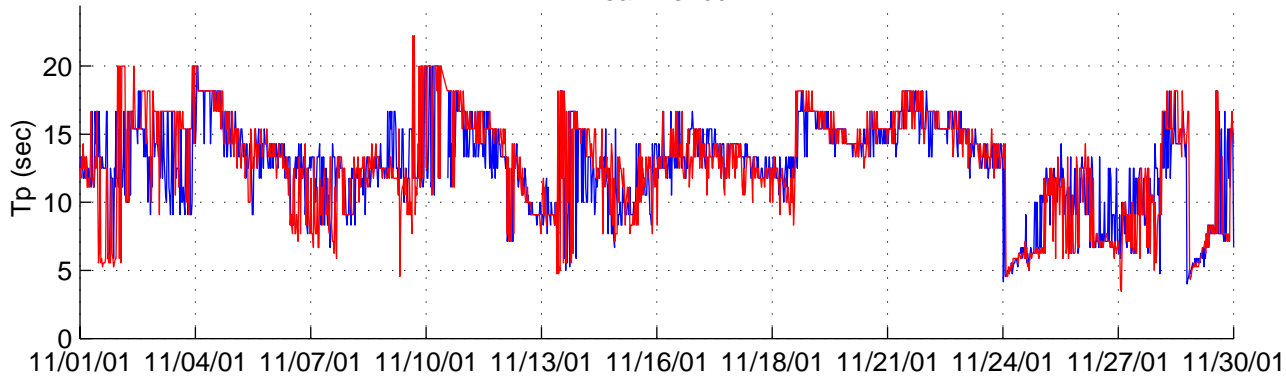
FIGURE 8c.

Changes in sand level on 07 February 02 relative to 01 February 02 (the previous survey). Contour interval is 0.5 meters. Dotted black line marks the northern boundary of the original nourishment region. The amount of material dumped during this time period is estimated to be $\sim 13,300 \text{ m}^3$ (based on data within the yellow box).

Torrey Pines
11/01/01 00:15 to 11/30/01 23:45 (UTC)
Significant Wave Height



Peak Period



Peak Direction

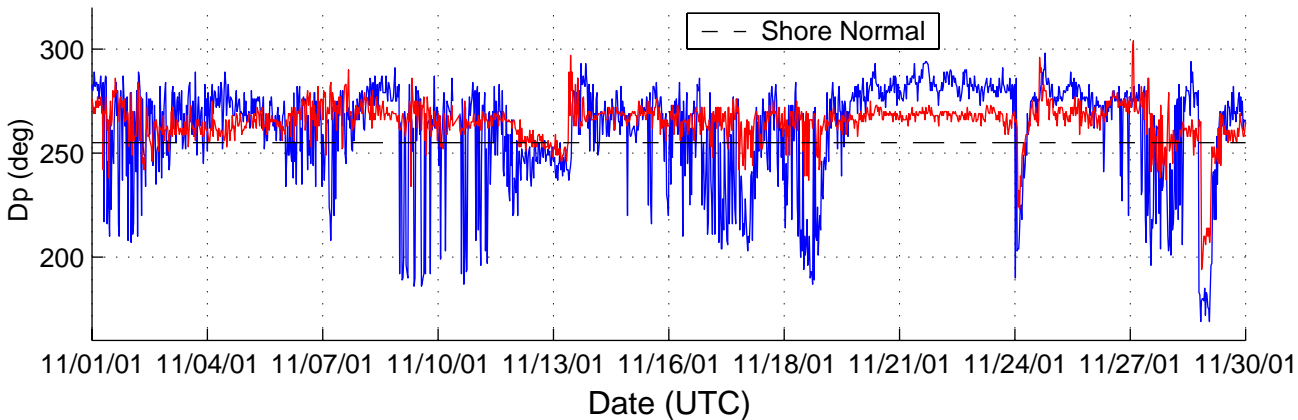
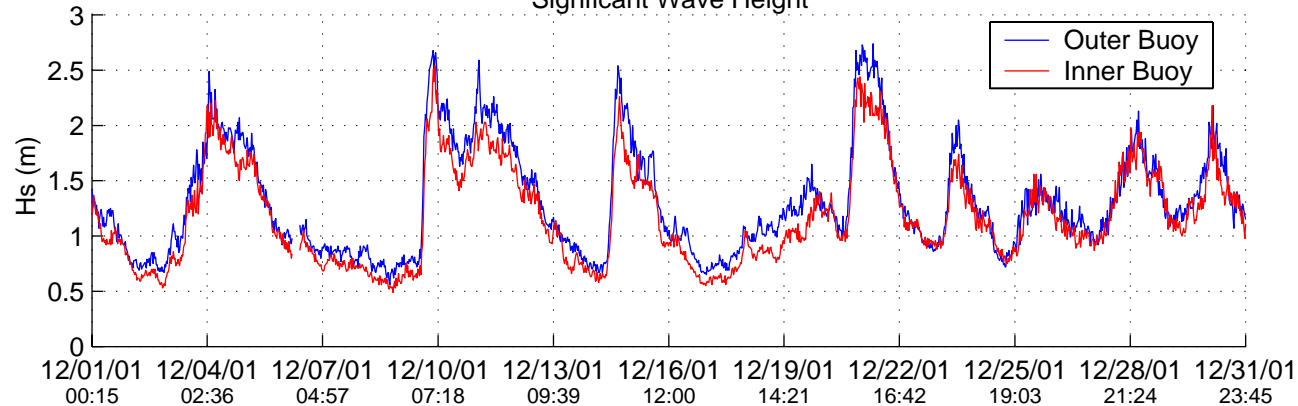


Figure 9a: November 2001 Wave Data for Torrey Pines Inner and Outer Buoys

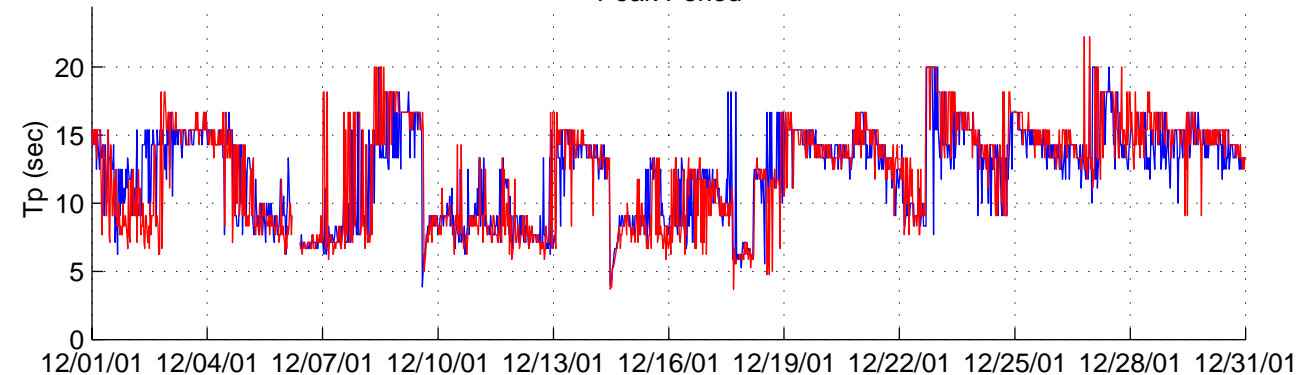
Torrey Pines

12/01/01 00:15 to 12/31/01 23:45 (UTC)

Significant Wave Height



Peak Period



Peak Direction

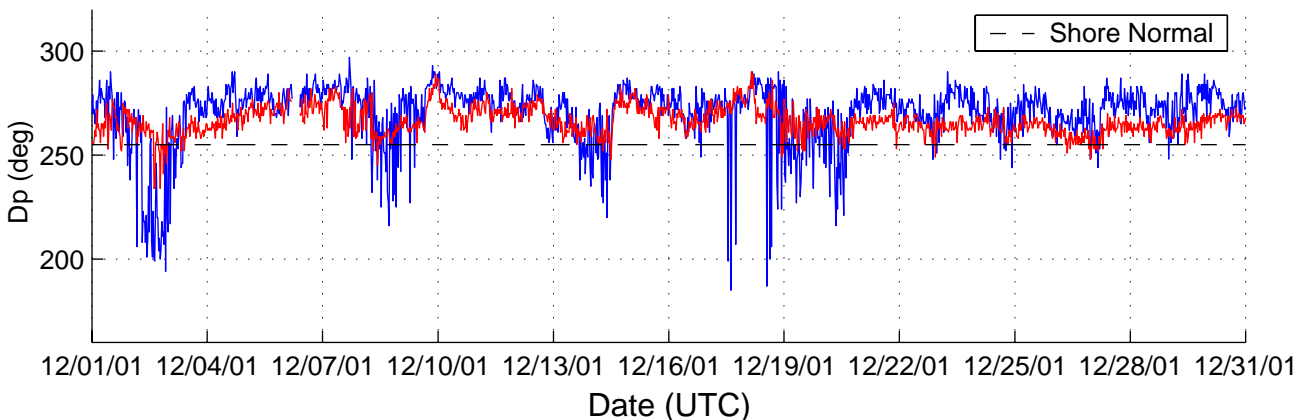


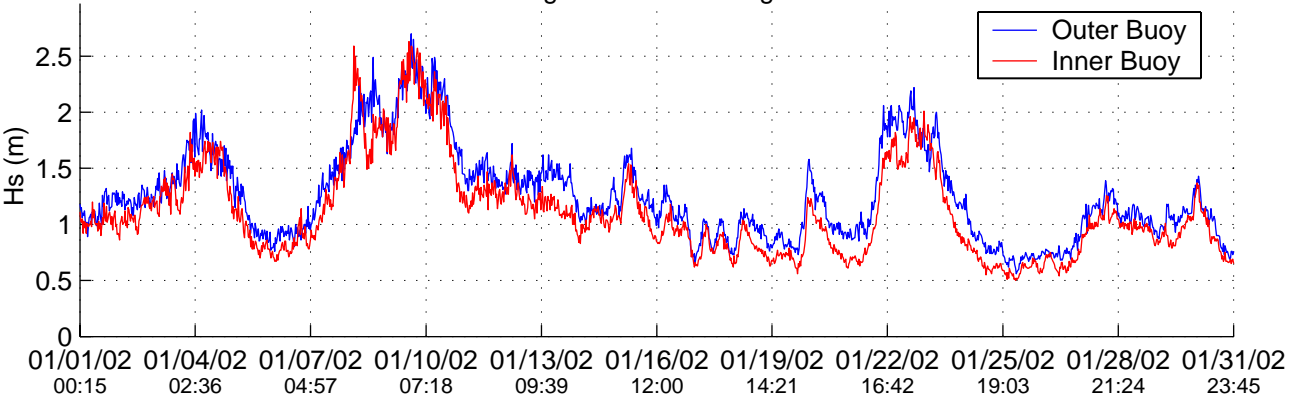
Figure 9b: December 2001 Wave Data for Torrey Pines Inner and Outer Buoys

Torrey Pines

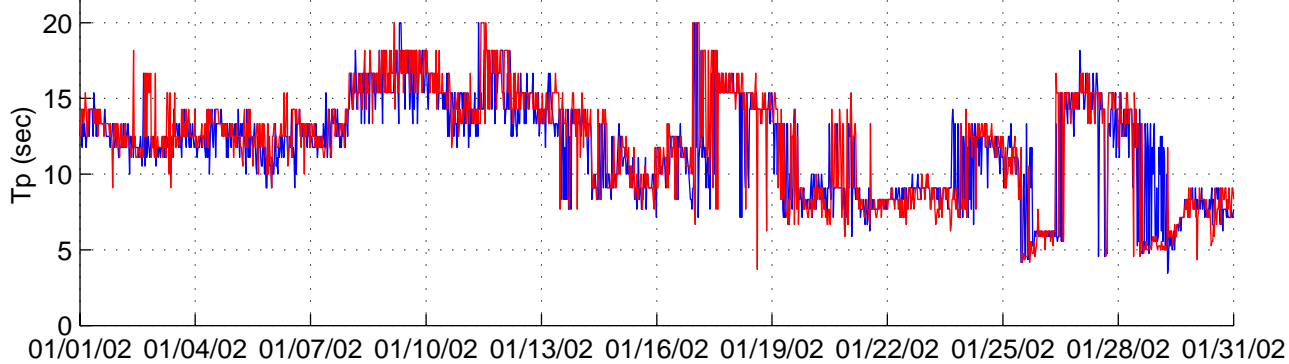
01/01/02 00:15 to 01/31/02 23:45 (UTC)

Significant Wave Height

Outer Buoy
Inner Buoy



Peak Period



Peak Direction

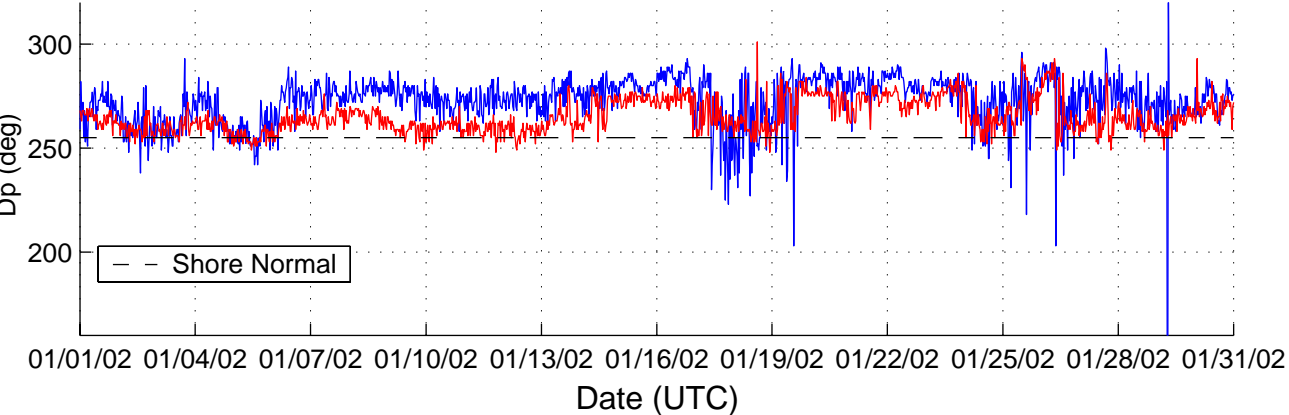
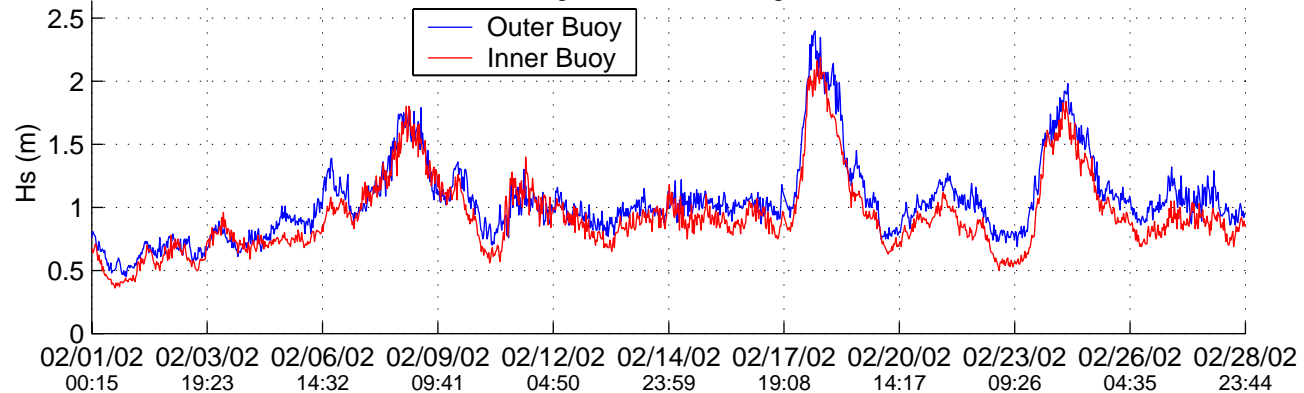


Figure 9c: January 2002 Wave Data for Torrey Pines Inner and Outer Buoys

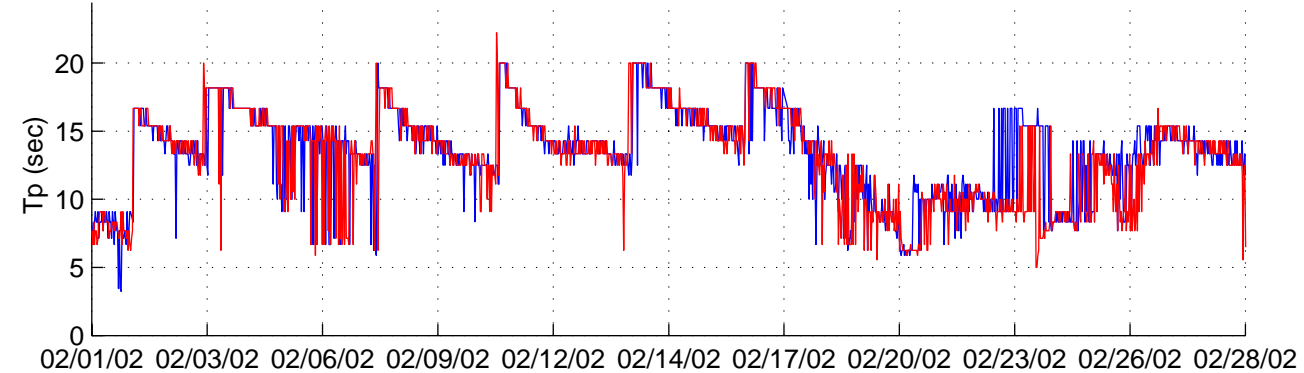
Torrey Pines

02/01/02 00:15 to 02/28/02 23:44 (UTC)

Significant Wave Height



Peak Period



Peak Direction

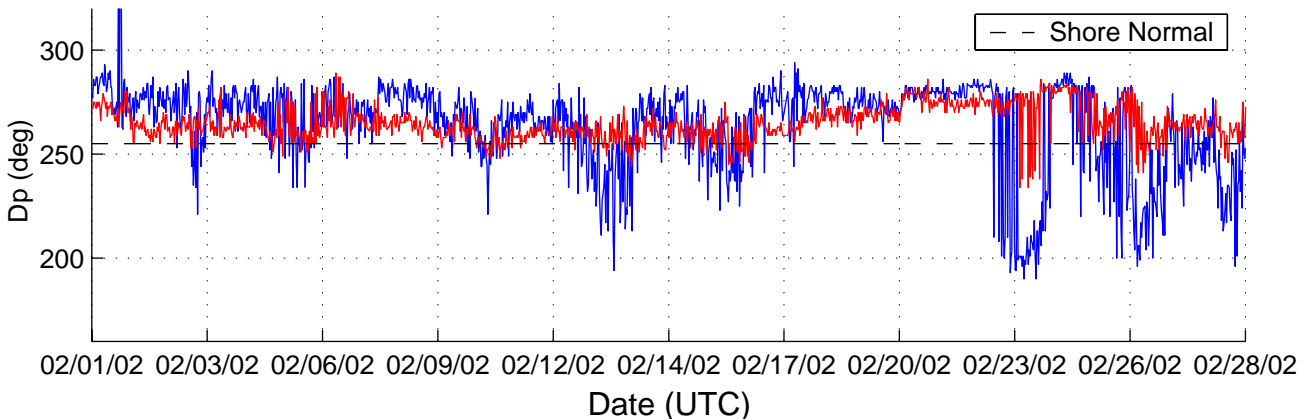


Figure 9d: February 2002 Wave Data for Torrey Pines Inner and Outer Buoys