

Episodic, seasonal and longer-term variations in beach morphology and sediment transport in northern Monterey Bay, California

2015 Annual Report

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Introduction

This report summarizes fiscal year 2015 (October 1, 2014 – September 30, 2015) activities and preliminary findings for research conducted under a United States Army Corps of Engineers grant. Research under this grant consists of GPS and sonar surveys of the beach and nearshore region in northern Monterey Bay from Santa Cruz to Moss Landing. This was the first year of an ongoing monitoring program to assess seasonal and interannual changes in sand volume and shoreline position within the study area. Spring and fall field surveys were timed to record the maximum extent of winter storm-driven changes and subsequent beach recovery during the summer/fall. Two additional surveys were performed to document the effects of a large wave event that occurred in December 2014.

Methods

Nearshore bathymetry data were collected using two personal watercraft (PWC), both equipped with single-beam echosounders and GPS (fig. 1). Topographic data were collected on foot with GPS mounted on backpacks, on an all-terrain vehicle and with ground-based Lidar. The survey design consists of a series of transects oriented in the cross shore direction at intervals of 50 – 200 m along the coast (fig. 2). Along each line, data were collected from landward of the primary dune crest (or any hard structures) to a depth of 12 m. Topographic data were collected during low tide and bathymetric data were collected at high tide to maximize the overall extent of data coverage, often resulting in seamless coverage of the beach and nearshore (fig. 3).

Additional data were collected between the transects to characterize the morphology of subaerial beaches in detail. These additional data were collected with ground-based Lidar at Main Beach and Cowells in Santa Cruz, and the mouth of Soquel Creek in Capitola resulting in detailed maps of beach topography in those regions (fig. 4). Additional data between transects were collected using an ATV equipped with GPS from New Brighton State Beach to Moss Landing.

Data Collected

A total of 4 surveys were performed in northern Monterey Bay between October 2014 and March 2015. Comprehensive surveys of beach topography and nearshore bathymetry were performed in the fall 2014 (Oct. 20-24) and again in spring 2015 (Mar. 16-20). Two additional surveys with limited extent were performed on Dec. 10 and Dec. 18, 2014, before and after a large storm that impacted the region (Table 1). A total of 16 maps showing coverage of individual surveys are provided in Appendices A-D.

Table 1. Survey dates, extent and types of data collected during the 4 surveys performed between October, 2014 and March, 2015.

		Total Distance surveyed (km)			Scan Positions
Survey Date	Extent	PWC	Backpack	ATV	Lidar
Oct. 20-24, 2014	Complete	205	83	209	-
Dec. 10, 2014	SC and Capitola	-	7.1	-	4
Dec. 18, 2014	SC and Capitola	30.6	20.5	-	6
Mar. 16-20, 2015	Complete	249	106	193	8

Preliminary Results

Processing and analysis of the data described above is ongoing, but a few preliminary remarks are provided here. The monitoring program observed measureable changes in sand volume and shoreline position throughout the study area. The shoreline position migrated landward (eroded) between the late summer and spring surveys, presumably in response to larger wave energy during the winter months. On average, the position of the mean high water (MHW) shoreline (defined here as 1.45 m elevation relative to the North American Vertical Datum of 1988, or NAVD88) migrated an average of approximately 12 m landward between October, 2014 and March, 2015 (fig. 5). One area of pronounced landward movement of the shoreline occurred along Sunset Beach State Park, where the average was 20 m.

Landward migration (erosion) of the shoreline between Oct. 2014 and Mar. 2015 was often associated with larger and more pronounced bars offshore (fig. 6), resulting in little net volume change along many profiles. This pattern is part of a typical seasonal cycle along many West Coast beaches characterized by offshore sand transport and the formation of offshore bar(s) in winter, and onshore sand migration resulting in shoreline accretion in summer. Future surveys will provide additional insight into interannual changes as well as into responses to large storms and possible changes in wave climate.

Figures

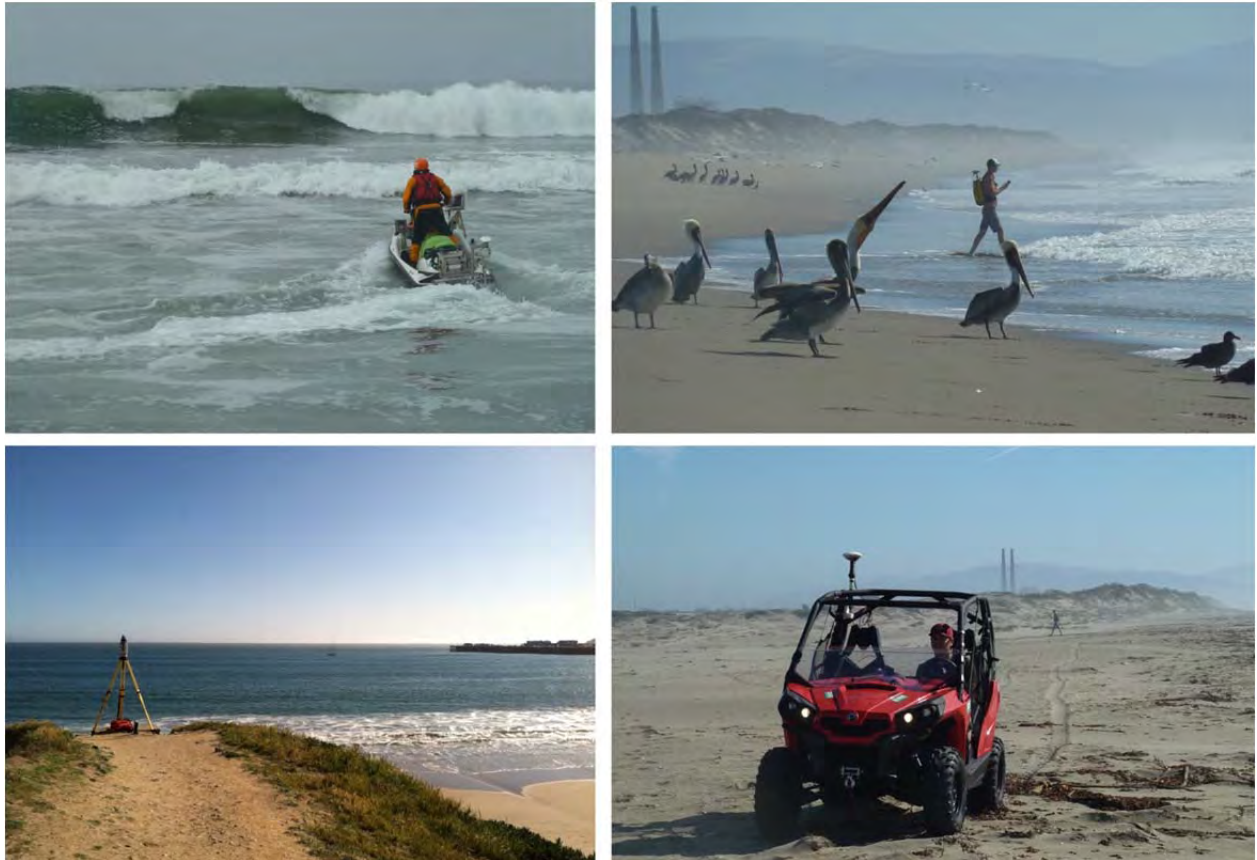


Figure 1. Photographs showing equipment used to collect nearshore bathymetry and beach topography along northern Monterey Bay beaches between Oct., 2014 and Mar., 2015.

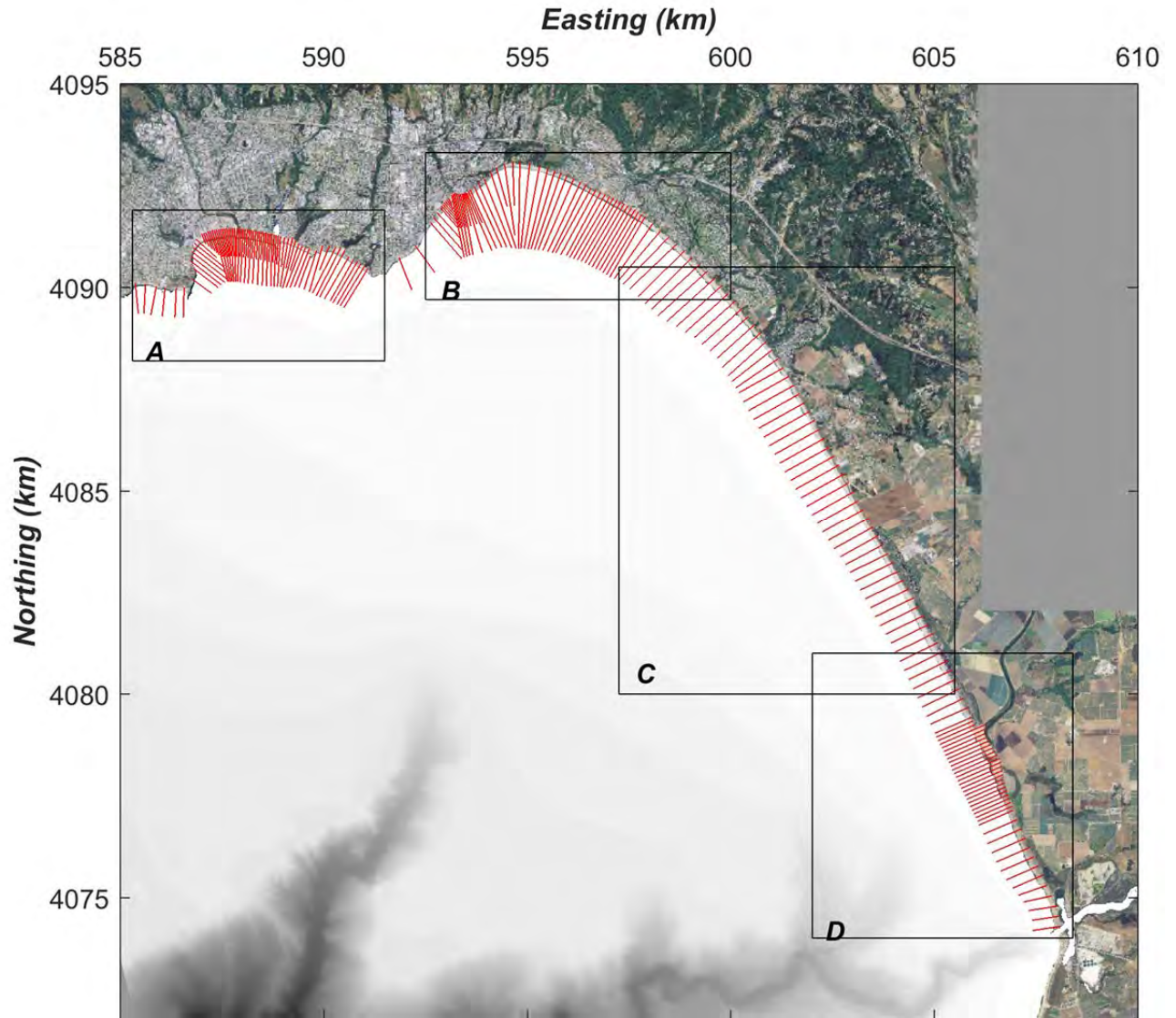


Figure 2. Map showing overview of planned survey lines used for the northern Monterey beach and nearshore coastal morphology monitoring program. Detail areas A-D are shown separately. Map projection is UTM, Zone 10 North, km.

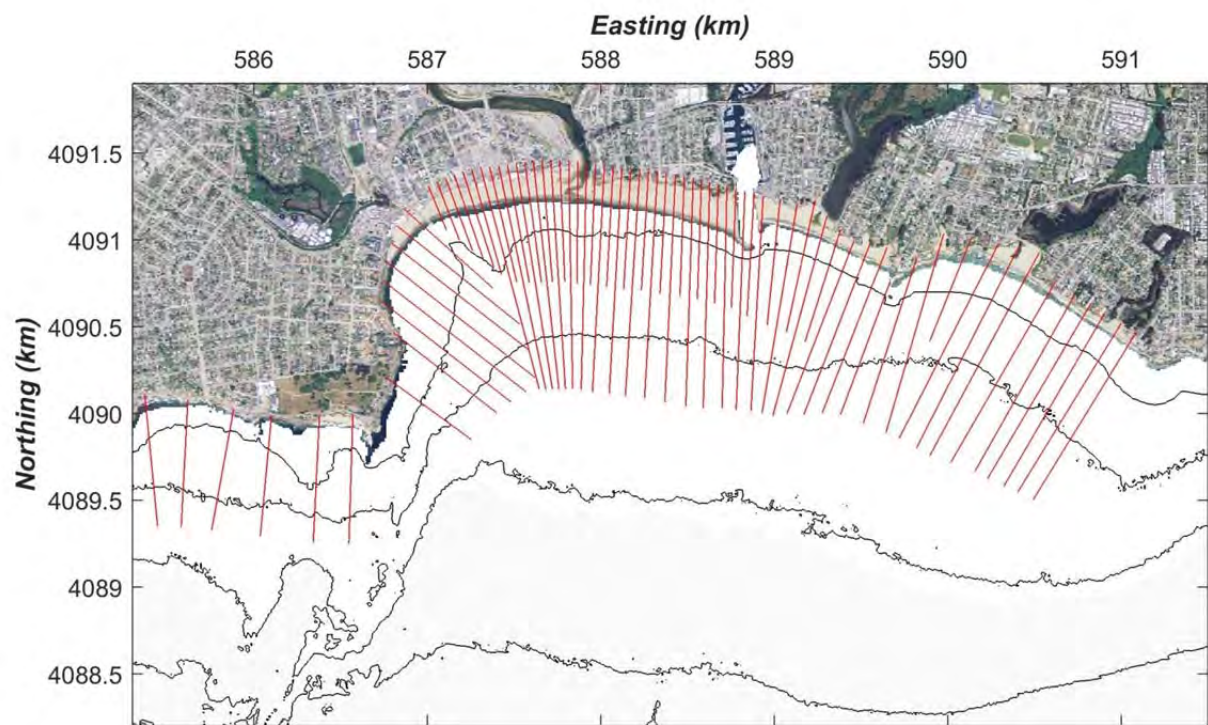


Figure 2 (continued). Planned lines for the Santa Cruz detail area.

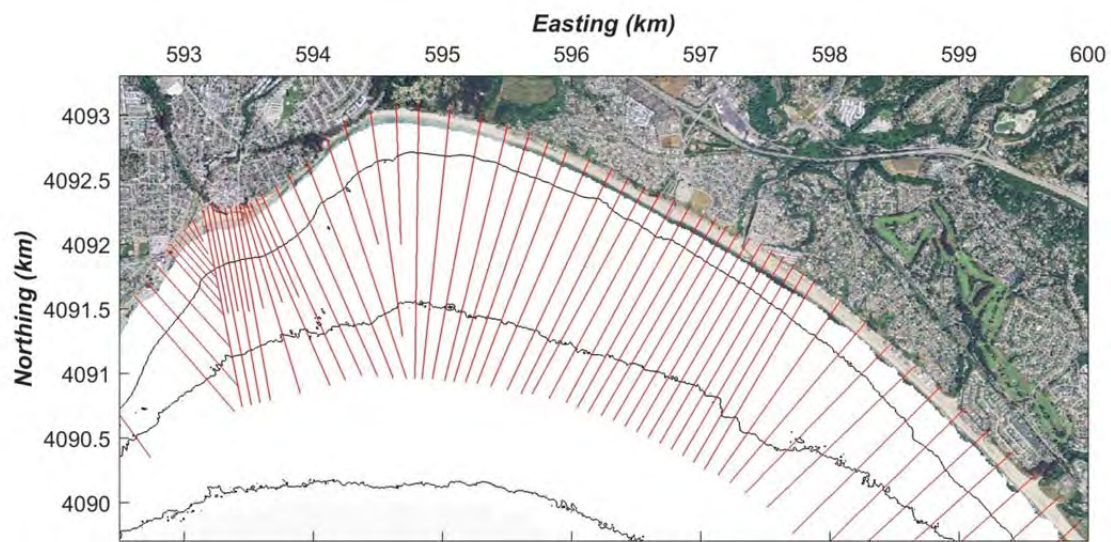


Figure 2 (continued). Planned Lines for Capitola to Seacliff State Beach.

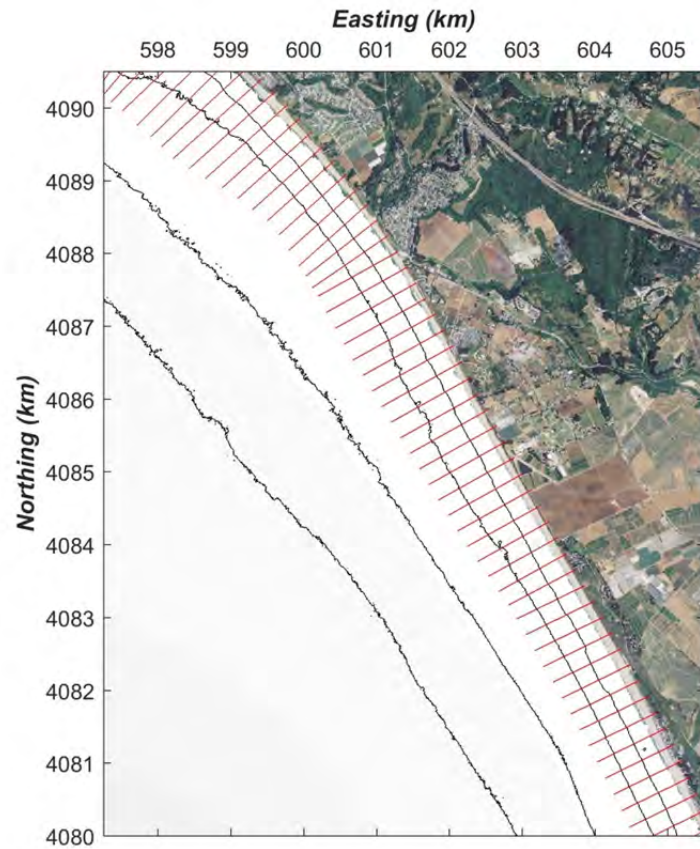


Figure 2 (continued). Planned lines for Seacliff State Beach to Sunset State Beach

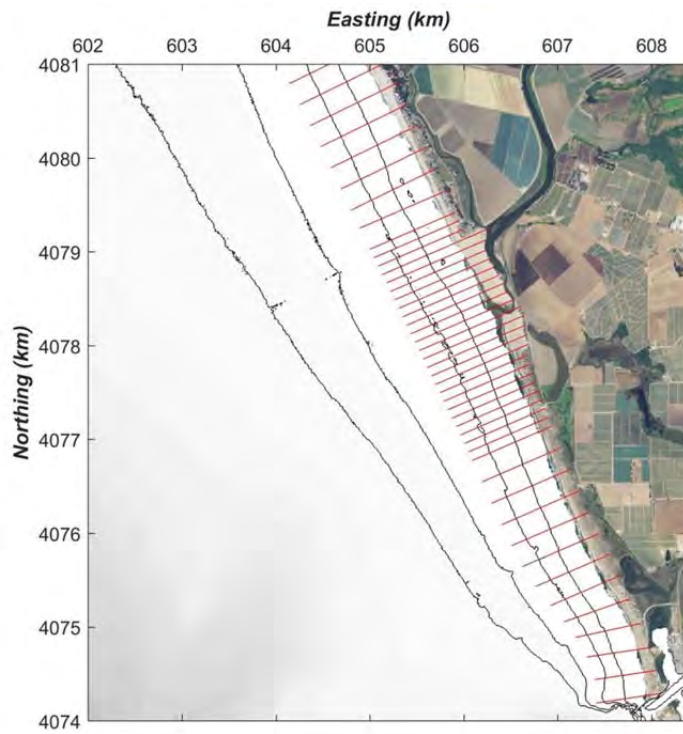


Figure 2 (continued). Planned lines for Sunset State Beach to Moss Landing State Beach.

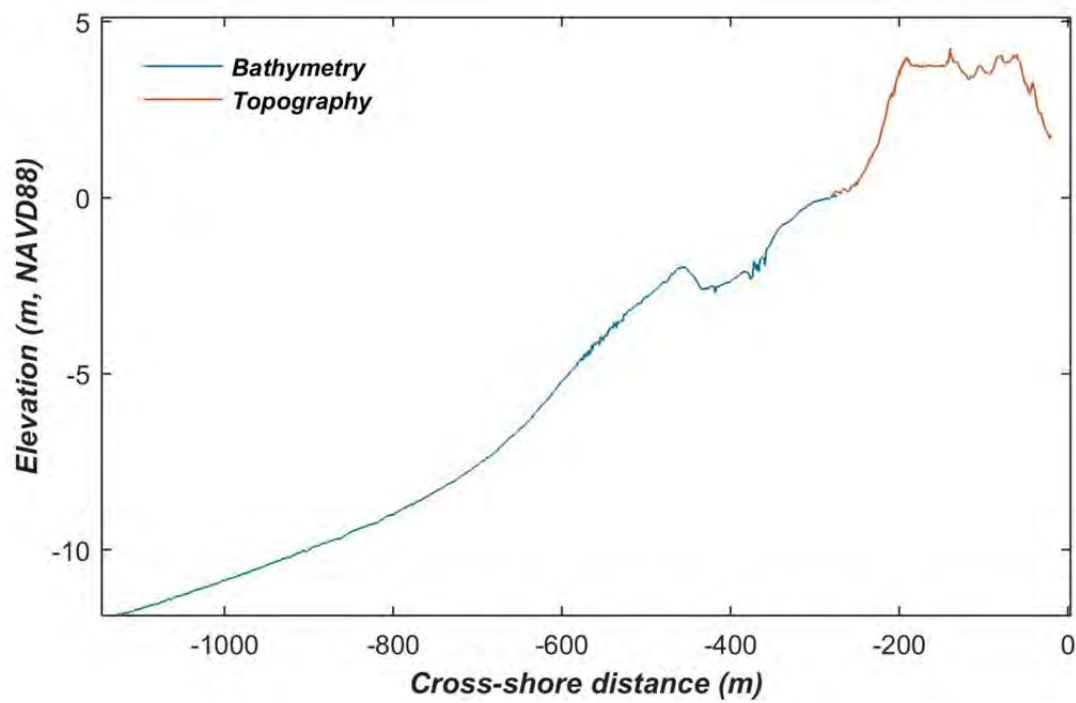


Figure 3. Example profile collected near the mouth of the Pajaro River in March 2015 showing merged nearshore bathymetry collected with a personal watercraft (blue) and topographic data collected on foot (red).

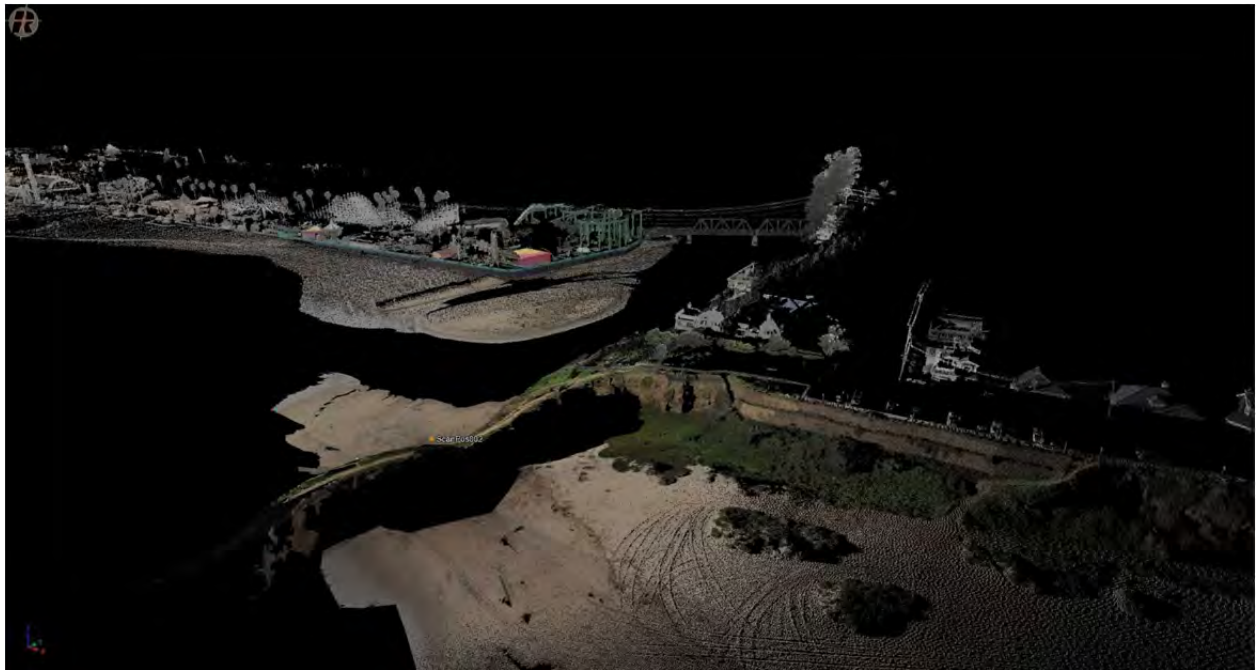


Figure 4. Example of data from ground-based Lidar showing perspective view of portions of Main and Seabright Beaches in Santa Cruz.

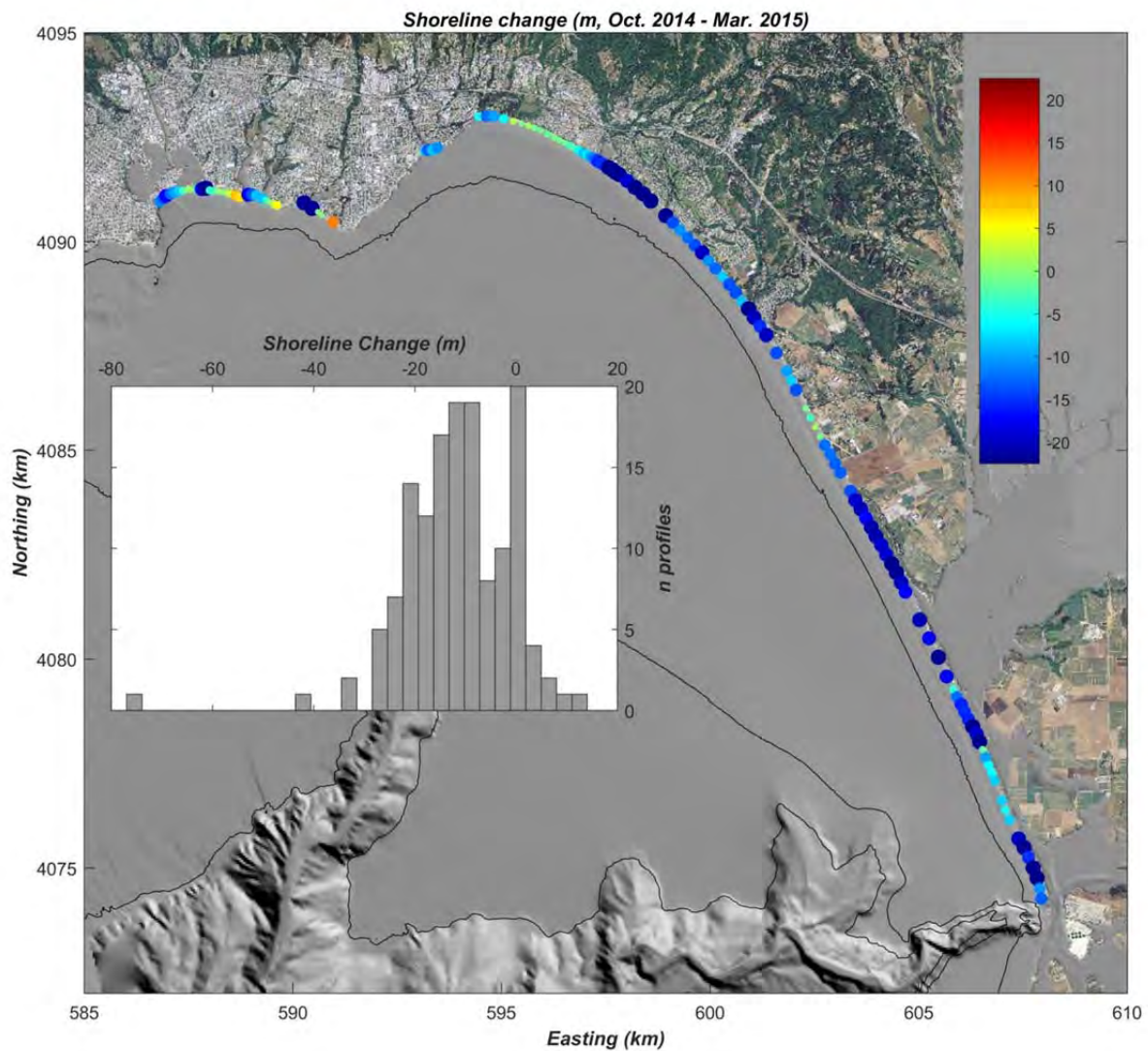


Figure 5. Map showing changes in the position of the MHW shoreline between October 2014 and March 2015. Blue indicates landward migration (erosion) and red indicates seaward migration (accretion) of the shoreline along each profile. The inset provides a histogram of all measurements of shoreline change throughout the study area.

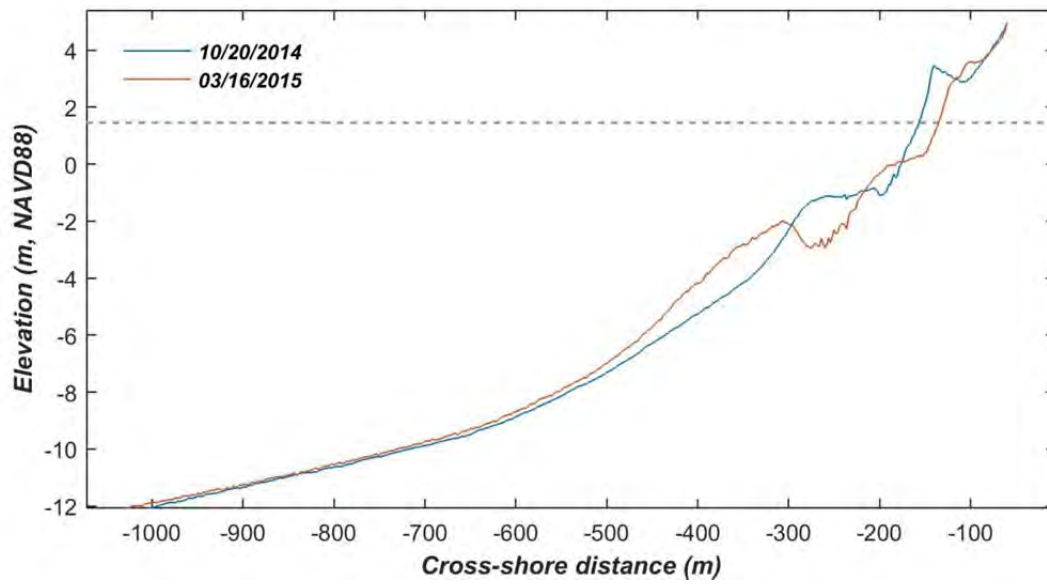


Figure 6. Example profile (line 146, along Sunset State Beach) showing typical changes in the beach profile between summer and winter. During winter, sediment is eroded from the beach and stored in a subtidal bar. Dotted line indicates the elevation of the MHW shoreline.

Appendix A. Maps of data coverage for the survey performed between October 20 and 24, 2014.

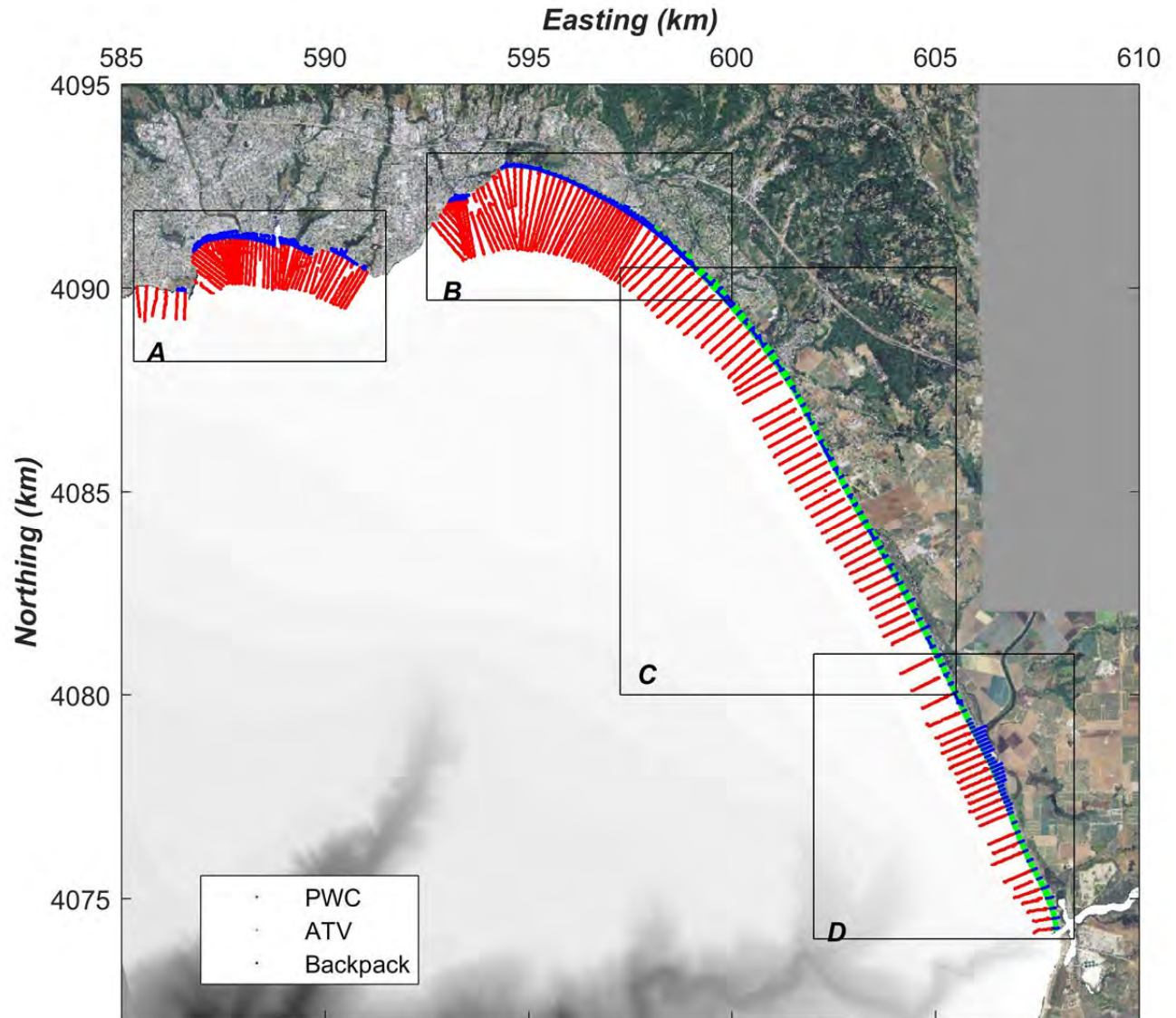


Figure A1. Map showing bathymetric (PWC) and topographic (ATV, Backpack) data coverage for the October 20-24, 2014 survey. Detail areas A-D are shown separately. Map projection is UTM, Zone 10 North, km.

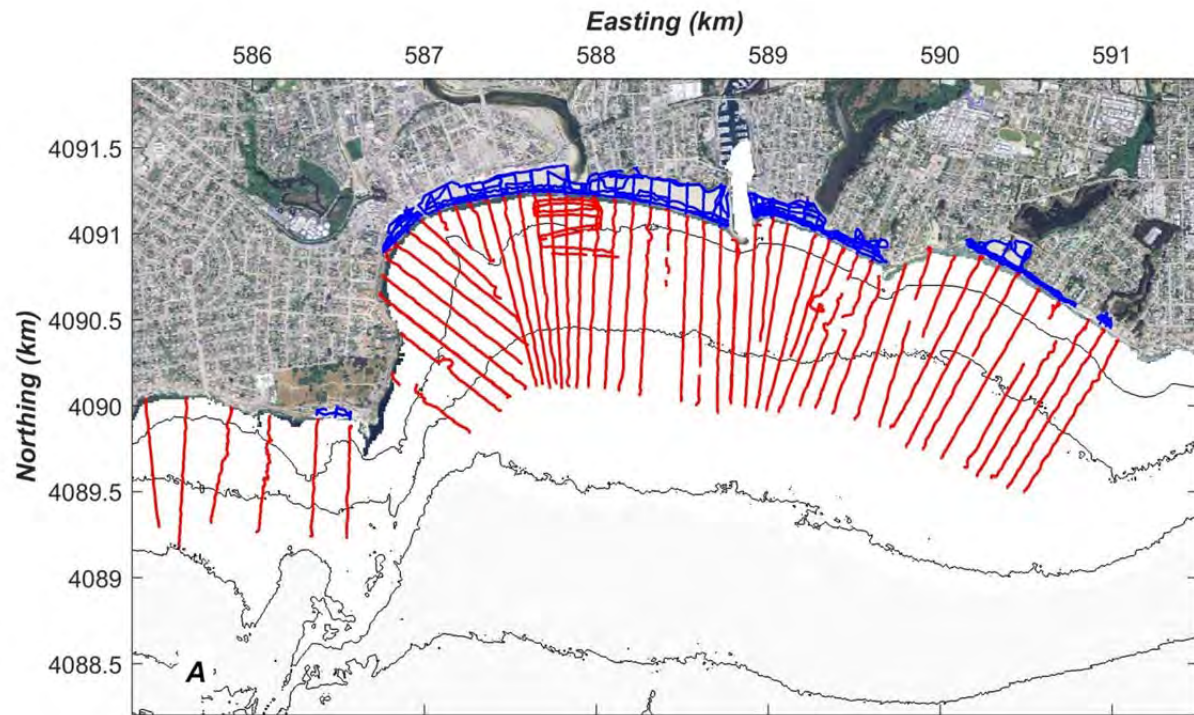


Figure A1 (continued). Detail area A.

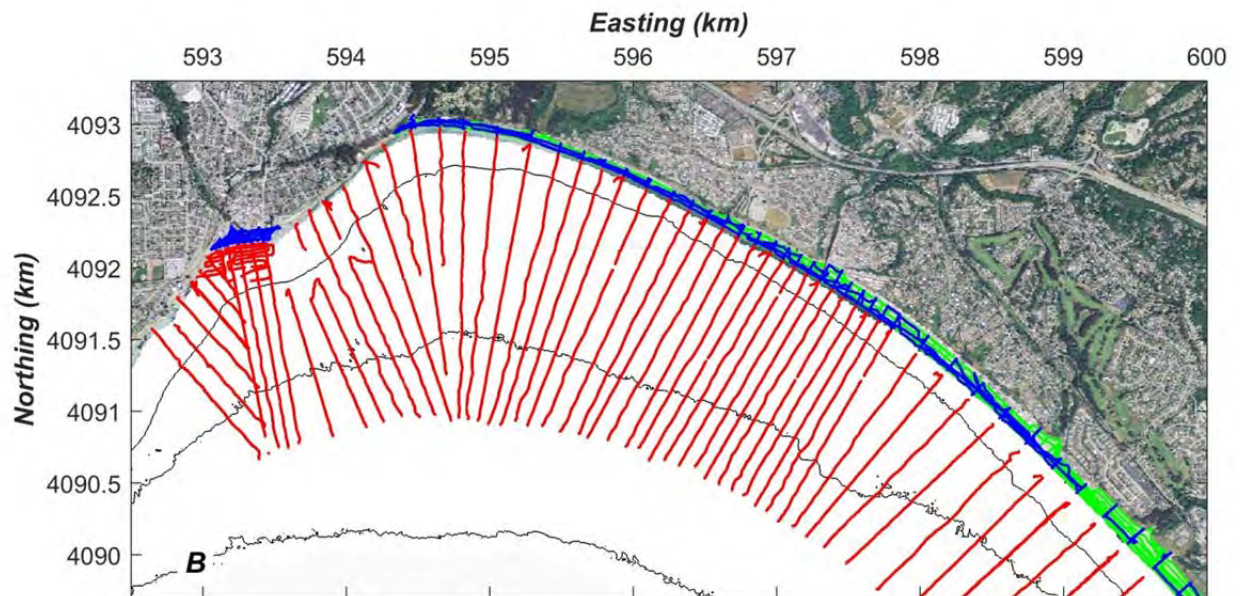


Figure A1 (continued). Detail area B.

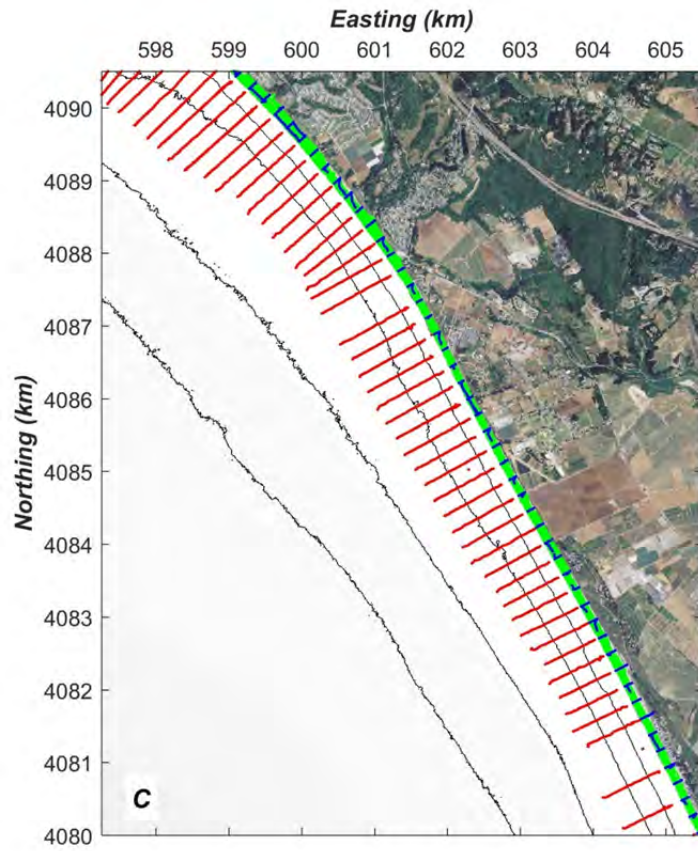


Figure A1 (continued). Detail Area C.

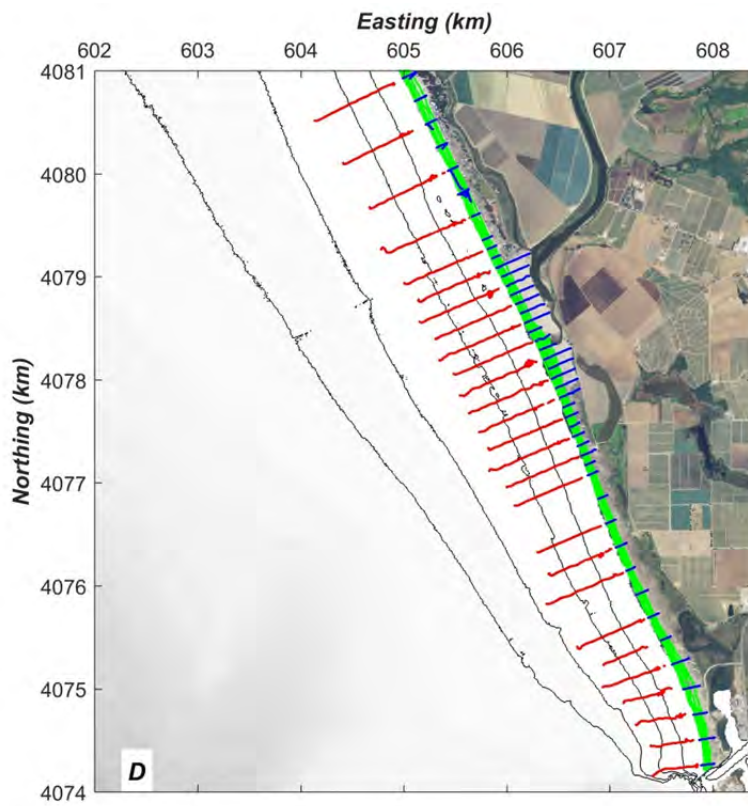


Figure A1 (continued). Detail Area D.

Appendix B. Maps of data coverage for the survey performed on December 10, 2014.

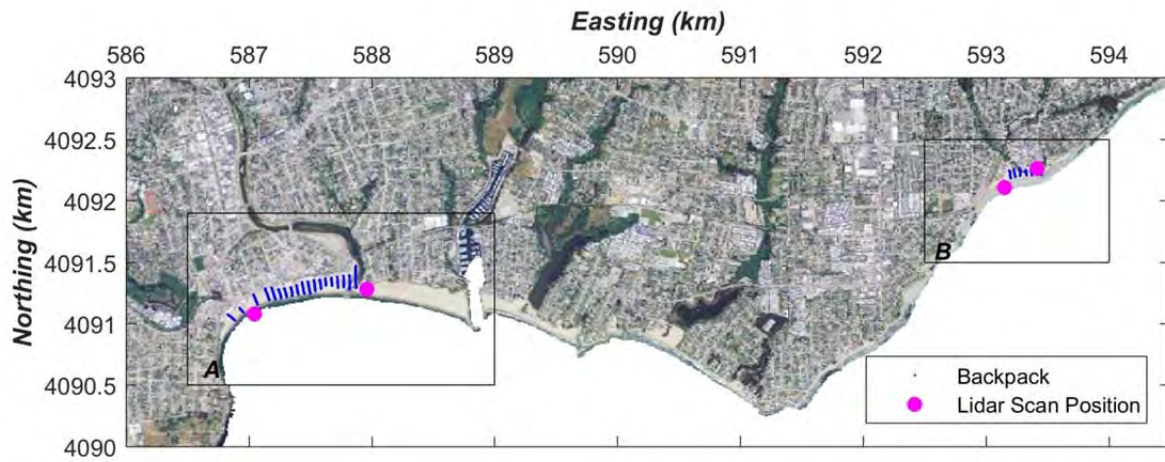


Figure B1. Map showing topographic (Backpack, Lidar) data coverage for the December 10, 2014 survey. Detail areas A-B are shown separately. Map projection is UTM, Zone 10 North, km.

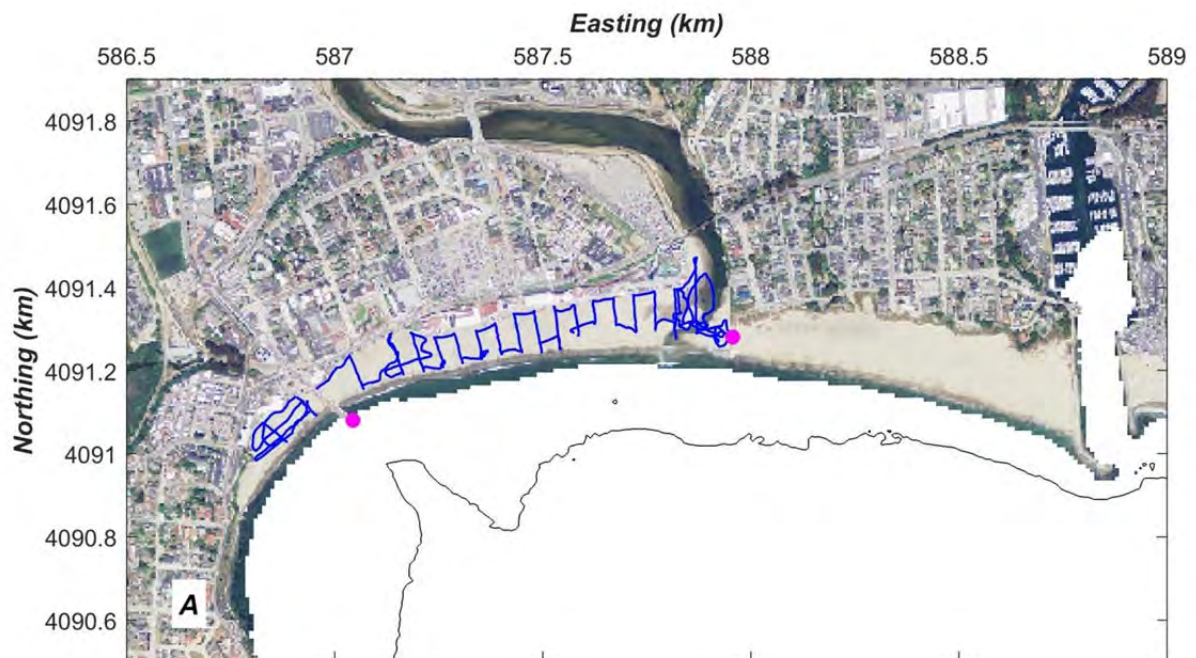


Figure B1 (continued). Detail area A.

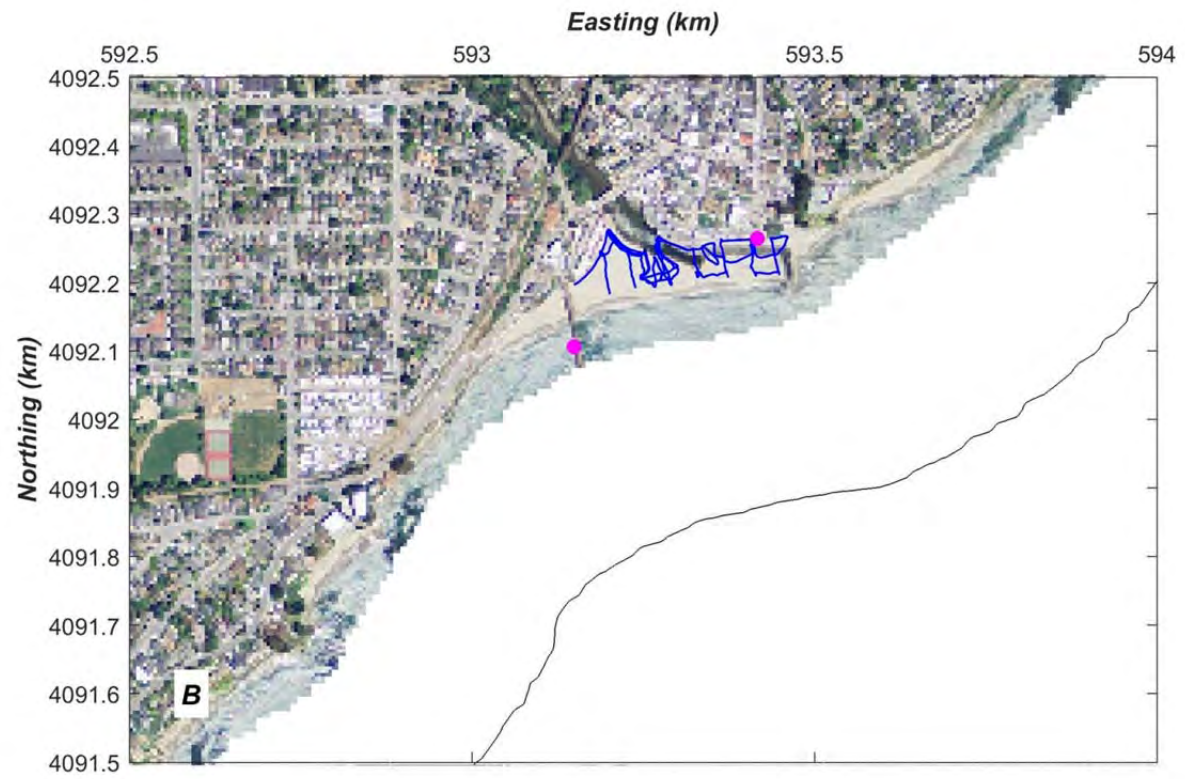


Figure B1 (continued). Detail area B.

Appendix C. Maps of data coverage for the survey performed on December 18, 2014.

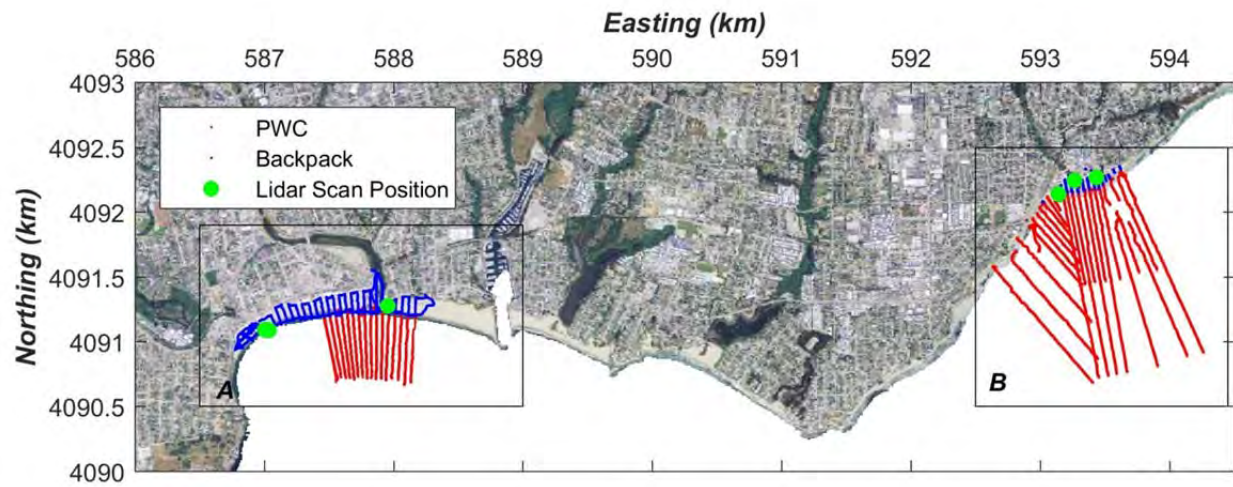


Figure C1. Map showing topographic (Backpack, Lidar) and bathymetric (PWC) data coverage for the December 18, 2014 survey. Detail areas A-B are shown separately. Map projection is UTM, Zone 10 North, km.

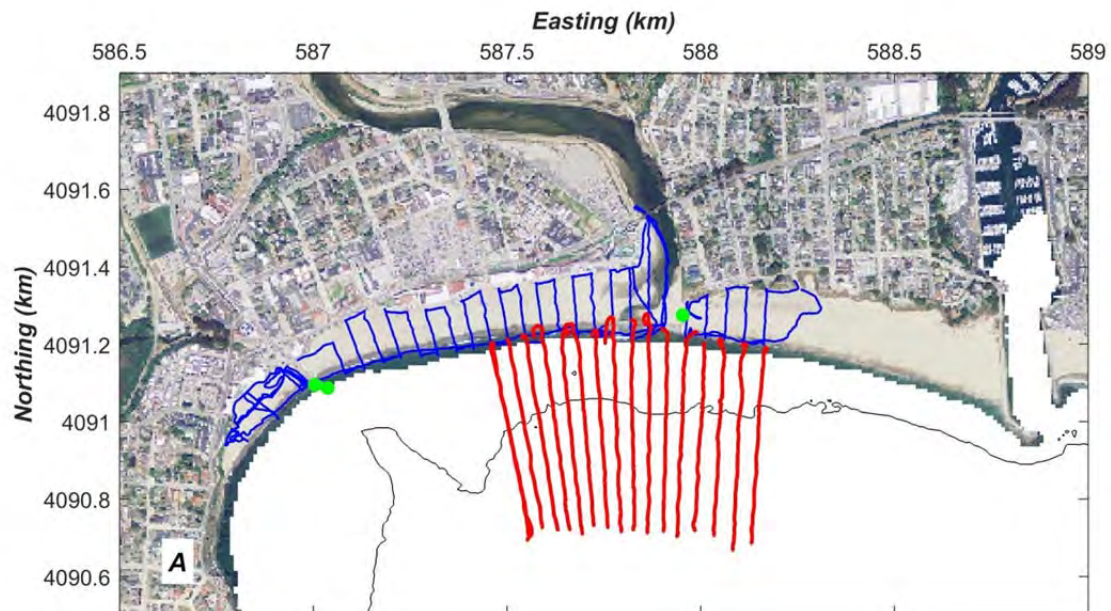


Figure C1 (continued). Detail area A.

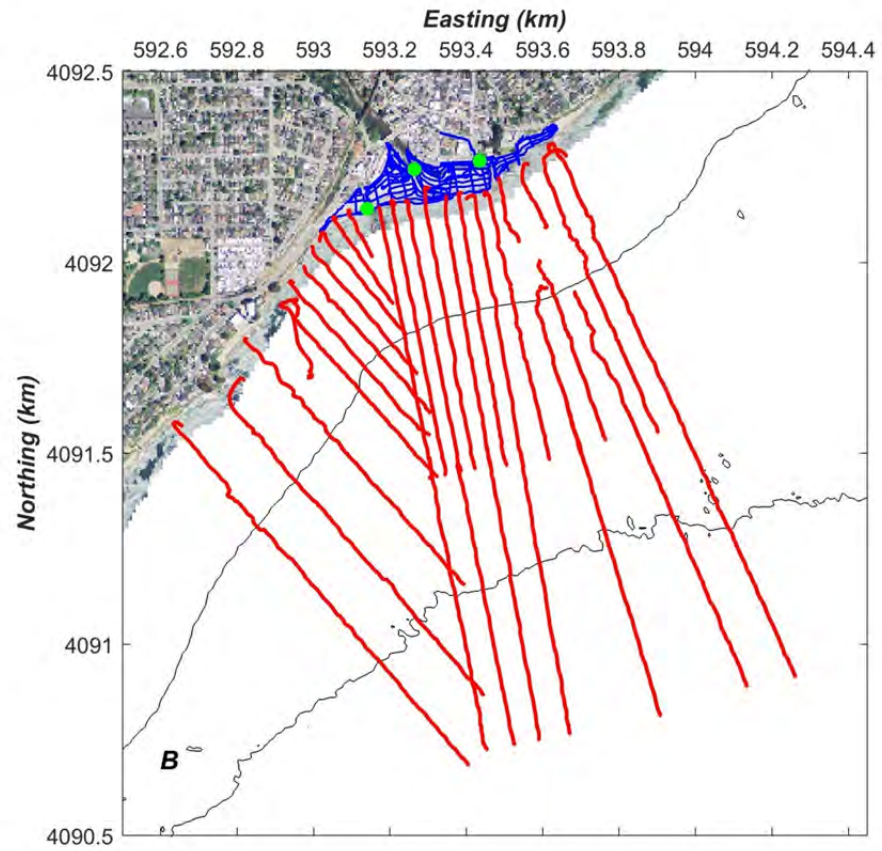


Figure C1 (continued). Detail area B.

Appendix D. Maps of data coverage for the survey performed between March 16 – 20, 2015.

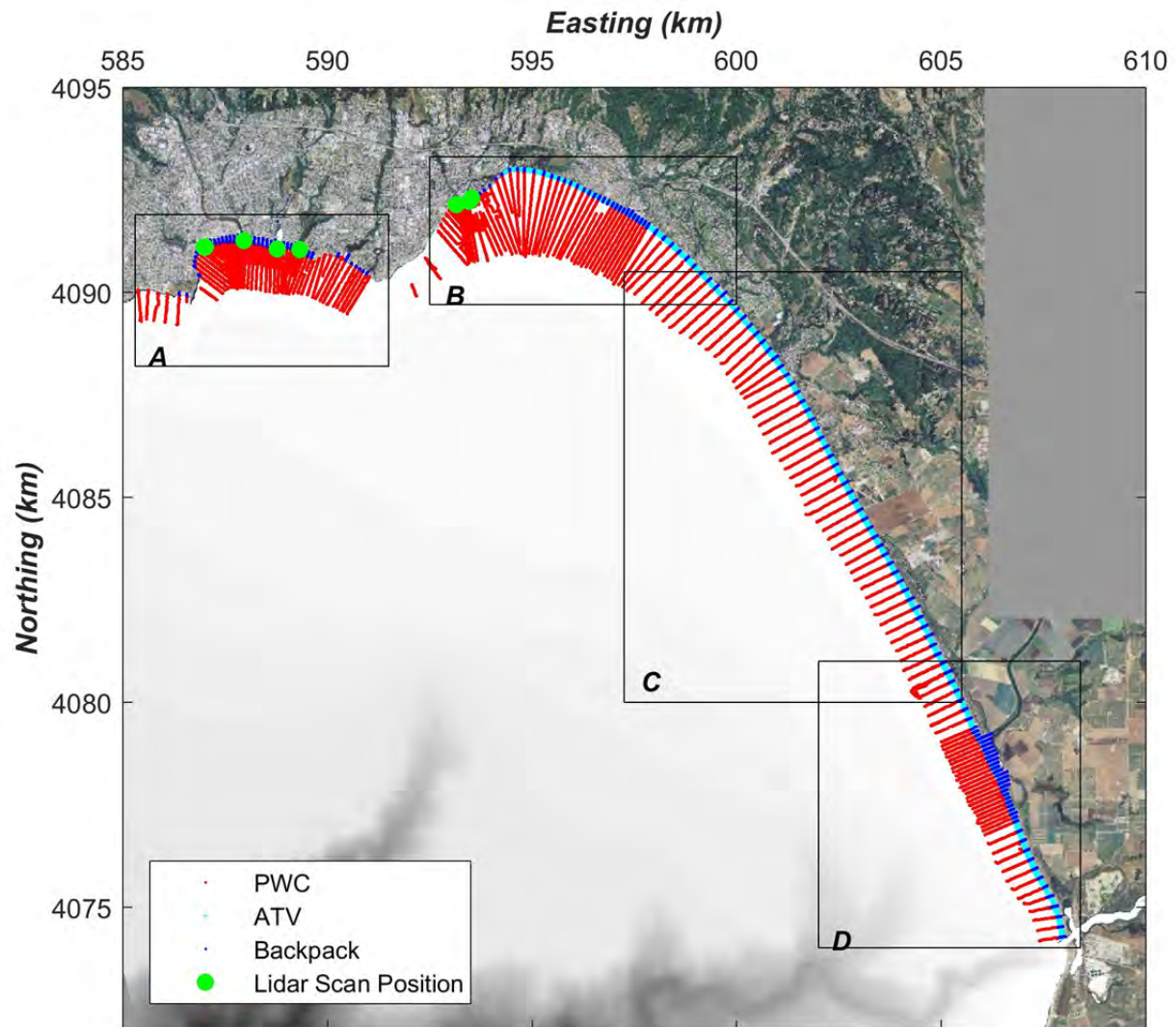


Figure D1. Map showing bathymetric (PWC) and topographic (ATV, Backpack, Lidar) data coverage for the March 16-20, 2015 survey. Detail areas A-D are shown separately. Map projection is UTM, Zone 10 North, km.

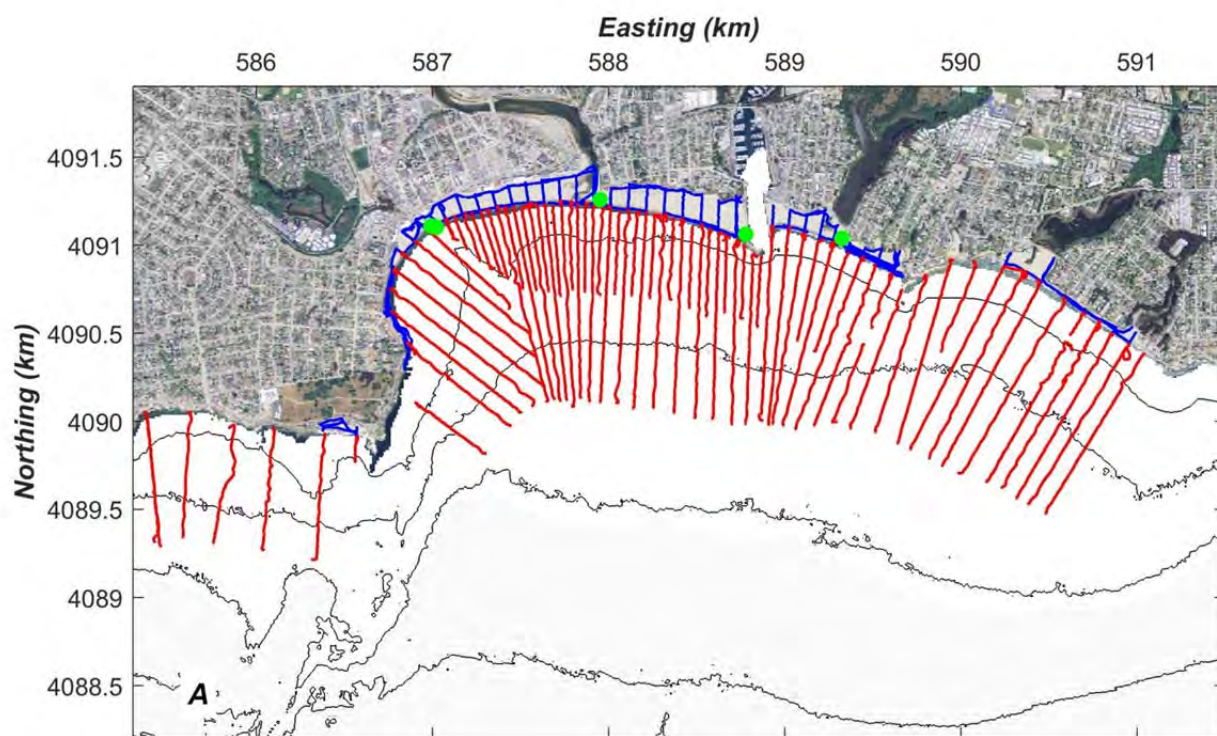


Figure D1 (continued). Detail area A.

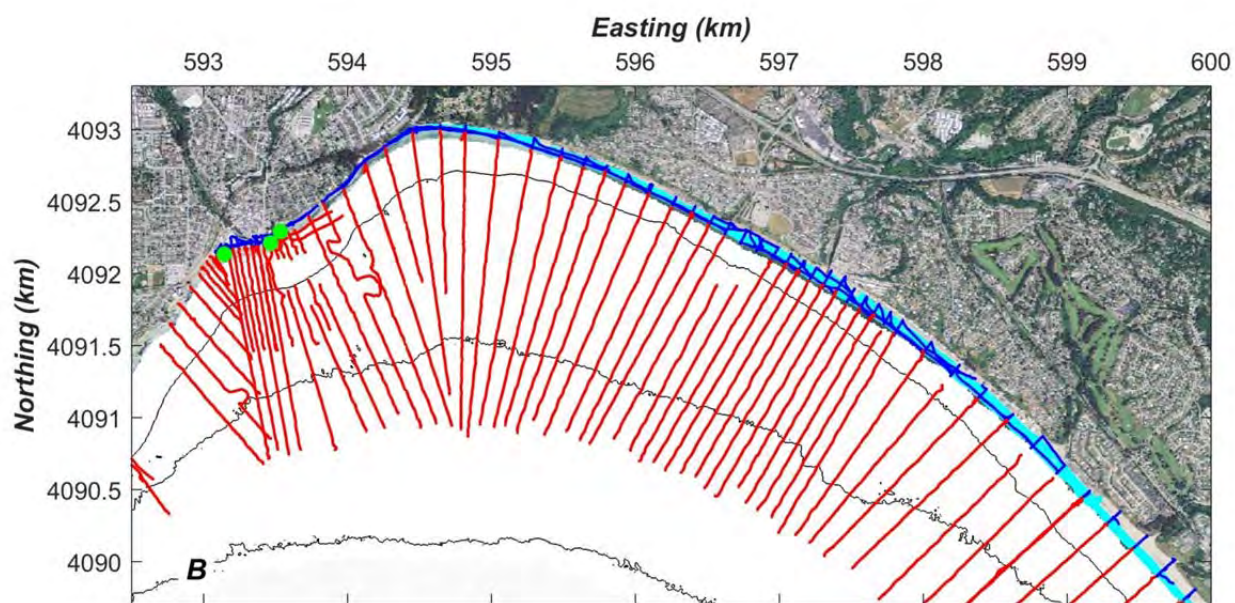


Figure D1 (continued). Detail area B.

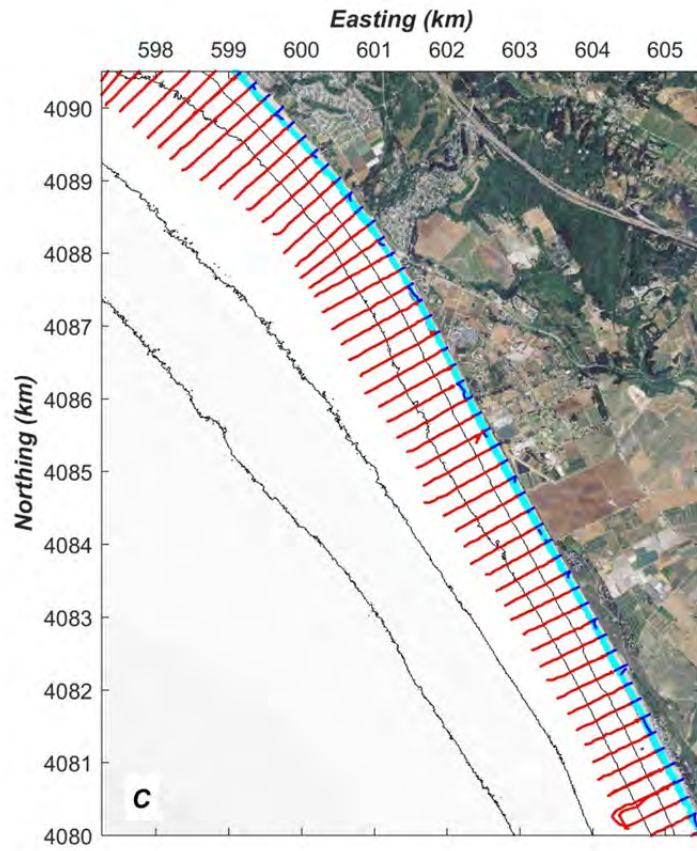


Figure D1 (continued). Detail Area C.

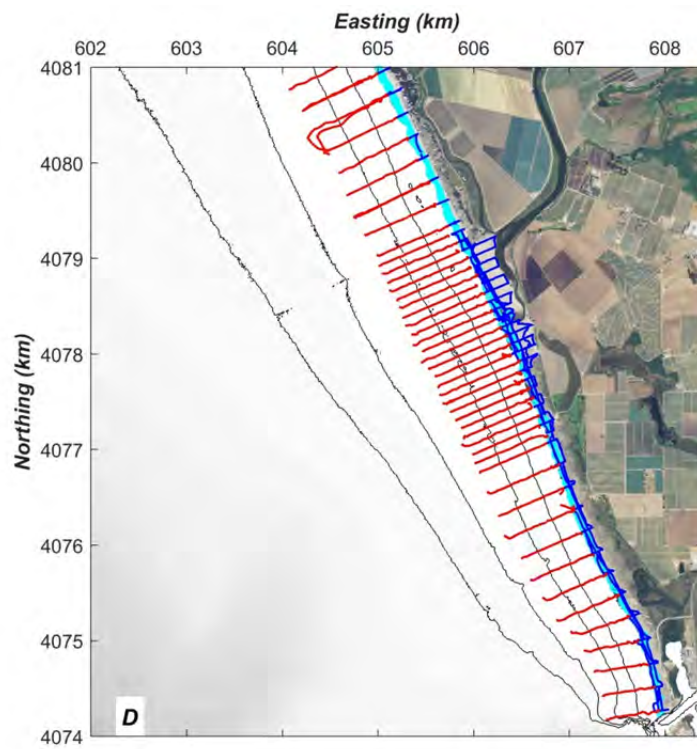


Figure D1 (continued). Detail Area D.