Section 3: Long-Term Oceanographic Observations in Massachusetts Bay: Field Program

By Bradford Butman, Michael H. Bothner, Marinna A. Martini, Jonathan Borden, Richard R. Rendigs, and Dann S. Blackwood

Long-term oceanographic observations have been obtained as part of the USGS program to understand the transport and fate of sediments and associated contaminants in Massachusetts and Cape Cod Bay. These observations help to identify the processes causing sediment resuspension and transport and provide data for developing and testing numerical models (see Section 6). The long-term observations document seasonal and interannual changes in currents, hydrography, and suspended-matter concentration, and infrequent catastrophic events, such as major storms. These long-term oceanographic observations were made in partnership with the MWRA and with logistical support from the U.S. Coast Guard (USCG).

Long-term oceanographic observations were made at two locations in western Massachusetts Bay: LT-A (33-m water depth) from December 1989 through January 2006, and LT-B (21-m water depth) from October 1997 through February 2004 (fig. 3.1) (Butman and others, 2004a). LT-A is approximately 1 km south of the new ocean outfall that began discharging treated sewage effluent from the Boston metropolitan area into Massachusetts Bay in September 2000. This station was established to characterize oceanographic conditions in the immediate vicinity of the ocean outfall. LT-B is about 27 km southeast of the outfall at a water depth of 21 m and approximately 5 km from the coast. This station was established to characterize conditions at a location downstream of the new outfall and where the along-coast flow was anticipated to be well developed and diagnostic of the larger bay-wide circulation. Meteorological observations (wind, temperature, salinity, and waves) were obtained from a National Data Buoy Center discus buoy (Station 44013) located to the east of LT-A (fig. 3.1).

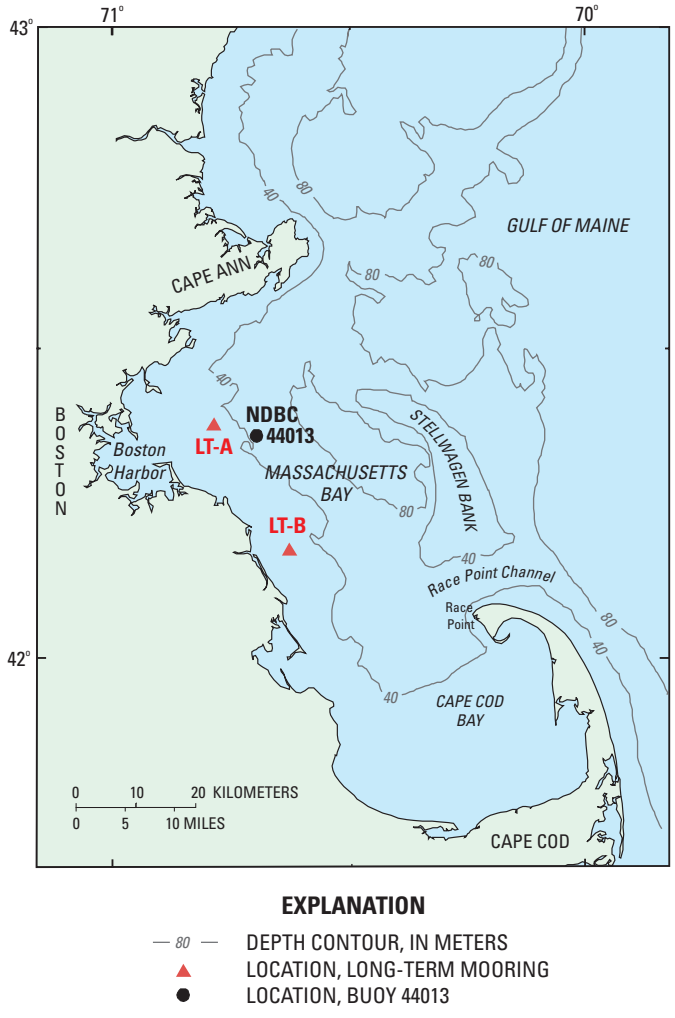

Figure 3.1. The location of long-term oceanographic moorings LT-A and LT-B in western Massachusetts Bay. The LT-A mooring is about 1 km south of the new ocean outfall in a water depth of about 33 m. The mooring at LT-B is in a water depth of about 21 m. NDBC 44013 marks the location of the National Data Buoy Center (NDBC) discus buoy where meteorological observations are made. Prior to November 1993, the meteorological observations were made from a U.S. Coast Guard Large Navigation Buoy maintained near LT-A. Contour lines show water depth in meters.

Prior to November 1993, these meteorological measurements were made from a U.S. Coast Guard Boston Large Navigation Buoy maintained near LT-A.

Instruments at LT-A and LT-B were attached to a tripod frame that rests on the sea floor to obtain measurements near the bottom, or to a subsurface mooring supported by a float to obtain measurements in the water column (figs. 3.2, 3.3A, 3.3B, 3.4, and 3.5). The time-series measurements at LT-A included currents 1 meter above bottom (mab), currents throughout the water column, temperature, pressure, light transmission, and conductivity. Time-series photographs of the sea floor were also obtained at LT-A. At LT-B, measurements included currents throughout the water column and near-bottom temperature and salinity. At both sites, a time-series sediment trap and tube sediment traps (figs. 3.2, 3.3, 3.4, and 3.5) were deployed to collect suspended sediments. These samples were analyzed to characterize the amounts and chemical composition of sediments in the water.

The tripod systems and subsurface moorings for the long-term observations were recovered and replaced about every 4 months, typically in February, June, and September. This measurement strategy was necessary to recover data, replace batteries, ensure that instruments were functioning properly, and prevent degradation of data caused by biological fouling of the sensors. To recover a tripod, an acoustic signal released a float that brought a recovery line to the surface. To recover a subsurface mooring, an acoustic signal released the mooring from the anchor allowing it to float to the surface. Once floats were on the surface, the instruments were recovered with the ship's crane and winch (fig. 3.4). Once the instruments were retrieved, the internally recorded data were decoded, calibrated, checked for instrument malfunction, and edited to remove spurious points and create an evenly spaced time series.

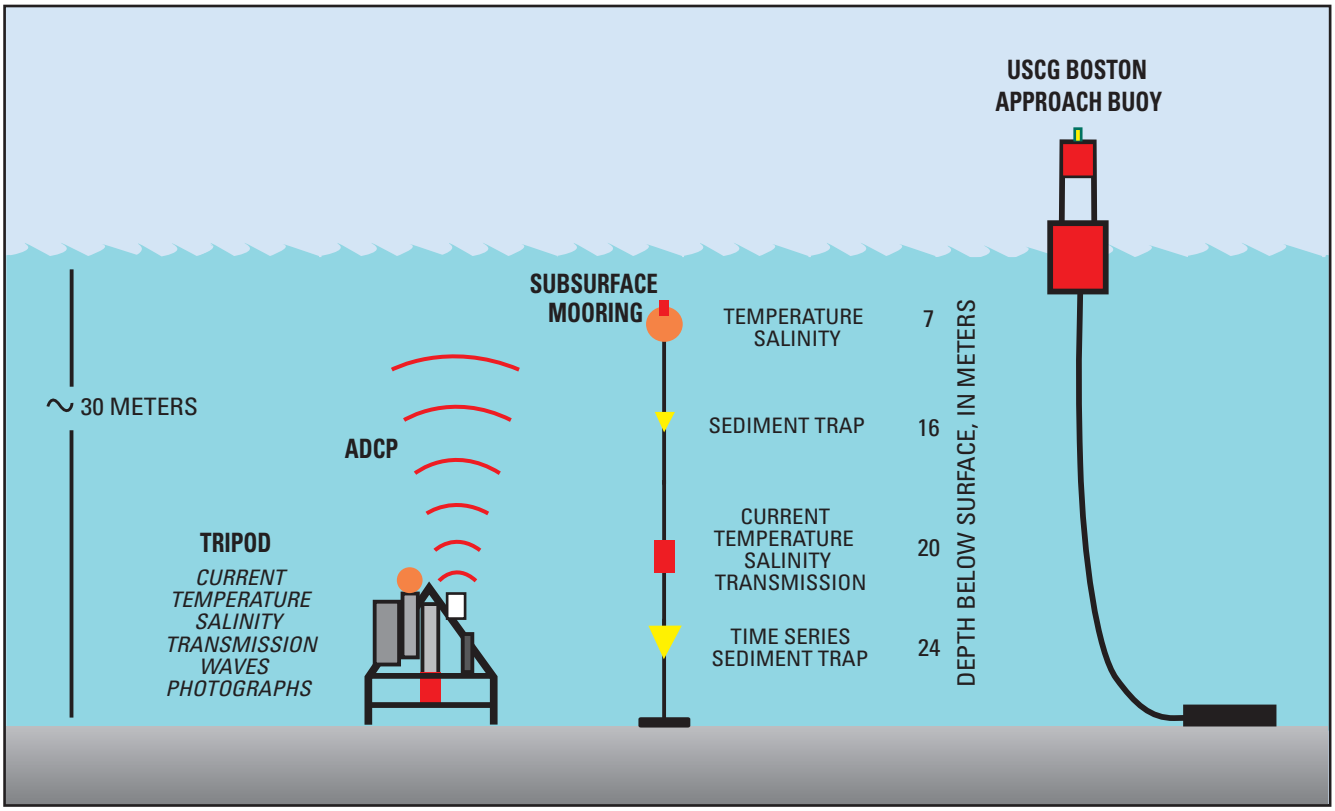

Figure 3.2. Configuration of oceanographic instruments deployed at long-term site LT-A in western Massachusetts Bay from 1996 to 2006. During this period, instruments were deployed on a tripod frame that rests on the sea floor (fig. 3.3A) and on a subsurface mooring (fig. 3.4). The acoustic Doppler current profiler (ADCP), mounted on the bottom tripod, uses sound to obtain a profile of current throughout the water column in 2-m intervals (fig. 3.3B). Slightly different instrument configurations were deployed prior to 1996. U.S. Coast Guard (USCG).

A

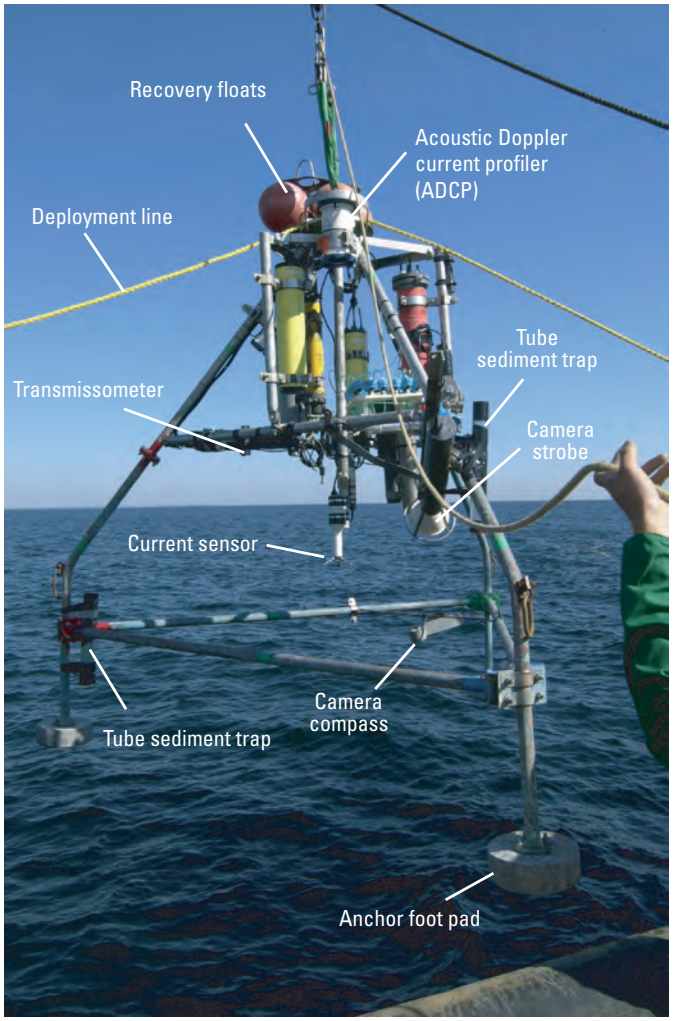

Figure 3.3 *(A).* Tripod system being deployed from the U.S. Coast Guard Cutter *Marcus Hanna* at site LT-A. The tripod frame, made of stainless steel pipe, is about 4.6 m high. The frame and attached instruments are lowered to the sea floor where they collect and record data unattended for about 4 months. For recovery, an acoustic signal releases the floats on the top of the tripod that pull a recovery line to the surface. The current sensors on this tripod include an acoustic Doppler current profiler (ADCP) and an acoustic Doppler velocimeter (ADV).

B

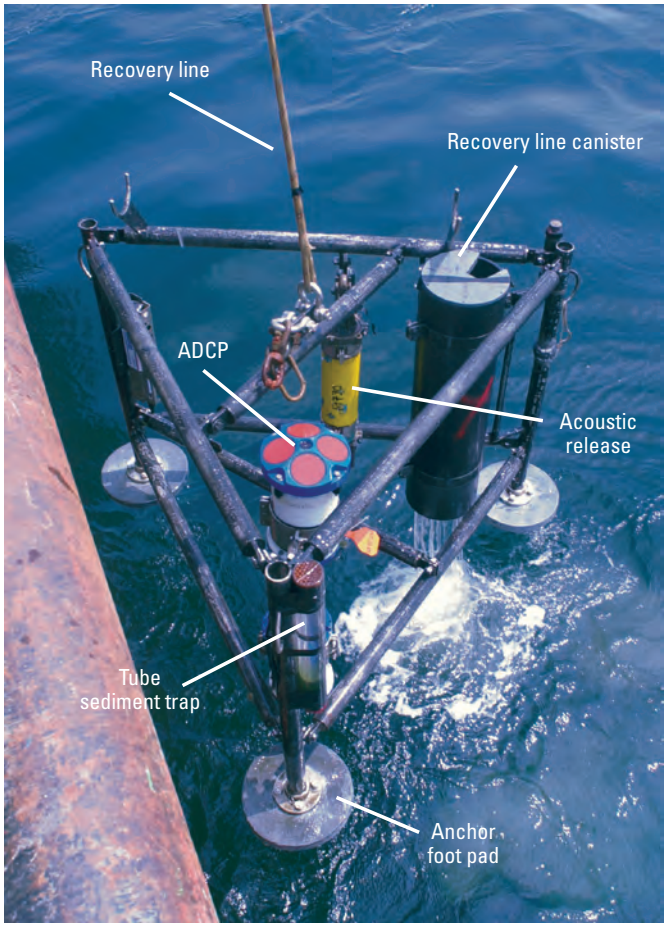

Figure 3.3 *(B).* An acoustic Doppler current profiler (ADCP) mounted in the corner of a small tripod frame, about 1.5 m high, being recovered at site LT-B. The ADCP remotely measures currents throughout the water column using two pairs of upward-looking transducers that transmit pulses of sound that are reflected from particles moving with the currents in the water. The measured speed of the particles moving toward and away from the transducers is used to calculate the current.

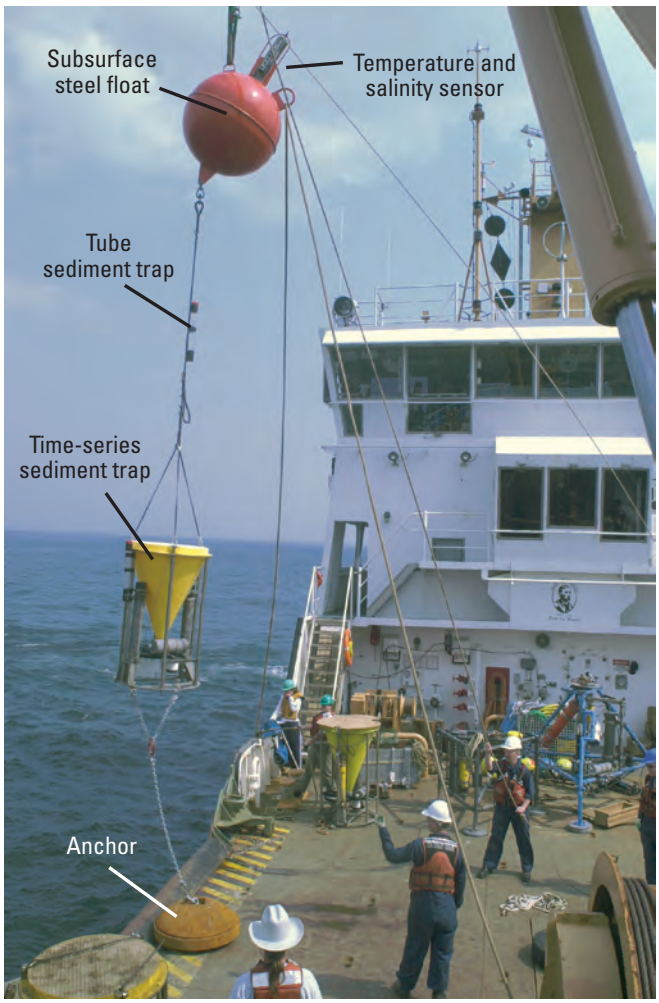

Figure 3.4. A subsurface mooring being deployed from the U.S. Coast Guard Cutter *Marcus Hanna* at site LT-B.

Figure 3.5. A time-series sediment trap. These traps were deployed at long-term sites LT-A and LT-B in western Massachusetts Bay. The yellow funnel (0.8-m diameter) directs suspended material into 1 of 13 plastic jars (500-mL capacity), which are sequentially moved under the funnel for 9-day intervals during a typical 4-month deployment.