A trawl-resistant ocean-bottom seismometer

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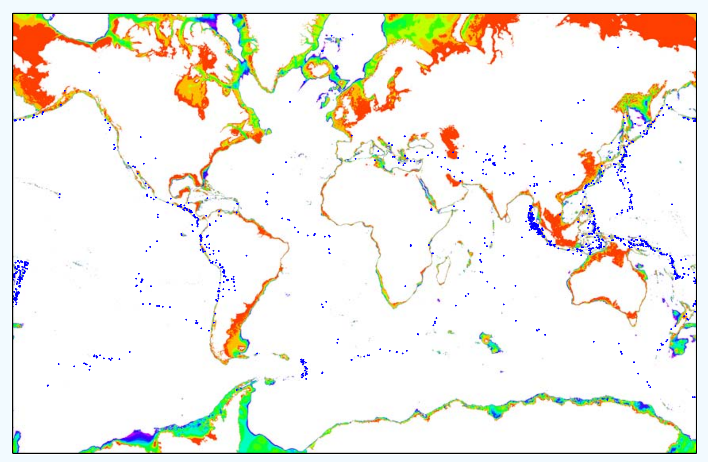
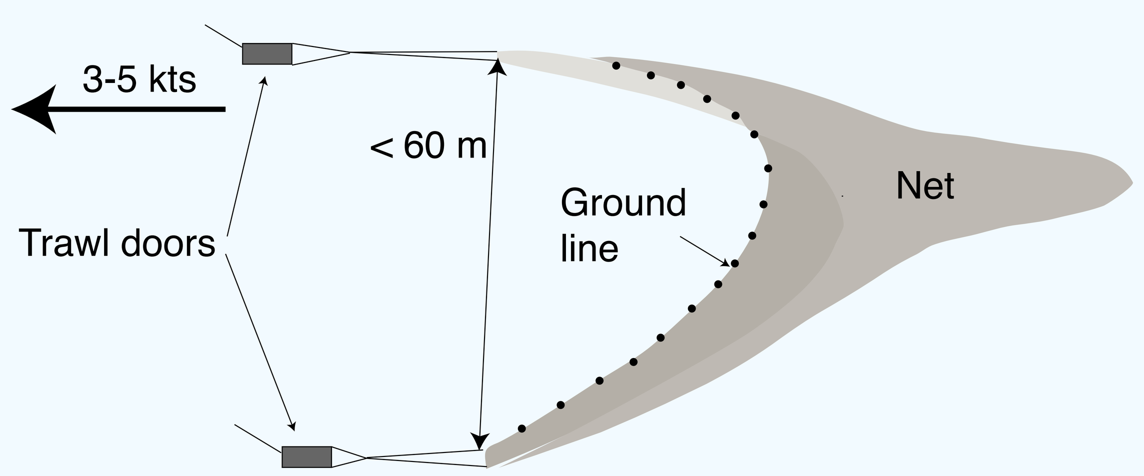
Long-term ocean-bottom seismometer (OBS) deployments are difficult on continental shelves and other shallow regions because of the hazard from bottom trawling. The OBS lab at Lamont-Doherty Earth Observatory (LDEO) has developed a trawl-resistant OBS that is designed to resist and deflect bottom-trawling equipment. Fifteen trawl-resistant OBSs were deployed in July 2011 from the *R/V Wecoma* as part of the Cascadia Initiative.

Bottom trawling and ocean-bottom seismometers

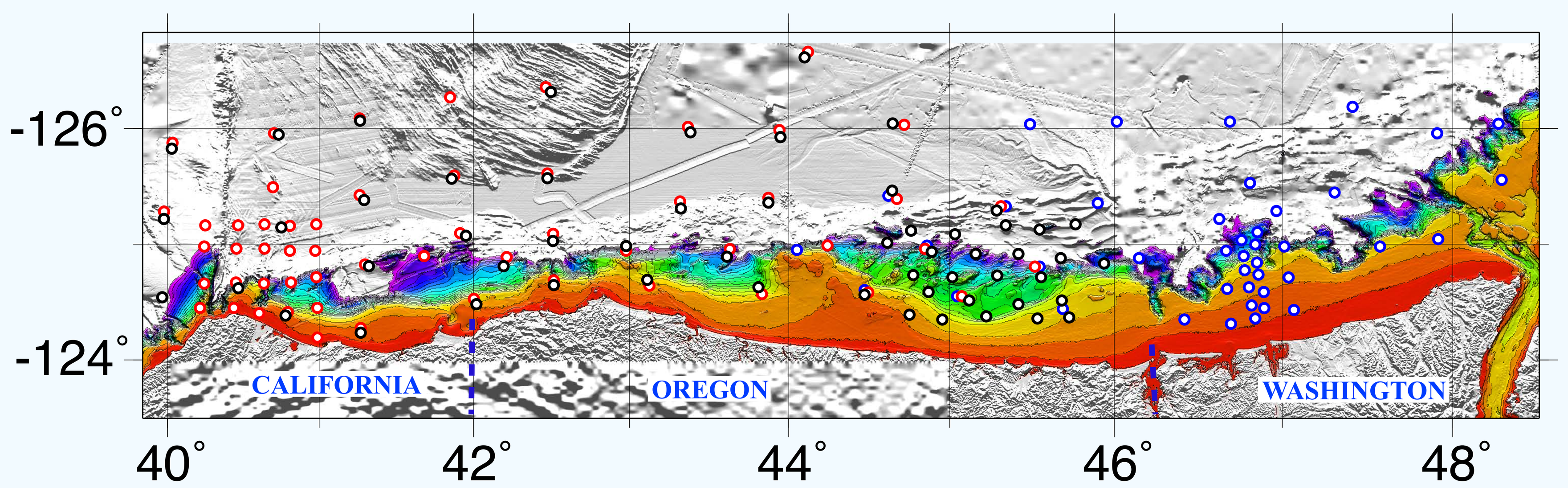
Seafloor instruments can be damaged, destroyed, or prematurely released by a trawl net that is weighted with rollers and dragged across the seafloor. Bottom trawling is extensive in many areas and past instrument losses have led the U. S. OBS Instrument Pool (OBSIP) to avoid long-duration deployments in water depths shallower than 1000 m. This restriction is particularly limiting for passive-source seismic studies at active continental margins. The Figure (right) shows seafloor depths < 1000 m and one year of M > 5 earthquakes (blue circles)





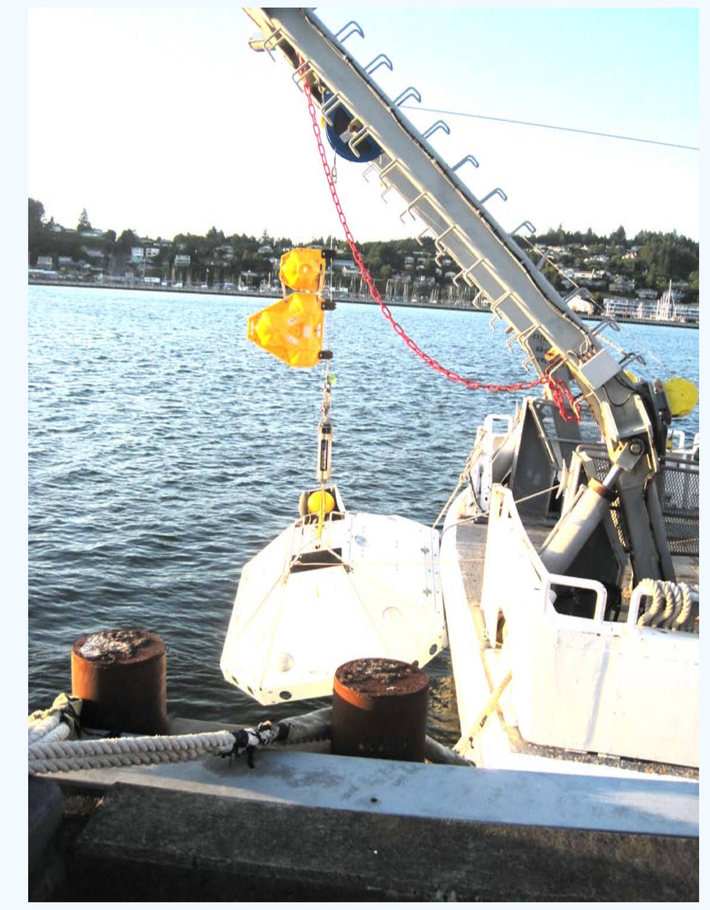
The greatest hazard to OBSs is the ground line of heavy rollers that is designed to disturb fish on the seafloor (top right). Impact from trawl doors (bottom right) is less likely but more damaging.

The Cascadia Initiative



The Cascadia Initiative is a multi-year program to instrument the Cascadia margin from Cape Mendocino to Cape Flattery with land seismometers, GPS sites and a fleet of 60 OBSs. Provisional OBS locations within the area of the Figure are shown as circles. Blue-years 1 and 3; red-year 2; black-year 4. Bottom trawling is extensive along the coast in water depths 0 to 1000 m (shaded bathymetry in Figure, with color change every 50 m). Fifteen LDEO trawl-resistant OBSs were deployed at the shallowmost Cascadia sites in , 2011.

The LDEO trawl-resistant OBS



Shield: Eight-sided; 1/4" steel plate. Heavy (~700 kg in air) and with low, smooth profile to deflect trawling gear. No anchor left on seafloor.

Seismometer: Trillium Compact sensor in 360° leveling system. Sensor tube decoupled from shield.

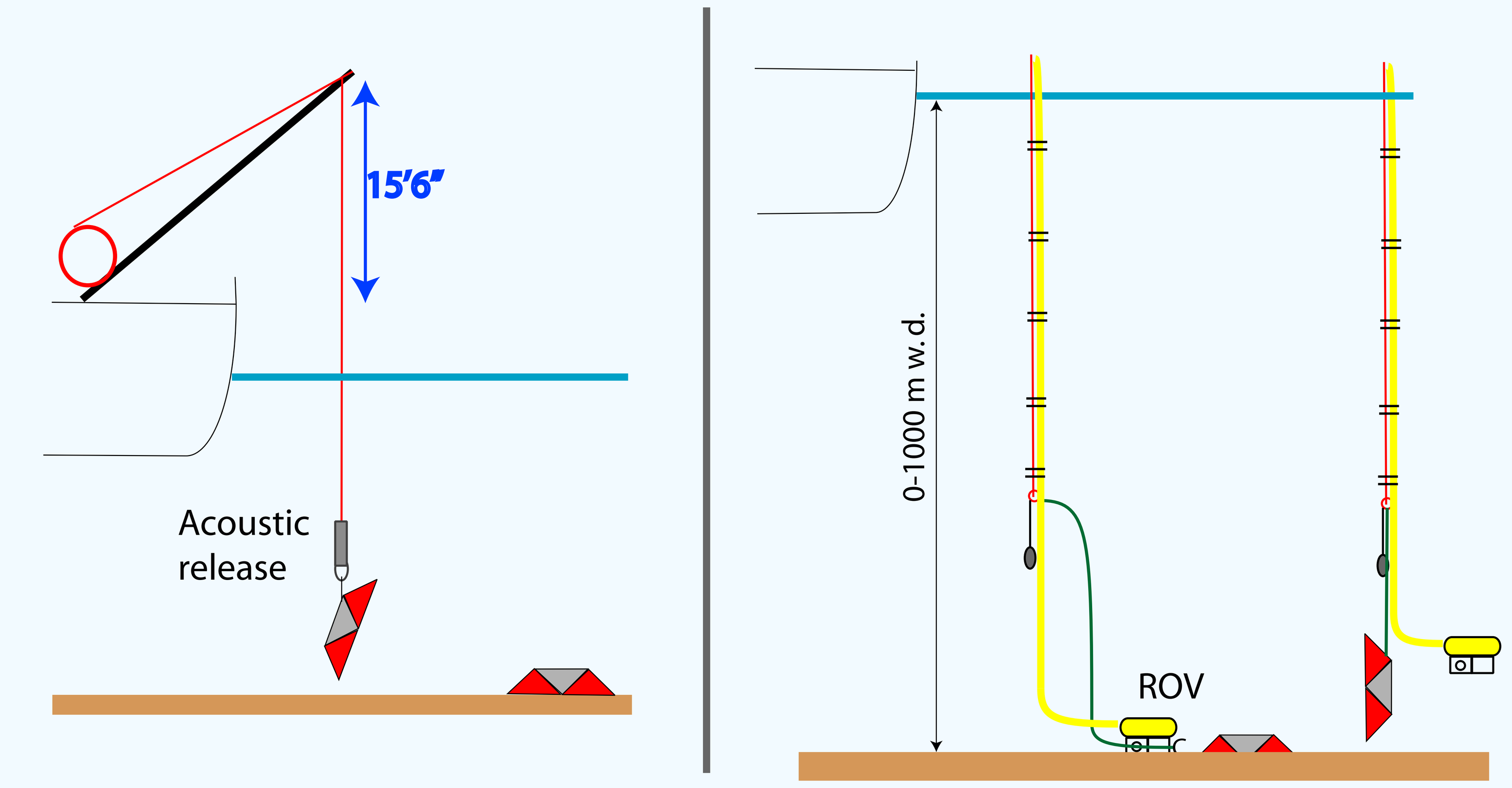
Absolute pressure gauge: 0-10 Hz. Uses new LDEO FPGA datalogger. Clock signal from OBS datalogger.

Hydrophone: 1 Hz-Nyquist.

Datalogger: LDEO low-power OBS datalogger for seismometer and hydrophone. Sampling rate 125 s/s for entire year.

1000 m depth rating. Components rated to > 2000 m.

Deployment and Recovery



The heavy weight and low profile of the instrument preclude the use of dropweights for deployment and recovery. The OBS is instead lowered to the seafloor using a wire and acoustic release. It is recovered by attaching a lifting line using a remotely-operated vehicle (ROV). Instruments in water depths shallower than 170 m are equipped with popup buoy release systems.

Challenges

The LDEO trawl-resistant OBS was developed to allow long-term seismic observations on continental shelves and is a complete departure from previous OBS designs. Deployment and recovery procedures are still being developed and refined: the significant remaining challenges to cheap, safe and flexible operation are outlined below. Solving these issues may also allow the development of instruments that can address other OBS-related problems, such as the long-period noise induced by seafloor currents.

Heave During Deployment

The wire tension during the July 2011 deployments varied from 200 lb to 6000 lb. (One line parted and an instrument was lost as a result of this.)

We need to find a way to deploy the shields (they fall like open umbrellas), possibly by tilting them, possibly using a heave-compensated winch.

ROV Recovery

The 2012 recoveries will use ROPOS or JASON which are both expensive full-ocean depth systems. A smaller, 1000 m system that can complement the LDEO 300 m ROVs would be an ideal solution.

Recovering seafloor packages by ROV is feasible given the proper skills and experience.

Minimizing vessel threshold

Most of the future OBS deployments are expected to be close to shore, and may involve multiple deployment/recovery cruise legs in a single year. The optimum deployment and recovery approaches should minimize the ship size and type and non-standard equipment required.

Popup buoys

Acoustic popup buoy releases were attached to ten of the LDEO OBSs. One open-ocean test was successful; one necessary recovery failed when the line was cut by the edge of the shield. For the 2012 recoveries we need to (1) develop procedures for recovering OBSs with popups and (2) protect the recovery line.