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Delayed recolonization of foraminifera in a suddenly flooded tidal (former freshwater) marsh in Oregon (USA): Implications for relative sea-level reconstructions

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Stratigraphic sequences beneath salt marshes along the U.S. Pacific Northwest coast preserve 7000 years of plate-boundary earthquakes at the Cascadia subduction zone. The sequences record rapid rises in relative sea level during regional coseismic subsidence caused by great earthquakes and gradual falls in relative sea level during interseismic uplift between earthquakes. These relative sea-level changes are commonly quantified using foraminiferal transfer functions with the assumption that foraminifera rapidly recolonize salt marshes and adjacent tidal flats following coseismic subsidence. The restoration of tidal inundation in the Ni-les'tun unit (NM unit) of the Bandon Marsh National Wildlife Refuge (Oregon), following extensive dike removal in August 2011, allowed us to directly observe changes in foraminiferal assemblages that occur during rapid "coseismic" (simulated by dike removal with sudden tidal flooding) and "interseismic" (stabilization of the marsh following flooding) relative sea-level changes analogous to those of past earthquake cycles.

We analyzed surface sediment samples from 10 tidal stations at the restoration site (NM unit) from mudflat to high marsh, and 10 unflooded stations in the Bandon Marsh control site. Samples were collected shortly before and at 1- to 6-month intervals for 3 years after tidal restoration of the NM unit. Although tide gauge and grain-size data show rapid restoration of tides during approximately the first 3 months after dike removal, recolonization of the NM unit by foraminifera was delayed at least 10 months. Re-establishment of typical tidal foraminiferal assemblages, as observed at the control site, required 31 months after tidal restoration, with Miliammina fusca being the dominant pioneering species. If typical of past recolonizations, this delayed foraminiferal recolonization affects the accuracy of coseismic subsidence estimates during past earthquakes because significant postseismic uplift may shortly follow coseismic subsidence at subduction zones. Depending on the location and dimensions of past plate-boundary earthquake ruptures, delayed recolonization of foraminifera may result in an underestimation of coseismic subsidence for past earthquakes at Cascadia.