Big Lagoon Bog

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The Big Lagoon Bog is an inconspicuous 1.3 ha peatland in coastal northwestern California (Figs. 1&2). A reason the bog is of interest to me is that it contains both *Sphagnum* and *Drosera rotundifolia*—neither are rare by any stretch of the imagination. What makes this location special is that the bog is isolated with the nearest *Drosera rotundifolia* neighbors about 80 km north and 200 km south. Peat bogs are rare at low elevations along the coast in California. In contrast, the *Darlingtonia* bogs in the Klamath region are perennial wet, nutrient poor, ultramafic outcrops with little or no *Sphagnum*.

The Big Lagoon Bog lies 3 m above sea level and is within 300 m of the Pacific Ocean coastline. The bog drains into Big Lagoon, a 590-ha brackish embayment separated from the ocean by a narrow 6 km long sand bar. Winter rainfall raises the water level in the lagoon several meters above sea level where hydrostatic pressure and high surf breaches the sand bar allowing the lagoon to drain into the ocean and then receive tidal inflow until wave action reforms the bar.

Big Lagoon Bog is one of the few peatlands in California that have received floristic study (Leppig 2002; Smith 2014). Leppig (2002) found a total of 77 vascular taxa at the bog of which 5 taxa were rare (*Carex huxbaumii*, *C. viridula*, *Lathyrus palustris*, *Lycopodiella inundata*, and *Lycopus uniflora*) and 13 alien taxa. The high proportion of alien taxa is due to the area having been logged and grazed, with adjacent homes, a county park, and a nearby campground.

The area was originally occupied by the Yurok people, but when European settlers arrived in the 1870s, the forests were logged and the land converted to farming and grazing. In the late 1920s

Figure 1: An overview of the Big Lagoon area and the Big Lagoon Bog (inset right). Image from Google Earth.

Figure 2: Big Lagoon Bog overview (left) and close-up (right).

vacation cabins were built immediately west of the bog. The surrounding forest now consists of 90-year-old even-aged Sitka spruce (*Picea sitchensis*). In 1973, the bog became part of the Big Lagoon County Park when the land was purchased by Humboldt County. The Big Lagoon Elementary School is 300 m upstream of the bog and the small community of Big Lagoon (population 78) is located to the immediate southwest.

The climate is cool Mediterranean with a narrow temperature range. In July, the average high temperature is 18°C and the low is 11°C, and in January the average high is 13°C and the low 5°C. Freezing temperatures are uncommon. Average annual precipitation is 172 cm, 90% of which falls between October and April. Fog is prevalent. In 1939, the U.S. Navy established an airport 20 km south of the bog, only to discover it to be located in the third foggiest weather in the world (Shettle 1997). This foggy area is the result of an east-west offshore submerged ridge that causes upwelling of the cold Alaskan current. The contact between the cold ocean water and relatively warmer air produces fog. The old Navy airport is now Humboldt County's commercial airport where weather delays are not unusual.

The offshore submerged ridge is at the Mendocino Triple Junction, the point where the Gorda plate, the North American plate, and the Pacific plate meet, linking convergence of the northern Cascadia subduction zone and the southern San Andreas Fault system, making this one of the most seismically active areas in the world. The Cascadia subduction zone is a 1000 km undersea fault that runs from British Columbia down through Washington and Oregon and terminating at the Triple Junction 30 km off the northern California coast.

The oral history of tribes living along the Pacific Northwest coast consistently contain stories and myths of great tsunamis covering the land – including Big Lagoon. For example, a myth recorded over a century ago by ethnographer A.L. Kroeber, Ann of Espell of the Yurok tribe recounted: "Thunder wants people to eat. He thinks they will if prairies are made into ocean. He asks Earthquake for help. Earthquake runs about, land sinks, and prairies become ocean teaming with salmon, seals, and whales" (Kroeber 1976; Carver 1998). Until the early 1980s, the Cascadia region was thought to be incapable of producing earthquakes greater than magnitude 7.5 and that any tsunami striking the coast would have originated from afar (Atwater *et al*. 2005).

There is no written record by people living along the Pacific coast before about 1800. However, Japanese researchers found several tsunami records in Japan from AD 1700 with no indication of a local cause (Satake *et al*. 1996; Atwater *et al*. 2005). Based on calculated travel time of the tsunami from North America to Japan, the last major Cascadia subduction earthquake was determined to have occurred at 9 p.m. local time on 26 January 1700. From the tsunami heights, the earthquake

is estimated to have been magnitude 9, one of the world's largest, and ruptured the entire 1000 km length of the Cascadia subduction zone. The resulting tsunami is estimated to have been 15-20 m high near Big Lagoon (Rice 2016). Research has now estimated that the Cascadia fault has produced at least seven magnitude 9 or greater megathrust earthquakes and associated tsunamis in the past 3500 years, a frequency that indicates a return time of 300 to 600 years (Atwater *et al*. 2005).

In 1988, John Parker studied sedimentation in the 81-ha deltaic marsh at the head of the Big Lagoon embayment about 1 km east of the Big Lagoon Bog (Parker 1988). By surveying and measuring sediment from 70 cores, he estimated the minimum age of the marsh to be 315 years based on progradation rates. This estimated age is interesting since it was made before the tsunami of 1700 had been identified.

In 1992, concern over safety of the 55 students at the Big Lagoon Elementary School led Kathleen Fairchild to research the local tsunami risk and to develop an evacuation plan (Fairchild 2012). In 2000, her 13-year-old son undertook a study of the Big Lagoon Bog for the County Science Fair. He took core samples and found a layer of sand. He examined the sand in the core samples under the microscope and found the single-celled marine zooplankton, foraminifera, indicating the likely past occurrence of tsunami activity. His project was recognized with a Special Award at the Humboldt County Science Fair.

The strong sand lens and substrate containing marine foraminifera clearly indicates the Big Lagoon Bog was inundated by the great tsunami of January 1700. It has now been 318 years since that event. The next great Cascadia earthquake has a one-in-ten chance of occurring in the next 50 years, and that it may attain magnitude 9 (Atwater *et al*. 2005). The predicted future earthquake and resulting tsunami will likely again reform the coastal landscape. The subsequent fate of the Big Lagoon Bog is unknown.

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