

The health of maritime forests in three Mid-Atlantic National Seashores

Summary Presentation of Approved Data
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Introduction and Study Design

The Mortality of Maritime Forests

The old-growth maritime forests host unique ecosystems of local species, provide stop-over sites for migrating shore birds, and are important parts of the larger barrier-island natural habitats preserved in National Seashores that occur few other places on the East Coast.

The recent unusual and substantial mortality in the old-growth holly maritime forests on Fire Island and Sandy Hook and the near-complete devastation of the old-growth pine maritime forest on Assateague indicate that global climate change threatens the near-term (10- to 50-year) viability of these ecosystems. The old-growth maritime forest ecosystems in these three barrier-island settings are well-adapted to shallow groundwater, salt-spray events on an annual time scale, and storm-tide inundation events on a decadal time scale. However, long-term changes in shallow groundwater level and salinity and increased height and frequency of storm inundation brought on by sea level rise are suspected primary or secondary causes of recent mortality. Additional data collection, analysis, and modeling are required to verify these hypotheses and provide detailed information to aid in local NPS management of these old-growth forests.

The purpose of this study was to collect, compile and analyze data on groundwater and surface-water levels, land-surface elevation, near-surface salinity, and ecosystem responses to aid in defining the physical mechanisms thought to be associated with the viability of the old-growth ecosystems at Assateague, Fire Island and Sandy Hook (Figure 1).

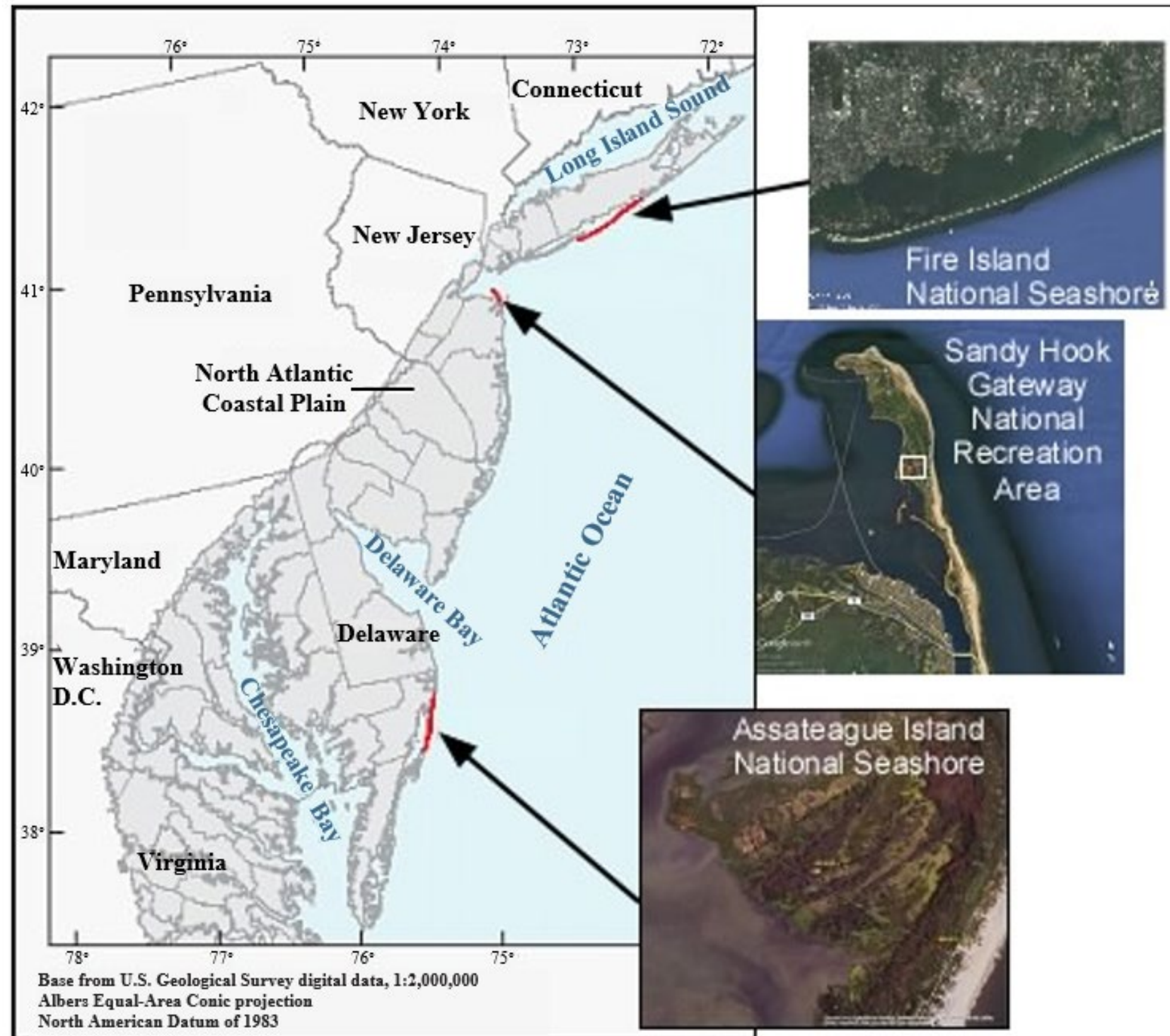


Figure 1: Project study areas on Fire Island National Seashore, NY, Sandy Hook Gateway National Recreation Area, NJ and Assateague Island National Seashore, MD.

Sea Level Rise Mechanisms

Two mechanisms were considered in determining the effects of sea level rise on forest mortality:

1. Thinning of the unsaturated zone causing increased salinity or freshwater drowning of the plant roots.

Thinning of the unsaturated zone can lead to increased salinity and accompanying forest mortality (Saha and others, 2011) and can also cause mortality by freshwater drowning of the roots of plants that require a thicker unsaturated zone (Werner and Simmons, 2009; Terry and Chui, 2012; Holding and Allen, 2014; Masterson and others, 2014). Freshwater wetland herbaceous species (for example, swamp smartweed) are colonizing depression sites in the Sunken Forest, perhaps because their tolerance of a thinner unsaturated zone caused by SLR is allowing them to out-compete the extant vegetation (Jordan Raphael, National Park Service, written communication, 2016). Geomorphological changes alter the structure of the habitat, resulting in patterns of vegetation die off (Hayden and others, 1995). Changes in geomorphology and shallow groundwater hydrology have resulted in mortality of slash pine on Sugarloaf Key, Florida, coastal hardwood hemlocks-buttonwood forests of Everglades National Park (Ross and others., 1994; Saha and others, 2011), and affected vegetation in coastal areas of Virginia (Hayden and others, 1995).

2. Transient storm-inundation events leading to changes in groundwater salinity and increased saline uptake by plant roots.

Results of recent USGS data collection and simulation of groundwater flow at the three subject National Seashores (Misut and Dressler, 2021; Carleton and others, 2021; Fleming and others, 2021) indicate that increases in long-term average salinity in shallow groundwater is unlikely except for areas close to (50 - 100 m) saltwater bodies. However, changes in groundwater salinity associated with transient storm-inundation events were not analyzed in detail in the three recent studies and the role of normal (1-year to 5-year) and extreme (50-year to 100-year, such as Hurricane Sandy) storm-inundation events are not well understood, much less the effects of short-lived inundation in salinity (if any) on forest health.

Methods

Analysis techniques were formulated on the assumption that the mortality in maritime forests was due to either poisoning of the trees from inundating or encroaching salt water and/or the drowning of tree roots due to an increase in the water table elevation.

To study the potential effects of these mechanisms, a cluster of shallow wells (1 to 5 m deep) were installed in low-lying near-shore areas in each of the three forests. Wells with salinities greater than 3 ppt within 5 m of the land surface elevation were screened 1 ft below the water table (Figure 2). Wells with salinities less than 3 ppt within 5 m of the land surface elevation required screen installations at increasing depth until salty water was reached. Each well was equipped with a pressure transducer to measure changes in water level and a specific conductance sensor to measure changes in salinity.

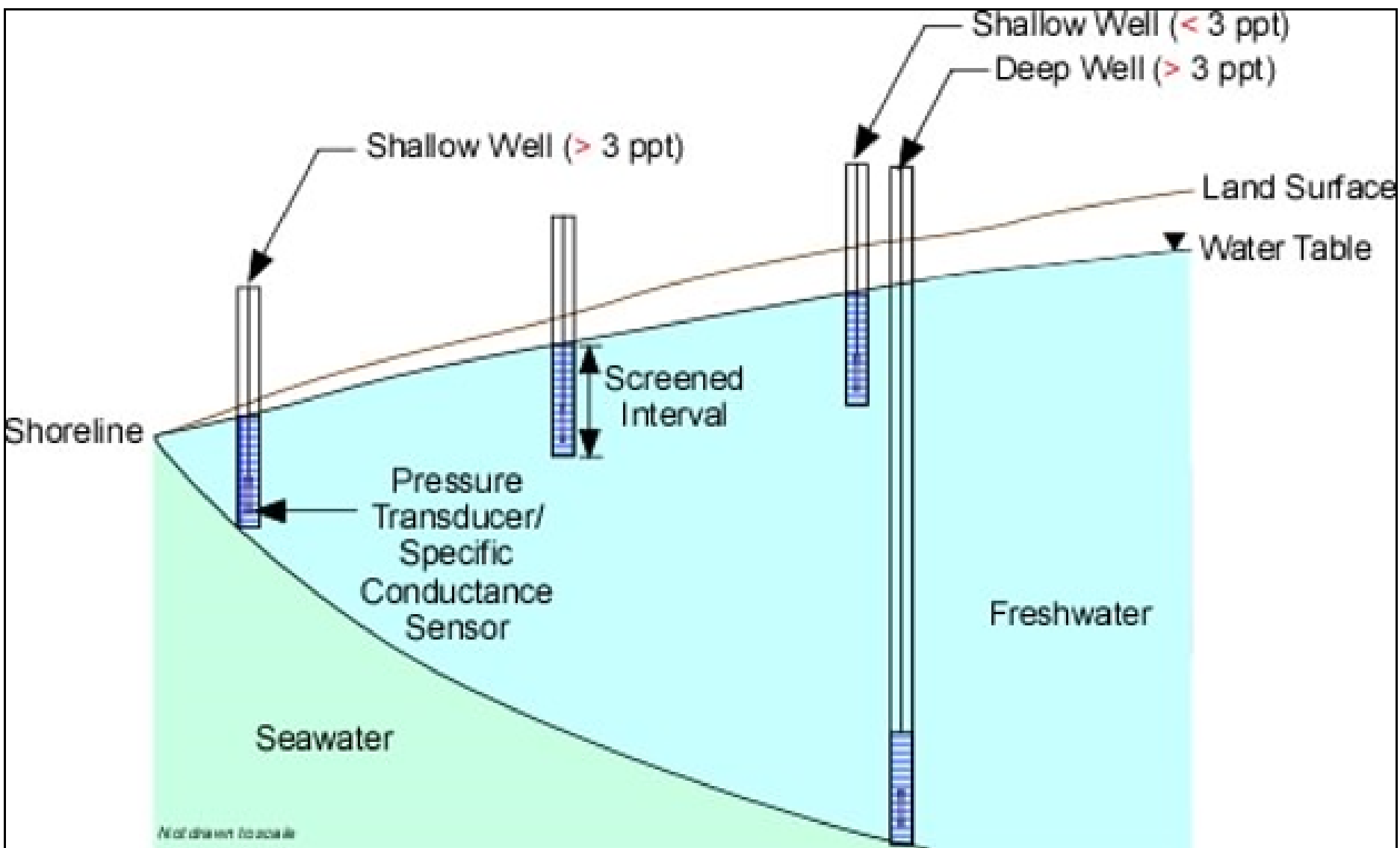


Figure 2: Distribution of near shore wells to study potential forest mortality mechanisms.

To study pure shallow groundwater effects, a shallow well (1-3 m deep) was also installed further inland from the shore and equipped with a pressure transducer to measure changes in water level (Figure 3).

Data was collected in 15-minute intervals over an 15-18-month period from August 2017 to March 2019. This was planned to coincide with both the hurricane season and the occurrence of both monthly and seasonal tides. The data was run through the USGS approval process and analyzed against tidal, precipitation and wind data retrieved from USGS and/or National Oceanic and Atmospheric Administration (NOAA) gages.

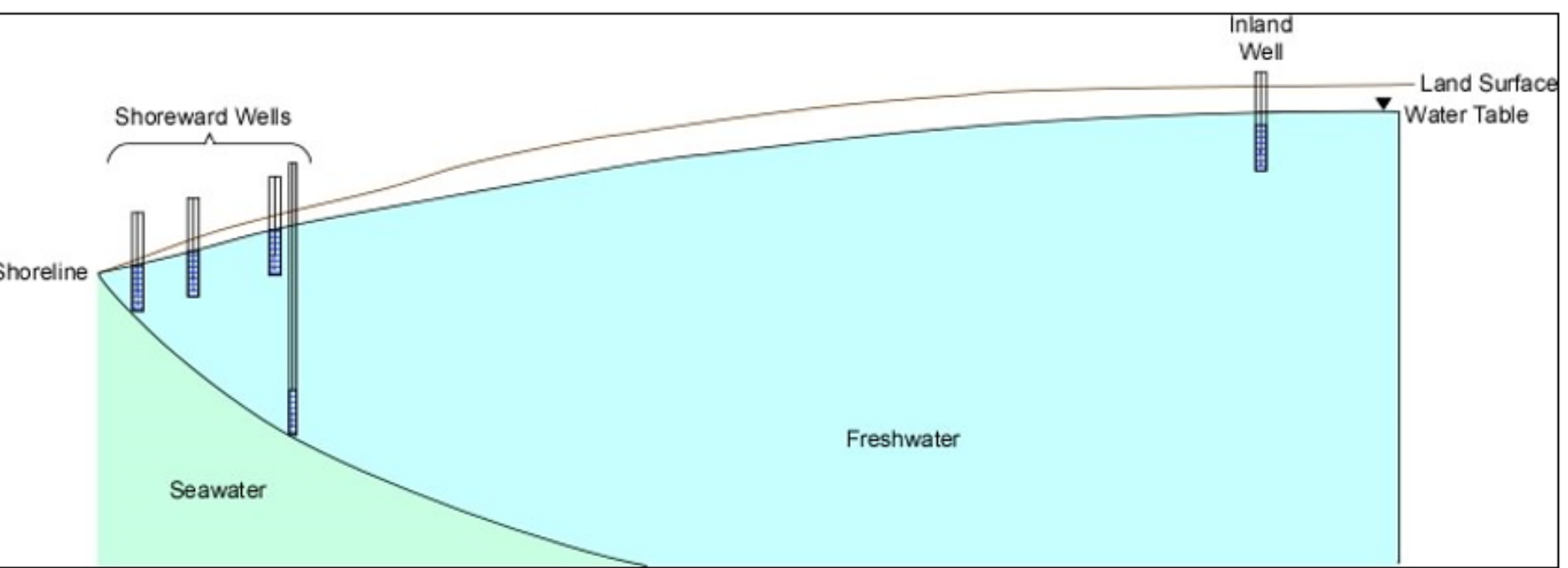


Figure 3: Distribution of near shore and inland well to study potential forest mortality mechanisms.

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