Effect of Soil Type on Endangered *Arenaria paludicola* Growth

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Abstract

Arenaria paludicola is a critically endangered California wetland plant. Only one original population exists at Oso Flaco Lake in San Luis Obispo County, in addition to some out plantings that have been established. Current knowledge of the ideal habitat and conditions for *Arenaria paludicola* is limited, making it difficult to identify sites that would be ideal for new out plantings to preserve the species. This study investigates the ability of *Arenaria paludicola* to grow in five soil types to evaluate the viability of a natural seep site located on UC Santa Barbara's campus as a location for planting a new population. In addition, the seep water was used on two replicates of the experiment to determine if the water itself is suitable for *Arenaria paludicola*. The soils that showed the most growth over the course of the study were coarse commercial sand mixed with compost and potting mix, with the campus loam showing no growth, and the heavy clay and fine sand soils native to the site showing the least growth and most death. In addition, the seep site plantings uniformly declined in health and died, showing the seep water is unsuitable. From this we can conclude that *Arenaria paludicola* prefers coarser sand and potting mix to finer grained sandy soils and clays, and that the seep site is unlikely to support a population of *Arenaria paludicola*.

Introduction

Introduction to *A. paludicola*: *Arenaria paludicola* is a critically endangered wetland plant in the Caryophyllaceae. In California it is reduced to a single original population at Oso Flaco Lake in San Luis Obispo county. Efforts are underway to better understand the plant's biology, as little is known about its ideal habitat and growing conditions.

Purpose: The identification of the best environment for *A. paludicola* will aid conservation biologists in determining suitable new locations for out-planting to create new populations and prevent extinction. One such site being investigated for its potential to host *A. paludicola* is a naturally occurring seep at East Storke Wetland on the UCSB campus. Since this plant is poorly understood and many experimental out-plantings have failed, this experiment was undertaken to assess the soil preferences of this species, and determine its potential to grow in the existing soils at the site. This allows us to determine whether the site would be conducive to supporting an *A. paludicola* population. Since *A. paludicola* is thought to prefer sandy soils, some sand-based non-native soils were tested, as there is a possibility that the replacement of some soil at the site with a sandy mix could accommodate more plant species, including *A. paludicola*. Lastly, the water the seep produces was also tested on all soils to determine if that had any effect on plant health or growth.

Ethical Considerations: All plant material used for this experiment was done under the supervision of the nursery manager of the Cheadle Center, UCSB, as permitted by the USFWS. *Arenaria paludicola* is generally very easy to propagate by stem division, and the plant makes many stems from which ramets can be harvested without any cost incurred by the parent material.

Two full grown *Arenaria paludicola* plants.

Results

The *Arenaria* ramets were each placed in their respective soil type and initial observations were taken, as the rooted cuttings varied slightly in size at initial planting. The growth and health of each plant was monitored weekly.

Soil Results: Potting soil (1) and the coarse sand and compost mix (2) fared the best of all soils, with the tap water treatments ending with an average heath score of 3 and 3.33 respectively. The campus loam (3) showed decline overall in health and height measurements but did not die by the end of the experiment, instead stagnating in growth and ending with a final average health score of 1. The native seep sand (4) stayed about the same height during the experiment but overall declined in health, ending with a score of 0.67. Finally, the heavy clay (5) declined beginning in week 2 and all plants died by week 3, ending with a health score of 0.

Seep Water Results: All seep water treatments declined and died by week 5, giving them a health score of 0.

Results

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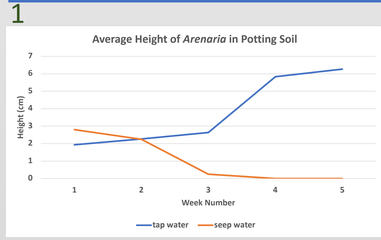

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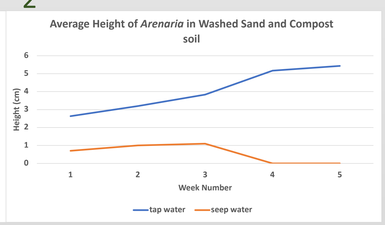

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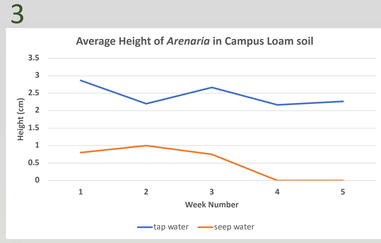

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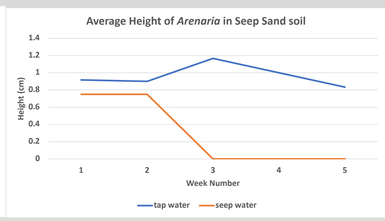

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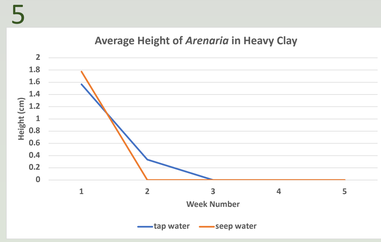
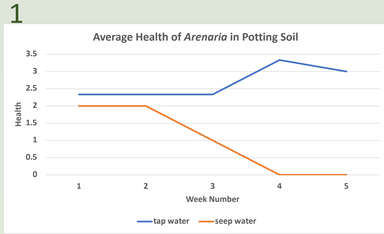


Average height of the *Arenaria paludicola*, measured in centimeters over the course of the 5-week experiment. Averages were taken of the three replicates in the tap water and the two replicates in the seep water.

1



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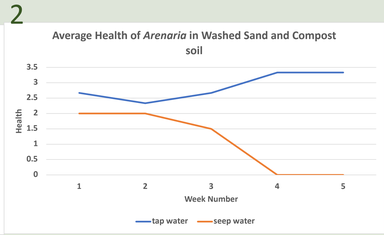

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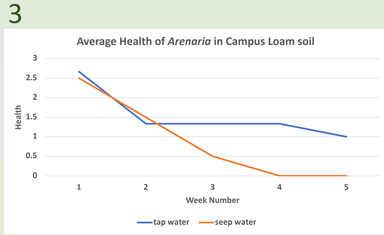

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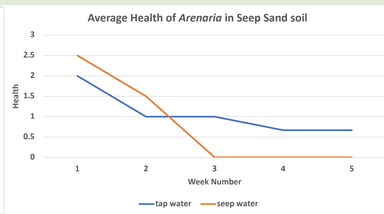

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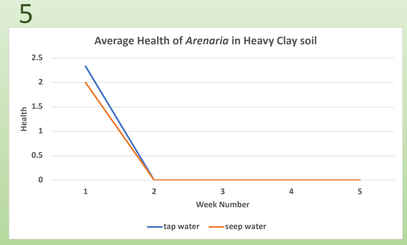

Average health of the *Arenaria paludicola*, evaluated on a 4-point scale over the course of the 5-week experiment. 0 corresponds to death and 4 corresponds to vigorous growth. Averages were taken of the three replicates in the tap water and the two replicates in the seep water.

Materials and Methods

Soil: 1- potting soil, 2- coarse sand + compost, 3- campus loam, 4- seep sand, 5- heavy clay. Top image: seep water treatments. Bottom image: tap water.

Cuttings were taken in mid January 2022 from healthy plants and rooted in an EZ CLone aeroponics machine. On February 3, 2022, the rooted ramets were then placed into 5 pots (McConkey Co. SP5X5 72 cubic cm) each of 5 different soil types, making 25 pots total. The soils included 1) a standard potting mix used at the nursery that *Arenaria paludicola* were known to grow well in, 2) a coarser-grained washed sand mix mixed with 25% compost by volume, 3) a very fine-grained sandy loam native to campus and potentially available in suitable quantity, 4) a fine grained sandy soil native to a small section of the site, and 5) a heavy clay native to the majority of the site. Three of the replicates were placed into shallow (2") trays (McConkey Co. JMCSFONHMDPB-MC) of tap water (which has been proved to support *A. paludicola*), and two were placed into the same trays filled with water gathered from the seep site. The water collected from the seep was measured for salinity and conductivity using a YSI 2030 meter. The water in both treatments was refilled as needed and replaced entirely every two weeks to prevent accumulation of salts. Weekly observations of plant height and health were taken. Height was measured using a standard ruler in centimeters, and health was measured on a 5-point scale: 0- death, 1- no growth, 2- slight growth, 3- moderate growth, and 4- vigorous growth. These observations were collected over 5 weeks.

Conclusions

Soil Treatments: Five soils and two water treatments were used here to evaluate the potential of the seep site at UCSB to support *Arenaria paludicola*. The soils showed definite variation in their ability to support *A. paludicola*, with potting soil (1) and the combination of washed coarse sand and compost (2) showing the best health outcomes and greatest increase in height. The campus loam soil (3) had consistent height and health data, so not much growth occurred but the plants also did not decline. The seep sand (4) did not kill the *A. paludicola*, but the health and height overall declined during the experiment. The worst plant health outcomes came from the heavy clay soils (5) native to the majority of the seep site. The death of all ramets in this soil type by the third week demonstrated that this soil is incompatible with *A. paludicola*.

Seep Water Effects: The second aspect of this experiment aimed to determine if the seep water itself was conducive to the growth of *Arenaria paludicola*, since it was suspected to be slightly brackish, measured at 5.9 ppt salts and 7380 in conductivity, and the species was known to be salt-sensitive. The ten experimental plantings placed in seep water treatments uniformly declined in health and height over the experiment, and ultimately all died. This indicates that the seep water is likely too salty to support *A. paludicola* and may not be a suitable location for the species even with the replacement of the soil.

Note on Ramets used: It should be noted that all ramets used were very young and delicate, just beginning to root, and selected for their readiness for use and similar place in their growth trajectories. Furthermore, one ramet in a desirable soil type watered with tap water also died. However, even though larger, more established plants may have fared better, this study clearly indicates that salts in the water at the hopeful restoration site may be as prohibitive to the growth of *A. paludicola* as the majority of the soils appear to be.

Acknowledgements

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