VARIATION IN SALT TOLERANCE OF SLASH PINE *(PINUS ELLIOTTII)* FAMILIES

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The average temperature is going up, the glaciers are melting, and sea levels are rising! Salt tolerance will become an important factor in restoring vegetation in coastal environments. In Mississippi, Alabama, and Florida, slash pine *(Pinus elliottii)* occurs in coastal and barrier island environments that are often subject to salt-water exposure. No information is available on the inheritance of saltwater tolerance in slash pine though one might expect that the barrier island pines would be more tolerant than mainland sources.

Bayne Snyder, François Mergen, and Jeff Burley collected seed from the Mississippi Barrier Islands with companion collections from nearby mainland sources and found significant morphological differences between island and mainland sources (Mergen et al.1966). However, they did not test for saltwater tolerance. Sam Land (1973) studied salt-tolerance in loblolly pine *(P. taeda)* families from the North Carolina State University Tree Improvement Program. He included controls of pond pine *(P. serotina)* and slash pine. The only significant difference that he found was that salt tolerance was higher in slash pine than in loblolly pine or pond pine. Family differences among the loblolly pine were not apparent. It does not seem coincidental that slash pine is the only pine found on the Mississippi barrier islands.

We conducted several experiments to compare salt tolerance of island populations of slash pine with mainland populations (see map). We had two basic questions to answer: Is there a salt-tolerant island ecotype, and are there genetic differences among individual families in salt tolerance?

Adjusting our experimental conditions to attain a consistent response that allowed a separation of populations and families took some trial and error. Complete immersion of the seedlings in water containing salt was always fatal. Exposure of root systems to salt

concentrations approaching that of seawater (35 ppm salt) through irrigation from below killed the seedlings too soon to separate the responses of families or populations.

Nevertheless, we did find evidence of family differences and some indication of population differences in salt tolerances in these our early trials. We also found strong indication that loblolly pine was less salt tolerant than slash pine.

In the current experiment, we collaborated with the University of Southern Mississippi's Gulf Coast Research Laboratory (GCRL) to use their facilities to draw brackish water from the Mississippi Sound for our saltwater treatments.

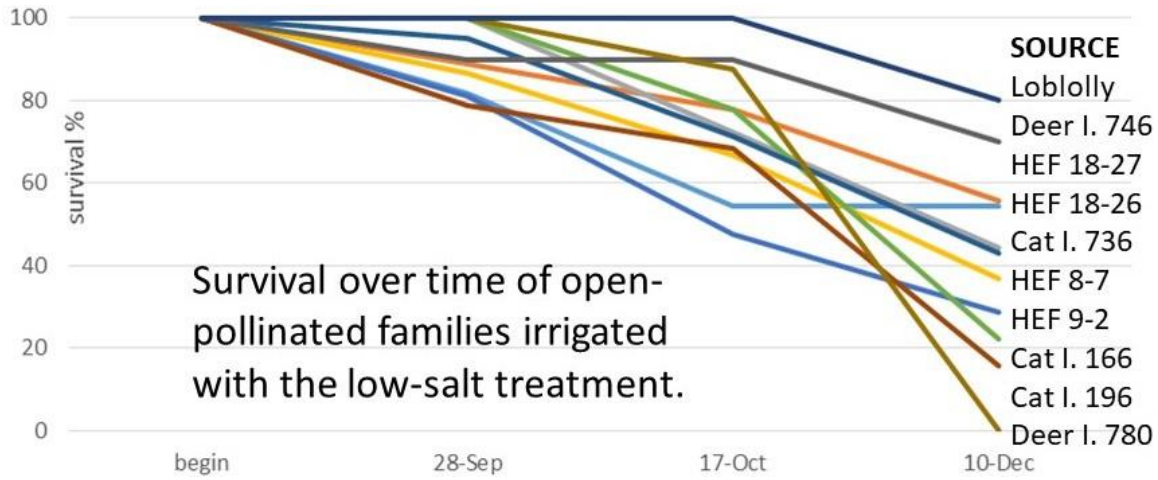
In addition, we used GCRL's immersion boxes for irrigating the plants with the drawn brackish water. We tested 16-month-old seedlings of open-pollinated (OP) families of natural slash pine from three populations: Cat Island (a barrier island 15 km offshore), Deer Island (a near-shore island 100 m off-shore) and inland, from the Harrison Experimental Forest (HEF, 55 km north of the coast) (refer to map above). Also included was one open-pollinated family of loblolly pine. We planted seed from 5 HEF, 3 Cat Island, and 4 Deer Island trees plus one loblolly pine. The seedlings of the 13 open-pollinated families were taken to GCRL 31 July 2019 and three treatments began 29 August 2019. The boxes were filled up to the ground line (root collar) of the seedlings with either fresh water or brackish water depending on treatment. The boxes were filled, then drained about an hour later, according to the schedule (0 salinity = fresh water):

Treatment	29Aug	4Sep	7Sep	11Sep	14Sep	18Sep	24Sep	29Sep	5Oct	11Oct
- Salinity – parts per thousand (ppt) -										
Control	0	0	0	0	0	0	0	0	0	0
Low Salt	12	0	0	0	19	0	0	0	19	0
High Salt	12	0	19	0	19	0	19	0	19	0

We found that the "low salt" treatment, i.e., three treatments of watering roots only from below at bi-weekly intervals with natural brackish water (12 to 19 ppt salinity) from the Mississippi Sound gave us overall survival around 50% and good family separation.
We found ample and significant family-in-source variation in survival (P=0.0385). Survival of families varied from 0 to 70% at the end of the study in the low-salt treatment, a range that appears to be useable in a breeding program.

The slash pine seedlings showed only small, non-significant differences among populations for survival (P = 0.0963). Loblolly pine was not included in the statistical analysis. There did not appear to be significant adaptation to salt-water inundation by the island sources versus the mainland sources.

In a related field study planted on Deer Island using Deer Island and HEF families we found significant family differences in survival after a storm flooded the planting with



brackish water (Schmidtling and Nelson 2019) but no seed source differences. Only the two sources were included in the study, but we had a large number of families (over 50).

In this study, the one difference that stood out was the better survival of the loblolly pine family. This was opposite the expected, based on previous studies (Land 1973) and our own studies. The loblolly family used, B-145-L, was from west of the Mississippi River. All other studies, including Land (1973), used families from east of the Mississippi River.

It has been established that loblolly pine from west of the Mississippi River are slower growing, more drought resistant, and more fusiform rust resistant than sources from east of the river (Schmidtling 2001). This could explain the difference we have observed in this study, i.e., if western loblolly seed sources are also more salt tolerant, a reasonable assumption

So far, the evidence for a salt-tolerant slash pine ecotype on the barrier islands seems lacking. There does, however, appear to be exploitable family variation in salt tolerance. The possible difference in salt tolerance in western versus eastern loblolly seed sources also may become important. Our next experiment will incorporate not only more island slash families, but also eastern and western loblolly pine sources. We are also setting up our own facilities at the HEF, similar to the GCRL facilities. This will give us better daily control without the necessity of driving 30 miles to tend the experiment.

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