Ammophila breviligulata from Michigan side of the lake

Genetic Structure of Natural and Restored Populations of *Ammophila breviligulata*

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Ammophila breviligulata at Illinois Beach State Park

Dune Restorations: Importance of Beachgrass

American Beachgrass, *Ammophila breviligulata,* is one of the first plants to colonize sandy shores beyond the water's edge. It functions to create and stabilize the beach and dune system, because of its tolerance of unstable beachfront conditions and ability to spread utilizing underground rhizomes. The importance of Beachgrass for creating and stabilizing dunes has been recognized since at least 1958 (Olson, 1958). In our own Lake Michigan shoreline study area, Beachgrass has been introduced at several Chicago lakefront sites, as well as in surrounding areas. This study investigated the current methodology for the restoration of dune systems using Beachgrass. We collected samples from spontaneous Illinois populations, planted populations and suppliers of beachgrass rootstock. We were able to show that in planted populations, the level of genetic diversity tended to be lower than that of natural populations, with a more uniform distribution of clones and fewer genotypes over a small spatial scale. Natural, well-established populations had more diversity over a smaller scale in more heterogeneous environments, while dense lawns were composed of a large monomorphic population.

Beachgrass Biology

Little is known about the genetic composition and structure of natural populations of *Ammophila breviligulata.* Beachgrass produces long, underground rhizomes that generate further stems and, consequently, a single clone is capable of rapidly colonizing large areas of open beach (Krajnyk & Maun, 1981). This rapid vegetative growth, and its apparent low production of fertile seed has led to the assumption that many populations of Beachgrass are comprised of one to a few clones.

Ammophila breviligulata

Consequently the *Ammophila breviligulata* being used for beach stabilization throughout the United States are derived from a limited number of suppliers, and rarely are the plants used for restoration collected locally, despite a number of studies which suggest that the genetic diversity of populations of clonal species is equivalent to that of most sexual species.

Literature Cited

Krajnyk & Maun 1981 "Vegetative reproduction in the juvenile phase of *Ammophila breviligulata*" *Canadian Journal of Botany* 59:883-892
Olson 1958 "Lake Michigan dune development. II. Plants as agents and tools of geomorphology" *Journal of Geology* 66:345-351

Chicago Lakefront Collection Area

Beachgrass samples were collected at:

- ***Illinois Beach State Park*** **(natural)**
- ***Kathy Osterman Beach*** **(natural)**
- ***Montrose Beach*** **(natural/augmented)**
- ***South Shore Beach*** **(restored)**
- ***Rainbow Beach*** **(natural)**

= Collection sites
(Taken from http://www.chicagotraveler.com/maps/chicago -beaches-map.htm)

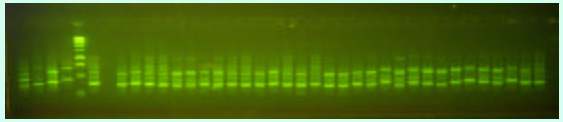
Questions

This genetic analysis focused on answering two questions. First, what is the natural population structure of *Ammophila breviligulata* on undisturbed beaches in the Illinois region of Lake Michigan? i.e. How much diversity can be found within and between Illinois beaches? Second, on those beaches in which there are multiple clones, what is the spatial distribution of clones within this area?

Materials and Methods

Beachgrass was collected from 4 spontaneous Chicago populations: Rainbow Beach, Montrose Beach, Illinois Beach State Park and Kathy Osterman Beach. Material was also collected at two restored sites: South Shore Beach and an area of Montrose Beach that had been augmented. Plant material was also collected at Vine Pines Nursery, a source of material for planting projects.

DNA was extracted and used for duplicate polymerase chain reaction (PCR) analysis with three ISSR primers. Polymorphic bands were identified and used to generate haplotypes. Haplotype analysis was performed within clumps (small spatial scale), within populations and between populations.



Example of Gel: Intermingling of Genotypes on Illinois Beach

Results and Discussion

Diversity in Spontaneous versus Planted

For this analysis, we compared spontaneous Beachgrass populations to populations that had been planted. Population diversity varied between beaches (2-8 haplotypes), but was only partially related to whether the beach was natural or planted (only one planted beach contained more than two clones).

Distribution of Clones in Illinois

A comparison of the distribution of individual clones showed that many of the spontaneous beaches shared clones, suggesting that these had spread throughout the region. The nursery stock was comprised of a single clone, which was also identified on two of the planted beaches, suggesting that this supplier might have been the source of the planted material. This clone was also found in many of the spontaneous populations, suggesting it is of local origin (assuming it was not introduced by planting). South Shore, a recently planted population, had no clones in common with any other beach. A pair-wise comparison (data not shown) showed this population to be the most distantly related, i.e. this population was the most unlike any other population.

Table 1: Clonal Frequency by Site

	N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	No. of Clones	No. of Polymorphic Loci	Gene Diversity
Well-established Populations																					
Illinois Beach State Park	82						5							4	4	1	15	4	8	6	0.870
Montrose Beach	43													31	4	28	1		4	2	0.589
Rainbow Beach	43						38	5											2	2	0.139
New Populations																					
Kathy Osterman Beach	43												43						1	1	0.000
Montrose planted	23												23				2		2	1	0.181
Known Planted Populations																					
South Shore Beach	22	10	2	3	1	1													5	4	0.632
Nursery Stock																					
Vans Pines Nursery	23											23							1	0	0
		10	2	3	1	1	43	5	0	0	0	23	66	35	8	29	3	4			

Distribution of Clones within Population

One of the differences between natural and planted beaches was the diversity within plant clumps. As we observed a higher number of genotypes per population than predicted, we decided to look at the distribution of the clones on a finer spatial scale. For this study, a set of five samples was collected per square meter (clump). It had been assumed that these clumps were made of a single clone; however, within a well-established, spontaneous population there were usually two, and in some cases even three clones within a clump. This is likely a consequence of clones intermingling with time. This pattern varied from planted populations, which usually had 1 or sometimes 2 clones per clump. In natural, well-established populations, the number of clones per clump tended to be higher at lower plant densities, while denser stands would usually be composed of a large monomorphic stand.

Conclusion

For beach rehabilitation, the use of a local supplier, with locally adapted clones is to be recommended. To better emulate a natural population, it might be worth:

1) Planting rootstocks in pairs of different clones to better recreate a mosaic of clones, rather than large monoclonal patches.
2) Obtain plants from several local suppliers to increase the overall genetic diversity of planted populations, and thereby more closely mimic natural beaches.