

Use of American Lotus in Pond Remediation

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P-1 Pond March 2006

P-1 Pond May 2009

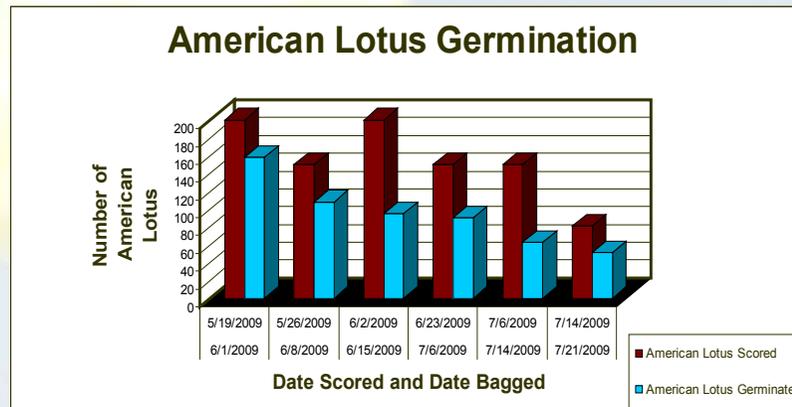
P-1 Pond Remediation Project

The P-1 pond remediation project is a large scale community remediation effort to study restoration activities associated with native grass communities, wetland and pond remediation, and riparian buffer establishment for a pond system located at the East Tennessee Technology Park (ETTP) site. The trophic structure of the pond system is being re-engineered by converting the system from a plankton-dominated system to a macrophyte-dominated system and changing the food-web from a planktivorous, bottom feeder dominated community (i.e. shad, carp) to a community of mid-water feeders (i.e. sunfish, mosquitofish). This is expected to create a more ecologically stable system that will have a lower flux rate of Poly-Chlorinated Biphenyls (PCBs) from the sediments up into the food-web, thereby lowering the ecological risk. The work includes lowering the water level in the pond, Rotenone elimination of fish communities, restocking of desirable fish communities, invasive plant treatments, culture and planting of native wetland and emergent plant species, including American Lotus (*Nelumbo lutea*) culture and planting.



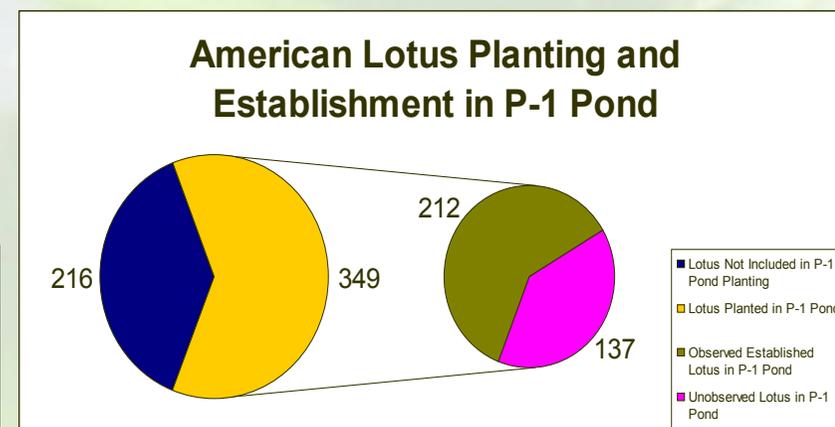
American Lotus (*Nelumbo lutea*)

The American Lotus is a perennial, flowering, aquatic herb. It is found in shallow water in ponds, lakes, sluggish streams, and marshes from Massachusetts to the Gulf of Mexico, throughout the Mississippi Valley, to the Great Lakes. American Lotus is recognized for its floating and emergent, large, round leaves, up to 60 cm in diameter. It also possesses a distinctive bright yellow flower, up to 25 cm in diameter. Its leaves and flowers arise directly from its rhizomes. Its seeds are round, hard, and nut-like, contained within a light spongy structure, normally requiring either scoring or animal digestion for germination. Native cultures baked the large roots like sweet potatoes, ate the leaves like spinach and the seeds were prepared to be eaten like nuts or ground into flour. The American Lotus can have a lifespan in excess of 20 years.



Lotus Culture and Germination Results

Throughout the summer of 2009, a total of 931 American Lotus seeds were scored and soaked for germination. Of those 931 scored seeds, 565 germinated sufficiently to warrant planting in burlap bags, and then were allowed to mature in living stream tables. The 61% germination rate of the American Lotus seed is expected to increase over the next two summers as the project continues due to better and more selective seed sourcing, modification of culture and germination techniques, and an accelerated timetable for planting at the P-1 pond itself.



Lotus Planting and Establishment Results

Throughout the summer of 2009, a total of 349 American Lotus were planted in the P-1 pond. Of those 349 American Lotus planted, 212 were observed to have established themselves through further growth and through increased leaf size and number. The 61% success rate of establishment is expected to increase over the next two summers through the utilization of more cage planting, the relocation of geese who use the lotus as a food source, and through the use of healthier, more mature lotus plants in the future.

We also expect to see a lower PCB flux rate and bio-accumulation in the P-1 pond due to the root structure and rhizomes of the American Lotus binding the soil, locking the PCB contamination in place, in addition to the other remediation and restoration efforts used to repair the P-1 pond system, thereby, significantly reducing the ecological risk.



American Lotus Seed and American Lotus Seed Scored and Germinated



American Lotus Planted in Burlap Bags in Living Stream Tank



American Lotus Fully Germinated with Leaf Growth

American Lotus Culture Methods

American Lotus seeds were collected in February 2009 from a native population in the Hiwassee River. American Lotus seeds were also purchased from a commercial seed source. The seeds were first scored to penetrate the tough outer shell, then left to germinate in an indoor living stream tank under controlled light and temperature conditions for a period of up to two weeks. Once sufficient growth had been attained, the seeds were planted in small burlap bags, filled using a mixture of pea gravel, potting soil, and native soil. This method of planting allowed for easier planting from shore and from a boat, due to their ability to house the root structure of the American Lotus and sink to the bottom of the pond. They were then transferred to an outdoor living stream tank. Once sufficient leaf maturity and growth were reached, the seeds were transported in small tree pots to the pond system for final planting.



Hand Planting American Lotus



Boat Planting American Lotus

American Lotus Planting Methods

American Lotus were planted using two primary methods. Using chest waders, it was planted in bio-degradable burlap bags by hand along the most accessible locations from the shore. Using both motor driven and paddle boats, American Lotus were planted in protective cages and other selected locations throughout the P-1 pond.

