The Creation and Restoration of Wetlands, Part 3

Variations due to Age, Localized Conditions, and Successional Factors Within Species

by Sydney T. Bacchus

The first and second parts of this three-part series discussed hydrologic factors, in part 1, and response differences of various wetland species, in part 2, as important considerations for successful wetland creation and restoration.

This final part focuses on differences within a given plant species during different stages of its life cycle (seedling, sapling, young tree, mature tree), and due to subtle adaptations of populations of a species to localized conditions. These factors, in addition to successional factors that are also discussed in this article, are often overlooked during the creation/restoration design phase, and can result in drastic reduction in the success rate of the created/restored wetland.

Age Factors

The most well-documented example of differences in ecological requirements during different stages of development can be found in cypress. Germination of cypress seeds has been shown to be inhibited by standing water, and seedlings subjected to standing water during the first year of growth have been killed. However, mature cypress are tolerant of normal flood conditions.

For other wetland species, a paucity of data exist regarding specific requirements for germination, growth during different stages of development, maintained vigor, and successful reproduction.

Yet differences in tolerances or requirements at different ages can become a critical factor in the successful outcome of a wetland creation or restoration project. For example, because cypress require periods of approximately one to two years without standing water for seeds to germinate and for seedlings to become tolerant of prolonged inundation of their roots, cypress wetlands with natural hydroperiods would have a low probability of becoming re-established by reproductive means if mature trees are removed through logging or other means. Pond cypress (*Taxodium ascendens* Brongn.) appear to have evolved a vegetative means of re-establishment through stump sprouting (coppice growth) under some conditions, but comparable re-establishment of bald cypress (*Taxodium distichum* (L.) L.C. Rich.) canopies has been unconfirmed.

Age factors of individual species, in addition to site-specific conditions, should be considered when evaluating which species should be expected to become re-established naturally. All other species should be planted at the site at an age at which they will be best suited for survival under the existing site conditions.

Localized Factors

Under the "Genetic Factors" section in Part 2 (*The Palmetto,* Winter 1991), differences between species were discussed. This section, "Localized Factors", addresses variation within different populations of the same species.

Currently, little, if any, consideration is given to the source of plant material incorporated into restoration or creation projects. The importance of using plant material from seed collected within the climatic zones of the recipient site has been documented in the literature. Although most examples are confined to commercially important conifers, limited unpublished accounts related to tidal marshes were found.

With respect to commercially important conifers, a 1962 study verified that average stem volumes of ponderosa pines (*Pinus ponderosa*), a western North American species, from non-local sources were only 2% of the average stem volumes of trees from local sources. A later study determined that loblolly pines (*Pinus taeda*) from local sources grew four times faster than loblolly pines from a non-local source.

Unfortunately, increases in height can be a misleading evaluation parameter. A 1989 study reported that rapid initial height growth of non-local test trees in California led to the assumption that these trees were of superior stock, and they were distributed widely for planting. Stands of these "imported" loblolly pines later were devastated by infrequent local climatic conditions to which the "imports" were not adapted.

Another example can be found in Douglas fir trees from coastal sources that were planted in the interior of their range. These interior trees were killed during an unusual period of low temperatures while local populations survived. Similar examples are cited for interior stock relocated to the coast.

Delayed death of introduced stock after the first few years of growth is not uncommon and is anticipated in long-lived organisms such as trees, which must face not only normal seasonal fluctuations, but also cyclic or episodic events such as droughts, unusually low temperatures, or pest epidemics.

Such problems are not restricted to trees, however, as exemplified by the phenomenon that occurred at a tidal marsh mitigation site on Ono Island, Alabama. The U.S. Army Corps of Engineers' Mobile Office confirmed that smooth cordgrass (*Spartina alterniflora*) from the Tampa area (which has a latitude of ~28°00′, longitude ~82°30′) was transplanted to the mitigation site (lat. 30°15′, long. 87°30′) at the Alabama/Florida state line between 1984 and 1986. Vegetative growth was "thriving and lush" for several years, until below freezing temperatures occurred during the winter of 1988/89. As a result of that freeze, approximately 90% of the two miles of tidal marsh vegetation was killed. Two years later, re-establishment of the introduced cordgrass was still sparse. Local populations of smooth cordgrass were relatively unaffected by the freeze. although the Ono Island mitigation site is approximately 292 miles northwest of the source of the plant material, this represents little more than a 2° change in latitude, a distance of approximately 146 miles due north. This change in latitude is *less* than the latitude difference between Tampa and Jacksonville, or Tampa and Tallahassee.

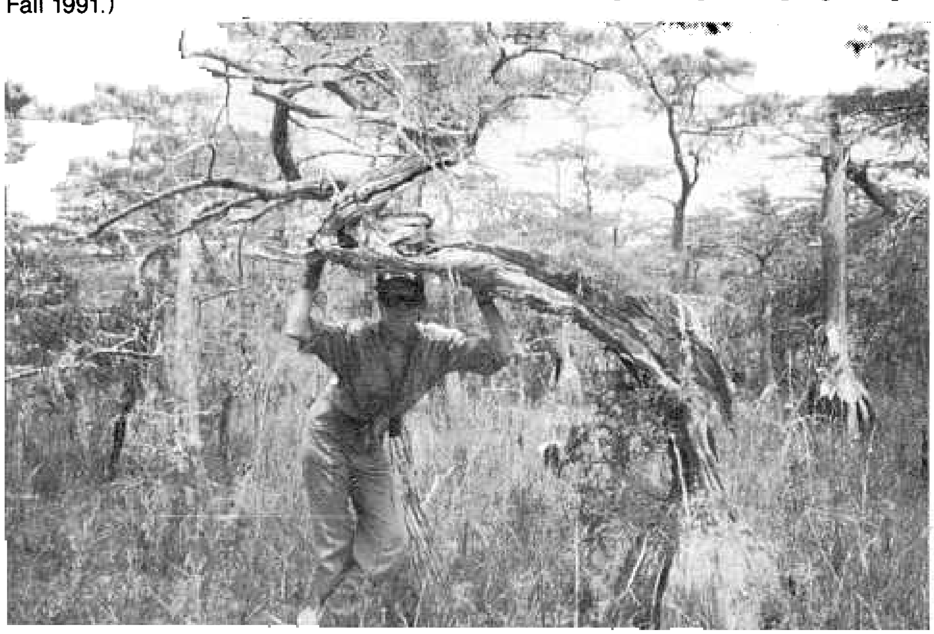
A 1958 study reported similar intraspecific (within species) differences in pond pine (*Pinus serotina*) seedlings. Seeds were collected from a single individual tree in each of two separate populations representing different soil conditions, as well as geographical locations. The northern seed source population (Craven County, North Carolina) was growing in peat approximately three feet deep, and trees exhibited slow growth. The second seed source population (Horry County, South Carolina) was growing in sandy soil, located approximately 135 miles south of the northern population, and trees in the stand exhibited more rapid growth. In this experiment, growth of seedlings collected from the southern source was inhibited by concentrations of 400 ppm of calcium. Higher levels of calcium are common in certain Coastal Plain soils. Optimum nitrogen and potassium requirements also differed for the seedlings from the two seed sources. Conclusions were that "physiological variation occurs within the pond pine taxon and may influence apparent site quality."

A similar scenario may be evident in pond cypress in Florida. Populations of extremely old, stunted trees, known as "hat-rack" or "dwarf" cypress, are assumed to be pond cypress, and can be found in the Florida Panhandle and in south Florida. Although no research has identified the cause of the stunting, the author believes the trees are responding to unusual soil conditions. The tract containing the northern population is proposed for development, and it is highly unlikely that pond cypress stock from nearby "normal" wetlands would survive in such an area if used as "mitigation" for natural wetlands that are destroyed.

Despite concern over the proximity of seed and propagation sites to the final planting site, care should be taken not to carry this concept to the extreme, restricting collection of seeds to a few individuals within the immediate vicinity. Researchers have cautioned that increased inbreeding resulted in poor health and vigor and that inbreeding for restored sites that are isolated from native individuals of the same species, thus precluding natural outbreeding with native stock, can result in the long-term death of the population. Based on this concern, researchers have recommended no fewer than 25 individuals as seed donors for re-establishment of each species. The same occurrence is to be expected with islands of "conservation" wetlands surrounded by a sea of pavement or manicured turf.

A final concern is that imported, non-local plant material may survive long enough to breed with locally adapted plants. Such cross-breeding will dilute the gene pool of the adapted population, with the potential of rendering the cross-bred population unsuited for its habitat within a few generations.

Stunted, "hat-rack" cypress population in northwest Florida apparently adapted to local conditions atypical from those in other pond cypress stands nearby and throughout Florida (compare with typical pond cypress stand shown on the cover of *The Palmetto*, Fall 1991.)



Joe Schuster

Successional Factors

The last ecological consideration to be addressed is the role that succession plays in efforts to create or restore wetlands. A concept first posed by early ecologists that remains unresolved today is the concept of "colonizing", "pioneer", or "successional" species versus "climax" species, a summary of which is provided here:

"Colonizing" Species	**"Climax" Species**
wide ecological amplitude	narrow ecological amplitude
disturbed substrate	undisturbed substrate
wind-dispersed seeds	animal dispersed seeds
smaller/lighter seeds	larger/heavier seeds
many seeds	fewer seeds
rapid growth	slow growth
shade intolerant	shade tolerant
short lifespan	long lifespan

Using the characteristics provided above, examples of some forested wetland canopy species common in Florida could be categorized as follows (although they may not exhibit all of the characteristics under a given category):

"Colonizing" Species	**"Climax" Species**
ashes	cypresses
red maple	loblolly bay
sweetgum	sweet bay
willows	tupelos

Although categorizing a given plant

species as either a "colonizing" or "climax" species may be an oversimplification, it generally is recognized that some wetland species, such as willows and cattails, can become established rapidly on newly exposed or disturbed substrate under a wide range of hydrologic regimes, while other species, such as cypress and tupelo, appear to require considerable human assistance to become established under those same regimes.

Examples of the time required for establishment of mature forested systems has been provided in the literature, which notes that the establishment of forest trees on the shores of Glacier Bay in Alaska was a slow process, requiring 50 to 100 years in some areas, and that a similar duration of time (~50 years) was required for the development of stands of forest on newly exposed substrate on a tropical island. A discussion of the role of soil development in facilitating establishment of extensive forested systems was provided.

The importance of substrate in the outcome of the associated plant community has been addressed by several researchers and was discussed previously in this series. Armed with this knowledge, a prediction could be made that the greatest potential for success of restoration/creation would be at sites with the natural wetland substrate intact. As might be predicted, the lowest potential for success would be at sites lacking natural wetland substrate or wetland sites with highly disturbed soils.

The second tier of variables then would be whether the wetland type to be restored or created is composed primarily of plant and animal species that can thrive under a broad range of soil and/or hydrologic conditions, or that have a very narrow tolerance range for optimum growth, vigor, and reproduction. The former might be achieved in a relatively short span of time (~5 to 10 years), while the latter might not be attained within our lifetime.

Summary

Sufficient evidence exists to suggest that our current level of knowledge cannot provide assurance of successful restoration or creation of wetlands under most circumstances, and particularly for forested systems. A list of factors that may maximize the probability of successful wetland restoration or creation include:

- utilization of undisturbed parent substrate (for example, "restoration" of wetland vegetation that existed previously on undisturbed wetland soil) where the natural hydroperiod has not been altered;
- collection of extensive vegetative, soil, hydrologic, and elevation baseline data of the wetland proposed for removal (or, in the case of restoration, baseline data collected from a "reference wetland" — a system similar to the one to be restored);
- immediate incorporation of wetland soils transferred from wetlands permitted to be removed, with placement of the soils at precontoured elevations that match the natural wetland and include establishment of any necessary confining layers;
- selection of plant species adapted to soil and hydrologic conditions at the site;
- selection of plant stock from a sufficiently large number of individuals (recommendations in the literature are for a minimum of 25 individuals) to prevent inbreeding;
- selection of plant stock from a local (adjacent) population having the same ecological conditions, to prevent dilution of the gene pool and to maximize local adaptations in plants to increase the probability that they will be healthy, thrive, and successfully reproduce;
- selection of plant stock only from nurseries maintaining and providing thorough records of the origin of all nursery stock (for example, precise locations where seed or cuttings were collected);
- implementation of long-term monitoring (five years minimum for herbaceous wetlands, and 15 years minimum for shrub or forested wetlands), including permanent photo points, to ensure that the system is well established, has lived through varying weather cycles (for example, unusual heat, cold, drought, and rain conditions), and is performing all life functions in a normal manner.

Although not applicable to uses of "restoration" following some devastating past event, the conclusions of various researchers who conducted recent reviews of wetland mitigation was that an assessment of alternatives performed properly and early in the project formulation stage can reduce project costs, increase certainty, and, most importantly, result in avoidance of unnecessary impacts and protection of valuable wetland resources. According to one reviewer, the most reliable success criteria would appear to be avoidance.

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