The Long Term Viability of Restored Wetlands

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ABSTRACT

One of the more significant outcomes of our research at Corkscrew Swamp was an awareness of the necessity for having a long term perspective in managing the sanctuary. This perspective required not only an understanding of existing ecosystem characteristics and the processes that control them, but also a knowledge of the time frames over which different portions of the system change. These changes can be natural or a result of man's activities, and being able to distinguish between them is a crucial component of successful management. A long term perspective has been invaluable for evaluating the commitment involved in proposed restoration efforts and the significance of potential impacts of activities on surrounding lands. Temporal variability occurs in all natural ecosystems. It is particularly important in wetlands, since these plant and animal communities are not only adapted to it, but are frequently dependent on it. Establishment of adequate buffers to protect a site's most important resources and a timely approach to dealing with exotic vegetation invasions are also important aspects of the long term maintenance of the Kissimmee River's communities and populations. In summary, early planning for the long term management of a dynamic Kissimmee River ecosystem must be an integral part of any restoration program that is likely to be successful over the long run.

INTRODUCTION

As I have gotten more involved in working with highly altered wetlands, I have become more and more aware of how fortunate I was to have begun my wetland ecology research at Corkscrew Swamp Sanctuary, where I had the opportunity to study a virtually undisturbed ecosystem. Its undisturbed character was due largely to being near the top of its watershed, and little of the area upstream of the sanctuary had been developed. What development there was downstream of us, was far enough away that it was not having significant impacts

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on the sanctuary.

However, when I started work at Corkscrew in 1973, there was a perception by Audubon that Corkscrew Swamp had been drained by a canal system built in the early 1960s to the south of the sanctuary. As a result of this perception, I was asked to determine what was needed to restore the ecosystem to a natural, pristine condition. We started by documenting current conditions at Corkscrew Swamp, including the plant communities, soils, and hydrology, and how they related to one another as well as to other aspects of the ecosystem, such as climate, fire regimes, and man's influences. Once we established this baseline, we related it to our best estimate of predisturbance conditions. The net result of these studies was that the more information we put together, the more apparent it became that we could not detect any significant differences between conditions before and after the canals were built.

So, it turned out that while there had been some changes in the Corkscrew Swamp ecosystem, none were major or irreversible. The most important management actions required to bring the system into a more natural condition included cessation of current water management activities that had been instituted to address the perceived drainage; modification of the existing prescribed burning program; and development of an exotic plant control program.

LONG TERM MANAGEMENT PERSPECTIVE

One of the more significant outcomes of our work at Corkscrew Swamp was an acute awareness of the necessity for having a long term perspective in managing the sanctuary. This perspective required not only an understanding of existing ecosystem characteristics and the processes that control them, but also a knowledge of the time frames over which different portions of the system change. These changes can be a result of either natural processes such as community succession or wildfires, or they can be caused by man's activities, such as onsite prescribed burning or agricultural development on surrounding lands. Successful management requires that a manager be able to identify unacceptable activities before they have significant or irreversible impacts on the sanctuary. This in turn, requires an ability to anticipate both the direction and rate of change that is likely to occur following any particular modification of the sanctuary's environment.

Patterns of Change in Plant Communities

Succession is a process by which vegetative structure and species composition on a site changes as a result of the arrival of new species at a site. Some of these new immigrants then come to dominate the site until yet other species arrive and replace them. This process continues until no new species are capable of replacing the current dominants, which then continue to replace themselves indefinitely. In South Florida it is inevitable that a severe disturbance, such as fire, will occur at some point in this sequence, and severely impact the existing community. When this occurs, species from an earlier stage of succession can reenter the site and again dominate it for a period. Figure 1 schematically illustrates the process of succession in South Florida plant communities. While the pattern of succession is usually fairly predictable, the rate at which it occurs can be quite variable because of uncertainty as to when new species arrive at a site and establish permanent populations.

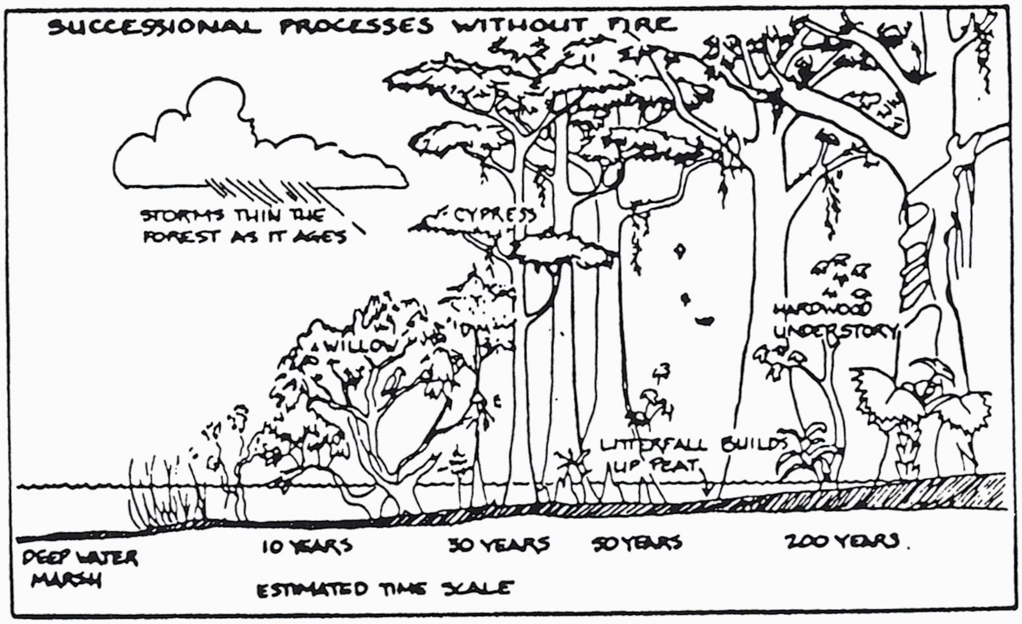

Figure 1. Succession from a marsh community to a hardwood hammock community in South Florida (Wharton et al. 1977).

Marshes, the earliest successional stage on most South Florida sites, will be maintained if they are burned about every 2 to 5 years. At Corkscrew Swamp, after 15 to 20 years without fire, shallow marshes on mineral soil had changed to wax myrtle shrub thickets, and portions of a sawgrass marsh on a deep organic soil had succeeded to a willow thicket. While these changes were initially ascribed to drainage from the downstream canals, it turned out that they were merely natural processes operating in the absence of fire. At the other extreme, when Corkscrew Swamp Sanctuary was established in the mid-1950s, there were extensive open marshes over much of the area. At that time, these were perceived as the natural undisturbed character of these sites. However, research showed that they were a product of an unnaturally high fire frequency maintained by cattlemen to improve dry season grazing conditions on open range.

The main reason Corkscrew Swamp Sanctuary exists is to protect its old growth cypress forest, and the wood stork colony that nests in these trees. A cross-sectional profile of the cypress forest shows a dense stand of relatively small trees near the edge grading into a stand of large, scattered trees at the center. We looked at a variety of possible explanations for this forest structure, which hopefully would provide insights into the kinds of management that would be most useful to its long term maintenance.

The explanation turned out to be relatively simple. The longer the cypress lived, the bigger they were (Duever et al. 1984). But why do we see the bigger, older trees only in the forest interior?

The increasing depth of the organic soils as one moves from the cypress forest edge to its interior turned out to be an important piece of the puzzle. It turned out there was an excellent correlation between organic soil depths and both tree size and how long the peat mass remained in contact with the water table during the dry season. The latter was important because those portions of the swamp where the peat was in contact with the water table were more protected from severe fires. Thus, as one approached the forest interior, with its increasingly deeper peats, these sites burned less frequently and severely and, as a result, supported larger, older trees.

Now again, looking at the time perspective, the oldest trees along the transect are on the order to 300 - 500 years. It is obvious that if you're going to maintain this old growth system, it is not very realistic to think in terms of 5, 10, or 20 years; you have to think in terms of centuries. Also, the organic soils have an important relationship to the structure of the forest, and thus its maintenance. Using carbon-14 dating techniques, we know the peats that underlie this old growth forest are on the order of 3000 - 5000 years old (Kropp 1976). Since organic soils can be rapidly oxidized when exposed to the atmosphere for even relatively short periods of time, and they require thousands of years to develop, they deserve special consideration when potential affects of either development or restoration are being evaluated.

The wettest sites at Corkscrew Swamp are ponds, which have an unvegetated ground surface or support floating plants. On these sites water stands above ground all year during most years, but during periodic droughts, even these sites will be dry. We found these open water habitats exist because of peat fires that occur during extreme drought events. Again using carbon-14 dating techniques, we estimated one pond to be over 500 years old (Taylor 1980). Thus, unless draglines are to be brought in, infrequent droughts and fires will need to continue to play a role in maintaining them as a component of the Corkscrew Swamp ecosystem.

Over the past 15 years we have worked to integrate the research discussed above, as well as many other pieces of information, into a coherent model describing the major factors controlling the plant communities at Corkscrew Swamp. The current version of this model sorts these communities on the basis of their hydroperiod, the annual period of inundation from 0 to 365 days per year, and the amount of time during which succession has occurred following a severe fire (Figure 2). Hydroperiod is clearly the most important factor, since it determines not only the major structural type of community on a site, but also the site's fire regime.

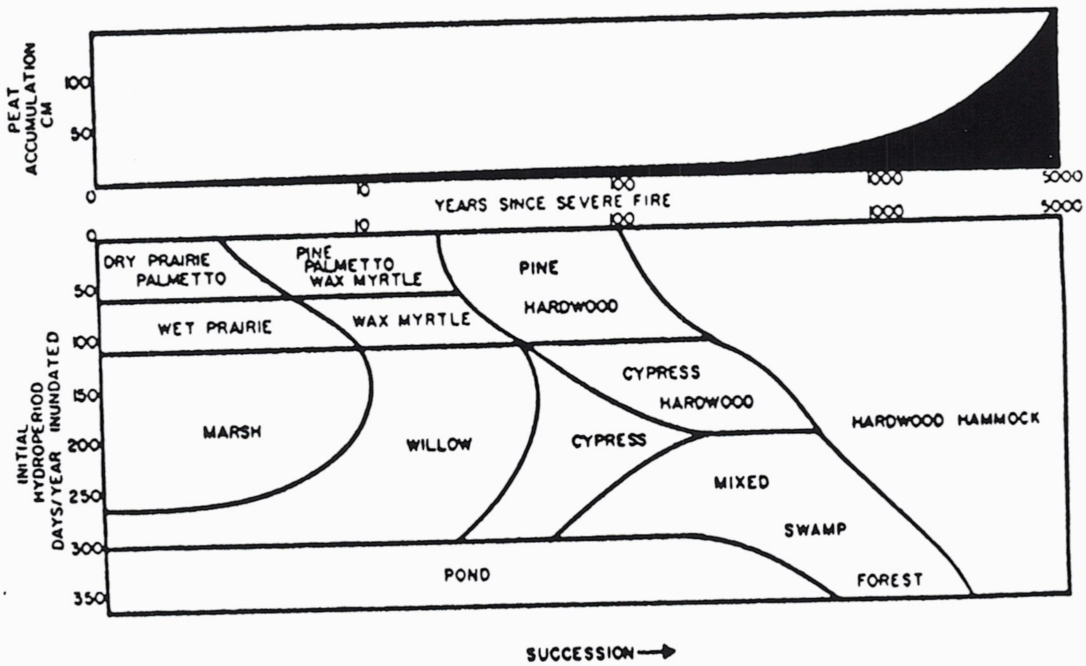

Figure 2. South Florida successional patterns as a function of hydroperiod and time since severe fire, and peat accumulation as a function of time (Duever 1984).

In addition, to identifying the major factors controlling Corkscrew's plant communities, the model summarizes available information about the time periods over which these communities change. Herbaceous communities exist on sites that experience frequent severe fires, and the different kinds of herbaceous communities are a function of how long a site is wet. As time passes without the occurrence of fire on a site, more and more woody components enter, until the site is dominated by a forest community.

Management Implications

The development of an understanding of the time frames over which the different communities change in response to either natural or anthropogenic influences was an important aspect of our research at Corkscrew Swamp. It was also a necessary piece of information if the sanctuary manager was going to be able to design a realistic management program to maintain the kinds of communities he considers desirable, and to be able to evaluate the success of his management activities. In addition, this understanding of the time frames involved provides a perspective on the commitment required by any restoration efforts he might contemplate. For example, how long will it take for a cypress community to develop on a site currently dominated by a shrub community? Or how often should a site be burned to restore a marsh in an area that has become dominated by shrubs? The precision of this general model, which is affected by a variety of other modifying factors, is less crucial than is the perspective it provides on the time frames involved. Thus, it is going to take at least decades before a cypress community can even begin to develop on a shrub site, much less come to dominate it, but the marsh could be restored within a few years by the application of prescribed annual or biennial fires.

The model also permits an evaluation of the significance of potential impacts by proposed activities, whether they are onsite management or development on adjacent properties. When a citrus grove or a wastewater treatment facility has been proposed in the vicinity of the sanctuary, our first concerns have been "How will this development affect the hydrology of the site to be developed", and "How far beyond the development site boundary will significant affects extend?" With the answers to these questions, the manager can now make decisions with a high degree of confidence as to whether there are likely to be unacceptable impacts on the sanctuary as a result of these activities. Of particular importance, a manager, or a new inexperienced successor, is able to make this decision on the basis of effects that may not occur immediately or in the near future, but which are likely over the ten or hundred year time periods over which these systems function. This perspective also provides a basis for making these decisions before either the manager or an adjacent landowner have made a significant financial commitment to their activities.

The lack of this kind of information is the reason that Audubon originally perceived that the sanctuary was being impacted by downstream canal development. Namely, they didn't understand the natural hydrologic variability, natural successional patterns and rates, or the role of fire in the long term maintenance of these communities. This made it very difficult for them to make appropriate decisions about what were, or were not, potentially significant impacts of activities on surrounding lands.

VARIABILITY

Another important aspect of the long term perspective is explicit recognition of the existence of temporal variability in natural ecosystem characteristics and processes. Variability exists over a number of time scales, such as monthly, seasonal, annual, and longer term cycles and fluctuations. In this symposium we have heard mention of a number of examples of seasonal and annual patterns of water level fluctuation, as well as year to year variations in the means and ranges of these patterns. Figure 3 illustrates two annual cycles of water level fluctuation under two different sets of climatic conditions for an undisturbed site in the Big Cypress Swamp. The period from May 1957 through April 1958 had unusually high precipitation during the dry season, and as a result, water levels remained fairly constant all year. In contrast, the same period in 1970-71 had a dry season with very little rainfall, and the water table declined steadily through the winter and spring months.

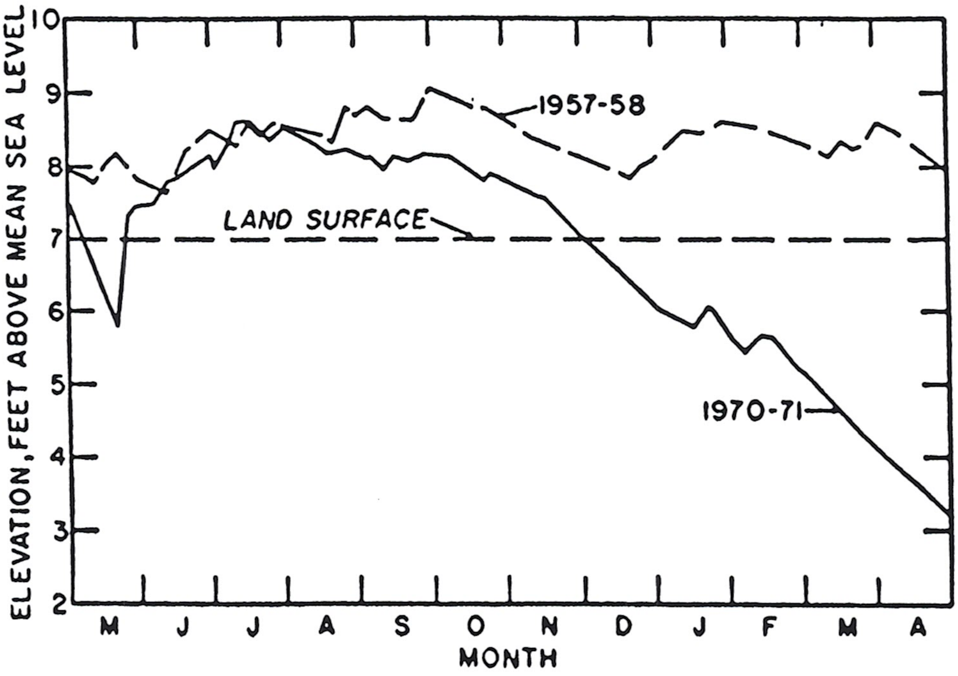

Figure 3. Hydrographs showing water levels at Tamiami Trail bridge 105 between Forty Mile Bend and Monroe Station during a year with a "wet" dry season (1957-58) and one with a "dry" dry season (1970-71) (Freiberger 1972).

In addition to these relatively short term patterns, certain parts of the United States have recently experienced dramatic examples of longer term changes in hydrologic patterns. The Great Salt Lake and Lake Michigan represent major systems where climatic cycles have changed, producing historically unprecedented high water levels and major impacts on man's activities on surrounding lands. Similarly, it is imperative that restoration plans for the Kissimmee River and its floodplain communities be designed so they are able to adjust their boundaries in response to temporal fluctuations, including such long term events as shifting climatic patterns, if they are to continue to exist over the long run.

Variability is a part of all natural processes, and is particularly important in wetlands, since these plant and animal communities are not only adapted to it, but are frequently dependent on it. While severe environmental fluctuations may adversely affect some species in some seasons or years, few wetland species require optimum conditions all the time. This is one of the reasons these species are favored by the variability inherent in wetlands, since it eliminates competition from those species who do require a more stable environment. Cypress is a good example of a species that is dependent on this variability. It is very long lived and tends to show strong year classes on the order of every twenty to fifty years. These strong year classes appear to develop during rare extended droughts that permit sufficient time for the seeds to germinate and seedlings to grow tall enough to escape flooding during subsequent wet seasons. However, cypress also needs regular inundation, and a more or less normal hydroperiod during most years for the forest to survive the occasional fires that may threaten it. So, different portions of the life history of a species may require very different conditions if that species is to survive in an area.

Trying to eliminate or control natural fluctuations in an ecosystem requires a great deal of effort. Indeed, it is a major aspect of many of man's development activities. A restoration design that maintains, rather than attempts to overcome this natural variability will be much cheaper over the long run, since it will have a greater chance of successfully dealing with natural fluctuations that will inevitably occur.

BUFFER LANDS

A third aspect of long term planning that has become obvious during our work at Corkscrew is the necessity for the establishment of buffer areas to protect a site's most important resources from impacts of activities on surrounding lands. Whether or not buffers are designed as part of a site management or restoration plan, they are going to exist on or adjacent to a site.

An aerial view of Corkscrew Swamp Sanctuary would show the existence of a variety of land uses on surrounding properties. Some of these began before we had any real sense of how they might affect the sanctuary or our ability to manage it. For most of these land uses there is still relatively little data on their specific impacts on wetlands. However, it does not take much to see that when the edge of a citrus grove lies right across your property line, and the hydrology of that site has been significantly altered from its original undisturbed condition, the resulting buffer area between the grove and the sanctuary is going to be on sanctuary property. Where these activities have been in place for some time, there is little we can do to change them, and our options for management to compensate for their effects are frequently quite limited. All we can normally do is hope that the more important habitats on the sanctuary are at some distance from this property boundary, and will still be sufficiently buffered from the impacts of the grove's management activities.

However, when new development is being proposed around the sanctuary, it is possible to anticipate the location and approximate width of buffer zones that will exist along our common boundary. It does not seem unreasonable that adjacent landowners should be willing to accept responsibility for absorbing at least some, if not all of a buffer zone, since they are the individuals altering existing conditions. Just as they want to be able to use their land as they please, we should have the same right and should not have to suffer impacts that degrade our intended land uses.

Similarly, when a new site is to be restored and managed as a natural ecosystem or to benefit certain species, consideration must be given to the design of that system so as to provide adequate buffer lands. This requires that arrangements be made, whether they are acquisitions, leases, zoning of adjacent lands, or whatever, so that there is a buffer area of sufficient size around the prime Kissimmee River resource areas to protect them from surrounding land development activities that cannot otherwise be stopped or modified to produce minimal impacts on these resources.

CONTROL OF EXOTIC VEGETATION

Recognition of the problems posed by exotic vegetation, and prompt and adequate response to their initial appearance is the final aspect of the long term maintenance of natural communities or populations that I would like to mention. While it is so much easier to deal with exotics when they first appear, this is also the time when it is easiest to ignore them because there are always "more pressing needs". Considering the extent of proposed system alteration in the restoration of the Kissimmee River, plans for dealing with exotic plant invasions should be a major and continuing part of the restoration effort. The Hole in the Donut in Everglades National Park is a good example of a situation where a major restoration effort has been thwarted by the presence of exotic plants. Tremendous amounts of money have been spent to deal with this situation, with a still uncertain outcome. Again, this points to the importance of looking at the restoration effort with a view toward identifying potential problems that may not become significant for years, but which will inevitably play an significant role in determining the long term success of the effort.

CONCLUSIONS

In summary, planning for the long term management of a dynamic Kissimmee River ecosystem must be an integral part of any restoration program that is likely to be successful over the long run. This effort should be a part of the initial planning process and formulation of project objectives. The kinds of ecosystems desired must first be decided upon, then the management activities necessary to maintain them must at least be roughed out, and finally the constraints on the attainment of these management goals must be evaluated. This will help to identify important trade-offs, particularly initial development costs as opposed to long term management costs. Consideration must also be given to the legal aspects of management activities, such as prescribed burning, water management, exotic control programs, etc. in relation to existing and potential future land uses on surrounding properties not under the control of the state.

In the current stage of the restoration process, it is easy to think "We can deal with all of those details later on when we have the physical system in place". However, as has been learned the hard way at a number of Audubon's own properties, all to often when the system is in place, if major impacts become imminent or actually begin to occur, it can be very expensive, or all too often impossible, to even minimize, much less eliminate those impacts on a site.

REFERENCES

Duever, M.J., J.E. Carlson, L.A. Riopelle, Corkscrew Swamp: A Virgin Cypress Strand, Pages 334-348 in Cypress Swamps, K.C. Ewel and H.T. Odum, editors, University of Florida Press, Gainesville, 1984.

Duever, M.J., Environmental Factors Controlling Plant Communities of the Big Cypress Swamp, Pages 127-137 in Environments of South Florida Present and Past II, P.J. Gleason, editor, Miami Geological Society, Coral Gables, 1984.

Freiberger, H.J., Streamflow Variation and Distribution in the Big Cypress Watershed during Wet and Dry Periods, Florida Bureau of Geology Map Series No. 45, 1972.

Kropp, W., Geochronology of Corkscrew Swamp Sanctuary, Pages 772-785 in Cypress Wetlands for Water Management, Recycling and Conservation, H.T. Odum, K.C. Ewel, J.W. Ordway, and M.K. Johnston, editors, Center for Wetlands, University of Florida, Gainesville, 1976.

Taylor, J., Lateral Expansion and Peat Accumulation in Corkscrew Swamp Sanctuary Central Marsh Transect, Unpublished Report, 1980.

Wharton, C.H., H.T Odum, K. Ewel, M. Duever, A. Lugo, R. Boyt, J. Bartholomew, E. DeBellevue, S. Brown, M. Brown, and L. Duever, Forested Wetlands of Florida - Their Management and Use, Center for Wetlands, University of Florida, Gainesville, June, 1977.