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SURFACE WATER HYDROLOGY OF AN IMPORTANT CYPRESS STRAND

CORKSCREW SWAMP SANCTUARY

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INTRODUCTION

The National Audubon Society's Corkscrew Swamp Sanctuary is a 4400 ha wetland preserve located in southwest Florida approximately 50 km northeast of Naples. The drainage area of the sanctuary is 295 km^2, of which about 90 km^2 is normally inundated for more than 6 months each year. Major surface flows enter the sanctuary along its eastern boundary and leave to the south, although during high water periods, significant outflows also occur to the west.

At present, no major canals drain a significant portion of the watershed and a change in timing of runoff associated with agricultural activities in the surrounding uplands seems to be the only type of hydrological modification that is occurring. This involves pumping water out of agricultural areas during high water periods, and irrigation during dry periods from deep wells, which to date appears to more than compensate for increased wet season outflows.

In 1973, we initiated a study of the Corkscrew Swamp ecosystem to develop an understanding of the major processes controlling the kinds, distribution, and condition of its plant communities. Since hydrology is probably the major environmental factor affecting these communities, one of our highest priorities was to obtain information on depths of water above and below the land surface in different seasons, hydroperiods, flows, and water quality in the major habitats on the sanctuary. While much hydrologic data are available for south Florida, few studies have tried to relate these to natural undisturbed habitats.

METHODS

Most of our research was conducted from 1974 to 1977 along four transects across the major flowway through the sanctuary. Thirty-one shallow wells were installed along these transects in representative habitats, and were correlated with measurements at two staff gauges monitored by sanctuary personnel since 1959. Precipitation and surface water flows were measured to determine quantities entering and leaving the sanctuary, and water quality was determined for surface, shallow groundwater, and precipitation samples. In addition to precipitation and hydrologic studies, we examined soil profiles and vegetation characteristics along each transect.

WATER LEVELS

As would be expected, upland habitats were consistently drier throughout the year than were marsh and cypress (Taxodium distichum) habitats. The marsh and cypress sites had a similar range of water levels during the dry season, but only the deeper marsh and shallow cypress areas overlapped during the wet season. The 1974 dry season was one of the three most severe recorded during the period from 1959 to 1980. By May, water levels had declined to 130-160 cm below ground in the upland pine and hardwood hammock sites, to 70-130 cm in marshes, and to 70-140 cm in cypress habitats. Wet season water depths generally reach from about 10 cm below to 20 cm above ground in upland habitats, 20-45 cm above ground in marshes, and 40-60 cm above ground in cypress during most years. Willow (Salix caroliniana) sites had water depths similar to the cypress sites. Ponds with open water or dominated by floating plants or flag (Thalia geniculata) were the deepest habitat.

The water level range for a particular habitat type on different sites was small during the wet season, but broadened considerably in the dry season. The highest dry season water levels were maintained by capillarity at marsh and cypress sites with organic sediments in excess of 1 m deep. The lowest levels regardless of habitat type were found in areas shallowly underlain by extensive shell beds which appeared to rapidly conduct ground water away.

Since 1959-1977 rainfall and water level data from Corkscrew Swamp correlate well and these data were not available prior to 1959, we compared Corkscrew and Fort Myers precipitation records for this period to see if Fort Myers rainfall data, which is available back to 1892, could be used to calculate earlier Corkscrew water levels. Correlations between the two stations were lower ($r = .81$) when individual months were compared, but were high ($r = .97$-$.98$) when dry season (January-May), wet season (June-September), or annual (June-May) precipitation data were compared. Also, a preliminary examination of Fort Myers precipitation data revealed no major changes in rainfall patterns during the period of record, so that water level data gathered at Corkscrew since 1959 is probably representative of hydrologic conditions there over the entire period back to 1892.

HYDROPERIOD

We used the staff gauge-well site correlations to calculate hydroperiods in major habitats for 14 annual cycles between 1959 and 1977. We were able to calculate hydroperiods for a total of 43 sites since we surveyed the length of each transect at about 8 m intervals, and could make estimates for habitats between those with wells on the basis of our topographic data. Mean hydroperiods ranged from 10 to 346 days and standard errors were consistently between 7 and 22 days.

Hydroperiods for pine and hardwood hammock sites were not significantly different, and were less than 60 days. Marsh hydroperiods were normally in a range of 224 to 278 days, but at three sites, they were only 111-155 days. These latter sites are somewhat different in species composition than the wetter marshes and are probably more appropriately termed "wet prairie" than "marsh." Two marsh sites with unusually long hydroperiods (286-296 days) are

affected by impoundment and seepage through a dike.

The four sites with the largest and fastest growing cypress had hydroperiods of 286-296 days. Tree-ring analyses indicated that longer hydroperiods of 306-325 days at four cypress sites along the dike were slowing cypress growth rates.. Growth rates were also relatively slow on the four sites with shorter hydroperiods of 133 to 270 days. Poor growth was particularly obvious on the 133-day hydroperiod site, where there was a vigorous shrub stratum of wax myrtle (Myrica cerifera), a species characteristic of sites with hydroperiods between 45 and 155 days. In our study areas, willows grow where hydroperiods are between 278 and 291 days, but we have observed them growing well elsewhere on canal banks or in similar situations where they have a much shorter hydroperiod but where their root systems have access to water most of the year. Ponds, Corkscrew's deepest habitats, had average hydroperiods of 310 to 346 days. No natural habitat was continuously inundated; within the 18 years of record through 1977 there were three times when no natural surface water was present at Corkscrew Swamp.

What we regard as wetland habitats had hydroperiods of over 223 days. Peat accumulation was insignificant at sites with hydroperiods of less than 241 days, but was characteristic of habitats inundated for longer periods.

It is important to recognize that the relationship between water depths and hydroperiods observed at Corkscrew Swamp are a function of this strand's topography. The Corkscrew cypress forest has an average ground elevation range of 23 cm from the strand center to its periphery. Since we consider hydroperiod to be a more important factor than water depth, we expect that other cypress forests would have similar hydroperiods, although they might have quite different topographic gradients and hence different seasonal water depths.

WATER FLOWS

When water levels are low enough to restrict surface water flows, flow patterns become much more complex than the generally southward wet season pattern described earlier. During the dry season, soil porosity and permeability can locally control the general direction of water movement. Relatively impermeable peat masses, which are a regular feature of major wetlands, tend to restrict flows, while maintaining a relatively high water table associated with capillarity resulting from their fine structure. Although more erratically distributed, shell beds can very significantly depress water tables during the dry season where the beds are extensive enough to function as conduits. In some cases, they appear to control boundaries of major plant communities by lowering dry season water levels more than would be expected on the basis of site topography.

Dry season water flows are also affected by differential rates of water level decline associated with evapotranspiration from sites with and without standing water. At this time of year flows were typically from wetland areas with standing water into the dry surrounding uplands. As the water table declined below ground in the wetlands, water levels tended to equilibrate throughout the area. When the water table finally declined below the root zone, soils and regional gradients became the dominant factor controlling flows. The diurnal pattern of water level fluctuation associated with evapotranspiration disappeared at depths of about 150 cm below ground in pinelands, and at about 100 cm in mineral soil marshes. Even during severe drought years, the water

table did not drop below the root zone at any of the healthy cypress or organic soil marsh sites.

Early in the wet season, water flows tend to move from the uplands toward the wetlands, again associated with the fact that it takes more water to raise levels in an area where it is above ground than where the water table is still below ground. Thus, these data demonstrate that, wetlands such as Corkscrew Swamp can be important in reducing water level fluctuations in an area by absorbing wet season inputs and conserving dry season water supplies that would otherwise be lost as runoff.

Actual flow rates were measured at 13 marsh and cypress sites with water depths of 40-65 cm during peak water levels in 1975. Along one transect flows varied from 1.3-3.5 cm/sec, and along another they varied from 0.3-0.8 cm/sec. Peak annual water levels during the period from 1960 to 1977 varied by as much as 20 cm above or below the 1975 levels for which these flow rates were determined.

Total flows were measured at all inflow and outflow points on the sanctuary for the spectrum of normal water levels, and in combination with precipitation and evapotranspiration data, will be used to construct a water budget for the sanctuary.

WATER QUALITY

We have approximately two years data on concentrations of seven elements in surface and ground water as well as for soils and vegetation, and lesser amounts of information on about seven other elements, but we have not yet had time to analyze all of this information. However, a couple of points of interest concern:

1. wet season dissolved oxygen concentrations were less than 2 ppm in the swamp, in dense marsh communities, and at night in open marshes;
2. pH's of surface water in the swamp are typically about 6.5-7.0, but may reach 9.2 during the day in some open marshes due to photosynthetic activity;
3. phosphate levels in surface peat are normally less than 50 ppm, but may reach concentrations of 8000 ppm in the more heavily used portions of the wood stork rookery.