Abstract No: A-231

FORESTED PEATLAND MANAGEMENT IN SOUTHEAST VIRGINIA AND NORTHEAST NORTH CAROLINA, USA

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SUMMARY

The U.S. Fish and Wildlife Service manage 130,000 ha of forested peatlands in southeast Virginia and northeast North Carolina, U.S.A. at three national wildlife refuges: Pocosin Lakes, Alligator River, and Great Dismal Swamp. The refuges contain extensive networks of roads and drainage canals; the legacy of past logging and farming activities. Canals have contributed to peat subsidence and facilitated the conversion of wetland forest communities to upland forest communities. During drought periods, drained peat is prone to wildfires that can burn for several months and pose health risks to neighboring communities. Refuge managers are working to restore historic forest communities and stop peat loss through hydrologic restoration, forest management, and fire management. Following four separate severe peat fires on refuges in 2008 and 2011, emphasis has been placed on improving water control capability to support habitat restoration and fire suppression activities.

Keywords: *Pocosin, forested peatland, peatland restoration, controlled drainage, national wildlife refuge*

INTRODUCTION

The South Atlantic Coastal plain of the United States is home to extensive forested wetlands on peat soils known as pocosins (Richardson, 1991). Also described as evergreen (or southeastern) shrub bogs, the pocosin vegetation community consists of an open-pine canopy underlain by a dense shrub layer. Pocosins cover hundreds of square kilometers on the Coastal Plain from Virginia to Florida with the highest concentration in coastal North Carolina (Richardson 1991). They are found on peatlands that have formed on interfluves with low topographic relief, near the edge of estuarine wetlands, or in depressions with poor drainage (Brinson**,** 1991). Maximum peat depths approach 5 meters and peat accretion has been occurring for 8,000 – 10,000 years (Richardson, 1982, Brins**on,** 1991). Pocosin peatlands are typically ombrotrophic with no inflowing surface water or groundwater supplies (Daniel III**,** 1981). The peat is typically saturated to land surface during the cool season (November – April) but the water table may drop 60 – 90 cm below land surface during the warm season (May-October) **(**Richardson**,** 1982).

The United States Fish and Wildlife Service (USFWS or Service) is the principal federal agency responsible for conserving, protecting, and enhancing fish, wildlife, plants, and their habitats in the United States. The Service protects 130,000 ha of pocosin peatlands at Great Dismal Swamp (45,300 ha), Pocosin Lakes (24,000 ha), and Alligator River (61,200 ha) National Wildlife Refuges (NWR) (Figure 1). The refuges were established between 1974 and 1990 on land previously used for commercial activities like forestry, agriculture and peat mining. There are hundreds of kilometers of drainage canals on each refuge constructed to support previous land use activities. Historic land use and the associated canal construction are implicated in reducing the species diversity of the forest communities, increasing the frequency and severity of peat fires, and significantly altering the peatlands' hydrology (USFWS, 2006; USFWS, 2007; USFWS, 2008).

The primary goal of each refuge is to preserve and protect the unique forested wetlands for the benefit of the species that depend on them. Restoration to mimic the pre-disturbance hydrology of the peatlands is viewed as one of the best management tools for achieving that goal. This paper presents the refuges' approach to hydrologic restoration and describes the application of this approach to address specific management concerns associated with water management, saltwater intrusion, and peat fires.

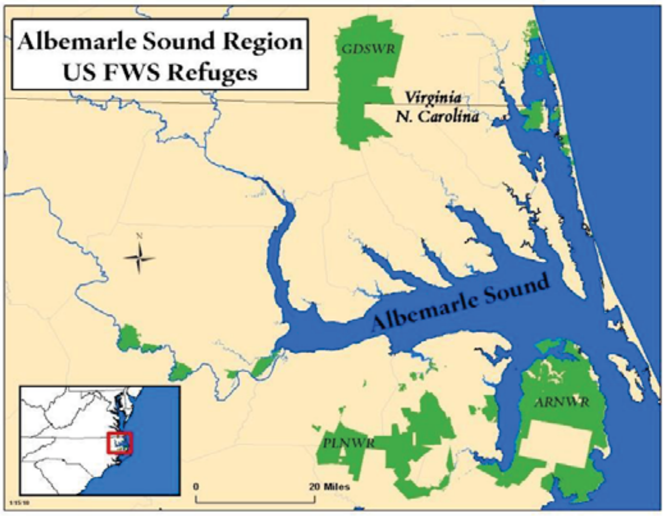

Figure 1: Location of Great Dismal Swamp (GDSWR), Pocosin Lakes (PLNWR), and Alligator River (ARNWR) National Wildlife Refuges in southeast Virginia / northeast North Carolina, USA. Map courtesy of The Nature Conservancy (TNC).

METHODS

Water Control Structure Installation

The Service's strategy for hydrologic restoration follows controlled drainage practices used on agricultural land and managed forests on the Virginia and North Carolina Coastal Plain. Engineered structures (referred to here as water control structures) are installed in canals to slow drainage and set canal water levels (Dukes *et al.*, 2003, Evans *et al.*, 2007). Canal flow rates and water levels are controlled by manually adding or removing 15-cm wide boards, or stop-logs.

Depending on the alignment of the canal with the contours of the peat surface, a single control structure can influence water levels in several kilometers of a canal. Canal blocking strategies developed for Pocosin Lakes NWR, recommend placing water control structures in canals at each 30 cm change in elevation (SCS 1994). The approach is similar to those described in other peatlands (Lunt *et al.*, 2010, Jaenicke *et al.*, 2010, Landry and Rochefort 2012). In practice, water control structures are placed less frequently due to funding limitations or the configuration of the canal network.

The most common structure installed in refuge canals are made locally from corrugated aluminum culvert material (Figure 2). Culvert diameters are typically 1.5 – 2.0 m with 2 – 3 m wide riser sections. Two or three structures may be installed at a site to provide enough capacity for expected flow rates. Structures are usually placed in canals at road crossings using heavy excavating equipment. Headwalls of aluminum, stone, and wood are often added on the upstream and downstream faces of the structures to reduce erosion (Figure 3). After the structure is in place, 15 cm boards are added to the riser section to control the elevation of the water surface in the canal.

Figure 2: Pre-fabricated aluminum water control structure ready for transportation to installation site. Culvert diameter: 1.2 m. Culvert length: 14 m. Riser height: 2.1 m.

Figure 3: Recently installed water control structure at Great Dismal Swamp NWR.

The goal of installing these structures is to give managers the capability to control canal drainage. The refuges monitor hydrologic conditions, soil respiration, peat subsidence, and forest health to evaluate if water control structures are meeting management objectives.

RESULTS / DISCUSSION

Accommodating Variation in Canal Flow Rates

Canals change peatland hydrology by capturing sheetflow and concentrating runoff. Peak flows tend to be higher in drained peatlands than undrained peatlands (Daniel III 1981). Water control structures designed to raise canal water levels can be compromised if they are unable to pass peak flows (Ritzema *et al.*, 2014). At Great Dismal Swamp NWR, canal discharge measurements over 5 years range from 0 m^3/s during dry periods to more than 2 m^3/s following large, intense precipitation events (>200 mm in 48 hours). The refuges prefer water control structure designs that can be adjusted to different flow conditions. Structures that are not adjustable, like canal plugs and fixed weirs, are used infrequently due to concerns they will be compromised by peak flows. In addition to corrugated aluminum structures (Figure 2 and 3), Great Dismal Swamp NWR is installing adjustable weirs to control drainage in some locations (Figure 4).

Figure 4: Example of an adjustable weir type water control structure. Weir width approximately 4.5 m. Great Dismal Swamp NWR. Photo courtesy David Byrd, USFWS.

Limiting Saltwater Intrusion

The unique challenge of hydrologic restoration at Alligator River NWR is the refuge's proximity to the Albemarle and Pamlico Sounds (Figure 1). Canals draining to the sounds act as conduits for salt water, particularly during wind tide events. Saltwater intrusion via canals accelerates the conversion of forested wetlands to saltwater marsh (Bryant et al 2012). Water control structures at Alligator River are fitted with flex check valves (Figure 5) to allow freshwater to exit the canal but prevent the landward migration of saltwater from the Pamlico Sound.

Alligator River NWR is also experimenting with canal plugs to prevent salt water intrusion on smaller canals (< 3 m). Plugs are constructed using vinyl sheetpile surrounded by earthen fill and placed near shoreline outlets. Freshwater flow is insignificant on these canals and no accommodation is made for freshwater outflows.

Figure 5: Water control structures at Alligator River NWR ready for installation. Tide-check flex valves installed on the outlet end to prevent saltwater intrusion upstream of water control structures. Photo courtesy of TNC.

Facilitating Fire Suppression

Fire is considered one of the most important controls on vegetation distribution in pocosins peatlands (Christensen 1981, Frost 1989). Although fire is common enough for pocosins to be considered fire-dependent ecosystems, fire return intervals are sufficiently long in undrained pocosins to allow for peat accretion and forest stand development (Frost 1989, Richardson 1991). Drainage tends to increase the frequency and severity of ground fires in peatlands (Turetsky et al 2010) and large ground fires have been a common occurrence in drained pocosins (Frost 1989). Between 2008 and 2011, approximately 36,000 hectares burned on the three refuges in four separate fires.

Fire suppression techniques developed for pocosin peatlands focus on attempting to douse ground fire by flooding the burning area. Water is transported to the fire using pumps powered by the Power Take-Off (PTO) drives on farm tractors and the existing canal network. Water is pumped from low elevation sources to fires on higher elevation peat. Pumping operations move water against the natural slope of canals using PTO pumps positioned at multiple dams (Figure 6). PTO pumps can move large volumes (18,000 liters/minute) but are limited to low head applications. To maximize efficiency, pump stations are placed every 1-2 km and/or every 30 cm change in elevation. In addition, water must be kept on the land 2 – 3 weeks to extinguish the burning peat. During the most recent fires in 2011, the existing water control structure network at Alligator River and Great Dismal Swamp was insufficient to meet these criteria. Temporary dams were coupled with the existing network of water control structures to transport water to the burning areas.

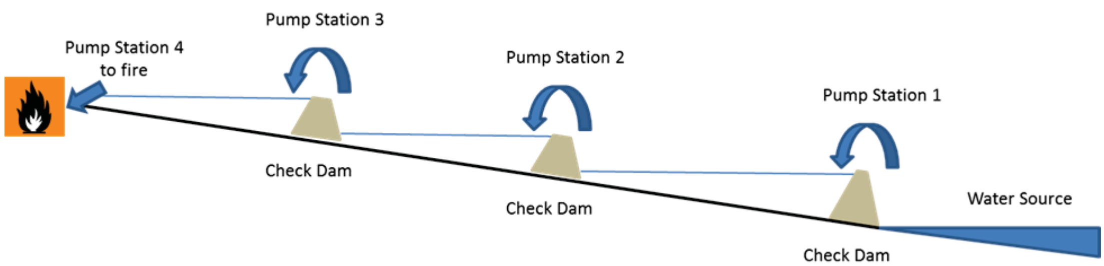

Figure 6: Schematic of pumping stations and temporary dams used to transport water against the slope of a refuge canal.

SUMMARY

Despite the history of disturbance in pocosin peatlands, relatively large tracts of these unique wetlands are protected by the USFWS and other conservations organizations in southeast Virginia and northeast North Carolina. In most cases the protected areas were established after earlier land-use activities such as logging, farming, or peat mining had failed. At each refuge the USFWS has inherited hundreds of kilometers of canals that continue to negatively impact the peatlands' hydrology. Installing water control structures to block canals, slow drainage, and re-wet peat has been a management focus at the refuges since their establishment. The basic concepts guiding canal blocking are similar to those being applied on other peatlands (Lunt et al. 2010, Jaenicke et al 2010, Landry and Rochefort 2012) although the materials and installation techniques follow local practices used on nearby agricultural land. In addition to raising dry season water levels, water control structures are used to facilitate pumping operations during fires and slow saltwater intrusion in freshwater wetlands.

ACKNOWLEDGEMENTS

Preserving and protecting pocosin peatlands is a team effort involving many individuals at multiple agencies and partner organizations. All the individuals cannot be named here but include representatives from the following organizations: U.S. Fish and Wildlife Service, U.S. Geological Survey, U.S. Department of Agriculture Natural Resource Conservation Service, U.S. Army Corps of Engineers, Duke University, North Carolina State University, Christopher Newport University, Virginia Polytechnic Institute and State University, The Nature Conservancy, Albemarle-Pamlico National Estuary Program, Duke Energy, The Conservation Fund, TerraCarbon, North Carolina Department of Environmental Quality, North Carolina State Parks, North Carolina Forest Service, and Virginia Department of Game and Inland Fisheries.

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