# ATLANTIC WHITE CEDAR SALVAGE EFFORTS IN THE GREAT DISMAL SWAMP FOLLOWING HURRICANE ISABEL

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*Abstract:* On September 18, 2003, Hurricane Isabel made landfall near Drum Inlet on the Outer Banks of North Carolina, and inflicted considerable damage to forests throughout North Carolina and Virginia. Some of the most severe damage occurred within the mature stands of Atlantic white cedar (AWC) in the Great Dismal Swamp National Wildlife Refuge (GDSNWR). No mature stands of AWC within the GDSNWR escaped without significant damage. The thick layer of debris including a tangled mat of uprooted, snapped and standing storm damaged trees prohibited natural regeneration of AWC and represented a severe fuel loading situation. Between the spring of 2004 and fall 2006, the GDSNWR conducted two timber sales to reduce the fuel loads and create an environment suitable for the establishment, survival and growth of cedar. This report discusses available information on Hurricane Isabel, the damage to cedar and cedar restoration efforts to date.

*Keywords:* Atlantic white cedar, Great Dismal Swamp, Hurricane Isabel, establishment, *Chamaecyparis thyoides*

## INTRODUCTION

Many coastal forests are subject to recurrent, large scale perturbations due to hurricanes, fire or other catastrophic events (Wright and Heinselman 1973, White 1979). Hurricanes are a major factor controlling ecosystem structure, function, and dynamics in coastal forest (Boose and others 2001). Very little is actually known about the long term impact of hurricanes on forested ecosystems (Lugo and others 1983).

High winds, torrential rains and storm surges are usually associated with hurricanes. The storm surge and heavy rains associated with a hurricane may cause flooding in coastal systems, tributaries, floodplains and headwater systems. Hurricane force winds may cause defoliation, breakage and windthrow in the forest. Weaver (1989) reported the severity of damage related to the storm intensity, forest structure and soil conditions.

Extensive research has been conducted on the hurricane damage to several coastal forested communities including hardwood, pine and cypress forests (Touliatos and Roth 1991, Hedlund 1969, Craighead and Gilbert 1962, Stoneburner 1978, Duever and others 1984, Hook and others 1991, Peart and others 1992, Boose and others 2001). However, very little has been written about the effect of hurricanes on AWC swamps.

AWC is susceptible to wind damage, because of its shallow root system and spongy characteristics of the peat (Little 1950). Korstian and Brush (1931) suggested cedar that has grown in dense stands on peat soils never become wind-firm. Mylecraine and Zimmermann (2000) reported cedar as being especially susceptible to windthrow when a stand is opened from a disturbance.

Cook (1857) provided some of the earliest documentation of cedar stands that had been damaged by winds. He noted that cedar trees that were being mined from in the peat had blown down and their upturned roots were still present. Hawes (1939) reported that extensive stands of cedar near Voluntown, Connecticut were heavily damaged by a hurricane in 1938. Several acres were completely leveled, while in other places the trees were pushed only partly over.

In September 2003, Hurricane Isabel struck portions of eastern North Carolina and southeastern Virginia. The objective of this report is to describe the damage to AWC in the GDSNWR; and summarize current restoration efforts.

## HURRICANE ISABEL

Hurricane Isabel made landfall as a Category 2 storm on September 18, 2003 (figure 1) with the eye of the storm passing near Drum Inlet, NC (Beven and Cobb 2004). Estimated maximum sustained winds were 157 - 166 km/hr and a 1.8 – 2.4 m storm surge was recorded over the eastern portions of the Pamlico and most of the Albemarle Sounds. Isabel weakened as it moved inland and became a tropical storm as it moved northwestward over southern Virginia and lost its tropical characteristics on September 19$^{th}$ as it moved across western Pennsylvania.

Widespread damage from wind and storm surge occurred throughout Isabel's path. Estimated insured property damage for Isabel was $1.7 billion and the total damage was estimated to be $3.4 billion. Isabel was the twelfth most costly hurricane to make landfall in the United States. Isabel was one of the most significant hurricanes to affect portions northeastern North Carolina and southeastern Virginia since Hurricane Hazel in 1954 and the Chesapeake-Potomac Hurricane of 1933.

## IMPACT TO CEDAR

Historically, AWC formed one of the two dominant forest types in the GDSNWR; however, past harvesting practices, changes in hydrologic regime, and fire suppression, have promoted the establishment of communities dominated by red maple (*Acer rubrum*). Prior to Hurricane Isabel, the GDSNWR contained approximately 1,000 ha of mature AWC stands and approximately 4,000 ha of cedar mixed with hardwood and pine forest (Carter 1997, USFWS 2004).

As Hurricane Isabel passed to the southwest of the GDSNWR, it inflicted considerable damage to the forest throughout the GDSNWR especially within the mature pure AWC stands. USFWS (2004) estimated 85 percent of the mature cedar-dominant stands were destroyed and numerous individuals and clusters of trees that appeared to have survived the storm have since died. Storm damage included snapping and uprooting trees, which left the forest floor littered with a thick layer of debris (figures 2 and 3). Debris created by Isabel would prohibit natural regeneration of AWC and presented fuel loading problems for the GDSNWR.

## CEDAR RESTORATION

GDSNWR forest management programs are directed towards restoring and enhancing the natural habitat diversity by mimicking the natural forces that once maintained habitat and wildlife diversity. Historically, cedar was regenerated by catastrophic fires occurring every 50-300 years (Frost 1995). However, the use of fire to regenerate cedar after Hurricane Isabel was not practical. Therefore, a salvage logging program was developed to promote cedar regeneration and reduce fuel loading by removing debris left by Isabel.

In the spring of 2004, salvage logging began within the Blackwater Cut. The 28-ha site was selected because of its close proximity to Corapeake Road. Salvage logging operations, using an excavator mounted with a grapple saw and skidder, continued until spring 2005. DeBerry and others (2003) estimated the pre-Isabel stocking level of cedar at the site was 1,006 stems/ha and comprised 180 MT/ha of dry biomass. Habitat$_e$ was applied via aerial spraying in September 2004 to release the cedar seedlings that germinated since the beginning of salvage operations. Belcher and others (These Proceedings) provide additional information and quantify the number of cedar seedlings within the Blackwater Cut as of the winter of 2006.

Much of the severely damaged cedar was far from existing roads (USFWS 2004). These stands were inaccessible to conventional equipment used to harvest and transport timber because of the instability of the deep organic soils. To reduce impacts to soils and water quality the GDSNWR required timber removal to be conducted by helicopter logging and specialized low-pressure equipment. Carson Helicopter Services, Inc. was awarded the second salvage logging contract for 445 ha. Between March 2005 and November 2006, a total 260 ha of cedar were harvested and yielded an estimated 3 million board feet of timber. In addition to the saw timber, Carson removed approximately 4

million kg of fuel and has an additional 4-8 million kg stockpiled and awaiting removal (figure 4). These fuels consisted primarily of splintered cedar logs and material discarded due to extensive heart rot.

Carson used a combination of ground based equipment and a Super S-61 logging helicopter. In a few stands within close proximity to an existing road, an excavator mounted with a processing head was used to cut and process trees (figure 5). The excavators worked off of barge mats and a road constructed from slash. A tracked forwarder then collected the processed logs and carried them back to an existing road (figure 6).

For more remote sites, excavators were used to cut and pile trees for whole tree skidding by helicopter. A grapple was initially used to remove the cedar, but it was unable to hold the trees once airborne. Carson then switched to a choke cable system (figure 7).

## DISCUSSION

Conner (1997) suggested, since coastal forest developed in areas prone to hurricanes, it is likely that these forests have developed mechanisms to reestablish themselves rapidly following a disturbance. However, anthropogenic degradation at a landscape level has affected species composition and the self-maintenance potential of cedar within the GDSNWR. (Belcher and others, These Proceedings). Without salvage logging operations cedar stands damaged by Isabel would be replaced by hardwood swamps dominated by red maple (USFWS 2004).

Salvage logging operations to date have been very successful in reducing fuel levels and exposing the underlying seedbed to an increased level of light. Belcher and others (These Proceedings) assess cedar regeneration associated with three discrete areas (salvage logged areas, skidder trails, and control) in the Blackwater Cut.
To date, no formal estimates have been made on cedar regeneration within sites salvaged logged by Carson.

Additional monitoring of competition control, cedar seedling germination, survival and growth is needed prior to fully assessing the effects of salvage logging on cedar regeneration.

## ACKNOWLEDGEMENTS

We gratefully acknowledge the logistical support and assistance of Travis Comer of Malcolm Pirnie. We also wish to thank two anonymous reviewers for their helpful comments and suggestions.

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**Figure 1 - Isabel's path based on Beven and Cobb 2004.**

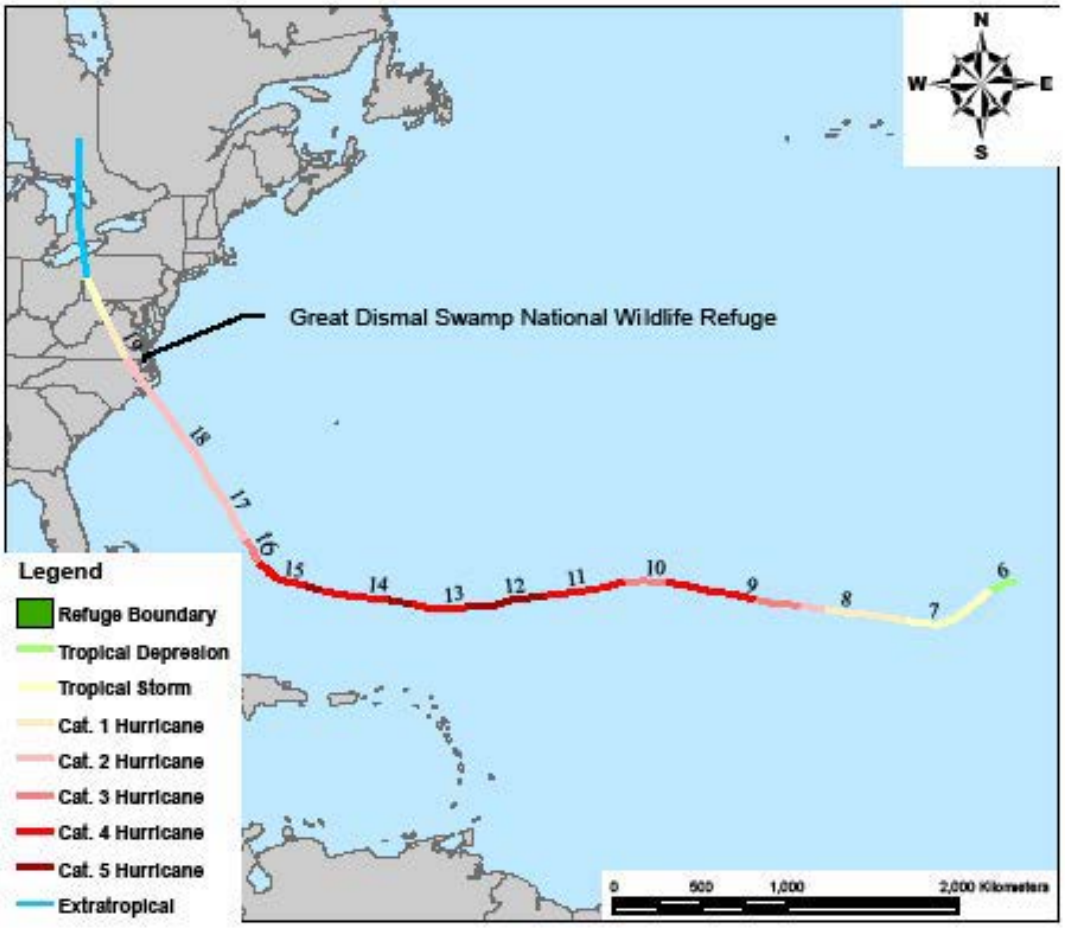

**Figure 2** - Aerial photographs showing damage caused by Hurricane Isabel, a) pre-Isabel conditions, b) post-Isabel conditions, photo courtesy of USFWS.

a.

b.

**Figure 3** - Bryan Poovey, Refuge Forester assessing cedar damage from the ground, photo courtesy of USFWS.

**Figure 4** - Scattered, split and rotten logs awaiting removal from the GDSNWR. During a conventional logging operation these logs would have remained within the site.

**Figure 5** - Daewoo excavator with processing head.

**Figure 6** - Tracked forwarder collecting processed cedar logs

**Figure 7 - Carson's helicopter after dropping its load at the logging deck, photo courtesy of USFWS.**