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Legacy tree retention in young aspen forest improves nesting habitat quality for Golden-winged Warbler (*Vermivora chrysoptera*)

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ABSTRACT

Residual canopy trees as biological legacies in harvested aspen stands may mimic characteristics of naturally disturbed forests. We investigated the effects of legacy tree retention in young aspen (*Populus* spp.) forest stands on the quality of nesting habitat for the Golden-winged Warbler (*Vermivora chrysoptera*), a species of conservation concern that is dependent upon recently disturbed forest and shrub habitats. Habitat quality was assessed by evaluating male density, male pairing success, percent of successful nests, daily nest survival, and productivity in young aspen stands (4–7 years post-harvest) with retained conifer legacy trees ($n = 3$), with retained hardwood legacy trees ($n = 3$), and without legacy trees (also referred to as clearcuts; $n = 3$). Male pairing success was higher in stands with legacy trees (68% in stands with conifer legacy trees, 71% in stands with hardwood legacy trees) than in clearcuts (10%). Only one nest was found in clearcuts. The percent of successful nests, daily nest survival rate, and productivity did not vary between stands with conifer legacy trees and stands with hardwood legacy trees. Based on high pairing success (resulting in high levels of nesting activity), retention of legacy trees in young aspen stands provided higher quality nesting habitat than clearcuts. Male density was an excellent indicator of pairing success (pseudo $R^2 = 0.976$). Aspen stands harvested for nesting habitat should support a minimum density of 0.2 males/ha to have approximately 75% of males successfully paired. High male densities (>0.2 males/ha) were achieved by retaining at least 13 legacy trees/ha with at least nine of these comprising hardwood species with a mean diameter at breast height $\geq$ 16 cm.

1. Introduction

In post-disturbance environments, biological legacies such as scattered live trees fill important ecological roles, and their retention may allow silvicultural treatments to more closely emulate natural disturbances (Seymour et al., 2002; Lindenmayer et al., 2006; Manning et al., 2006). Legacy canopy trees as individuals or patches are known to increase bird diversity in managed aspen (*Populus* spp.) forests (Merrill et al., 1998), and can also benefit certain bird habitat-guilds or individual species in other forest communities (Hansen et al., 1995; Schieck and Hobson, 2000; Tittler et al., 2001; Lefort and Grove, 2009). The impact of legacy canopy trees on bird habitat quality has been investigated using proxies for quality such as nest success (Tittler and Hannon, 2000; Duguay et al., 2001; Stuart-Smith and Hayes, 2003) and body condition in the post-breeding season (McDermott and Wood, 2010). Such demographic traits are generally accepted as better indicators of habitat quality than abundance or density estimates alone (Van Horne, 1983). Most previous research suggests that bird nest predation rates in forest stands was not affected by green-tree retention harvests or by density of retained trees (Tittler and Hannon, 2000; Duguay et al., 2001; Stuart-Smith and Hayes, 2003). One of these studies (Duguay et al., 2001) reported species-specific nest success for five passerine species, with higher nest predation rates in harvested stands with retained trees versus unharvested stands for one species, Acadian Flycatcher (*Empidonax virescens*).

We investigated the impact of legacy canopy tree retention, also called green-tree retention, in young aspen stands on a high conservation priority migratory songbird, the Golden-winged Warbler (*Vermivora chrysoptera*), during the breeding season. This species is dependent on disturbance events in forest ecosystems to create appropriate breeding habitat (Confer et al., 2011). The species' recent declines have been blamed in part on the maturation of forests in eastern North America (Confer et al., 2011). The Golden-winged Warbler, like other shrubland-dependent species, likely evolved to utilize forest openings regenerating with shrubs and young trees created by natural disturbances such as wind, fire, and beaver activity in forested landscapes (Hunter et al., 2001; Lorimer, 2001). These openings likely contained both live and dead legacy canopy trees in varying densities with scattered individuals and patches depending on the intensity of the disturbance (Foster and Boose, 1992; Frelich, 2002; Fig. 1a). Retention of legacy canopy

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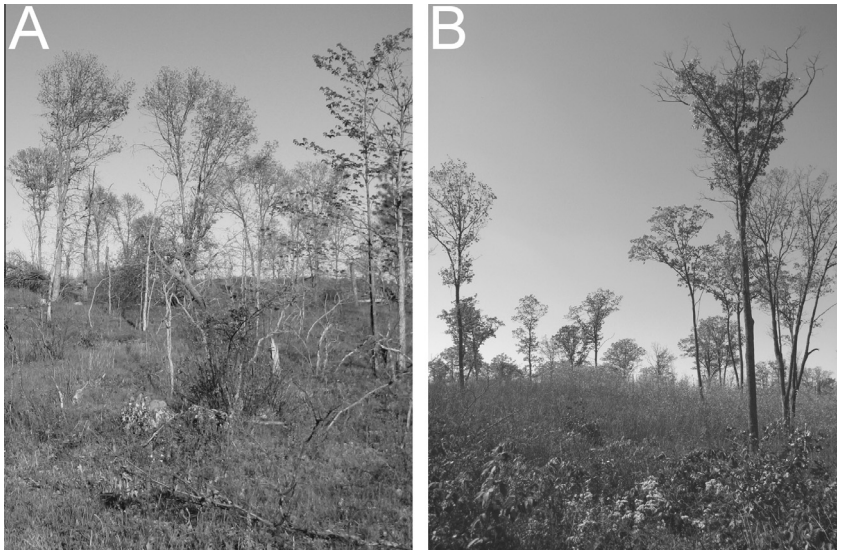

Fig. 1. Disturbed forests occupied by Golden-winged Warblers. (A) Blowdown caused by a straight-line windstorm in an aspen-oak stand in northwestern Wisconsin. The photo was taken one year after the storm following salvage removal of fallen trees. (B) Commercially-managed aspen stand with retention of hardwood legacy trees, primarily northern red oaks, three years post-harvest in north-central Wisconsin. Photos by Amber Roth.

trees in harvested even-aged forest stands has been proposed as a means of silviculturally mimicking this natural disturbance pattern (Seymour et al., 2002; Lindenmayer et al., 2006; Fig. 1b).

An estimated 76% of the global population of Golden-winged Warblers breeds in the Boreal-Hardwood Transition Bird Conservation Region (Blancher et al., 2007). Thus, management practices that create high quality breeding habitat in this region are critical to the species' future. Regenerating aspen forests supported the highest relative abundance of Golden-winged Warblers among several habitat types occupied by Golden-winged Warblers in northern Wisconsin (Martin et al., 2007). Among regenerating aspen stands, Golden-winged Warbler abundance or density was quite variable suggesting that not all stands are equally attractive and that stand characteristics may explain differences in use and quality (Roth and Lutz, 2004; Martin et al., 2007). Our objectives were to: (1) evaluate effects of legacy tree retention and legacy tree type on nesting habitat quality for Golden-winged Warblers in young aspen stands using male density, pairing success, nest survival, and productivity, (2) determine if male density reflects habitat quality based on demographic indicators, and (3) recommend aspen forest silvicultural guidelines for foresters and land managers interested in providing high quality nesting habitat for Golden-winged Warblers.

2. Methods

2.1. Study area

We selected nine young, aspen-dominated forest stands in Oneida and Vilas Counties, Wisconsin (45°43'N, 89°32'W) in an area defined by glacial moraines and outwash plains. Soils were characterized as sand, sandy loams, or loamy sands and ranged from moderately well-drained to excessively drained (Soil Survey Staff, 2010). Three stands were selected for each of three treatments: (1) aspen stands with no legacy tree retention, referred to hereafter as clearcuts, (2) aspen stands with conifer retention, and (3) aspen stands with hardwood retention. Stands ranged from 17 ha to 44 ha in area, and were commercially harvested using green-tree retention guidelines between 1997 and 2002. The regenerating aspen was therefore 4–7 years-old at the start of this study. Timber harvest prescriptions called for removal of all aspen and most tree species except trees to be retained. Retained trees included individuals marked by the forester and all large diameter pine (*Pinus* spp.) and oak (*Quercus* spp.; C. Dalton, pers. comm.). Aspen stands were dominated by *Populus tremuloides* and *Populus grandidentata* and included other abundant regenerating species, especially *Acer rubrum*, *Amelanchier* spp., *Prunus serotina*, *Quercus rubra* (northern red oak), and *Betula papyrifera* (paper birch). The dominant shrubs were *Rubus* spp. and *Corylus* spp. All sites were selected without prior knowledge of Golden-winged Warbler occupancy.

2.2. Field methods

Golden-winged Warbler territory and nest surveys were conducted 10 May–2 July 2007, 19 May–21 July 2008, 19 May–15 July 2009, and 16 May–3 July 2010. We captured and banded an estimated 88% of territorial adult males and 9% of adult females among all sites. Adults were targeted for capture using mistnets with tape playback (Kubel and Yahner, 2007) and then given a unique color band combination including an aluminum US Geological Survey Bird Banding Laboratory band for individual identification. In subsequent years, resighted birds were used to calculate annual return rates.

To determine territorial male densities in nesting habitat, we mapped locations for all territorial males using a modification of the protocol of Robbins (1970). Surveys for the same individual or stand were conducted at least three days apart. When possible, we used teams of two observers with one observer recording locations on a map and marking song perches while the second observer tracked the bird. Because of the dense vegetation, it was difficult to continually track a bird and thus considerable time was spent checking bands to make sure the same individual was resighted before resuming the survey. An identifiably unique individual was tracked until the observer(s) completed a full circuit of the bird's territory such that the bird primarily began using marked perch trees. Unbanded males prior to capture were identifiable by unique song characteristics, favorite song perches, discrimination from banded neighboring males, or other characteristic behaviors. We did not survey males into the fledging period. All perches were marked with flags and coordinates were collected later with a handheld Trimble XM Geographic Positioning