Longevity and Bird Use of Hardwood Snags Created by Herbicides

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Abstract: Herbicides are frequently used in pine stands to control competing hardwoods. We investigated the longevity of 4 species of hardwood snags (mockernut hickory [*Carya tomentosa*], sweetgum [*Liquidambar styraciflua*], southern red oak [*Quercus falcata*], and post oak [*Q. stellata*]) after treatment with 2,4-D herbicide. In addition, we observed evidence of foraging activity and cavity excavation by cavity-nesting birds. Hickory and sweetgum were the least durable; by the fifth year only 16% of sweetgum and 47% of mockernut hickory snags remained standing, and only 11% of the original snags of each species was standing the sixth year post treatment. The oaks were somewhat more durable with 44% of southern red oak snags and 65% of post oak snags remaining by the sixth year. However, by the eighth year only one-fourth of these original snags remained. Bird foraging activity began the first year for sweetgum, the second year for post oak and the third year for southern red oak and hickory. Foraging activity was present at all heights once begun and continued until the snag fell. Ten bird cavities (9 woodpecker and 1 brown-headed nuthatch (*Sitta pusilla*)) and 2 mammal cavities were observed in the 76 snags over the course of the 16-year study.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 49:332–339

Cavity-using birds and other animals are integral components of forest systems and may be appropriate indicators of ecosystem health. Bird populations may help control insect populations at endemic levels (e.g., Dickson et al. 1979). Snags are a critical habitat component for cavity-using birds. Throughout North America approximately 85 species of birds use snags for nesting, roosting, perching, foraging, or singing (Scott et al. 1977, Miller and Miller 1980). In the coastal plain of the Southeast, snags help support 19 species of cavity-nesting birds (Hamel 1992), 11 species of mammals (Hamilton 1943), and once the snags are on the ground, some 23 species of amphibians and reptiles (Martof et al. 1980).

Primary cavity nesters excavate and use cavities, which later are used by a host of secondary cavity users. McKenzie (1952) found that secondary cavity-nester populations increased when unlimited nesting and roosting sites were provided. Cavities are important as roost sites for birds, especially in winter. Energy of birds is conserved in winter when birds roost in cavities, and cavities are important to survival of birds in cold climates (Kendeigh 1960).

Regional land use patterns are changing. Commercial timberlands throughout the southern United States are expected to decline by approximately 8 million ha by 2030 as compared to 1952 (U.S. Dep. Agric. For. Serv. 1982). These stands are being converted to urban areas, pastureland, etc. Mixed pine-hardwood stands occupy about 10.9 million ha (15%) of the timberland in the South (U.S. Dep. Agric. For. Serv. 1988). Pine plantations are replacing an increasingly larger portion of these pine-hardwood stands. From 1952–1985, short-rotation pine plantations in the Southeast increased from 0.7 million ha to 8.5 million ha and are expected to more than double by 2030 (U.S. Dep. Agric. For. Serv. 1988).

These changes may limit snag availability. Scott (1978) found that 30% of ponderosa pine (*Pinus ponderosa*) snags were lost during harvest and cavity-nesting birds declined 52% in ponderosa pine stands when conifer snags were removed during harvest. Short rotations that maximize timber production may reduce the number of trees growing large enough to house large nest cavities (Conner 1978).

Southern pines are a valuable resource and commercial forest production often favors valuable pines over hardwoods of lesser value. Sometimes pines are favored over hardwoods for ecological reasons, such as maintaining longleaf stands for the red-cockaded woodpecker (*Picoides borealis*). Many hardwood species are tolerant of space and light competition and develop in the canopy of pine-hardwood stands or in pine understories. In favoring pines, encroaching hardwoods often are killed by herbicides.

Knowledge of factors that contribute to snag production and longevity are important to accommodate cavity-using wildlife. Hardwoods killed by herbicides become snags. Conner et al. (1981) found that herbicide-treated trees create snags with fungal heart rots which were capable of providing suitable nest sites for woodpeckers. Picloram was successfully used to create snags and increase cavity nesting birds in mixed pine-hardwood forest of the central Appalachian Mountains (McComb and Rumsey 1983).

In this study we evaluated snag formation, longevity, and use of herbicide-injected hardwood trees by wildlife in a pine-hardwood stand in eastern Texas. This information should be helpful for managers to provide snags for wildlife in southern pine forests.

The authors acknowledge the helpful reviews of earlier drafts of this manuscript by Melissa Parker, Tony Melchiors, and William McComb.

Methods

The study area (part of a broad study on ecological assessment of 2,4-D treatment on a pine-hardwood ecosystem) was selected from a 100-ha mixed pine-hardwood stand on North Boggy Slough Wildlife Management Area owned by Temple-Inland Inc. in Houston County, Texas. The stand was typical of second-growth upland pine-hardwood stands of the southern coastal plain. The area was comprised primarily of mature shortleaf pine (*P. echinata*) with a midstory of southern red oak, white oak (*Q. alba*), post oak, sweetgum, blackgum (*Nyssa sylvatica*), and upland hickories (*Carya* spp.). Soil type on the area is Sacul and Bowie fine sandy loam, and Darco loamy fine sand.

All hardwood trees in the study area were basal injected with 2,4-D amine (dichlorophenoxyacetic acid) after the trees had refoliated in 1978. Twenty larger trees of each of 4 common species (southern red oak, post oak, sweetgum, and mockernut hickory) representative of the study area were selected for monitoring. Tree species and number were stamped on aluminum tags and attached to each tree. Trees were marked with colored flagging tape to accommodate location in subsequent years. Tree height (m), diameter breast height (cm), and crown diameter (m) in 4 cardinal directions were recorded for each tree (Table 1). Injected trees were monitored annually each winter for 16 years post treatment to determine snag longevity and assess use by cavity nesting birds. At each annual inspection each tree was categorized vertically into 5 standardized, equal height sections. Evidence of woodpecker foraging from excavations and nesting cavity formation was recorded for each height section.

Results and Discussion

Snags were effectively created by basal injection of 2,4-D herbicide. Of the 80 trees selected to be monitored, only 4 (1 southern red oak, 3 post oak) failed to die from the herbicide injection.

Table 1. Height, dbh, and crown diameter of snags created by injecting 2,4-D herbicide 1 year after injection.

	Height (m)		DBH (cm)		Crown diameter (m)	
	Mean	Range	Mean	Range	Mean	Range
Southern red oak	17.3	14–22	24.9	19–34	6.6	4.0–10.0
Post oak	13.6	10–18	23.8	19–36	6.1	3.5–8.5
Sweetgum	18.6	14–24	24.7	19–35	5.2	3.5–7.5
Mockernut hickory	15.8	13–22	25.3	19–39	6.3	4.0–9.0

The lateral limbs of tree crowns were the most fragile part of the snags. By the third year post treatment, < 25% of sweetgum and mockernut hickory snags had any crown remaining. Dead oak limbs persisted longer. The last southern red oak crown was gone after year 5 and the last post oak crown after year 8.

Generally, snag height diminished rapidly (Fig. 1). By year 2, mean sweetgum snag height was less than half the height of the original snags and by year 3, mean hickory snag height was about a third of the height of original hickory snags. Oak snags gradually lost their crowns and were broken over a longer time. Several oak snags broke off at heights of 1 to 5 m, leaving short stubs. Most of these short snags persisted longer than the taller snags because they had a lower center of gravity and less force from weather factors. However, short snags still are important for nesting and as foraging substrate. Conner (1978) found nest heights for norther flicker (*Colaptes auratus*), downy (*Picoides pubesceus*), hairy (*P. villosus*), red-bellied (*Melanerpes carolinus*), and red-headed (*M. erythrocephalus*) woodpeckers and black-capped chickadees (*Parus atricapillus*) as low as 2 to 4 m. Mean brown-headed nuthatch nest height was 2.4 m in pine and hardwood snags with extremely decayed wood (O'Halloran and Conner 1987).

Mockernut hickory and sweetgum were the least durable of all snags (Fig. 2). By the fifth year, only 16% of sweetgum and 47% of mockernut hickory snags remained standing. By the seventh year, only 1 sweetgum snag remained, and all mockernut hickory snags had fallen. Both species apparently were very susceptible to wood-decaying sap and heart rot fungi. Southern red oak and post oak persisted longer. Oaks were more durable because the tannins and other wood chemicals impeded decay (Panshin and deZeeuw 1970). Slightly over half of post oak snags and 39% of southern red oak snags were still standing by the seventh year. However, by the ninth year only 3 snags of each oak species remained, and they were short (<6 m).

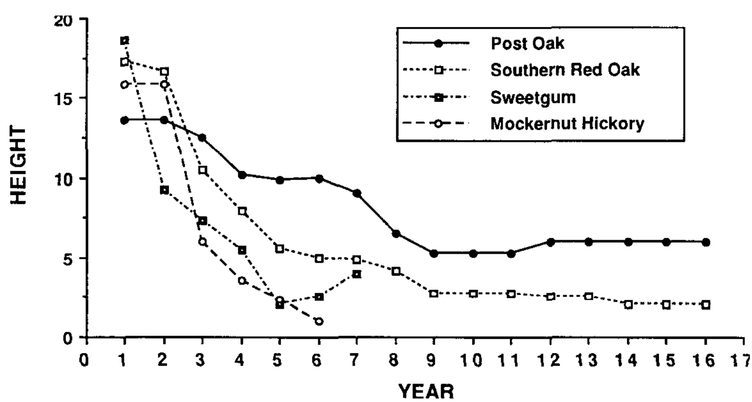

Fig. 1. Mean height of snags standing after 2,4-D herbicide treatment of 4 species of hardwood trees.

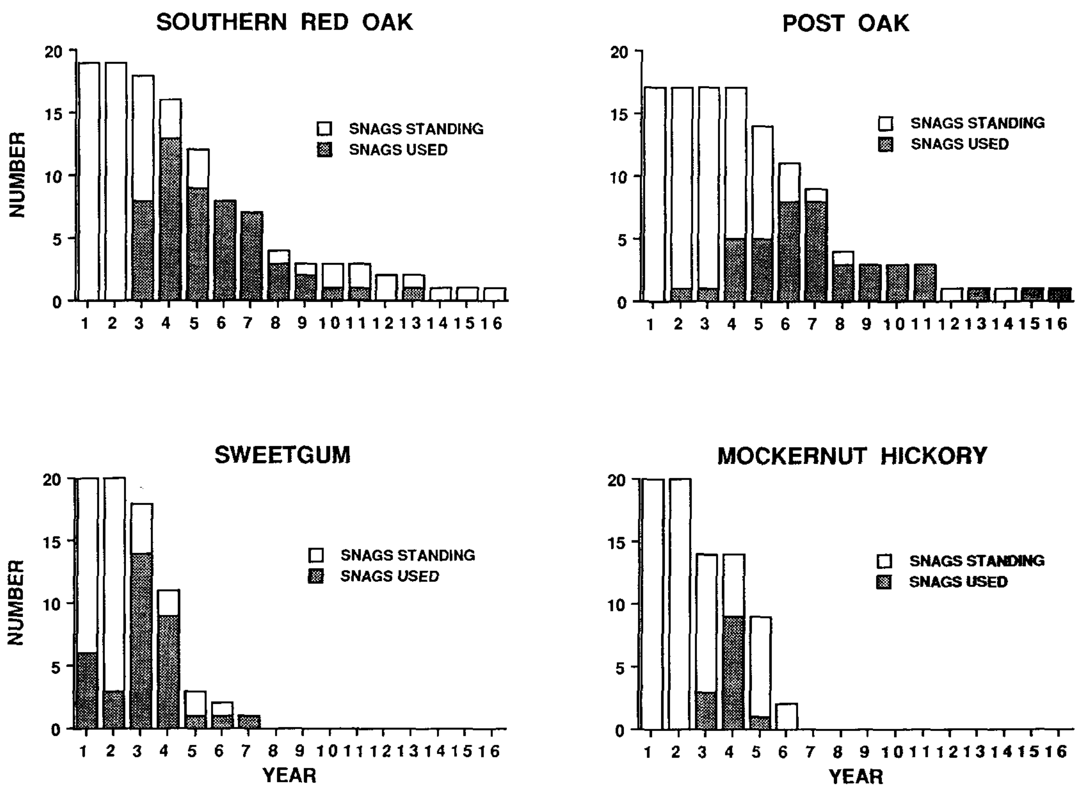

Fig. 2. Longevity (number standing) and use (number used for foraging by woodpeckers) of snags created by injecting trees with 2,4-D herbicide.

Snag longevity in the current study is similar to another study in eastern Texas assessing effects of snags on bird communities in clearcuts (Dickson et al. 1983). In that study, all of the herbicide-treated sweetgum snags and more than half of the mockernut hickory snags had fallen after 4 years, while all of the white oak and blackjack oak (*Q. marilandica*) and 93% of the post oak snags were still standing.

Generally, bigger trees stand longer than smaller trees (Dickson et al. 1983). The large western conifer snags usually persist a long time. One half of lodgepole pine (*Pinus contorta*) trees killed by fire lasted 8 years (Lyon 1977) and half of ponderosa pine snags created by fire stood for 10 years and about a quarter of them stood for 20 years (Dahms 1949). Half of western yellow-pine killed by bark beetles lasted 7 years (Keen 1929).

How trees are killed and the rate of wood decay affect how long snags persist. In ponderosa pine 5 years after treatment, all of the snags created by topping with chainsaw were still standing, 75% of those created with herbicide remained, but less than half of those from trees killed by mountain pine beetle were still standing (Bull and Partridge 1986). Conner et al. (1983) found that herbicide killed southern red oak trees decayed faster than those killed by girdling.

In our study, foraging began the first year after injection on the rapidly decaying sweetgum, the second year on post oak, and the third year on southern red oak and mockernut hickory. Initiation of bird foraging on snags was variable; however once begun, bird foraging continued throughout the life of the snags (Fig. 2). Evidence of foraging was observed on all vertical portions of the snags. The importance of snags as substrate for bird arthropod prey has been noted (Evans and Conner 1979). We believe the snags were substantial arthropod habitat which was important for prey provision for many birds in this pine-oak forest. Snags were especially important after several years of decay when snag numbers were dwindling and remaining snags were consistently used.

Ten bird cavities (9 woodpecker and 1 brown-headed nuthatch) and 2 mammal cavities were observed in the 76 snags over the course of the study. The use rate of study trees probably would have been higher if the availability of total snags created by the herbicide treatment had been lower. Woodpecker cavities were identified as pileated, red-bellied, and downy. Six of the cavities were in post oak, 3 in sweetgum, 2 in southern red oak, and 1 in mockernut hickory. There were more cavities in the oak species, probably because they were available for use longer than the sweetgum and hickory. Most of the cavities were detected between year 3, when the snags had decayed substantially and year 6, before snag numbers and height had drastically declined.

Management Implications

Young, intensively managed southern forests may contain few snags, especially large diameter snags required by some species. Snags can be left standing during timber harvest except those posing safety hazards (Conner 1978, Dickson et al. 1983, Braun et al. 1984). During silvicultural operations or management focused specifically on cavity-using wildlife, creating snags by biological, chemical, or mechanical means can enhance cavity-user habitat. Here we demonstrated that hardwood snags can be created easily by herbicide application and that birds and other wildlife use herbicide created snags for foraging and nesting. Forest management plans that provide for periodic creation of and continuous availability of snags will positively affect cavity nesting wildlife and help maintain forest biological diversity.

In this study oak snags stood and were available for use longer than gum or hickory. But mature living oaks also are valuable to vertebrate communities for the mast they provide, often in areas with limited mast producers. Thus, selection of trees to be converted to snags must be balanced against the need for mast production.

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