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Research Paper

Tree cavity use by Chimney Swifts: implications for forestry and population recovery

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ABSTRACT. The Chimney Swift (*Chaetura pelagica*) is an aerial insectivore and a cavity-nesting/roosting specialist designated as threatened in several jurisdictions. As the occurrence of suitable chimneys declines, Chimney Swifts may increasingly nest and roost in tree cavities. It is therefore important to identify characteristics of suitable nest or roost trees and assess their frequency of occurrence. We reviewed 59 historic and modern records of trees used by Chimney Swifts to understand characteristics of suitable nest or roost trees. Chimney Swifts used at least 13 different deciduous and coniferous tree species. All of the trees were greater than 0.5 m diameter at breast height (DBH) and were described as hollow or having cavities. Nest or roost tree height was 12.7 ± 7.0 m (mean ± SD; range: 3.6–28.0 m; n = 25) and DBH was 1.0 m ± 0.5 m (range 0.5–2.1 m; n = 21). According to our description of used trees, the number of suitably hollow Chimney Swift nest or roost trees may be two to three times higher, although still rare, in most unlogged compared to logged hardwood forests. Whether the current total supply of suitable nest or roost trees is sufficient to carry the anticipated increase in use by Chimney Swifts as chimney habitat is modified or deteriorates is unknown. Monitoring the frequency of use of tree cavities by nesting and roosting Chimney Swifts over time, and more robustly quantifying the availability of suitable tree cavities in different forest types for nesting and roosting Chimney Swifts, particularly in unlogged versus logged forests, are fruitful areas for future research.

Utilisation de cavités d'arbres par le Martinet ramoneur : incidence sur les plans de l'exploitation forestière et du rétablissement des populations

RÉSUMÉ. Désigné « menacé » par plusieurs autorités concernées, le Martinet ramoneur (*Chaetura pelagica*) est un insectivore aérien et un spécialiste de cavités dans lesquelles il niche et dort. Étant donné que le nombre de cheminées propices à leur nidification est en diminution, les martinets nichent et dorment peut-être davantage dans les cavités d'arbres. Il apparaît alors important d'identifier les caractéristiques des arbres favorables à la nidification ou au repos et d'évaluer leur fréquence d'occurrence. Afin de cerner ces caractéristiques, nous avons passé en revue les mentions historiques et contemporaines d'arbres utilisés par cette espèce. Les Martinets ramoneurs ont utilisé au moins 13 essences de feuillus ou de conifères. Tous les arbres avaient un diamètre à hauteur de poitrine (DHP) supérieur à 0,5 m et étaient creux ou portaient des cavités. Leur hauteur était de 12,7 ± 7,0 m (moyenne ± écart type) (étendue : 3,6-28,0 m; n = 25) et leur DHP s'élevait à 1,0 ± 0,5 m (étendue : 0,5-2,1 m; n = 21). D'après la description des arbres occupés, le nombre d'arbres creux convenables pour la nidification ou le repos du Martinet ramoneur pourrait être de 2 à 3 fois plus élevé – quoique ces arbres sont quand même rares – dans la plupart des forêts de feuillus non-récoltées, comparativement aux forêts récoltées. Nous ne savons pas si la quantité actuelle d'arbres propices est suffisante pour satisfaire l'utilisation accrue anticipée par les Martinets ramoneurs vu la détérioration ou la destruction des cheminées. Le suivi temporel de la fréquence d'utilisation des cavités d'arbres par les martinets pour y nicher ou y dormir et une meilleure quantification de la disponibilité de cavités d'arbres propices dans différents types de forêts, en particulier les forêts intactes versus récoltées, sont des avenues de recherche prometteuses.

Key Words: *aerial insectivore; cavity nesting; cavity roosting; Chimney Swift; Chaetura pelagic; ecological specialization; forest management; population decline.*

INTRODUCTION

Ecological specialization, e.g., for nesting, roosting, foraging, is associated with population declines in various animals including birds (e.g., Owens and Bennet 2000). This relationship is at least partly due to the inability of individuals of certain species to use alternatives when critical resources are limited or disappear (Beissinger 2000). The Chimney Swift (*Chaetura pelagica*) is an aerial insectivore and a cavity-nesting/roosting specialist (Cink and Collins 2002), which is threatened in several jurisdictions (e.g., Canada; COSEWIC 2007). The Chimney Swift's ecological specialization for nesting and roosting in cavities may be contributing to its unprecedented population decline (Environment Canada 2010) because loss of habitat has been identified as a limiting factor throughout most of the species' range (COSEWIC 2007).

Prior to European colonization of North America, Chimney Swifts nested primarily in large hollow trees (Cink and Collins 2002). The Chimney Swift adapted to nesting and roosting in man-made chimneys only a few decades after European colonization (the earliest record is 1672; Graves 2004). The species is now thought to nest and roost almost exclusively in chimneys (Graves 2004). However, availability of suitable chimneys is decreasing and may be contributing to population declines in

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some regions (COSEWIC 2007). By contrast, the availability of suitable chimneys does not currently appear to be limiting populations in southern Ontario because 75% of suitable chimneys are estimated to be unoccupied, but with continued loss, suitable chimneys could become limiting in the future (Fitzgerald et al. 2014).

Chimney Swifts do still nest and roost in tree cavities, but the frequency of use is not known (e.g., Ferguson and Ferguson 1991, Damro 2005, Hines et al. 2013). The presence of Chimney Swifts in areas located far from suitable chimneys during the breeding season, e.g., remote areas in Algonquin Park, Ontario, Canada (Tozer 2012) suggests that nesting and roosting in tree cavities may be more common than previously thought. As the number of suitable chimneys decline, Chimney Swifts may increasingly nest and roost in tree cavities. It remains to be seen whether availability of nest or roost trees will then be a compounding limiting factor contributing to population declines. This may be of particular concern in logged forests where large hollow trees, which are most attractive for nesting and roosting, tend to be less common (e.g., Crow et al. 2002). It is therefore important to identify characteristics of suitable nest or roost trees and assess their frequency of occurrence in case Chimney Swifts start to use natural nest sites more commonly in the future.

We reviewed historic and recent records of trees used by Chimney Swifts to develop a quantitative and qualitative description of suitable nest or roost trees. We used our description to estimate the quantity of suitable nest or roost trees currently found in logged versus unlogged forests.

METHODS

We consulted several sources across the geographic breeding range of Chimney Swifts for observations of nest or roost trees, including books, peer-reviewed articles, nest record schemes, breeding bird atlases, researchers, online birding listservs and forums, and volunteer monitoring programs (e.g., Swiftwatch programs, http://www.bsc-eoc.org/volunteer/acswifts/index.jsp, and http://www.bsc-eoc.org/research/speciesatrisk/chsw/index.jsp). Reports were found in journals (54%), nest record schemes (18%), books (17%), by personal communication (9%), and through online birding forums (2%). Reports were included in our review only if observers noted nests, eggs, or chicks, agitated adults near a tree cavity suggesting the presence of an active nest, or adults flying into or out of a tree cavity suggesting the presence of an active nest or roost. All available information describing nest or roost trees was gleaned from each report, e.g., tree species, height. We summarized tree height and diameter at breast height (DBH) by calculating mean, standard deviation, and the range between minimum and maximum.

RESULTS

We found 69 observations of Chimney Swift nest or roost trees, but only 59 met our criteria, which we used for further inference (Table 1). Observations occurred between 1840 and 2013. All but 6 trees were in remote areas, and all trees were described as hollow or having cavities. Nest or roost tree height was 12.7 ± 7.0 m (mean ± SD; min-max range: 3.6–28.0 m; n = 25). Nest or roost tree DBH was 1.0 m ± 0.5 m (mean ± SD; min-max range 0.5–2.1 m; n = 21).

Although not always specified, 7 observations were in live trees, described as dying or decaying, and 18 were in dead trees. Deciduous tree species accounted for 27 observations, whereas coniferous tree species accounted for 21 observations. At least 13 different tree species were used (see Table 1 for complete species list). The deciduous tree species were primarily yellow birch (*Betula alleghaniensis*; n = 7), maples (*Acer* spp.; n = 6), and sycamores (*Platanus* spp.; n = 5). The coniferous tree species were primarily cypress (Cupressaceae; n = 8), white pine (*Pinus strobus*; n = 7), and unidentified pines (*Pinus* spp.; n = 3).

In 15 reports, the top of the tree was broken, forming a chimney-like opening used by the swifts. Seven reports specified that the opening was formed by weather damage or broken limbs. In 3 reports, the entrance used by Chimney Swifts was a cavity previously created by Pileated Woodpeckers (*Dryocopus pileatus*).

DISCUSSION

Chimney Swifts used a variety of live, dead, deciduous, and coniferous trees for nesting or roosting, but all were large with DBHs greater than 0.5 m, and 50% had DBHs between 0.6 and 1.3 m. Plus all of the trees were described as hollow or having cavities. These findings further support the premise that Chimney Swifts specialize on large diameter, extensively hollow nest or roost trees. The findings also provide, for the first time, an estimate of the minimum DBH for suitable Chimney Swift nest or roost trees.

The tree species used by Chimney Swifts for nesting or roosting were likely indicative of a preference for large-diameter trees. Many of the tree species are known for their longevity and for growing to massive sizes. For example, white pine is one of the largest and longest-lived conifer species in northeastern North America, and sycamore and cypress are known to grow to diameters of 3-5 m and live for several hundred years (Burns and Honkala 1990). Older and larger trees are more likely to develop large hollow sections because of accumulation of extensive long-term heart rot (e.g., Bull et al. 1997). Thus, the tree species used by Chimney Swifts may have figured prominently in our review because their longevity and large average size led to higher incidence and greater hollow volume, a prerequisite for use by Chimney Swifts.

We found similar numbers of observations of swifts entering through the side of the trunk or branch compared with the top or end. Notably, entryways were sometimes surprisingly small. Some swifts entered through apertures less than 5 cm in width, requiring them to land on the surface rather than flying in directly (Brewster 1937; R. Tozer, *personal communication*). In some of the observations, Chimney Swifts used entrances created by Pileated Woodpeckers located on the sides of trunks. Although it was not specified whether Chimney Swifts were using Pileated Woodpecker nest or roost cavities, it seems likely that Pileated Woodpecker roost cavities are more suitable because of their larger cavity size (Bull and Jackson 2011). Pileated Woodpecker roost trees are also used by the closely-related Vaux's Swift (*C. vauxi*) for nesting and roosting (Bull and Collins 2007) and may be an important source of Chimney Swift nest or roost trees.

Trees greater than 0.5 m DBH are uncommon in most forests within the Chimney Swift's breeding range. For instance, trees greater than 0.5 m DBH comprised only 4% (range: 1-5%) of trees

Table 1. Reports of Chimney Swift nest and roost trees in North America. Sycamore = *Platanus* spp.; Tulip tree = *Leriodendron tulipifera*; White pine = *Pinus strobus*; Yellow birch = *Betula alleghaniensis*; Silver maple = *Acer saccharinum*; Black gum = *Nyssa sylvatica*; Balsam poplar = *Populus balsamifera*; White oak = *Quercus alba*; White spruce = *Picea glauca*; Sugar maple = *Acer saccharum*; Red maple = *Acer rubrum*; PIWO = Pileated Woodpecker (*Dryocopus pileatus*).

Source	Year first observed	Location	Tree Species	Height (m)	DBH (m)	Description of condition	Opening
1	1803	Marietta, OH	Sycamore	4.5	1.7	Decayed and fallen	-
2	~1808	Louisville, KY	Sycamore	18	2.1	Decaying	Broken, hollowed branch
3	1863	St. Stephen, NB	Birch	-	-	Hollow	-
4	~1865	Deep woods of middle TN	Tulip Tree	15.2	1.8	-	Broken limb, 2ft wide
5	1870	New Hartford, Oneida County, NY	-	-	-	Hollow	-
6	1875	Clarksville, TN	Sycamore	-	-	-	-
7	1879	Lake Umbagog Region, ME	-	-	-	Dead	Natural, on the side
8	1879	Hyde Park, London, ON	Elm	-	-	Hollow snag	-
9	1880	Lake Umbagog Region, ME	Elm	-	-	Live	6 in diameter
10	1887	Pembina County, ND	-	-	-	Multiple hollow trees	-
11	1896	South bank of the Androscoggin, ME	White pine	-	-	Dead	Small, round hole on the side
12	1896	Banks of Rapid River, ME	Pine	-	-	Hollow snag	Open top
13	1897	Great Dismal Swamp, Lake Drummond, VA	Cypress	-	-	Hollow	-
14	1897	Great Dismal Swamp, Lake Drummond, VA	Cypress	-	-	Hollow	-
15	1905	Methals Lake, NS	White pine	4.5	1	Dead stub	-
16	~1910	Northern wilderness, MN	-	-	-	Hollow snag	Small hole under limb
17	1915	Walsh County, ND	-	-	-	Multiple hollow trees	-
18	1917	Bethany, WV	Sycamore	-	-	Hollow	-
19	1918	Chippewa River, Holcombe, WI	White pine	3.6	0.5	Hollow stub	Open top
20	1919	Mellen, WI	Yellow birch	12	-	Hollow snag	Open top
21	1925	The Smokies	-	-	-	Hollow	-
22	1928	Opposite Cranberry Island, Buckeye Lake, OH	Oak	-	-	Dead, hollow	Open top
23	1947	Liscom Game Sanctuary, NS	Hemlock	-	-	Dead	PIWO hole, on the side
24	1947	Wildlife Research Area, Algonquin Park, ON	-	-	-	Dead snag	On the side
25	1951	Fish lake near Barlow, Ballard County, KY	Cypress	-	-	Multiple hollow trees	-
26	1952	Fish lake near Barlow, Ballard County, KY	Cypress	-	-	Partially dead, hollow	Open top
27	1954	Alger and Schoolcraft counties, MI	Yellow birch	26	-	Live, multiple openings	Two PIWO holes
28	1956	Duluth, MN	Yellow birch	-	-	Live, multiple openings	PIWO hole
29	1960	Slide Mountain, Ulster County, NY	-	-	-	Hollow	-
30	1961	Hamilton County, NY	White pine	18	0.9	Hollow snag	Open top
31	1964	Norman, OK	Maple	-	-	Hollow	-
32	1964	Labelle, QC	-	5.4	-	Hollow	-
33	1977	Kinderhook, IL	Silver maple	25	0.7	Live until cut	-
34	1979	Black River Lake, near Dead Brook, NS	Pine	6	-	Dead, hollow snag	-
35	1979	Standard Aggregate Quarry, Milton, ON	Hemlock	18	-	Partially dead, hollow	-
36	1980	Methals Lake, outlet, NS	Pine	6	-	Dead, hollow snag	-
37	1981	Tuscumbia River, McNairy County, TN	-	-	-	Hollow snag	Side cavity
38	1983	Mountain Lake Biological Station, VA	Black gum	7.3	0.5	Hollow snag	Open top
39	1985	Macpès, Rimouski, QC	Balsam poplar	-	0.6	-	Natural, on the side
40	1987	Near East Gate, Algonquin Park, ON	White pine	-	-	-	-
41	1988	Memphis, TN	White Oak	28	1.4	Dead, hollow	Broken limb, on the side
42	1994	Mew Lake, Algonquin Park, ON	White spruce	-	-	Hollow	-

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43	2001	Forêt Sainte-Perpétue, QC	Sugar maple	8.2	0.61	Hollow	
44	2002	Saint-Quentin, NB	Maple	10	-	Hollow snag	-
45	2003	Westboro Township, Taylor County, WI	Red maple	11	0.6	Dead, hollow	Broken limb, on the side
46	2004	North Sylvania Wilderness, Gogebic County, MI	White pine	14	1.2	Dead, multiple openings	Open top
47	2005	Forêt Tourville, QC	Sugar maple	-	-	-	
48	2005	10 km west of tip of Long Point, ON	Red Oak	10	0.8	Partially dead, hollow	Broken, hollow, dead branch
49	2006	Brushy Lake, AR	Bald Cypress	15.5	1	Hollow, live	Vertical fissure, broken top
50	2008	Crowfoot Lake, AR	Water Tupelo	7.5	0.79	Hollow, live	Broken branch
51	2008	Belknap Lake, AR	Bald Cypress	-	1.25	Decayed top	
52	2008	Goose Lake, AR	Bald Cypress	-	1.25	Decayed top	
53	2008	Buck Lake, AR	Bald Cypress	-	1.25	Decayed top	
54	2009	Squire's Ridge, Long Point, ON	Oak	20	0.6	Dead, hollow	Open top
55	2010	Butler Road, Black River Lake, NS	White pine	-	-	Hollow snag	-
56	2012	Vinton County, OH	Oak	9	-	Dead, hollow	Open top
57	2013	North Tea Lake, Nipissing District, ON	Yellow birch	15	0.5	Dead, hollow	Open top
58	-	Maple River, Gratiot County, MI	-	-	-	Hollow snag	-
59	-	Mt. Carmel, IL	Sycamore	-	-	-	-

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on average in 46 logged hardwood stands, and 11% (10-12%) of trees on average in 38 unlogged hardwood stands, across Minnesota, Ontario, New York, and Quebec (Hale et al. 1999, McGee et al. 1999, Angers et al. 2005; D. Tozer, *unpublished data*). However, only a small but unknown portion of these trees would be suitably hollow for nesting or roosting Chimney Swifts (e.g., Hale et al. 1999). In logged forests, cutting is often too frequent to allow trees to attain the age and size required for extensive heart rot and associated hollow cavities for nesting and roosting Chimney Swifts (e.g., Savignac and Machtans 2006, Tozer et al. 2012). Additionally, the number of suitable nest or roost trees may be limited by removal during harvest under occupational health and safety legislation requirements, and historical and regional differences in interpretation and application of forest management requirements and recommendations. Thus, the number of suitably hollow Chimney Swift nest or roost trees may be two to three times higher, although still rare, in most unlogged compared to logged hardwood forests.

We developed for the first time a quantitative and qualitative description of Chimney Swift nest or roost trees based on all existing data. According to our description, the number of suitably hollow Chimney Swift nest or roost trees may be higher but still rare in most unlogged compared to logged hardwood forests. Whether the current total supply of suitable nest or roost trees is sufficient to carry the anticipated increase in use by Chimney Swifts as chimney habitat is modified or deteriorates is unknown. Monitoring the frequency of use of tree cavities by nesting and roosting Chimney Swifts over time, and more robustly quantifying the availability of suitable tree cavities in different forest types for nesting and roosting Chimney Swifts, particularly in unlogged versus logged forests, are fruitful areas for future research.

Responses to this article can be read online at:
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