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Changes in the Structural and Functional Characteristics of Fisher (*Pekania pennanti*) Rest Structures Over Time

Abstract

Resting habitat used by fishers (*Pekania pennanti*) has been relatively well studied but information on the persistence of their resting structures over time is unknown. We selected for reexamination 73 of 195 resting structures used by by fishers in northwestern California and compared their condition on the date they were found with their condition 8.2–12.1 years later. Resting structures were classified into three functional groups: live trees, snags, and logs. Each group was classified further into structural stages of decay or decomposition. A total of 19.2% of resting structures changed structural stage over the assessment period, transitioning from one structural stage to another within or between groups. However, none of the structures declined in function to the point that they could not be used for resting. One tree jumped two functional groups, transitioning from a live tree to a log. Based on the rates of degradation that we observed, we recommend monitoring the fate of fisher resting structures every few decades. This will help us provide information about the loss rate of resting structures that, when combined with new information about the rate of cavity creation in trees and snags, will help us determine whether the forces of resting structure loss and gain are in dynamic equilibrium.

Keywords: fisher, *Pekania pennanti*, rest structures, snags, cavities

Introduction

Fishers (*Pekania pennanti*) are among a wide variety of species of wildlife that use cavities or chambers in live and dead trees as daily refugia and for reproduction (Zielinski et al. 2004a, Lofroth et al. 2010, Weir et al. 2012). These resting and denning structures are most typically the largest diameter standing live trees, snags, or logs (conifers and hardwoods) available (Zielinski et al. 2004a, Purcell et al. 2009, Lofroth et al. 2010, Aubry et al. 2013) and are considered critical elements for the maintenance of fisher populations (Paragi et al. 1996, Purcell et al. 2009, Lofroth et al. 2010, Weir et al. 2012). We use the term "resting structure" here to refer to the feature that includes the resting location (typically a cavity or a platform in the structure), whereas "resting site" is used to refer to the small area (typically 1 ha) in the immediate vicinity of the resting structure (Slauson and Zielinski 2009, Lofroth et al. 2010). Fisher resting habitat is influenced by the resting structure as well as the resting site (Lofroth et al. 2010, Weir et al. 2012, Aubry et al. 2013).

Resting structures are created by forest growth processes that produce large trees and snags interacting with primary excavators and agents of decay that produce cavities (Lofroth et al. 2010, Cockle et al. 2011, Remm and Lõhmus 2011). Natural disturbances (fire, wind, drought, insects) influence the transition probabilities of live trees into snags or logs and regulate the development of cavities. Some silvicultural practices—particularly clear cutting, individual tree selection, and salvage harvest—can negatively affect the availability of large trees, snags, and logs (Lindenmayer and Franklin 2002, Russell et al. 2006, Bunnell and Houde 2010, Remm and Lõhmus 2011). Thus, the availability of resting structures on the landscape is a dynamic interaction of the production of live trees and snags with cavities, balanced with the loss due to natural disturbance or timber harvest. Understanding the development of resting structures is particularly important for fisher conservation because fishers have inexplicably low rates of reuse of the same structures (3.5% during our study; Zielinski et al. [2004a]) and thus may require dozens, to hundreds, of different resting structures during their lives.

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The recruitment and loss of snags, particularly those used by cavity-nesting birds, has been the subject of considerable study (e.g., Raphael and White 1984, Morrison and Raphael 1993, Edworthy et al. 2012), resulting in recommendations that forest managers need to consider both the processes that produce and degrade this resource and the rates at which creation and destruction occur. Snag production and retention rates have been estimated for various forest types in western ecosystems (e.g., Morrison and Raphael 1993, Ohmann 2002). In western Oregon and Washington, snags persisted longer if they were killed by insects or natural suppression than if killed by weather or root disease (Ohman 2002). Surprisingly, nearly half of all trees that died fell to the ground within 10 years, making them less available as habitat for species of wildlife that use cavities (Ohman 2002). Moreover, cavities can take over 100 years to develop in large Douglas-firs (*Pseudotsuga menziesii*) (Rose et al. 2001) such that deficits in cavity abundance can take decades to restore. Little is known, however, about the fate of cavities in live or dead trees (Edworthy et al. 2012, Lindenmayer et al. 2012) and there is no information on the persistence or usability over time of structures that are known to be used as resting locations for fishers.

Fishers regularly use cavities, and require them for their natal dens (Lofroth et al. 2010). Thus, understanding the dynamics of structures that produce cavities is essential to fisher conservation. We describe the fate, and estimate the functional value, of a sample of fisher rest structures that we evaluated approximately 10 years from when they were first observed in use. In doing so we provide the first assessment of how natural factors may affect the availability of resting structures over time, and establish a baseline for chronicling their change and loss in the future.

Methods

From 1993–1997 we conducted a study of the ecology of fisher habitat and home range on a 400 km^2 study area primarily on the Six Rivers National Forest (SRNF) (Zielinski et al. 2004a, 2004b). The study area was within the Northern California Coast Range ecosection (Bailey 1994) located primarily in Humboldt County, California. It has a weather pattern typical of California's Mediterranean climate: summers are hot and dry and winters are cool and moist, with precipitation falling as snow in the higher elevations. Topography is dominated by South Fork Mountain, a 72-km-long continuous ridge joining the two subareas of our study: Pilot Creek and Cedar Gap. Elevations range from ~600 to 1800 m and the area is vegetated by stands of Douglas-fir, white fir (*Abies concolor*), Oregon white oak (*Quercus garryana*), tanoak (*Notholithocarpus densiflorus*), red fir (*A. magnifica*), and dry grasslands, with a minor component of California black oak (*Q. kellogii*), canyon live oak (*Q. chrysolepis*), incense cedar (*Calocedrus decurrens*), and ponderosa pine (*Pinus ponderosa*) (USDA Forest Service 1995, Jimmerson et al. 1996).

During the original study (Zielinski et al. 2004a) we located 22 radio-collared fishers (8M:14F) at 195 different resting structures. Each structure's location was documented using GPS. We selected 73 of these structures (37.4%) to visit for the purpose of reevaluating their status. This subset of structures was selected to approximate the proportion of the original collection of structures in each of three categories: live tree (conifers and deciduous, including cavities and platforms; 68.3%), snag (conifer and hardwood; 26.2%) and log (5.2%). Structures to sample within each category were randomly selected. We used GPS to relocate the 73 selected structures during the summer of 2005. The site of the original structure was confirmed by finding the metal tag that had been attached to each tree and by referring to drawings of the structures that were created when they were originally discovered. Structures were relocated and their status reevaluated from 8.2–12.1 years after their original location.

In addition to determining whether the structure was still in its original functional group (live tree, snag or log) we also assigned the structure a condition class rating developed by Maser et al. (1979). Each structure was rated when it was first discovered and when it was relocated. Live trees were either stage 1 (live) or stage 2 (declining health). Snags were stage 3 (dead with bark), stage 4 (dead with loose bark), stage 5 (no bark), stage 6 (broken), stage 7 (broken and decomposed), stage 8 (down material), or stage 9 (stump). Logs were either class 1 (bole suspended above ground by broken limbs), class 2 (lying directly on ground), class 3 (partially imbedded in ground), class 4 (nearly decomposed) or class 5 (completely decomposed). We interpreted changes in group or class rating using three perspectives for usability. The conservative view of usability assumed that if there was *any* change in condition class (say, from snag class 4 to snag class 5) the structure was of questionable use because it had changed, even slightly, from the characteristics it possessed when the fisher originally chose to rest there. The intermediate view held that a structure remained usable to a fisher if the change occurred only within the functional group (e.g. it remained a live tree, remained a snag or remained a log). This view assumes that small changes in the integrity of the structure would not affect its reuse. The liberal view of usability assumed that the structure remained useful as long as it had not become a fully decomposed log (i.e., just about any change in the structure would be viewed as acceptable to a fisher seeking to use the structure again).

Results

The original status of the 73 trees we selected to revisit included 49 live trees (67.1%), 21 snags (28.8%), and 3 logs (4.1%). This corresponded well with the original proportions of each of these functional groups in the larger data set (see above). Fifty-nine of the 73 structures (80.8%) did not change status upon reevaluation (i.e., were the same Maser stage or class when reevaluated) (Table 1). Thus, our conservative usability view suggested that 19.2% of the structures were altered by time to a condition that was different than when fishers first used them. On the other end of the spectrum, none of the structures became so decomposed as to be impossible to reuse for resting (Table 1). Between these views was our intermediate perspective which found that 8.2% of the structures changed from structure type to another (i.e., from tree to snag or from snag to log). Three of the 49 live trees (6.1%) died and became snags and of the 21 structures that were originally snags, two (9.5%) fell and became logs. The extreme case was one structure that was originally classified as a live tree but, when revisited, had fallen and become a log. In sum, depending on which view is

TABLE 1. Status of resting structures upon revisit from 8–12 years after initial observation, Six Rivers National Forest, Humboldt County, California.

		Conservative view		Intermediate view		Liberal view	
Type of change	No. of structures	Usable	Questionable	Usable	Questionable	Usable	Questionable
Live tree to live tree (no change)	43	43		43		43	
Live tree: stage 1 to stage 2	2		2	2		2	
Live tree to snag	3		3		3	3	
Live tree to log	1		1		1	1	
Snag to snag (no change in stage)	14	14		14		14	
Change in snag stage[a]	5		5	5		5	
Snag to log	2		2		2	2	
Log to log (no change in class)	2	2		2		2	
Change in log class[a]	1		1	1		1	
Log to questionable use[b]	0		0		0		0
Total structures	73	59	14	67	6	73	0
Percent usable or questionable		80.8%	19.2%	91.8%	8.2%	100%	0%

[a] Any change from one snag stage or log class to a higher number.
[b] Decayed to log class 4 or 5.

considered, from 0–19.2% of the resting structures became of questionable use by fishers as a result of their decomposition or death.

Discussion

Large trees with cavities are keystone structures in forests (Tews et al. 2004, Remm and Lõhmus 2011) and fishers are one of many species that are obligate cavity users. We found that after about 10 years the great majority of resting structures used by fishers were still available for use by them and resembled their original condition. Most of fisher resting structures are live trees and almost all of these (91.8%) retained their original condition class. This is encouraging because, barring fire or logging, large live trees retain their cavities much longer than do snags (Lindenmayer and Wood 2010, Edworthy et al. 2012). Thus, if the abundance of live trees with cavities does not change much over time, the total population of trees with cavities should also be relatively stable. Snag persistence is also a function of its size (Russell and Weiskittel 2012); thus, growing trees to large size is also the best way to guarantee a supply of adequately-sized dead structures. Because fishers do not frequently rest in logs, at least in California, few logs were in our sample and, thus, there were few resting structures that could decompose fast enough in 10 years to become unusable. Species for which logs and coarse woody debris are more commonly used as resting structures, such as the Pacific marten (*Martes caurina*) (Martin and Barrett 1991, Spencer 1987, Slauson and Zielinski 2009), would experience a more rapid loss of resting structures over time than species like the fisher that primarily use standing live and dead trees for resting.

Our study area was not affected by any wildfire during the sample period. Had a severe crown fire occurred, we would most likely have lost many of the resting structures. A vigorous debate is occurring as to whether fisher resting habitat is best protected from wildfire by applying mechanical treatments to thin the forest and reduce the likelihood of severe crown fire (e.g., Scheller et al. 2011, Zielinski et al. 2013). If mechanical thinning can reduce the probability of losing large and old cavity-bearing trees and snags, then it may be beneficial. However, the thinning would need to avoid the removal of candidate resting structures, or those likely to become so in the near future. Prescribed fire and mechanical thinning can increase the number snags (Stephens and Moghaddas 2005), but many are smaller than those that are typically used by fishers.

Lindenmayer et al. (2012) suggest the Douglas-fir forests of the Pacific Northwest, which includes our study area, are among the forest ecosystems worldwide where the loss of cavities in trees is a looming problem. Much of this is due to the asymmetry between the rapidity with which large trees can be removed by harvest and the time that must elapse for them to regrow and provide structural features like cavities (Franklin et al. 1981). A stable supply of tree holes in forest communities requires a balance in the rate of cavity creation with the rate of cavity loss. Our work is only a superficial assessment of the "balance sheet" for provisioning large, cavity-bearing trees for use by fishers and other species. We recommend that forest inventory programs in the western United States monitor the abundance of cavity-bearing trees, and trees likely to produce cavities, and that fisher researchers mark and geolocate a sample of resting structures so that we can improve our estimates of loss of these important habitat features. We plan to periodically revisit the 73 trees we marked to determine their fates. Our data suggest that, barring wildfire or other disturbance, revisiting a sample of rest structures every few decades would be sufficient to estimate their rates of loss. This assumes that the rates of change we observed are linear. If not, resampling may need to occur more frequently. Forest ecologists will also need to help develop a means to estimate the *creation* of candidate resting structures so that we can determine whether the loss and creation of these important habitat features are in dynamic equilibrium.

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