PNW
Pacific Northwest Research Station

Science FINDINGS

issue fifty-seven / october 2003

INSIDE

"Science affects the way we think together."
Lewis Thomas

COMING HOME TO ROOST: THE PILEATED WOODPECKER AS ECOSYSTEM ENGINEER

"When a keystone species disappears from its habitat, a 'domino effect' sees species losses cascade through the habitat, as the loss of one species prompts the loss of still others."
—North Carolina Zoological Park

Credit: E. Bull

Pileated woodpeckers are well adapted to life on vertical surfaces. They have strong toes with long sharp nails to cling to bark or smooth wood, and stiff tail feathers to brace against the bole of a tree when excavating cavities and foraging.

Before the northern spotted owl became a household word, the pileated woodpecker had its 15 minutes of fame as a creature whose well-being was linked to the well-being of the forest. As a management indicator species (MIS), its presence was closely associated with "mature and old-growth forest conditions," and monitoring was to be conducted to determine if established habitat areas were helping to maintain its populations on National Forest lands.

But the Northwest Forest Plan edged out the pileated woodpecker and other indicator species when the focus shifted from single-species management to ecosystem management. The MIS approach was subsumed under the new regional plan, which included standards and guidelines for timber harvest in matrix lands for leaving or creating a certain number of snags (standing dead trees) to provide nest trees for woodpeckers.

"However, in the first major study of pileated woodpeckers within the range of the northern spotted owl, we have found that pileateds nest in live, decadent trees as often as they do in snags, and use different species of trees with different decay characteristics for roosting than they do for nesting," says Keith Aubry, research wildlife biologist with the PNW Research Station at Olympia, Washington. "In fact, finding enough suitable places to roost at night may be more challenging for pileateds than finding a tree to nest in."

What's more, tree species used for nesting and roosting and the importance of logs as foraging sites for pileated woodpeckers may vary from one locality to the other.

IN SUMMARY

Prior to 1994, the pileated woodpecker was a management indicator species (MIS) of mature and old-growth forest conditions on 16 of 19 national forests in the Pacific Northwest Region. This status required each of those national forests to establish pileated woodpecker habitat areas that included tracts of mature and old-growth forest with minimum densities of large, hard snags for nesting and foraging. The Northwest Forest Plan removed special management provisions for MIS because it was believed that late-successional reserves and new standards and guidelines for green-tree and snag retention during timber harvest would provide adequate habitat for pileated woodpeckers and other late-successional forest associates.

Empirical information on the habitat relations of pileated woodpeckers in west-side forests, however, is extremely limited, and it is not clear that current management provisions will provide adequate habitat for them in coastal forests. In particular, new findings on the structures required for nesting, roosting, and foraging indicate that providing only snags for nest trees may not support viable populations of these woodpeckers.

Because of the ecological benefits it provides for numerous other species through its various excavations, the pileated woodpecker is believed to be a "keystone" species. Additional monitoring of pileated woodpecker populations and the habitat components they require may be needed to ensure that current management guidelines provide adequate habitat for this ecosystem engineer at multiple spatial scales.

BACK TO THE DRAWING BOARD

The notion that viable populations of woodpeckers can be maintained in managed landscapes by providing enough nest snags to support 40 percent of potential population levels—the current management strategy—is based on speculations made almost 25 years ago by biologists working in the Blue Mountains of northeastern Oregon, according to Aubry. This percentage was incorporated into standards and guidelines for green-tree and snag retention in harvest units on lands managed under the Northwest Forest Plan, even though it has never been critically evaluated with data obtained in the field for any species of woodpecker east or west of the Cascades.

"Thus, current management guidelines for woodpeckers in this region are based on professional judgments, some data, and the best of intentions, but they are essentially untested hypotheses," says Aubry.

With colleague Catherine Raley, a wildlife biologist with the PNW Research Station in Olympia, Aubry has recently completed a 6-year study of pileated woodpeckers on Washington's Olympic Peninsula that has produced new information on the nesting, roosting, and foraging ecology of the pileated woodpecker in coastal forests.

"Our findings provide resource managers with critically needed information on the habitat relations of pileated woodpeckers in west-side forests," Raley explains. "This information can be immediately applied to existing standards and guidelines in the Northwest Forest Plan for preserving key habitat structures in retention patches in ways that will improve the habitat quality of managed forests for pileateds."

KEY FINDINGS

- The pileated woodpecker may be a keystone habitat modifier in forested ecosystems of the Pacific Northwest. Their old nest and roost cavities provide unique habitat for secondary cavity-users, and their excavations provide foraging opportunities for other species, accelerate decay processes and nutrient cycling, and may facilitate the spread of heart-rot fungi and mediate insect outbreaks.
- On the west side, pileateds use snags **and** decadent trees equally for nesting. Despite the rarity of decadent trees in the forest, over 48 percent of nests found were in live, dead-top trees.
- Nesting and roosting cavities require different extents and stages of heart-rot decay. Both east and west of the Cascades, the species selected for nesting differs from the species selected for roosting.
- In contrast to findings in northeastern Oregon, pileateds in coastal forests rarely used logs for foraging.

Single-Species Management Approaches

Indicator species: *Changes in the population level of an "indicator" species that result from management activities are assumed to reflect similar trends for other species that occupy the same habitat.*

Umbrella species: *An "umbrella" species has such large area requirements in the habitat of interest that conservationists assume that saving it will save many other species that occupy the same habitat.*

Keystone species: *A "keystone" species is functionally linked to the persistence of an array of other species, and influences the ecosystem in ways that are disproportionately large compared to its abundance or biomass.*

THE BUILDING BIRD

The pileated woodpecker is renowned for its red crest, its large size compared with other woodpeckers, and its skill at opening up new neighborhoods for numerous small cavity dwellers besides its own young.

Pileated woodpeckers are primary excavators; in other words, they excavate their own nest cavities. The nest cavity has a single entrance and is large compared to other woodpecker species (typically about 21 cm wide and 51 cm deep). Sometimes birds will start more than one cavity before selecting their final nest site. "The function of these 'cavity-starts' is unknown," Aubry says, "but they may be involved in courtship activities, they may serve as alternative nest sites, or they may be used in subsequent years. Pileateds excavate new nest cavities each year and exhibit strong selection for nest trees on the basis of diameter, height, decay characteristics, and surrounding habitat conditions."

Pileateds roost individually at night or during inclement weather in hollow trees to reduce the risk of predation and to conserve heat. Typically, roost chambers are much larger than

Purpose of PNW Science Findings

To provide scientific information to people who make and influence decisions about managing land.

PNW Science Findings is published monthly by:

Pacific Northwest Research Station
USDA Forest Service
P.O. Box 3890
Portland, Oregon 97208
(503) 808-2137

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United States Department of Agriculture

Forest Service

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http://www.fs.fed.us/pnw

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nest cavities and have multiple openings to provide escape routes from predators. To access potential roost sites, pileateds excavate openings into hollow trees.

"One of the reasons roost sites may be more limiting for pileateds than nest sites, is because hollow trees are relatively rare in forests; they are created only by the process of heartwood decay occurring in live trees over a long period of time," Raley explains.

Pileated woodpeckers mate for life, and may live as much as 10 years or more in the wild. Once a nest cavity has been excavated and used by a pair to rear their young, it then becomes available to a host of other birds and mammals. The cavities that pileated woodpeckers excavate are the only ones big enough for the larger cavity-using birds and mammals, which include a variety of tree-dwelling ducks, owls, carnivores, and squirrels. Several are species of management concern in the Pacific Northwest, including the common merganser, fisher, and American marten. Altogether, more than 20 species of secondary cavity dwellers have been documented using old cavities or openings excavated by pileated woodpeckers in the Pacific Northwest.

Credit: C. Raley

A tree climber retrieves trapped birds, which are held in place unharmed on the bole of the tree or at the cavity ledge.

ECOSYSTEM ENGINEER AT WORK

This network of relationships is one of the reasons that Aubry and Raley consider the pileated woodpecker to be a "keystone" species. "A keystone species is an organism that influences the ecosystem in ways that are disproportionately large compared to its abundance or biomass," Aubry explains. "Keystone species play critical roles in the ecosystems they occupy because they're functionally linked to the persistence of an array of other species."

Although most well-known keystone species are predators such as the sea otter, there can also be keystone prey, mutualists, hosts, and habitat modifiers. Habitat modifiers like the pileated woodpecker are also called "ecosystem engineers," because their activities substantially alter the physical structure of the environment, influencing both available habitat for other species and various ecosystem processes. The beaver is another good example of a keystone habitat modifier.

The usefulness of the keystone species concept has come under fire recently, but Aubry and Raley support its value. "Unlike indicator or umbrella species, keystones are functionally linked to a suite of other species. Thus, management for the persistence of keystones benefits other species by maintaining key ecosystem functions or structures," Aubry points out. "Furthermore, by studying keystone species, we can gain important knowledge about forest ecosystems and improve our ability to manage or replace various functions."

Pileateds influence habitat conditions for other species in three ways, the researchers note: excavating nest cavities and cavity-starts, excavating openings into roost cavities, and through their foraging activities.

In contrast to other woodpeckers in the Pacific Northwest, pileateds select trees for nesting that are in the early stages of heartwood decay and have relatively sound wood. Consequently, not only are pileated cavities larger than those of other primary cavity nesters, but they have greater structural integrity. "Nest cavities and cavity-starts excavated by pileated woodpeckers may provide more protection from potential predators, have greater longevity, and provide habitat for secondary users over a longer period of time than those of other woodpeckers," Raley says.

Credit: C. Raley

The pileated woodpecker is about the size of a crow, with a thick-walled skull, a tough membrane around the brain, and strong skull muscles to absorb the shock of lifelong pounding.

FORGING ECOSYSTEM RELATIONSHIPS

The pileated woodpecker takes the keystone role into varied ecological terrain. Four particular areas stand out.

"The pileated woodpecker is the only species that excavates extensively into sapwood and heartwood for invertebrate prey," Raley explains. "Because other Northwest woodpeckers are weak excavators, and typically locate prey by gleaning, scaling bark, or pecking, the extensive excavations that pileated woodpeckers create during their foraging activities enable them to prey on invertebrates they could not access on their own."

Through cavity creation and foraging excavations, pileateds directly and indirectly accelerate wood decomposition, and ultimately nutrient cycling, by breaking apart sound and decaying wood and exposing wood in live trees, snags, and logs to insect attack and fungal infection.

W R I T E R ' S   P R O F I L E

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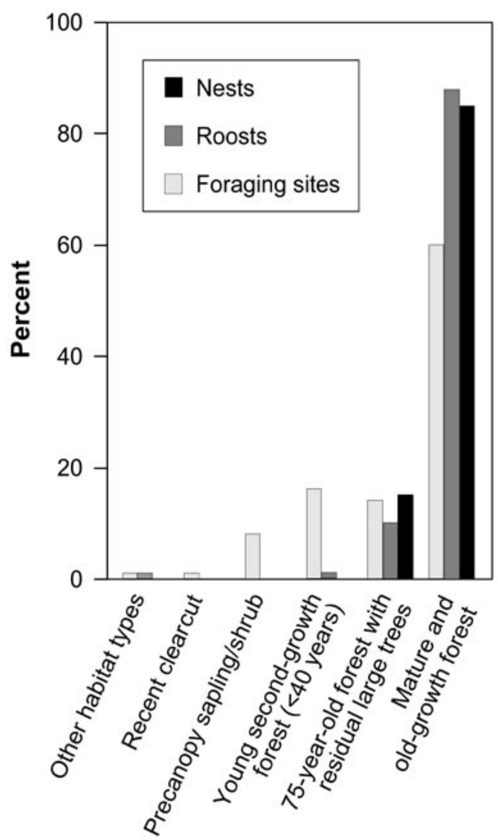
"The pileated is the only local woodpecker that can excavate in sound wood. By exposing healthy trees to infection by heart-rot fungi, they may contribute to the creation of future nesting, roosting, and foraging habitat for both themselves and for other species," Aubry explains.

Although it has not been demonstrated, another contribution of pileated woodpeckers to ecosystem processes may be the mediation of insect outbreaks. The primary item (>50%) in the diet of pileated woodpeckers is carpenter ants, but beetle larvae are also important prey, and their importance in woodpecker diets can vary with population outbreaks. "Obviously, pileateds reduce insect populations to some extent by preying on them, but pileated foraging excavations also alter microhabitat conditions for insects that escape predation, especially developing eggs and larvae, and make them more vulnerable to parasites and other predators," Raley says.

LAND MANAGEMENT IMPLICATIONS

- Because of their keystone role, ensuring the persistence of pileated woodpeckers in managed landscapes will provide many ancillary ecological benefits.
- New findings on nest- and roost-tree preferences in west-side forests can be applied immediately to existing standards and guidelines in the Northwest Forest Plan for retaining key habitat structures in green-tree retention patches of harvest units.
- New findings indicate that the current emphasis on nesting structures for pileated woodpeckers needs to be expanded to include explicit consideration of structures needed for roosting and foraging.
- Resource managers in any locality can determine which tree species are most likely to provide nesting and roosting habitat for pileated woodpeckers by evaluating forest composition, age structure, history of disease and insect infestation, and other environmental stress factors.



On the Olympic Peninsula in western Washington, pileated woodpeckers nested and roosted primarily in unmanaged late-successional forest types, but they also used forests that were about 75 years old with large, residual live trees and snags. Habitats used by birds for foraging, however, were more variable and included all forest types within the study area. Between 1991 and 1995, Aubry and Raley trapped and radio-tagged 26 adult birds, and collected more than 2,400 telemetry locations that represented year-round habitat use.

THE WEST-SIDE VARIATIONS

Prior to Aubry and Raley's work, most of what was known about pileated woodpeckers in the Pacific Northwest came from long-term studies conducted in northeastern Oregon by Evelyn Bull, research wildlife biologist with the PNW Station at La Grande. Their west-side study has revealed both similarities and differences in the habitat relations of pileated woodpeckers as compared with those on the east side of the Cascade Range. These findings signal the need for a reevaluation of current management guidelines within the range of the northern spotted owl.

"Contrary to findings in coniferous forests east of the Cascades, pileated woodpeckers in coastal forests of western Washington use snags *and* decadent trees—live, dead-top trees—equally for nesting," Aubry says. "Although half the nests we found were in decadent trees, such structures were extremely rare in our study area. Thus, our findings indicate that in coastal forests of western Washington, decadent trees appear to be more important for nesting by pileated woodpeckers than snags."

Current management prescriptions for pileated woodpeckers are directed solely at nesting habitat. However, on the Olympic Peninsula, trees selected by pileated woodpeckers for nesting differed in both size and decay characteristics from those selected for roosting, the researchers say. Specifically, nest sites were selected in trees whose heartwood had only been partially softened by the early stages of heartwood decay. Roost cavities, on the other hand, were typically large, natural hollows created by late stages of heartwood decay with both natural and excavated openings.

"The tree species pileated woodpeckers selected for nesting also differed from that selected for roosting," Aubry says. "In our study area, Pacific silver fir was preferred for nesting, whereas western redcedar was preferred for roosting and was not used for nesting. Although the tree species used on the east and west sides are different, the *pattern* was the same: different species and decay conditions were selected for nesting than for roosting, and the species used for roosting was almost never used for nesting."

However, the tree species selected for nesting or roosting may not be static in a given locality. In general, trees that are older, suppressed, or otherwise stressed are less capable of resisting infection by heart-rot fungi than are younger, healthier trees. Thus, the researchers note, if a tree species goes into a period of decline for some reason, such that the prevalence of heart-rot infection changes among species, then the tree species that pileateds select for nesting and roosting may also change.

Another pattern that was strikingly similar east and west of the mountains had to do with the number of roost trees each bird needs. "A pair needs only one nest tree each year, but in both coastal Washington and northeastern Oregon, each bird used an average of seven or more different roost trees during the course of the year," Raley explains.

Finally, in coastal forests of Washington, pileated woodpeckers rarely foraged on logs: a stark contrast to findings from northeastern Oregon, where pileateds commonly foraged on logs. Aubry and Raley believe that in the wet, cool moisture regimes of coastal forests, logs resting on the ground become too saturated with water to support colonies of carpenter ants. These new findings indicate that greater consideration should be afforded to standing dead wood in west-side habitats.

NEW TECHNIQUES FOR RESEARCH

In the course of gathering data on pileated woodpecker ecology in coastal forests, the researchers developed a new technique for capturing the birds at nest and roost sites so they could outfit them with radio transmitters. Previously, the trapping method of choice required the birds to enter their nest cavities. A device was then triggered to block the entrance to the cavity and trap the bird inside.

The problem was the window of opportunity for capturing pileateds without disturbing their nesting activities was very small, a 2-week period at most. To avoid nest abandonment, researchers had to wait until the eggs hatched, and then trap birds before the nestlings grew so big that the parents no longer needed to enter the cavity to feed them.

Similar to the "noose carpets" that have long been used to capture birds of prey, the trap they developed works by snaring the bird's feet in an array of nooses as it hops up to the cavity entrance. A tree-climber then ascends the tree and retrieves the bird, which is held in place unharmed on the bole of the tree or at the cavity ledge. "Our technique does not require birds to enter a cavity, and thus expands trapping opportunities at nest trees, and enables researchers to capture pileated woodpeckers at roost trees and foraging sites, which was very difficult to do with previous techniques," Raley explains. "This technique could also be used to capture other birds, especially the smaller woodpeckers."

The only way to locate pileated woodpecker roost trees is with radio-telemetry. "Using our noose trap, we were able to capture and radio-tag all nesting pairs within our study area and locate 144 different roost trees," Aubry says. "Our study indicates that large, old western redcedars may be particularly important as roost sites for pileateds. Such trees often form the kinds of hollows that are selected by pileateds and are undoubtedly used by many other species." Because redcedars are resistant to fire and disease and may persist on the landscape for centuries, they are likely to be particularly important structures for pileateds and other wildlife. This may be especially true in landscapes where such mortality factors have limited the availability of large hollows in other tree species.

The connection between wildlife and forest health continues to unfold.

APPLICATIONS IN MANAGEMENT

Aubry and Raley's research is the only long-term study conducted to date on pileated woodpeckers west of the Cascade Range. Information on nest and roost trees, foraging sites, home range size, and habitat use at both stand and landscape scales is regularly requested by federal and state agencies, as well as private industry.

Unofficially, Aubry says, their findings are already starting to be used in west-side management strategies. Biologists are getting a better feel for the types of trees that should be left for woodpecker habitat, the importance of heart-rot decay characteristics, and the crucial role of decadent trees as well as snags. Snags present a significantly greater safety threat to logging operators trying to leave "legacy" trees than do decadent trees. Furthermore, decadent trees will provide habitat for pileated woodpeckers for a longer period of time than will the already dead snags.

"New knowledge about the relationship between trees selected by pileated woodpeckers and heartwood decay will enable resource managers to identify the tree species that are most likely to provide optimal nesting and roosting habitat for this ecosystem engineer," Raley says. "By evaluating tree species composition, age structure, history of disease and insect infestation, and other environmental stress factors in a given locality, managers now have the tools to identify which tree species are most susceptible to infection by heart-rot fungi and, therefore, are most likely to provide key habitat structures for pileateds."

This information will help managers design landscape-scale strategies for pileated woodpeckers in ways that will contribute substantially to the goals of ecosystem management, Aubry points out. "Because of their potential keystone role, maintaining viable populations of pileated woodpeckers in managed landscapes will result in a variety of ancillary ecological benefits, including critical habitat for larger cavity-using birds and mammals, foraging opportunities for weak excavators, and the facilitation of a suite of ecological processes."

Aubry and Raley's current research is focused on the foraging ecology of pileated woodpeckers on the east slope of the Cascade Range in Oregon. To date no attempt has been made to identify the prey species that are associated with different forest structures or foraging behaviors. Additionally, there is no information on the density of foraging structures that may be needed to support viable populations of pileated woodpeckers. "We hope that the results of this study will enable resource managers to develop more comprehensive plans for pileated woodpeckers in managed landscapes," says Raley.

Clearly, this ecosystem engineer has a great deal of insights to offer for improving management of both reserved and matrix lands under the Northwest Forest Plan.

> *"The practice of 'cleaning up' woodland of decaying wood almost guarantees the absence of this grand species."*
>
> —Ron Austing, wildlife photographer

FOR FURTHER READING

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