snags 10.0" DBH and larger, and all snags 20.0" DBH and larger are included in the estimate of snags 15.0" DBH and larger.

The total primary sampling units (PSUs) are the number of FIA plots within the domain of interest, such as wilderness/roadless or with a specified dominance group. The number of forested PSUs are the number of FIA grid locations that have at least a portion of the PSU with a "forested" condition. The information from the "forested" portion of the PSUs are used in the analysis.

3.0 Preliminary analysis of snag densities on Eastside Forests

We evaluated snag densities on the eastside Forests of Region 1 using a hierarchical approach.

3.1 Comparison of Snag Density within and outside of Wilderness and Roadless Areas
First, we looked at the density of snags within and outside of wilderness and roadless areas. Timber harvest and human access can have substantial effects on snag density and longevity (Wisdom and Bate, 2008; Russell et al. 2006). Exploring the density of snags in wilderness and roadless areas can provide insight to natural snag abundance and distribution on a Forest. These can be compared to paired field plots outside wilderness/roadless to help to understand differences between areas that have been influenced by management and unmanaged areas. There is some uncertainty how climate, a period of cool and moderate precipitation, and fire suppression from 1930-1985 has affected snag density and distribution in wilderness and roadless areas. Harris (1999) notes similar uncertainty concerning effects of fire suppression on creation of snags in unharvested areas of western Montana. However, even with some degree of uncertainty it is the best quantitative data available to represent natural forested systems. To date, there has been no known extirpation of cavity nesting species from eastside Forests, within or outside of roaded areas. It follows that, in general, analysis of the roadless portion of these Forests will represent an appropriate range of snag numbers and distribution to develop desired snag conditions for planning purposes.

As shown by Table 2, there are fewer snags in each of the diameter classes outside of wilderness and roadless areas for the eastside, in general, and for all of the Forests except the Helena. Furthermore, the larger the snag, the less common it is. This is largely due to less trees living to an older age, as trees age, they grow slower, never reaching very-large diameters, and the inability of systems to contain large old trees and snags due to various types of disturbance agents which kill and remove them over time.

Table 2: Mean snag densities per acre with 90% confidence interval, by diameter classes, inside and outside of wilderness/roadless areas for all eastside Forests and for each Forest.

	Area	Snags per Acre 10"+ Mean	Snags per Acre 10"+ 90% CI - Lower Bound	Snags per Acre 10"+ 90% CI - Upper Bound	Snags per Acre 15"+ Mean	Snags per Acre 15"+ 90% CI - Lower Bound	Snags per Acre 15"+ 90% CI - Upper Bound	Snags per Acre 20"+ Mean	Snags per Acre 20"+ 90% CI - Lower Bound	Snags per Acre 20"+ 90% CI - Upper Bound	Total Number PSUs	Number Forested PSUs
In Wilderness / Roadless	Eastside Forests	12.2	10.8	13.7	2.9	2.5	3.3	0.7	0.5	0.8	937	747
	Beaverhead Deerlodge	10.6	8.5	13.0	2.6	1.9	3.3	0.5	0.3	0.8	325	253
	Custer	12.7	7.0	19.4	3.8	1.8	6.2	1.0	0.4	1.6	84	44
	Gallatin	17.6	14.4	21.1	4.7	3.7	5.9	1.3	0.9	1.8	221	170
	Helena	10.1	5.9	15.0	0.9	0.3	1.6	0.2	0.0	0.4	85	79
	Lewis & Clark	10.3	7.7	13.2	2.2	1.5	3.1	0.4	0.2	0.7	222	201
Outside Wilderness / Roadless	Eastside Forests	4.4	3.5	5.3	1.1	0.8	1.4	0.2	0.1	0.3	538	428
	Beaverhead Deerlodge	2.9	1.9	4.0	0.7	0.4	1.0	0.2	0.1	0.3	222	189
	Custer	3.2	1.5	5.2	1.1	0.4	1.8	0.0	0.0	0.2	111	61
	Gallatin	7.4	4.2	11.0	2.5	1.2	3.9	0.4	0.1	0.9	64	53
	Helena	5.0	2.7	7.6	1.2	0.4	2.1	0.4	0.1	0.8	64	59
	Lewis & Clark	6.7	3.6	10.6	0.9	0.3	1.6	0.1	0.0	0.3	77	66

3.2 Estimates of Snag Density by Habitat Type Groups

Second, estimates of large-snag density, by aggregations of habitat types (Pfister, 1977), referred to as habitat type groups, commonly used for eastside vegetation assessments (Appendix B) were derived (Table 3). Each of these habitat type groups have similar biophysical and disturbance regime characteristics that determine snag abundance ranges during various stages of succession. Habitat type groups were used instead of Vegetative Response Units (VRUs) because habitat type groups are a consistent classification utilized across all eastside Forests for planning and analysis.

Within wilderness/roadless areas, some habitat type groups contain similar densities of large snags (e.g., warm and very dry, warm and dry). Habitat groups with similar snag densities are shaded in Table 3. Each of these shaded habitat type groups have characteristic disturbance regimes that are generally different between groups and contribute to snag abundance, during various stages of succession, in different ways. One of the differences is the numbers of snags produced. The warm groupings have fewer snags, most likely due to frequent, low- to mid-severity fire that tended to produce a relatively constant level of snags at low numbers. The cool group, with a characteristic fire regime that tended to have less frequent, but with more severe fires, produced pulses of snags, and generally a greater quantity of snags, especially early in the forest succession cycle. Then as stands aged, the density of snags increased, until another high-severity stand replacing fire occurs. The cold types tend to produce high snag densities as characteristic disturbance regimes produced persistent snags over a long periods due to colder climates, where decomposition rates are slower, and the period of time between stand replacing events were likely the longest. One again, we see that the larger the snag, the less common they are within the forest. Individual Forest's snag densities, by these habitat type groups are displayed in Appendix C, Table 1.

Table 3: Mean snag density per acre and 90% confidence interval, by diameter class, inside and outside of wilderness/roadless areas by initial habitat type groups, for all eastside Forests.

Area	Habitat Type Group	Snags per Acre 10"+			Snags per Acre 15"+			Snags per Acre 20"+			Total # PSUs	# Forested PSUs
		Mean	90% CI Lower Bound	90% CI Upper Bound	Mean	90% CI Lower Bound	90% CI Upper Bound	Mean	90% CI Lower Bound	90%CI Upper Bound		
In Wilderness / Roadless	Warm & Very Dry	5.1	2.8	7.9	1.4	0.7	2.3	0.3	0.1	0.6	105	105
	Warm & Dry	5.8	1.8	10.9	1.4	0.5	2.6	0.3	0.0	0.6	44	44
	Warm & Moist	4.7	2.1	7.8	1.1	0.2	2.2	0.3	0.0	0.9	31	31
	Cool & Moist	12.2	7.6	17.5	2.5	1.0	4.3	0.5	0.1	1.0	68	68
	Cool & Dry to Moist	14.0	11.0	17.1	3.0	2.2	4.0	0.6	0.4	0.9	207	207
	Cool & Moist to Wet	16.2	9.8	23.6	2.6	1.3	4.3	0.5	0.1	0.9	36	36
	Warm to Cool & Dry	13.7	8.7	19.4	3.5	2.0	5.3	0.8	0.3	1.4	45	45
	Cool & Wet	18.3	12.0	25.1	5.5	3.2	8.2	1.5	0.5	2.9	39	39
	Cold & Dry to Wet	18.9	14.2	24.1	4.4	3.0	6.1	1.1	0.6	1.6	95	95
	Cold & Dry	11.5	6.8	16.9	3.3	2.0	4.6	1.1	0.6	1.6	60	60
Outside Wilderness / Roadless	Warm & Very Dry	2.0	1.2	3.1	0.8	0.4	1.2	0.2	0.0	0.3	124	124
	Warm & Dry	3.1	1.5	4.9	0.9	0.3	1.7	0.4	0.1	0.8	53	53
	Warm & Moist	2.5	0.8	4.5	0.4	0.0	1.0	0.2	0.0	0.5	39	39
	Cool & Moist	3.4	1.5	5.5	0.8	0.0	1.8	0.2	0.0	0.4	51	51
	Cool & Dry to Moist	5.2	3.1	7.5	0.8	0.3	1.5	0.1	0.0	0.3	97	97
	Cool & Moist to Wet	6.6	0.0	17.0	1.2	0.0	4.6	0.0	0.0	0.0	5	5
	Warm to Cool & Dry	12.5	6.1	20.0	3.2	1.3	5.6	0.9	0.1	2.0	19	19
	Cool & Wet	6.7	1.5	13.6	1.6	0.0	4.1	0.0	0.0	0.0	15	15
	Cold & Dry to Wet	16.6	5.9	30.4	4.0	1.4	7.0	0.4	0.0	1.1	15	15
	Cold & Dry	11.5	0.0	31.2	2.0	0.0	7.7	0.0	0.0	0.0	5	5

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southern flying squirrel, *Glaucomys volans* L., and related life history information in relation to habitat factors. M.S. Thesis, Univ. of Missouri, St. Louis. 84pp.

SVIHLA, R. D. 1930. A family of flying squirrels. J. Mammal. 11:211–213.

TAYLOR, W. E., AND R. G. HOOPER. 1991. A modification of Copeyon's drilling technique for making artificial red-cockaded woodpecker cavities. U.S. For. Serv. Gen. Tech. Rep. SE-72. 31pp.

U.S. FISH AND WILDLIFE SERVICE. 1985. Red-cockaded woodpecker recovery plan. U.S. Fish Wildl. Serv., Atlanta, Ga. 88pp.

WEIGL, P. D. 1978. Resource overlap, interspecific interactions and the distribution of the flying squirrels, *Glaucomys volans* and *G. sabrinus*. Am. Midl. Nat. 100:83–96.

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HABITAT USE AND MANAGEMENT OF PILEATED WOODPECKERS IN NORTHEASTERN OREGON

1993

EVELYN L. BULL, USDA Forest Service, Pacific Northwest Research Station, 1401 Gekeler Lane, La Grande, OR 97850
RICHARD S. HOLTHAUSEN, USDA Forest Service, Pacific Northwest Region, P.O. Box 3623, Portland, OR 97208

Abstract: We determined home range size and habitats used by pileated woodpeckers (*Dryocopus pileatus*) to provide essential information for proper management of the species in northeastern Oregon. Twenty-three pileated woodpeckers fitted with transmitters were followed for 5–10 months (Jun–Mar) during 1989–90. Mated pairs ($n = 7$) ranged over smaller areas ($\bar{x} = 407$ ha) than birds ($\bar{x} = 597$ ha) whose mates had died ($n = 9$). Habitat use within home ranges was not random. Stands with old growth, grand fir (*Abies grandis*), no logging, and ≥60% canopy closure were used more ($P < 0.01$) than expected, and all other types of stands were used less than expected. From June until March, 38% of the observations of foraging were on downed logs, 38% on dead trees, 18% on live trees, and 6% on stumps. We recommend that management for pileated woodpeckers in northeastern Oregon include increasing density of snags for nesting and foraging, increasing density of downed logs in foraging areas, and increasing management areas from the existing 121 ha to 364 ha of forest. Within these areas, we recommend that 75% be in grand fir forest type; 25% be old growth; and the remainder be mature stands; at least 50% have ≥60% canopy closure; and at least 40% be unlogged with the remainder in mature stands.

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The pileated woodpecker was selected as a management indicator species for older forests by some regions in the U.S. Forest Service because it nests and roosts in large-diameter dead trees or snags (Hoyt 1957, McClelland 1977, Harris 1982, Bull et al. 1992*b*), and is largely dependent on dead wood (standing and down) for foraging (Bull 1987). These habitat components are most common in older forests.

Management for pileated woodpeckers on public lands in the western United States has been based on guidelines that recommend leaving specified densities of snags for nesting and roosting to provide for different population levels of woodpeckers (Thomas et al. 1979, Brown 1985). In addition, 121-ha patches of older forests have been maintained for nesting pairs on National Forests in the Pacific Northwest Region. Neither of these management approaches has been tested, however, to ascertain whether it supports the woodpecker in eastern Oregon.

Research conducted elsewhere suggests that the 121-ha management areas are inadequate in coniferous forests. Radio-tagged pileated woodpeckers in western Oregon had home ranges of 257–1,056 ha (Mellen et al. 1992). In contrast, radio-tagged birds in Missouri used only 53–160 ha during April–August (Renken and Wiggers 1989). However, this research was conducted in deciduous forests that are typically more diverse than coniferous forests, so a comparison of home range sizes is not valid.

We felt it necessary to determine population density of pileated woodpeckers in 9 study areas with different snag densities to test the snag guidelines currently in use, and to test the existing guidelines for 121-ha management areas maintained in old-growth conditions in the Pacific Northwest Region.

We are grateful to M. A. Bishop, H. D. Cooper, R. D. Dixon, J. E. Hohmann, S. M. Lindstedt, and A. L. Wright for their assistance with

Table 2. Habitat characteristics (averages) within the home ranges and within 4 size classes of home ranges of pileated woodpeckers, northeastern Oregon, 1989–91.

Characteristic	All pairs	Home range size class (ha)			
		<300	300–499	500–799	>800
n (home ranges)	7	3	6	6	1
Home range (ha)	407	220	370	647	1,464
Home range (forested ha only)	364	208	345	566	1,324
Forest type series (%)[a]					
Ponderosa pine[b]	3	2	2	13	68
Douglas-fir	23	27	19	34	26
Grand fir	74	71	79	53	5
Successional stage (%)[a]					
Young	6	0	5	4	8
Mature	70	59	71	67	88
Old growth	24	41	22	29	4
Logging activity (%)[a]					
None	43	81	38	64	9
Partial	49	19	53	34	81
Shelterwood	8	0	9	2	10
Canopy closure (%)[a]					
<10%	8	1	7	4	15
10–59%	41	24	43	52	68
≥60%	51	75	50	44	17

[a] Values are percentage composition of the home ranges.
[b] Best predictor ($R^2 = 0.78$; $P < 0.01$; stepwise multiple regression) of home range size.

Douglas-fir, and western larch snags were preferred ($F = 7.48$; 5, 75 df; $P < 0.01$). Snags ≥38 cm dbh also were preferred ($F = 63.05$; 3, 45 df; $P < 0.01$).

Dead standing trees and logs were particularly important for foraging, yet their use changed over the year (Fig. 3). When we compared foraging strata without snow (≤5 cm) with foraging strata with snow (>5 cm), we noted an increase in use of live trees (17–22%), an increase in use of dead trees (35–55%), a decrease in use of logs (41–18%), and a slight decrease in use of stumps (7–5%).

DISCUSSION

We believe that home ranges did not overlap a great deal except in situations when birds had lost mates. Birds whose mates had died usually had more overlap and larger home ranges than did pairs. These birds may have expanded their ranges to search for mates, or to forage over larger areas because of poorer habitat.

We were unable to predict size of home range very accurately with the habitat variables. However, the birds did not use habitat within their home ranges at random and selected for stands with old growth, grand fir, no logging, and >60% canopy closure. Similarly, Conner (1980) reported that pileated woodpeckers in Virginia used the oldest stands with the highest basal area and density of stems available for foraging.

The snag densities in the study areas were variable, and while we did not consider some areas (Spring and Wallowa) capable of supporting self-sustaining pileated populations, we felt others (Bear and Syrup) were self-sustaining and capable of acting as sources for other areas because of the high density of pairs (7 and 5 pairs, respectively) and successful reproduction (75% of nesting pairs fledged young). We estimated that 16% of the snags ≥51 cm in Bear and Syrup had resulted from activity of spruce budworm or Douglas-fir beetle, so 16% of the snag density can be subtracted from the total to yield a density without the influence of an insect outbreak. We were unable to judge the ability of the remaining areas to support self-sustaining pileated populations because of only 1 year of observations and very variable reproduction.

Our observations of foraging differed somewhat from observations in the eastern United States. Conner (1980) reported more snags (49%) and live trees (45%) and fewer downed logs (1%) used by pileateds for foraging in Virginia. Con-

Table 3. Characteristics c
available logs and snags th

Characteristic
Tree species[a]
Grand fir
Douglas-fir
Ponderosa pine
Western larch
Other[b]
Dbh (cm)[c]
<25
25–37
38–50
≥51
Decay class[e]
Recent-dead
Intermediate-dead
Long-dead
n

[a] Species of logs (F = 5.98;
availability.
[b] Primarily lodgepole pine.
[c] Diameter classes of logs (F
to availability.
[d] Limited to 15–24 cm dbh.
[e] Long-dead logs preferred (

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Table 3. Characteristics of foraging strata (%) where pileated woodpeckers were observed foraging, and characteristics of available logs and snags that were measured at 240 plots (20 × 20 m) in 12 home ranges, northeastern Oregon, 1989–91.

Characteristic	Downed log		Snag		Live tree observed
	Observed	Plots	Observed	Plots	
Tree species[a]					
Grand fir	23	28	47	75	41
Douglas-fir	25	6	21	9	21
Ponderosa pine	30	27	16	5	16
Western larch	20	14	14	7	21
Other[b]	2	25	2	4	1
Dbh (cm)[c]					
<25	26	46[d]	8	59[d]	9
25–37	34	33	26	27	27
38–50	24	12	30	9	29
≥51	16	8	36	5	35
Decay class[e]					
Recent-dead	1	18	24		
Intermediate-dead	23	66	61		
Long-dead	76	16	15		
n	995	2,779	1,030	558	484

[a] Species of logs ($F = 5.98$; 5, 45 df; $P < 0.01$; Friedman's) and snags ($F = 7.48$; 5, 75 df; $P < 0.01$; Friedman's) not used in proportion to availability.
[b] Primarily lodgepole pine.
[c] Diameter classes of logs ($F = 3.28$; 3, 33 df; $P = 0.03$; Friedman's) and snags ($F = 63.05$; 3, 45 df; $P < 0.01$; Friedman's) not used in proportion to availability.
[d] Limited to 15–24 cm dbh.
[e] Long-dead logs preferred ($F = 47.67$; 2, 22 df; $P < 0.01$; Friedman's).

ner (1979*a*) also reported a variety of foraging strategies for pileateds with the majority of excavation occurring in winter, and more pecking and scaling occurring during the spring and summer. Excavation involved gaining access to interior wood where the woodpeckers fed primarily on ants, probably carpenter ants (*Camponotus* spp.) and some thatching ants (*Formica* spp.) (Bull et al. 1992*a*). Pecking the bark may have uncovered some ants (*Lasius*, *Leptothorax*) and beetles that occurred under the bark rather than in the interior wood (T. R. Torgersen and E. L. Bull, unpubl. data). Tree gleaning occurred primarily in June and July on live Douglas-fir and grand fir when the birds were probably feeding on larvae of western spruce budworm. We found budworm mandibles in woodpecker scats (Bull et al. 1992*a*).

budworms

We observed pileated woodpeckers gleaning branches of live Douglas-fir and grand fir that were infested with western spruce budworm larvae in June and July. This timing coincided with the highest use of live trees (42%) that we observed and also coincided with the greatest abundance of the large, late-instar budworms (Fellin and Dewey 1986). Use of live trees again increased from November to January when we observed woodpeckers frequently excavating at the base of live western larch. We think they were feeding on carpenter ants in these larch because ant galleries were evident in some of them. Conner (1981) also noted pileateds feeding on carpenter ants near the base of live trees in winter.

Use of snags was greatest in the winter, presumably because logs became inaccessible when snow covered them. Shallow snow apparently did not preclude use of logs because we observed birds wiping snow off logs with their bills and then feeding in the log.

MANAGEMENT IMPLICATIONS

Past management for pileated woodpeckers followed guidelines presented by Thomas et al. (1979) that were based on providing specified snag densities in 121-ha territories. These guidelines were based on the best knowledge available at the time. From our findings, we now know that 121-ha areas are much smaller than observed pair home ranges, and habitat components other than snags are important in managing for pileated woodpeckers in northeastern Oregon. Management plans for pileated woodpeckers should be revised to incorporate this new information.

We recommend using an average home range

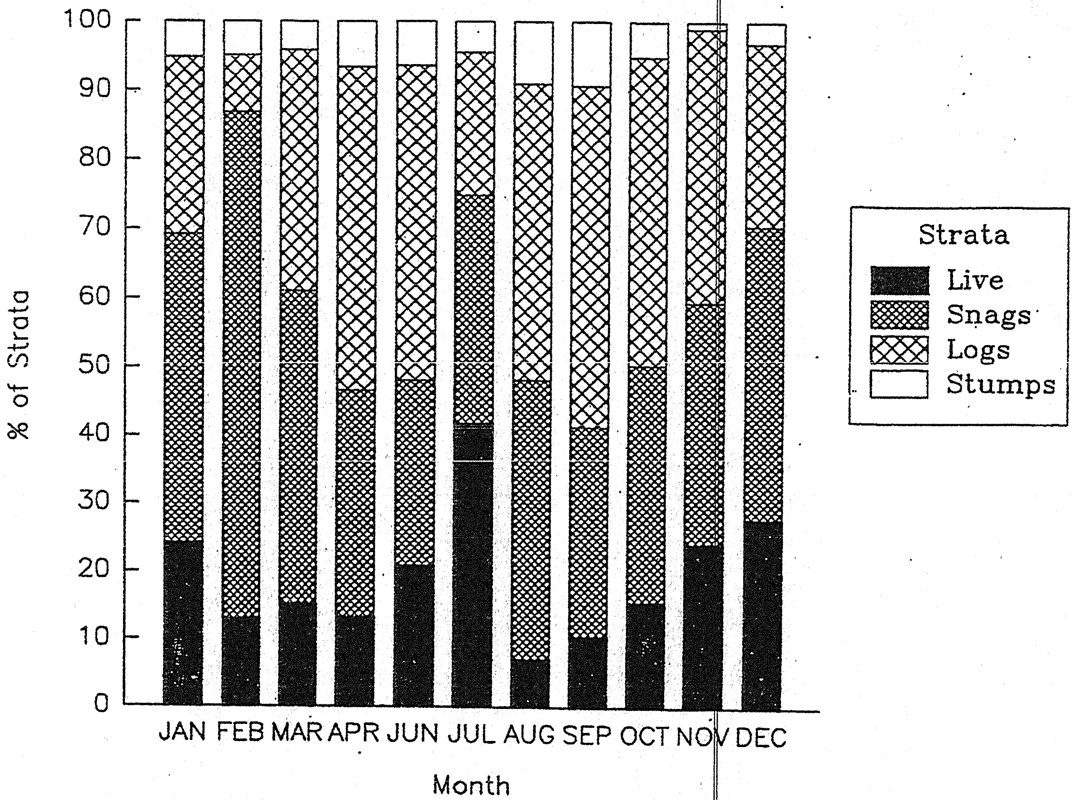

Fig. 3. Monthly foraging strata used by radio-tagged pileated woodpeckers, northeastern Oregon, 1989–91.

910 ac

size of 364 ha of forest, more than 3 times the size of current prescribed management areas. Within those home ranges, we recommend that about 75% be in the grand fir forest type; at least 25% be old growth and the remainder be mature; at least 50% of the area should have ≥60% canopy closure; at least 40% of the area should remain unlogged, with the remainder having no more than partial overstory removals so mature stands are retained after logging.

logs 250/ac

15"

Downed logs were a critical component of the foraging habitat, but only 37% showed evidence of pileated woodpecker feeding. We recommend leaving ≥100 logs/ha in management areas, with a preference for logs ≥38 cm in diameter (long-dead logs) and for all species except lodgepole pine. We also recommend leaving ≥8 snags/ha for nesting, roosting, and foraging; at least 20% of these snags should be ≥51 cm dbh.

The existing pileated management areas (121 ha) on National Forests are about 8 km apart. If only 1 pair of pileateds occurs in each management area, and there is 1 management area for every 4,860 ha, then only 2% of the total forest is being managed for pileated woodpeckers. Additionally, our observations indicate that isolated pairs in marginal (i.e., minimum standard) habitats are unlikely to sustain a population. This information suggests that larger blocks of habitat (for >1 pair), in closer proximity, should be managed for pileateds to provide self-sustaining populations. Such management action is similar to that recommended for the northern spotted owl (*Strix occidentalis*) (Thomas et al. 1990), and would increase the probability of birds finding new mates because if 1 member of a pair dies, the surviving mate does not leave the territory.

Managing for minimum levels of a species is risky (Conner 1979*b*). Consequences can be unfortunate when new data reveal that current recommendations are inadequate to provide the population levels desired, because other options often have been eliminated. Therefore, we recommend managing clusters of 3 or more pairs in 1 block of habitat with blocks distributed across the landscape through time. This man-

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LITERATURE C

ALLDREDGE, J. R., .
comparison of
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AVERY, T. E. 1978
interpretation.
308. 41pp.
BROWN, E. R., tech
of wildlife and
Oregon and W
R6-F&WL-192
BULL, E. L. 1987.
pecker in north
51:472–481.
———, R. S. HOL
1992*a*. Arthro
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eastern Orego
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CONNER, R. N. 1
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survival. Page
Conner, R. R.
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systems. Acad
———. 1979*b*.
wildlife mana
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———. 1980. F
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ement should include the appropriate forest types, successional stages, logging activities, canopy closures, snag densities, large-diameter live trees, and downed log densities within a larger home range area.

LITERATURE CITED

ALLDREDGE, J. R., AND J. T. RATTI. 1992. Further comparison of some statistical techniques for analysis of resource selection. J. Wildl. Manage. 56:1–9.

AVERY, T. E. 1978. Forester's guide to aerial photo interpretation. USDA For. Serv., Agric. Handb. 308. 41pp.

BROWN, E. R., technical editor. 1985. Management of wildlife and fish habitats in forests of western Oregon and Washington. USDA For. Serv., No. R6-F&WL-192-1985. 332pp.

BULL, E. L. 1987. Ecology of the pileated woodpecker in northeastern Oregon. J. Wildl. Manage. 51:472–481.

———, R. S. HOLTHAUSEN, AND R. C. BECKWITH. 1992*a*. Arthropod diet of pileated woodpeckers in northeastern Oregon. Northwest. Nat. 73:42–45.

———, ———, AND M. G. HENJUM. 1992*b*. Roost trees used by pileated woodpeckers in northeastern Oregon. J. Wildl. Manage. 56:786–793.

———, ———, AND ———. 1990*a*. Techniques for monitoring pileated woodpeckers. USDA For. Serv., Gen. Tech. Rep. PNW-GRT-269.

———, ———, AND D. B. MARX. 1990*b*. How to determine snag density. West. J. Appl. For. 5:56–58.

———, AND R. J. PEDERSEN. 1978. Two methods of trapping adult pileated woodpeckers at their nest cavities. North Amer. Bird Bander 3:95–99.

CONNER, R. N. 1979*a*. Seasonal changes in woodpecker foraging methods: strategies for winter survival. Pages 95–105 *in* J. G. Dickson, R. N. Conner, R. R. Fleet, J. A. Jackson, and J. C. Kroll, eds. The role of insectivorous birds in forest ecosystems. Academic Press, New York, N.Y.

———. 1979*b*. Minimum standards and forest wildlife management. Wildl. Soc. Bull. 7:293–296.

———. 1980. Foraging habitats of woodpeckers in southwestern Virginia. J. Field Ornithol. 51:119–127.

———. 1981. Seasonal changes in woodpecker foraging patterns. Auk 98:562–570.

CONOVER, W. J. 1980. Practical nonparametric statistics. Second ed. John Wiley and Sons, New York, N.Y. 493pp.

FELLIN, D. G., AND J. E. DEWEY. 1986. Western spruce budworm. USDA For. Serv., For. Insect and Dis. Leafl. 53. 10pp.

HARRIS, R. D. 1982. The nesting ecology of the pileated woodpecker in California. M.S. Thesis, Univ. of California, Berkeley. 79pp.

HOYT, S. F. 1957. The ecology of the pileated woodpecker. Ecology 38:246–256.

JOHNSON, C. G., JR., AND F. HALL. 1990. Plant associations of the Blue Mountains. USDA For. Serv., R6-Ecol. Area 3. 116pp.

MCCLELLAND, B. R. 1977. Relationships between hole-nesting birds, forest snags, and decay in western larch–Douglas-fir forests of the Rocky Mountains. Ph.D. Thesis, Univ. of Montana, Missoula. 496pp.

MELLEN, T. K., E. C. MESLOW, AND R. W. MANNAN. 1992. Summer time home range and habitat use of pileated woodpeckers in western Oregon. J. Wildl. Manage. 56:96–103.

RENKEN, R. B., AND E. P. WIGGERS. 1989. Forest characteristics related to pileated woodpecker territory size in Missouri. Condor 91:642–652.

STRICKLER, G. S. 1959. Use of the densiometer to estimate density of forest canopy on permanent sample plots. USDA For. Serv., Research Note 180. 5pp.

THOMAS, J. W., R. G. ANDERSON, C. MASER, AND E. L. BULL. 1979. Snags. Pages 60–77 *in* J. W. Thomas, ed. Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. U.S. Dep. Agric. Handb. 553.

———, E. D. FORSMAN, J. B. LINT, E. C. MESLOW, B. R. NOON, AND J. VERNER. 1990. A conservation strategy for the northern spotted owl. U.S. Gov. Printing Office 1990-791-171/20026. 427pp.

WELLNER, C. A. 1978. Effects of past events. Pages 185–189 *in* M. H. Brookes, R. W. Stark, and R. W. Campbell, eds. The Douglas-fir tussock moth: a synthesis. U.S. For. Serv., Tech. Bull. 1585.

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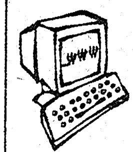
Associate Editor: Mannan.

Region One Vegetation Classification, Mapping, Inventory, and Analysis Report				$\bar{x} = \frac{\sum x}{n}$

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Estimates of Old Growth for the Northern Region and National Forests

Renate Bush [1]
Doug Berglund [1]
Andy Leach [2]
Renee Lundberg [1]
Art Zack [3]

[1]USDA Forest Service, Region 1, Forest and Range Management, 200 E Broadway, Missoula, MT 59807
[2]USDA Forest Service, Inventory and Monitoring Institute, 2150 Centre Ave., Bldg. A, Suite 300, Ft. Collins, CO 80526
[3]USDA Forest Service, Idaho Panhandle National Forest, 3815 Schreiber Way, Coeur d'Alene, ID 83815

Introduction

This document summarizes analysis conducted using Forest Inventory and Analysis (FIA) data to estimate the percentage of old growth on forested lands in the Northern Region and on National Forests in the Northern Region.

Overview of FIA

The national Forest Inventory and Analysis (FIA) program provides a congressionally mandated, statistically-based, continuous inventory of the forest resources of the United States. Since 1930, the FIA program has been administered through the Research and Development branch of the Forest Service, which makes it administratively independent from the National Forest System. The Interior West Forest Inventory and Analysis work unit, headquartered at the USFS Rocky Mountain Research Station in Ogden, Utah oversees the FIA inventory in Region 1. More information on IW-FIA is available on the internet at: http://www.fs.fed.us/rm/ogden/sitemap/index.shtml.

FIA inventory design is based on a national hexagon of inventory plots. Data is collected on all forested portions of the plots, throughout the United States, regardless of ownership. FIA protocols specify sample plot location within this hexagonal grid. Data collection standards are strictly controlled by FIA protocols. The sample design

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and data collection methods are scientifically designed, publicly disclosed, and repeatable. Data collection protocols are publicly available on the internet (http://www.fia.fs.fed.us/). There are also stringent quality control standards and procedures, carried out by FIA personnel of the Rocky Mountain Research Station. All of this is designed to assure that data is collected consistently throughout the United States, and that stated accuracy standards are met by the field crews.

FIA Sampling

To estimate the percent old growth for large areas, such as the Northern Region, individual National Forests, or even large landscape areas, it is infeasible to maintain an inventory for every acre of the millions of acres of forestland. FIA provides a statistically-sound representative sample designed to provide unbiased estimates of forest conditions at broad- and mid-levels. The FIA sampling frame uniformly covers all forested lands, regardless of management emphasis. Therefore, wilderness areas, roadless areas, and actively managed lands all have the same probability of being sampled.

Table 1: Date of Inventory by National Forest

National Forest	Date of FIA Periodic Inventory
Eastern Montana	
Beaverhead-Deerlodge	1996-1997
Custer	1997
Helena	1996-1998
Gallatin	1997-1998
Lewis & Clark	1996-1997
Western Montana	
Bitterroot	1994-1995
Flathead	1993-1994
Kootenai	1993-1997
Lolo	1995-1996
Northern Idaho	
Idaho Panhandle	2000-2003
Clearwater	1998-2002
Nez Perce	2000-2002

Using FIA data to assess the percent of old growth allows the Region to base its monitoring on an unbiased, statistically sound, independently designed and implemented representative sample of forest lands. This inventory is reasonably current because FIA plots in Region 1 were installed during 1993 to 2004 (see Table 1 for specific inventory year by National Forest). All forested[1] plots that are located on the National Forest lands are used to derive these estimates.

[1] "..land at least 10 percent stocked, or currently nonstocked but formerly having such stocking, with timber and/or woodland trees, and where human activity on the site does not preclude natural succession of the forest (i.e., the site will be naturally or artificially regenerated)." *Interior West Forest Land Resource Inventory Field Procedures, 1995-1996.*

Table 2: Northern Region and individual National Forest estimates of percent of old growth, standard error, and 90%-confidence intervals.

Unit	Percent Old Growth Estimate	90%-Confidence Interval - Lower Bound	90%-Confidence Interval - Upper Bound	Total Num. PSUs	Num. Forested PSUs
Northern Region	13.5%	12.8%	14.2%	3883	3423
Beaverhead-Deerlodge	22.9%	20.5%	25.4%	547	442
Bitterroot	12.5%	10.0%	15.3%	252	226
Idaho Panhandle	11.8%	9.6%	14.0%	413	397
Clearwater	9.4%	7.3%	11.8%	305	300
Custer	10.1%	6.4%	14.1%	195	105
Flathead	10.1%	8.2%	12.0%	382	338
Gallatin	25.5%	21.7%	29.3%	285	223
Helena	10.9%	7.8%	14.1%	149	138
Kootenai	8.8%	7.0%	10.7%	370	352
Lewis & Clark	13.3%	10.6%	16.2%	299	267
Lolo	9.5%	7.6%	11.4%	347	327
Nez Perce	14.4%	11.8%	17.2%	339	308

141.3 172.7/13 13.38

Distribution of Old Growth within Individual National Forests

Using FIA data, the same methodology can also be used to estimate the percent old growth on medium to large geographic areas, landscapes, or watersheds within individual National Forests. Estimates of old growth across these areas provide a means for examining the distribution of old growth within a National Forest. Reports for ~~individual National Forests provide this watershed or landscape-level information.~~ In order to obtain reliable estimates of old growth with meaningful confidence limits, the landscape area must be large enough to encompass a reasonable number of FIA plots. Because of the resolution of the FIA data, it should not be used for estimates within a project-area as there are seldom enough plots to derive estimates of old growth with ~~any sort of reliability.~~

Relationship to Forest Maps of Allocated Old Growth Stands, and Project-level Mapping

Broad-level estimates of old growth are intended to be used in conjunction with project-level estimates and associated maps and maps of stands allocated to old growth management by a National Forests. These broad-level estimates are intended to allow land managers to assess forest-plan compliance and to set the context for the maps of

Those FIA plots in which wildfire or harvest have occurred since the dates of inventory until November, 2003 were assumed to not meet the old-growth criteria. This results in conservative estimates as not all wildfire and harvest activities remove all old growth on the landscape. To remain current, FIA has started to re-measure 10% of its plots every year. As these re-measured plots accumulate, we will periodically update our FIA old-growth analysis and report.

All plots installed in Montana from 1993 until 1996, utilized a sample location (field plot) composed of five to seven variable-radius plots with trees 5 inches and larger, in diameter at breast-height (DBH) tallied with a basal area factor of 40. The number of plots installed depended upon the year of inventory; early inventories had a seven-plot cluster, whereas those inventories collected 19995-1996 had five plots.

After 1996, FIA adopted a national plot layout consisting of a cluster of four plots. Trees 5-inches DBH and larger were measured on a 1/24th-acre plot. In 2002, Region 1 worked with IW-FIA to modify the national layout by adding a ¼-acre macro-plot. These protocols were integrated into the IW field procedures and data collection software, and loaded into IW-FIA's database. These protocols dictate that trees 5.0 – 20.9 inches DBH were measured on the 1/24^{th-} acre plot and trees 21.0 inches DBH and larger were measured on the ¼-acre plot. Data collected in 2002 was completed by IW-FIA crews while crews were collecting data. All plots that did not have the ¼-acre plot installed in 2002 had the ¼-acre plot augmented to the standard FIA plot layout in 2003 and 2004. These data were measured by contract crews, overseen by Region 1, using IW protocols and software. For a detailed description of field procedures see http://fsweb.ogden.rmrs.fs.fed.us/data_collection/data_collection.html

FIA field procedures dictate that age for trees 3.0" DBH and larger is measured by counting annual growth rings at breast height, and recorded as "breast-height age". Breast-height (BH) is defined as 4.5' tall. It follows that BH age is the number of years the tree has survived since it reached 4.5 feet tall, which is less than its total age. In temperate regions similar to the Northern Region, coniferous trees always take several years to reach breast height, and these years need to be added to "breast-height age" to get the total age of the tree. The minimum age criteria for old growth used in *Green and others (1992, errata corrected 02/05)* is total age rather than breast-height age. The data used for estimating old growth should be consistent with *Green and others* definitions. Therefore, a conservative estimate of the number of years a currently large tree took to reach BH is added to the BH age (ring count) to account for the difference between the old-growth definition of tree age and FIA field measurement protocols. See Estimates *of Years to Breast Height for Large Conifer Tree Species in the Northern Region* (Berglund, Bush, and Zack, in preparation).

some specific purposes when developing a project-level management approach however, these are not required characteristics as per the Green and others document and therefore are not used for the broad-level analysis.

FIA-plot-level data and analysis methods used here are similar to the plot-level data and analysis methods used by Green and others (2005) when determining the old growth criteria. Neither dataset or analysis method specifies a minimum acre requirements for the size of an old growth polygon.

When using FIA data to estimate old growth amounts, it is important to note that FIA protocols measuring age of trees 3 inches diameter breast-height and larger is to record "breast height age", which is the annual-growth ring count at breast height, 4.5 feet above ground level. This is not the same as total age of the tree, which was used by Region 1 when developing the old-growth criteria. Conifer trees in the Northern Region ecosystems always take a number of years to reach breast height. Therefore, to obtain the total age of a tree, which is the criteria in the old growth definition, the annual ring count at breast height must have a factor added to account for the number of years it takes a tree to grow to breast height. Based on analysis carried out by the Region, taking into a review of the scientific literature and consideration cumulative distribution curves, the factor for the number of years to grow to breast height is established at the 20th-percentile age as derived by species, geographic zone, and habitat-type group. This means that the factor is based on the top 20% fastest growing trees. Conversely, 80% of the tree generally takes longer to grow to breast height. This is considered a conservative estimate that minimizes the risk of over-estimating the total age of the tree, and thus overestimating the percent of the FIA plots that met old growth criteria. For further information see *Estimates of Years to Breast Height for Large Conifer Tree Species in the Northern Region*, by Berglund and others.

For further detail on the statistical foundation of using FIA data to assess old growth on national forests see: *Application of Forest Inventory and Analysis (FIA) Data to Estimate the Amount of Old Growth Forest and Snag Density in the Northern Region of the National Forest System* (Czaplewski).

Percent Old Growth in the Northern Region and on Individual National Forests

Table 2 provides a summarization of the estimates of percent old growth on forest-lands for the Northern Region and individual National Forests as per the Region 1 Green and others definition of old growth. Forests have varying old growth requirements in their current Forest Plans which are not reflected in this table. See the Forest Plans and/or Monitoring Reports for more information on old growth standards and guidelines for each Forest.

Literature Cited

Bush, Renate, D. Berglund, A. Leach, R. Lundberg, J.D. Zeiler. Overview of R1-FIA Summary Database, Region 1 Vegetation Classification, Inventory, and Analysis Report #06-02, 2006. http://fsweb.r1.fs.fed.us/forest/inv/classify/index.htm

Czaplewski, Raymond L. 2004. Application of Forest Inventory and Analysis (FIA) Data to Estimate the Amount of Old Growth Forest and Snag Density in the Northern Region of the National Forest System. USDA Forest Service; Research and Development Deputy Area; Rocky Mountain Research Station; Natural Resource Assessment, Ecology, and Management Science Research, Research Work Unit RMRS-4852; 2150 Centre Ave. Bldg. A., Fort Collins, CO 80526. http://fsweb.r1.fs.fed.us/forest/inv/fia_data/analysis.htm.

Foster,D.R., D.A. Orwig, and J.S. McLachlan. 1996. Ecological and conservation insights from reconstructive studies of temperate old-growth forests. Trends in Ecology and Evolution. 11:419-424, Harvard Forest, Harvard University, Petersham, MA.

Green, P.; J. Joy; D. Sirucek; W. Hann; A. Zack; and B. Naumann. 1992 (errata corrected 2/05). Old Growth Forest Types of the Northern Region. United States Department of Agriculture, Forest Service, Northern Region. Missoula, MT. 60 p

Leach, Andy. 2002. A Case Study in the Evaluation of Confidence Interval Algorithms. United States Department of Agriculture, Forest Service, Inventory & Monitoring Institute. Ft. Collins, CO. 16p. http://fsweb.r1.fs.fed.us/forest/inv/fia_data/r1_sum_db.htm

Leach, Andy. 2005. Bootstrap Calculation of Confidence Intervals for the Estimates of Means by Stratum. United States Department of Agriculture, Forest Service, Inventory & Monitoring Institute. Ft. Collins, CO. 4p. http://fsweb.r1.fs.fed.us/forest/inv/fia_data/r1_sum_db.htm

Spies,T.A. and Franklin, J.F. 1996. The diversity and management of old growth forests, in Biodiversity in Managed Landscapes (Szaro,R. and Johnston, D., eds) pp.235-248, Cambridge University Press

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J. Raptor Res. 22(4):107–115

NESTING AND FORAGING HABITAT OF GREAT GRAY OWLS

EVELYN L. BULL, MARK G. HENJUM AND RONALD S. ROHWEDER[1]

ABSTRACT.—During 1982–1986, 46 Great Gray Owl (*Strix nebulosa*) nests were located in northeastern Oregon. Twenty-five of these nests were on stick platforms, 11 were on artificial platforms, and 10 were on broken-topped dead trees. Mean dbh and height of trees containing stick nests were 58 cm and 30 m, respectively, and the majority (76%) of nests were in live western larch (*Larix occidentalis*). Broken-topped dead trees with nests averaged 78 cm dbh and 11 m tall. Forest types in which nests were found included: Douglas-fir (*Pseudotsuga menziesii*)–grand fir (*Abies grandis*) (50%); western larch–lodgepole pine (*Pinus contorta*) (29%); ponderosa pine (*Pinus ponderosa*)–Douglas-fir (15%); and ponderosa pine (7%). Nesting males foraged primarily in mature, open stands (11–59% canopy closure) of ponderosa pine or Douglas-fir.

The Great Gray Owl (*Strix nebulosa*) is the largest strigiform found in North America and is an impressive owl of great interest to bird enthusiasts. This circumpolar species is widespread and occurs in boreal forests from Alaska, east to Ontario, south to Idaho, western Montana, northwestern Wyoming, northern Utah, northern Minnesota, northern Wisconsin, and the Sierra Nevada in California; in Eurasia, this owl occurs in northern portions of Scandinavia, Russia and Siberia (American Ornithologists' Union 1983).

Surprisingly little is known about the Great Gray Owl, making management difficult. To manage for the species, information on the habitat used for nesting and foraging is essential. If foraging habitat is lacking and prey densities are low, the owls will not nest even if nest sites are available. If prey is adequate and nest sites are lacking, again there will be no nesting.

Because these owls depend on existing nest platforms such as old raptor nests, broken-topped dead trees, and artificial platforms (Nero 1980; Mikkola 1983; Winter 1986; Bull et al. 1987; Franklin 1987; Forsman and Bryan 1987), managers have a good opportunity to manage the species by providing nest platforms where they want the owls—provided there is adequate prey and habitat to support them. It is therefore essential to know what habitats are suitable for nesting and foraging.

Our objectives were to determine habitat used for nesting and foraging of Great Gray Owls during the breeding season in northeastern Oregon. Nesting habitat included the nest tree and the area surrounding the tree, in addition to the habitat used by juveniles after fledging who were still dependent on the adults. Foraging habitat included areas used by males who were feeding females and offspring.

STUDY AREA

During March–May 1982 we surveyed for Great Gray Owls in 2 large areas: the area within a 60-km radius around La Grande, Oregon and a 50 km² area 47 km north of Enterprise, Oregon. During 1983–1986 survey efforts were confined to 4 areas where Great Gray Owls were located in 1982—the Spring, Bowman, Sheep and Thomason study areas.

Forest types in each area were categorized using a modification of Burr's (1960) classification by tree species in the dominant and codominant crown classes. Dominant trees were defined as those with crowns extending above the general level of the crown, and codominant trees were those whose crowns formed the general level of the crown (Smith 1962:33). Each of the 4 study areas contained 4 different forest types: 1) ponderosa pine (*Pinus ponderosa*), 2) ponderosa pine–Douglas-fir (*Pseudotsuga menziesii*), 3) Douglas-fir–grand fir (*Abies grandis*), and 4) western larch (*Larix occidentalis*)–lodgepole pine (*Pinus contorta*).

Successional stages in each area were classified based on tree size and stand structure as subclimax, mature, over-mature and remnant. In subclimax stands all trees were <30 cm dbh; in mature stands the largest trees were 30–50 cm dbh; over-mature stands were unlogged and larger trees were ≥50 cm dbh; remnant stands were typically logged and had 1–3 trees/ha ≥50 cm with the remainder of trees <30 cm. The remnant stage identified stands that did not resemble unlogged over-mature stands but contained a few large-diameter trees.

The Spring study area (44 km²) was 17 km west of La Grande at 930–1140 m elevation. Cover types included conifer forest (63% of area), shallow-soiled grasslands (32%) and clearcuts (5%). During the previous 10 yrs, 66% of forested stands within the Spring study area had been selectively logged. As a result most forests in this area consisted of open, park-like stands dominated by ponderosa pine. These stands were on deep soils with a dense cover of grasses. Isolated stands of unlogged, large trees (≥50 cm dbh) comprising 22% of this study area remained Isolated stands contained Douglas-fir, lodgepole pine,

[1] Deceased.

110- one study area
had 141 ac/pair
- another = 330 ac/pair

Table 1. Characteristics of 3 types of Great Gray Owl nest structures at 46 nest sites in northeastern Oregon, 1982–1986.

Characteristic	Nest Structure: Stick		Broken-topped Tree		Wooden Platform	
No. nests in Spring	16		1		4	
No. nests in Bowman	3		2		2	
No. nests in Sheep	5		1		—	
No. nests in Thomason	1		6		5	
Nest tree species						
Western larch	76%		10%		45%	
Douglas-fir	20%		20%		—	
Ponderosa pine	4%		70%		36%	
Lodgepole pine	—		—		18%	
	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.
Nest height (m)	17	5.05	11	3.88	12	3.01
Tree dbh (cm)	58	17.16	78	15.24	58	17.20
Tree height (m)	30	4.98	11	3.65	29	8.73
Bole height (m)	10	5.00	8	4.24	13	6.59
Tree age	151	35.07	173	25.40	129	51.73

78 cm = 30.7"

western larch, and occasionally grand fir. A total of 52 artificial nest platforms were erected in 1984 in the Spring area.

Bowman (27 km^2) was 50 km west of La Grande at 1380–1500 m elevation. Cover types included coniferous forest (68%), shallow-soiled grasslands (20%) and clearcuts (12%). Dense stands of lodgepole pine or mature and over-mature stands of grand fir and Douglas-fir with some western larch and ponderosa pine dominated the Bowman area. About 60% of the forested area had been logged in the 15 yrs prior to our study; lodgepole pine stands had been clearcut, and ponderosa pine and Douglas-fir stands had been selectively logged. Fifty-four artificial nest platforms were erected in this area in 1984.

Sheep (78 km^2) was 37 km southwest of La Grande at 1290–1500 m elevation. Cover types included coniferous forest (68%), clearcuts (12%), wet meadows along streams (12%) and shallow-soiled grasslands on ridges (8%). Ponderosa pine forests occurred on south-facing slopes, and lodgepole pine stands or mixed stands of Douglas-fir, western larch and grand fir occurred on north-facing slopes. Greater than 80% of the forested area had been logged (40% clearcut and 60% selectively logged) during the 15 yrs prior to this study.

Thomason (34 km^2) was 47 km north of Enterprise at 1350–1470 m elevation. Cover types included coniferous forest (71%) and wet meadows (29%). Forest stands were lodgepole pine and ponderosa pine or mixed stands of Douglas-fir, western larch and grand fir. About 80% of the area had been selectively logged in the 10 yrs prior to this study. There were 38 artificial nest platforms in Thomason at the onset of this study.

METHODS

Locating Birds and Nests. Owls were located after dark in February, March and April by imitating the territorial call of a male Great Gray Owl every 0.1 km while walking through each study area. Areas containing owls were searched for active nests during the day.

Surveys,

Radio Telemetry. Adult Great Gray Owls were captured with bal-chatri traps, noose poles and mist nets (Bull 1987). Radio transmitters (AVM Instrument Co.—SM1, L Module) were placed on 10 males and 13 females and 35 post-fledging juveniles. Transmitters were attached to the bird with a back-pack harness of 6 mm tubular teflon ribbon. The entire package weighed 25 g and lasted 242–505 d. A Telonics TR-2 receiver with a hand-held 2-element Yagi antenna was used for locating owls.

Adult radio-tagged owls were located each spring at their nests. Juveniles were located every 1–3 d for 7 d after fledging. Eight nesting males were followed in the morning (first light until roosting) and evening (departure from roost until dark) 1–2 times/wk from the time transmitters were put on until 2 mo after fledging, or until the radio failed or the nest was abandoned.

Habitat Quantification. Variables recorded at nests included nest type (stick, broken-topped dead tree, or artificial platform), nest height (m), tree species, dbh (cm), height (m), age (increment bore used), and bole height (height of lowest live branch) (m) (Table 1). Stick nests were classified as natural platforms created by dwarf mistletoe (*Arceuthobium* spp.) or as vacated nests built by Northern Goshawks (*Accipiter gentilis*) or Red-tailed Hawks (*Buteo jamaicensis*). At 4 sites we saw hawks con-

Table 2. Habitat characteristics in circular 0.1-ha plots centered on 46 Great Gray Owl nests in northeastern Oregon, 1982–1986.

CHARACTERISTIC	$\bar{x}$	S.D.	FREQUENCY
Forest type			
Douglas-fir–grand fir			50
Lodgepole pine–western larch			29
Ponderosa pine–Douglas-fir			15
Ponderosa pine			7
Successional stage			
Mature			26
Over-mature			41
Remnant			33
Logging			
None			72
Partial cut			19
Adjacent to clearcut			9
Canopy closure (%)			
0–10			7
11–59			30
≥60			63
Live trees/0.1 ha ≥50 cm dbh	3.2	2.51	
Dead trees/0.1 ha ≥50 cm dbh	1.0	2.10	
Live trees/0.1 ha <50 cm dbh	26.7	14.70	
Dead trees/0.1 ha <50 cm dbh	9.2	7.80	
Leaning trees/0.1 ha <10 cm dbh	5.1	14.45	
Regeneration (trees/0.1 ha)	41.8	55.47	
Distance to water (m)	231.6	209.98	
Distance to clearing (m)	77.1	70.13	

structing nests in prior years; at the remainder, a nest below the canopy in a dense forested stand was classified as an old Goshawk nest, and a nest high in the canopy of a more open forest was classified as an old Red-tailed Hawk nest.

In a circular 0.1-ha plot centered on each nest, we recorded the variables listed in Table 2. Regeneration included all trees ≤10 cm dbh. We also recorded landform (flat, draw, or slope), slope aspect and gradient, number of canopy layers and height (m) of tallest canopy. With aerial photos (scale 1:24 000) and a planimeter, we determined the percent area in forest, grassland, clearcut and selectively logged forest within a 500-m radius of each nest. The linear distance in edge between forest and grassland within the 500-m radius was calculated with a map measure. Edge was defined as a 60-m wide band where forests and openings met.

Juvenile owls were located every 1–3 d during the week after fledging. Each time a juvenile owl was located, we recorded type of perch used (branch, leaning tree, or top of a broken-off dead tree) and perch height. Tree species, condition (live or dead), dbh, and height of the tree used for perching were measured. In addition we noted the presence of leaning trees that provided owlets access to perches in upright trees. For the next 2 mo, juveniles were located every 1–2 wks and locations recorded on aerial photographs.

While following radio-tagged males, activity and habitat use data were recorded at 15-min intervals and each time an owl hit the ground when pursuing prey (hereafter referred to as a foraging site). Activity categories were hunting or roosting. Birds actively searching for prey, flying from perch to perch, and staring intently at the ground were classified as hunting. Birds quietly perched in a tree next to the trunk and not watching the ground intently were classified as roosting.

Every 15 min we recorded location of the bird on an aerial photo, estimated canopy closure over the bird and recorded forest type, successional stage, physiognomy of the stand (open or dense forest or edge), logging activity, number of stand layers, type of perch and tree species supporting perch. If a bird was roosting when first located, we recorded the data once and waited until the bird left the roost before continuing.

At each foraging site we recorded percent, height and type of ground cover within a 1-m radius, presence or absence of downed wood within a 1-m radius, diameter (at largest point) of the downed wood, distance owl flew to prey, height of perch, diameter of perch tree and distance to nest. Home range of hunting males was delineated by connecting the outermost radio locations to form minimum convex polygons which were then measured with a planimeter.

LANDSAT data (Isaacson et al. 1982) were used to determine forest canopy closure classes (0–10%, 11–59% and ≥60%) available in 3 of the study areas and in the home range of 5 of the 8 males. The 0–10% class comprised openings; the 11–59% class contained relatively open stands, many of which had been selectively logged; the ≥60% class was primarily unlogged, overmature forest stands.

Density. We calculated density of active nests of Great Gray Owls in Spring and Thomason by counting the number of nests within a polygon defined by the outermost nests in 1984. We chose 1984 because we believe all nesting pairs within the polygons were located that year. We did not present the density as number of nests/study area because we believe all nests in the study areas were not found.

Analysis. Chi-square analyses were used to compare the observed number of foraging locations in each canopy closure class and in edge with the expected number of locations based on the percent edge and canopy closure classes in the home range of each radio-tagged male. We compared habitat characteristics of hunting birds in Spring with those in Bowman and Sheep using a Chi-square analysis. Habitat used by 3 birds studied in Sheep and Bowman were combined because of the small sample size and because the 2 areas had similar habitat and logging activity. We used $P < 0.05$ as the level of significance. We could not test for preference for nest type or nest habitat because we did not determine the number or distribution of available nest sites.

RESULTS

Nest Sites. During 1982–1986, we located 46 nests, 14 of which were used more than once (Table 1). Of the 14 nests used more than once, 6 were used 2 years, 6 were used 3 years, 1 was used 4 years, and 1 was used twice in the same year, so we observed 69 nesting attempts on 46 nest structures. Fifty-four pecent of the nests were stick platforms, 24% were artificial platforms and 22% were natural depressions on broken-topped dead trees (Table 1). Of the stick nests, 68% were originally made by Northern Goshawks, 12% were made by Red-tailed Hawks and 20% were natural platforms created by dwarf mistletoe infections.

All 3 types of nests were commonly used, although nests in broken-topped trees and wooden platforms had a lower rate of nest failure (20%) than did nests in stick platforms (34%), suggesting that the latter was a less stable structure because young or eggs fell through on at least 4 occasions. The majority of stick nests were in large diameter (≥50 cm dbh) live western larch (Table 1). The majority of nests in broken-topped dead trees were in large diameter ponderosa pine at least 7 m tall. Nests in wooden platforms were at least 9 m above the ground in live trees.

The mean size of 11 stick nests was 74 cm (SD = 17.32) long, 65 cm (S.D. = 11.97) wide, 27 cm (S.D. = 14.04) high, with a depression 7 cm (S.D. = 2.70) deep. The only nest on a broken-topped dead tree that was measured had a circular depression in the top of the tree that was 56 cm in diameter and was 26 cm deep.

The majority of the nests occurred in Douglas-fir–grand fir forest types and in over-mature and remnant stands (Table 2). Sixty-nine percent of nests occurred on slopes, 22% on flat ground, and 9% in draws; mean slope gradient at nests was 13% (S.D. = 9.28). Sixty-five percent of nests were on north-facing slopes. Northern aspects are preferred by Northern Goshawks (Reynolds et al. 1982), the primary builder of nests used by Great Gray Owls.

Western larch comprised the dominant crown class at 52% of nest sites, ponderosa pine 28%, and Douglas-fir and grand fir the remainder. Ponderosa pine comprised the dominant crown class at nests in Thomason, and western larch comprised the dominant crown class in the other study areas. The co-dominant crown class was comprised of lodgepole pine at 51% of the nests, Douglas-fir at 31% and ponderosa pine at 18%.

Seventy-two percent of nest sites had not been logged, but 60–80% of stands in each study area had been logged. Forty-four (96%) of 46 nest sites had ≥ 2 canopy layers, the tallest layer having a mean height of 34 m (S.D. = 4.90). Density of live trees < 50 cm dbh at nest sites ranged from 5–64 stems/0.1 ha, and of live trees ≥ 50 cm dbh ranged from 0–10 stems/0.1 ha. Density of dead trees ranged from 0–36 stems/0.1 ha at nest sites. Regeneration ranged from 0–290 stems/0.1 ha.

Area in forest within a 500-m radius of each nest ranged from 52–99%, and forested area that had been logged ranged from 0–97%. The amount of edge between forests and openings within 500 m of the nest averaged 4.2 km (range = 0.7–8.3 km). The amount of area in natural openings within 500 m of the nest ranged from 0–40%. Nests in Thomason contained the greatest amount of natural opening ($\bar{x}$ = 25%), and nests in the other 3 study areas contained 13–15%. Bowman contained the greatest amount of clearcut area (13%) within 500 m of nests; nests in the other 3 areas contained ≤6%. Total area in openings (natural and clearcut combined) ranged from 18–26%.

Nest Site Fidelity. We observed 18 nesting attempts by 9 pairs where at least 1 member of each pair was radio-tagged. Of the 18 nesting attempts, 39% were on the same nest the next year, 39% were within 1 km of the nest used the previous year, and 22% were farther than 1 km away from the nest used the previous year. Average distance between alternate nests was 1.3 km (range = 0.2–4.5 km, Fig. 1). In 4 cases in which a bird or a pair moved farther than 1 km from their previous year's nest, we found previous nest sites occupied by new pairs.

Density. Shortest distance between 2 active nests was 430 m; 2 other nests were 460 m apart. In 1984 the minimum density of owls was 7 pairs/9.4 km² (entire study area was 44 km²) at Spring and was 5 pairs/2.9 km² (entire study area was 34 km²) at Thomason. At Spring, 2 different females used the same nest in 1984 and were counted as 2 pairs.

5 pr/2.9 km² = 1 owl/.58 km² = .22 sq mi = 141 acres

Perches Used by Juveniles. Owlets left the nest before they could fly but were capable climbers, using talons, bills and wings to claw and flap their way up tree trunks. For the first few days, leaning trees with bark were easiest for the young to climb. After several days, juveniles could climb up some vertical trees, particularly those with branches or deeply fissured bark (characteristic of large-diameter trees). As owlets aged, they perched higher in the

7 pr/9.4 km² = 1.3 km²/pr
= 0.5 sq mi or 320 acres
. shortest distance nests = .27 mi

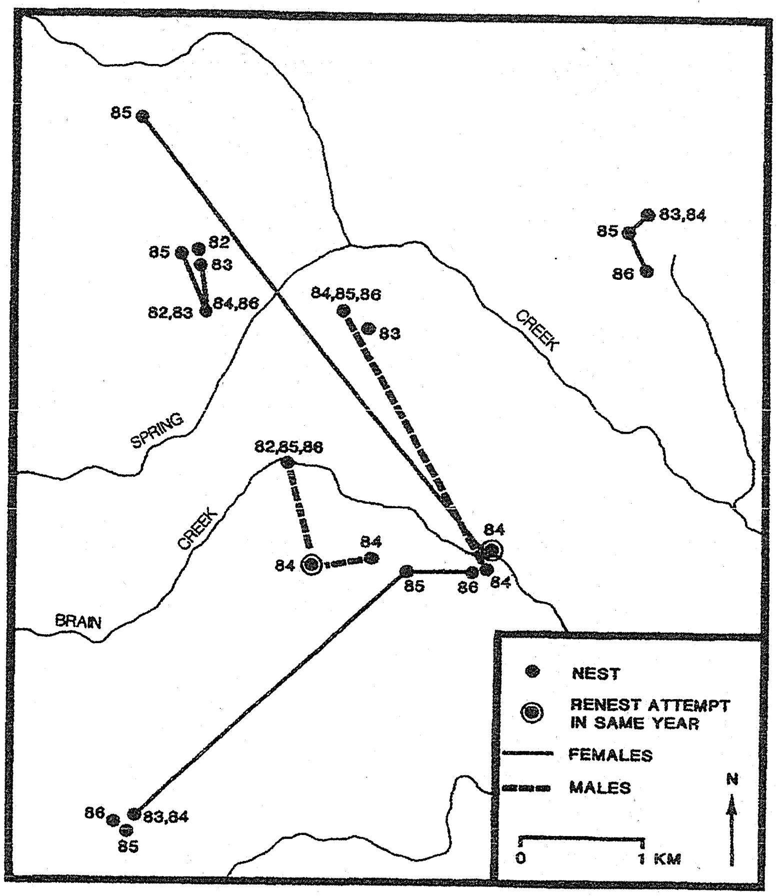

Figure 1. Locations of nests of radio-tagged Great Gray Owls in Spring area 1982–1986. Lines connect nests used in successive years by the same bird.

canopy. Perches used the first week after the young left the nest averaged 6.2 m (S.D. = 4.13) above the ground, had an average canopy closure of 50% (S.D. = 22.16) and were all within 200 m of the nest.

Of 116 perches used by juveniles, 67% were leaning trees or trees which could be reached by climbing a leaning tree; the remainder were branches or broken-topped trees. Leaning perch trees were typically small-diameter ($\bar{x}$ = 16 cm, S.D. = 7.82) lodgepole or ponderosa pine, with an average of 87% (S.D. = 23.80) of the bark remaining. Branches used as perches were typically in live ponderosa pine or Douglas-fir trees with a mean dbh of 37 cm (S.D. = 20.10).

67% perches leaning tree.

After leaving the nest, juveniles typically moved toward dense forest cover (if the nest was not in a dense stand). Within 2 wks after fledging juveniles gradually became more mobile but generally stayed within forest stands with ≥60% canopy closure (Fig. 2). Family group C ranged the farthest and roosted less frequently in stands with dense canopies than did other family groups (Fig. 2).

Foraging Habitat. During 229 hrs of radio-tracking 8 male Great Gray Owls, we recorded 223 foraging sites and 622 hunting locations at 15-min intervals. Males usually hunted in open forested stands from perches close to the ground. Hunting perches averaged 5.5 m (S.D. = 6.65) high and were in trees with mean dbh of 27 cm (S.D. = 14.06). Mean distance males flew from perches to prey was 10.5 m (S.D. = 9.39). Vegetative ground cover at foraging sites averaged 88% with an average plant

perches = close to ground 18'

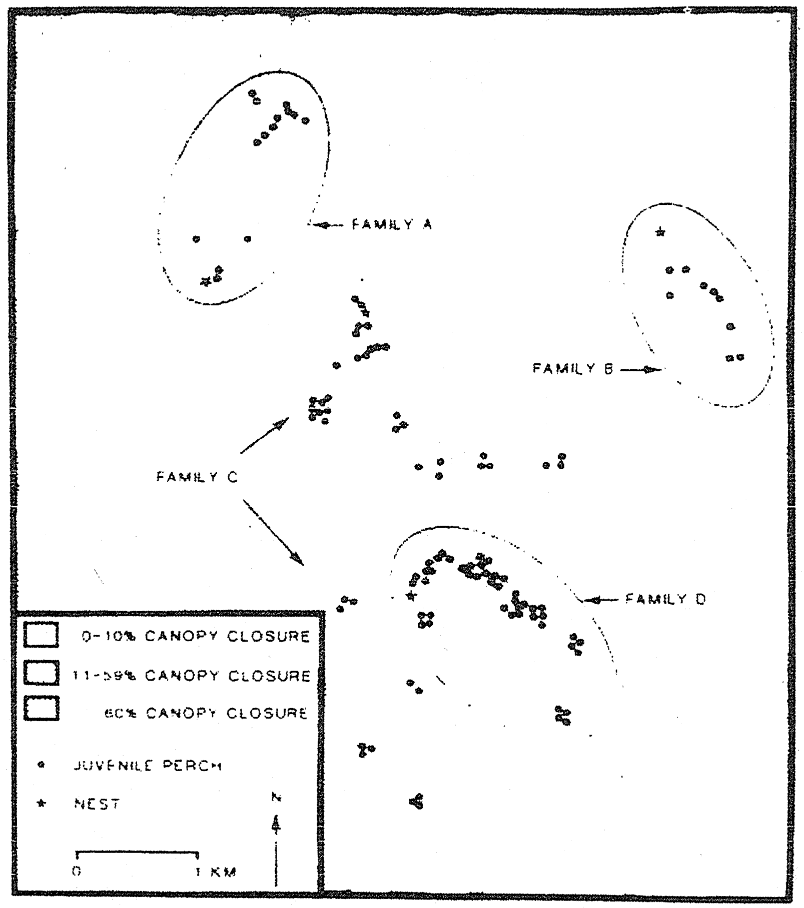

Figure 2. Location of nests and perches used by juveniles of 4 Great Gray Owl family groups in Spring study area. Juveniles were located during 2 mo after fledging. Family groups A and B nested in 1983, and family groups C and D nested in 1985.

Downed wood

height of 21 cm. Grasses dominated in 96% of the sites. Downed wood with a mean diameter of 20 cm was present within 1 m in 77% of the sites.

Mean distance the 8 males moved from the nest when hunting was 0.62 km. One male foraged no further than 0.7 km from his nest, whereas the greatest distance foraged by a male was 3.2 km. Home range of 5 males with ≥ 90 foraging locations averaged 4.5 km² (range = 1.3–6.5 km²).

There was a significant difference in canopy closure of stands used for foraging by 5 males compared to expected use based on availability (χ^2 values for 5 males: 48.1, 41.1, 37.3, 109.8, 58.4; 2 df, $P <$ 0.01). Males preferentially foraged in stands with 11–59% canopy closure and avoided clearings. Four of the males avoided stands with >60% canopy closure, while 1 male used such stands in proportion to their occurrence. Use of edge was significantly greater ($P < 0.05$) than expected with 2 males, less than expected with 2 males, and not different than expected with 1 male.

There were significant differences between 5 foraging males at Spring and 3 at Sheep and Bowman in all habitat variables measured except canopy closure (Table 3). Males at Spring hunted more often in stands that were open, logged, younger, with 1–2 canopy layers and containing more ponderosa pine than did males at Sheep and Bowman (Fig. 3). Males

Home Range = 1.3 → 6.5 km² =
= 0.5 m² (320 ac) → 2.5 m² (1600 ac)
Area used while nesting = avg

at Sheep and Bowman hunted more often in stands that were unlogged, older, with 2–3 canopy layers and containing more Douglas-fir and lodgepole pine.

Males roosted during the day in stands with 11–59% canopy closure (71%) and stands with 60% or more canopy closure (29%). Eighty-three percent of 62 roost sites were in mature or older stands with 2 or more canopy layers. Sixty-eight percent of roosts were in unlogged stands. Owls roosted at least 7 m above the ground 56% of the time, 3–6 m above the ground 38% of the time and lower than 3 m 6% of the time.

DISCUSSION

Great Gray Owls are versatile in their use of nest structures and readily use artificial nests. In Finland Mikkola (1981) observed the species using nests on branches, on stumps, on the ground, on a cliff and on a barn. Great Gray Owl use of artificial nest structures has been reported by Nero et al. (1974), Nero (1982) and Helo (1984) and provides opportunities for management. Owls may prefer artificial structures over natural platforms; 3 females in our study nested on platforms even though stick nests were available nearby.

Great Gray Owls are flexible in their use of habitats as well. Nero (1980) and Servos (1986) found Great Gray Owl nests in poplar (*Populus* spp.) and tamarack (*Larix larcinia*) trees adjacent to muskeg in Canada. Winter (1986) found nests on dead trees in conifer forests only within 260 m of meadows in California. Harris (1984) described nests in forests of tamarack and black spruce (*Picea mariana*) in Canada, and Mikkola (1981) reported nests in dense spruce and pine forests, deciduous stands, wet spruce moors, and swamps in Finland and Sweden. Mikkola (1981) suggested that the owls preferred edges of older stands rather than the interior of large, dense forests. In Oregon we found Great Gray Owl nests in all forest types available within the study areas; however, the majority of nests were in over-mature or remnant stands of Douglas-fir and grand fir forest types on north-facing slopes.

Preferred habitat

Although the majority of each study area had been logged within 15 yrs of our study, 72% of nests occurred in unlogged stands. Either owls preferred unlogged stands or there was a disproportionate number of potential nest sites in stands, as logging activities often remove large-diameter live and dead trees that could support nests.

Leaning trees and dense cover near nests are important habitat components for fledglings. Owlets left the nest before being able to fly, but leaning trees enabled owlets to climb to perches above the ground. Without leaning trees owlets would be vulnerable to terrestrial predators.

Male Great Gray Owls foraged in a variety of habitats; partially logged stands did not appear to be detrimental, as 62% of foraging locations occurred

Table 3. Foraging site characteristics of 8 nesting male Great Gray Owls in northeastern Oregon, 1985 (data in percent).

CHARACTERISTIC	SPRING (N = 357)	SHEEP/BOWMAN[a] (N = 265)
Forest type (χ^2 = 264.2, 3 df, $P < 0.01$)		
Ponderosa pine	62	3
Ponderosa pine–Douglas-fir	25	5
Douglas-fir–grand fir	11	60
Lodgepole pine–western larch	2	32
Successional stage (χ^2 = 12.1, 3 df, $P < 0.01$)		
Subclimax	23	17
Mature	61	58
Over-mature	6	6
Remnant	10	19
Physiognomy of stand (χ^2 = 82.6, 2 df, $P < 0.01$)		
Open forest	84	51
Edge	14	30
Dense forest	2	19
Logging (χ^2 = 54.2, 2 df, $P < 0.01$)		
Unlogged	25	49
Partial cut	74	46
Clearcut	1	5
No. stand layers (χ^2 = 130.6, 2 df, $P < 0.01$)		
1	46	13
2	52	54
3	2	33
Perch location (χ^2 = 28.3, 2 df, $P < 0.01$)		
Branch	68	55
Trunk	27	25
Leaning tree	5	20
Tree species of perch (χ^2 = 318.2, 3 df, $P < 0.01$)		
Ponderosa pine	82	7
Lodgepole pine	9	55
Douglas-fir	7	25
Other	2	13

[a] The 3 birds in Sheep and Bowman were combined due to sample size.

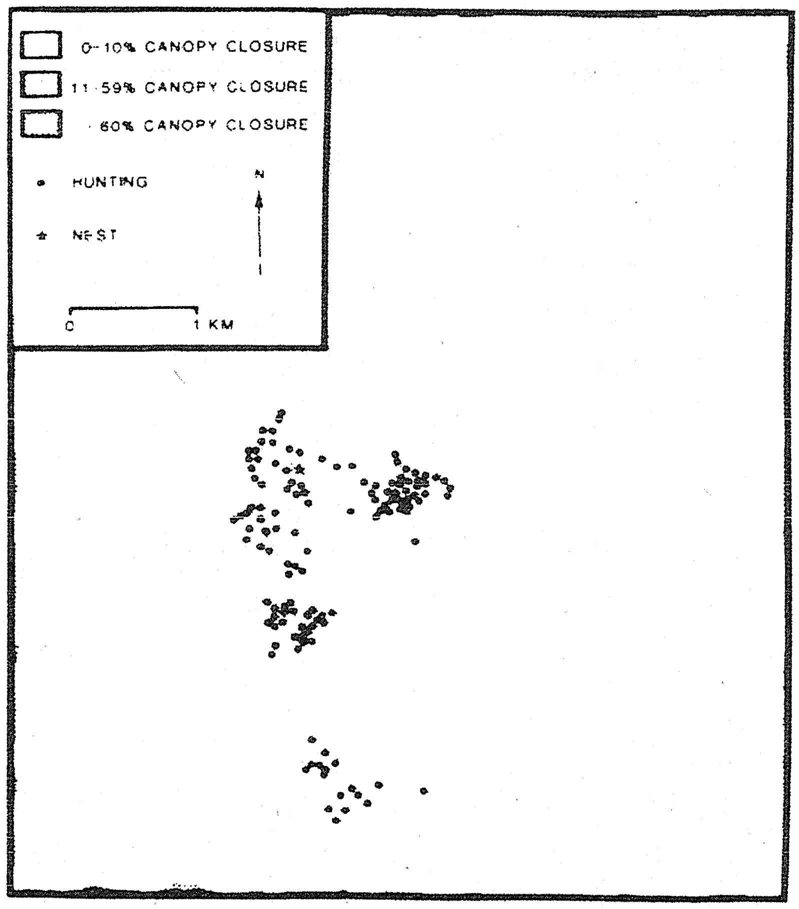

Figure 3. Locations at 15-min intervals of a hunting male Great Gray Owl in Spring study area during daylight. Observations were made on 10 d from 1 April–22 July 1985.

there. Open stands of mature forests were used most for foraging, while subclimax and dense over-mature stands and clearcuts were used less frequently. Winter (1986) reported that Great Gray Owls foraged primarily in or along meadow edges; Franklin (1987) found them foraging in clearcuts. Factors that are important in foraging habitats include high prey density, perch availability and forests that are open enough to allow birds to move freely.

Relatively close spacing of some nesting pairs in Oregon support the belief that Great Gray Owls defend only the immediate vicinity around a nest (Bull and Henjum 1987). Höglund and Lansgren (1968) reported pairs within 100 m of each other in Sweden; Mikkola (1976) reported 3 nests within 400 m of each other in Finland; and Wahlstedt (1974) reported 5 pairs within 3 km in April. More recently, Lehtoranta (1986) found 2 nests in Finland only 49 m apart, but since only 1 male was seen, polygamy seems possible.

Because the species does not generally maintain mutually exclusive territories, fairly high densities can be obtained. Mikkola (1981) reported 8 nests in 100 km² in Finland, and Wahlstedt (1974) found 5 nests and an additional 4 pairs that he believed were nesting in a 100 km² area in Sweden. In Oregon we found the highest density of nesting Great Gray Owls reported for either North America or Europe.

Trees and Logs Important to Wildlife in the Interior Columbia River Basin

Evelyn L. Bull, Catherine G. Parks, and Torolf R. Torgersen

Companion to General Technical Report
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Snag distribution—Snags can either be left in clusters or scattered across the landscape, although where to retain them depends largely on where they currently are. Typically, snags are in clumps naturally because the agents of disease, insects, fire, or flooding that kill many trees act in a localized area. Clusters of snags may be easier to protect during management activities than snags evenly distributed across the landscape. Worker safety is an issue when harvesting adjacent to snags. Retaining snags in clusters, as well as the live trees between the snags, keeps workers away from snags and provides canopy cover for wildlife using the snags.

Two studies on woodpecker use of snag clusters reported different results. No difference was found between woodpecker use of snag clusters versus scattered snags in western Oregon (Chambers 1997). In areas where stand-replacement fires had burned in ponderosa pine/Douglas-fir stands in Idaho, Saab and Dudley (1997) found that cavity nesters as a group select clusters of snags for nest sites instead of evenly spaced trees.

5-25

Most studies recommend managing snags in every 5- to 25-acre patch (Bate 1995, Evans and Martens 1995). Because woodpeckers are territorial, only one pair of each species occupies the same territory; therefore, to attain the maximum density of cavity nesters, snags need to be distributed across the landscape.

In addition, retaining snags on all aspects and on all positions of the slope ensures habitat availability for wildlife species with different preferences. For example, pileated woodpeckers tend to roost in draws during summer but roost higher on slopes in winter (Bull and others 1992). Martens rest or travel in riparian areas a third of the time in summer but only half that often in winter; upper slopes are used half the time in winter but only a third of the time in summer (Bull 1995).

Retaining snags close to living trees provides cover for cavity users. If snags are retained in the middle of a clearcut, species like northern flickers, Lewis' woodpeckers, bluebirds, and American kestrels (*Falco sparverius*) will use them for nesting, but most other woodpeckers will not nest in open areas.

In many areas, fuel-wood cutters are likely to remove snags along roads. This potential problem can be remedied by not leaving snags in areas that are accessible to fuel-wood cutters or by not counting snags left adjacent to accessible roads toward the number retained for a particular stand.

In summary, wherever the objective is to provide viable populations of primary and secondary cavity nesters, prudent managers will provide large-diameter snags when available, snags in a variety of structural classes, snags in every 5- to 25-acre stand and in clusters if available, and snags on all slope aspects and positions of the slope, and adjacent to green trees.

Snag densities—Limited information is available on numbers of snags to retain for wildlife species in the interior Columbia River basin (Bate 1995, Bull and Holthausen 1993, Dixon 1995, Evans and Martens 1995) (table 1). The guide most widely used in the past, Thomas and others (1979), prescribed the number of nest and roost trees to leave for specified woodpecker populations, but the number was based on a hypothetical, untested model and did not include any snags for foraging. Three studies (Bate 1995, Bull and Holthausen 1993, Dixon 1995) conducted in eastern Oregon have shown that retaining foraging structure is essential, in addition to nest and roost trees in managed landscapes. The Thomas model provided only two roost trees per pair per year, yet research has shown that individual pairs of pileated woodpeckers and white-headed woodpeckers use considerably more than two per year (Bull and others 1992, Dixon 1995). Radio-telemetry studies have shown that home range sizes of pileated woodpeckers (Bull and Holthausen 1993), white-headed woodpeckers (Dixon 1995), and three-toed and black-backed woodpeckers (Goggans and others 1988) are considerably larger than those used in the Thomas model. Raphael and White (1984) found that the relation between numbers of snags and cavity nesters is not linear, which was assumed in the Thomas model. The substitution factor used in the Thomas model is variable and largely a function of snag density. Neitro and others (1985) thought allowing substitution of snags that reduced the number retained was not appropriate. The Thomas model did not take into account the habitat needs of some of the secondary cavity nesters, like bats and brown creepers, that use such snag features as loose bark. In addition, Bull and Holthausen (1993) found lower densities of pileated woodpeckers in nine study areas than predicted by Thomas and others (1979) based on the number of snags present. The above studies present new data suggesting that some of the assumptions and data used in the Thomas model are not valid, and that the prescribed snag densities need to be revised upward.

We know of only three studies in the interior Columbia River basin that have calculated both the density of snags and woodpeckers in managed and unmanaged landscapes. Bate (1995) used six study areas in ponderosa pine stands and found woodpecker abundance was best predicted by hard snag density, large green tree density, canopy height, and number of canopy layers. Of the nine study areas, only one represented a relatively unmanaged forest with the number of snags that probably approximated historical ones. In this stand, Bate found 3.8 snags greater than 10 inches d.b.h., and 60 percent were larger than 20 inches d.b.h. These snag numbers supported 32.3 woodpeckers per 247 acres and represented the study area that most likely supported viable populations of cavity nesters. Dixon (1995) found similar results in some of the same study areas Bate used.

Another study relating woodpecker density to snag density was conducted in northeastern Oregon (Bull and Holthausen 1993). The two study areas that contained viable populations of pileated woodpeckers had an average of 4.2 and 3.8 snags (10 inches or larger d.b.h.) per acre and 0.5 and 0.4 nesting pairs per 247 acres, respectively. The two study areas were in lightly managed landscapes predominated by mixed-coniferous stands with a high density of logs.

Evans and Martens (1995) recommended densities of snags for retention on the Payette National Forest based on their ecological value, encompassing soil health, seedling regeneration, moisture retention, nutrient recycling, and wildlife use (table 1). The numbers that they recommended were derived from actual snag numbers identified during

Thomas

timber inventory and vegetation plots but were scaled down to the lower ranges of the snag numbers for the recommendations and include snags 10 inches d.b.h. and larger.

Ideally, data would be available on the exact number of snags required to support specific populations of primary and secondary cavity nesters. Unfortunately, this kind of information is not available. We do know, however, that the snag numbers presented by Thomas and others (1979) are not adequate to support the populations intended because of a lack of foraging strata and invalid assumptions used in the model. If management agencies have an objective to manage for viable populations of woodpeckers, providing numbers of snags that have been shown to support viable populations in the recent studies would be prudent.

Although snags are the key structure typically focused on for cavity nesters, realizing the importance of the forest surrounding the snags also is essential. Some species like the pileated and white-headed woodpeckers and American martens are associated with older forests. For white-headed woodpeckers, the snags must be in association with large-diameter ponderosa pines. For pileated woodpeckers and martens, logs, large-diameter green trees, and a dense canopy are needed. Leaving large-diameter snags or green trees in younger forests, also has value as providing biological legacies.

Canopy

Snag retention in burns—The above management implications apply to healthy green stands. With vast areas of Oregon, Washington, and Idaho burned by wildfires in the 1990s, there is much interest in determining numbers of snags to retain in burned areas after harvesting. Saab and Dudley (1997) reported that woodpeckers selected nest sites with snag densities greater than those measured at random sites in ponderosa pine/Douglas-fir forests with stand-replacing fires. From 10 to 14 snags per acre were retained in burned stands that were harvested; about 38 to 42 snags per acre were in the unharvested burned stands. Seven species of cavity nesters using the burned stands selected nest sites with more than 20 snags per acre, where snags were distributed in clumps. Lewis' and white-headed woodpeckers, and American kestrels selected the largest, most heavily decayed snags available for nesting. Evans and Martens (1995) presented recommendations for numbers of snags to leave in burned stands.

Green tree replacements—Snags are a dynamic resource; old snags fall and living trees die to become new snags. Snag-dependent wildlife need a continuous supply of snags over time. To provide a continuum of snag habitat, future snags must be planned for by leaving green trees to eventually become snags in managed stands. To determine the number of green tree replacements, information on fall rate of standing snags, snag density, live stem density, and mortality rate of live stems is required. Various models have been developed to calculate the number of green trees to provide for recruitment when specific stand inventory information is available (Bull and others 1980, Cimon 1983, Schommer and others 1993). If snags are to be created by killing green trees when the stand becomes snag deficient, the number of green trees required is less because the manager does not have to rely on natural mortality to replace those snags that fall. Creating snags is costly, however, and stands are seldom monitored to determine when trees need to be killed.

Snag Longevity

Snag longevity, or the amount of time a snag stands, is essential information for managing the snag resource. The length of time snags stand is a primary factor in determining the number of green tree replacements needed to maintain a specific snag density over time. Snag longevity is a function of many factors including species, diameter and height, percentage of heartwood, cause of death, soil type and moisture, forest type, and prevalence of windstorms. Because so many factors influence how long a snag stands, fall rates should be determined by species and size class on each management area. Listed below are studies that report snag fall rates. When possible, the amount of time when 50 percent of snags in a particular study have fallen will be reported.

Several studies have reported fall rates of beetle-killed ponderosa pine. Keen (1955) reported that 50 percent of the ponderosa pines in southern Oregon and northeastern California fell 9 to 10 years after death on pumice soils and 6 to 7 years after death on loam soils. The percentages of snags that fell after 7 years by diameter class, are presented in the following tabulation:

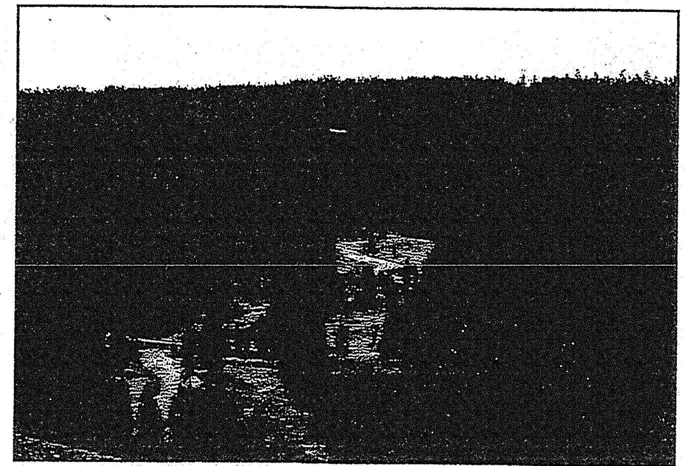
Diameter class (inches)	Percentage
10-18	75
20-28	65
30-38	50
40-48	35
> 50	30

Most of the beetle-killed ponderosa pines in Colorado fall between 7 and 10 years after infestation (Schmid and others 1985). Trees were 7 to 22 inches d.b.h.

In northeastern Oregon, half the ponderosa pines less than 10 inches d.b.h. fell 7 to 8 years after death and half those 10 to 19 inches d.b.h. fell after 8 to 9 years (Bull 1983). Beetle-killed lodgepole pines have similar fall rates, with half of those less than 10 inches d.b.h. falling within 6 to 7 years and half of those 10 inches and larger falling after 7 to 8 years (Bull 1983). In a second study in northeastern Oregon (Bull and Partridge 1986), half of the ponderosa pine snags less than 20 inches d.b.h. fell after 6 years; half of the ponderosa pine snags 20 inches and larger fell after 9 years.

Beetle-killed spruce in Colorado stood much longer than ponderosa pines reported in the studies above. Mielke (1950) found that 84 percent of beetle-killed spruce remain standing after 25 years. Hinds and others (1965) found that 72 percent of beetle-killed spruce remain standing after 20 years.

Fire-killed snags may or may not stand longer than beetle-killed snags, depending on the area. Dahms (1949) reported that a little over half the ponderosa pine snags are down 10 years after a fire in central Oregon. In Montana, nearly half of all lodgepole pine snags fall by the fifth season (Lyon 1977). In California, Kimmey (1955) described the



INTRODUCTION

More than 80 species of birds, mammals, reptiles, and amphibians use living trees with decay, trees with brooms, hollow trees, snags, and logs in the interior Columbia River basin. Animals use these structures for foraging, nesting, denning, roosting, and resting. Most notable of these wood-using wildlife species are the primary cavity nesters, the woodpeckers and nuthatches, that excavate nest cavities in decayed wood in standing trees. Their vacated cavities are subsequently used by many other birds and mammals. About 25 percent of the bird species nesting in the northern Rocky Mountain forests are cavity nesters (McClelland and others 1979). Many of the primary and secondary cavity-nesting birds eat forest insects and thus play an important role in regulating their populations. Machmer and Steeger (1995) provide a thorough review of the effect these birds have in reducing numbers of tree-feeding insects.

Tree decay is an important ecological process affecting wildlife habitat. Once begun, the decay process can take hundreds of years as a tree dies, falls to the ground, and decomposes into the forest floor. As it decays, the tree supports many different wildlife groups that use it for foraging substrate, for nesting, and for shelter. The group of wood decomposers is diverse. It includes many arthropods, but in this publication, we focus on decay fungi as the primary organisms in decay. Decay fungi are an essential resource to forest ecosystems in storing and retaining nutrients and in soil development.

This publication provides managers with a description of the ecological processes that create wildlife trees, snags, and logs. It provides qualitative and quantitative information on five distinct structures: living trees with decay (such as internal decay), hollow trees, trees with brooms (misshapen branches), dead trees (snags), and down woody material (logs). We describe the value of these structures to wildlife, the decay or infection processes that produce each type of structure, principles to help in selecting the best structures to retain, and management implications. Although this document cannot prescribe the amount of landscape to manage for a particular species or a specific, desired population size, it does present information managers can use to make informed decisions regarding the conservation and enhancement of dead wood structures most valuable to wildlife. Forest management practices that fail to properly manage wood components may adversely affect wildlife, soil and stream quality, and forest ecosystem functions.

The information included here applies to coniferous forest lands in the interior Columbia River basin: the area east of the crest of the Cascade Range in Oregon and Washington, all of Idaho, and a portion of western Montana (fig. 1). Tree species characteristic of high-elevation forests, (such as whitebark pine [*Pinus albicaulis*], alpine larch [*Larix lyallii*], mountain hemlock [*Tsuga mertensiana*], and Pacific silver fir [*Abies amabilis*]) are excluded because they typically grow where active management for wildlife trees is seldom needed; these areas are seldom logged. Most of the tree species we deal with here are conifers, although black cottonwood (*Populus trichocarpa*), quaking aspen (*Populus tremuloides*), and paper birch (*Betula papyrifera*) are

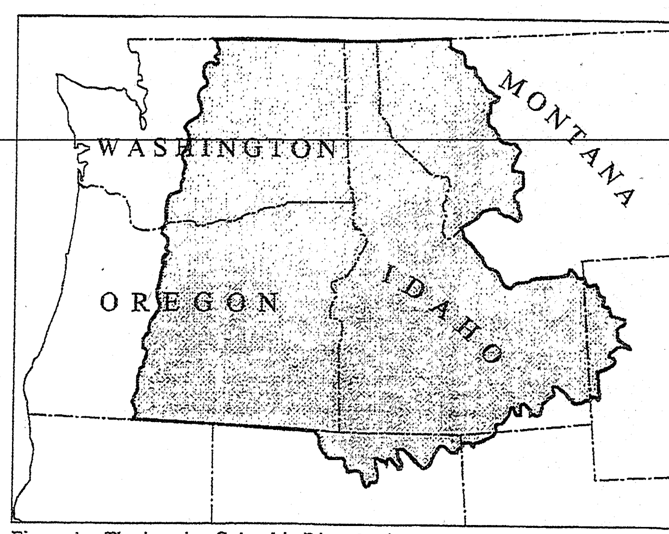


Figure 1—The interior Columbia River basin.

breakup of a fire-killed stand, although specific fall rates were not presented. In the fourth and fifth year after the fire, many ponderosa and Jeffrey pine (*Pinus jeffreyi*) broke off at the ground or up to 50 feet above the ground. By the fifth year, the general breakup continued until only scattered barkless snags and stubs remain.

In northeastern Oregon, different methods of killing ponderosa pines were investigated (Bull 1996c, Bull and Partridge 1986). Trees that had been topped stand the longest; half of those less than 20 inches d.b.h. are down after 10 to 12 years; half of those 20 inches or larger are down after 12 to 17 years. Half the trees injected with a silvicide are down 7 years after treatment. Half the girdled trees are down 9 years after treatment.

Fall rates of snags that have been created differ. Ponderosa pines infected with dwarf mistletoe were frilled and poisoned with an herbicide in the Southwest; after 10 years, 95 percent of those trees are down (Fairweather 1995).

All of these studies suggest that most ponderosa pine and lodgepole pine that died from fire or beetles in the interior Columbia River basin have fall rates of less than 10 years. Small-diameter snags fall sooner than do larger ones.

Sampling Techniques

Knowledge of snag density is essential for managing forest stands effectively, as well as for complying with standards and guidelines. Various methods have been used to determine snag densities: area-wide counts, fixed-radius circular plots, variable-radius plots using prisms (Bull and others 1990), and variable-strip transects (Bate and others, in press). Total counts of snags over large areas are very time-consuming but yield the most accurate density information. Fixed-radius plots typically need to be at least 1 acre because snags are usually scarce and variance is high. Many plots are usually required to accurately estimate snag density.

Bate and others (in preparation) have developed a more efficient method of sampling snags than either area-wide counts or fixed-radius plots: data are collected from a pilot sample transect and used in a computer program. The program determines the optimal length and width of a strip transect within a given area; the optimal size is that which minimizes the cost and variance. The program then provides the necessary sample size to obtain a snag density within the desired statistical bounds. Transect lengths are either 164 or 328 feet; transect widths range from 33 to 131 feet. The

Table 1—Density of snags reported or recommended in four areas; numbers are snags per acre larger than 10 inches d.b.h. (unless otherwise stated), and the percentages represent snags larger than 20 inches d.b.h.

	Locality			
Forest type	Western Idaho[a]	Central Oregon[b]	Northeast Oregon[c]	North-central Idaho[d]
Ponderosa pine:				
Open canopy[e]	1.6(75%)			
Closed canopy[f]	4.8(44%)	4(60%)		
Mixed conifer:				
Open canopy	2.5(72%)			
Closed canopy	9.0(39%)		3.8(29%)	10-48
Lodgepole pine:				
Open canopy	4.5			
Closed canopy	7.7			
Spruce/fir	9.5(21%)			

[a] Recommendations for snag densities selected from the lower ranges of snag numbers on timber inventory plots and fixed-radius plots on the Payette National Forest; different snag levels recommended for burned and unburned stands (Evans and Martens 1995).
[b] Snag numbers based on variable-width transects conducted in an unmanaged stand of old growth in central Oregon where woodcutting was prohibited (Bate 1995).
[c] Numbers based on density of snags in two 4,000-acre study areas in northeastern Oregon that supported viable numbers of pileated woodpeckers; areas had some timber harvest but no woodcutting (Bull and Holthausen 1993).
[d] Densities based on timber inventory plots in unmanaged stands of large saw timber. The snag density varied depending on what snags were included in the count. The 10 snags per acre included only snags 15 inches d.b.h. or larger and 50 feet or taller. The 48 snags per acre included all snags 15 inches d.b.h. or larger of any height. Western white pine snags were not counted (Craig 1995).
[e] Stands with less than 30 percent canopy closure.
[f] Stands with more than 30 percent canopy closure.

program also provides a "distribution index," which is an estimate of the percentage of the sampled landscape supporting target snags or trees.

Creating Wildlife Trees

In managed stands, retaining existing snags is the most ecologically sound and economical approach to providing wildlife trees. If stands are devoid of snags, however, an option is to alter or kill living trees. Depending on the method used, killing trees can be costly and may not produce the desired decay conditions. Years may pass before the decay is sufficiently advanced to promote cavity-nester excavations.

Bull and Partridge (1986) investigated six methods of killing ponderosa pine. They determined that topping trees with either a chainsaw or explosives produced snags that stood the longest and received the greatest nest use by woodpeckers (figs. 48 and 49). In this study, girdling, fungal inoculation, and beetles attracted by pheromones did not consistently kill the tree. Trees killed by girdling or silvicides fell over too quickly to provide wildlife nest trees.

In a study in New Mexico, all of the ponderosa pines killed by girdling were used for foraging by woodpeckers. Most of the trees greater than 16 inches d.b.h. were standing after 7 years, and about 30 percent contained woodpecker nest sites (Parks 1996b). Because the climate in the New Mexico sites is drier than in the Oregon study area used by Bull and Partridge (1986), basal decay of killed trees may have been less, so the trees stood longer.

Recent work by Parks and others (1996a, 1996b) documents a new method of inoculating live trees with decay fungi. Six years after inoculation of 60 living western larch, 14 percent contained woodpecker cavities near the point of inoculation. These trees may remain alive for decades with a pocket of decay that woodpeckers can use for nesting. Trees may be logged next to these trees without safety concerns, and live trees are less likely than dead trees to be lost to fuel-wood cutters. These preliminary results for western larch suggest that inoculation produces desirable wildlife trees at a lesser cost than killing trees to create snags.

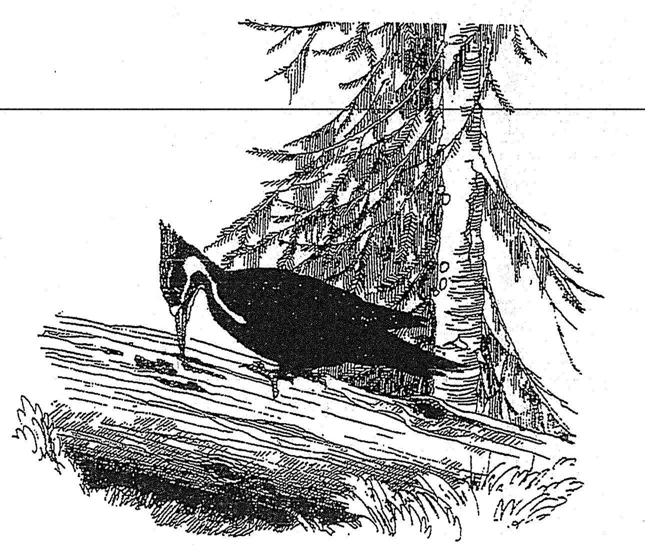
A variety of wildlife tree structures can be created with a chainsaw in standing, living trees. Trees can be topped leaving a horizontal branch structure on which ospreys (*Pandion haliaetus*) can build nests (fig. 50). A depression can be cut into the top of a tree that has been topped to produce a nest site for great gray owls (fig. 51). Artificial cavities and hollows can be cut into standing and downed trees (figs. 52, 53, and 54). Slits can be cut into trees to create roosting habitat for bats (fig. 55). These techniques and others are described by Brown (1996).

Three primary considerations in creating wildlife trees are the target wildlife species for which the structure is being created; the tree species, size of tree, and habitat locality most likely to be used by the targeted wildlife species; and the method of altering or killing trees that is most likely to produce long-standing trees in a given geographic area. Rainfall, snowfall, incidence of windstorms, and prevalent decay organisms all must be considered.

Thousands of trees have been killed to create snags in the interior Columbia River basin in the last 15 years. Few of them have been monitored, however, to determine whether long-lasting, quality snags were actually produced. Because climate and decay organisms differ with area, results of management activities, such as snag creation, must be monitored to ensure that results warrant the cost of these treatments. We include a data form to monitor wildlife use of created snags in appendix A.

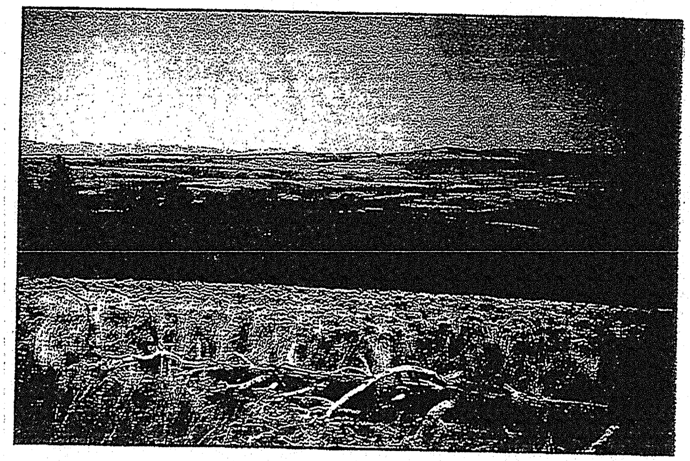
Review

- Ponderosa pine, western larch, quaking aspen, and paper birch are favored tree species for nest sites of woodpeckers in many areas in the interior Columbia River basin.
- 5-25 Large-diameter snags provide nest habitat for the greatest variety of cavity nesters and stand longer than smaller snags.
- Snags can be classed into three structural classes that are a simplified version of past decay class categories.
- Snags should be provided in every 5- to 25-acre stand, in clusters if available, on all slope aspects and positions of the slope, and adjacent to green trees.
- Recent studies have shown that the snag model developed by Thomas and others (1979) did not accurately predict woodpecker abundance based on snag abundance. New information suggests that foraging strata (snags and other structures) must be incorporated into any snag model, and that snag numbers need to be revised upward.
- Published data suggest that populations of cavity nesters were viable in stands of ponderosa pine and mixed-conifer forests that contained about four snags per acre, a large component of old-growth stands, and abundant logs. 4/ac
- Snags can be retained over time by using models for green tree replacements.
- Snag longevity depends on cause of death, tree species, diameter, height, amount of heartwood, geographic area, and site conditions.
- Creating snags and other wildlife structures can mitigate the loss of natural habitat, but retaining existing structures is most cost effective and ecologically sound.



Review

- Size, species, and number of logs per acre are fundamental descriptors of the suitability of log resources for wildlife.
- Logs 15 inches or greater in large-end diameter are particularly important for species such as pileated woodpeckers.
- In mixed-conifer stands, logs of western larch, Douglas-fir, and grand fir were favored for foraging by pileated woodpeckers in northeastern Oregon.
- Late- and old-seral stands of mixed conifers have about 90 logs per acre in northeastern Oregon.
- Logs averaged 34 feet long in mixed-conifer stands in northeastern Oregon, but logs should be as long as possible to offer the greatest range in diameters.
- Hollow logs of any species and size class are important structural components to favor.



CONCLUSIONS

Thomas

This document presents new information on the retention and selection of trees and logs most valuable to wildlife. This new information may be useful in the forest planning process. As additional information becomes available, agencies can incorporate it into their management guidelines.

Current direction for providing wildlife habitat on public forest lands does not reflect this new information. Since the publication of Thomas and others (1979), new research suggests that to fully meet the needs of wildlife, additional snags and habitat are required for foraging, denning, nesting, and roosting. Although we do not suggest specific numbers of snags to retain by forest type, two recent studies indicate that viable woodpecker populations occurred in areas with about four snags per acre (Bull and Holthausen 1993, Dixon 1995).

We suggest that the next step in snag management should involve creating a model that incorporates the new information on woodpecker foraging substrates (live trees, snags, and logs), home range sizes, number and characteristics of roost trees, multiple occupancy of snags, and needs for other habitat structures. Once this information is incorporated, the model may suggest changes to guidelines that specify numbers of snags and other habitat features by forest type and geographic area. Additional information on fall rates of snags, foraging needs of black-backed and three-toed woodpeckers, relation of the density of woodpeckers to that of secondary cavity nesters, and relation of snag density to woodpecker density would greatly improve the model.

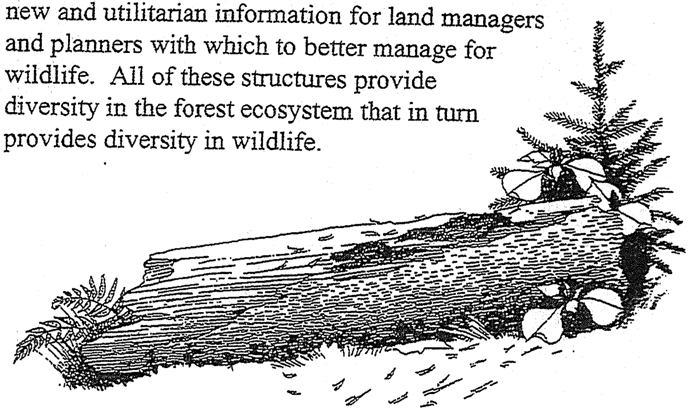
Although hollow trees provide benefits to many wildlife species, no framework regarding their management exists. Additional research is needed to clarify how and when heart-rot decay is initiated, and how long hollow trees persist. Management actions that foster the development and retention of hollow trees need to be developed.

In spite of the value of dwarf mistletoe brooms to wildlife, many managers are still reluctant to retain such structures in stands. With creative management, selected areas can be identified in which to retain trees with dwarf mistletoe brooms but still minimize the risk of spread of dwarf mistletoe to the rest of the stand. Information presented here suggests that retaining trees with brooms caused by broom rusts or Elytroderma offers little risk of tree mortality within a stand.

We are just beginning to recognize the importance of logs in wildlife management. Inventories in 22 areas in northeastern Oregon showed that late- and old-seral stands of mixed conifers contained about 90 logs per acre. These inventories raise questions regarding current guidelines that call for only 6 to 20 logs per acre. Logs are important not just for wildlife but for maintenance of nutrient recycling, water economy, and structural properties for plant growth and soil development that logs provide.

For any management plan to be effective, a reasonable estimate of existing conditions is essential. To obtain this information, inventories of snags, logs, hollow trees, and trees with brooms can be done by using techniques recommended in this text. For down logs, the minimum information needed for wildlife purposes are large-end diameters of logs, lengths, and numbers per acre. Fuel inventories do not provide this information. Once existing conditions are known, management direction can dictate the number and type of structures to retain and the number that can be removed without jeopardizing wildlife objectives.

We hope that this document will provide some new and utilitarian information for land managers and planners with which to better manage for wildlife. All of these structures provide diversity in the forest ecosystem that in turn provides diversity in wildlife.



territorial and will not tolerate close neighbors while nesting, or the fact that species like the black-backed woodpecker need more foraging options. Overall, more snags are needed than other studies have previously recommended.

Based on their results, Lorenz and her colleagues see the critical role that mixed-severity fires play in providing enough snags for cavity-dependent species. Low-severity prescribed fires often do not kill trees and create snags for the birds. In addition to benefiting the cavity nesters, a mixed-severity prescribed burn could also aid species that, historically, did not prefer to nest in snags. During their field work, Lorenz and Fischer observed that white-headed woodpeckers, a species traditionally associated with old-growth forest, used prescribed burns presumably because of shortages in suitable nest sites.

"I think humans find low-severity fires a more palatable idea. Unfortunately or fortunately, these birds are all attracted to high-severity burns," Lorenz says. "The devastating fires that we sometimes have in the West almost always attract these species of birds in relatively large numbers."

Many studies have shown that a severely burned forest is a natural part of western forest ecosystems. Snags from these fires attract insects that love to burrow beneath charcoal bark. And where there are insects, there are birds that love eating these insects.

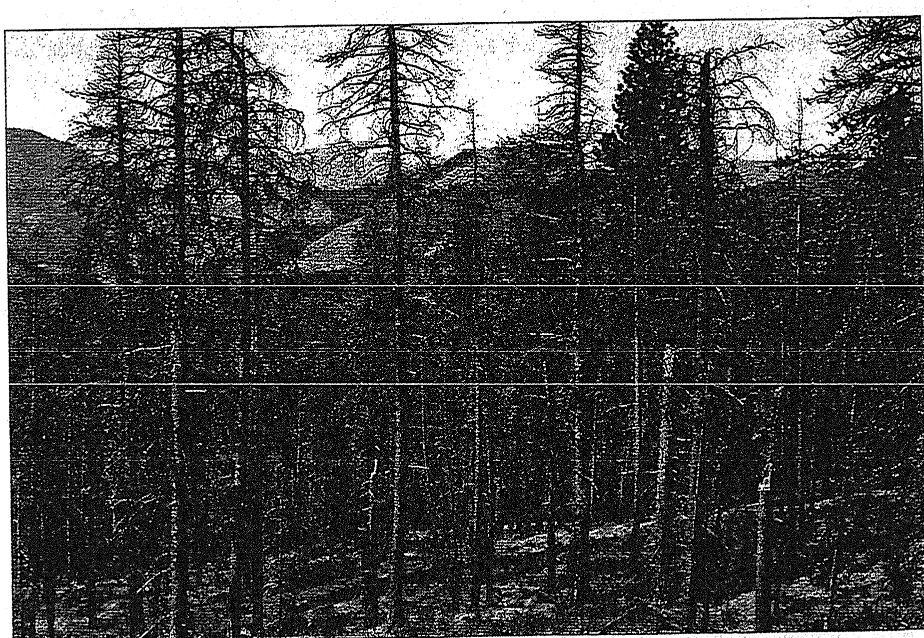
Lorenz and her colleagues stress that providing snags that woodpeckers can excavate is crucial for forest ecosystem health in the Pacific Northwest, where more than 50 wildlife species use woodpecker-excavated cavities for nesting or roosting.

"This study was just the beginning of what I hope will be decades of research," Lorenz says. Picking up on what she learned in this study, Lorenz is now collaborating with Forest Service colleague Michelle Jusino to investigate a kind of fungi that follows forest fires. "There is some mechanism by which the death of a tree somehow enables some species of fungi to decay the wood," she says. The research is bound to take her back into the forests of the Pacific Northwest, where woodpeckers follow forest fires in a timeless cycle of change.

"The powerful play goes on and you may contribute a verse."
—Walt Whitman, *Leaves of Grass*

LAND MANAGEMENT IMPLICATIONS

- Providing snags that woodpeckers can excavate is important for forest ecosystem health in the Pacific Northwest, where more than 50 wildlife species use woodpecker-excavated cavities for nesting or roosting.
- Mixed-severity prescribed-fire may be useful in creating breeding habitat for the white-headed woodpecker, a species traditionally associated with old-growth forest.



Teresa Lorenz

The prescribed burn conducted in this stand flared up in patches, creating a mosaic of burned and unburned trees (a mixed severity burn) that is still used by white-headed woodpeckers and black-backed woodpeckers 10 years after the fire. Tree death is usually required to initiate the process of wood decay—which softens the wood, making it suitable for woodpecker excavation.

For Further Reading

Lorenz, T.J.; Vierling, K.T.; Johnson, T.R.; Fischer, P.C. 2015. The role of wood hardness in limiting nest site selection in avian cavity excavators. Ecological Applications. 25: 1 016–1033. https://www.treesearch.fs.fed.us/pubs/49102.

Lorenz, T.J.; Vierling, K.T.; Kozma, J.M., et al. 2015. Space use by white-headed woodpeckers and selection for recent forest disturbances. Journal of Wildlife Management. 79: 1286–1297. https://www.treesearch.fs.fed.us/pubs/53384.

Lorenz, T.J.; Vierling, K.T.; Kozma, J.M.; Millard, J.E. 2016. Foraging plasticity by a keystone excavator, the white-headed woodpecker: Are there consequences for productivity? Forest Ecology and Management. 363: 110–119. https://www.treesearch.fs.fed.us/pubs/53385.

Matsuoka, S. 2000. A method to measure the hardness of wood in standing woodpecker nest trees. Japanese Journal of Ornithology. 49: 151–155.

Writer's Profile

Natasha Vizcarra is a science writer based in Boulder, Colorado. She can be reached through her website at www.natashavizcarra.com.

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appeal

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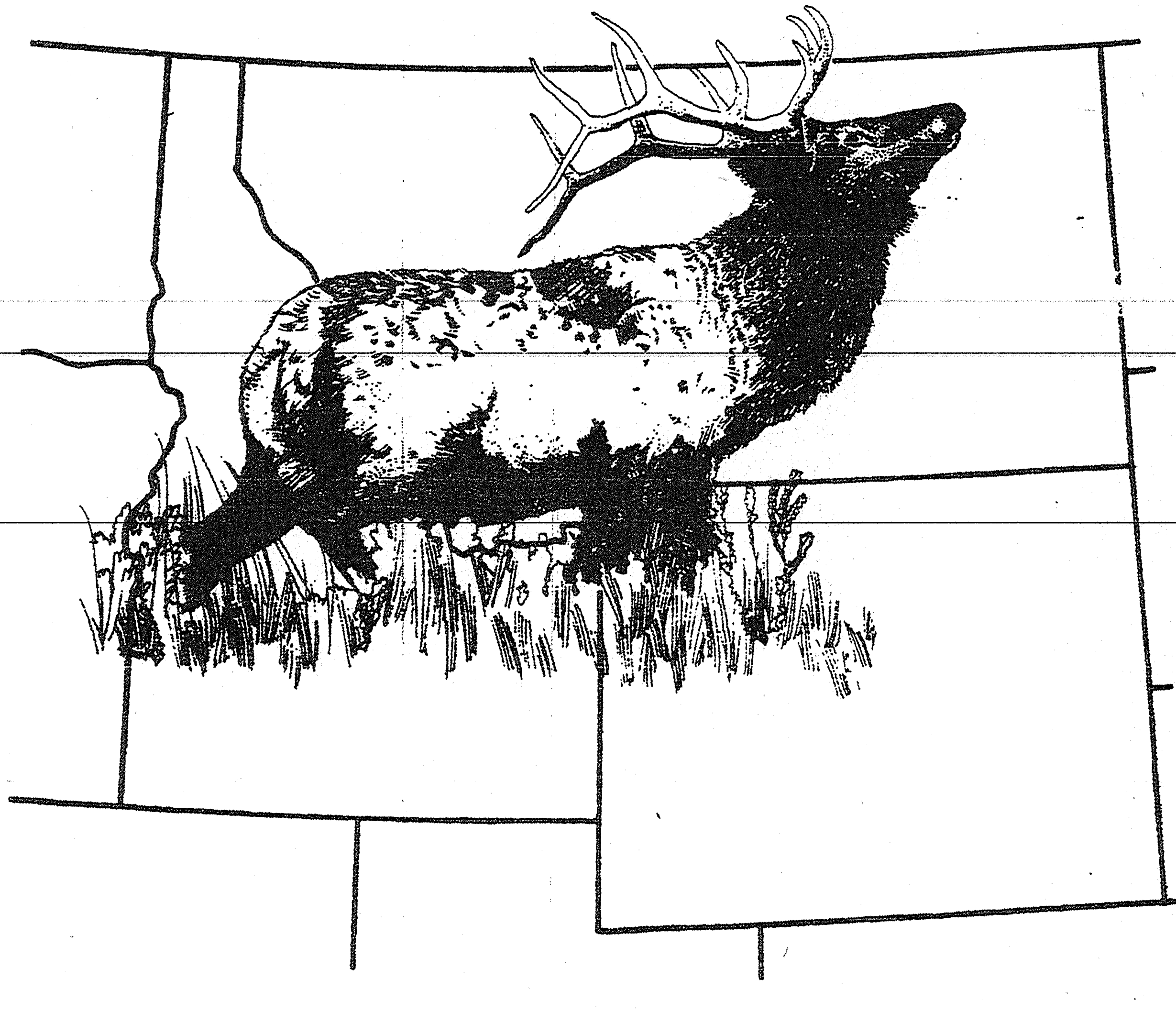

Elk Management in the Northern Region: Considerations in Forest Plan Updates or Revisions

Alan G. Christensen
L. Jack Lyon
James W. Unsworth

INTRODUCTION

In the West, a large percentage of elk habitat is managed by the Forest Service, U.S. Department of Agriculture. Elk are a giant economic factor in Montana and Idaho, easily accounting for over $100 million annually for hunting alone. This activity is especially important to many small, rural communities. At the same time, elk management can be controversial where it conflicts with other resource activities such as grazing, logging, and public access. As the habitat manager for this valuable resource, the Forest Service must develop management programs based on the best available information, work closely with State game managers, fully inform the public and disclose the effects of management actions, and embrace implementation of an ecological approach to elk management.

When the initial forest plans were developed in the early 1980's, there was no cohesive direction identifying a common set of elk management standards. As plans were written, generally recognized key pieces of elk management information were creatively modified by virtually every forest in an attempt to meet local needs. This often resulted in adjacent forests having startlingly different goals, objectives, standards, guidelines, and terminology.

In these forest plans, the approach to elk was usually narrow and focused. Because elk was a regional indicator species, managers established population targets, habitat standards, and monitoring goals. We recognize now that elk are part of a bigger picture and that elk habitat management must be placed within the context of ecosystem management, biodiversity, State management strategies and goals, and shifting public demand and interest that now embrace nonconsumptive and consumptive interests.

This problem has been recognized and a solution proposed for the Northern Region of the Forest Service. Common terminology, a new perspective on elk vulnerability, and a better understanding of the application of habitat effectiveness have created the opportunity for forests to be more consistent and in tune with State management objectives. In the interest of better elk management, it is imperative State plans and forest plans address the same issues. Elk vulnerability is the framework issue.

We present an initial overview under which individual forests can creatively address elk management and yet retain consistent and cohesive approaches within regional and State boundaries. Emphasis has been placed on process, content, and implementation of new information rather than on numerical standards, although these remain important for measuring success. Specific process guidance for biologists in the Northern Region of the Forest Service is provided in the appendix.

KEY COMPONENTS OF ELK MANAGEMENT

The relationship between National Forest lands and elk needs to be recognized for the following key components:

1. Habitat in which elk grow, reproduce, and exist as elements of biological diversity.
2. The basis upon which State management programs depend. While hunting mortality accounts for upward of 90 percent of elk mortality, the States depend on habitat availability and condition for their programs to exist.
3. Sites for the public to have the opportunity to hunt and view elk. Recreation is an important product of National Forest lands. In most areas, use of forests peaks during fall hunting seasons, but in other areas wildlife viewing is a year-around product. The setting needs to be considered along with other habitat issues.
4. Maintenance of elk as a part of the natural community and recognition of elk habitat in a landscape context and in response to natural processes.

These key components can be recognized and evaluated in the following three types of habitat considerations:

Habitat effectiveness: This is a measure to be applied to nonhunting, summer and fall habitat situations. It was developed from research related to the ability of habitat to meet elk needs for growth and welfare requirements. It has been consistently misapplied as a measure of security during hunting season.

Elk vulnerability: This deals with security for elk during the hunting season. There is a rapidly expanding body of new information relating to this management concept that will be available for inclusion in forest plans as they are updated, revised, or amended.

Winter range: This has been a collective term referring to elk habitat during the nonsummer and fall, nonhunting season. However, during some years elk will move to winter habitat during the fall hunting season and, in most situations, become vulnerable. In updates, revisions, or amendments we must recognize and deal with this possibility as well as deal with traditional considerations.

HABITAT EFFECTIVENESS

Summer range includes the habitat used by elk from about late green-up (May) until they move to winter ranges, but prior to the hunting season. Summer range is the complete matrix upon which elk herds depend for growth, reproduction, and thrift. Management focus is on maintaining the ability of the habitat to meet elk needs for forage, water, seclusion, and special features (such as licks and moist areas). Forest Service lands that support summer range are the basis for State elk management; specifically, if habitat is degraded or poorly managed, the elk population will be degraded and, thus, directly influence State elk population management programs.

Habitat effectiveness is defined as the percentage of available habitat that is usable by elk outside the hunting season (Lyon and Christensen 1992). This is the measure of success in meeting elk needs on summer range. Based on years of research from various sites in Montana and Idaho, relatively sophisticated technologies exist for calculating habitat effectiveness. In forest plan revisions, updates, and amendments, this term should be used as a measure of summer range ability to support elk. Sources of information for habitat effectiveness and the major factors that influence it are included in Irwin and Peek (1979), Leege (1984), Lyon (1983, 1987), Lyon and others (1985), Thomas and others (1979), and Wisdom and others (1986). (See the References section at the end of this publication.)

Considerations for Forest Plans Related to Habitat Effectiveness

The following list is not inclusive but does cover the main issues managers need to consider.

1. *Roads*—density (miles per square mile), construction standards, seasons of use, method of closure.
2. *Special features*—wet sites, riparian habitat, licks, movement corridors.
3. *Cover*—extent, shape, size, connectiveness.
4. *Scale of analysis*—site specific, herd unit, habitat analysis unit.
5. *Spatial relationships*—intermingled ownerships, adjacent administrative units, district or forest "averaging."
6. *Domestic livestock*—forage and spatial competition.

Recommendations

Roads—Roads are undoubtedly the most significant consideration on elk summer range.

1. Use figure 1 (Lyon 1983) road model for determining habitat effectiveness related to roads. Avoid classifying roads as primitive and downgrading their effect unless they really are.
2. Discuss methods of closure. For elk, physical closure with "trashing" is desirable for year-long closure. Area closures are needed where terrain features and cover characteristics do not favor closure with gates or barriers. Honor systems of closure have been only moderately successful, at best.
3. Discuss construction standards. Where roads will be system roads, strive for construction and design features that lay lightly on the land. Identify temporary roads where they are an option. Avoid "tie through" systems where possible. Strive for minimum miles of new construction in summer range. Identify logging technology that reduces road construction. Avoid key habitat features when locating roads.
4. Any motorized vehicle use on roads will reduce habitat effectiveness. Recognize and deal with all forms of motorized vehicles and all uses, including administrative use.
5. Levels of habitat effectiveness:

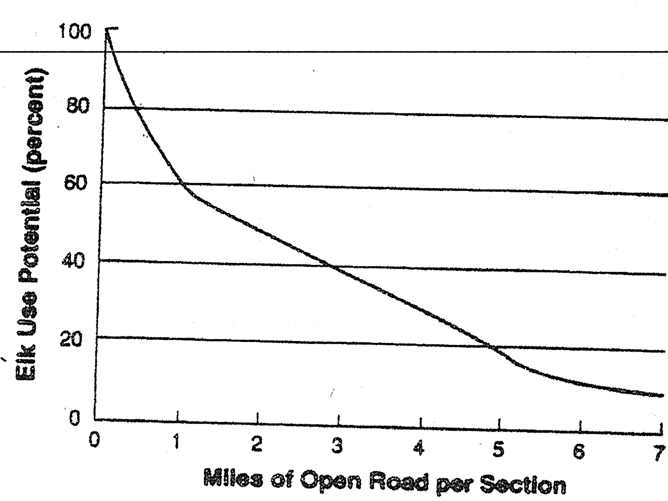

Figure 1—Habitat effectiveness for elk determined by road density (Lyon 1983).

0.75? 2.2 mi, ~50%

a. For areas intended to benefit elk summer range and retain high use, habitat effectiveness should be 70 percent or greater.

b. For areas where elk are one of the primary resource considerations habitat effectiveness should be 50 percent or greater.

c. Areas where habitat effectiveness is retained at lower than 50 percent must be recognized as making only minor contributions to elk management goals. If habitat effectiveness is not important, don't fake it. Just admit up front that elk are not a consideration.

d. Reducing habitat effectiveness should never be considered as a means of controlling elk populations. A population over target is not a Forest Service habitat problem. Remember that in most situations, populations can be reduced through hunting.

Special Features—Wet drainage heads, saddles, riparian habitats, shadowed draws with cool air movement, and wet meadows are some examples of special features. In many areas these features support a disproportionate level of elk use and contribute significantly to overall elk use of a larger area. Generally, these sites are highly desirable for forage, water, temperature regulation, movement, or a combination. Such sites should be recognized and protected in prescriptions that deal with elk summer range. Logging activities, road locations, and siting of structures or activities should all be evaluated. Avoid damaging these features where elk are a benefiting resource (Lyon and others 1985).

Cover—Early guidelines greatly emphasized analysis of cover, specifically thermal and hiding cover (Thomas and others 1979). Today, detailed analyses of hiding and thermal habitat components are not considered as essential except in habitats with high natural levels of openings or where conifer cover is at a premium. Some approaches have created the classification "optimal cover" (Wisdom and others 1986) as an aid in analyzing cover from aerial photographs. Another approach, where stand analysis data are available, is provided by the HIDE2 hiding cover computer model (Lyon 1987).

While we still need to recognize the importance of maintaining cover blocks and movement corridors, a more meaningful approach to cover analysis includes maintenance of security, landscape management of coniferous cover, and monitoring elk use with radio telemetry or other means. Recognition that summer cover blocks are also fall hunting season security areas is an important coordinating consideration.

Cover unit size, patterns on a landscape basis, connectiveness with other cover, the amount of cover available to elk, and known use patterns by elk should be considered in prescriptions.

Scale of Analysis—Early guidelines tended to be project specific in scale; often 3,000 to 10,000 acres was recommended. However, while road locations, special features, and the location of cover or cutting units still need project-level analysis, such analysis also needs to recognize the project in a broader context of herd units (where known), habitat analysis units, or other meaningful, larger scale perspectives. Herd units need to be identified in cooperation with State biologists. Consideration of project-level effects may necessitate analysis in light of influences on adjacent herd units, adjacent forests, or even adjacent States over landscape units from 30,000 to 150,000 acres.

Another consideration in establishing factors for scales of analysis are known movement patterns. If your management of summer range may influence elk in terms of their movement to adjacent fall or winter ranges, the scale of analysis should be appropriate.

Spatial Relationships—This criterion has to do with habitat features, values, or project analyses that have a relationship to intermingled ownerships, concurrent and adjacent activities, or adjacent features that are significant to your concerns for elk habitat.

When elk habitat crosses intermingled ownerships, activities that reduce habitat effectiveness on intermingled lands require the Forest Service to decide how they will be dealt with in prescriptions. Adjacent and concurrent activities beyond Forest Service control, such as logging and grazing on private land, should be recognized in prescriptions, and courses of action for the Forest Service should be identified. Federal managers need to coordinate with State biologists on these activities.

Internally controlled activities that affect elk summer range should also be recognized. An example is the relationship of herd units or analysis areas to each other and, collectively, to forest elk habitat. Each individual unit should have an identified role for elk and a level of habitat effectiveness. In this way, the whole area or forest can achieve an expected level. It is undesirable to play off one unit against another. For example, recognizing high habitat effectiveness values in adjacent wilderness areas should not be a justification for excessive reductions in habitat effectiveness in managed areas, even if some average level for the forest is met.

Significant reductions in habitat effectiveness in areas identified as benefiting elk cannot be recovered at a pace equal to our ability to move activities around a forest. In addition, patterns of recreational activity related to elk can be significantly affected by this type of management.

Domestic Livestock—Current perspective is that cattle on elk summer range are not as significant a conflict as formerly thought and probably only warrant analysis where local understanding indicates a problem may exist. Elk appear to avoid areas where cattle are present if other options exist. Where no other options exist, elk will tolerate some cattle use.

Major points of conflict are wet sites and gentle terrain with succulent vegetation. Season-long cattle occupation of these types of sites undoubtedly reduces their value to elk.

Forests where cattle are a concern need to work with State biologists on standards and guidelines for cattle and elk relationships.

Of equal concern is the perception that elk herd expansion is causing cattle use reductions on National Forests. In developing management guidance, forests should address this issue and strive to gather habitat use data that will help clarify this situation.

Summary for Summer Range

1. Habitat effectiveness is the method of measurement.
2. The presence and motorized use of roads is the major impact on elk habitat effectiveness.
3. Detailed cover: forage analysis is important only when cover is at a premium.
4. Landscape levels of analysis are necessary.
5. Recognition of adjacent activities, intermingled ownerships, and cumulative effects is needed in plan revisions and updates.
6. Analysis of elk and domestic livestock conflicts is probably warranted where it is considered a problem locally.
7. Forests should set standards for habitat effectiveness that are congruous with goals for a prescriptive unit. Specific prescriptive guidelines should reflect the level of habitat effectiveness desired.
8. Close coordination with State biologists and recognition of identified State management goals for elk are necessary in all aspects of summer range management.
9. Forests should recognize traditional uses of elk as well as burgeoning nonconsumptive interest in elk.

ELK VULNERABILITY ANALYSIS

The primary source of elk mortality is hunting. While the State manages hunters, the Forest Service management of access and cover are extremely influential in affecting the ability of hunters to kill elk. Therefore, it is important that in forest plan revisions or updates, prescriptive guidance is identified for elk vulnerability analysis. This procedure applies during the hunting season and is not to be confused with habitat effectiveness. Vulnerability is a separate issue that forests need to recognize in elk management and write into prescriptions. Vulnerability results from an extremely complex relationship involving access, cover, topography, hunter density, and weather. A great deal of intercorrelation among these factors exists, and a great deal of cooperation between agencies will be necessary to achieve the goals of elk vulnerability management.

The measure of success for elk vulnerability is the level of compatibility between Forest Service and State management plans. Often, this will be the number of bulls per hundred cows surviving the hunting season or some expression of the quality of the recreation experience provided.

Considerations for Forest Plans Related to Elk Vulnerability

The following list is not inclusive but does include the main issues managers need to consider:

1. *Roads*—season of use, density.
2. *Security areas*—distance from roads, size, cover characteristics, closures (area), topographic characteristics.
3. *Cover management*—description, connectiveness, scale, terrain relationships.
4. *Mortality models*—demonstrated predictors of elk mortality based on habitat quality, hunter density, or other factors.

Recommendations

Roads—As with habitat effectiveness, access to and use of roads appear to be the most significant factors in vulnerability analysis.

Two studies in Idaho have demonstrated direct relationships between levels of road access and bull mortality (Leptich and Zager 1991; Unsworth and Kuck 1991). In Montana, Youmans (1991) implicated "road densities as the key factor in increased elk vulnerability."

Concerning open roads during hunting season, forests should develop criteria that meet State management goals for elk. Information on the relationship between roads and elk vulnerability is so new that specific criteria are scarce. However, the studies in northern Idaho provide initial guidance. Unsworth and Kuck (1991) found bull survival more than doubled in situations comparing road densities in excess of 4 miles per section with densities under 0.5 mile per section. In a different study area, Leptich and Zager (1991) reported bull mortalities of 62, 45, and 31 percent in study areas with 4.5, 2.6, and 1.0 miles of open road per section. In both these studies, cover during the hunting season was not considered limiting.

1. In areas with heavy cover, road management can be extremely influential in meeting desirable postseason bull:cow ratios.
2. Where heavy cover is not available, reduced open road densities contribute to maintaining some level of quality hunting opportunity through the season and to meeting postseason bull:cow ratios. In areas of

more open cover and, perhaps, gentler terrain, roads speed up the harvest of available bulls and make bulls more vulnerable throughout the season. Increased emphasis should be placed on security where poor cover conditions exist.

3. Even primitive roads that see little summer use are often used extensively during the hunting season. Area closures with open routes designated will most likely provide better security than individual closures. Area closures should address all motorized vehicles including all-terrain vehicles.

Security Areas—Security is the result of a combination of factors that allow elk to remain in a specific area while under stress from hunting. In Forest Service management, such areas are defined by cover blocks and road management. Specifically, these are areas of coniferous cover large enough and far enough away from open roads to provide security. There have been efforts on the Lolo and Deerlodge National Forests to develop criteria for managing security. The "Hillis paradigm" (Hillis and others 1991) provides these criteria and, with careful consideration, may be appropriate for other forests to use as a general guide. Briefly, this model identifies the size (250 or more acres), shape (nonlinear), and distance from open roads (over 0.5 mile) for security areas as well as how much of the area (over 30 percent) should be dedicated to security.

In discussions with biologists in Idaho and Montana, there appears to be a gradient from west to east regarding the significance of cover in this equation. In northern Idaho, it appears that open road density, hunter numbers, and topographic roughness are the major considerations (Unsworth and others 1993). Cover is so ubiquitous that security can be controlled with road management alone. As you move east into Montana and over the Continental Divide, cover considerations become more important because cover is less abundant and less contiguous. It is extremely important for forest biologists to work with their State counterparts in developing criteria for security areas, including their size, extent, distance from roads, and vegetative characteristics. Data from radio telemetry studies are the best source for developing such criteria.

Cover Management—This criterion is directed mostly at the more naturally open elk habitat in central and southwestern Montana and southern Idaho where care must be taken to recognize and retain adequate coniferous cover. In developing this criterion, a landscape-level perspective is absolutely necessary. Size, location on the landscape, connectiveness with other cover, and vegetative composition are important considerations (Hillis and others 1991). Data from Montana hunting seasons suggest that elk are less selective about the specific vegetative characteristics of coniferous cover and more responsive to size of units, connectiveness with adjacent units, and the scale of cover on the landscape (Lyon and Canfield 1991). A strong relationship exists between maintaining cover for summer range habitat effectiveness and maintaining the same cover for security during fall hunting. Where coniferous cover may be a limiting factor, it will be important to develop long-term perspectives (rotation length) on cover management that address condition, quantity, location, and configuration.

Mortality Models—Models that link habitat, hunter density, and elk mortality can provide guidelines to coordinating habitat condition and State management objectives. Unsworth and others (1993) have developed a model for northern Idaho that predicts bull elk hunting season mortality using open road density, circular standard deviation of aspect, and hunter intensity (density for the length of the season). This model virtually requires a computerized Geographic Information System for calculating the aspect variable. But the effect can be estimated based on the fact that greater topographic relief reduces elk vulnerability. The more moderate the topography (fig. 2), the more impact road density and hunter density have. If we assume average topography and around 10 hunter days per section spread over a 26-day season, the probability of mortality for a bull elk is 60 percent greater in an area with 1 mile of road per section than in an unroaded area. Likewise, 2 miles of road per section will more than double the mortality probability, and at higher road densities bulls usually do not survive the hunting season.

Using a different measure of hunting intensity, Vales and others (1991) and Vales (1993) presented data from northeastern Oregon indicating that the ratio of hunters to available elk can also provide an estimate of probable mortality; basically, there is a consistent increase in harvest rate as the number of hunters per elk increases (fig. 3). These data are important because they indicate that excessive hunting pressure can, in the end, overwhelm all other provisions of elk vulnerability management.

Summary for Elk Vulnerability

1. Roads appear to be the single most important variable that the Forest Service manages. Roads not only directly affect elk mortality but also affect hunter opportunity by accelerating bull mortality. Forests must work closely with State biologists to identify acceptable levels and locations of motorized access to meet postseason bull:cow ratios and maintain optimum hunter opportunity.

2. Security area definition is variable across the region. Some forests have developed criteria. It is essential that cooperation and coordination with State biologists be used to formulate criteria.

3. Elk vulnerability analysis, a new concept, will be further defined. Hunter density and opportunity

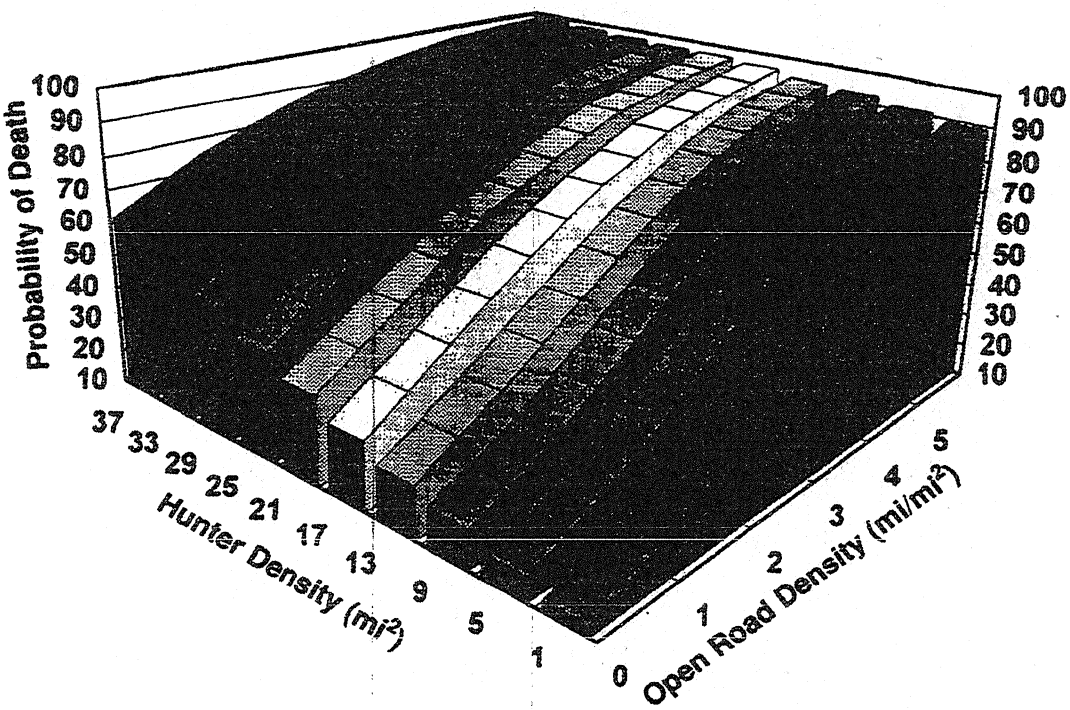

Figure 2—Elk vulnerability influenced by hunter density and road density (Unsworth and others 1993).

afforded by State regulations are also major components. It is essential that forest biologists and planners and their State counterparts communicate and coordinate extensively on this topic as forest standards and guidelines are developed.

4. Recently available mortality models can establish numerical standards for elk mortality. Local data bases may exist to help tailor mortality models to specific geographic areas. Numerical standards for elk mortality can be established through coordination with State biologists.

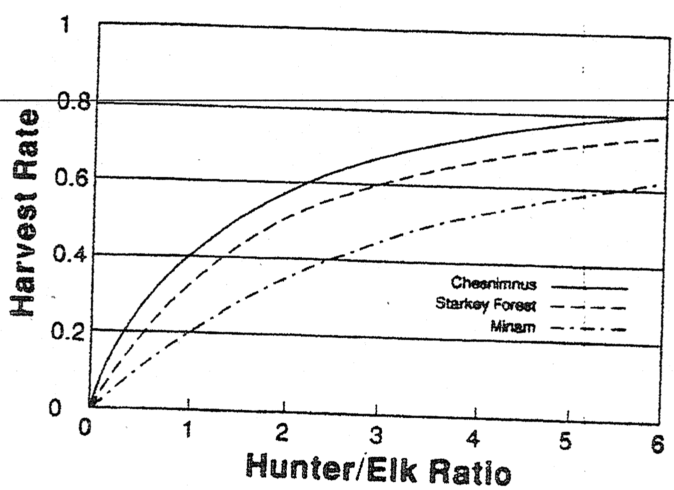

Figure 3—Elk vulnerability influenced by hunter to elk ratio (Vales 1993).

WINTER RANGE

Management of winter range remains the single most site-specific consideration for elk habitat. Each winter range is unique in some way. In this section, we briefly address the traditional considerations that already appear in the majority of forest plans. We again mention, however, that winter range should be evaluated as a part of the vulnerability assessment where appropriate to do so.

Traditionally, winter ranges for elk have been viewed as geographic sites on which animals concentrate seasonally because of snow depths. Heavy utilization of available plants, and animal die-off in severe winters, have been commonly recorded. For many years, the primary objective of management was to improve, or at least prevent deterioration of, existing vegetation.

In recent years, our understanding of animal physiology on winter ranges has modified this view. Forage is important, but in severe weather many animals substitute an energy-conservation strategy for forage intake. Thus, management of winter range to improve thermal cover and prevent harassment may be as important as anything done to change forage quantity or quality.

Considerations for Forest Plans Related to Winter Range

The following list is not inclusive but does include the main issues managers need to consider:

1. *Forage quantity and quality*—methods for improvement.

2. *Thermal cover*—energy conservation considerations.

3. *Roads and other disturbances*—energy conservation considerations.

4. *Livestock management*—forage allocation management.

Recommendations

Forage Quantity and Quality—In the majority of situations, actually modifying forage quantity or quality on the winter range is a difficult management challenge. Encroaching vegetation can sometimes be removed mechanically or with fire, and large or decadent shrubs can be burned to produce resprouting.

Thermal Cover—Some winter ranges lack thermal cover, which does not mean thermal cover serves no purpose where it is available. Where behavior patterns have been recorded, elk select resting and feeding sites based on control of energy transfer rather than forage availability. We recommend selective retention of larger trees where possible.

Roads and Other Disturbances—Disturbance and harassment result in tremendous energy costs to wintering animals. Selective road closures and restrictions on recreational use have proved effective in reducing these costs.

Livestock Management—Appropriate management of domestic livestock can, in some cases, be an important consideration in management of elk winter ranges. Local range specialists should be consulted about grazing techniques designed to leave adequate winter forage for elk.

REFERENCES

Hillis, J. Michael; Thompson, Michael J.; Canfield, Jodie E.; Lyon, L. Jack; Marcum, C. Les; Dolan, Patricia M.; McCleerey, David W. 1991. Defining elk security: the Hillis paradigm. In: Christensen, A. G.; Lyon, L. J.; Lonner, T. N., comps. Proceedings: elk vulnerability symposium; 1991 April 10-12; Bozeman, MT. Bozeman, MT: Montana State University: 38-54.

Irwin, L. L.; Peek, J. M. 1979. Relationship between road closures and elk behavior in northern Idaho. In: North American elk: ecology, behavior and management. Laramie, WY: University of Wyoming: 199-204.

Leege, Thomas A. 1984. Guidelines for evaluating and managing summer elk habitat in northern Idaho. Bull. 11. Boise, ID: Idaho Department of Fish and Game. 38 p.

Leptich, David J.; Zager, Peter. 1991. Road access management effects on elk mortality and population dynamics. In: Christensen, A. G.; Lyon, L. J.; Lonner, T. N., comps. Proceedings: elk vulnerability symposium; 1991 April 10-12; Bozeman, MT. Bozeman, MT: Montana State University: 126-131.

Lyon, L. Jack. 1983. Road density models describing habitat effectiveness for elk. Journal of Forestry. 81(9): 592-594, 613.

Lyon, L. Jack. 1987. HIDE2: Evaluation of elk hiding cover using a personal computer. Res. Note INT-365. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 2 p.

Lyon, L. Jack; Canfield, Jodie E. 1991. Habitat selections by Rocky Mountain elk under hunting season stress. In: Christensen, A. G.; Lyon, L. J.; Lonner, T. N., comps. Proceedings: elk vulnerability symposium; 1991 April 10-12; Bozeman, MT. Bozeman, MT: Montana State University: 99-105.

Lyon, L. Jack; Christensen, Alan G. 1992. A partial glossary of elk management terms. Gen. Tech. Rep. INT-288. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 6 p.

Lyon, L. Jack; Lonner, Terry N.; Weigand, John P.; Marcum, C. Les; Edge, W. Daniel; Jones, Jack D.; McCleery, David R.; Hicks, Lorin L. 1985. Coordinating elk and timber management: final report of the Montana Cooperative Elk-Logging Study, 1970-1985. Bozeman, MT: Montana Department of Fish, Wildlife and Parks. 53 p.

Thomas, Jack Ward; Black, Hugh, Jr.; Scherzinger, Richard J.; Pedersen, Richard J. 1979. Deer and elk. In: Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. Agric. Handb. 553. Washington, DC: U.S. Department of Agriculture, Forest Service. 512 p.

Unsworth, J. W.; Kuck, L. 1991. Bull elk vulnerability in the Clearwater drainage of north-central Idaho. In: Christensen, A. G.; Lyon, L. J.; Lonner, T. N., comps. Proceedings: elk vulnerability symposium; 1991 April 10-12; Bozeman, MT. Bozeman, MT: Montana State University: 85-88.

Unsworth, J. W.; Kuck, L.; Scott, M. D.; Garton, E. O. 1993. Elk mortality in the Clearwater drainage of northcentral Idaho. Journal of Wildlife Management. 57(3):495-502.

Vales, David J. 1993. Vulnerability curve data. [Personal communication]. May. Moscow, ID: University of Idaho.

Vales, David J.; Coggins, Victor L.; Matthews, Pat; Riggs, Robert A. 1991. Analyzing options for improving bull:cow ratios of Rocky Mountain elk populations in northeast Oregon. In: Christensen, A. G.; Lyon, L. J.; Lonner, T. N., comps. Proceedings: elk vulnerability symposium; 1991 April 10-12; Bozeman, MT. Bozeman, MT: Montana State University: 174-181.

Cal Fire burns next to Bald Eagle nest, eaglets die (/stories/2022/4/15/2092201/-Cal-Fire-burns-next-to-Bald-Eagle-nest-eaglets-die)

Defiance Canyon Raptor Rescue (/users/defiance canyon raptor rescue)
Community (This content is not subject to review by Daily Kos staff prior to publication.)

Friday April 15, 2022 · 3:51 PM MDT

Bald eagle chick, dead in nest tree after Cal Fire control burn next to the nest in 2021. Cal Fire has not committed to stop burning by the nest this year. Who would think it would be a problem for public agencies to adhere to laws that protect wildlife?

Climate change impacts have been worsening for years, raising temperatures and exacerbating fire danger in California and the world. In many cases though, trees and other plants are being treated as enemies to be annihilated, rather than as the ecosystems that enable life on earth to exist.

In California, both Cal Fire and PG&E are being given exemptions from any environmental review for their "fuel reduction" or "vegetation management" programs. In this time when thousands of scientists worldwide are screaming and waving red flags about biodiversity and climate catastrophe, the impacts of these projects are being ignored, particularly to wildlife and habitat.

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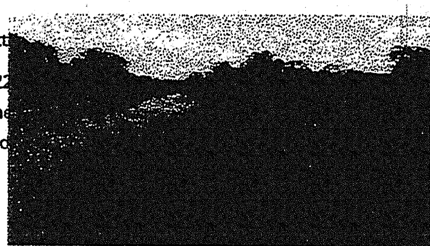
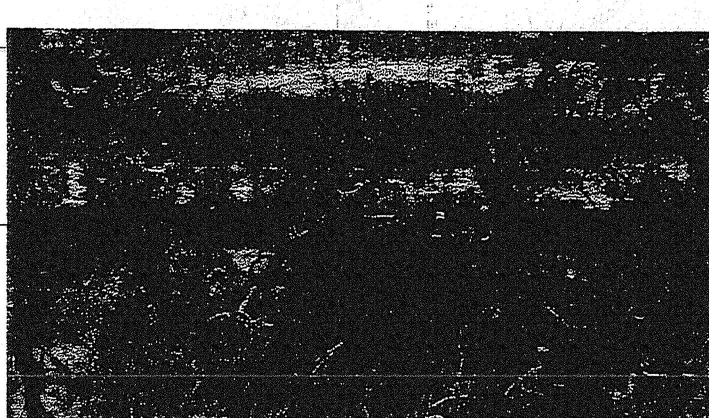
What has happened over the past several years to a bald eagle nest east of Red Bluff, California illustrates what is occurring because of these exemptions from any oversight. The fear of fire is being exploited to the detriment of the natural world, rather than substantive actions being implemented to reduce the emissions which are causing climate disaster.



Hwy 36, east of Red Bluff. The eagle nest is to the right (south side). This is the roadside Cal Fire has burned in 2020 and 2021 when the eagle nest was occupied. There is little reason to burn here, and many reasons not to.

The eagles' nest to the south of the highway, circled in red.



Parent eagle with young eaglet in front (little grey head) in nest tree, April 2022.

Local residents have been watching this nest since 2020. A photographer from Red Bluff was going out to the nest every day in 2021. At the end of May, the photographer saw a notice that there was going to be a control burn by the nest in a few days. She contacted a local eagle group, who called Cal Fire to tell them about the nest which was occupied by two young eaglets. The eagle group left a message and received a message back from Cal Fire saying their biologist said it was fine to be burning near the nest. The eagle group called back to get the biologist's name, but received no answer then or later. It wasn't "fine".

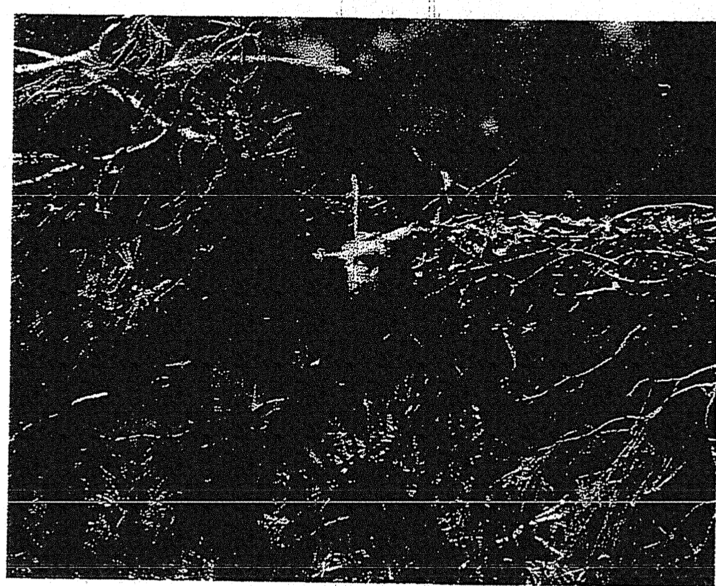
The burn was done on June 1st. This nest is approximately 100 feet down a ravine from the highway. The eaglets were probably only 6-7 weeks old, 4 or 5 weeks from being able to fly.

The photographer was standing next to the nest during the burn and taking photographs. The Cal Fire people were slightly to the east of the nest. The smoke and flames can be seen on the south side of the highway, on the same side as the nest.

Cal Fire burning next to eagle nest, 2021. How much extra CO2 is being emitted by extra equipment use and burning unnecessarily?

The photographer went to check the nest a few days later and saw one adult perched above the nest, but could see no eaglets.

The next morning, the photographer took a photo which shows a dead eaglet hanging from the nest. The photographer contacted me (Marily Woodhouse from Defiance Canyon Raptor Rescue). We went to search for the other eaglet, in the hope it was still alive.



Dead eaglet hanging from the nest.

Both the adults were at the top of the tree, above the nest. I went down the ravine to the nest tree to walk around beneath it to search for the second eaglet and the adults stayed in the tree top. I walked to the southeast side of the tree and looked up and saw the other eaglet hanging dead in the tree, below the nest about 10'.

The second eaglet, dead below the nest.

We reported the deaths to US Fish and Wildlife and CA Department of Fish and Wildlife, but never received any notification of any action taken.

A State Wildlife Health Lab biologist wrote to us later that:

"A bird's respiratory system is more sensitive to toxins, including smoke, than a mammal's respiratory system. This is because birds have a higher oxygen demand than mammals and a bird's lungs are 10 times more efficient at capturing oxygen. The rapid efficiency of gas exchange in bird lungs makes them more susceptible to inhaled toxic agents, including smoke. Inhaled toxins, such as smoke, can cause irritation and damage the respiratory system. It also can

compromise the immune system, making the bird more susceptible to infections. This is especially true in young birds in the nest that are unable to escape the smoke. Smoke inhalation toxicity in birds is caused by irritant gases (aldehydes, hydrogen chloride, and sulfur dioxide), particulate matter, and nonirritant gases (carbon monoxide, carbon dioxide, and hydrogen cyanide) released by combustion."

There was a burn done next to the Dales Station nest in 2020 also. I was called upon to rescue an eaglet who got out of the nest before he could fly that year. It was several days before the burn was done that year, so he was away from the nest when the burn occurred. His sister was still in the nest during the burn. I received a call from Dales Station, less than a mile from the nest, in August, 2020 about an eaglet who had been on the ground for 3 days, standing next to a shallow pool of Paynes Creek. My determination was that it was the female from the nest. She was open-mouthed breathing with a raspy noise. She died a few hours after she was caught and transported. The Wildlife Lab report said: "This was a juvenile female in poor nutritional condition with no fat reserves and minimal pectoral muscle development. Internally, there was evidence of an extensive infection. The visible infection resembled avian tuberculosis which is caused by the bacterium Mycobacterium avium. It's widespread in the environment in soil and dust and is usually an opportunistic infection. Depending on where the lesions are in the bird, gives an idea of how it entered the body. The lesions in this bird were primarily in the air sacs suggesting it was inhaled."

The male who had been in care was released in 2020. A first year eagle was seen back at the nest in 2021. Judging by his and the adults' behavior, it was the male who was in care away from the nest during the burn in 2020.

2020 bald eaglet being released. He was away from the nest in rehab care during Cal Fire's control burn in 2020, which probably saved his life.

I had occasion to contact Cal Fire in February 2022 about another issue. I had just been informed that the Dales Station bald eagle nest was occupied, so mentioned it in the hope of preventing another burn next to the nest. Cal Fire and its employees are public servants. It is their job to uphold state and federal laws, which include protection of wildlife, but the answer from a Cal Fire employee contained only dismissive, condescending remarks, clearly refusing to take steps to ensure any protections were implemented.

Many letters, calls, and emails have ensued since February (most unanswered). I made maps from Cal Fire's own fire database showing how rarely the area around the nest has burned. The ravine area there is extremely rocky and is grazed by cattle. And then there are the State and Federal laws that protect nesting birds. Still, Cal Fire will not commit to refrain from burning by the nest again this year.

Last week a biologist from a PG&E contractor company working in Greenville (a town that burned in the Dixie fire last year) called Raptor Rescue because they wanted us to take eggs from a nest in a tree they wanted to cut down. I explained the multitude of reasons that was a bad idea, along with it being illegal for them to do. The man said "We have an exemption". How many nesting birds are being destroyed in California due to these stupid, thoughtless exemptions and the complete lack of oversight which is occurring?

There have got to be protections enforced. Apparently that won't happen without widespread public outrage.

Here are some state employees to contact if you will help tell them there is a problem with their practices:

George Morris, Cal Fire Northern Region Unit Chief (530) 224-2445 (They would not give out his email address)

Dave Russell, Cal Fire Tehama/Glenn Unit Chief (530) 528-5199 dave.russell@fire.ca.gov

Tina Bartlett, Regional Manager CDFW, (530) 225-2300 tina.bartlett@wildlife.ca.gov

People often focus on individual species, but we believe every species is important, whether it is on a man-made list or not. Habitat fragmentation and loss have significant impacts on wildlife. Defiance Canyon Raptor Rescue works to rescue, rehabilitate, and return raptors to their wild lives, along with our work to protect watersheds and forests of California.

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Shining a light on MOOSE

Are these popular big game animals disappearing from parts of Montana? FWP research biologists search for better ways to track population trends while learning what causes the large, long-legged forest dwellers to die.

BY TOM DICKSON

Every year during his three decades as the area wildlife biologist in Thompson Falls, Bruce Sterling has faced a moose management dilemma. "On one hand, I wonder if I'm issuing more hunting licenses than the moose population can support," he says. "On the other, if the population can withstand a higher harvest and I don't issue enough licenses, I'm denying hunters the hunting opportunity of a lifetime."

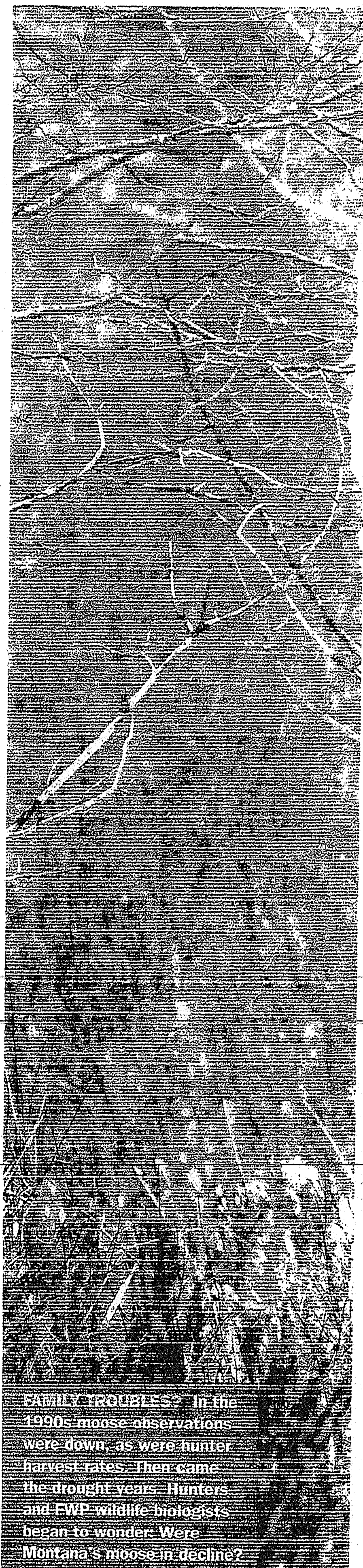
Sterling isn't alone. Across Montana's moose range, wildlife managers hampered by sparse data struggle to manage the large, charismatic game animals. Most frustrating is not knowing how moose populations are "trending," or increasing or decreasing in size. Without that data, biologists can't know with certainty to what extent they should increase or decrease hunting harvest from year to year, according to Justin Gude, head of FWP wildlife research. What's more, says Gude, "if they don't know which factors are driving populations, whether it's predators or habitat succession or something else, they have a tough time knowing how to respond when moose numbers start dropping."

MOOSE UNDER THE RADAR

For decades moose management in Montana ambled along much like moose themselves—slowly, quietly, and largely out of view. *Alces alces* is a popular animal. A sighting can be the highlight of a vacationer's summer, and hunters compete for scarce moose tags. Each year roughly 25,000 hunters apply for the 500 to 1,000 moose hunting licenses that FWP provides. Yet abundant elk and deer attract far more attention from hunters, wildlife watchers, and FWP biologists. In 2010, hunters shot 25,000 elk and 95,000 white-tailed and mule deer combined. The moose harvest was just 292.

Moose emerged into the spotlight in the mid-1990s, when hunters and landowners began reporting fewer of the animals in parts of western Montana. At the same time, hunter harvest success rates began declining, and successful hunters spent more days afield to kill their moose. Then came the drought and high temperatures of the 2000s.

Moose require cold, wet climates, making much of Montana too warm and dry for their survival. During the drought years, summer



FAMILY TROUBLES? In the 1990s moose observations were down, as were hunter harvest rates. Then came the drought years. Hunters and FWP wildlife biologists began to wonder: Were Montana's moose in decline?

SUMIO HARADA

and winter temperatures hit record highs while rain and snow were sparse. In another moose state, Minnesota, biologists had begun documenting moose population declines during the drought decade. It seemed logical the same would be true in Montana.

What's more, logging and wildfires had been curtailed. In previous decades those forest disruptions had opened large chunks of canopy to sunlight, boosting growth of the willow shrubs that moose eat in winter. Now those early succession forests were aging. To top it off, wolves, black bears, grizzly bears, and mountain lions were increasing across Montana's moose range. Adding up the anecdotal evidence, it appeared that moose might be in trouble. "The thing is, we didn't know for sure," says Gude. "And if populations were in fact declining, we didn't know why. We needed to find out."

Other moose states and provinces with similar concerns had begun searching for answers. In recent years Minnesota, Ontario, North Dakota, Wyoming, and Utah had evaluated the status and management of their moose populations and begun field research to learn more. Now it was Montana's turn.

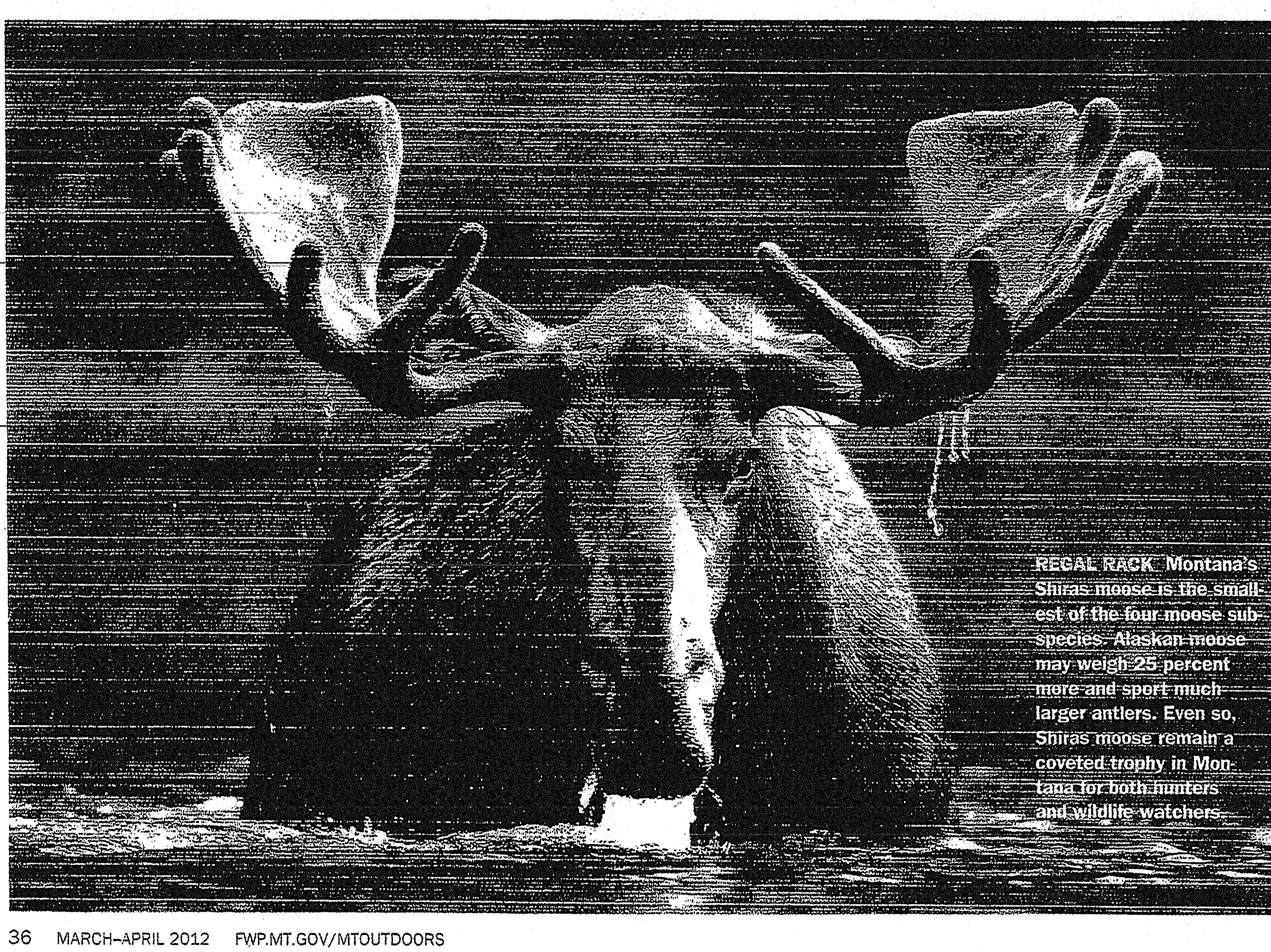
Tom Dickson is editor of Montana Outdoors.

CENTRAL CLEARINGHOUSE

FWP's first step was to consolidate the department's moose information. Because no FWP biologist was dedicated solely to moose, information was scattered among more than a dozen area offices. Data resided in typed reports, computer files, and even hand-written field books half a century old. To do the legwork, Gude hired Ty Smucker, a research associate at Montana State University's (MSU) Ecology Department. Smucker's job was to interview state and federal biologists in Montana's moose range and pore over survey information, harvest reports, and other data. The goal was to identify knowledge gaps hampering moose conservation and management.

Most biologists told Smucker that moose populations in their area appeared to be either stable or decreasing. Declines were particularly alarming in the Gallatin and Big Hole Valleys, historically moose strongholds. Smucker found some exceptions. Gary Olson, wildlife biologist in Conrad, reported seeing more moose along the Rocky Mountain Front in recent years than at any time during his 34 years working there. And Ryan Rauscher, wildlife biologist in Glasgow, was seeing growing numbers of moose in the state's northeastern region, likely migrants from Saskatchewan.

Statewide harvest data that Smucker compiled told a grimmer story. The number of FWP-issued moose permits statewide dropped 48 percent from 1995 to 2010, from 769 to 395. Success rates also dropped, from an average of 85 percent in the 1990s to less than 70 percent in 2009. And



REGAL RACK Montana's Shiras moose is the smallest of the four moose subspecies. Alaskan moose may weigh 25 percent more and sport much larger antlers. Even so, Shiras moose remain a coveted trophy in Montana for both hunters and wildlife watchers.

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MONTANA'S SHIRAS MOOSE

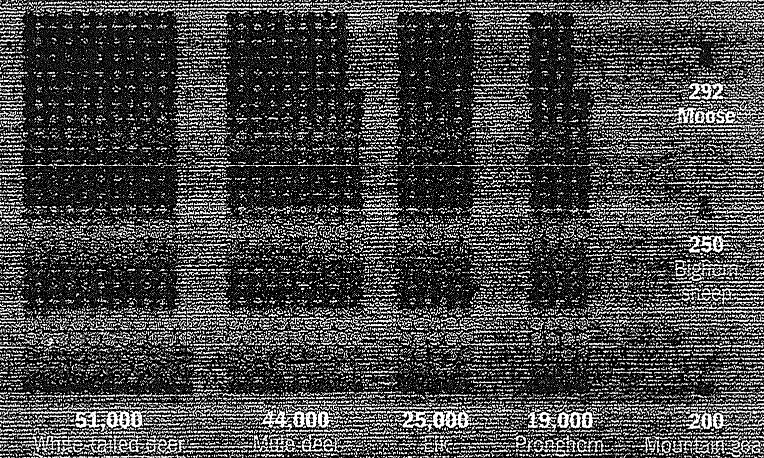
Though popular, moose comprise only a tiny portion of Montana's big game harvest each year. As a result, moose management for years took a backseat to elk and deer.

Over the past 25 years, moose hunters have been less successful even while putting in more effort.

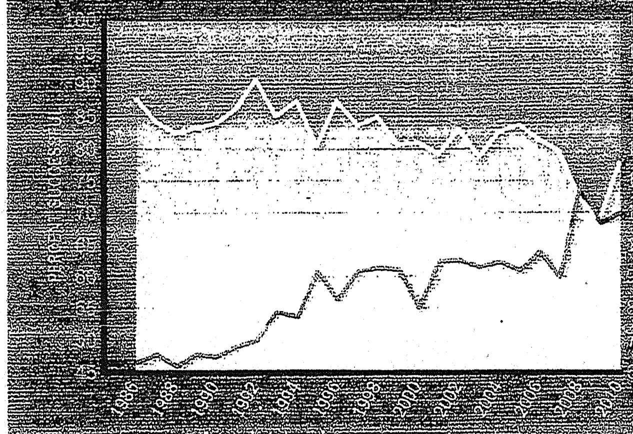
Though some moose hunting is available throughout much of Montana, almost all harvest is west of the Continental Divide.

Though moose harvest peaks and valleys over the past half-century are not uncommon, declines since the mid-1990s have worried biologists, hunters, and others who like to see the large, long-legged animals.

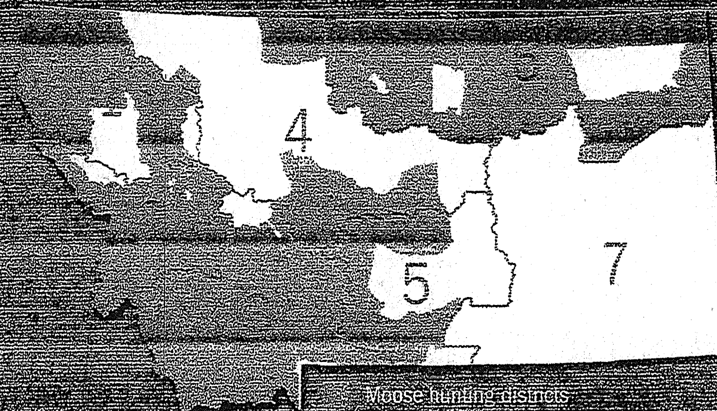
Montana big game hunter harvest, 2010



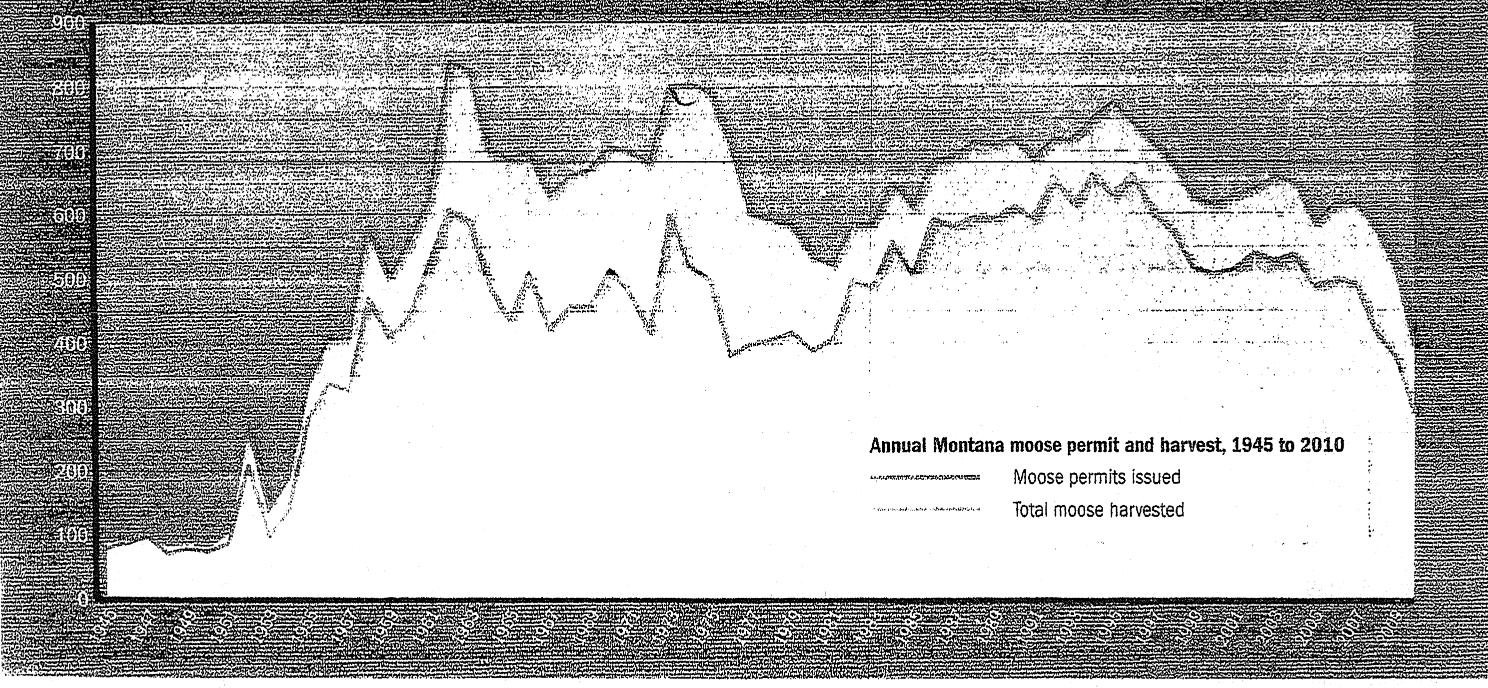
Moose success rate and hunter effort, 1986–2010



Moose permits by region, 2010



Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7
155 permits	45 permits	236 permits	13 permits	10 permits	2 permits	0 permits
33%	10%	51%	3%	2%	<1%	



successful hunters required more days to bag a moose than in previous years, from an average of 6.5 days in the late 1980s to about 10 in the first decade of the 2000s.

Whether these figures reflected a declining statewide population was open to debate. In most of the state's moose range, biologists say they can only guess at local population numbers and trends. "And when there's doubt, biologists have to be very conservative with the harvest quotas they set," says Gude.

For an animal that can weigh 1,000 pounds and stand 6 feet at the shoulder, a moose is surprisingly hard to spot, even from the air. Moose stay in thick timber, which is cooler in summer and warmer in winter and where their dark coats render them nearly invisible. Moose are best viewed from the air, during winter, but even then they emerge into open areas infrequently.

Smucker found that in most of Montana, biologists have done at least some aerial moose monitoring. Unfortunately, the results often have limited value for estimating population trends. The most consistent helicopter and airplane surveys occur in the Cabinet, Purcell, and Yaak areas in the northwest and the upper Big Hole Valley and Gravelly Complex (Ruby River and Centennial Valleys) in the southwest. "Most other survey work was spotty—done at widely varying times of year, or in small areas, or without information on snowpack or other factors that influence moose concentrations in winter," Smucker says.

After analyzing the findings, Smucker, Gude, and MSU ecology professor Bob Garrott concluded that in order for FWP to set harvest quotas with more confidence and respond to population declines, the agency needs two things: additional and more-reliable information on long-term moose population trends; and a better understanding of how predation, habitat, disease, parasites, and climate affect moose populations. An FWP research project starting this year is designed to provide that information.

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Total Montana moose harvest in 2010

FINDING BETTER WAYS

Ideally, each biologist in moose range could request a piloted helicopter at a moment's notice when viewing conditions are optimal. But aerial survey work is costly, time consuming, and hard to predict. A goal of the new study is to find less expensive ways of estimating population trends.

FWP biologists currently use hunter harvest information, gathered each fall at check stations and in winter from phone surveys. Yet no one is sure how the information corresponds to moose population trends. "Just because only 60 percent of moose hunters in a hunting district were successful doesn't necessarily mean there weren't many moose there," explains Vanna Boccadori, FWP wildlife biologist in Butte. "It could be that hunting conditions were particularly bad that year, or that trophy hunters were passing on smaller bulls."

The new study will compare harvest data over the past several decades to aerial surveys in portions of southwestern and northwestern Montana that have long-term survey data. Researchers will see if harvest success increases in years when biologists spotted more moose from the air during the previous winter. And, if so, are the two rates of increase similar? If the moose researchers can detect a strong statistical correlation, then biologists who don't do aerial surveys could make better use of hunter harvest data to estimate population trends.

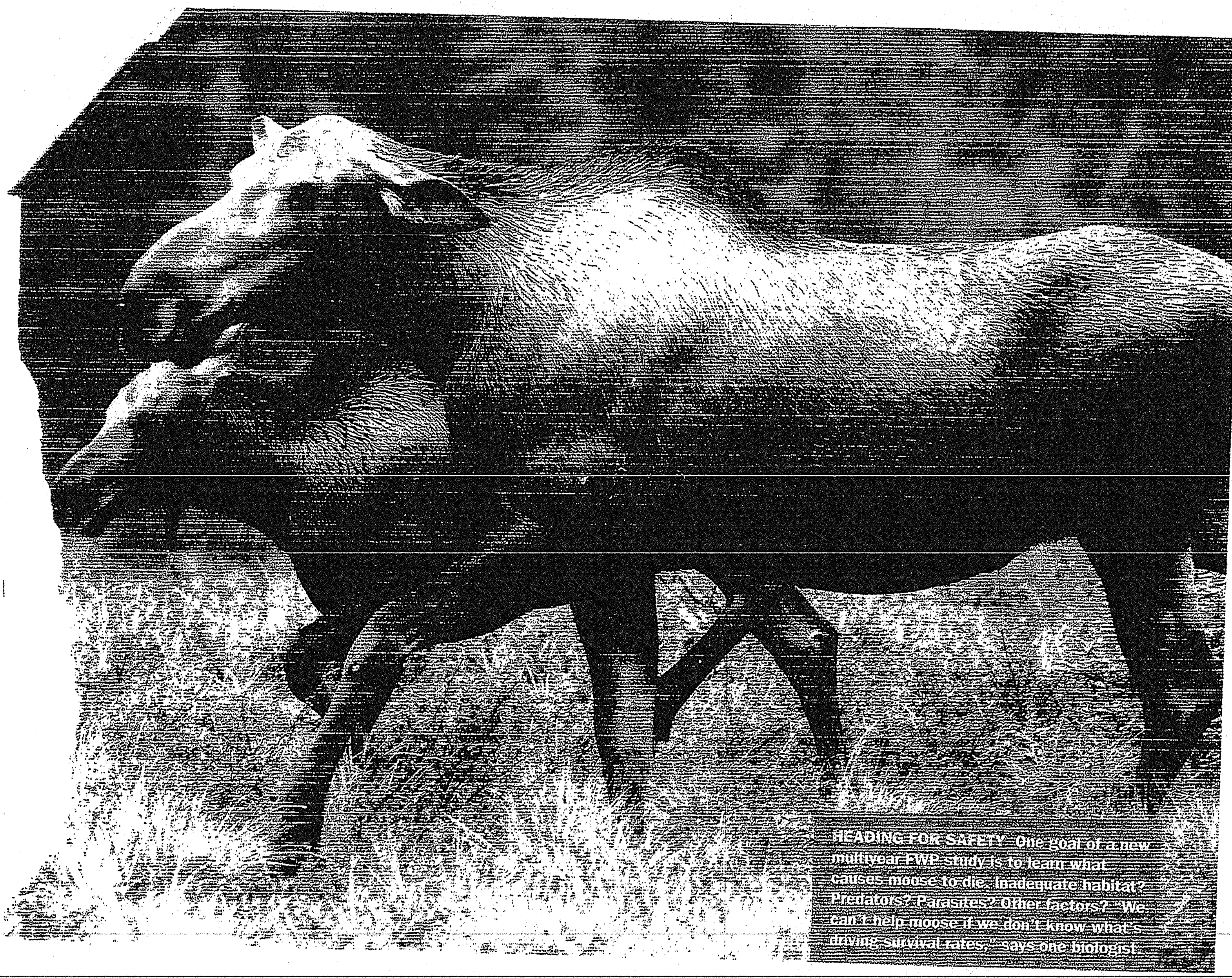
Another way to determine population trends may be to track observations of moose by elk and deer hunters. Researchers in the new study will compare hunter observations with aerial population surveys to see how well the two match up. "If there's a strong correlation, that could be real helpful, because with hunters you have a lot of accurate eyeballs out there," says Sterling, the Thompson Falls biologist.

Researchers will also examine how accurately aerial surveys reflect actual moose numbers on the ground in various habitat types. "When I'm flying, I assume I'm seeing at least the majority of the moose populatic down there," says Boccadori. "But I'm n certain, so we need to test that assumptio

Researchers will also look at the feasib ity of surveying moose in "trend areas" t could reflect larger populations. And th will determine if tracking survival rates moose cows and calves can provide insi into population trends. "The bottom line the monitoring portion of the study is to f ways for us to get accurate moose popula trend estimates without spending e money," says Gude.

The study's other half will look at fac driving moose survival. Over the next t years, FWP's new soon-to-be-hired m research biologist and other FWP staf capture and radio-collar 30 cow moo each of three study areas—the East Cab south of Libby, the Beaverhead Mounta the upper Big Hole, and the Rocky Mou

LINKING HARVEST TO POPULATIONS
Does an increase in hunter harvest indicate a growing moose population? FWP biologists aren't sure. A new study should help answer the question.



HEADING FOR SAFETY One goal of a new multiyear FWP study is to learn what causes moose to die. Inadequate habitat? Predators? Parasites? Other factors? "We can't help moose if we don't know what's driving survival rates," says one biologist.

Front from western Teton County northeast to the Sweet Grass Hills. They will then monitor the fate of those moose during the next seven years. "If we don't know what drives moose survival and recruitment [the percentage of young that survive one year], then we don't know how to respond if numbers are declining," says Gude. "Do we increase predator harvest? Work with landowners and federal agencies to improve moose habitat? Decrease hunter harvest? We can't do everything, and some things are much harder and more expensive than others. We need to know if they are worth doing."

Researchers' other goals for the ambitious ten-year study:

Learn how various habitats affect moose survival. Researchers will analyze fecal pellets to learn what plants moose are eating. To track the nutritional quality of those foods, they will use ultrasound equipment to measure body fat in captured moose and monitor the percentage of cow moose that give birth to twins.

Find out to what extent parasites such as brain worms (carried by white-tailed deer), arterial worms (carried by mule deer), liver flukes, and winter ticks are killing moose.

Examine how heat affects moose, which become stressed at temperatures above 23 degrees Fahrenheit in winter and 59 degrees in summer.

Learn if bears are killing a higher proportion of newborn moose along the Rocky Mountain Front and East Cabinets, where bear numbers are higher, than in the upper Big Hole.

Determine whether predation by wolves is higher in the East Cabinets, which consistently has a higher number of wolves than the other two study areas.

If researchers can secure additional funding, they will also try to determine the cause of moose calf mortality. In each of the three study areas, researchers will capture and radio-collar 30 newly born moose and track the animals over the following year to learn the cause of any deaths.

Gude says the research team will share their findings with biologists throughout the study period. "This entire project is driven by management needs," he says.

For Sterling, the information won't come a moment too soon. "Right now, I have very limited data on the number of moose out there," he says. "What we need is a better comfort factor when we're setting quotas. That's what we want, and that's what hunters want."

LEFT TO RIGHT: PAT MUNDAY; JOE MCDONALD

NRC Research Press

ARTICLE

Wolverines (*Gulo gulo luscus*) on the Rocky Mountain slopes: natural heterogeneity and landscape alteration as predictors of distribution

J.T. Fisher, S. Bradbury, B. Anholt, L. Nolan, L. Roy, J.P. Volpe, and M. Wheatley

2013

Abstract: A species' occurrence can be influenced by natural and anthropogenic factors; disentangling these is a precursor to understanding the mechanisms of distribution. Anthropogenic factors may be especially important at contracting range edges. We test this premise for wolverines (*Gulo gulo luscus* L., 1758) at the edge of their Rocky Mountain range in Alberta, Canada, a mosaic of natural heterogeneity and extensive landscape development. As wolverines have a suspected negative response to human activity, we hypothesized their occurrence on the Rockies' slopes is predicted by a combination of natural and anthropogenic features. We surveyed wolverines at 120 sites along a natural and anthropogenic gradient using hair trapping and noninvasive genetic tagging. We used abundance estimation, generalized linear, and hierarchical models to determine whether abundance and occurrence was best predicted by natural land cover, topography, footprint, or a combination. Wolverines were more abundant in rugged areas protected from anthropogenic development. Wolverines were less likely to occur at sites with oil and gas exploration, forest harvest, or burned areas, even after accounting for the effect of topography. The relative paucity of wolverines in human-impacted portions of this range edge suggests that effective conservation requires managing landscape development, and research on the proximal mechanisms behind this relationship.

Key words: range edge, wolverine, *Gulo gulo luscus*, occupancy models, abundance estimation, habitat fragmentation, landscape scale.

Résumé : La présence d'une espèce en un lieu donné peut être influencée par des facteurs naturels et humains; la compréhension des mécanismes de répartition commence entre autres par la clarification des rôles de ces facteurs. Les facteurs humains peuvent s'avérer particulièrement importants aux bordures d'aires de répartition en contraction. Nous vérifions cette hypothèse pour le carcajou (*Gulo gulo luscus* L., 1758) à la bordure de son aire de réparation dans les montagnes Rocheuses de l'Alberta (Canada), une mosaïque d'hétérogénéité naturelle et de secteurs aménagés. Comme il est soupçonné que le carcajou réagit négativement à l'activité humaine, nous avons postulé que sa présence sur les pentes des Rocheuses peut être prédite par une combinaison de caractéristiques naturelles et anthropiques. Nous avons étudié des carcajous en 120 sites le long d'un gradient naturel et anthropique en utilisant le prélèvement de poils à l'aide de pièges et le marquage génétique non invasif. Nous avons utilisé l'estimation de l'abondance et des modèles linéaires généralisés et hiérarchiques pour déterminer si le meilleur prédicteur de l'abondance et de la présence en un site était la couverture naturelle du sol, le relief, l'empreinte ou une combinaison de ces facteurs. Les carcajous étaient plus abondants dans les secteurs accidentés protégés de l'aménagement humain. Ils étaient moins susceptibles d'être présents dans des sites d'exploitation pétrolière et gazière et de coupe forestière ou dans des brûlis, et ce, même en tenant compte de l'effet du relief. La rareté relative des carcajous dans les portions de cette bordure d'aire de répartition touchées par des impacts d'origine humaine laisse croire que la conservation efficace nécessite la gestion de l'aménagement du paysage et de la recherche sur les mécanismes proximaux qui sous-tendent cette relation. [Traduit par la Rédaction]

Mots-clés : bordure d'aire de répartition, carcajou, *Gulo gulo luscus*, modèles d'occupation, estimation de l'abondance, fragmentation de l'habitat, échelle du paysage.

Introduction

Habitat loss, fragmentation, and alteration are a primary cause of many species' declines, and remain a pervasive anthropogenic phenomenon affecting ecological systems (Fahrig 1997, 2003). Determining the correlates of a species' spatial distribution across heterogeneous (and fragmented) landscapes is a key precursor to elucidating the ecological processes creating those patterns (e.g., Wiens et al. 1993). In particular, disentangling natural from anthropogenic correlates of distribution is a necessary requirement for effective conservation and management, and is often demanded when species conservation potentially conflicts with economically important landscape development. This task is further complicated because pattern and process can change markedly among landscapes as ecological and spatial contexts change, potentially preventing reliable inference from other landscapes (Fisher et al. 2005; Wheatley and Johnson 2009); this may be particularly true of circumboreal species distributed over highly varied landscapes, such as wolverines (*Gulo gulo* L., 1758).

Wolverines once inhabited boreal, tundra, and mountain habitats across North America and Eurasia (Pasitschniak-Arts and Larivière 1995) but their range has contracted, and populations declined,

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J.T. Fisher. Ecosystem Management Unit, Alberta Innovates – Technology Futures, Vegreville, AB T9C 1T4, Canada; School of Environmental Studies, University of Victoria, Victoria, BC V8W 3R4, Canada; Department of Biology, University of Victoria, Victoria, BC V8W 3N5, Canada.
S. Bradbury. Fish and Wildlife Division, Alberta Environment and Sustainable Resource Development, Edson, AB T7E 1T2, Canada.
B. Anholt. Department of Biology, University of Victoria, Victoria, BC V8W 3N5, Canada; Bamfield Marine Sciences Centre, Bamfield, BC V0R 1B0, Canada.
L. Nolan and L. Roy. Ecosystem Management Unit, Alberta Innovates – Technology Futures, Vegreville, AB T9C 1T4, Canada.
J.P. Volpe. School of Environmental Studies, University of Victoria, Victoria, BC V8W 3R4, Canada.
M. Wheatley. Provincial Parks Division, Government of Alberta, Hinton, AB T7V 2E6, Canada.
Corresponding author: J.T. Fisher (e-mail: Jason.Fisher@albertainnovates.ca).

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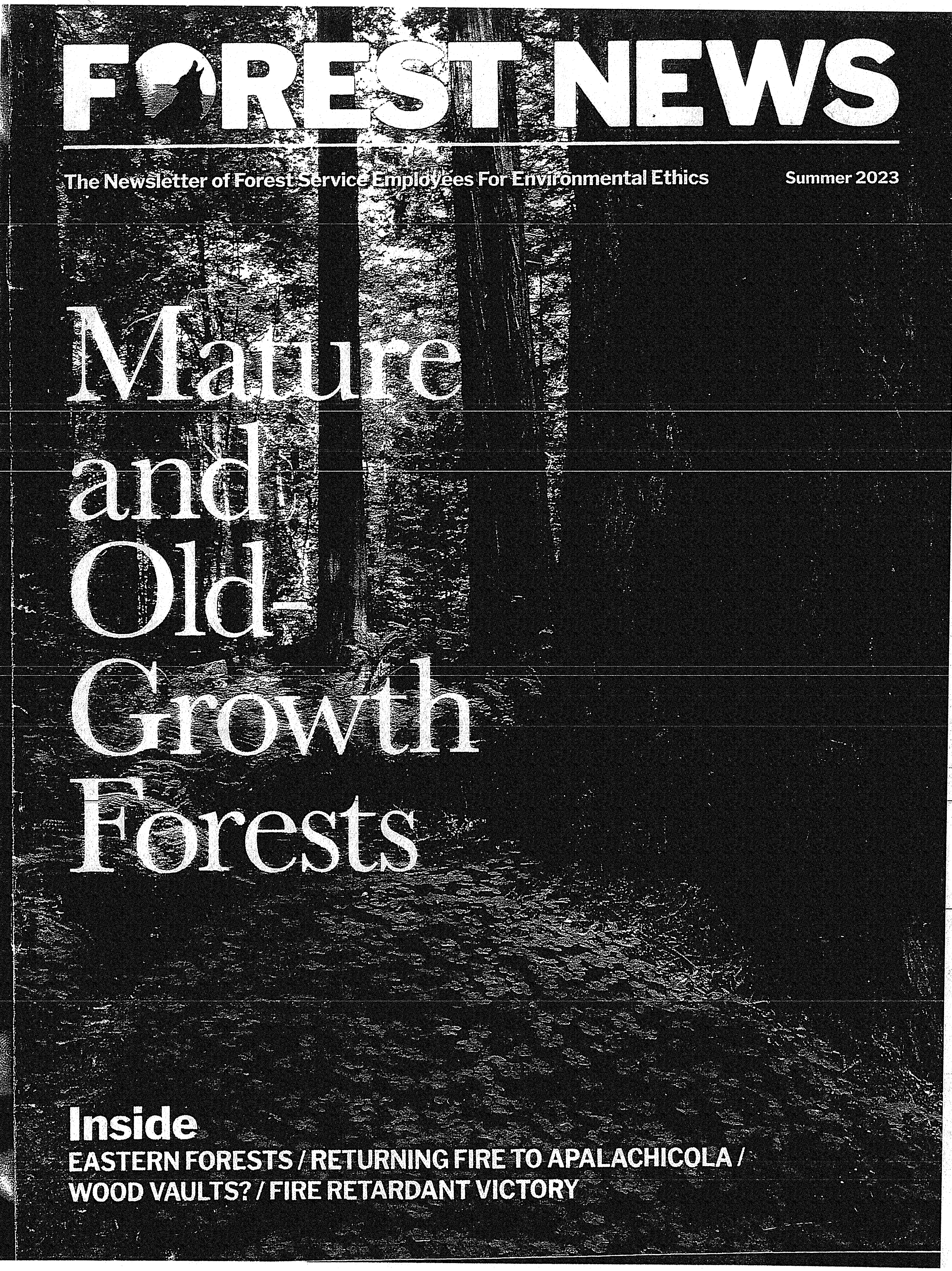

FOREST NEWS

The Newsletter of Forest Service Employees For Environmental Ethics Summer 2023

Mature and Old-Growth Forests

Inside

EASTERN FORESTS / RETURNING FIRE TO APALACHICOLA / WOOD VAULTS? / FIRE RETARDANT VICTORY

In Depth

Mature and Old-Growth Forest Inventory

The first national inventory of old-growth and mature forests on federal lands was completed this spring in response to Executive Order 14072, issued by President Joseph Biden on Earth Day 2022. The forest inventory report estimates that public lands managed by the Forest Service and the BLM are home to more than 178 million acres of forest, including more than 32 million acres of old-growth forests (18%) and about 80 million acres of mature forests (45%). Forest Service lands account for 24.4 million acres of old-growth forest and 67.4 million acres of mature forest, according to the report. While the forest inventory represents a needed starting point, a close reading of the report provides little motivation for breaking out the champagne.

The forest inventory is based on information compiled by the Forest Service's Forest Inventory and Analysis (FIA) program, which began in 1930 and defines forest land as "currently or recently having at least 10 percent canopy cover and at least 1 acre in size." As the federal forest inventory was being prepared, two other studies of mature and old-growth forests were published, as noted by the federal report: "The Federal estimate is larger than DellaSala et al. (2022) and Barnett et al. (2023) when compared at equivalent scale [excluding Alaska] ... more than 104 million acres as compared to 53 million acres and 59 million acres respectively." The federal report attributes these differences to "differing goals and methodologies."

How the methodologies differ is unclear as the methodology used to define mature forests for the federal inventory is not revealed in the report. To define old-growth forests, "the agencies decided in late fall to apply existing structural old-growth definitions as currently maintained by each Forest Service region. These definitions "were first developed in the early 1990s," a time when court decisions and endangered species listings made the agencies wary of classifying forests as old growth for fear that they would be prevented from selling the timber. Additionally, the federal inventory report states that the estimates of mature and old-growth forest acreage are subject to a "68 percent confidence interval" — i.e., the numbers have a 32% chance of being wrong.

In introducing the forest inventory findings, the report states, "The initial inventory and definitions for old-growth and mature forests are part of an overarching climate-

Old-growth ponderosa pine forest in Deschutes National Forest (Forest Service photo).

informed strategy to enhance carbon sequestration and address climate-related impacts, including insects, disease, wildfire risk, and drought." The report concludes by reiterating these points — i.e., the "next steps" called for in Biden's executive order. In a statement announcing the release of the inventory report, Department of Agriculture Undersecretary Homer Wilkes repeated these talking points: "Our forest ecosystems and communities are struggling to keep up with the stresses of climate change, whether it's fire, drought, or insect infestations, it is clear that we must adapt quickly."

While highlighting the risks from these natural forces, neither government officials nor the report itself mentions logging as a threat to mature and old-growth forests. In fact, the motif established by Biden's executive order, woven into the inventory report, and reiterated by officials like Wilkes, sets the stage for accelerated logging activity greenwashed as "wildfire mitigation" to enhance "forest resilience."

Comments from timber industry representatives go further, suggesting that the forest inventory was a waste of time as they push to hasten logging for fire mitigation, which received a massive infusion of cash through the Infrastructure Investment and Jobs Act and the Bipartisan Infrastructure Law. The Federal Forest Resource Coalition represents companies that harvest timber on federal land. The industry coalition's executive director, Bill Imbergamo, commented on the report: "The Forest Service's most recent science shows that fire, insects and other factors are leading to large-scale losses in mature forests, not timber harvest.... We hope the Forest Service can get back to implementing the billions of dollars Congress provided to protect our forests from fires, bugs, and disease using proven management techniques, like forest thinning and the creation of fuel breaks."

Table 1.—National total area (acres) of mature and old-growth forest land[a] on Forest Service and BLM lands, shown by Congressionally designated land use allocations. "Other" category includes all remaining land use allocations.

Agency & Land Use Allocation	Younger Forest *acres*	Younger Forest *SE%[b]*	Old Growth *acres*	Old Growth *SE%[b]*	Mature *acres*	Mature *SE%[b]*	Total Forest Land *acres*
Forest Service	**52,505,613**	**1**	**24,400,019**	**1**	**67,413,361**	**1**	**144,318,993**
Wilderness[c]	9,937,704	2	4,194,748	3	9,335,433	2	23,467,885
Inventoried Roadless Area	12,094,84	2	9,116,931	2	16,076,595	2	37,288,373
National Monument	243,552	15	88,470	26	212,917	15	544,938
Other	30,229,50	1	10,999,871	2	41,788,417	1	83,017,797
BLM	**13,212,751**	**2**	**8,258,370**	**3**	**12,698,776**	**2**	**34,169,897**
Wilderness	589,153	10	494,901	11	495,233	11	1,579,287
Wilderness Study Area	1,111,718	7	1,231,592	7	982,506	8	3,325,816
National Conservation Lands[c]	575,959	10	837,732	8	727,802	9	2,141,492
Other	10,935,92	2	5,694,145	4	10,493,235	3	27,123,302
Total BLM & Forest Service	**65,718,364**	**1**	**32,658,390**	**1**	**80,112,137**	**1**	**178,488,890**

[a] Forest land includes areas meeting the FIA forest land definition, https://www.fia.fs.usda.gov/. Sample area excludes 3.4 million acres of forested land managed by the Forest Service and 27.5 million acres of potentially forested land managed by the BLM in Alaska; permanent field plot monumentation is prohibited in Alaska. Forest Service wilderness areas and Interior Alaska have not yet been inventoried by FIA but are in progress for inclusion in future inventories.

[b] SE% is percent sampling error. Estimate plus and minus one sampling error gives a 68 percent confidence interval.

[c] Forest Service Wilderness includes both Wilderness and Wilderness Study Areas. National Conservation Lands include National Monument, National Conservation Area, and other similar designations, collectively referred to as NM/NCAs.

Table from* Mature and Old-Growth Forests*, the federal forest inventory report, showing estimated acreage of mature and old-growth forest on federal lands.

A growing body of scientific research refutes Imbergamo's statement, and he goes on to make demonstrably false statements: "On many National Forests, particularly those east of the Mississippi River, we have millions of acres of older forest that are not producing quality wildlife habitat, sequestering carbon, or providing support for local forest-based economies."

In conjunction with the forest inventory report, the Forest Service issued an advance notice of the proposed rule for managing mature and old-growth forests. Published in the *Federal Register*, the notice makes clear the timber industry's vested interest in thinning forests and creating fuel breaks: "Harvests designed to improve stand health and resilience by reducing forest density or removing trees damaged by insect or disease make up 86 percent of [commercially harvested] acres ... within the National Forest System."

Andy Kerr has provided a brief overview of all three recent inventories of mature and old-growth forests in which he observes, "The Forest Service and the BLM have never wanted to know just how much mature and old-growth (MOG) forest they have. They have rightfully feared that to map the MOG will lead to protection of the MOG from logging.

"Back in the day, when old growth first hit the spotted owl fan, the agencies assured the public that there was no shortage of old growth. However, when pressed to define and count its old growth, the Forest Service steadfastly refused to count and narrowly defined old-growth Douglas-fir as only the most cathedral-like stands ... leaving out the vast majority of old-growth forests."

Now, armed with Biden's executive order and flush with billions in funding for wildfire-mitigation logging, the agency has changed its tune.

1988.
ODFW Nongame
Rept 87-3-02.

HABITAT USE BY THREE-TOED AND BLACK-BACKED WOODPECKERS, DESCHUTES NATIONAL FOREST, OREGON

by

Rebecca Goggans, Rita D. Dixon, and L. Claire Seminara

Nongame Project Number 87-3-02

Oregon Department of Fish and Wildlife

U.S.D.A. Deschutes National Forest

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ABSTRACT

Patterns of habitat use for home ranges, foraging, nesting, and roosting, were described for three-toed (Picoides tridactylus) and black-backed (Picoides arcticus) woodpeckers on the Deschutes National Forest, Oregon, during April-September, 1986 and 1987. A severe mountain pine beetle epidemic had created an abundance of dead and dying trees, and an agressive pest management and timber salvage program had created a patchwork of logged areas, primarily shelterwood cuts, on the study area.

All nests excavated by three-toed and black-backed woodpeckers were in portions of lodgepole pine (Pinus contorta) trees with heartrot. Evidently, both species require soft wood for excavating cavities, because of morphological adaptations associated with 3 toes on each foot. Habitat selection for mature and overmature forest stands, and against younger stands and logged areas, was documented for three-toed woodpeckers using 16 nests, 493 forage bouts, and 16 roosts, and for black-backed woodpeckers using 35 nests, 395 forage bouts, and 20 roosts. Home range sizes for 3 radio-tagged three-toed woodpeckers were 751, 351, and 131 acres (n=170, 352, and 131 locations, respectively). Home range sizes for 3 radio-tagged black-backed woodpeckers were 810, 303, and 178 acres (n= 124, 86 and 112 locations, respectively). Intra-specific home range overlap among both species appeared limited or nonexistent, except among paired individuals near the nest site. Inter-specific home range overlap was common between three-toed and black-backed woodpeckers and other Picidae.

Guidelines for management included establishing Management Areas which retain the characteristics of mature and overmature lodgepole pine or lodgepole pine-mixed conifer forest stands. Recommended sizes of Management Areas were 528 acres per pair of three-toed woodpeckers, at a minimum elevation of 4500 ft, and 956 acres per pair of black-backed woodpeckers, with some Areas at elevations less than 4500 ft. One Management Area could be designated for both species, if the respective habitat needs were met.

SUMMARY

INTRODUCTION

Three-toed and black-backed woodpeckers are two of the least known species of woodpeckers in North America. They are sympatric over most of their North American range and both are nonmigratory residents on the east slope of the Cascade Mountain Range. The woodpeckers are associated with trees characterized by scaly or flaky bark, but differ in the species of trees with which they are associated; the three-toed woodpecker is more closely associated with spruce (Picea spp.), and the roosts were on the lower study area where only lodgepole pine forest type was available. Mean canopy closure at roost sites was 40%. Mean dbh of trees in the roost stand was 6.0 in. Mean basal area of roost stands was 115 ft^2/acre. Lodgepole pine trees were used for 14 roosts. Mean dbh of roost trees was 11.0 in. Mean tree height was 65 ft.

MANAGEMENT IMPLICATIONS

Mature and overmature forest stands have a high incidence of disease, decay and mortality. Trees with disease and decay are undesirable components of a managed forest, but were used by three-toed and black-backed woodpeckers for home range, nesting, roosting, and foraging habitat. Nests were excavated in trees with heartrot, roosts were in diseased portions of trees or decayed snags, and forage sites were in mature and overmature stands, which have abundant disease and decay, and consequently abundant wood-boring insects. Conversion to and maintenance of lodgepole pine and lodgepole pine-dominated mixed conifer stands in a young, vigorous condition may eliminate or severely restrict incidence of wood-boring insects and heartrot, leading to declines in populations of three-toed and black-backed woodpecker.

Acreage of mature and overmature lodgepole pine forest stands are declining throughout the Oregon Cascades, because these stands are the prime target of the mountain pine beetle. Stands which experience high mortality nonetheless provide habitat for three-toed and black-backed woodpeckers. Individual trees within a stand may remain standing 10, 15 or 20 years, thus providing a continuum of habitat. Treating these stands, by logging, immediately converts them to a vigorous condition where incidence of death and decay is severely restricted, thus potential nesting and foraging substrate is drastically reduced. Although in time, stands without treatment may be structurally similar to treated stands, the time to reach that condition differs significantly. Because stands without treatment continue to provide habitat over a longer time than treated stands, thus there is a shorter period when old growth lodgepole pine is absent or scarce on the Deschutes or other National Forests. Consequently, a larger population of woodpeckers may survive, thereby increasing the potential for maintening viable populations of both species.

Designation of the three-toed woodpecker as an Indicator Species for mature and old growth lodgepole pine appeared appropriate, but only at elevations greater than 4500 ft. Much of the pure lodgepole pine on the east slope of the Cascade Mountain Range in Oregon occurs at elevations less than 4500 ft. We recommended the black-backed woodpecker as an Indicator Species for mature and old growth lodgepole pine, instead of the three-toed woodpecker. Unlike the three-toed woodpecker, the black-backed woodpecker used a range of elevations coincident with lodgepole pine. Futher, it responded to play-back recordings more frequently, over a longer time period, and with louder vocalizations than the three-toed woodpecker, thus may be more effectively monitored than the three-toed woodpecker.

Until more information is available, we believe the most effective method of insuring habitat for three-toed and black-backed woodpeckers is to exempt areas (i.e. Woodpecker Management Areas) from commercial or salvage timber management and place these areas under a special management strategy, which retains the characteristics of mature or overmature lodgepole pine habitat as long as possible, without treatment. Woodpecker Management Areas should be in lodgepole pine or lodgepole pine-dominated stands with the greatest probability of surviving the longest time, but if these stands no longer retain the characteristics of mature and overmature stands, or if the number of trees remaining is inadequate to support a pair of woodpeckers, then the designated Woodpecker Management Area should be relocated to a selected replacement. Replacement stands should be selected now, to provide the earliest possible replacement for declining Woodpecker Management Areas. Woodpecker Management Areas, and replacement areas, may be within areas previously designated as protected, such as old-growth areas, Spotted Owl Habitat Areas, winter recreation sites, Research Natural Areas, etc. Management Areas for each pair of three-toed woodpeckers should be 528 acres of lodgepole pine or mixed conifer forest in mature and overmature condition and at an elevation of 4500 ft or higher. Management Areas for each pair of black-backed woodpeckers should be 956 acres of lodgepole pine or lodgepole pine-dominated mixed conifer forest in mature and overmature condition. One Management Area of 956 acres, at an elevation of

4500 ft or higher, could be designated for 1 pair of both species. However, Management Areas for black-backed woodpeckers should not be restricted to elevations greater than 4500 ft because this species may be better adapted to conditions at lower elevations.

Black-backed woodpeckers are not currently assigned a special status (e.g. Indicator Species), thus designation of Woodpecker Management Areas may not be practical at this time. An alternative management strategy can be applied on a sale-by-sale basis. On each sale, habitat can be preserved for each pair of black-backed woodpeckers by removing 956 acres of inter-connected blocks of mature/overmature habitat from harvest. For example, if a sale area is 9500 acres of mature or overmature lodgepole pine-dominated habitat, management at 60% of potential would be for 6 pairs, or 6 areas of 950 acres each. The traditional approach for management of cavity-nesters at 60% of potential by retaining 60% of the snags and live replacement tree may be ineffective for black-backed and three-toed woodpeckers for two reasons. One - snags provide more than nesting habitat; snag retention at the 60% level is unlikely to occur in sufficient amounts to provide adequate feeding substrate for species dependent on wood-boring insects associated with trees with flaky/scaly bark. Two - this approach addresses a singular, albeit a key, component of the species' habitat. The interrelationships of an old growth, or mature/overmature ecosystem, and the species associated with it, are little known, but likely complex. Land managers do not, at this time, have the information necessary to manipulate habitat and insure these interrelationships will be maintained.

No harvest

2650

5700

5700

The figures for home range sizes and the amount of mature or overmature stands used by woodpeckers were estimated under conditions of abundant food supply. As the mountain pine beetle epidemic runs its course, and prey abundance declines, it is likely that the amount of area required to support a pair of three-toed or black-backed woodpecker will increase.

Three-toed and black-backed woodpeckers should be monitored to track changes in population levels as the mountain pine beetle epidemic runs its course and as the forest becomes increasingly managed, resulting in reduced levels of disease and decay. Survey routes to document number of woodpecker responses

EVIDENCE OF SNOW-PLUNGING BY BOREAL AND BARRED OWLS

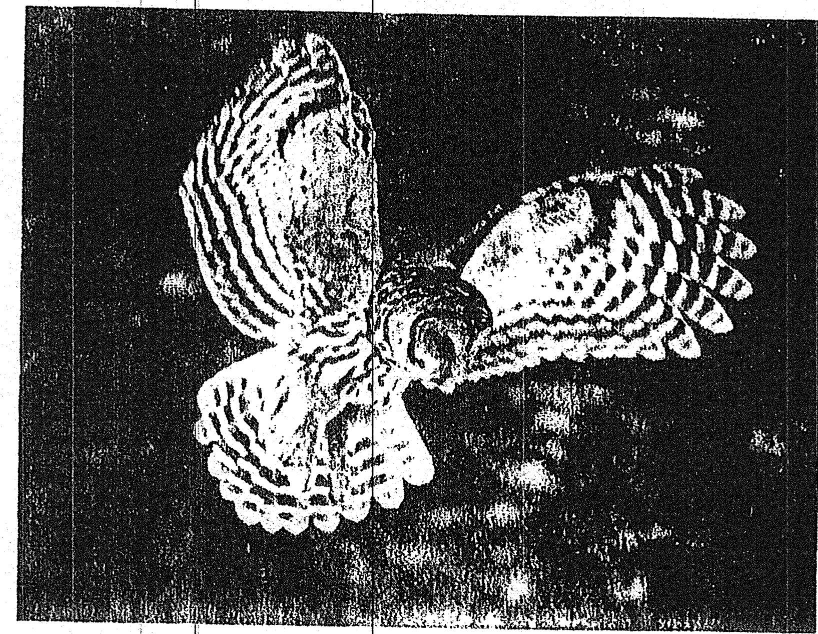
ROBERT W. NERO, Box 14, 1495 St. James Street, Winnipeg, Manitoba, R3H 0W9

In 1978, Curry-Lindahl, in his foreward to a major reference on technical publications about owls, noted that "...many species of owls rely not only on a sensitive vision, but, if necessary, to a considerable extent also on remarkable auditory powers when hunting rodents and shrews during the winter when these mammals often move under the snow cover. At least the tawny owl, Short-eared Owl (*Asio flammeus*) and Long-eared Owl (*A. otus*) are able to localize from the air, invisible small mammals and to catch them 'blindly' on the right spot below the snow surface. Probably also other species of owls use this technique; I am almost certain that the Boreal (Tengmalm's) owl (*Aegolius funereus*) does it."[2]

Snow-plunging as a method of obtaining prey under deep snow conditions is so common a characteristic of the Great Gray Owl that plunge-marks can be used to prove the presence of this species.[1,5,6] Norberg, in a review of feeding behaviour of northern forest owls, pointed out that the large size of the Great Gray Owl's head and face "improves its probabilities of auditory detection of concealed prey and enhances localization accuracy. The asymmetry of the external ears improves sound localization.... Its large weight enables it to make deep plunge-holes in the snow and to catch prey deep below the snow surface where lighter owls could not possibly get at the prey."[6] Norberg cites one report of a Great Gray Owl that plunged through a snow crust hard enough to bear an 80-kg man.[6]

Typically, a perching or hovering owl — and the broad wings of the Great Gray owl suit it admirably for hovering or gliding slowly — locates prey by sound, then drops head downward and forcibly into the snow, breaking its fall with its wings and reaching deep with its long legs for its prey. Mikkola writes: "As it dives downward its head is suddenly directed towards its prey and it almost seems that the head hits the surface of the snow first. However, both Eero Kemila [whose photo beautifully illustrates this behaviour] and Leinonen ... believe that in the instant before hitting the snow the owl will draw back its head, extend its legs and stretch its feet forwards with the talons fully spread. However, the high speed of the dive renders it impossible to prove precisely what does happen by direct observation."[4] Not all plunge-marks made by Great Gray Owls are of the same size; in some cases, birds drop only their feet into the snow, barely touching with their body. At times there may not even be any mark left by the wings. Small mammals feeding or tunnelling at or near the surface of the snow — and this is not uncommon — may be taken by a shallow pounce, rather than by a full-out dive. Thus interpretation of plunge-marks requires some caution.

Brief mention has been made of an observation by Richard Knapton of snow-plunging by a Boreal Owl.[5] Because of the apparent scarcity of this behaviour in this species, Knapton's note is presented here in detail for the first time. The following is from a letter he sent to Soren Bondrup-Nielsen on 25 January 1979: "A Boreal Owl has been seen in the Assiniboine 'Forest' here in Winnipeg for the past two days; today (25 January) I observed the bird for about 35 minutes at noon while it was hunting along ski trails and in open spots in the wood. On one occasion the bird plunged into the snow from a perch about 2 metres up in an aspen; the plunging behaviour seemed similar to that of the Great Gray Owls — that is, the bird finished its plunge into the snow with its wings open and resting on the surface of the snow (primaries were traced on the snow). The plunge hole was about 10 cm deep (estimated, not measured) and the shape resembled those of Great Grays — large body indentation with 'bulges' on the side presumably caused by wings. It evidently failed to capture prey, as it flew onto a nearby perch with nothing in its talons. It continued hunting by flying distances up to 30 metres, perching and looking intently at the ground for up to 2 minutes, then off to another perch, and so on. The day was cloudy, totally overcast, hence the bird's activity at midday" (pers. corres., 26 October 1987, R. W. Knapton).



Snow-plunging Barred Owl. *James R. Duncan*

As Norberg indicated, the Boreal Owl may be too light in weight to successfully snow-plunge. Unless the snow is especially soft, it probably couldn't go deep and, moreover, its legs are relatively short compared to those of the Great Gray Owl. The Barred Owl, in the same genus as the Great Gray Owl, and considerably heavier than the little Boreal Owl, conceivably could snow-plunge. Yet this behaviour is apparently uncommon in this species. Mark Elderkin, who studied Barred

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