# Habitat Estimates For Maintaining Viable Populations of the Northern Goshawk, Black-backed Woodpecker, Flammulated Owl, Pileated Woodpecker, American Marten, and Fisher

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## Habitat Estimates for Maintaining Viable Populations

*Ecosystem Thresholds*

Estimating a habitat threshold for maintaining viable populations is difficult and requires separating the effects of habitat loss and habitat fragmentation (Fahrig 1997). A review by Fahrig (2003) of recent habitat fragmentation studies (n = 100) suggests habitat loss and not habitat fragmentation has consistently negative effects on species persistence. Over half of studies reviewed by Fahrig suggest a positive response of populations to habitat fragmentation (Fahrig 2003: 505) and independent of whether species are habitat "specialists" or "generalists."

Two recent model-based estimates suggest a "threshold" effect on species persistence is reached when approximately 20-30% (Fahrig 1997, Flather and Bever 2003) of the habitat remains on the landscape. Empirical evidence to support any threshold concept is limited (Jansson and Angelstam 1999); few studies control for the separate effects of habitat loss and habitat fragmentation (Fahrig 2003). Clearly, "due to the complexities involved, the predictive capacity of ecology is limited and large uncertainties still remain" relative to ecological thresholds (Muradian 2001: 7). Nevertheless, these model-based estimates (20-30%) do exceed an earlier 10% minimum ecosystem threshold recommended by the International Union for Conservation of Nature and Natural Resources (IUCN 1980) and others to maintain native species.

In 1999, a coalition of national conservation organizations lead by T. H. Ricklетts, World Wildlife Fund, evaluated and ranked the conservation status of each Ecological Province in North America (Ricklетts et al. 1999). In the Northern Region, remnant central tall grass prairie in North Dakota was considered to be Globally Outstanding and Critical—the highest rating. Montane valley grassland, northern mixed prairie and shortgrass prairie were considered to be Nationally Important and Vulnerable—a very significant rating. Northern Rocky Mountain forests were of Bioregional Importance and Vulnerable—a relatively low conservation rating.

Today, in the Northern Region, more forest exists than at the time since European settlement. Gallant et al. (2003: 385) in the Greater Yellowstone Ecosystem found " the primary forest dynamic in the study area is not the fragmentation of conifer forest by logging, but the transition from a fire-driven mosaic of grassland, shrub land, broadleaf forest, and mixed forest communities to a conifer-dominated landscape." Area of conifer-dominated landscapes increased from 15% of the study area in the mid 1850's to

50% in the mid 1950's. In addition, "substantial acreage previously occupied by a variety of age classes has given way to extensive tracks of mature forest" in the Greater Yellowstone Ecosystem.

On June 5 1805, in west-central Montana, Lewis observed their first sage grouse, suggesting that much of the pre-European landscape in the eastern part of Montana was grassland and not shrubland (Zwickel and Schroeder 2003). In southwest Montana, Lesica and Cooper (1992) suggested a large and irreversible conversion of grassland to shrubland occurred in the 1850s and 1860s as a result of intensive grazing by introduced domestic livestock (sheep and cattle). Both eastern and southwestern Montana appear to have experienced recent and European-induced irreversible ecosystem changes, from grassland to shrub/tree dominated landscapes.

In the Interior Columbia Basin, "Grassland conversion to agriculture excluded fires because many historical surface fires in dry forests actually began on grassy benches, ridge tops, or valley bottoms adjacent to dry forests and woodlands, or in nearby shrub steppe communities, and then migrated into dry forests" (Hessburg et al. 2005: 120). Importantly, "The most widely distributed change in forest structure across the Interior Columbia Basin was sharply increased area and connectivity of intermediate (not new or old) forest structures" (Hessburg and Agee 2003: 44).

Extension of conifers into grassland and other open habitat throughout the Rocky Mountains due to fire suppression is well documented (e.g., Gruell 1983). For example, in northern Montana, Habeck (1994:69), using General Land Office Records, found with the reduced frequency and influence of fire Douglas-fir "has made major gains in stand dominance over ponderosa pine and western larch, especially on north aspects: on south aspects, former savanna and grassland communities have experienced conifer invasions" (see also Arno and Gruell 1986).

Overall, substantial evidence exists for increases in forest area in the Northern Rocky Mountains versus any forested area approaching the minimum 20-30% habitat threshold when effects of habitat fragmentation, specifically patch size and patch isolation, are predicted to have an influence on species population persistence.

*Species Thresholds*

An alternate approach to the 20-30% threshold of historic habitat is to estimate the amount of habitat required to maintain a viable population for a species.

At the scale of forestry operations, a consistent and quantitative approach to identify species susceptible to change in amount and quality of their habitat is to construct a decision tree. Working in a managed southern Canadian boreal forest, Hannon et al. (2004) have constructed a six-step decision tree to identify species susceptible to changes in their habitat due to forestry operations. Their six-step decision tree approach was to filter species data using five factors: species abundance, distribution, habitat specificity, temporal variability and detectability; in order to identify priority species and conservation needs.

In the following description of Hannon et al.'s (2004) six step decision tree, the decision criteria to move a species from step to step is in parentheses and the deciding criteria to move a species to a subsequent evaluation criteria is in italics.

> Step 1: Relative abundance (high versus *low*). Criteria exist to evaluate relative abundance: surveys, trend information, and in particular, body size. Relative abundances are often negatively correlated with body mass (Holling 1992) and territory size (Dobson et al. 1995); and, therefore, relative abundances should be correlated to body size.
>
> Step 2: Geographic distribution and remove peripheral species (peripheral/transient versus *core*). Conservation of species should focus on the core of their respective distributions (Rodriguez 2001). Populations near the periphery of their respective distributions are expected to "wink" in and out in terms of presence and persistence (Brown 1995).
>
> Step 3: Remove species that are rare in commercial forests and whose primary habitat is in non-commercial forest habitats (non-commercial versus *commercial forest*). Species may occur in low densities in marginal habitat in comparison to preferred habitats. Moreover, species found in a variety of habitats are unlikely to be habitat specialists, and, therefore, are not as vulnerable to local extinction (Hannon et al. 2004).
>
> Step 4. Identify species that are rare in some years but abundant in others (rare, short-term versus *rare, long-term*). Many species show temporal variability in abundance, particularly those that specialize on certain resources, such as outbreaks of insects (Helle and Monkkonen 1998) or experience short-term declines due to severe winter (Hannon et al. 2004).
>
> Step 5. Identify species that may be difficult to detect with standard sampling procedures (low versus *high*). As a precaution, species due to distribution or behavior may be poorly known and or difficult to survey and should be considered until adequate information is available.
>
> Step 6. Prioritize species based on Steps 1 to 5, with a strong focus on 1) specialists whose habitats are influenced by forest management, 2) those at risk due to one of the other factors, and 3) those with restricted ranges that narrowly overlap the affected habitat type.

To date, in the Northern Rocky Mountains, no clear evidence other than Newmark (1995) exists that describe which species are most susceptible to habitat fragmentation nor are estimates of the minimum area available for any species. Hejl (1994: 241) found "no data substantiate human-induced 100-yr, west-wide trends for any bird in western coniferous forests." Species breeding in ecosystems such as the boreal forest where frequent small- and large-scale natural disturbances have occurred historically may be more resistant to habitat changes (Schmiegelow et al. 1997) are, therefore, less affected by habitat fragmentation.

Effects of habitat fragmentation on birds are reported to be less in the western United States in comparison to those reported in seminal and numerous studies in the Midwest and East (Tewksbury et al. 1998). Clearly, "the majority of evidence in support of habitat-loss-induced bird declines comes from studies carried out in fragmented landscapes with a matrix of agriculture, suburban, or urban habitats in eastern North America (Donovan and Flather 2002)" (Leupin et al. 2004: 1919).

No data suggest that the northern goshawk (*Accipter gentilis*), black-backed woodpecker (*Picoides arcticus*), flammulated owl (*Otus flammeolus*), pileated woodpecker (*Dryocopus pileatus*), or the American marten (*Martes americana*) would be susceptible to change in their habitat as affected by forest management following a consistent and quantitative approach such as a decision tree. The fisher (*Martes pennati*), due to survey methodology (Step 6), may qualify. All six species—the northern goshawk, black-backed woodpecker, flammulated owl, pileated woodpecker, American marten and fisher—are secure (G 5 rating) in the northern Rocky Mountains (http://www.natureserve.org; accessed February 5, 2006).

*Threshold Habitat Amounts*

A long-held recommendation in the science of viable populations was that a net effective population (a population level of breeding individuals required to maintain 95% of initial heterozygosity after 100 years) equal to 50 breeding individuals was adequate "as a general minimum requirement for short-term conservation" (Allendorf and Ryman 2002: 76).

Allendorf and Ryman (2002), however, point out that generation interval is an important consideration to species persistence. Generation length is linked to body size (Holling 1992, Brown 1995)—small-bodied species are less long-lived than large bodied species. The positive and log-linear relationship of body-size to home range size is referred to as an allometric relationship. Allometric relationships are important to explain patterns, from molecular and intracellular levels up to the largest organism (West and Brown 2005) and are central to managing for biodiversity (Risser 1995) and to the understanding of the hierarchical nature of ecosystems (Holling 2001).

Silva and Downing (1994) were among the first conservationists to provide specific conservation recommendations using allometric relationships and minimal densities required to conserve species [mammalian carnivores in this case, see also Diniz-Filho et al. (2005). In her review of 800 study sites in 339 published studies of mammalian carnivores, Smallwood (1999:103) applied allometric relationships to "predict the areas of high quality habitat needed to support populations of terrestrial mammalian carnivores."

Allen et al. (2001) provide another example where species-specific home range estimates provide a base to estimate amounts and distributions of habitat required to maintain minimum viable population sizes. The Allen et al. (2001) approach to identify a critical habitat threshold for species persistence was to:

1) develop a habitat relationships model using available information and the scientific literature;

2) obtain home range estimates in the scientific literature;

3) use a rule-of-thumb (50 breeding individuals) number necessary for a minimum viable population;

4) estimate the critical amount of habitat required by multiplying home range size by 50 and divide by two to account for intersexual overlap in home ranges; and

5) incorporate dispersal, only "habitat within the dispersal distance of a species" (page 137) should be considered to be critical threshold habitat.

The species-specific habitat estimates in Allen et al. (2001: 136) that incorporate home range size times 50 divided by 2 and dispersal distance were referred to as the "minimum critical area areas (MCA) to support minimum viable populations (MVP)."

*Home range estimates*

A recent summary and analysis of factors that influence the distribution of northern goshawk nests on the on the Kaibab Plateau in Northern Arizona indicates that territoriality and not habitat determines their spacing (Reich et al. 2004). This concussion is supported in a detailed review of northern goshawk conservation and management (Squires and Kennedy in press). Spacing of nests by the northern goshawk is consistent and a value of 1.6 km is provided by Reich et al. (2004). The spacing of nests at 1.6 km suggests use of an area (hexagon) of 2.2 $km^2$.

Territory size around a nest cavity for the black-backed woodpecker varies, e.g., 61 ha in Vermont, 72 ha in southwest Idaho (n = 1), to 124 ha in Oregon (as cited in Dixon and Saab 2000). The home range estimate of 72 ha is used in this analysis in that the Northern Region includes portions of Idaho.

Linkhart et al. (1998) reported a mean size territory (four males equipped with radio transmitters) of 11.1 ± 1.9 ha in 1982 and 18.3 ± 5.1 ha in 1983. The estimate of 11.1 ha is used in that this analysis is to estimate minimum habitat thresholds.

Reported territory size for the pileated woodpecker varies considerably, i.e., means of 87.5 ± 31.6 ha (Renken and Wiggins 1989), 407 ± 110.3 ha (Bull et al. 1992), 478 ± 219 ha (Mellon et al. 1992), 597 ± 338.1 ha (Bull and Holthausen 1993), to 1,360 ± 762.2 ha

(Bonar 2001). Habitat in the study area of Bull et al. (1992) is similar to areas in the Northern Region and a value of 407 ha is used in this analysis.

*Minimum viable population number*

Calder [1983: 224 (33)] calculated the life expectancy of one-half of the original first year adult birds as a measure of mean generation length by the following.

$$t_{exp}\ (yr) = 0.410\ m^{0.46}\ (m = \text{mass in grams})$$

A female body mass of 987 gr (mid point of Nevada northern goshawk body weights in Squires and Reynolds 1997 Appendix 1) was used to estimate mean generation length of 9.7 years, close to the 11 to 12 year range reported in the literature (Kennedy 2003).
for northern goshawk.

The mean life expectancy estimated for the black-backed woodpecker based on body size (body mass = 70 grams) is 2.9 years, less than a maximum of 6 to 8 years suggested by Dixon and Saab (2002).

For the flammulated owl, a body weight of 63gr (midpoint in body weights following McCallum 1964 Appendix 1, range 51 – 63 grams for females) lead to an estimate of mean generation length of 2.8 years.

The pileated woodpecker (body mass = 287 g, midpoint from Bull and Jackson 1995, Appendix 2, D and E) life expectancy is 5.6 years, below the length the life expectancy (7 to 9 years) as measured by a handful of band returns (Bull and Jackson 1995).

The species-specific net effective population ($n_e$) estimates are interpretations from Figure 4.1 in Allendorf and Ryman (2002) which depicts generation length and net effective population size: northern goshawk = 110 (substantially greater than 37 reported by de Volo et al. 2005); pileated woodpecker = 180; black-backed woodpecker = 330; and flammulated owl = 340.

*Critical Habitat Thresholds*

Critical habitat thresholds for a minimum viable population for four species (northern goshawk, black-backed woodpecker, flammulated owl, and pileated woodpecker) are estimated by multiplying home range size by $n_e$ divided by two to account for intersexual overlap in home ranges (Table 1).

Smallwood's (1999: 107) threshold value of 70 $km^2$ is recommended as a critical habitat threshold for the American marten given the basis in the summary of empirical studies (i.e., 800 study sites in 330 published studies). Smallwood (2002: 109) estimates a critical fisher habitat threshold for population persistence to be 405 $km^2$.

*Dispersal and Well-distributed Habitat*

The 1982 planning rule (36 CFR 219.19) requires that "habitat must be well distributed so that those individuals can interact with others in the planning area." Dispersal ability of young is the measure of well-distributed habitat (Thomas et al. 1992, Appendix P). In the President's Plan to conserve the oldgrowth forests of the Pacific Northwest, Thomas et al. (1992: 367) concluded for the spotted owl (*Strix occidentalis*) that "the distances between Habitat Conservation Areas should be within the known dispersal distances of at least two-thirds (67%) of all juveniles" in order to satisfy the 219.19 requirement for well distributed habitat. Subsequent modifications of the original Habitat Conservation Area network by the spotted owl recovery team also meet this criterion. The 9th Circuit Court has upheld the President's Plan.

Dispersal of young is an important component of population viability, yet is difficult to measure (Koenig et al. 2000). Researchers rarely look beyond their respective study areas to relocate banded birds or to recover dead birds. No broad-scale surveys exist to relocate banded birds and few telemetry-based studies are adequate in scope to address dispersal distances.

In an overall review of dispersal distance in birds, Bowman (2003: 198) found a relationship between median dispersal distance and the square root of territory size for a species that can be described as follows.

> Median dispersal distance (km) = 12 times the square root of the territory size (ha).

The approach to dispersal distance in birds developed by Bowman (2003) was used in Samson (2005) to determine if habitat was well distributed for the northern goshawk, black-backed woodpecker, flammulated owl, and pileated woodpecker. In each case, suitable species habitat was within the species-specific dispersal distance, indicating that well-distributed habitat is not an issue in the Northern Region for the four bird species mentioned above.

In a review of dispersal distance in mammals, Bowman et al. (2002:) found a relationship between median dispersal distance and home range size for a mammal species that can be described as follows.

> Median dispersal distance (km) = 7 times the territory size (ha)

## Habitat Estimates for Minimum Viable Populations By Species

*Northern Goshawk*

Kennedy (2003) and Squires and Kennedy (in press) provides comprehensive information on northern goshawk systematics, distribution and abundance, activity patterns, habitat, feeding habits, breeding ecology, threats, and viability. Insufficient information is

Table 1. Summary of critical habitat thresholds (km$^2$) to maintain minimum viable populations for six species in Northern Region. Total estimated habitat is included by National Forest for each species (Samson 2005).

| | Northern goshawk | Black-backed woodpecker | Flam-mulated owl | Pileated wood-pecker | American marten | Fisher | |
|---|---|---|---|---|---|---|---|
| Total/Regional Minimum Viable population Habitat Threshold (km$^2$) | | | | | | | |
| | 122 | 119 | 19 | 366 | 70 | 405 | |
| Forest total | | | | | | Sum-mer | Winter |
| Idaho Panhandle | 3,812 | 1,253 | 133.4 | 2963 | 4,927 | 2,077 | 4,812 |
| Kootenai | 2,656 | 357 | 43.0 | 866 | 2,642 | 752 | 2,448 |
| Flathead | 2,323 | 1,021 | 23.2 | 387 | 2,230 | 682 | 2,741 |
| Lolo | 2,950 | 1,259 | 64.4 | 637 | 2,749 | 644 | 2,148 |
| Bitterroot | 1,530 | 1,631 | 64.1 | 316 | 1,662 | 385 | 1,158 |
| Clearwater | 2,445 | 261 | 64.4 | 1,364 | 3,275 | 1,448 | 2,703 |
| Beaverhead-Deerlodge | 3,990 | 705 | 19.7 | 187 | 3,388 | 780 | 2,844 |
| Helena | 1,276 | 427 | 32.4 | 147 | 899 | 147 | 657 |
| Lewis and Clark | 1,964 | 145 | | 175 | 1,515 | 352 | 1,683 |
| Nez Perce | 2,814 | 1,528 | 160.1 | 1,815 | 3,661 | 1,658 | 2,815 |
| Gallatin | 1,274 | 311 | 55.8 | 246 | 1,511 | 465 | 1,386 |
| Custer | 413 | 315 | | | 339 | 18 | 150 |

available to conduct a quantitative population viability analysis due to lack of long-term demographic information. It is clear that the northern goshawk home range will defend the post fledging area (about 120 ha) from other goshawks and neighboring pairs overlap in use of foraging areas.

Multiplying 110 ($n_e$) by 221 ha and dividing by 2 provides a critical habitat estimate of 122 km$^2$ for a minimum viable population for the single population of the northern goshawk in the Northern Region.

Table 1 compares the 122 km$^2$ minimum viable population habitat threshold for the regional population to the estimated northern goshawk habitat amounts on each National Forest in the Northern Region. It is important to note that native habitat for the northern goshawk is naturally limited on four forests—Custer, Gallatin, Flathead, and Kootenai, as reflected in the Montana Natural Heritage species' distribution map (http://nhp.nris.state; accessed February 5, 2006) and the northern goshawk is known to breed on the Idaho Panhandle, Clearwater, and Nez Perce National Forests (www.idahobirds.net; accessed April 12, 2006).

*Black-backed woodpecker*

Territory size around a nest cavity for the black-backed woodpecker varies, e.g., 61 ha in Vermont, 72 ha in southwest Idaho (n = 1), to 124 ha in Oregon (as cited in Dixon and Saab 2000). Multiplying 330 ($n_e$) by 72 ha (selected as a territory size value due to proximity to the Northern Region) divided by 2 provides a habitat threshold estimate of 119 $km^2$ for a minimum viable population across the Northern Region.

It is important to note that native habitat for the black-backed woodpecker is naturally limited on most Forests—Kootenai, Flathead, Lolo, Bitterroot, Beaverhead-Deerlodge, Lewis and Clark, and Helena, and is very uncommon on the Beaverhead-Deerlodge, Gallatin, and Custer; as reflected in the Montana Natural Heritage species' distribution map (http://nhp.nris.state; accessed February 5, 2006). 2006). It is known to breed on the Idaho Panhandle, Clearwater, and Nez Perce National Forests (www.idahobirds.net; accessed April 12, 2006).

*Flammulated owl*

Multiplying 340 ($n_e$) by 11.1 ha and dividing by 2 provides critical habitat estimates of 19 $km^2$ for a flammulated owl minimum viable population in the Northern Region (Table 1).

Table 1 compares the estimated habitat required for a regional flammulated owl minimum viable population to that available on each respective Forest. It is important to note that native habitat for the flammulated owl is naturally limited on six Forests—Kootenai, Flathead, Lolo, Helena, Beaverhead-Deerlodge, and Gallatin; non-existent on the Lewis and Clark and Custer as reflected in the species' distribution map (http://nhp.nris.state; accessed February 5, 2006); and is suspected to breed on the Clearwater and Nez Perce National Forests (www.idahobirds.net; accessed Aril 12, 2006).

*Pileated woodpecker*

Multiplying 180 ($n_e$) by 407 ha (well within the few published estimates for territory size) and dividing by 2 provides a critical habitat estimate for a viable pileated woodpecker population of 366 $km^2$ for a viable population within the Northern Region.

Table 1 compares the 366 $km^2$ habitat threshold for a Region-wide minimum viable population to estimated pileated woodpecker habitat amounts on each National Forest in the Northern Region. It is important to note that native habitat for the pileated woodpecker is naturally limited on four forests—Lewis and Clark, Gallatin, and Beaverhead-Deerlodge, non-existent on the Custer, as reflected in the Montana Natural Heritage species' distribution map (http://nhp.nris.state; accessed February 5, 2006).

*American marten*

Table 2. Summary of key characteristics (mean values) of American marten home ranges, rest sites, and den sites reported in published studies since 2000.

| Authors | Total Basal area ($m^2$/ha) | Snags | Canopy coverage (%) | Down woody material (no./ three 40 m transects) | Tree height (m) | Tree age (years) |
|---|---|---|---|---|---|---|
| Gosse et al. (2005) | | | Mature conifer >25; coniferous shrub <50; insect <25; burned <25 | Mature conifer 17.3; coniferous shrub .7; insect 26.3; burned 13.4 | Mature conifer >9.6; coniferous shrub <9.6; insect >9.6; burned 4.7-10.2 | Mature conifer >80; coniferous shrub >80; insect <25; burned <25 |
| Fuller and Harrison (2005) Leaf on | 13 | | 62-71% | | >9 | |
| Leaf off | <13 | | <30 | | >9 | 80-140 |
| Porter et al. (2005) | | (no./circular 15 m plot) resting sites 1.58; subnivien foraging 1.4; stumps .75; scent marking sites 13.3 | Dens shrub 34.9; shrubby trees 20.4 | | | |
| Payer and Harrison (2000) | 18 | 20.2 ($m^2$/ha) | | Snags 5.1 ($m^2$/ha) | >=9 | |

Table 3. Habitat relationship model for the American marten for the USDA Forest Service Northern Region.

| BA_WTD_DBH[1] (cm) | Dominance group[2] | Canopy coverage (%) |
|---|---|---|
| > 23 cm | ABGR[3], ABGR-1MIX, ABLA, ABLA-1MIX, BEPA, BEPA-1MIX, IMXS, LAOC, LAOC-1MIX, PICO, PICO-1MIX, PIMO3, PIMO3-1MIX, PIEN, PIEN-1MIX, PIPO, PIPO-1MIX, POPUL, POPUL-1MIX, PORT5, PORT5-1MIX, PSME, PSME-1MIX, TABR2, TABR2-1MIX, TASH, TGCH, TSHE, TSHE-1MIX. | >30 |

[1] BA_WTD_DBH is the sum of the diameter of the tree times the number of trees the tree represents times basal area of the tree divided by total basal area.
[2] Vegetation council algorithms for stand classification (Berglund et al. 2005).
[3] Grand fir (ABGR), subalpine fir (ABLA), birch (BEPA), intolerant mix (IMXS), larch (LAOC), lodgepole pine (PICO), western white pine (PIMO3), Engelmann spruce (PIEN), ponderosa pine (PIPO), cottonwood (POPUL), aspen (PORT5), Douglas-fir (PSME), yew (TABR2), tolerant mix of subalpine fir-spruce-mountain hemlock (TASH), tolerant grand fir-cedar-hemlock (TGCH), western hemlock (TSHE).

The American marten's range extends from Alaska to Newfoundland, south into the Allegany's, Great Lakes region, Rocky Mountains south to New Mexico, Sierra Nevada, and Cascades (Clark et al. 1987).

Throughout most of its distribution, American marten are reported to be closely associated with relatively closed canopy (>30-50%) late succession conifer or mixed-conifer stands with complex structure on or near the ground (Buskirk and Ruggiero 1994, Buskirk and Powell 1994).

An example of American marten home range habitat is in northern Idaho. Tomson (1999) reported the American marten use of oldgrowth (> 22.9 cm dbh) was significantly greater than random in areas selected for home ranges. In that study, roads, slope, and aspect did not significantly influence American marten habitat use. American marten were observed by Tomson (1999) to use a variety of sites for rest sites (live trees, cavities in snags, cavities in down logs, and talus) and riparian areas were used for movement.

Bissonette et al. (1997) suggest that the American marten selects habitat at a 1) landscape (tens to hundreds of $km^2$) scales, 2) home range (one half to several $km^2$) scale, and 3) micro or sub-stand (several $m^2$) scale. As with the fisher, managing the landscape within the natural range of composition, structure and frequency and extent of ecological drivers (fire, insects, and wind) may be most effective for long-term American marten persistence (Heinemeyer and Jones 1994).

In Ontario, Canada, Savage (2004) considered 5 variables at the landscape level—logging and fire disturbance, forest cover type, weather, spatial pattern, and road density—and harvest statistics (1972-1990) to identify variable contribution to long-term patterns in harvest levels of the beaver *Castor canadensis*, fisher, lynx *Lynx canadensis* and American marten. Forest cover type, weather, and spatial pattern accounted for most variation in harvest, while disturbance and road densities had little impact. Savage (2004) suggests disturbance from logging and fire is not affecting furbearer harvest of the four species.

At the home range scale, most studies show the American marten to select mid- to late-successional conifer or mixed-conifer with relatively high level canopy closure (>30-50%) and complex structure of woody material on or near the ground (Buskirk and Powell 1994).

In Maine, at the home range scale, Fuller et al. (2005) describe how the American marten in the leaf-on season (1 May to October 31) select partially harvested (<13 $m^2$/ha basal area, > 9m tree height) second-growth and mixed-aged stands and select against clearcuts (Table 2). In that study, use of partially harvested stands in the leaf-off season (1 November to April 30) corresponded with greater canopy closure (>30%) and higher basal area (>18$m^2$/ha).

In eastern Newfoundland, Gosse et al. (2005) developed an index of seasonal requirements and American marten home range size. Gosse et al. (2005) report American marten use of 1) mature forest was proportionally more than availability (Table 2); 2) two habitats, coniferous shrub and insect-defoliated, were proportional to availability; and 3) open and areas recently burned were avoided.

Poole et al. (2004) describe American marten habitat use in an area of overgrown agricultural lands consisting primarily of 30 to 40 year old trembling aspen (*Populus tremuloides*) stands. Poole et al. (2004) report average home range size was small suggesting such overgrown agricultural lands to be high quality habitat.

At the micro or sub-stand scale, American marten select habitat features that provide for foraging, resting, and denning opportunities. American marten are considered dietary generalists, taking advantage of seasonally abundant food items—fruits and insects in summer and fall (Koehler and Hornocker 1977). Voles and pine squirrels important American marten prey in winter (Buskirk and Ruggiero 1994).

American marten select habitat structure types for resting that provide for both thermal refugia (Taylor 1993) and protection from predation (Slauson 2003). Use of rest sites varies by season with above ground sites (i.e., platforms in live trees or snags, cavities in logs, and so on) preferred more often in summer and subnivien structures (those created by root wads) used more often in winter (Bull and Heater 2000).

Recently, Porter et al. (2005) in British Columbia report American marten are more selective in use of habitat for resting than for foraging and no selectivity for habitat for traveling was evident (Table 2). Porter et al. (2005) suggest habitat features selected for,

Table 4. Summary of key habitat characteristics fisher habitats in studies published since 2000.

| Authors | Scale | Vegetation | Canopy closure (%) | Course woody debris ($m^3$/ha) | Tree density (stems/ha) |
|---|---|---|---|---|---|
| Weir and Harestad (2003) | Home range | Spruce, aspen | Summer: 21-40; winter 21-60 | <200 | Autumn (>40 cm) 1-20; winter >51-100 |
| | Patch | | Coniferous 41-60, deciduous 21-40 | 1-200 | 1,000-4,000 |
| Zielinnski et al. (2004) | Home range | Sierran mixed conifer, ponderosa pine, montane hardwood | Dense[1] 66.3%, moderate 22.5%, open 5.9%, sparse 1% | | Large/medium[2] tree 12.7%, small tree 60.7 %, pole 21.8%, sapling 1.6% |

[1] Dense (60-100%), moderate (40-59%), open (25-39%), and sparse 10-24%.
[2] Large/medium >61 cm, small tree 29-61 cm, pole 15.3-28.9, and sapling 2.56-15.2.

e.g., rootballs and wide-diameter snags, could be retained in managed forests and is the reason "why marten are able to survive in this and other sites that provide seemingly unsuitable habitat" (page 901).

Typically, den sites of the American marten include arboreal cavities in live trees and snags (Gilbert et al. 1997, Bull and Heater 2000) or are located in logs, rock crevices, and red squirrel middens (Ruggiero et al. 1994). Woody structures (live trees, snags, and logs) used by American marten for resting and denning tend to be large in size and their use is disproportionate to availability (Gilbert et al. 1997). Fisher and Wilkinson (2005) provide a review of mustelid (including the American marten) response to timber harvest and forest fire.

Other than Fuller et al. (2005), little recent (>2000) information has been published to describe the relationship of American marten to timber harvest or post burn habitat. Payer and Harrison (2000: 1965) report "uneven-aged silvicultural systems, which closely mimic natural disturbance by defoliating insects, may have particular promise for maintaining marten habitat." Payer and Harrison (2000: 1695) further suggest that vertical structure provided by large snags (Table 2) "can offset limited availability of live trees for marten, particularly where coarse woody debris and understory vegetation is plentiful."

5. Habitat relationship model for the fisher for the USDA Forest Service Northern Region.

| Model | BA_WTD_DBH[1] (cm) | Potential Vegetation Type[2] | Dominance Group[3] | Canopy coverage (%) |
|---|---|---|---|---|
| Summer | Group 1 >= 35, Group 2 >= 23 | Group 1: ABGR[4], ABGR-1MIX, ABLA, ABLA-1MIX, IMXS, LOAC, LOAC-1MIX, PIEN, PIEN-1MIX, PSME, PSME-1MIX<br><br>Group 2: BEPA, BEPA-1MIX, PICO, PICO-1MIX, POPUL, POPUL-1MIX, PORTR5, PORT5-1MIX | TABR2[4], TASH, TGCH, THPL, THPL-1MIX | >= 40 |
| Winter | >= 35 | Group 1 and 2 | | >= 40 |

[1] BA_WTD_DBH is the sum of the diameter of the tree times the number of trees the tree represents times basal area of the tree divided by total basal area.
[2] Potential vegetation types [Montana, Pfister et al. (1977); Idaho, Cooper et al. (1991)]. Relationship of potential vegetation groups to Forest Inventory and Analysis is provided by Berglund et al. (2005).
[3] Vegetation council algorithms for stand classification (2004).
[4] Grand fir (ABGR), subalpine fir (ABLA), birch (BEPA), intolerant mix (IMXS), larch (LAOC), western white pine (PIMO3), Engelmann spruce (PIEN), cottonwood (POPUL), aspen (PORT5), Douglas-fir (PSME), yew (TABR2), tolerant mix of grand fir, cedar, and western hemlock (TASH), tolerant grand fir-cedar-hemlock (TGCH), western hemlock (TSHE).

Smith and Shaffer (2002) summarize American marten home range sizes reported in the scientific literature (2.5 $km^2$ to 27.6 $km^2$ for females and 2.6 $km^2$ to 27.5 $km^2$ for males).

Recently, in a study in the Northwest Territories, Gosse et al. (2005) report large American marten home range sizes (29.54 $km^2$ for males and 15.19 $km^2$ for females) in an area of low prey abundance. In contrast, Poole et al. (2004) report average home range size as low as 3.3 $km^2$ for males and 2.0 $km^2$ for females on agricultural lands consisting primarily of 30 to 40 year old trembling aspen suggesting high quality habitat.

*Habitat Model*

The habitat model (Table 3) is intended to describe characteristics of the American marten home range. The values (tree size and canopy cover) included in the habitat relationship model reflect the literature (Table 2). It is not possible at this point to model resting site or natal area requirements. Project evaluation for the American marten should consider coarse woody debris important to resting sites and natal areas.

*Habitat Threshold*

A summary of habitat estimates for the American marten by National Forest in the USDA Forest Service Northern Region using the Northern Region American marten habitat relationship model (Table 3) and FIA is provided in Table 1.

Smallwood (1999) estimate of the minimum critical habitat threshold habitat amount required for the American marten persistence is 70.0 $km^2$. Smallwood's value (70.0 $km^2$) is recommended (Table 1) as a habitat amount required for a Region-wide viable population given the basis in the summary of empirical carnivore studies (800 study sites and 330 studies).

Individual home ranges that collectively represent the critical threshold level of 14.0 $km^2$ should be within the dispersal capability of the American marten. Kelt and Van Vuren (2001: 643), in review of over 700 studies and 1,128 home range estimates for 279 Table mammal species, describe a statistically significant relationship of body size to home range. Following Bowman et al. (2002), and using the body mass/home range relationship described by Kelt and Van Vuren (2002) [i.e., average female body weight of 719 gr (Tomson 1999)], the estimated median dispersal distance for the American marten is 44.1 km.

It is important to note that native habitat for the American marten is naturally limited to east of the Continental divide, rare on the Beaverhead-Deerlodge, as reflected in the Montana Natural Heritage species' distribution map (http://nhp.nris.state; accessed February 5, 2006).

*Fisher*

Fisher distribution is closely associated with the boreal forest of Canada (from British Columbia to eastern Canada), as well as in the United States, the extensive hardwoods forests of New England and the montane coniferous forests of the West. (Powell 1981).

In general, studies in the Western United States show the fisher to be associated with mature coniferous forests and require specific structural elements—particularly large trees and coarse woody debris (Ruggiero et al. 1994). An example of fisher habitat is in central Idaho. Jones (1991) found that the fisher preferred oldgrowth and mature forests in summer (92% and 74% of nesting- and hunting sites, respectively), young and oldgrowth forest in winter, and had a strong affinity for riparian areas in both seasons.

Four spatial scales at which fisher habitat may be evaluated include: 1) landscape, 2) home range, 3) within a home range, and 4) elements, e.g., denning or resting site (Weir and Harestad 2003).

In Ontario, Canada, Savage (2004) considered 5 variables at the landscape level—logging and fire disturbance, forest cover type, weather, spatial pattern, and road density—and harvest statistics (1972-1990) to identify variable contribution to long-term patterns in harvest levels of the beaver, fisher, lynx, and American marten. Forest cover type, weather, and spatial pattern accounted for most variation in harvest, while disturbance (fire and harvest) and road densities had little if any impact on furbearer harvest.

In British Columbia, at the home range scale, Weir and Harestad (2003: 76) report fisher selected for "stand classes with moderate values of most structural attributes (and) avoided extreme stand classes (i.e., those stands classified as either being high or low values of particular structural attributes." Canopy closure in that study selected for by the fisher was higher in winter than in summer as were stems/ha (Table 4). In contrast, Zielinski et al. (2004) in California described a pattern in home range habitat selection that included small trees (60.7%) and high levels of canopy closure (from 1% to 66.3%) (Table 4).

Fishers appear able to use "many different habitats as long as these areas provide overhead cover at either the stand or patch scales" (Weir and Bio 2003: 9). Sufficient overhead cover in foraging habitat may be provided by either tree or shrub cover. At the patch scale, Weir and Harestad (2003), found fishers selected habitat that included all structural attributes with the exception of mean tree diameter (Table 4). Fishers exhibited further patch-scale selectivity in use of stands with extremes of structural attributes, i.e., a coniferous stand with high canopy cover but low near-ground structural diversity.

Weir and Harestad (2003) describe 32 resting sites and 5 natal or den sites for the fisher in British Columbia. The diameter breast height of trees used for rest sites (from 103.2 cm for Douglas-fir to 46.3 cm for hybrid spruce) was significantly larger than that available based on the general sample. Coarse woody debris (mean diameter = 80.3 cm) near rest sites also was significantly different (bigger) than that available.

*Habitat thresholds*. Based on the allometric relationship of home range size to body size (and 850 study areas in 330 published studies), Smallwood (1999: 109) estimates a critical fisher habitat threshold for population persistence of 405 $km^{2.}$ This value of 405 $km^2$ for a threshold habitat level to maintain a viable population is within the range (212 $km^2$ to 6,291 $km^2$) estimated through the use of net effective population size ($n_e$ = 125) and home range sizes (9.8 $km^2$ and 82.6 $km^2$).

The critical threshold level of 301 $km^2$ should be within the dispersal capability of the fisher. Individual home ranges that collectively represent and total area of the critical habitat threshold level of 301 $km^2$ should be within the dispersal capability of the fisher. Kelt and Van Vuren (2001), in a review of over 700 studies and 1,128 home range estimates for 279 mammal species, describe a statistically significant relationship of body size to home range. Following Bowman et al. (2002), and using the body mass (Powell 1981,)/home range relationship described by Kelt and Van Vuren (2002: 643) [i.e., a female body weight of 2 to 2.5 kg (Powell 1981)], the estimated median dispersal distance for the fisher is 55.6 km.

Table 5 describes the Northern Region habitat relationship model for the fisher. Attributes of the model are drawn from the recent published literature (Table 4), specifically tree size (BA_WTD_DBH) and canopy coverage. It is not possible at this point to model resting site or natal area requirements. Project evaluation for the fisher should consider coarse woody debris important to resting sites and natal areas.

The wildlife habitat relationships nest site model (Table 5) for the fisher in the Northern Region in combination with FIA (see Samson 2005) provides an estimate of habitat amount for the fisher by National Forest (Table 1). Given the natural distribution of habitats, it is unreasonable in ecological framework to expect each national forest to maintain a viable population for each species. Each Forest should maintain a viable population where the capability of the natural habitat permits and contribute within the capability of native habitat to the viability of other species.

## Summary

Allometric principles account for most of the observed variation in the life history of birds and mammals and provide the basis for a unifying theory of biological structure and organization from genomes to ecosystems (West and Brown 2005).

Major outcomes of this assessment are as follows.

- The six species considered in this assessment are secure in terms of persistence (http://www.natureserve.org/ explorer/serve/NatureServe; accessed March 6, 2006).

- Below (and not above) a threshold of 20-30% of habitat amounts, effects of fragmentation (i.e., patch size and isolation) are suggested to have a negative impact on species persistence. Effects of habitat fragmentation on birds are described to be less in the western United States in comparison to those reported in seminal and numerous studies in the Midwest and east.

- No indication exists that forested ecosystems in the Northern Region have reached the 20 to 30% threshold of historic. Forested systems in the Northern Region are more extensive than in historic (~ 1800) times (Hessburg and Agee 2003, Gallant et al. 2004, Hessburg et al. 2005).

- Comparison of habitat required for a species-specific minimum viable population to that available indicates well-distributed habitat far excess to that needed, given the natural distribution of species and their habitats as mapped by the Montana Natural Heritage Program, Idaho Birdnet, and the scientific literature.

- Region-wide habitat modeling for the American marten and fisher is restricted by the unavailability of sample-based information on large down woody debris and the variability evident in habitat use by both species (Tables 2 and 4). Site-specific models for the American marten and fisher may need to be adjusted to include resting site and nest site information which may or may not influence habitat amount estimates in Table 1.

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