Introduction to Detection and Survey Methods

William J. Zielinski[1] and Thomas E. Kucera[2]

Background

The integrity of an ecosystem may be measured by the health of its vertebrate carnivore populations. Carnivores influence the structure and reflect the vigor of trophic levels on which they depend, and are sensitive to the abundance and behavior of the human populations with which they coexist (Eisenberg 1989). Concern for the conservation of mammalian carnivores in the western United States has centered on two large species, the gray wolf (*Canis lupus*) and the grizzly bear (*Ursus arctos*). The public is well acquainted with the plight of these species; a wealth of popular literature on their natural history and a long tradition of folk knowledge have built a foundation of awareness. In contrast, the four species that we address in this manual, the American marten (*Martes americana*), fisher (*Martes pennanti*), lynx (*Lynx canadensis*), and wolverine (*Gulo gulo*) (henceforth collectively referred to as MFLW), are no less important constituents of their biological communities than the wolf or grizzly bear, but much less familiar.

Fortunately, MFLW have begun to emerge from the shadows of public and scientific awareness (Kucera and Zielinski 1995). In the past 7 years in the Pacific Southwest Region of the USDA Forest Service, 58 actions such as timber sale appeals, lawsuits, and Freedom of Information Act requests were filed concerning the marten, 54 concerning the fisher, and 20 concerning the wolverine (lynx do not occur in California). Each species is receiving increased levels of administrative and legal protection. The wolverine is a "candidate" for Federal listing under the Endangered Species Act (Category 2 [C2]) in nine States, and listed as either "State Endangered" (SE) or "State Threatened" (ST) in three of them. A C2 designation indicates that more information is necessary to support a listing decision by the Fish and Wildlife Service (USFWS), U.S. Department of Interior. The lynx is a C2 species in nine states and either SE or ST in two states. The fisher is a C2 species in three states and SE or ST in two. The marten has no Federal status, but is SE in New Mexico. Each species is also listed as either "Sensitive" or as a "Management Indicator Species," as provided for in the National Forest Management Act, on most National Forests throughout its range (Macfarlane 1994). Sensitive species are those whose population viability is a concern because of significant current or predicted downward trend in abundance or habitat capability (Forest Service Manual 2670.32). Management Indicator Species are used by National Forests to reflect how particular habitats or habitat elements respond to management activities (Forest Service Manual 2670.5).

In the early 1990's the Fish and Wildlife Service (USFWS) was petitioned to list the fisher as "Endangered" in California, Oregon, and Washington under the Endangered Species Act (Central Sierra Audubon Society and others 1990), and the lynx was petitioned to be listed in Washington (Greater Ecosystem Alliance and others 1991). Both petitions were denied on the basis of inadequate information (U.S. Department of Interior, Fish and Wildlife Service 1991, 1992). Recently the USFWS was again petitioned to list both species, this time throughout their ranges in the western United

[1]Research Wildlife Biologist, Pacific Southwest Research Station, USDA Forest Service, 1700 Bayview Dr., Arcata, CA 95521, and Associate Faculty, Wildlife Department, Humboldt State University, Arcata, CA 95521

[2]Lecturer and Specialist, Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA 94720

States (Biodiversity Legal Foundation 1994a, 1994b). The lynx petition was denied again (U.S. Department of Interior, Fish and Wildlife Service 1994), and the fisher decision is pending. A petition to list the wolverine as "Endangered" in the contiguous 48 United States (Biodiversity Legal Foundation 1994c) also was denied (U.S. Department of Interior, Fish and Wildlife Service 1995). The Natural Resources Defense Council challenged the USDA Forest Service in California to suspend logging of late-successional forests until a plan to ensure the viability of forest carnivore populations is in place (Yassa and Edelson 1994). The first major conference on the biology of martens and fishers occurred in 1991 (Buskirk and others 1994), and in the same year the Western Forest Carnivore Committee, an interagency group of managers and scientists, was created to address the conservation needs of MFLW. Recently, a conservation assessment was conducted for the four species considered here to evaluate the state of our knowledge on their ecology and to consider the management implications of this information (Ruggiero and others 1994). The second conference on the biology of martens and fishers occurred in 1995.

The list above indicates that managers, administrators, and citizens of many western states are concerned about the status of MFLW. This concern stems from the possible deleterious effect of trapping and from habitat loss. Several investigators suspect that the accelerated harvest of old-growth forest has reduced, in particular, the populations of fisher and marten (Buskirk and Ruggiero 1994, Powell and Zielinski 1994) and that human encroachment on the range of the wolverine has reduced its numbers (Banci 1994). There is growing consensus that the southern portions of these species' historic ranges in the western United States have recently contracted (Douglas and Strickland 1987, Gibilisco 1994, Maj and Garton 1994, Nead and Halfpenny 1985, Ruggiero and others 1994, Weaver 1993).

The relative obscurity of MFLW and the logistical and financial difficulty of studying them may explain why so little is known about their biology and the effect of land-use changes on their populations. These species occur at low densities, are primarily nocturnal, have inconspicuous mating behavior, leave little sign, and shun human activity. Unless they are commercially harvested by trapping, their presence will often go unnoticed. In addition, managers may have assumed that carefully regulated trapping programs would monitor the distribution of each species and detect declining populations. Whether this was ever possible is now moot; collectively, MFLW are no longer a significant part of the fur harvest in the conterminous western United States. Changing public attitudes regarding trapping, poorly regulated harvests, and suspicions about excessive mortality from commercial harvest have contributed to the closure or restriction of trapping seasons. MFLW are legally trapped in only a few (one, lynx; two, wolverines; two, fisher; six, marten) of the seven western States, excluding Alaska, and quotas have been as low as two per State (Ruggiero and others 1994). It is likely that none of these species, with the possible exception of marten, will continue to be commercially harvested in the western conterminous United States for long.

Historically, MFLW occurred throughout northern North America including mountainous regions of the western United States (Gibilisco 1994, Grinnell and others 1937, Hagmeier 1956, Koehler and Aubry 1994), but none occupies all of its recent historical range (Banci 1994, Douglas and Strickland 1987, Gibilisco 1994, Koehler and Aubry 1994, Kucera and others 1995, Nead and Halfpenny 1985, Zielinski and others 1995). In the western United States, most of the range of MFLW occurs within the Rocky Mountains, the Cascade Range, the Coast Range, and the Sierra Nevada. Within these regions all four species are associated with coniferous forest ecosystems. Marten and fisher occur primarily in late-successional forests (Buskirk and Powell 1994), lynx are associated with a variety of seral stages (Koehler and Aubry 1994), and the wolverine inhabits areas with a mixture of forested and non-forested habitats (Banci 1994, Hash 1987, Hatler 1989). All are primarily carnivorous. Marten and fisher eat predominantly small- to medium-sized mammals (e.g., rodents and lagomorphs) (Douglas and Strickland 1987, Martin 1994, Strickland and Douglas 1987). Lynx prey largely on snowshoe hares (*Lepus americanus*) (Koehler and Aubry 1994), and wolverines depend mostly on carrion, especially that of ungulates (Hornocker and Hash 1981).

In sum, these species have similar habitat associations, are sympatric over much of their range, often occur at low densities, have relatively low reproductive potentials, occupy somewhat similar niches in their respective communities, and may be affected in similar ways by human land-use practices. Range-wide, the densities of martens, fishers, lynx, and wolverines have been reported as low as one individual for every 2.5, 20.0, 200.0, and 700 km^2, respectively (Arthur and others 1989, Banci 1987, Nellis and others 1972, Thompson and Colgan 1987). In addition, each frequently occurs in small, scattered subpopulations, making them especially vulnerable to extirpation (Gilpin and Hanski 1991, Weaver 1993). For these reasons, it is appropriate to consider detection and survey methods collectively for these four species. Moreover, we recognize the need to focus whenever possible on collective components of ecosystems rather than individual species.

Recent developments in the field of conservation biology suggest that we can no longer assume that the existing distribution of National Parks, and the prevailing management on National Forests, will guarantee the long-term persistence of large vertebrate populations (Newmark 1985, 1987; Salwasser and others 1987). Reserves cannot be created that are large enough to permit the persistence of MFLW populations; the multiple-use lands between reserves must also be managed with the conservation of these species in mind. Moreover, populations of lynx and wolverine in particular may depend on source populations in Canada; thus, conservation efforts must consider connectivity of habitat between the United States and southern Canada (Hatler 1989, Ruggiero and others 1994, Weaver 1993). Eventually, a spatially explicit conservation strategy should be developed for these species. This must include all land management agencies in western North America and model the viability of each species and population throughout the region. An initial step taken by the USDA Forest Service was a conservation assessment for MFLW that summarizes existing information and suggests research needs (Ruggiero and others 1994). In addition, general hierarchical guidelines for the conservation of fisher have been proposed for the western United States (Heinemeyer and Jones 1994). One of the key information needs identified in these documents is knowledge of the present geographic distribution of each species. Because commercial trapping is no longer a source of data on the distribution of these species, a new approach to the acquisition of distributional data must be developed.

Developing new methods to collect distributional data is a logistically and financially challenging problem, but it must be addressed and it must begin now. It is essential for several purposes: (1) to develop a contemporary benchmark for the geographic distribution of each species, (2) to generate data for habitat-relations models, (3) to evaluate the effects of land-use changes (e.g., timber harvest, mining, recreation) on populations, (4) to evaluate the effects of human density and disturbance on distribution, (5) to relate species occurrence to landscape physiognomy and composition (Fahrig 1988, Pulliam and others 1992), (6) to collect information that will assist the development of spatially explicit population viability models (e.g., Thomas and others 1990), (7) as an essential step in the development of a population-monitoring program, and (8) to assist in determining the necessity of protecting any of the species under the Endangered Species Act.

Others have addressed the issues of inventory and surveying populations of the carnivores considered here (Jones and Raphael 1993, Raphael 1994, Spowart and Samson 1986). However, they either address a particular technique or species or describe the issues in a general fashion. We hope that the present manual will facilitate the collection of distribution data for all four species in a standardized fashion, using methods that can be tailored to the local environment and particular target species. For this reason we expect it to be an important step toward addressing all of the objectives described above.

Species Detection

This publication is designed to help resource managers detect the *presence* of lynx, wolverines, fishers, and martens by using standardized, non-lethal methods. It should allow a biologist to conduct a search for MFLW that will provide reasonable assurance that the species are not present if they are not detected. However, until additional research is conducted on the probabilities of detecting individuals known to occur in an area, "failing to detect" should not be the same as concluding "absent" (see section on "Interpretation," below).

If the target species is detected, the location of the detection and the habitat features associated with it should become part of a larger database that includes all sites where each species was detected. Thus, detection efforts, if conducted in a standardized fashion, can describe the distribution of a species throughout a region of interest (see Chapter 2, "Definition and Distribution of Sample Units").

We describe three methods: cameras, sooted track plates, and snow tracking. Each offers ease of use, effectiveness, and economy. For each method we provide, in "cookbook" fashion, information about how to acquire or build the components and a protocol for using the method and recording the data collected. We do not recommend a particular method for a particular circumstance or geographic region. Instead, we describe the contexts in which each method works best, estimate the costs, and allow the biologist planning the survey to choose among the three techniques.

We considered other techniques such as habitat surveys, live trapping, and hair snares but decided not to include them in this manual. Habitat surveys are based on the assumption that habitat suitability is sufficiently well known that we can create a model that relates habitat attributes to species' presence. Unfortunately, existing models have had little testing, and factors other than habitat quality frequently affect distribution (Raphael 1994). Live trapping is uneconomical, given the low capture rates per unit effort for the species considered here. Snares that collect a sample of hair from individuals that visit a bait (e.g., Barrett 1983, Scotts and Craig 1988) are relatively inefficient, and species are not always readily identifiable by individual hairs (Fowler and Golightly 1993, Raphael 1994). However, DNA fingerprinting, which can determine the identity of species and individuals from DNA in cells at the base of the hair (e.g., Morin and others 1994), may soon resolve this issue. Individual marten have been identified using DNA extracted from hair collected from wooden "cubbies" lined with a sticky snaring medium (Minta and Heinemeyer 1995). Consequently, hair collected at station locations or encountered while snow tracking should be saved for future analysis.

It is important to emphasize that we recommend the use of the three methods for *detection only*. We assume here that the primary objective of a biologist responsible for the management of these species is to determine *whether* they occur in a particular locale and *where* they occur within the area. We refer to these as "Regional Surveys." Beyond this, biologists often are called upon to determine whether MFLW occur within a proposed management activity area ("Project Surveys"). This manual provides information on how to use standard methods to conduct both types of survey. Two of the chapters introduce detection methods that depend on "devices" (track plates and cameras); the final chapter describes snow tracking, which does not require a detection device.

Differences Among Survey Methods

No study has compared all of the methods and types of devices described in this manual, and therefore we cannot contrast their relative efficiencies. However, the methods differ in the following respects: the seasons during which they can be used, difficulty of identifying sign, amount of training necessary, labor and material costs, and whether they have successfully detected each species (*table 1*). No single method is better than the others in all categories (Raphael 1994).

Snow tracking and cameras have successfully detected all four species. Track plates have detected only fisher and marten. This is probably because track-plate boxes have not been enlarged to accommodate the larger species, and neither enclosed or unenclosed plates have received as widespread use in the western United States as the other methods. Because bobcats (*Lynx rufus*) have been detected at track plates, we know that felids can be attracted to the baits and will enter the boxes. Snow tracking, track plates, and line-triggered camera systems have the disadvantage of being limited to specific seasons. In addition, the difficulty of identifying the sign of the four species is greater for track-based methods than camera methods because images of the entire animal are almost always easier to identify than tracks. The extent of training necessary to use snow tracking and cameras successfully is greater than that required for track plates. Moreover, any method used in winter requires more training (for safety and travel) than methods used during other seasons.

Although cameras are technically challenging and snow tracking requires extensive experience to conduct properly, track-plate surveys are simple by comparison. A record of the sign from enclosed track plates is easier to retrieve from the field and provide to another individual for identification than is the information provided in a snow track. The 35-mm cameras are the least labor intensive because, unlike the other methods,

Table 1—***Methods described in this publication and characteristics of their use for the detection of lynx, wolverines, fishers, and martens.***

Methods	Target species detected using the method[1]	Seasons of use	Difficulty of verifying identity	Amount of training necessary to use method	Labor intensity	Cost of materials
Cameras						
Line triggered	F, M	Summer primarily	Low	Moderate	Moderate	Low
Dual sensor	W, L, F, M	Summer and winter	Low	Moderate	Low	High
Single sensor	L, F, M	Summer and winter	Low	Moderate	Low	High
Track Plates						
Box-enclosed	F, M[2]	Summer primarily	Moderate	Low	Moderate	Low
Unenclosed	F, M[2]	Summer exclusively	Moderate	Low	Moderate	Low
Snow Tracking	W, L, F, M	Winter exclusively	Moderate—High	High	High	Very low

[1]L=lynx W=wolverines F=fishers M=martens.
[2]No lynx, but bobcats have been detected.

they can operate untended for weeks. However, the material costs for snow tracking are much less than for the 35-mm camera systems.

The benefits and limitations of each method should be evaluated for each location, budget, and the objectives of the survey. We will learn much more about the efficiency of each method when it can directly be compared to other methods. Therefore, we encourage users to take every opportunity to sample survey areas using more than one method, and to publish these results. The work of Jones and Raphael (1990), Bull and others (1992), Laymon and others (1993), Fowler and Golightly (1993), and Foresman and Pearson (1995) are a start toward this goal. In Washington State, unenclosed track plates detected somewhat fewer martens than did line-triggered cameras (Jones and Raphael 1990). However, because martens may have removed bait at track plates without detection and rain reduced the legibility of tracks, this difference is trivial. Bull and others (1992) compared snow tracking, enclosed track plates, and line-triggered cameras and concluded that when conditions permitted, snow tracking was the most effective method for detecting martens. Track plates were better than line-triggered cameras when snow was absent or of poor quality for tracking. However, only 16 sample locations along one 10-km transect were included in this study. Laymon and others (1993) found that more vertebrate species were detected at unenclosed track plates than at line-triggered cameras. In this study, unenclosed track plates and the single-sensor camera had equivalent efficiencies of detecting species, including martens. Fowler and Golightly (1993) compared enclosed track plates and line-triggered cameras at 76 stations and found that track plates were the more effective method to detect martens. This is consistent with the results of comparisons of marten detections in Yosemite National Park (L. Chow, pers. comm.). J. Copeland (pers. comm.) detected wolverines at photographic bait stations more frequently by tracks in the snow than by photographs. In a recently completed study comparing the Manley dual sensor camera, open and enclosed track plates, and snow-tracking methods, Foresman and Pearson (1995) favored the use of 35-mm cameras to detect marten, fisher, and wolverine. Cameras and track plates detected martens and fishers at the same survey units, but snow tracking failed to detect marten at some units, and fishers at all the units, where they were detected by another method. A wolverine was photographed at one survey unit but was undetected there by track plate or snow tracking methods. Snow tracking was considered the least effective method given its dependence on ideal snow conditions and well-trained technicians (Foresman and Pearson 1995). Additional experimentation is necessary before the effectiveness of each method for each of the four species can be properly evaluated.

Survey Durations

It is important to emphasize that surveys conducted only to determine presence should be terminated when the intended species is detected, or if undetected, after some reasonable amount of effort (a combination of duration and spatial extent of survey). Terminating surveys when the target species is detected is the most economical way to survey large areas. The amount and schedule of maximum effort (if target species are not detected) are necessarily different for the device-dependent methods and the snow-tracking methods, and are outlined in detail in Chapters 3, 4, and 5. General considerations of the distribution of survey sample units are provided in Chapter 2.

For the purposes of this publication we refer to the use of more than one device at a time, and running more than a trivial distance of snow-track transects, as a *Survey* (see Chapter 2: Definition and Distribution of Sample Units). We accept the definition that a survey is "an exercise in which a set of qualitative or quantitative observations are made, usually by means of a standardized procedure and within a restricted period of time and over a restricted area" (Hellawell 1991). A survey can be as superficial as using more than one device during a specified time period in the same general area, or traveling a significant distance searching for tracks. However, we dedicate much of this manual to recommending minimum survey durations and effort over specified areas. To restate this important point, we use detection methods to determine presence at a point location, either a camera or track-plate location or an intersection point on a snow transect. Our surveys are *not* methods for indexing population density, population size, or change in population size.

Population Monitoring

Censuses involve counts of individuals, *indices* are counts of some object related to the number of individuals (Caughley 1977), and *monitoring*, as we define it, is an attempt to detect change in population size over time, i.e., trend. Although we do not recommend particular monitoring methods here, we envision this publication as an important step in the development of monitoring schemes. The detection methods described herein are probably the same tools that will eventually be used to index changes in population size. Hiby and Jeffrey (1987) discussed photographic techniques for population studies of rare species, and Mace and others (1994) reported the first attempt that we are aware of to use photographic methods to estimate population size. Karanth (1995) used photographic methods to estimate the population size of tigers (*Panthera tigris*) in India. Camera stations, track-plate stations, and snow transects each could be the detection technique used as the basis for a monitoring program, in much the same way that the scent-station visit was used in an attempt to assess coyote (*Canis latrans*) population status (Roughton and Sweeny 1979, 1982) and scat transects were used to monitor change in bear (*Ursus americanus* and *U. arctos*) populations (Kendall and others 1992). In fact, plans for monitoring fisher population change using track plates (Zielinski and Stauffer, in press) and cameras (York and others 1995) recently have been proposed.

We recognize the urgent need to develop monitoring schemes for the species considered here. The populations of MFLW in the conterminous United States appear to have declined, and population safeguards could be instituted if we had solid evidence of declines. However, we caution that population monitoring efforts require considerable planning and statistical evaluation before implementation (de la Mare 1984, Diefenbach and others 1994, Gerrodette 1987, Kendall and others 1992, Peterman and Bradford 1987, Taylor and Gerrodette 1993, Verner and Kie 1988). The objective of such monitoring is usually to detect a change in an index of population abundance over time. Thus, the null hypothesis that there has been no change in the population size between two points in time must be tested against the alternative that the population has changed (either increased or decreased: two-tailed test), or has declined or has increased (one-tailed tests).

The possible outcomes of testing the null hypothesis include two familiar types of errors. A Type I error occurs, with probability α, when we mistakenly reject the null hypothesis if it is true. A Type II error occurs, with probability β, when we mistakenly do not reject (i.e., 'accept') the null hypothesis when the alternative hypothesis is true. If we detect no change in a population and consider minimizing only the Type I error rate, there are two possible interpretations. Either there has been no change in the population and we are correct in our decision, or there has been a change in the population and we have insufficient information to detect this change. Small sample size and large variance reduce the ability to detect change (Cohen 1988). We must therefore ask the important question: if a significant population decline has occurred, what is the probability that we will detect it with our survey? The answer is critical to a monitoring program. However, the probability of detecting a change if it has occurred, i.e., rejecting the null hypothesis when the alternative hypothesis is true, called statistical power (1-β), is rarely determined. In developing a sampling design to monitor population change, it is essential to determine *a priori* the probability of detecting significant changes for varying sample sizes; this allows the investigator to choose an adequate sample size to detect population change with an acceptably high probability.

The literature is replete with examples of hastily implemented monitoring schemes that, after the expenditure of many of thousands of dollars, were determined to be insufficient to detect even catastrophic declines in populations over short periods. To embark on a monitoring scheme without complete familiarity with the detection method, without consultation with a competent statistician, and without simulating possible monitoring scenarios is a waste of time and money. For example, an established monitoring scheme thought to be sufficient to detect declines in whale stocks was found to be inadequate to detect a 50 percent change over a 10-year period (de la Mare 1984). Other examples of ill-fated monitoring schemes are documented in the fisheries literature (e.g., Peterman and Routledge 1983), and we cannot overemphasize the importance of conducting pre-monitoring evaluations of statistical power (Gerrodette 1987, Millard 1987, Peterman 1990, Taylor and Gerrodette 1993). Even the long-standing coyote monitoring program instituted by the U.S. Fish and Wildlife Service (Roughton and Sweeney 1979) suffered from poor planning that resulted in major changes years after the first data were collected (Roughton and Sweeney 1982).

The recent examples of monitoring schemes to track changes in bear (Kendall and others 1992) and bobcat (Diefenbach and others 1994) populations demonstrate the level of planning necessary before one considers population-level monitoring using sign surveys. Detection of even relatively large changes in population size (e.g., 25 percent) may require prohibitively large sample sizes to achieve sufficient power (Diefenbach and others 1994). Finally, one must realize that the conclusion from evaluating proposed monitoring schemes may be that it is not statistically valid or economically feasible to conduct population monitoring via inventory; demographic studies to estimate population growth rate may be preferable (Taylor and Gerrodette 1993).

Although much of the planning that goes into developing a monitoring scheme involves simulation modeling, the process also requires empirical data. For example, the probabilities of detecting (POD) animals that are known to occur in the survey area, after varying survey durations, need to be estimated. These can be estimated by determining how many radio-marked animals in the vicinity of the detection effort are actually detected (provided that previous capture does not affect subsequent detection), an approach taken by Fowler and Golightly (1993) for marten, or by using the data from multiple surveys where POD is a function of the distribution of "number-of-days-to-first-detection" (Azuma and others 1990, Zielinski and Stauffer in press). Regardless of method, POD should be estimated in a variety of habitats and physiographic provinces to determine whether regional differences exist.

A simple form of population monitoring may be possible using the system recommended in this publication. If detection surveys are conducted over a relatively short period of time, the collective information in a region can provide a "snapshot" of the local distribution of each species. A good example of this approach is represented by North American Breeding Bird Atlases (Smith 1990) and the Atlas of Mammals of the British Isles (Arnold 1978). Zielinski and others (in press) and Kucera and others (in press) describe the current distributions of fishers and American martens in California, based on techniques described in this document. Insofar as these distribution maps can be compared over time, the method can be interpreted as a way to monitor changes in species distribution.

This publication represents a significant first step toward the development of regional monitoring programs. They are urgently needed. If we are successful, and the methods described in this manual receive widespread use, biologists from private organizations and public land-management agencies will become familiar with the standard use of detection methods. They will be prepared to implement cooperative population monitoring schemes when the necessary research and planning have been done *and* when the results suggest that the effort is statistically and economically feasible.

Alaska and Canada

We expect that the methods described herein will be valuable to biologists throughout the range of each species. However, we recognize that in Alaska and Canada, where MFLW are most common, the emphasis will be less on their detection and more on the management of commercial harvest. Trapping still provides information on distribution and abundance of populations in the north, and the more open forests make aerial surveys for some species feasible (e.g., Becker 1991, Golden and others 1992). Thus, some of the methods described here may currently be less useful in Alaska and Canada. However, if the abundance of MFLW decreases and commercial trapping is reduced or prohibited, the methods described here for the conterminous western United States may have equal utility farther north.

Habitat Assessments

Ideally, a standardized survey protocol should be integrated with a standardized method for describing the habitat of both the area surveyed and the locations of detections. However, for a number of reasons, we do not propose standardized vegetation sampling methods in this publication. First, to develop a habitat sampling protocol sufficient to encompass the myriad habitat types included within the ranges of the four species considered here would be an enormous task. Second, a variety of methods already are used by different agencies or states to describe habitat (Anderson and Gutzwiller 1994), some with the goal of achieving statewide standards (e.g., California Wildlife Habitat Relationships System; Mayer and Laudenslayer 1988). We are not prepared to propose methods that would have universal appeal nor do we wish to distract from ongoing efforts. Finally, although it may be possible to standardize the type of information collected at point locations (e.g., detection stations), the scales that are most appropriate for the species treated herein are the watershed and the landscape. Field and computer methods for characterizing the biological and physical attributes at these scales are just developing and will require the coordinated effort of wildlife biologists, landscape ecologists, geomorphologists, and plant ecologists, among others. Geographic Information Systems will be an essential element of this process. The approach to characterizing habitat at this scale is far beyond the scope of our objectives here.

Even though we do not recommend a particular scheme to characterize habitat, we believe habitat information is important. We strongly recommend that some habitat assessment be included in every survey. Track plates, in particular, have been used to assess habitat use by fishers (e.g., Raphael 1988, R. Golightly, pers. comm.; M. Higley, pers. comm.; R. Klug, pers. comm.). However, the number of stations visited and the frequency of detection at individual stations can be influenced by factors other than habitat quality (e.g., hunger, learning, age, sex, population density, weather, season), so this measure should be interpreted with caution. Habitat sampling should be standardized across the largest scale possible and designed to be compatible with protocols created for other purposes. Statewide standards are best, but standardization within agency boundaries (e.g., National Forest) is preferable to none at all. The recent assessment of the conservation status of MFLW (Ruggiero and others 1994) discusses stand and landscape features associated with the occurrence of each of the four species and combinations of species (Lyon and others 1994). Consult this and other published information when deciding how to characterize landscapes surveyed and vegetation at sampling points.

Interpretation of Results

Failure to detect a species has several implications. For the species considered here, additional research on probability of detection must be conducted before we will know whether failure to detect is equivalent to "absent." And, even when the failure to detect indicates a high probability of absence, the dynamic nature of populations suggests that areas of suitable habitat that are currently uninhabited could be occupied in the future. Because most management activities occur in small areas relative to the home ranges of the largest species considered here, communication with the managers of adjacent lands is essential. The existence of a nearby population (e.g., in an adjacent Ranger District) indicates the potential for recolonization of currently unoccupied but suitable habitat. Thus, management activities planned for the area being evaluated could indirectly or cumulatively affect the species even if it is not detected in the project area.

Cautions

The central concern in the management of MFLW is to determine if any occur in a region of interest. This publication is intended to provide the technical background to begin a search for each of the four species. However, the detection of these species requires specialized skills that are acquired only after specific training. The publication is designed for biologists inexperienced with the techniques and is a necessary element in preparation for detection work. However, we emphasize that reading this manual is no substitute for practice using the methods in the field. We recommend that those interested in conducting a survey assist in work being conducted by more experienced technicians before beginning their own studies.

We encourage readers, regardless of experience level, to submit their questions and comments about the information provided herein. The publication will be improved with the addition of experience from other practitioners and by evaluating data collected using the procedures described here. This feedback, and the development of new methodologies, may necessitate an improved second edition.

Disposition of Data

The Western Forest Carnivore Committee has recommended that a data clearinghouse be established for the storage and analysis of information on the distribution of lynx, wolverines, fishers, and martens (B. Ruediger pers. comm.). Although a structure for data input has been drafted (E. Burkett pers. comm.), a process for the transmittal of information to a central repository (or repositories) has not been established. We realize, however, that this publication may stimulate the implementation of numerous detection surveys. This will provide us the tools to standardize the process by which the data are collected and managed thereafter.

We recommend that whenever a target species is detected, a copy of the Species Detection form (sample form included in the appendix of each method chapter and in the pocket on the inside back cover) be submitted to the Natural Heritage program in the state where the species are detected. A list of the addresses of the Natural Heritage program offices for each state is provided in *appendix A*. A duplicate of the Species Detection form should also be archived in a local administrative office of the agency sponsoring the survey (e.g., Forest Supervisor's Office, USDA Forest Service). This assumes that the Natural Heritage program in the state maintains a database for the target species detected. Currently this will be a problem for marten because many states do not maintain records for this species. Until they do, copies of the form should at least be forwarded to a designated administrative office, perhaps at the regional level.

Because most state Natural Heritage databases record information only on positive results from surveys, we also recommend that a Survey Record form (sample form also included in the appendix of each chapter and in the pocket on the inside back cover) be completed and filed at the appropriate administrative office. These forms become an official record of where surveys have been conducted, regardless of results, and are just as important as the record of detections.

Finally, we encourage coordination, communication, and sharing of data among the individuals, agencies, and organizations conducting detection surveys to maximize our understanding of this poorly known group of species.

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Appendix A—Addresses of State Natural Heritage Programs

Alaska Natural Heritage Program
707 A Street, Suite 208
Anchorage, AK 99501
PHONE: (907) 279-4549
FAX: (907) 258-9139

California Natural Heritage Division
Department of Fish and Game
1220 S Street
Sacramento, CA 95814
PHONE: (916) 322-2493
FAX: (916) 324-0475

Colorado Natural Heritage Program
College of Natural Resources CSU
103 Natural Resources Building
Ft. Collins, CO 80523
PHONE: (303) 491-1309
FAX: (303) 491-0279

Idaho Conservation Data Center
Department of Fish and Game
600 S. Walnut Street, Box 25
Boise, ID 83707
PHONE: (208) 334-3402
FAX: (208) 334-2114

Montana Natural Heritage Program
State Library Building
1515 E. 6th Ave.
Helena, MT 59620
PHONE: (406) 444-3009
FAX: (406) 444-0581

Nevada Natural Heritage Program
Dept. of Conserv. & Natural Resources
123 West Nye
Carson City, NV 89710
PHONE: (702) 687-4245
FAX: (702) 885-0868

New Mexico Natural Heritage Program
University of New Mexico
2500 Yale Blvd. SE, Suite 100
Albuquerque, NM 87131
PHONE: (505) 277-1991
FAX: (505) 277-7587

Oregon Natural Heritage Program
Oregon Field Office
1205 NW 25th Ave.
Portland, OR 97210
PHONE: (503) 229-5078
FAX: (503) 228-3153

Utah Natural Heritage Program
3 Triad Center, Suite 450
355 W North Temple
Salt Lake City, UT 84180-1204
PHONE: (801) 538-4759
FAX: (801) 538-4709

Washington Natural Heritage Program
Department of Natural Resources
P.O. Box 47016
Olympia, WA 98504-7016
PHONE: (206) 902-1450
FAX: (206) 902-1783

Wyoming Natural Diversity Database
1604 Grand Ave., Suite 2
Laramie, WY 82070
PHONE: (307) 745-5026
FAX: (307) 745-5026