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HABITAT SUITABILITY INDEX MODELS: FISHER

Fish and Wildlife Service

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by

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PREFACE

This document is part of the Habitat Suitability Index (HSI) Model Series (FWS/OBS-82/10), which provides habitat information useful for impact assessment and habitat management. Several types of habitat information are provided. The Habitat Use Information Section is largely constrained to those data that can be used to derive quantitative relationships between key environmental variables and habitat suitability. The habitat use information provides the foundation for HSI models that follow. In addition, this same information may be useful in the development of other models more appropriate to specific assessment or evaluation needs.

The HSI Model Section documents a habitat model and information pertinent to its application. The model synthesizes the habitat use information into a framework appropriate for field application and is scaled to produce an index value between 0.0 (unsuitable habitat) and 1.0 (optimum habitat). The application information includes descriptions of the geographic ranges and seasonal application of the model, its current verification status, and a listing of model variables with recommended measurement techniques for each variable.

In essence, the model presented herein is a hypothesis of species-habitat relationships and not a statement of proven cause and effect relationships. Results of model performance tests, when available, are referenced. However, models that have demonstrated reliability in specific situations may prove unreliable in others. For this reason, feedback is encouraged from users of this model concerning improvements and other suggestions that may increase the utility and effectiveness of this habitat-based approach to fish and wildlife planning. Please send suggestions to:

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CONTENTS

ACKNOWLEDGMENTS

Mr. Richard Earle, Michigan Department of Natural Resources; Mr. James C. Pack, West Virginia Department of Natural Resources; Dr. Roger A. Powell, Departments of Zoology and Forestry, North Carolina State University; Mr. Michael Raine, Western Wildlife Environments Consulting Ltd., Calgary, Alberta; and Ms. Marjorie Strickland, Ministry of Natural Resources, Ontario, Canada, have all provided useful and valuable critiques of earlier drafts of the HSI model for fisher. The comments and suggestions of these individuals have added significantly to the quality of this HSI model, and their contributions and time are gratefully acknowledged. The cover of this document was illustrated by Jennifer Shoemaker. Word processing was provided by Carolyn Gulzow and Dora Ibarra.

FISHER (Martes pennanti)

HABITAT USE INFORMATION

General

The fisher (Martes pennanti) is the largest member of its genus and is found only in North America (Powell 1982). Within the contiguous United States, indigenous and reintroduced populations presently inhabit portions of the Appalachian Mountains from New England south to West Virginia in the east; northern Wisconsin, Minnesota, and Michigan's upper peninsula in the Midwest; northern Idaho and western Montana in the Northwest; and as far south as northern California along the West Coast.

Fishers are solitary except for brief periods during the breeding season (deVos 1952; Coulter 1966; Powell 1982). The species may be active during any part of the day with one to three activity periods typically lasting from 1 to 5 hours (Powell 1982). Fishers in New Hampshire were generally crepuscular during all seasons (Kelly 1977). Although fishers do climb trees, the majority of their activity is terrestrial (Brander and Books 1973; Pittaway 1978; Powell 1979a, 1982; Leonard 1980).

Food

The fisher will prey on any animal that can be caught and overpowered (Powell 1982). The snowshoe hare (Lepus americanus) has been consistently identified as a key component of the fisher's diet throughout its range (deVos 1951; Brander and Books 1973; Clem 1975; Powell 1978, 1979a, 1981, 1982). Leonard (1980) reported that the use of small mammals and the number of food items recorded per individual fisher declined with increasing hare density. Snowshoe hare, ruffed grouse (Bonasa umbellus), and blue grouse (Dendrogapus canadensis) are the dominant winter food items of fisher in Manitoba (Leonard 1980). In addition to snowshoe hares, major winter prey of fishers in Oregon are northern flying squirrels (Glaucomys sabrinus) and pine squirrels (Tamiasciurus spp.) (Ingram 1973). White-footed mice (Peromyscus spp.), red-backed voles (Clethrionomys spp.), meadow voles (Microtus spp.), and shrews (Sorex spp. and Blarina spp.) are the most common small mammals found in the fisher's habitat and are generally the most common small mammals in its diet (Powell 1982). Red-backed voles (C. gapperi) were the major prey of fishers in New Hampshire (Kelly 1977). The carrion of large animals is sometimes an important component of the fisher's diet (Hamilton and Cook 1955; Stevens 1968; Clem 1975; Kelly 1977; Powell 1979a, 1982). Fishers will stay in the vicinity of and feed on the carrion of deer, or other large animals, for several days (Powell 1982). The fisher is a specialized predator of the porcupine (Erethizon dorsatum) and is unique in the Northeast and Midwest as the only predator that consistently preys on this rodent (Powell 1979a, 1981, 1982). However, the fisher's diet does not always include porcupine due to the absence or extremely low densities of porcupines in some portions of the fisher's range (Kelly 1977).

Seasonal changes in the fisher's diet are minor (Clem 1975). Birds, berries, and insects became more important components of the fisher's diet in Maine as their availability increased in the spring and summer months (Coulter 1966). Fruits and mast were reported to comprise approximately 30% of the fisher's summer diet in New Hampshire (Stevens 1968). Vegetative foods are relatively unimportant constituents of the fisher's diet and are probably consumed only when other foods are difficult to obtain (Powell 1982).

Water

No specific information on the water requirements of the fisher was found in the literature.

Cover

Dense coniferous and mixed coniferous/deciduous forests are the preferred habitat of the fisher (deVos 1952; Coulter 1966; Brander and Books 1973; Clem 1977; Kelly 1977; Powell 1979a). The species is always found in or near forests with continuous overhead cover (Powell 1982). Fishers in New Hampshire selectively used forested habitats with 80 to 100% canopy closure while stands with less than 50% canopy closure were generally avoided (Kelly 1977). Forest stands of low canopy closure were used only if they were adjacent to areas with dense forest cover. Clearcut areas were avoided during the winter; however, some use of these areas was recorded during summer when vegetation provided overhead cover. Openings in forest cover are occasionally used by fishers for foraging; however, the species will not travel far into openings (Ingram 1973). Fishers in Ontario were absent from recently logged and burned forest stands (deVos 1951). Clearcutting of large areas can significantly reduce the availability of winter foraging areas (Powell 1982). Small clearcut areas, well interspersed with uncut forest stands, may not seriously affect fisher populations. Selectively cut forest stands are used by fisher for foraging.

Mature to climax successional stages of coniferous forests provide the most suitable fisher habitat due to adequate cover and an abundance of potential den sites (deVos 1951). However, the species will inhabit second growth forests if suitable cover is present. Ideal fisher habitat in Oregon was characterized as being dense mature forest, close to climax condition, containing a large percentage of coniferous trees with many windfalls (Ingram 1973). Fishers in New Hampshire chose to inhabit wetland associated forests, primarily alder (Alnus spp.), and mixed coniferous/deciduous (51 to 74% coniferous) forest types (Kelly 1977). Fishers avoided forested stands comprised of 74% or more deciduous trees. Mixed and pure stands of aspen (Populus tremuloides) and paper birch (Betula papyifera) were particularly poor fisher habitat in Ontario (deVos 1951). The dispersal of fishers from release sites in Maine occurred first, and most rapidly, in hilly terrain, regardless of the forest type present (Coulter 1960). Low lying coniferous forests containing a high proportion of bogs, or generally wet areas, did not support high populations of fishers. The majority of recorded observations of reintroduced fisher in West Virginia were in sugar maple (Acer saccharum), beech (Fagus grandifolia), yellow birch (Betula alleghaniensis), and red spruce (Picea rubens) cover types (Pack and Cromer 1981). No major expansion of fisher into oak (Quercus spp.)-hickory (Carya spp.) cover types was recorded. In California, the fisher is most closely associated with Douglas-fir (Pseudotsuga menziesii) and mixed conifer forest types (Schempf and White 1977). The mixed conifer forest type was defined as a mixture of pines (Pinus spp.) and either Douglas-fir or true firs (Abies spp.), in which pines comprised 20 to 80% of the timber cover. The occurrence of fishers in juniper (Juniperus spp.) forest types is uncommon. The mean elevations of the majority of fisher sightings in California's North Coast, North Sierra, and South Sierra regions were 975 m (3,200 ft), 1,676 m (5,500 ft), and 2,073 m (6,800 ft), respectively. Ingram (1973) reported that fishers in Oregon prefer dense, mature coniferous forests in the upper Transition and Canadian life zones. The species may range into lower elevation ponderosa pine (P. ponderosa) forests during winters when fisher populations are high.

Fishers in Ontario were most frequently trapped at the edges of conifer stands and in mixed coniferous/deciduous stands (Clem 1975). Fisher tracks indicated these forest types were used for foraging, and stands comprised solely of hardwoods were crossed without stopping. Monotypic evergreen forests (e.g., red pine [P. resinosa] plantations) in the Great Lakes region may provide less suitable habitat than do forests comprised of a mixture of evergreen and deciduous species (Earle, pers. comm.). However, monotypic evergreen wetlands [e.g., white cedar (Thuja occidentalis) swamps] are probably as suitable as any conifer/hardwood mixture. A 90:10 ratio of northern hardwoods to hemlock (Tsuga spp.) adjacent to, or interspersed with, an evergreen wetland can provide high quality fisher habitat because it is a preferred habitat for porcupines. Forests comprised of well interspersed stands of evergreen and deciduous types can be high quality fisher habitat because all resources are available within the home range of each fisher. Results of a questionnaire sent to Ontario trappers (683 responses), requesting information on where fisher sign was most often found, suggests the following breakdown of winter habitat use: swamp 23%; old mixed hardwood/conifer forest 21%; young mixed hardwood/conifer forest 21%; old hardwood forest 11%; old conifer forest 8%; young hardwood forest 8%; young conifer forest 6%; and other 2% (Strickland pers. comm.). Forested wetlands, which accounted for the greatest habitat use, were characterized as typically being comprised of alder, cedar (Thuja spp.), and black spruce (Picea mariana). The occurrence of fishers in mature hardwoods was probably largely due to the occurrence of porcupines, which den in mature hardwood trees during winter. The survey indicates greater use by fisher of mixed forest stands and a slight preference for mature stands over younger forest stands. Leonard (1980) frequently recorded fisher activity in the ecotones between homogeneous forest stands in Manitoba. Open, hardwood forest types are frequently avoided by fisher (Clem 1975; Kelly 1977), and mixed stands of coniferous/deciduous trees may be avoided when they are less dense than other available forested habitats (Coulter 1966).

The fishers' use of cover types seems to be correlated, in part, to the presence and abundance of prey species. However, in New Hampshire, fishers tended to den within dense, lowland coniferous and coniferous/hardwood forest types more than they used these types for hunting (Kelly 1977). Habitats with a high diversity of small mammals were preferred foraging areas. Hardwood stands with lower than average small mammal diversity and abundance were avoided. Although clearcut areas had the highest diversity of small mammals, these areas were avoided by fishers during the winter due to an absence of overhead cover and an excessive snow depth, which made small mammals less accessible. Raine (1982, 1983) believes that the movements of fishers are restricted by soft, thick snow. A snow depth of 20 cm (9 inches) was postulated to begin restricting fisher movements (Raine 1983). Fishers in Manitoba travelled upon snowshoe hare trails and established fisher trails to a greater degree during the midwinter period with deep snow than in the early winter period of thin snow cover, or the late winter period when snow cover was typically crusted. Established trails were believed to give fishers greater support, thereby increasing their ease of movement and conservation of energy during the midwinter thick snow period. Leonard (1980) also attributed modifications of the fisher's behavior to the amount and condition of snow cover. Declines and resurgence of fisher activity were found to be closely correlated to major changes in snow cover. Fluctuations in fisher activity were accompanied by changes in cover type selection and alterations in the modes of locomotion. Fishers confined their activity to forested cover types when snow depth reached 4 to 5 cm (1.5 to 2.0 inches). As winter progressed, and snow depths increased, the number of recorded fisher track observations decreased. Track records increased six fold after a thaw formed a supportive crust. Open bogs were avoided by the species during midwinter; however, these habitat types were used when a snow crust formed that was strong enough to support fishers. Raine (pers. comm.) found that fishers did not appear to avoid areas without overhead cover during winter. Open bogs and lakes were crossed as they were encountered.

Fishers use a variety of temporary shelters and sleeping sites that include: hollow logs; tree cavities; brush piles; burrows and dens of other animals; and snow dens (Coulter 1966; Powell 1982). Fisher dens in California were associated with snags and downed logs that were 75 to 100 cm (30 to 40 inches) in diameter (Buck et al. 1979). Fisher dens in Oregon were located in cavities within mature trees and in rocky ledges (Ingram 1973). Snow dens were occasionally used for short periods. Most temporary winter shelters of fishers in Manitoba were subnivian and were associated with the roots, trunks, or branches of fallen trees (Raine pers. comm.).

Reproduction

All known fisher maternity dens have been located high in hollow trees (Powell 1982). All identified fisher tree dens have been in hardwood species (Leonard 1980). The biological advantages of hollow trees for maternal dens include thermal protection for kits, protection from adult male fishers, and security from predators.

Interspersion

Fishers' movements are governed by topography, cover, and the availability of food (deVos 1952). Food abundance and availability is probably the most important factor affecting the fisher's movements (Strickland et al. 1982). Movements are mainly concentrated along drainages, ridgelines, and lake shores while straight line movements are usually the result of cross-country excursions (deVos 1951). Fishers in California used the same ranges and travel routes regardless of season (Buck et al. 1979). Fishers in Manitoba frequented conifer dominated ridgelines in midwinter (Raine 1983). Ridgelines provided the preferred habitat of the fisher's major prey species in the study area (e.g., snowshoe hare, red squirrel [*Tamiasciurus hudsonicus*], and microtine rodents). Thick stands of young conifers and windfalls were common on the ridgelines and were often investigated by fishers. The fisher's hunting pattern was described by Brander and Books (1973) as being a random investigation of brushy areas, windfalls, and hollow trees. More recent findings have correlated specific winter foraging patterns with particular habitat types (Powell and Brander 1977; Powell 1978, 1979a, 1982). Within dense conifer stands, where prey species other than porcupines are present in relatively high densities, the fisher's foraging strategy consists of frequent changes in its direction of movement to investigate coverts and other cover in order to flush prey. Conversely, within upland hardwood stands, typically good porcupine winter habitat, fishers move distances up to 5 km (3.1 mi) with infrequent changes in direction in order to find porcupines that are typically present in low densities. It appears that resident fisher are familiar with the locations of porcupine dens and direct their foraging activities toward these sites. Although fishers hunt within hardwood stands, chiefly for porcupines, they will alter their direction of travel in order to pass through and investigate small conifer stands (Coulter 1966; Powell 1979a). Powell (1979a) recorded concentrated multi-day use of conifer habitats in Michigan. Movements of up to 5 km (3.1 mi) to a new patch of lowland conifer habitat were followed by further multi-day stays. Kelly (1977) estimated that the average distance traveled by fishers in New Hampshire per active period was 2.5 km (1.6 mi). Adult females are the least mobile, adult males the most mobile, and subadults exhibit intermediate mobility. All fishers moved greater distances during winter months. No major seasonal shifts in elevation were recorded for fishers in California (Buck et al. 1979). Similarly, fishers in New Hampshire did not use separate seasonal ranges (Kelly 1977).

Estimates of fisher home range sizes in Michigan and California ranged from approximately 15 to 35 km^2 (5.8 to 13.5 mi^2) (Buck et al. 1979; Powell 1979a). Annual home range size in New Hampshire varied from 6.6 to 39.6 km^2 (2.5 to 15.2 mi^2) with an overall average of 19.2 ± 12.1 km^2 (7.4 ± 4.6 mi^2) (Kelly 1977). Mid-winter home ranges for two juvenile female fishers in Manitoba were 15.0 and 20.5 km^2 (5.8 and 8 mi^2) (Raine pers. comm.). The home ranges of female fishers are smaller than those of males (Kelly 1977; Leonard 1980; Powell 1982). There is extensive overlap of the home ranges of male and female fisher, while there is little encroachment of home ranges of the same sex (deVos 1952; Coulter 1966; Buck et al. 1979; Powell 1979b). Yearly home range overlap occurred among fisher of all age and sex classes in New Hampshire, and mutual occupancy of areas on a yearly basis by two or more fishers was not uncommon (Kelly 1977). There was no close relationship found between home range configuration and gross topographical features in a California study (Buck et al. 1979). However, Kelly (1977) reported the long axis of home ranges recorded for fishers in New Hampshire paralleled valleys and ended at, or nearly coincided with, streams. Within preferred habitats, there may be one fisher per 2.6 to 7.5 km^2 (1.0 to 2.9 mi^2) (Coulter 1966; Kelly 1977). Maximum density of fishers in northern Wisconsin and upper Michigan was estimated to be one animal per 13 km^2 (5.0 mi^2) (Peterson et al. 1977; Powell 1982).

Special Considerations

Practical management of the fisher is limited to regulation of trapping, maintenance of extensive forested areas, and transplanting programs (Hamilton and Cook 1955; Coulter 1960). The fisher may be used in forest management as a means to decrease excessive porcupine populations (Powell 1982). The fisher was believed to be the cause of the decline in porcupine populations in upper Michigan (Brander and Books 1973; Powell and Brander 1977; Earle 1978 cited by Powell 1982; Earle and Kramm 1982). Declines in porcupine populations following introduction of fishers or increases in fisher populations have also been recorded in New York (Hamilton and Cook 1955), Massachusetts (Dodge 1967 cited by Earle and Kramm 1982), Ontario (Strickland and Douglas 1981), and Nova Scotia (Dodds and Martell 1971).

The fisher has been successfully reintroduced into suitable habitats in the following States and provinces: Idaho (Morse 1961; Williams 1962); Massachusetts (Dodge 1977, cited by Powell 1982); Michigan (Irvine et al. 1964; Brander and Books 1973); Montana (Weckwerth and Wright 1968); New York (Kelsy 1977); Oregon (Morse 1961, Yocom and McCollum 1973); West Virginia (Pack and Cromer 1981); Wisconsin (Irvine et al. 1964; Peterson et al. 1977); Nova Scotia (Dodds and Martell 1971); and Ontario (Strickland and Douglas 1981).

The fisher has been eliminated from the majority of its original range within the United States because of extensive forest cutting and overtrapping (Powell 1982). Small clearcut areas interspersed with uncut areas may not affect fisher populations. However, extensive clearcut areas may limit fisher populations due to subsequent reductions in suitable winter foraging areas. Fishers will use selectively cut forest stands and second growth forests. Ingram (1973) suggested that impacts on fisher populations can be reduced by limiting the size of shelter wood cuts and clearcuts, maintaining forested cover on ridgelines and in drainage bottoms, and retaining and encouraging as much ground cover as possible in cutover areas to provide adequate cover for the fisher's prey. Old snags and hollow trees should be maintained as potential den sites. Uneven-aged forest management would generally favor fisher habitat quality (Earle pers. comm.). However, even-aged management using small clearcuts on a rotation of sufficient length to maintain most of the forest in mature age classes would maintain high quality fisher habitat. Either management technique may be appropriate depending on the cover type present, the species of regeneration desired, and the extent of the forested area being managed for fisher. Fishers are easily trapped, often in sets made for other furbearers, and have a low reproductive rate (Coulter 1966). Protection from trapping is believed to be the most important factor contributing to the increase in northeastern fisher populations. Powell (1979b) believed that only small increases in fisher mortality above natural levels may result in local fisher extinction. Only well established and widespread fisher popoulations should be subjected to trapping pressures.

Fisher and marten (Martes americana) compete for den sites and food (deVos 1952). Fisher and marten populations may be inversely related because of competition for these resources. Fisher are believed to be more adaptable to habitat alterations than are marten and may be found in second growth forest with good cover more often than marten. However, Clem (1975) attributed the inverse relationship between fisher and marten populations to a reflection of the habitat preferences of the two species more than their competition for habitat resources. Fishers appear to be more adapted to intermediate stages of forest succession than are marten (Powell pers. comm.). Data from Ontario indicate that as forests get older, fisher populations decrease while marten populations increase. Raine (1983) concluded that the temporal differences in habitat use exhibited by fisher and marten could be partially explained by their different responses to snow cover. Both species were reported to exhibit 10-year population cycles in Ontario (deVos 1952).

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This HSI model has been developed for application throughout the range of the fisher (Fig. 1).

Season. This model has been developed to evaluate the year-round habitat requirements of the fisher.

Cover types. This model was developed for application in the following cover types (terminology follows that of U.S. Fish and Wildlife Service 1981): Evergreen Forest (EF); Deciduous Forest (DF); Evergreen Forested Wetland (EFW); and Deciduous Forested Wetland (DFW).

Minimum habitat area. Minimum habitat area is defined as the minimum amount of contiguous habitat that is required before an area will be occupied by a species. Information on the minimum habitat area required by fisher was not located in the literature; however, the home range size for fisher has been reported to range from 6.6 to 39.6 km^2 (2.5 to 15.2 mi^2). Based on this information, it is assumed that a minimum of 259 km^2 (100 mi^2) of potentially suitable contiguous habitat must be present before an area will be successfully inhabited by a population of fishers. Smaller forest areas may maintain populations, particularly if the area is near, or adjacent to, larger areas of potentially suitable fisher habitat. Smaller forested areas, < 100 km^2 (38.6 mi^2), will probably be of insufficient size to support a population of fishers, particularly if the evaluation area is isolated from other large forested areas.

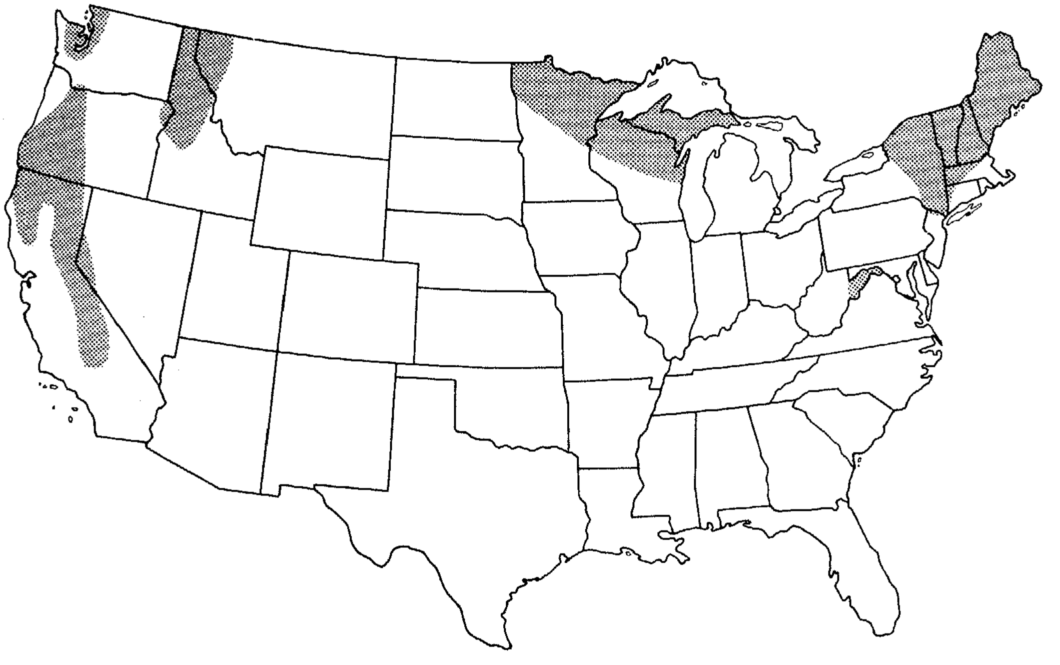


Figure 1. Approximate current distribution of the fisher in the contiguous United States (modified from Strickland et al. 1982).

Verification level. This HSI model provides habitat information useful for impact assessment and habitat management. The model is a hypothesis of species-habitat relationships and does not reflect proven cause and effect relationships. Earlier drafts of this model have been reviewed by Mr. Richard Earle, Michigan Department of Natural Resources; Mr. James C. Pack, West Virginia Department of Natural Resources; Dr. Roger A. Powell, North Carolina State University; Mr. Michael Raine, Western Wildlife Environments Consulting Ltd., Calgary, Alberta; and Ms. Marjorie Strickland, Ontario Ministry of Natural Resources. Improvements and modifications suggested by these persons have been incorporated into this model.

Model Description

Overview. The availability of prey and the foraging strategies of the species appear to determine the fishers' use of habitat. The fisher's diet is typically comprised of small mammals that inhabit all seral stages of forested habitats. However, non-forested cover types and clearcut areas must be in close proximity to forest and contain sufficient amounts of vegetation or debris to provide adequate security and foraging cover for the fisher. Non-forested cover types are rarely used by fisher for winter foraging due to decreased cover and prey availability resulting from relatively greater amounts of snow cover in these areas. Although other sites may be used, information presented in the literature indicates that the fisher selects large, mature, deciduous trees, or snags, for the establishment of maternal dens. Habitat use studies infer that dense forest stands in the latter successional stages are required to provide suitable winter habitat for the fisher. Although the fisher's use of habitat is more pliant when considered on an annual basis, the quality of winter/early spring habitat appears to be the most restrictive component of the fishers' annual habitat requirements. It is assumed that the variables used to define the potential quality of winter habitat for fisher will also reflect potential habitat quality for major prey species. Therefore, it is assumed that suitable winter cover for the fisher will characterize habitats that will support adequate numbers of prey to meet the fisher's food requirements. It is also assumed that dense, mature forest stands will contain sufficient numbers of potential den sites to meet the reproductive needs of the species. Based on the assumption that adequate winter cover will support ample prey and contain potential den sites, an evaluation of winter cover quality is assumed to reflect potential year-round habitat quality for the species.

The following sections provide documentation of the logic and assumptions used to translate habitat information for the fisher to the variables and equations used in the HSI model. Specifically, these sections cover: (1) identification of variables used in the model; (2) definition and justification of the suitability levels of each variable; and (3) description of the assumed relationships between variables.

The relationships of habitat variables, life requisites, and cover types to an HSI for the fisher are presented in Figure 2.

Winter cover. Dense, mature, and old-growth forest stands are assumed to provide potentially optimum winter habitat for fishers. These later successional stages of forest communities are assumed to provide adequate thermal cover, potential den sites for the fisher's winter cover, and adequate amounts of downed woody debris and understory vegetation to support an adequate prey base.

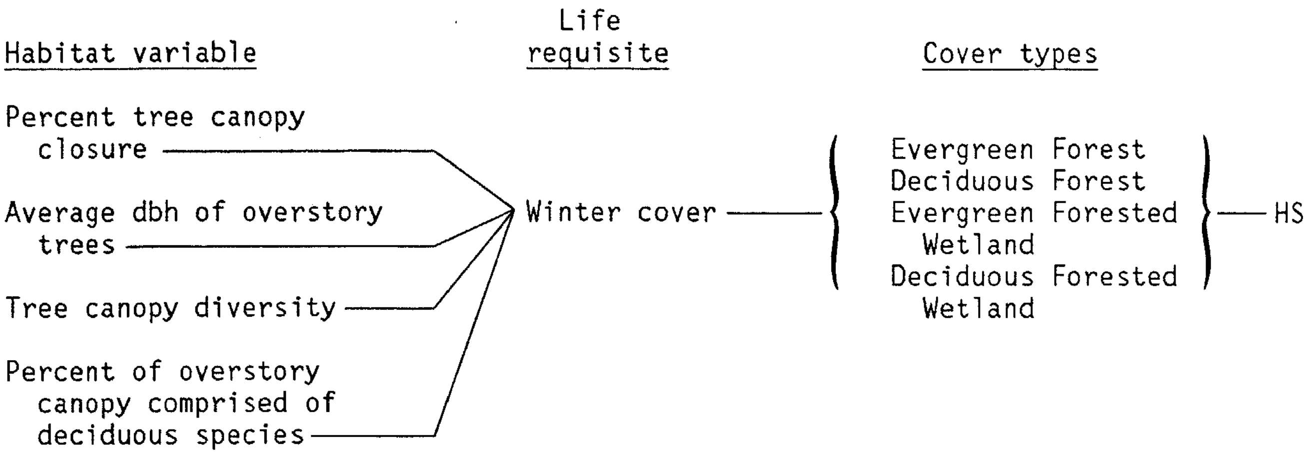


Figure 2. Relationships of habitat variables, life requisites, and cover types to an HSI for the fisher.

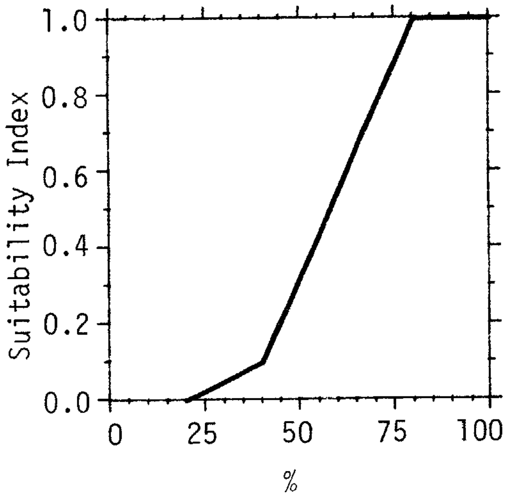
It is assumed that the average diameter at breast height (dbh) of overstory trees is correlated to the successional stage of a forest stand. An average dbh of overstory trees of 5.0 cm (2 inches) or less is assumed to be indicative of sapling or shrub dominated stands. Although forest stands of this type may provide foraging sites for fishers, they are assumed to be of little value in providing adequate winter cover. Forest stands with an average overstory tree dbh of 13 to 25 cm (5 to 10 inches) are assumed to be characteristic of sapling-pole successional stages. Stands of this type are assumed to provide more winter cover for fishers; however, they are of less value than mature stands. Mature forest stands are assumed to be characterized by an average dbh of overstory trees of 38 cm (15 inches) or larger. Forest stands dominated by trees that are 38 cm (15 inches) or greater in size are assumed to be one indicator of optimum winter cover for fisher. However, the average dbh of overstory trees is assumed to be directly influenced by tree density in predicting the potential quality of winter cover for fishers. Dense forest stands are the preferred habitat of the species. Although the average dbh of overstory trees may reflect optimum conditions for tree size, a decreased potential for suitable winter cover for fishers will be present if the total tree canopy closure of the stand is low. It is assumed that optimum stand density will exist when the percent tree canopy closure is 80% or greater. Dense stands of small diameter overstory trees have more potential for providing adequate winter cover for fishers than do sparse stands of trees in the same size class. It is assumed in this model that forest stands with a canopy closure of 20% or less have no potential as winter cover, regardless of the average dbh of the dominant trees in the stand.

The vertical structural diversity of a forest stand is also assumed to influence potential habitat quality for fishers. Forests comprised of trees in different size and height classes are assumed to provide a greater number of habitat niches, which may support more diverse prey populations. Even-aged stands, comprised of trees in the same general size and age classes, are assumed to have relatively low vertical diversity. Forest stands characterized by a single tiered canopy tend to be uniform in height and are assumed to provide comparatively fewer habitat niches for potential prey. Structurally diverse forests are also assumed to provide a greater number of shelter and refuge sites for fishers. Forests consisting of several age classes or general canopy levels (e.g., dominant and codominant overstory, understory, and shrubs) are assumed to provide greater vertical and horizontal diversity resulting in security and thermal and protective cover for the fisher and its prey.

The effect of a stand's canopy closure, its tree canopy diversity, and tree size in defining potential fisher habitat is directly influenced by the species composition of the stand. A mixture of forest types, or a mixture of evergreen and deciduous tree species in a stand, is assumed to reflect optimum conditions. Forests, or forest stands, comprised of a mixture of evergreen and deciduous tree species are assumed to provide a greater variety of den or shelter sites and a more diverse prey base for the fisher. Forests or stands with 50 to 90% of the overstory comprised of evergreen trees are assumed to reflect potentially optimum winter cover. Forest stands comprised totally of evergreen trees are assumed to be of slightly lower value for providing winter cover due to decreased diversity and a scarcity of potential den trees. Forest stands comprised solely of deciduous tree species are assumed to have minimal value as fisher winter cover due to decreased overhead cover and low prey abundance and diversity.

Model Relationships

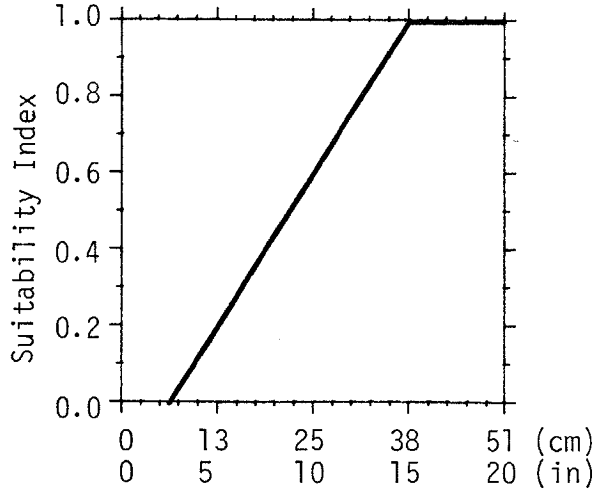
Suitability Index (SI) graphs for habitat variables. The relationships between various conditions of habitat variables and habitat suitability for the fisher are graphically represented in this section.

Cover type	Variable		
EF,DF, EFW,DFW	V_1	Percent tree canopy closure.	

EF,DF,
EFW,DFW

V_2

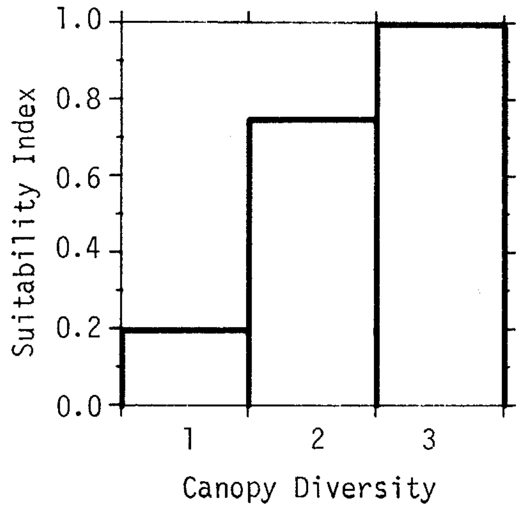
Average dbh of overstory trees.



EF,DF,
EFW,DFW

V_3

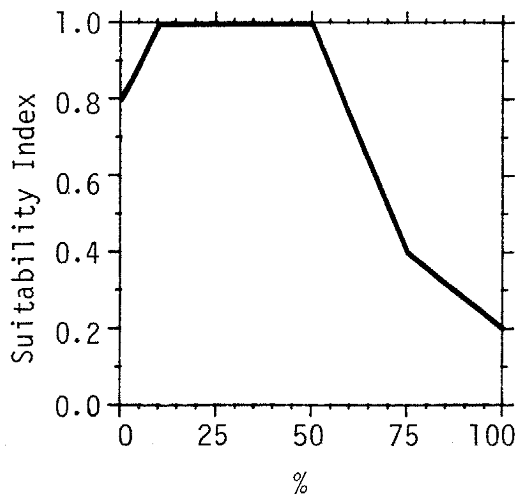
Tree Canopy Diversity
1. Single-storied stand.
2. Two-storied stand.
3. Multi-storied stand. (see Fig. 3 for definitions of these categories).



EF,DF,
EFW,DFW

V_4

Percent of overstory canopy comprised of deciduous species.



Equation. In order to obtain a life requisite value for the fisher, the SI values for appropriate variables must be combined. A discussion and explanation of the assumed relationships between variables was included under Model Description, and the specific equation in this model was chosen to mimic these perceived biological relationships as closely as possible. The suggested equation for obtaining a winter cover value in evergreen forests, evergreen forested wetlands, deciduous forests, and deciduous forested wetlands is:

$$(V_1 \times V_2 \times V_3)^{1/3} \times V_4$$

HSI determination. Since winter cover was the only life requisite considered in this model, the HSI for a specific cover type equals the winter cover value, determined for that cover type.

Application of the Model

This model may be used to determine HSI values for individual forest stands or for a number of forest stands, or types, that make up the total study area. In situations where two or more forest types are present, an overall weighted HSI (weighted by area) can be determined by performing the following steps:

1. Stratify the evaluation area into forest or stand types.
2. Determine the area of each forest type and the total area of the evaluation area.
3. Determine an HSI value for each forest type in the evaluation area.
4. Multiply the area of each forest type by its respective HSI value.
5. Add all products calculated in step 4 and divide the sum by the total area of all forest types to obtain the weighted HSI value.

The steps outlined above are expressed by the following equation:

$$\frac{\sum_{i=1}^{n} HSI_i \; A_i}{\Sigma \; A_i}$$

where: n = number of forest stands (types)

HSI_i = HSI of individual stand

A_i = area of stand i

Definition of variables and suggested field measurement techniques (Hays et al. 1981) are provided in Figure 3.

Variable (definition)		Cover types	Suggested techniques
V_1	Percent tree canopy closure [the percent of the ground surface that is shaded by a vertical projection of the canopies of all woody vegetation taller than 5.0 m (16.5 ft)].	EF,DF,EFW, DFW	Remote sensing, line intercept
V_2	Average dbh of overstory trees [the average diameter at breast height (1.4 m/ 4.5 ft) above the ground of those trees that are ≥ 80 percent of the height of the tallest tree in the stand].	EF,DF,EFW, DFW	Cruise for tallest tree in stand. Sample with optical range finder and Biltmore stick on strip quadrat.
V_3	Tree Canopy Diversity (an evaluation of the vertical structural diversity within a forest stand classed as one of the following). 1. Single-storied stand Stand canopy is comprised of dominant and codominant trees that are generally of the same age and size class. Canopies of trees are within the same height stratum, or are overlapping. Understory trees comprise less than 10% canopy closure.	EF,DF,EFW, DFW	Remote sensing, on site inspection

Figure 3. Definitions of variables and suggested measurements techniques.

Variable (definition)		Cover types	Suggested techniques
	2. Two-storied stand Stand canopy is stratified into two distinct layers: overstory and understory. The understory is clearly developed, having more than 10% canopy closure of trees with their crowns entirely below the dominant canopy strata.		
	3. Multi-Storied Stand Stand canopy is comprised of the crowns of trees in various age and size classes. Shrubs, trees of intermediate height, dominant and codominant trees all occur in the stand.		
V_4	Percent of overstory canopy comprised of deciduous species [the percent canopy closure of deciduous tree species in the overstory divided by the total canopy closure of all overstory trees].	EF,DF,EFW, DFW	Remote sensing, line intercept

Figure 3. (concluded)

SOURCES OF OTHER MODELS

No other habitat models for the fisher were located.

REFERENCES

Brander, R. B., and D. J. Books. 1973. Return of the fisher. Nat. Hist. 82(1):52-57.

Buck, S., C. Mullis, and A. Mossman. 1979. A radio telemetry study of fishers in northwestern California. Cal.-Nev. Wildl. Trans. 166-72.

Clem, M. K. 1975. Interspecific relationship of fishers and martens in Ontario during winter. Pages 165-182 in R. L. Phillips and C. Jonkel (eds.). Proc. of Predator Symp. June 16-19. Univ. Mont., Missoula.

Coulter, M. W. 1960. The status and distribution of fisher in Maine. J. Mammal. 41(1):1-9.

____________. 1966. Ecology and management of fishers in Maine. Ph.D. Thesis, State Univ. Coll. Forest., Syracuse Univ., Syracuse, NY. 183 pp.

deVos, A. 1951. Recent findings in fisher and marten ecology and management. Trans. N. Am. Wildl. Conf. 16:498-507.

_________. 1952. Ecology and management of fisher and marten in Ontario. Tech. Bull. Ontario Dept. Lands and Forests, Wildl. Ser. 1. 90 pp.

Dodds, D. G., and A. M. Martell. 1971. The recent status of the fisher, Martes pennanti (Erxleben), in Nova Scotia. Can. Field-Nat. 85:62-65.

Dodge, W. E. 1967. The biology and life history of the porcupine (Erethizon dorsatum) in western Massachusetts. Ph.D. Thesis, Univ. Massachusetts, Amherst. 173 pp. Cited by Earle and Kramm 1982.

___________. 1977. Status of the fisher (Martes pennanti) in the conterminous United States. Unpubl. rep. submitted to U.S. Dept. Int. Cited by Powell 1982.

Earle, R. D. 1978. The fisher-porcupine relationship in upper Michigan. M.S. Thesis, Mich. Tech. Univ., Houghton. 126 pp. Cited by Powell 1982.

_____________. Personal communication (letter dated 9 August 1983). Michigan Dept. Nat. Res., Houghton Lake Wildl. Res. Stn., Houghton Lake Heights, MI 48630.

Earle, R. D., and K. R. Kramm. 1982. Correlation between fisher and porcupine abundance in upper Michigan. Am. Midl. Nat. 107(2):244-249.

Hamilton, W. J., and A. H. Cook. 1955. The biology and management of the fisher in New York. New York Fish Game J. 2:13-35.

Hays, R. L., C. S. Summers, and W. Seitz. 1981. Estimating wildlife habitat variables. U.S. Dept. Int., Fish Wildl. Serv. FWS/OBS-81/47. 111 pp.

Ingram, R. 1973. Wolverine, fisher and marten in central Oregon. Oregon State Game Comm., Central Reg. Admin. Rep. 73-2. 41 pp.

Irvine, G. W., L. T. Magnus, and B. J. Bradle. 1964. The restocking of fishers in lakes states forests. Trans. N. Am. Wildl. Nat. Resour. Conf. 29:307-15.

Kelly, G. M. 1977. Fisher (Martes pennanti) biology in the White Mountain National Forest and adjacent areas. Ph.D. Thesis, Univ. Mass., Amherst. 178 pp.

Kelsy, P. 1977. The return of the fisher. New York State Environ. 6(8):10.

Leonard, R. D. 1980. The winter activity and movements, winter diet, and breeding biology of the fisher (Martes pennanti) in southeastern Manitoba. M.S. Thesis, Univ. Manitoba, Winnipeg. 181 pp.

Morse, W. B. 1961. The return of the fisher. Am. For. 64(4):24-26.

Pack, J. C., and J. I. Cromer. 1981. Reintroduction of fisher in West Virginia. Pages 1431-1442 in J. A. Chapman and D. Pursley, eds. Proc. 1st Worldwide Furbearer Conf., Worldwide Furbearer Conf. Inc., Baltimore, MD.

Peterson, L. R., M. A. Marten, and C. M. Pils. 1977. Status of fishers in Wisconsin, 1975. Wisc. Dept. Nat. Res. Rep. 92. 15 pp.

Pittaway, R. J. 1978. Observations on the behaviors of the fisher (Martes pennanti) in Algonquin Park, Ontario. Le Naturaliste Canadienne 105:487-489.

Powell, R. A. 1978. A comparison of fisher and weasel hunting behavior. Carnivore 1(1):28-34.

____________. 1979a. Ecological energetics and foraging strategies of the fisher (Martes pennanti). J. Anim. Ecol. 48:195-212.

____________. 1979b. Fishers population models and trapping. Wildl. Soc. Bull. 7:149-154.

____________. 1980. Stability in a one-predator-three-prey community. Am. Nat. 115:567-579.

__________. 1981. Hunting behavior and food requirements of the fisher (*Martes pennanti*). Pages 883-917 *in* J. A. Chapman and D. Pursley (eds.). Proc. 1st Worldwide Furbearer Conf., Worldwide Furbearer Conf. Inc., Baltimore, MD.

__________. 1982. The fisher, life history, ecology, and behavior. Univ. Minn. Press, Minneapolis. 217 pp.

__________. Personal communication (letter dated 8 September 1983). Dept. Zool., North Carolina St. Univ. P.O. Box 5577, Raleigh, NC 27650.

Powell, R. A., and R. B. Brander. 1977. Adaptations of fishers and porcupines to their predator-prey system. Pages 45-53 *in* R. L. Phillips and C. Jonkel, eds., 1975 Pred. Symp. Mont. For. Conserv. Exp. Stn., Univ. Mont., Missoula.

Raine, R. M. 1982. Ranges of juvenile fisher, *Martes pennanti* and marten, *Martes americana*, in Southeastern Manitoba. Can. Field-Nat. 96:431-438.

__________. 1983. Winter habitat use and responses to snow cover of fisher (*Martes pennanti*) and marten (*Martes americana*) in southeastern Manitoba. Can. J. Zool. 61(1):25-34.

__________. Personal communication (letter dated 8 September 1983). Western Wildlife Environments Consulting Ltd., Box 3129, Station B, Calgary, Alberta T2M 4L7.

Schempf, P. F., and M. White. 1977. Status of six furbearer populations in the mountains of Northern California. U.S. Dept. Agric., For. Serv., Calif. Region. 51 pp.

Stevens, C. L. 1968. The food of the fisher in New Hampshire. N.H. Dept. Fish Game, unpubl. rep. Concord, NH.

Strickland, M. A. Personal communication (letter dated 25 August 1983). Ontario Ministry of Natural Resources, 7 Bay Street, Parry Sound, Ontario P2A 1S4.

Strickland, M. A., and C. W. Douglas. 1981. The status of fisher in North America and its management in southern Ontario. Pages 1443-1458 *in* J. A. Chapman and D. Pursley, eds. Proc. 1st Worldwide Furbearer Conf. Worldwide Furbearer Conf. Inc. Baltimore, MD.

Strickland, M. A., C. W. Douglas, M. Novak, and N. Hunziger. 1982. Fisher. Pages 586-598 *in* J. A. Chapman and G. A. Feldhamer, eds. Wild mammals of North America: biology, management, and economics. Johns Hopkins Univ. Press, Baltimore, MD. 1,147 pp.

U.S. Fish and Wildlife Service. 1981. Standards for the development of habitat suitability index models. 103 ESM. U.S. Dept. Int., Fish Wildl. Serv., Div. Ecol. Serv. n.p.

Weckwerth, R. P., and P. L. Wright. 1968. Results of transplanting fishers in Montana. J. Wildl. Manage. 32:977-980.

Williams, R. M. 1962. The fisher returns to Idaho. Idaho Wildl. Rev. 15(1):8-9.

Yocom, C. F, and M. T. McCollum. 1973. Status of the fisher in Northern California, Oregon, and Washington. Calif. Fish Game. 59(4):305-309.

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Habitat preferences of the fisher (Martes pennanti) are described in this publication, which is one in a series of Habitat Suitability Index (HSI) models. A review and synthesis of the literature is followed by development of a model of the habitat requirements of the fisher throughout its range in the contiguous United States. HSI's are designed for use with Habitat Evaluation Procedures previously developed by the U.S. Fish and Wildlife Service.

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