Biological Services Program

FWS/OBS-82/10.11
FEBRUARY 1982

-HABITAT SUITABILITY INDEX MODELS: MARTEN

Fish and Wildlife Service

U.S. Department of the Interior

The Biological Services Program was established within the U.S. Fish and Wildlife Service to supply scientific information and methodologies on key environmental issues that impact fish and wildlife resources and their supporting ecosystems. The mission of the program is as follows:

- To strengthen the Fish and Wildlife Service in its role as a primary source of information on national fish and wildlife resources, particularly in respect to environmental impact assessment.
- To gather, analyze, and present information that will aid decisionmakers in the identification and resolution of problems associated with major changes in land and water use.
- To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

Information developed by the Biological Services Program is intended for use in the planning and decisionmaking process to prevent or minimize the impact of development on fish and wildlife. Research activities and technical assistance services are based on an analysis of the issues, a determination of the decisionmakers involved and their information needs, and an evaluation of the state of the art to identify information gaps and to determine priorities. This is a strategy that will ensure that the products producer-and disseminated are timely and useful.

Projects have been initiated in the following areas: coal extraction and conversion; power plants; geothermal, mineral and oil shale development; water resource analysis, including stream alterations and western water allocation; coastal ecosystems and Outer Continental Shelf development; and systems inventory, including National Wetland Inventory, habitat classification and analysis, and information transfer.

The Biological Services Program consists of the Office of Biological Services in Washington, D.C.. which is responsible for overall planning an management; National Teams, which provide the Program's central scientific and technical expertise and arrange for contracting biological services studies with states, universities, consulting firms,-and others; Regional Staffs, who provide a link to problems at theoperating level; and staffs a certain Fish and Wildlife Service research facilities, who conduct in-hous research studies.

FWS/OBS-82/10.11
February 1982

HABITAT SUITABILITY INDEX MODELS: MARTEN

by

Arthur W. Allen
Habitat Evaluation Procedures Group
Western Energy and Land Use Team
U.S. Fish and Wildlife Service
Drake Creekside Building One
2625 Redwing Road
Fort Collins, CO 80526

Western Energy and Land Use Team
Office of Biological Services
Fish and Wildlife Service
U.S. Department of the Interior
Washington, DC 20240

This report should be cited as:

Allen, A. W. 1982. Habitat suitability index models: Marten. U.S.D.I. Fish and Wildlife Service. FWS/OBS-82/10.11. **9 pp.**

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:

Habitat Evaluation Procedures Group
Western Energy and Land Use Team
U.S. Fish and Wildlife Service
2625 Redwing Road
Ft. Collins, CO 80526

ACKNOWLEDGEMENTS

We gratefully acknowledge Tim Clark and Tom Campbell for their review of this habitat model. The cover of this document was illustrated by Jennifer Shoemaker. Word processing was provided by Carolyn Gulzow and Dora Ibarra.

CONTENTS

MARTEN (Martes americana)

HABITAT USE INFORMATION

General

The marten (Martes americana) inhabits late successional forest communities throughout northern North America (Marshall 1951). The species is most abundant in association with mature coniferous forests, but also inhabits forests of mixed deciduous and coniferous species (Hagmeier 1956). Marten in Minnesota were observed or captured most often in conifer-dominated or mixed stands of coniferous and deciduous trees (Mech and Rogers 1977). Marten prefer softwood-dominated mixed stands in undisturbed forests in Maine (Soutiere 1979). The marten is mostly carnivorous, generally nocturnal, and active throughout the year.

Food

Marten consume a wide variety of food items throughout the year. Invertebrates, berries, and passerine birds were the most frequent food items recorded from spring through fall in a Montana study (Weckwerth and Hawley 1962). However, mammals were the most important food item on an annual basis, with the highest utilization of mammalian prey occurring during the winter months. Voles (Microtinae) are utilized more than any other single food item (Cowan and Mackay 1950; Lensink et al. 1955; Weckwerth and Hawley 1962; Koehler and Hornocker 1977; Soutiere 1979).

Mech and Rogers (1977) reported that food availability is probably the most important factor affecting the distribution of marten. Fluctuations in small mammal densities in Montana were believed to directly affect the carrying capacity of the study area for marten (Weckwerth and Hawley 1962). Clark and Campbell (1976) believed that limited access routes to get at prey below deep snow may be more restrictive on marten winter densities than the actual density of rodents present.

Water

No water requirements for the marten were described in the literature.

Cover

Mesic stands of mature coniferous trees with a canopy closure of 30% or more supported the highest marten activity in Montana (Koehler and Hornocker 1977). These sites also supported the greatest number of rodents and contained the highest diversity of understory plant species. Sub-alpine fir (Abies lasiocarpa), Engelmann spruce (Picea engelmannii), and Douglas fir (Pseudotsuga menziesii) stands were the most intensively used by marten during the winter months in Idaho (Marshall 1951). Stands of Ponderosa pine (Pinus ponderosa) were frequently used when adjacent to spruce-fir stands. Eighty percent of the marten observations in Colorado were in spruce-fir stands or in forest types which were at least partially comprised of spruce (Yeager and Remington 1956).

Marten in Wyoming frequently select large [35.5 to 60.9 cm dbh (14 to 24 in)], rotten Engelmann spruce or sub-alpine fir snags as refuge sites (Clark and Campbell 1976). Other commonly reported refuge sites include ground burrows, rock piles, and crevices (Mech and Rogers 1977), downfall, stumps, and brush or slash piles (Marshall 1951; Clark and Campbell 1976; Steventon and Major 1982). Downfall, in addition to providing refuge sites, allow marten access to below snow surface galleries of vegetation and fallen trees (Clark and Campbell 1976). These "entry" sites are believed critical to marten winter survival because they provide access to rodent prey active under deep snow. Such entry sites accounted for 92.8% of the recorded marten winter feeding sites in Wyoming. Ninty-seven percent of the marten winter resting sites located in Maine were beneath the snow surface within natural cavities formed around large decayed stumps (Steventon and Major 1982). These refuge sites were repeatedly used for several days at a time. Hagmeier (1956) found that, while marten ranged through a variety of vegetative types, most refuge sites were located within stands of coniferous trees. Summer refuge sites in Maine were in the crowns of conifer trees (Steventon and Major 1982). No refuge sites were located on the ground surface during this season.

Hawley and Newby (1957) believe that large openings serve as psychological barriers to marten, while Koehler and Hornocker (1977) believe that openings, which are avoided in the winter, may be used for foraging in the summer and fall seasons if adequate food and cover are present. Marten occasionally crossed openings up to 164.5 m (180 yd) in width in Maine during the winter months (Soutiere 1979). Although windfall and slash protruding from the snow were investigated by marten, movements across such openings were more direct than movements within uncut forest stands. Marten in Colorado have been observed at distances ranging from 0.8 to 3.2 km (0.5 to 2.0 mi) from forest cover types from May through November (Streeter and Braun 1968). In all such instances but one, the species was observed in large boulder fields which provided a food source [pika (Onchotona princeps)] and cover in the form of large boulders or rockslides.

Yeager (1950) believed that timber harvesting was the single most destructive factor contributing to the decimation of marten populations. Marten in Wyoming did not utilize harvested timber stands for at least 1 year after cutting (Clark and Campbell 1976). Marten in Maine rarely used clearcut areas less than 15 years old but were found in partially harvested stands (Soutiere 1979). Steventon and Major (1982) recorded significant avoidance of clearcut areas by marten during winter. Islands of uncut softwoods within and adjacent to clearcuts were heavily utilized for cover and foraging in summer and winter.

Reproduction

The reproductive requirements of the marten are assumed to be identical with cover requirements, as described above.

Interspersion

Marten populations are structured around male territories, which are rigidly defended during the spring and summer months (Clark and Campbell 1976). Home ranges of male martens are distinct, but female home ranges often overlap those of other females and males. Boundaries of marten home ranges often coincide with the edges of topographic or vegetative features, such as large, open meadows, burns and streams (Hawley and Newby 1957).

The mean home range size for marten in Montana was 2.4 km^2 (0.9 mi^2) and 0.69 km^2 (0.27 mi^2) for males and females, respectively (Hawley and Newby 1957). Similar sizes were reported in Wyoming: 2.4 km^2 (0.93 mi^2) for males and 0.88 km^2 (0.34 mi^2) for females (Clark and Campbell 1976). However, the average home range size in Minnesota was 15.6 km^2 (6.0 mi^2) for males and 4.3 km^2 (1.7 mi^2) for females (Mech and Rogers 1977). The average winter home range for male marten in Maine was 9.25 km^2 (3.57 mi^2) (Steventon and Major 1982). Summer home range size was between 5.0 and 10.0 km^2 (1.93 to 3.86 mi^2).

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This HSI model has been developed for application in boreal coniferous forests of the western United States.

Season. This HSI model was developed to evaluate the potential quality of winter habitat for marten. The winter cover requirements of this species are more restrictive than cover requirements during other seasons of the year. It is assumed that if adequate winter cover is available, habitat requirements throughout the balance of the year will not be limiting.

Cover types. This model was developed to evaluate habitat in Evergreen Forests (EF) (U.S. fish and Wildlife Service 1981).

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 for the marten was not reported in the literature, but home ranges in the western United States are approximately 2.38 km^2 (0.92 mi') for males. Based on this information, it is assumed that at least 2.59 km^2 (1 mi^2) of suitable habitat must be available before an area will be occupied by this species. If less than 2.59 km^2 (1 mi^2) of suitable habitat is present, the HSI is assumed to be 0.0.

Verification level. This model was reviewed by Tim W. Clark, Ph.D., Biology Department, Idaho State University. Dr. Clark concluded that this Habitat Suitability Index model would yield an accurate representation of marten habitat suitability (Clark, pers. comm.).

Model Description

Overview. All winter habitat requirements of the marten can be satisfied within boreal evergreen forests. The marten is, therefore, treated as utilizing evergreen forests only, and habitat evaluation using this model only considers the quality of life requisites provided by evergreen forests. It is assumed that food availability will not be limiting for the marten if adequate cover is present.

The following sections provide documentation of the logic and assumptions used to translate habitat information for the marten 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.

Figure 1 illustrates the relationships of habitat variables, life requisites, and cover types for the marten.

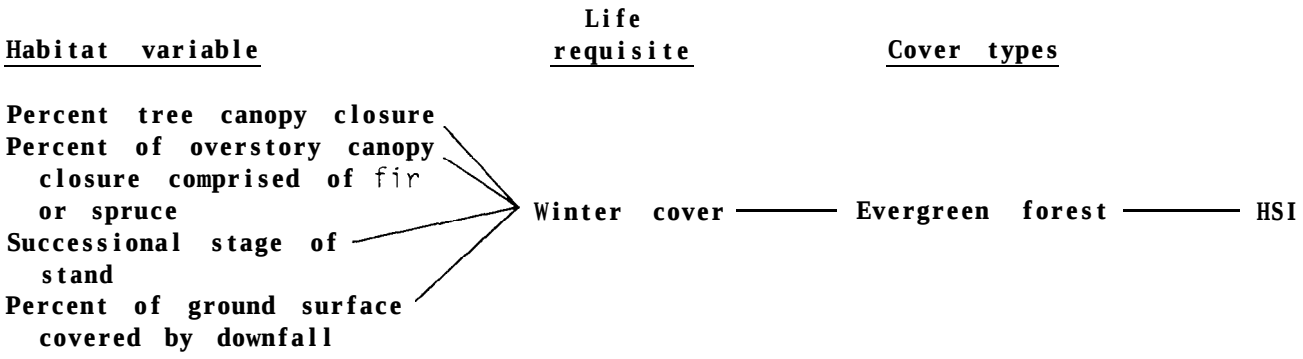


Figure 1. Relationships of habitat variables, life requisites, and cover types in the marten HSI model.

Cover component. The marten may range through various forested and non-forested cover types throughout the spring, summer, and fall. Based on the literature, mature stands of evergreen trees, particularly spruce and fir, are required during the winter months in order to provide adequate protective and thermal cover.

Suitable winter cover is a function of the successional stage of the stand, the percent of the stand which is comprised of spruce or fir, the total percent canopy closure of the stand, and the amount of downfall in the stand. Stands of mature to overmature coniferous forest, comprised of 40% fir or spruce, with a total canopy closure greater than 50%, are assumed to provide near optimal winter habitat. Forest stands which contain an abundance of downfall or windthrow are assumed to have a higher winter cover value because such materials provide refuge sites for the marten and accessibility to small mammals active under the snowpack. Although small diameter woody debris on the forest floor will provide cover for rodents, marten require the presence of partially fallen snags, or large logs, on the ground surface to provide access points for foraging under the snow's surface.

Sparse forest stands are assumed to provide marginal cover for marten; therefore, a tree canopy closure of less than 25% will indicate no value as winter cover for the species. It is also assumed that any tree species present within a forest stand will have some value as winter cover for marten. Therefore, the lowest value which may be obtained for this variable is 0.1. Forest stands dominated by shrubs or seedling sized trees are assumed to provide no value as winter cover for marten. Pole sized and young stands of trees provide some cover, while mature or old growth stands provide optimum cover. A ground surface covered by downfall ranging from 20% to 50% is assumed to have optimum value. However, the absence of downfall or presence of a high density of these materials will not severely limit the cover value for marten.

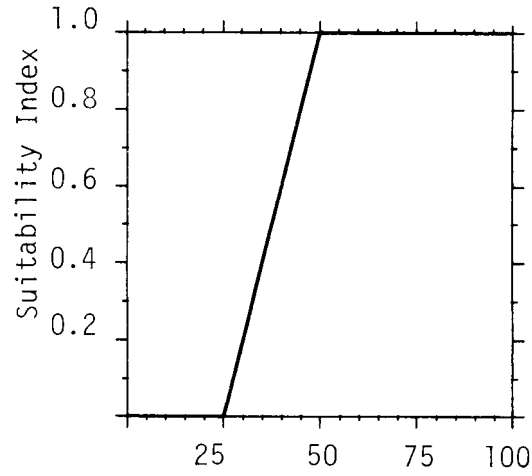
The percent tree canopy closure and successional stage of the stand are the two most limiting variables for determining the suitability of marten winter habitat. When either of these variables is outside the suitable ranges

defined above, marten habitat will not be present. The presence of little or no spruce or fir in a forest stand will lower the value of the habitat for marten. However, the absence of these species will not exclude the area as potential marten habitat. Although the percent of the ground surface covered by downfall has the least amount of influence in the determination of marten winter habitat suitability, such material is essentail to provide optimal winter habitat. An excessive amount of downfall (> 50%) is assumed to decrease the availability and accessibility of prey for marten. It is assumed that mature or old growth forest stands will provide a sufficient number of snags and partially fallen trees to allow entry points under the snow's surface.

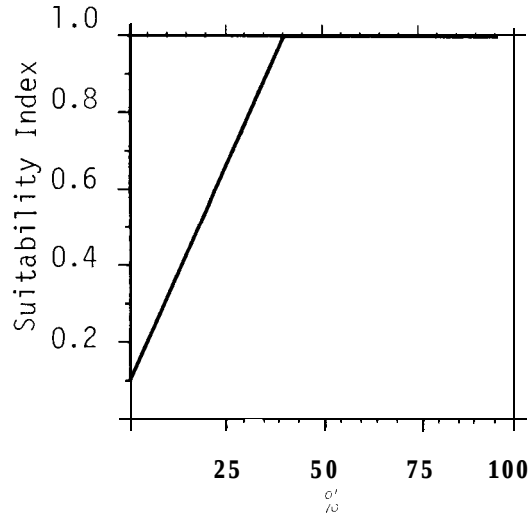
Model Relationships

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

Cover type	Variable	
EF	(V_1)	Percent tree canopy closure.

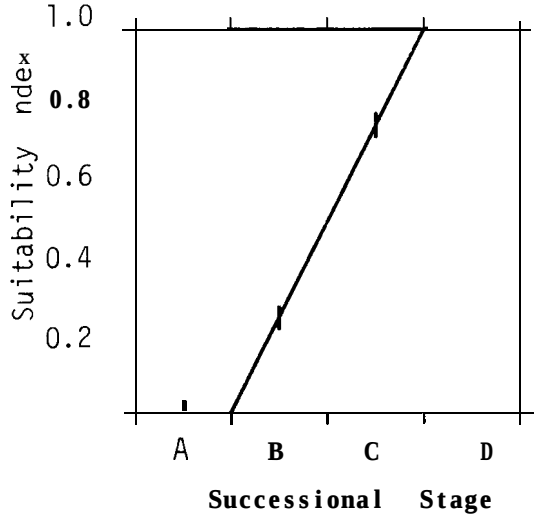


EF	(V_2)	Percent of overstory canopy closure comprised of fir or spruce.

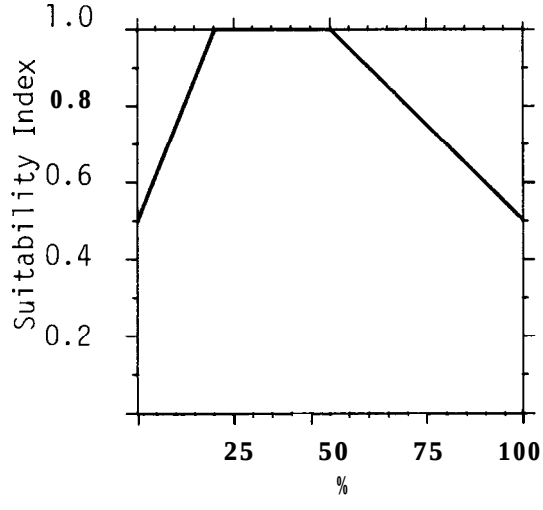


EF (V_3) Successional stage of stand.

A) shrub-seedling
B) pole sapling
C) young
D) mature or old growth



EF (V_4) Percent of ground surface covered by downfall which is ≥ 7.6 cm (3 in) in diameter.



Equations. In order to obtain life requisite values for the marten, the SI values for appropriate variables must be combined through the use of equations. 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 is presented below.

Life requisite	Cover type	Equations
Winter cover	EF	$(V_1 \times V_2 \times V_3 \times V_4)^{1/2}$

HSI determination. Since winter cover was the only life requisite considered in this model, the HSI equals the winter cover value.

Application of the Model

Definitions of variables and suggested field measurement techniques (Hays et al. 1981) are provided in Figure 2.

Variable (Definition)	Cover types	Suggested technique
(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	Line intercept, remote sensing
(V,) Percent of the over-story canopy closure comprised of fir or spruce. (The percent canopy closure of spruce or fir trees in the overstory divided by the total canopy closure of all overstory trees.)	EF	Line intercept, remote sensing
(V,) Successional stage of stand. (The structural condition of a forest community which occurs during its development.) Six recognized stages: 1. grass-forb 2. shrub-seedling 3. pole-sapling 4. young 5. mature 6. old growth	EF	On-site inspection, remote sensing

Figure 2. Definitions of variables and suggested measurement techniques.

(V_4)	Percent of ground surface covered by downfall which is ≥ 7.6 cm (3 in) in diameter. (The percent of the ground surface which is covered by dead, woody material which may include: tree boles; stumps; root wads; or limbs.)	EF	Line intercept, quadrat	3

Figure 2. (concluded)

SOURCES OF OTHER MODELS

No other habitat models for the marten were located.

REFERENCES CITED

Clark, T. W. Personal communication (letter dated 28 July 1981). Idaho State University, Pocatello, Idaho.

Clark, T. W., and T. M. Campbell, III. 1976. Population organization and regulatory mechanisms of martens in Grand Teton National Park, Wyoming. Proceedings of the First Conference on Scientific Research in the National Parks, U.S.D.I. Natl. Park Serv., Trans. Proc. Series 5. Vol. I. pp. 293-295.

Cowan, I. M., and R. H. Mackay. 1950. Food habits of the marten (Martes americana) in the Rocky Mountain region of Canada. Can. Field-Nat. 64(3):100-104.

Hagmeier, E. M. 1956. Distribution of marten and fisher in North America. Can. Field-Nat. 70(4):149-168.

Hawley, V. D., and F. E. Newby. 1957. Marten home ranges and population fluctuations. J. Mammal. 38(2):174-184.

Hays, R. L., C. S. Summers, and W. Seitz. 1981. Estimating wildlife habitat variables. U.S.D.I., Fish and Wildlife Service, FWS/OBS-81/47, 173 pp.

Koehler, G. M., and M. G. Hornocker. 1977. Fire effects on marten habitat in the Selway-Bitterroot Wilderness. J. Wildl. Manage. 41(3):500-505.

Lensink, C. J., R. O. Skoog, and J. L. Buckley. 1955. Food habits of marten in interior Alaska and their significance. J. Wildl. Manage. 19(3):364-368.

Marshall, W. H. 1951. Pine marten as a forest product. J. For. 49(2):899-905.

Mech, L. D., and L. L. Rogers. 1977. Status, distribution, and movements of martens in northeastern Minnesota. U.S.D.A. For. Serv. Res. Pap. NC-143. 7 pp.

Soutiere, E. C. 1979. Effects of timber harvesting on marten in Maine. J. Wildl. Manage. 43(4):850-860.

Steventon, J. D., and J. T. Major. 1982. Marten use of habitat in commercially clear-cut forest. J. Wildl. Manage. 46(1):175-182.

Streeter, R. G., and C. E. Braun. 1968. Occurrence of marten, Martes americana, (Carnivora: Mustelidae) in Colorado alpine areas. Southwest. Nat. 13(4):449-451.

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

Weckwerth, R. P., and V. D. Hawley. 1962. Marten food habits and population fluctuations in Montana. J. Wildl. Manage. 26(1):55-74.

Yeager, L. E. 1950. Implications of some harvest and habitat factors on pine marten management. Trans. N. Am. Wildl. Conf. 15:319-334.

Yeager, L. E., and J. D. Remington. 1956. Sight observations of Colorado martens. J. Mammal. 37(4):521-524.

0272 -101

REPORT DOCUMENTATION PAGE	1. REPORT NO. FWS/OBS-82/10.11	2.	3. Recipient's Accession No.
4. Title and Subtitle Habitat Suitability Index Models: Pine marten			5. Report Date February 1982 6.
7. Author(s) Arthur W. Allen			8. Performing Organization Rapt. No.
9. Performing Organization Name and Address	Habitat Evaluation Procedures Group Western Energy and Land Use Team U.S. Fish and Wildlife Service Drake Creekside Building One 2625 Redwing Road Fort Collins, Colorado 80526		10. Project/Task/Work Unit No. 11. Contract(C) or Grant(G) No. (C) (G)
12. Sponsoring Organization Name and Address	Western Energy and Land Use Team Office of Biological Services Fish and Wildlife Service U.S. Department of Interior Washington, D.C. 20240		13. Type of Report & Period Covered 14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

Habitat preferences and species characteristics of the pine marten (Martes americana) are described in this publication. It is one of a series of Habitat Suitability Index (HSI) models and was developed through an analysis of available scientific data on the species-habitat requirements of the pine marten. Habitat use information is presented in a review of the literature, followed by the development of a HSI model. The model is presented in three formats: graphic, word and mathematical. Suitability index graphs quantify the species-habitat relationship. These data are then synthesized into a model which is designed to provide information for use in impact assessment and habitat management activities.

17. Document Analysis a. Descriptors

Habitability
Wildlife

b. Identifiers/Open-Ended Terms

Marten
Martes americana
Habitat Suitability Index
Habitat

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Unlimited	Unclassified	
	20. Security Class (This Page) Unclassified	22. Price

DEPARTMENT OF THE INTERIOR

U.S. FISH AND WILDLIFE SERVICE

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of ournationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving theenvironmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.