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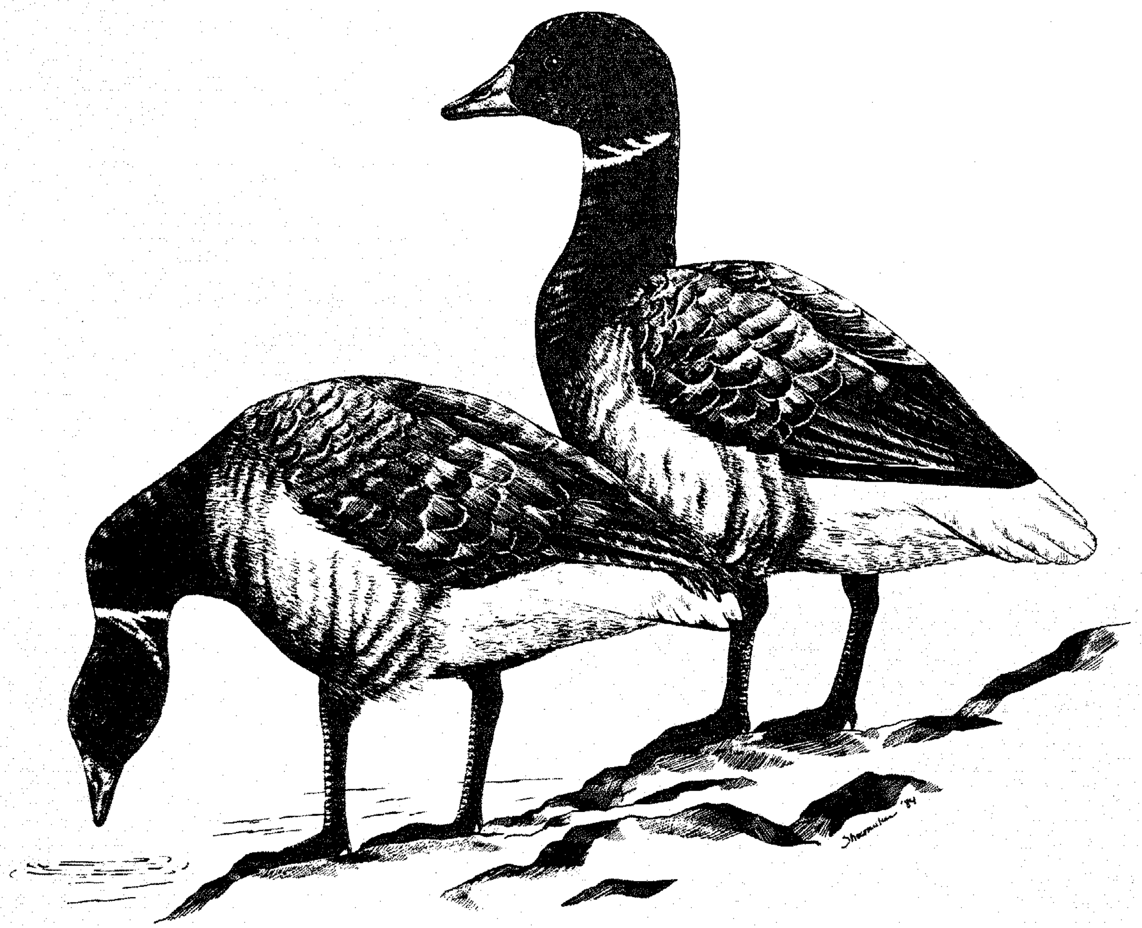
HABITAT SUITABILITY INDEX MODELS: BLACK BRANT



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HABITAT SUITABILITY INDEX MODELS: BLACK BRANT

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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BLACK BRANT (*Branta bernicla nigricans*)

HABITAT USE INFORMATION

General

The black brant (*Branta bernicla nigricans*) breeds in North America from western and northern Alaska east to northern MacKenzie and Banks, Melville and Prince Patrick Islands and migrates in the winter to suitable bays and estuaries along the Pacific coast from southeastern Alaska to southern Baja California (American Ornithologists' Union 1983). Preferred winter habitats are large, tidal lagoons, opening to the sea by one or more passes through a barrier beach (Smith and Jensen 1970).

This model is intended for use only in black brant wintering areas; therefore, information on nesting requirements is not included.

Food

Eelgrass (*Zostera marina*) is the most important winter food item of the black brant (Moffitt 1941; Cottam et al. 1944; Yocom and Keller 1961; Einarsen 1965). Black brant regularly wintered on larger California bays that supported eelgrass beds; little use was made of bays that did not support eelgrass beds (Moffitt 1941). Eelgrass comprised 81.3% of the food volume of black brant wintering on Humboldt Bay, California (Yocom and Keller 1961). Cottam et al. (1944) summarized several food habits studies and found that 76% of the winter food volume of black brant was eelgrass. Bays in Baja California with the largest numbers of wintering brant contained large areas of shallow water covered by extensive eelgrass beds (Leopold and Smith 1953). Einarsen (1965) stated that the presence of eelgrass and sea lettuce (*Ulva* spp.) indicates a habitat that is potentially suitable for wintering black brant.

Eelgrass is a plant of muddy or semisandy bottom habitats (Cottam et al. 1944). It occurs in protected coastal waters on both coasts of North America, in waters up to 3 m (10 ft) deep at low tide that vary in salinity from half the concentration of sea water to the full concentration (Moffitt and Cottam 1941). Eelgrass distribution in Humboldt Bay, California, is limited to the deeper mud flat areas; eelgrass is not as abundant along channel edges due to high water, turbidity, and tidal scouring (Henry 1980).

Eelgrass coverage in Humboldt Bay was almost 100% in areas below -0.3 m (-1.0 ft) in elevation and decreased as the elevation increased (Keller 1963). Above +0.3 m (+1.0 ft), only small patches of eelgrass existed, due to excessive desiccation during exposure at low tides.

Eelgrass beds have undergone occasional declines along both the east and west coasts (Cottam et al. 1944). As eelgrass declined along the west coast in the late 1930's, black brant fed on grass in inland locations, and on green algae (Ulvaceae), pickleweed (Salicornia spp.), and rock grass (Phyllospadix spp.) in coastal areas (Moffitt 1941). Black brant in California occasionally fed in pastures, winter grain fields, and truck crop fields (Leopold and Smith 1953). This feeding activity may have indicated a lowered carrying capacity of their natural feeding areas.

Eelgrass declines during the 1930's were more severe on the east coast than on the west coast (Cottam et al. 1944). The decline on the east coast was thought to be due to an infestation of the mycetozoan Labyrinthula, an organism that lives in eelgrass leaves and causes the plant to weaken and die (Moffitt and Cottam 1941). More than 90% of the eelgrass along the east coast died out from 1931 to 1933. Alternate foods of the Atlantic brant (B. b. hrota) following the eelgrass decline included wigeongrass (Ruppia maritima), sea lettuce, and algae (Enteromorpha spp.) (Cottam et al. 1944). Sea lettuce (U. lactuca) was the most important food of Atlantic brant along the New Jersey coast (Penkala 1975). Following the eelgrass decline in Norfolk, England, algae (Enteromorpha spp.) was the main food of European brant (B. b. bernicla), and eelgrass (Z. nona), although locally abundant, was not always eaten when available (Ranwell and Downing 1959).

It is not clear from the available literature whether or not black brant have the ability to sustain themselves in the absence of eelgrass, as the Atlantic and European brant are apparently able to do. Einarsen (1965) stated that a loss of eelgrass could be very harmful to black brant populations.

Brant normally forage during the last half of the ebb tide or the first half of the flood tide, when eelgrass beds are exposed or only under a few inches of water (Cottam et al. 1944). At high tide, black brant fed on eelgrass that was floating on the water surface (Kramer et al. 1979). As water levels lowered with the ebb tide, the brant fed by "tipping up", then by submerging their heads, and, finally, by grazing on the exposed eelgrass beds. Eelgrass beds suitable for brant must be accessible at some stage of the tide, because brant do not dive (Einarsen 1965). Abundant stands of eelgrass in deeper waters that are not exposed by the tide do not provide a dependable food supply for black brant.

San Quintin Bay in Baja California is 43.5 km^2 (16.8 mi^2) in size, and in 1975 had a peak population of 35,602 black brant (Kramer et al. 1979). Eighty-five percent of this bay was covered by eelgrass beds, and only 20% of the bay exceeded 1.8 m (5.9 ft) in depth at mean high tide.

Three factors that adversely affect the use of eelgrass beds as feeding areas by black brant are: (1) the lack of the exposure of the eelgrass by the tide; (2) boating and other human activities; and (3) the use of mechanical equipment (for example, power dredges) that disturbs the brant and destroys the eelgrass beds (Einarsen 1965).

The presence of grit is an important habitat feature for black brant (Bauer, pers. comm.; Springer, pers. comm.; Welch, pers. comm.). Brant in Baja California consumed coarse sand at a sand flat prior to moving to foraging areas (Kramer et al. 1979). The lack of grit (e.g., sandbars) in the Padilla Bay area of North Puget Sound in Washington appears to be a factor limiting the use of the area by black brant (Bauer, pers. comm.).

Water

Specific dietary water requirements for the brant were not found in the literature. Habitat requirements related to water are covered in other sections of this narrative.

Cover

Black brant may roost at night on sandy beaches, on sand bars out in bays (Jewett et al. 1953), or in open water areas (Kramer, pers. comm.; Springer, pers. comm.). Preferred bays contain exposed bars or isolated sandy beaches where the brant can rest at high tide without being disturbed (Smith and Jensen 1970). Sand bars, beaches, or flats are required sites for preening, resting, and for obtaining grit (Springer, pers. comm.).

Special Considerations

Human disturbance is one of the major factors restricting the numbers of black brant (Einarsen 1965). The proportion of black brant that wintered along the Pacific Coast of the United States declined from 50-65% to less than 10% of the North American population from 1954 to 1979 (Kramer et al. 1979). San Diego and Mission Bays in California were formerly important black brant wintering areas, but pollution, dredging, and other developments, as well as constant disturbance by boats and airplanes, have made these areas less suitable for brant. Humboldt Bay in California has traditionally been a major wintering area for black brant and is also a concentration area for brant on their northward spring migration (Denson and Murrell 1962). In 1962, Humboldt Bay was mostly undeveloped and was a very important habitat for black brant. However, recent winter populations of black brant on Humboldt Bay have been less than 100 birds, while peak spring densities in 1975 were 37,500 brant (Henry and Springer 1981). These densities represent a drastic reduction in winter numbers and a decrease in spring use. Eelgrass beds appear to be adequate and the primary reason for these declines is thought to be the greatly increased human activity on and around the bay. Black brant began to use the mainland coast of Mexico as a wintering area in the mid-1960's (Smith and Jensen 1970).

Black brant in Baja California avoided areas of San Quintin Bay that had constant human activity, such as areas around roads, motels, and residences (Kramer et al. 1979). Hunting of Atlantic brant can significantly affect brant use of local areas, and hunting regulations are the only active management option available for Atlantic brant (Penkala et al. 1975). Disturbance by hunters in Baja California resulted in five to six times more flight activity by black brant than on days without hunting (Kramer et al. 1979).

Movement of brant to the ocean was positively and significantly correlated to the level of hunting disturbance. Airplanes always disturbed black brant and usually resulted in the birds taking flight. Brant using Humboldt Bay in the winter took flight as a result of any aircraft activity below 300 m (984 ft) and within 1.6 km (1.0 mi) and helicopters were particularly disruptive (Henry 1980).

There is little that can be done to increase eelgrass production; therefore it is important to protect existing beds (Yocom and Keller 1961). Keller (1963) noted that excessive siltation, pollution, and certain oyster culture activities could significantly reduce the amount of eelgrass in Humboldt Bay. For example, oyster culture operations reduced the biomass of eelgrass in affected areas of Humboldt Bay by 96% after three dredgings (Waddell 1964).

Brant populations in Europe have declined in past years (Salomonsen 1958). Excessive winter hunting is believed to be the major cause of the decline, rather than disturbance of breeding areas or declines in eelgrass abundance.

Kramer et al. (1979) recommended several specific management practices in order to retain San Quintin Bay, in Baja California, as an active black brant wintering area that can provide recreational hunting. The recommended management practices included enforcement of existing laws, reducing the bag limit on black brant, setting aside a portion of the bay as a refuge, and avoiding disturbances which could negatively affect the eelgrass food supply.

The objective of the Pacific Flyway Management Plan for Pacific brant is to restore and maintain a midwinter population of 185,000 brant, including 58,000 in Washington, Oregon, and California (Pacific Waterfowl Flyway Council 1981). Management recommendations related to habitat include: (1) determining and monitoring habitat threats, such as oil spills; (2) mapping major eelgrass beds; and (3) determining the nutritional value of eelgrass at various locations.

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This model was developed for application in the Pacific coast wintering areas of the black brant.

Season. This model was developed to evaluate the winter habitat needs of the black brant.

Cover types. This model was developed to evaluate habitat quality in Estuarine (E) areas that occur either in bays or in other locations that are protected from the ocean (terminology follows that of 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 a species will occupy an area. Specific information on minimum areas required for winter habitat of black brant was not found in the literature.

Verification level. Previous drafts of this model were reviewed by Dick Bauer, U.S. Fish and Wildlife Service, Regional Office, Portland, OR; Gary Kramer, U.S. Fish and Wildlife Service, San Luis National Wildlife Refuge, Los Banos, CA; Paul Springer, Wildlife Research Field Station, Humboldt State University, Arcata, CA; and Joe Welch, U.S. Fish and Wildlife Service, Sheldon-Hart Mountain National Wildlife Refuge, Lakeview, OR. Specific comments from each reviewer were incorporated into the current model. The model presented here is not a statement of proven cause and effect relationships. Rather, the model represents hypotheses about the habitat requirements of the black brant.

Model Description

Overview. The major requirements for black brant wintering habitat are adequate food and cover resources and freedom from human disturbance. The primary food of black brant during the winter is eelgrass, and this model assesses both the abundance and accessibility of eelgrass to determine food values. Grit is an important requirement of the black brant and is provided by sand bars or sandy beaches. Cover needs of the black brant are provided by sand bars, beaches, and flats which are used for preening and resting. It is assumed that flats exposed by tidal movements will meet the need for preening and resting and that such flats will be available in all brant use areas. Therefore, cover is assumed to be adequate and not a limiting factor for black brant. Human disturbance severely restricts the amount of suitable winter habitat for black brant. This model assesses disturbance both on the shore and in the bays and estuaries. The relationship between habitat variables, model components, cover types, and the HSI for the black brant is illustrated in Figure 1.

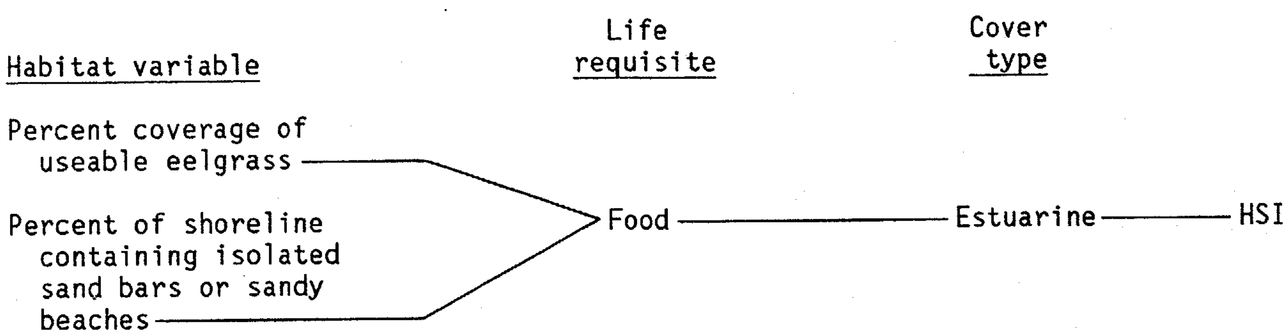


Figure 1. Relationships of habitat variables, the life requisite, cover type, and the HSI in the black brant model.

The following sections provide documentation of the logic and assumptions used to interpret the habitat information for the black brant in order to develop this HSI model. Specifically, these sections cover the following: (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 relationship between variables.

Food component. Eelgrass is the primary food of the black brant in wintering areas. Optimal habitat contains abundant stands of eelgrass that are useable by brant at low tide. Useable stands of eelgrass are both physically accessible and in areas that are not disturbed by human activities.

Black brant feed primarily by submerging their heads, "tipping up", or by grazing on exposed eelgrass beds. It is assumed that optimal habitats contain 90% or greater coverage of eelgrass that is either exposed or in water less than 0.3 m (1 ft) deep at mean low tide. Habitats lacking eelgrass beds that meet these conditions are assumed to provide no suitability.

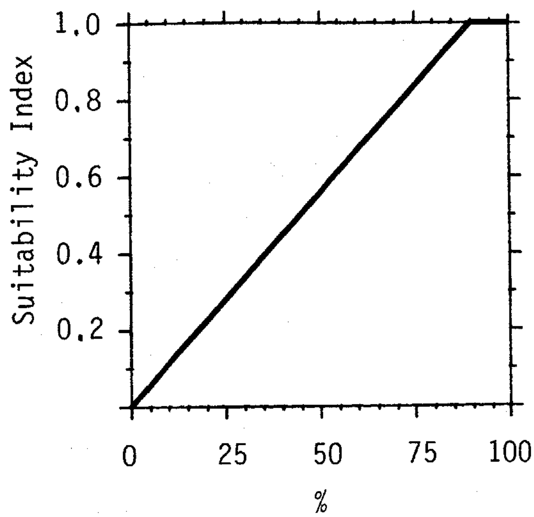
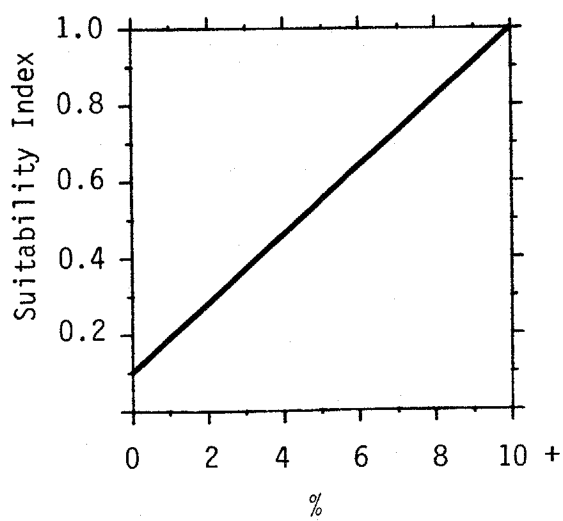
Human disturbance is one of the major factors restricting the abundance of black brant (Einarsen 1965). This model assumes that all areas of human disturbance, including a buffer zone around the disturbance, will be unuseable by black brant regardless of eelgrass quality. Different types of human activities cause different levels of disturbance in black brant. Sculling (refers to hunting brant in a boat capable of travel in very shallow waters), helicopter flights, and oyster and clamming activities are highly disruptive and it is assumed that brant will avoid all areas within 183 m (600 ft) of such disturbances. Hunting (other than sculling) and flight of fixed-wing aircraft are moderately disruptive, and it is assumed that brant will avoid areas within 137 m (450 ft) of such activities. All other activities, including general boating, swimming, fishing, and shoreline development, will cause low levels of disturbance, and brant will not use areas within 91 m (300 ft) of such disturbances.

Isolated sand bars or sandy beaches provide a source of grit for the black brant, and bays with 10% or more of the shoreline with such sandy conditions are assumed to be optimal. It is assumed that optimum conditions are provided when isolated sand bars or beaches are immediately adjacent to the estuarine habitat being evaluated. Areas with beaches or sand bars available outside the bay may provide moderate suitability and areas totally lacking isolated sandy shores may also provide moderate suitability because it is assumed that brant may obtain some grit from other sources, such as exposed flats.

Overall food suitability is related to the percent coverage of useable eelgrass and the availability of isolated sandy beaches for obtaining grit. It is assumed that the percent coverage of useable eelgrass is the most important variable, and thus will have a stronger influence than the presence of grit on the overall food value.

Model Relationships

Suitability Index (SI) graphs for habitat variables. This section contains suitability index graphs that illustrate the habitat relationships described in the previous section.

Cover type	Variable		
E	V_1	Percent coverage of useable eelgrass.	
E	V_2	Percent of shoreline containing isolated sand bars or sandy beaches.	

Equations. In order to determine the food value for the black brant, the SI values for appropriate variables must be combined through the use of an equation. A discussion 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 the food value in estuarine cover types is presented below.

$$\text{Food value} = (V_1^2 \times V_2)^{1/3}$$

HSI determination. The HSI for the black brant is equal to the food value.

Application of the Model

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

Determination of the suitability index for percent coverage of useable eelgrass in a bay involves several detailed steps, as follows:

1. Delineate on a map all eelgrass beds that are either exposed or in water less than 0.3 m (1 ft) deep at mean low tide. If there are no eelgrass beds that meet these criteria, the suitability will be zero, and the remaining steps do not need to be completed.

2. Delineate all areas of human disturbance, both over water and on the shoreline.

3. Delineate the appropriate buffer zone around the different types of human disturbance [i.e., 183 m (600 ft) for sculling, helicopter flights, and oyster and clamming activities; 137 m (450 ft) for fixed-wing aircraft flights, and hunting other than sculling; 91 m (300 ft) for general boating, swimming, fishing, and shoreline development].

4. Calculate the acreage of eelgrass beds that meet the criteria in Step 1 above, and that are outside the buffer zone of human disturbance, as described in Step 3.

5. Divide the acreage computed in Step 4 by the total acreage of the bay and multiply by 100. Enter this percentage into the graph for V_1.

Variable (definition)		Cover types	Suggested technique
V_1	Percent coverage of useable eelgrass (the percent of the bay or estuary that contains useable eelgrass beds; see page 8 for detailed instructions on how to determine the area of useable eelgrass).	E	Remote sensing; line transect; observation
V_2	Percent of shoreline containing isolated sand bars or sandy beaches (the percent of the shoreline area immediately adjacent to the estuarine habitat being evaluated that contains sandy areas that are isolated from human disturbance).	E	Remote sensing; observation

Figure 2. Definitions of variables and suggested measurement techniques.

SOURCES OF OTHER MODELS

No other habitat models for the black brant were located in the literature.

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16. Abstract (Limit: 200 words)

A review and synthesis of existing information were used to develop a habitat suitability model for wintering habitat of the black brant (Branta bernicla nigricans). The model consolidates 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). Habitat suitability index (HSI) models are designed to be used with Habitat Evaluation Procedures previously developed by the U.S. Fish and Wildlife Service.

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