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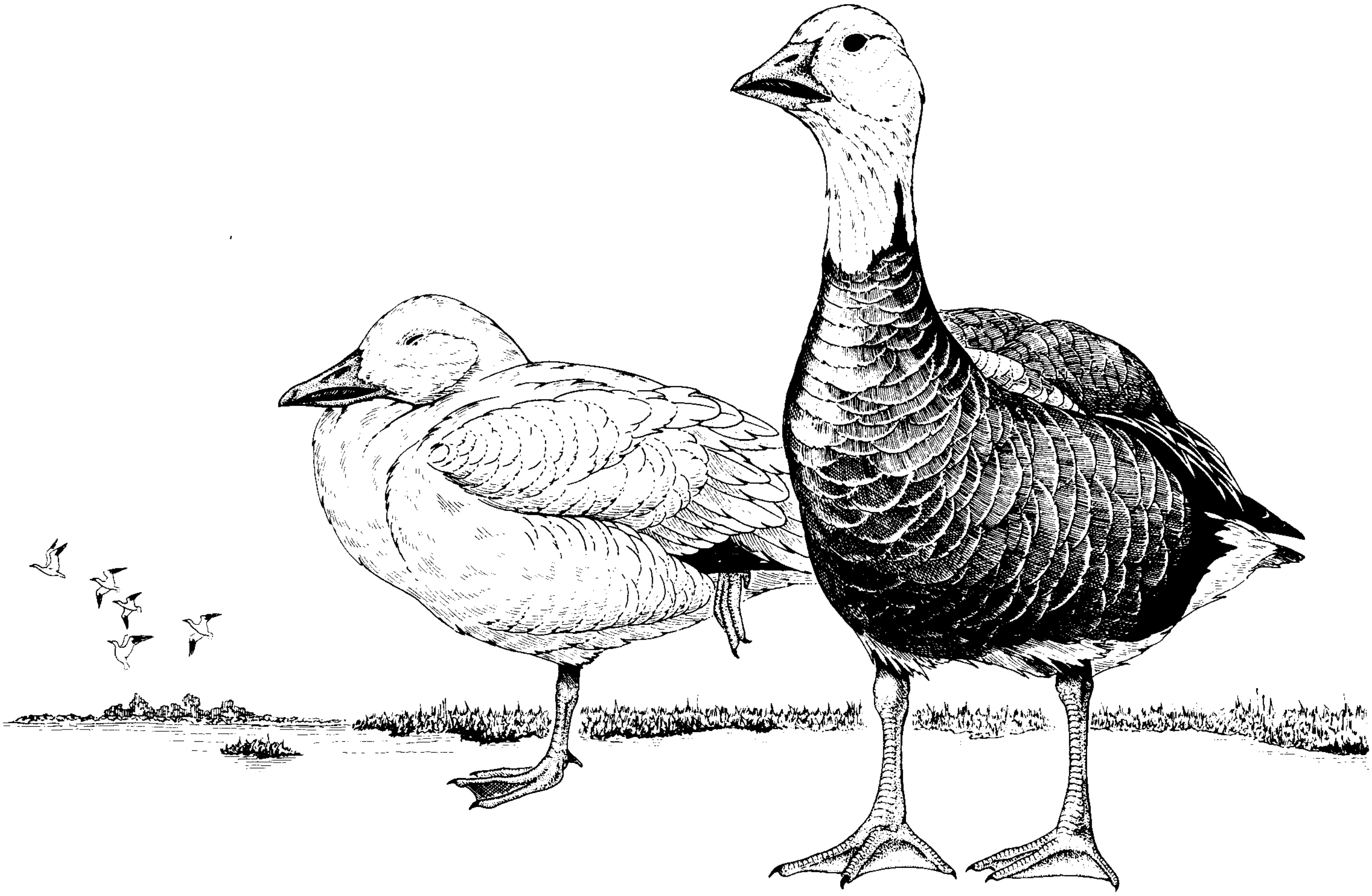

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HABITAT SUITABILITY INDEX MODELS: LESSER SNOW GOOSE (WINTERING)

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PREFACE

The habitat suitability index (HSI) model in this report on the lesser snow goose is intended for use in the U.S. Fish and Wildlife Service's (1981) habitat evaluation procedures for impact assessment and habitat management. The model was developed from a review and synthesis of existing information and is scaled to produce an index of habitat suitability between 0 (unsuitable habitat) and 1 (optimally suitable habitat). Assumptions used to develop the model and guidelines for model applications, including methods for measuring model variables, are described.

This model is a hypothesis of species habitat relationships, not a statement of proven cause and effect. The model has not been field-tested. For this reason, the U.S. Fish and Wildlife Service encourages model users to convey comments and suggestions that may help increase the utility and effectiveness of this habitat-based approach to fish and wildlife management. Please send any comments or suggestions you may have to the following address.

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ACKNOWLEDGMENTS

Development of the habitat suitabililty index model and narrative for the snow goose was monitored and reviewed by the following individuals who are actively involved with research or management of the snow goose: R. Chabreck and R. Hamilton, School of Forestry, Wildlife, and Fisheries, Louisiana State University, Baton Rouge; B. Brown, Refuge Manager, Lacassine National Wildlife Refuge, Lake Arthur, Louisiana; and J. Walther, Refuge Manager, Sabine National Wildlife Refuge, Hackberry, Louisiana.

Thorough evaluations of model structure and functional relationships were provided by personnel of the U.S. Fish and Wildlife Service's National Coastal Ecosystems Team. Model and supportive narrative reviews were also provided by Regional personnel of the U.S. Fish and Wildlife Service. Patrick Lynch illustrated the cover. Special thanks go to D. Hewitt and J. Zeno for typing the document. Finally, funding for the model development and publication was provided by the U.S. Fish and Wildlife Service.

LESSER SNOW GOOSE (*Chen caerulescens caerulescens*)

INTRODUCTION

The lesser snow goose may have the largest population of any goose in the world (Cooch 1958; Kerbes 1975; Ogilvie 1978). Its arctic breeding range has greatly expanded since the mid-1950's (Bellrose 1976). In the United States, it normally ranks behind only the Canada goose (*Branta canadensis*) in population size (Bellrose 1976; Owen 1980) and in harvest (Carney et al. 1981, 1982). Because up to 70% of the geese harvested annually by hunters in Texas and Louisiana are lesser snow geese (Carney et al. 1981), its importance as a waterfowl species of the Gulf of Mexico coast cannot be overemphasized. Surveys taken in the Central and Mississippi Flyways from 1955 to 1975 have shown an upward trend in the number of wintering snow geese (Bellrose 1976). On the wintering grounds snow geese tend to remain in large, very conspicuous flocks that please both hunters and non-consumptive viewers of wildlife.

Winter Range and Distribution

Lesser snow geese spend approximately 6 months on their Texas and Louisiana wintering grounds. Small flocks may first appear in Louisiana throughout late August and September, but the largest influx occurs in late October and early November (McIlhenny 1932). Bellrose (1976) reported that snow geese (predominantly blue-phase birds) fly non-stop from James Bay, Canada, to the Mississippi River Delta in early and mid-November. In southwestern Louisiana and coastal Texas, the peak arrival may be delayed until December since large segments of this predominantly white-phase population linger in the Midwest (Bellrose 1976; Lynch 1975).

Northward spring migration begins in late February and early March (Bellrose 1976). By late March almost all snow geese have left the wintering grounds.

Lesser snow geese in Louisiana winter primarily in two distinct regions along the gulf coast. In southeastern Louisiana, snow geese congregate around the active delta of the Mississippi River (McAtee 1910; McIlhenny 1932; Lynch 1975). Lynch (1975) reported that 300,000 snow geese wintered in this region during the 1930's and 1940's, but by 1970 the population had dropped to 50,000. In southwestern Louisiana, the primary winter range extends along the gulf coast from Vermilion Bay to the Texas border, encompassing coastal lagoons, marshes, and the grassy coastal prairies now developed into agricultural and livestock-grazing lands (Lynch 1975).

Historically, the winter range of snow geese in southwestern Louisiana was restricted to the vast gulf coast saline and brackish marshes. Large flocks of snow geese arrived on the gulf coast and seemed to disappear into the remote marshes and lagoons. McIlhenny (1932) noted that the range of snow geese extended only 12.8 km (8 mi) inland, so the flocks were usually seen only by trappers and hunters that regularly visited these largely inaccessible areas. This preference for coastal marsh was also evident in the James Bay nesting region where snow geese fed on the coastal tidal flats and restricted their flights generally along the shoreline, rarely venturing inland (Stirrett 1954).

During the first half of the 20th century snow goose winter activities were limited to the traditional "wilderness" areas of marshland, but during the late 1940's and 1950's snow geese began to appear in the rice fields and cultivated lands further inland along the coast (Lynch 1975).

With the expansion of rice agriculture in central and northeastern Louisiana, snow geese developed a secondary winter range completely removed from traditional marshland haunts. The use of inland agricultural fields by snow geese apparently started in the Pacific Flyway and spread through the West, then the Midwest, then into Texas and Louisiana (Bellrose 1976). Snow geese wintering in the gulf coast marshes of Texas began using rice fields in the 1930's (Lynch 1975), and Louisiana rice fields first attracted snow geese in the mid- to late 1940's (Linscombe 1972). Snow geese were first reported on Lacassine National Wildlife Refuge in 1946 (Linscombe 1972). Geese may be attracted to the rice agricultural regions of Texas and Louisiana because of the large amount of water present in rice fields (Hobaugh 1982). Many of the initial feeding forays were made by flocks which roosted in the coastal marshes and flew inland each morning to feed in the agricultural fields; but now many snow geese can be considered "full-time winter residents of ricefields and improved pastures" (Lynch 1975). Linscombe (1972) reported an upward trend from 1953 to 1971 in the number of snow geese associated with arable land in southwestern Louisiana. Leslie (1983) counted more than 44,000 snow geese in this agricultural winter range during a 1-day aerial survey of four central and northeastern Louisiana parishes.

SPECIFIC HABITAT REQUIREMENTS

Roosting

Owen (1980) believed that a suitable roost site was the primary requirement for optimum goose habitat. He thought that many excellent feeding areas were not exploited by geese because there were no convenient roost sites nearby, but he did not quantify the distance. McIlhenny (1932) reported that roosting and feeding areas could be up to 16 km (10 mi) apart. In addition to being conveniently located, the roost should also be safe from predators and disturbances, especially hunters. Geese also prefer to roost in relatively clear water and avoid areas subject to radical water level fluctuations (Lynch et al. 1947).

Geese may roost on dry land, especially in agricultural fields. Geese roosting on dry land feel secure, because the flat, open terrain allows them to detect a possible predator before it becomes threatening. The primary escape mechanism for geese roosting on dry land is flight; however, when roosting in a marsh their initial escape mechanism is to swim gradually away from the predator.

Because most snow geese roost communally, roosts are by necessity quite large. Although a large roost site may be used by more than one species, geese of the same species usually roost together with approximately one goose per square meter (Owen 1980). On Rockefeller Refuge, a recently burned area of approximately 8,000 ha (19,760 acres) was used for roosting in 1983 by upwards of 20,000 geese (T. Joanen, Rockefeller Refuge, Louisiana; pers. comm.).

Inland lakes, marshes, and estuaries are most often used as roost sites on the wintering grounds (Owen 1980). Roost sites may be occupied by geese during mid-day as they drink, bathe, and rest between feeding forays (Owen 1980). Hobaugh (1982) reported that in Texas large bodies of open water were used as roost sites.

In the coastal prairies that are slightly above sea level, geese may also create their own roost sites. McAtee (1910) told how voracious feeding by snow geese in lowland coastal cattle pastures produced holes that quickly filled with water. Continued, localized feeding produced shallow ponds, and if large numbers of geese roosted in these shallow ponds, the action of their feet deepened the ponds until small lakes were produced. These small lakes attracted other roosting geese, and eventually large roost sites were formed.

During cold periods accompanied by strong north winds, geese will select roost areas fringed with tall marsh plants (e.g., Phragmites australis) that provide protection from inclement weather (J. Walther, Sabine National Wildlife Refuge, Louisiana; pers. comm.).

Food and Foraging

Even though the snow goose has a definite set of life requisites it must fulfill while on the wintering grounds, the species should be viewed as very adaptable and capable of exploiting new habitats. Because of its mobility, it can simply overfly or totally abandon any habitat that does not fulfill its requirements. The snow goose can also make use of separate localities that are kilometers apart.

Coastal marshes. Snow geese have evolved as a "grubbing" species, developing a heavy, strong bill containing many hard, horny lamellae on either side. This bill is extremely well adapted to uproot tubers and rhizomes of bulrushes and marsh grasses in marshes and estuarine environments. Lynch et al. (1947) noted that snow geese can uproot the toughest rhizomes of marsh plants growing in firm clay soils. Fibrous roots too long to be swallowed in one gulp are easily bitten into smaller pieces, 2-5 cm (0.8-2.0 inches) long (Burton et al. 1979). Common marsh food plants used for food by snow geese are included in Table 1.

Table 1. Common marsh plants used by snow geese as a food source.

Plant	Common name	Plant parts eaten
Distichlis spicata	salt grass	roots, rhizomes
Echinochloa spp.	wild millet, barnyard grass	seeds
Eleocharis spp.	spikerush	roots, rhizomes
Leptochloa fascicularis	feathergrass	seeds
Panicum dichotomiflorum	fall panicum	seeds
Panicum repens	dogtooth grass	seeds
Paspalum baginatur	seashore paspalum	seeds, roots
Sagittaria platyphylla	delta duckpotato	tubers, roots
Scirpus americanus	freshwater three-square	roots, rhizomes
Scirpus californicus	bullwhip	roots , rhizomes
Scirpus olneyi	three-cornered grass	roots, rhizomes
Scirpus robustus	saltmarsh bulrush, coco	roots, rhizomes
Spartina alterniflora	sea cane	roots, rhizomes
Spartina cynosuroides	hogcane	roots, rhizomes
Spartina patens	wiregrass	roots, rhizomes
Typha spp.	cattail	roots, rhizomes

In southeastern Louisiana snow geese prefer to feed in areas of newest sediment deposits on sub-deltas of the Mississippi River and on alluvial fans present at man-made spillways (Lynch 1975). Optimum sites are protected from gulf salt tides and generally contain salt-free soils. Deltaic flats covered by shallow water are preferred feeding sites (Lynch et al. 1947). During low tides or northerly winds when the flats are dry, geese move inland to interior marshes that still contain water; when the flats are inundated by early spring floods, high tides, or strong southerly winds, geese also move inland to feed. In coastal marshes, snow geese feed during both the day and night, depending more on tidal influence than on period of day (Owen 1980). Burton and Hudson (1978) observed the effects of tide on snow geese feeding on *Scirpus* rhizomes and found that nearly all feeding took place in water 20 cm (7.9 inches) deep or less.

Because of tidal oscillations, the absence of a crop or food storage organ, and low digestive efficiency, snow geese must consume large quantities of food during short periods (Burton et al. 1979). Tidal fluctuations sustain the high marsh productivity that benefits marsh-feeding snow geese, and their intensive feeding in productive areas results in large regions of grazed and uprooted vegetation (Prevett et al. 1979).

Marshland and coastal prairies are frequently burned to improve forage conditions and to retard the growth of woody plants. Burned areas in marshland are heavily used by wintering snow geese (McAtee 1910). Fire removes most of the above-ground vegetation and allows for better visibility by the geese. Removal of above-ground vegetation also makes grubbing for rhizomes and roots easier. When not disturbed, snow geese may remain for several days to feed and roost on a marsh burn (R. Chabreck, Louisiana State University, Baton Rouge; pers. comm.). Some species of food plants grow sufficiently dense and rank to preclude geese landing in them. Geese that land outside the vegetation begin feeding on the edges of the plant growth. Other food plants grow sparsely and low enough that geese may alight and feed anywhere within the boundaries of the plant community.

Agricultural lands. While snow geese are predominantly grubbers when feeding on marsh plants, they easily adapt to a grazing strategy in a rice and pasture crop rotation system. Fallow rice fields planted with ryegrass attract snow geese in late winter; grazing geese may consume only parts of the foliage or they may strip the plant of all above-ground structures (Glazener 1946).

Mild weather and abundant food supplies on agricultural lands should allow snow geese to meet energy demands with minimal effort. Hobaugh (1982) reported that during most months the rice prairie region provided sufficient food supplies to meet the winter metabolic demands of geese. From October to March, immature snow geese significantly improved their body condition. Body condition of adults and immatures declined only in December when agricultural lands were producing little or no forage. Flickinger and Bolen (1979), however, found that all sex and age classes of lesser snow geese lost weight during the October to March wintering period in Texas.

Snow geese that utilize an agricultural food supply are somewhat dependent on farming practices and associated land-use patterns. During early winter (October-November) snow geese utilize rice stubble fields more than any other habitat type (Hobaugh 1982). Glazener (1946) noted the importance of rice in the diet of snow geese during early winter and believed that rice remained available to geese all winter. In a feeding preference test conducted by McFarland and George (1966), geese selected rice kernels in preference to six other grains. Esophageal contents of geese killed in October and November in Texas consisted almost entirely of rice kernels (Hobaugh 1982). However, rice kernels are subject to sprouting or deterioration that limits their availability, especially during periods of wet weather (Davis et al. 1961; Hobaugh 1982).

As the rice supply is depleted between October and January, geese revert to native grasses and forbs that sprout in the rice stubble. Growth of this native vegetation is stimulated by wet weather, and adequate rainfall produces an abundance of new plant growth. Glazener (1946) noticed that upland (field) feeding by snow geese occurred mostly during wet weather. Additionally, wet weather prevents plowing by farmers, which sets back plant succession. If farmers are unable to plow their fields in spring, sprouting grasses and forbs are available to geese (Hobaugh 1982). Fall plowing and light winter flooding of rice fields also encouraged field-feeding by geese (Linscombe 1972). In late winter, the fall-planted improved pastures and winter cover crops begin to germinate in rice fields, and the sprouting green vegetation increases food availability from mid-January to mid-March (Hobaugh 1982). Harvested soybean fields also contain sprouting vegetation at this time. Esophageal contents of geese examined by Hobaugh (1982) in February and March consisted entirely of green vegetation.

Geese can be classified as diurnal feeders on agricultural lands, but feeding intensity is greatest during the morning and evening hours. Apparently, geese feed in agricultural fields only when it is light enough to detect predators. If the feeding grounds are distant, geese will leave their roost sites early enough to arrive in the fields to feed at first light (Owen 1980).

Lynch (1975) stressed the importance of agricultural fields to wintering snow geese and believed that given proper management agricultural lands could winter all the snow geese in the Central and Mississippi Flyways. Agricultural grains are easier for geese to locate, more palatable, more nutritious, and easier to digest than native foods (Owen 1980). Because of the rapid (2-4 h) passage of food through the digestive system of geese, there is little time for complex digestive processes. Harwood (1977) reported no evidence of cellulose digestion, only simple absorption of cell solutes. Geese feeding on agricultural crops maximize their nutritional intake while expending little energy.

Grit

McIlhenny (1932) noted that because of their plant root diet, snow geese required some form of grit to facilitate digestion, but only two coastal sand banks supplying grit were available between the Atchafalaya and Mermentau Rivers. Geese regularly flew long distances to these grit locations, generally every second or third day. Owen (1980) also stated that geese would make regular flights to obtain grit if it was in short supply on roosting or feeding areas.

According to Lynch (1975), the sand beaches and associated cheniers present in the coastal marshes were unsuitable because they were composed of finely ground shell fragments and quartz sand deposited by wave action. Occasionally, layers of grit were buried under an "overlay" of marsh soils that could be removed by dynamiting, thereby creating new gritting areas for geese.

The shortage of natural gritting areas was recognized by biologists, and creating new grit sites or enhancing natural sites became an important management technique on the wintering grounds. The process of supplementing natural grit sites or creating new sites with coarse sand originated with McIlhenny (1932), and man-made grit sites are used as goose-banding locations on some national wildlife refuges (Schroer 1974).

Suitable sources of grit should also increase indirectly as a result of man's intervention and development on the wintering grounds. Less than 3.7 kg per 0.4 ha (8 lb per acre) of suitable grit was found in fallow rice fields by Davis et al. (1961), but Lynch (1975) believed that the sand, fine gravel, and shell used to surface rural roads could provide a ready source of grit.

Water

Snow geese prefer freshwater to drink, but can use brackish or saline water for considerable periods (Owen 1980).

Special Considerations

While not a physical parameter of the habitat itself, one of the most important factors determining habitat use and ultimate habitat suitability is disturbance. Although the level of disturbance does not depend on the physical variables of habitat, disturbance can determine habitat use. Lynch (1975) partly attributed the drastic decline in the number of snow geese wintering on the active delta of the Mississippi River to industrial intrusion and increased disturbance from aircraft and boat traffic.

Owen (1980) theorized that freedom from disturbance was one of the most important attributes of a feeding site. Despite an abundant, easily gathered food supply, geese will abandon an area if they are frequently disturbed. Geese learn potential sources of disturbance and select large, open fields to minimize the chance of sudden disturbance. Shooting is the most potent form of disturbance, followed by human movements and noise (Owen 1980). Geese will become habituated to a frequently experienced, non-threatening disturbance and they also quickly learn areas that are disturbance-free. Some wildlife refuges may benefit geese most by providing sanctuary.

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This model was developed primarily for application in the Gulf of Mexico coastal areas of Texas and Louisiana. It may also be applicable in other inland marshes outside the coastal zone within the normal range of the lesser snow goose.

Season. The model is designed to evaluate lesser snow goose wintering habitat for the period from October to March.

Cover types. Various wetland classifications and cover types are utilized by lesser snow geese on the wintering grounds. Cowardin et al. (1979) categorized wetlands into five systems (marine, estuarine, riverine, lacustrine, and palustrine), all of which can be found within the wintering range of the lesser snow goose. During the wintering season geese may utilize all five wetland systems to satisfy their life requisites, but this model is restricted to use in the estuarine (E), palustrine (P), and lacustrine (L) systems. This model is not developed for use in agricultural lands.

Minimum habitat area. Minimum habitat area is defined as the minimum amount of contiguous suitable habitat required for a species to successfully live and reproduce. For lesser snow goose wintering areas, the minimum habitat area refers to the minimum amount of suitable habitat required to meet the feeding and roosting requirements of the species. Specific information on the required minimum area for snow geese is lacking, but marshes of at least 40.5 ha (100 acres) are assumed acceptable for meeting their feeding and roosting needs. Marshes smaller than this should not be evaluated with the HSI model.

Verification level. Earlier drafts of the lesser snow goose HSI model were reviewed by R. Chabreck and R. Hamilton, School of Forestry, Wildlife, and Fisheries, Louisiana State University, Baton Rouge; B. Brown, Refuge Manager, Lacassine National Wildlife Refuge, Lake Arthur, Louisiana; and J. Walther Refuge Manager, Sabine National Wildlife Refuge, Hackberry, Louisiana. This model has not been field tested.

Model Description

Overview. The HSI model for the lesser snow goose evaluates four habitat variables that would affect habitat suitability in any marshland cover type. The model consists of two life requisite components, food and roosting cover, that are necessary during the winter season. Grit and water requirements should be met by adequate feeding and roosting sites. Both life requisite components may be provided in a single location, but need not be for the model to be applicable. The relationship of habitat variables and cover types to the HSI value is illustrated in Figure 1.

Feeding and roosting components. Lesser snow geese that winter in natural marshland feed almost exclusively on the roots and rhizomes of emergent vegetation, principally bulrushes and marsh grasses. The suitability of an estuarine feeding site increases with an increase in the percentage of the area that supports emergent vegetation (V_1). Optimal habitat would be almost 100% vegetated with food plants, with the only open areas utilized as roosting sites or landing sites.

Water depth (V_2) influences quality of feeding and roosting habitat. Deltaic flats covered by water 20 cm (7.9 inches) or less are

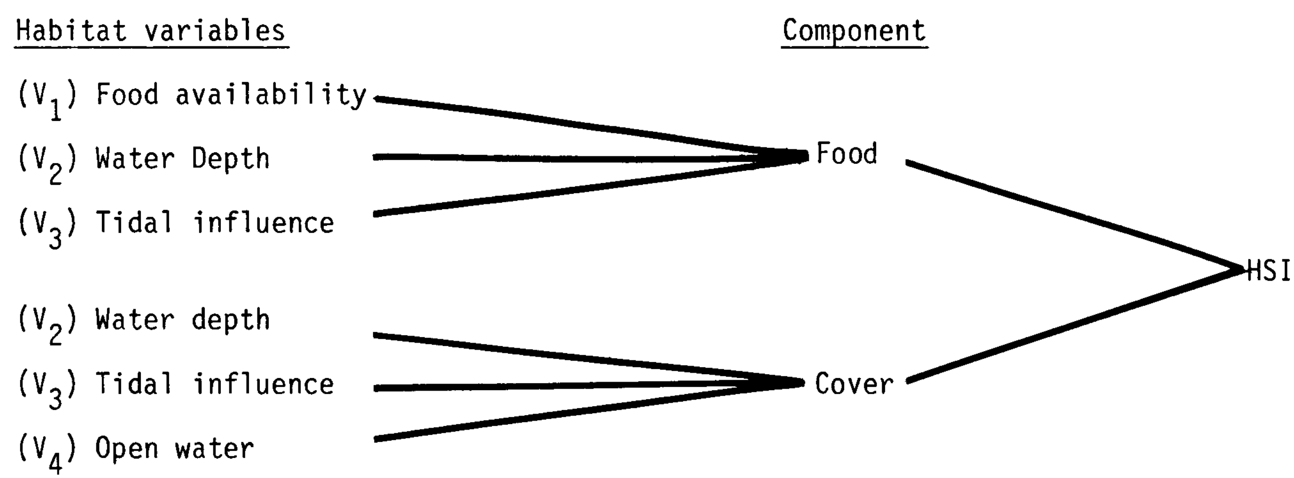


Figure 1. Relationship of habitat variables and life requisites to the HSI value for wintering habitat of the lesser snow goose.

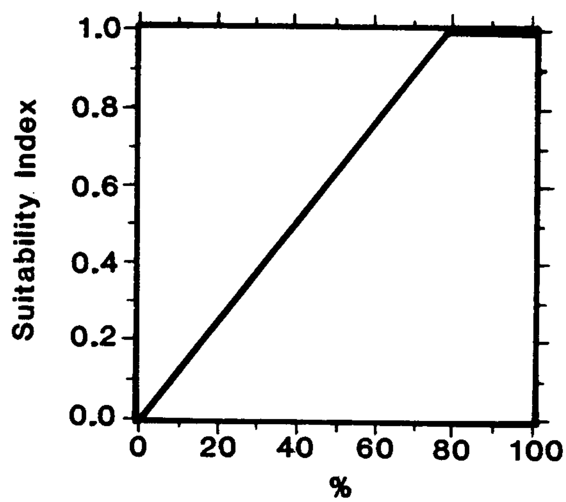
preferred feeding sites. Geese do not feed on dry flats or in deep water. Geese also prefer to roost in shallow water. We assume optimum roosting and feeding depths are similar.

A third habitat variable, tidal influence (V_3), also affects the suitability of a marsh as a feeding or roosting site. During extremely high tides, some food plants may be submerged to a depth that limits their accessibility to feeding geese. During periods of very active tidal exchange, geese may avoid a potential roosting site, because tidal currents and water movements would force them to expend additional energy that would normally be conserved when roosting.

The percentage of open water (V_4) in a marsh determines its suitability as a roosting site also. Geese roosting in a marsh require open water in close proximity for security, even though they may not be actually resting in the water. Areas with over 75% open water are assumed to be optimal, because geese would have ample warning about predators.

Suitability Index (SI) Graphs for Model Variables

This section presents graphic representations of the relationship between the value of habitat variables and the quality of estuarine (E), palustrine (P), and lacustrine (L) habitats for wintering snow geese. Optimal habitat would have a SI value of 1.0, and totally unsuitable habitat would have an SI value of 0. All variables are restricted to marshland habitats. Data sources and assumptions associated with the SI graphs are explained in Table 2.

Habitat	Variable		Suitability Graph
E,P,L	V_1	Percentage of area covered by food plants.	

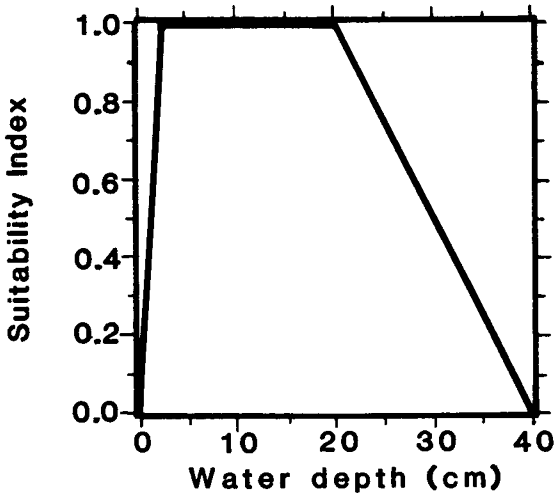
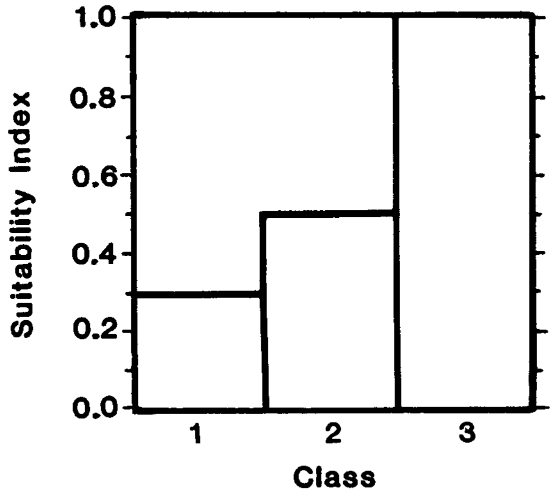
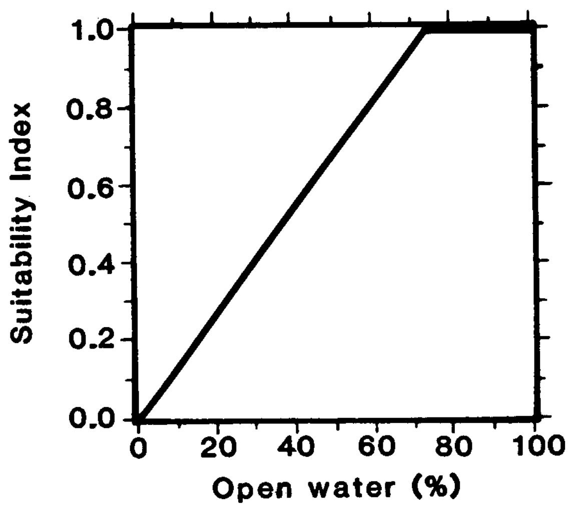
Habitat	Variable		Suitability Graph
E,P,L	V_2	Water depth.	
E,P,L	V_3	Tidal influence 1. Tide height 30 cm or greater; tide current noticeable 2. Tide height 15-30 cm; only slight tidal current 3. Tide height less than 15 cm; tidal current minimal or non-existent.	
E,P,L	V_4	Percentage of area that is open water.	

Table 2. Data sources and assumptions for snow goose suitability indices.

Variable	Source	Assumption
V_1	McAtee 1910 Stirrett 1954 Lynch 1975 Burton et al. 1979 Hobaugh 1982	Lesser snow geese utilize roots and rhizomes of native marsh plants as a food source.
V_2	Lynch et al. 1941 Burton and Hudson 1978 Owen 1980	Lesser snow geese change their feeding and roosting patterns depending on water depth.
V_3	Lynch et al. 1947 Owen 1980 Burton and Hudson 1978	Lesser snow geese modify or change their feeding patterns or schedules depending on tidal influence.
V_4	McAtee 1910 Owen 1980 Hobaugh 1982	Lesser snow geese roost in protected areas with open water nearby for escape.

HSI Determination

The following equations integrate the suitability index values determined for the habitat variables to determine component index values. Component index values may be combined to determine a habitat suitability index (HSI) value for the study area.

Component	Equation
Food (F)	$(SI_{V_1} \times SI_{V_2} \times SI_{V_3})^{1/3} = CI_F$
Cover (C)	$(SI_{V_2} \times SI_{V_3} \times SI_{V_4})^{1/3} = CI_C$

HSI = Highest value, F or C

Because of their extreme mobility, lesser snow geese can utilize separate habitats that are many kilometers apart. Morning flights to a distant attractive feeding site and afternoon flights back to the roost site are very common activities in southwestern Louisiana. Therefore, the authors feel that selecting the highest value component, F or C, for the HSI of a study area reflects the ability of lesser snow geese to maximize the benefits of a particular site. The geese are not limited by the component that is least available; rather, they take advantage of the component that is most attractive.

Three hypothetical study areas were evaluated, and an HSI value for each was derived (Table 3). The first study area represents a site with an abundant food supply that is slightly impacted by tidal action and water depth, but is not suitable roosting habitat because of its limited open water. Habitat variables are reversed in study area 2, with limited food supplies but ample open water for roosting. Study area 3 represents an almost ideal habitat for lesser snow geese: lots of open water of optimal depth for protection while roosting and abundant food supplies close at hand.

Table 3. Calculation of suitability indices (SI), component indices, and habitat suitability indices for three sample study areas using habitat variable (V) measurements and snow goose HSI model equations.

Model component	Study area 1		Study area 2		Study area 3	
	Data	SI	Data	SI	Data	SI
V_1	90%	1.00	25%	0.31	85%	1.00
V_2	10 cm	1.00	10 cm	1.00	20 cm	1.00
V_3	Class 2	0.50	Class 2	0.50	Class 3	1.00
V_4	25%	0.33	75%	1.00	60%	0.80
CI_F	0.79		0.54		1.00	
CI_C	0.55		0.79		0.93	
HSI	0.79		0.79		1.00	

Field Use of the Model

Habitat variables can be measured during any time of the year, but a field verification of all variables should be made during the actual wintering season. If no food plants are available, the area may be evaluated as cover only. All other areas must be evaluated for both variables. Open water can be planimetered or estimated from current aerial photography, but tidal influence and percentage occurrence of food plants must be analyzed on-site. Both variables should be analyzed in several areas on the study site or along representative transects. In most cases, the occurrence of food plants can be estimated if the observer is familiar with botanical identification. If the observer is not familiar with marsh plants and their identification, the authors suggest using one of the standard botanical techniques outlined in most botany laboratory manuals. Subjective estimates may adversely affect the consistency of model outputs.

Interpreting Model Outputs

A wintering lesser snow goose HSI derived with this model reflects only habitat potential. The model does not predict population numbers or actual use of the habitat by geese. Correct use of the model involves two comparisons: (1) the potential of two or more different habitats to support wintering lesser snow geese at the same point in time and (2) the potential for one particular habitat to support wintering lesser snow geese at two points in time. The higher the HSI, the more potential an area has to support geese.

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16. Abstract (Limit: 200 words)

A review and synthesis of existing information were used to develop a habitat model for lesser snow geese (Chen caerulescens caerulescens). The model is scaled to produce an index of habitat suitability between 0 (unsuitable) and 1.0 (optimally suitable) for lesser snow goose wintering habitat in the Gulf of Mexico coastal areas of Texas and Louisiana. Habitat suitability indices are designed for use with the habitat evaluation procedures previously developed by the U.S. Fish and Wildlife Service. Guidelines for application of the lesser snow goose model are provided.

17. Document Analysis a. Descriptors

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