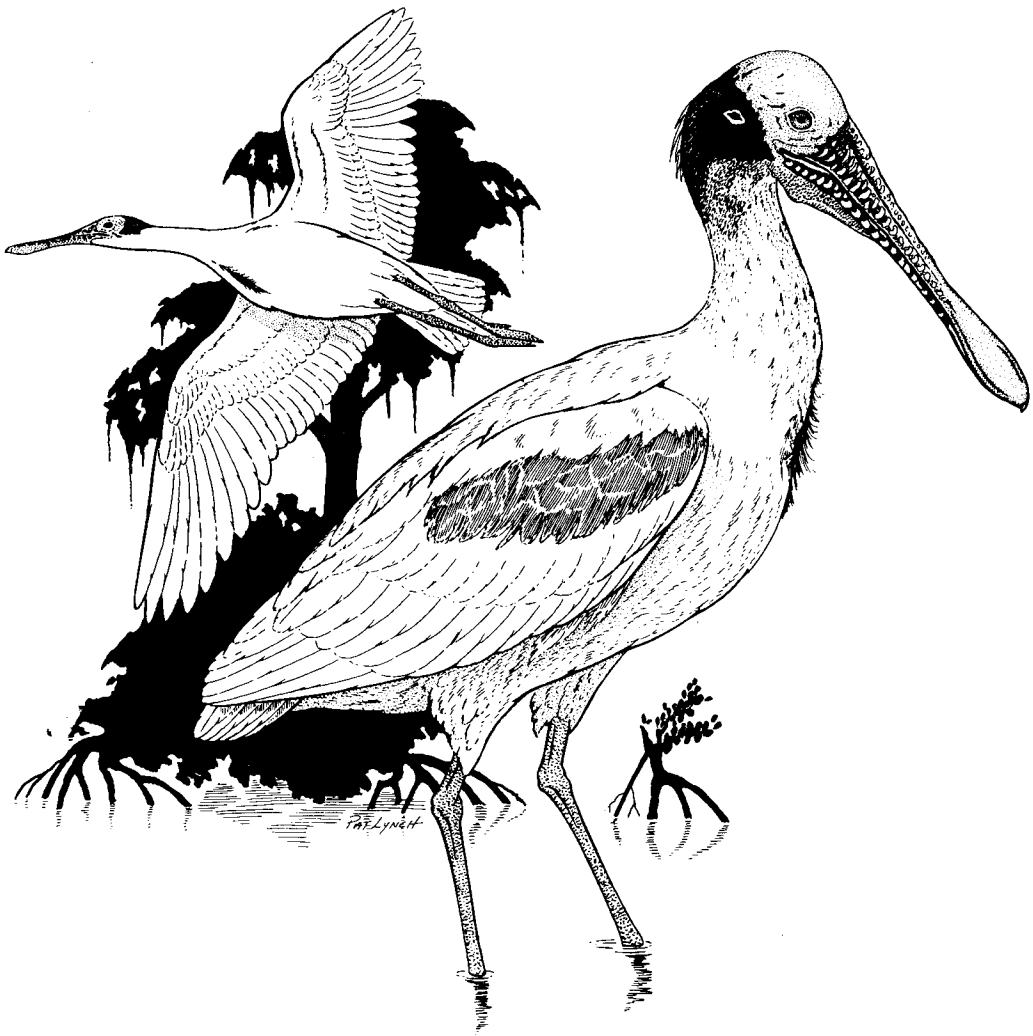
FWS/OBS-82/10.50
SEPTEMBER 1983

HABITAT SUITABILITY INDEX MODELS: ROSEATE SPOONBILL



Fish and Wildlife Service

U.S. Department of the Interior

FWS/OBS-82/10.50
September 1983

HABITAT SUITABILITY INDEX MODELS: ROSEATE SPOONBILL

by

James C. Lewis
Georgia Cooperative Wildlife Research Unit
School of Forest Resources
University of Georgia
Athens, GA 30602

Project Officer

Carroll Cordes
National Coastal Ecosystems Team
U. S. Fish and Wildlife Service
1010 Gause Boulevard
Slidell, LA 70458

Performed for
National Coastal Ecosystems Team
Division of Biological Services
Research and Development
Fish and Wildlife Service
U. S. Department of the Interior
Washington, DC 20240

This report should be cited as:

Lewis, J. C. 1983. Habitat suitability index models: roseate spoonbill. U. S. Dept. Int. Fish. Wildl. Serv. FWS/OBS-82/10.50. 16 pp.

PREFACE

The habitat use information and habitat suitability index (HSI) model in this report on roseate spoonbill is intended for use in 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) (U.S. Fish and Wildlife Service 1981). Assumptions used to transform habitat use information into the HSI 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 relationships. The model has not been field-tested, but it has been applied to three hypothetical data sets which are presented and discussed. 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 on the roseate spoonbill HSI model to:

National Coastal Ecosystems Team
U.S. Fish and Wildlife Service
1010 Gause Boulevard
Slidell, LA 70458

CONTENTS

	Page
PREFACE	iii
ACKNOWLEDGMENTS	vi
HABITAT USE INFORMATION	1
Introduction	1
Food Requirements	1
Nest and Roost Requirements	2
Interspersion	3
Special Considerations	4
HABITAT SUITABILITY INDEX (HSI) MODEL	4
Model Applicability	4
Model Description	4
Suitability Index (SI) Graphs for Model Variables	6
Habitat Suitability Index (HSI) Equations	11
Field Application of the Model	11
Interpreting Model Outputs	14
REFERENCES	15

ACKNOWLEDGMENTS

Development of the habitat suitability index model and narrative for roseate spoonbill was monitored, expertly reviewed, and constructively criticized by Dr. Alexander Sprunt, IV, National Audubon Society, Tavernier, Florida; Dr. R. Douglas Slack, Texas A & M University, College Station, Texas; and William B. Robertson, Jr., U.S. National Park Service, Homestead, Florida. Thorough evaluations of model structure and functional relationships were provided by Carroll Cordes and Rebecca Howard 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. Model development and publication were funded by the U. S. Fish and Wildlife Service. Recent U. S. Department of Agriculture publications (Soil Conservation Service 1982a, 1982b) have been used to standardize the use of Latin names in this report.

ROSEATE SPOONBILL (*Ajaia ajaja*)

HABITAT USE INFORMATION

Introduction

The roseate spoonbill is a long-legged wading bird with a height of approximately 80 cm (31.5 inches), a wingspan of 1.3 m (4.3 ft), and a weight of 1.6 kg (3.5 lb). The bill is narrower near the base (2-3 cm, 0.8-1.2 inches) than at the flattened tip (5 cm, 2 inches) and is 15-18 cm (5.9-7.1 inches) in length.

Roseate spoonbills occur and nest in peninsular Florida, coastal Louisiana, and Texas, south through the West Indies, Mexico, Central and South America to Argentina and Chile. Marine, brackish, and freshwater habitats are utilized, but brackish areas are favored (Blacklock et al. 1978). In the late 1970's there were 2,500 pairs nesting along the Texas coast (Texas Colonial Waterbird Society 1982), 1,300 pairs in southwestern Louisiana (Portnoy 1977), and 1,400 pairs in Florida (Robertson et al. 1983). These birds are resident year round in Florida, Louisiana, and Texas, but fewer birds are present during the nonbreeding season than in the breeding season. Some individuals move northward after nesting and have been reported in Georgia, Nebraska, Pennsylvania, Utah, and Wisconsin, but most spoonbills move south when they leave the breeding area.

The timing of nesting activities varies between Texas-Louisiana and Florida. Spoonbills move from Mexico into coastal Texas and southwest Louisiana in late February to early March and nest from April through June; the young fledge from May to mid-July. After nesting, some birds disperse before their departure to Mexico (Palmer 1962; Oberholser and Fuertes 1974). Roseate spoonbills, presumably from Cuba, move to Florida in late September through early October, lay eggs in November or early December, and fledge young during February (Ogden 1978). Another group of spoonbills, mostly subadults, apparently originates in Cuba (and perhaps adjacent areas) and moves into southern Florida in March. These birds occur from east Cape Sable north along the southwest coast of Florida to Palma Sola Bay and occasionally Tampa Bay. They return to the West Indies in September-October (Palmer 1962).

The age of sexual maturity is thought to be 4 years (Allen 1942). The clutch size is 2-5 eggs, with an average of 2.7-3 (Bent 1963; White et al. 1982). Incubation requires 22 days (White et al. 1982), and spoonbills nest only once each year.

Food Requirements

Shallow water is required for feeding. The tarsus length of spoonbills is 10.7-12.3 cm (4.2-4.8 inches) (Oberholser and Fuertes 1974). Total length of the unfeathered portion of the leg is about 20 cm (7.9 inches). Occasionally spoonbills feed at depths where their breast feathers are in the water and their heads

immersed, but more typically they feed in shallower water depths equal to or less than 12 cm (4.7 inches) (Holly Hobart, University of Arizona, Tucson; pers. comm.).

The spoonbill's bill is highly specialized. The mandibles are well supplied with sensitive nerve endings (Allen 1942), and the bird relies on tactile senses to capture prey. Oberholser and Fuertes (1974) referred to the bill as a supersensitive forceps. While feeding, the bird sweeps its partially open bill back and forth through the water in half circles, seizing potential prey. Spoonbills often feed in small groups. Mock (1978) suggested that this behavior may have evolved because the individual bird benefits from increased prey movement caused by its feeding neighbors.

Fish constituted 62% of the stomach contents of five spoonbills (Cottam and Knappen 1939; F. M. Uhler unpubl. in Allen 1942). Spoonbills commonly fed on sheepshead minnow (Cyprinodon variegatus), mosquitofish (Gambusia affinis), sailfin molly (Poecilia latipinna), several killifish of genus Fundulus, and silversides (Atherinidae) (Allen 1942). Second in overall food importance (21% by volume) were crustaceans, including crayfish (Cambarus sp.), shrimp (Penaeus spp.), prawns (Palaemonetes exilipes), fiddler crabs (Uca spp.), isopoda, and amphipoda (Allen 1942). Insects were third in volume (14%) and included backswimmers (Notonecta sp.), water boatmen (Trichocorixa sp.), predacious diving beetles (Thermonectes basilaris and Cybister fimbriolatus), and waterscavenger beetles (Tropisternus glaber, T. mexicanus, Berosus striatus). Mollusks were of minor importance and vegetative material was 3% by volume.

Spoonbills usually feed in daylight hours, but will also feed at night. Feeding activity peaks at low tide in areas of wide tidal range (Hobart, pers. comm.). The young are fed by both parents. They leave the nest at 5-6 weeks, but remain in the rookery vicinity until about the 8th week (Palmer 1962; Chaney et al. 1978). Young spoonbills learn to forage for themselves shortly after leaving the nest. By about the 9th week the juveniles are accompanying adults in flights to more distant feeding areas. Spoonbills will fly as far as 30 km (18.6 mi) to feed. W. B. Robertson, Jr. (National Park Service, Homestead, Florida, pers. comm.) reported that flights of 15-20 km (9.3-12.4 mi) are common from roost to feeding sites.

Nest and Roost Requirements

Islands, islets, or keys are sites where spoonbill rookeries are most frequently located. Limited freedom of access by predators, including humans, may explain the spoonbill's preference for island nesting sites. Allen (1942) described significant nest predation by raccoon (Procyon lotor) in Florida that caused spoonbills to desert a Manatee Keys rookery. Colonial Bird Register data (courtesy of N. P. McGinnis and D. A. McCrimmon, Jr., National Audubon Society Research Department) shows that islands occupied by spoonbills ranged in size from 0.5-70 ha (1.2-173 acres), and that the colony area ranged from 0.5-35 ha (1.2-86.4 acres). One 0.5-ha island contained 375 spoonbills (a large rookery population). The area of a potential rookery and island size seem to be poor measures of habitat suitability.

The second most important rookery location is shrub and forest wetlands on the mainland. Spoonbills also occasionally nest in upland forest and shrub habitats of the mainland.

Roseate spoonbills nest and roost in trees and shrubs such as mangroves (Rhizophora spp. and Avicennia spp.), desert hackberry (Celtis pallida), marsh elder

(Iva frutescens), baldcypress (Taxodium distichum), elderberry (Sambucus canadensis), sugar hackberry (Celtis laevigata), or willow oak (Quercus phellos) (Allen 1942). They often nest and roost in low (2-6 m, 6.5-19.6 ft) trees or shrubs but sometimes nest and roost at heights up to 30 m (98.4 ft). Dead trees were suitable roosts for nonbreeders (Allen 1942).

Although nest sites are highly variable, they generally include adequate room for the nest and roosting space for the adults, adjacent shallow water where fledged young can learn to forage and find abundant prey, and freedom from disturbance by humans and other mammalian predators (Allen 1942). Average nest height atop low vegetation at Nueces Bay, Texas, was 23.9 ± 2.4 cm (9.4 ± 0.9 inches) and average nest height in trees and shrubs was 70.6 ± 13.3 cm (27.8 ± 5.2 inches) (White et al. 1982). The nest is built on horizontal limbs and is composed of sticks and twigs lined with finer material such as leaves (Palmer 1962). Nests on the ground are unusual (Palmer 1962).

Spoonbill rookery and roost sites in Florida and the upper gulf coast differ because of the availability of habitats. In Florida, spoonbills often build their nests in thickets of red mangrove (Rhizophora mangle) and black mangrove (Avicennia germinans) on islands (Howell 1932; Bent 1963; Ogden 1978). For example, Bent (1963) described a 5-ha (12.3-acre) island in Florida where spoonbills nested in dense red mangroves 4-5 m (13.1-16.4 ft) above soft mud or water. In contrast, mangrove habitat is unavailable along most of the upper gulf coast, and dredged-material islands are the most important rookery locations in Texas. In 1976, 67% of 1,758 spoonbill nests in Texas were in vegetation on dredged-material sites (Chaney et al. 1978). Part of the attraction of these areas may be the shrub-small tree successional stage that is suitable as a nest location.

Roseate spoonbills often nest and roost in mixed species colonies that may include great egret (Casmerodius albus), little blue heron (Egretta caerulea), reddish egret (Egretta rufescens), cattle egret (Bubulcus ibis), great blue heron (Ardea herodias), snowy egret (Egretta thula), black-crowned night-heron (Nycticorax nycticorax), white ibis (Eudocimus albus), wood stork (Mycteria americana), white-faced and glossy ibis (Plegadis chihi, P. falcinellus), tricolored heron (Egretta tricolor), and olivaceous cormorant (Phalacrocorax olivaceus). Nonbreeders may roost apart from nesting colonies, along with nonbreeders of other wading bird species.

Interspersion

Interspersion of habitats required by roseate spoonbills has not been well described in published literature. Nests and roosts are adjacent for nesting adults. The member of the pair not on the nest roosts nearby. Shallow water feeding habitat should also be available next to the rookery because fledged young feed there 2-3 weeks before they join adults in flights to more distant feeding sites. The proximity of nest and roost sites to feeding sites is less critical for adults. Breeding spoonbills frequently fly 20-30 km (12.4-18.6 mi) from their nest site to feeding sites (Sprunt IV and Robertson, pers. comm.). D. H. White (U. S. Fish and Wildlife Service, Victoria, Texas; pers. comm.) noted breeding adults making frequent flights of 1-1.5 km (0.6-0.9 mi) from a rookery to feeding sites. Presumably there would be some advantages in energy conservation for those birds able to find sufficient food at short distances from the rookery.

Special Considerations

Disturbance of these birds by humans during the nesting period may cause nest abandonment (Allen 1942; Anderson 1981). Some habitats might appear ideal for nesting; but, if they are subject to frequent disturbance by humans, they are unlikely to be successful nesting sites. Anderson (1981) recommended that photographers and observers not be permitted closer than 100 m (328 ft) to a nesting colony of spoonbills and other associated nesting colonial birds.

Along the Florida coast, mangrove swamps and islands are indicative of good spoonbill nesting and roosting habitat. The more extensive mangrove swamps limit access by man and thereby provide a degree of isolation and protection. The more inaccessible mangrove islands provide similar isolation. Mangroves also provide good feeding sites for spoonbills. Along the Texas and Louisiana coasts, natural coastal islands and dredged-material islands provide similar benefits of isolation and protection from activities of man. An abundance of such coastal islands increases the probability that suitable nesting habitat will be present.

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

This model was developed for Atlantic and Gulf of Mexico coastal areas south of latitude 31° N and applies to Atlantic coastal areas of Florida and to the Gulf Coast States. Roseate spoonbill habitat types in these areas include estuarine (E) intertidal scrub-shrub wetlands and forested wetlands, palustrine (P) scrub-shrub wetlands and forested wetlands (Cowardin et al. 1979), and woody vegetation on upland (U) sites such as natural islands and islets, dredged-material islands, and spoil banks surrounded by or near water.

Minimum habitat area is defined as the minimum amount of contiguous suitable habitat that is required for a species to successfully live and reproduce. Information on minimum habitat area was not found in the literature for the roseate spoonbill.

The model was reviewed by the following ornithologists: R. Douglas Slack (Texas A & M University, College Station, Texas), Alexander Sprunt, IV (National Audubon Society, Tavernier, Florida), and William P. Robertson, Jr. (U.S. National Park Service, Homestead, Florida). Their comments have been incorporated into the current model.

Model Description

Overview. Prey species utilized by spoonbills are common in shallow waters all along the gulf and South Atlantic coast. Spoonbills will fly up to 30 km (18.6 mi) to feed and will feed on a wide variety of food items. Feeding habitat, consisting of shallow water areas, is abundant throughout the coastal area. Therefore, for the purposes of this model, food is not considered to be a limiting factor. Roosting-nesting habitat is the only life requisite considered in this model. Roseate spoonbills roost and nest in two main locations: (a) islands, islets, and keys, and (b) secluded sites along the mainland coast. Figure 1 shows how the habitat suitability index (HSI) is related to the roosting-nesting cover requisite and to specific habitat variables in island and in mainland sites.

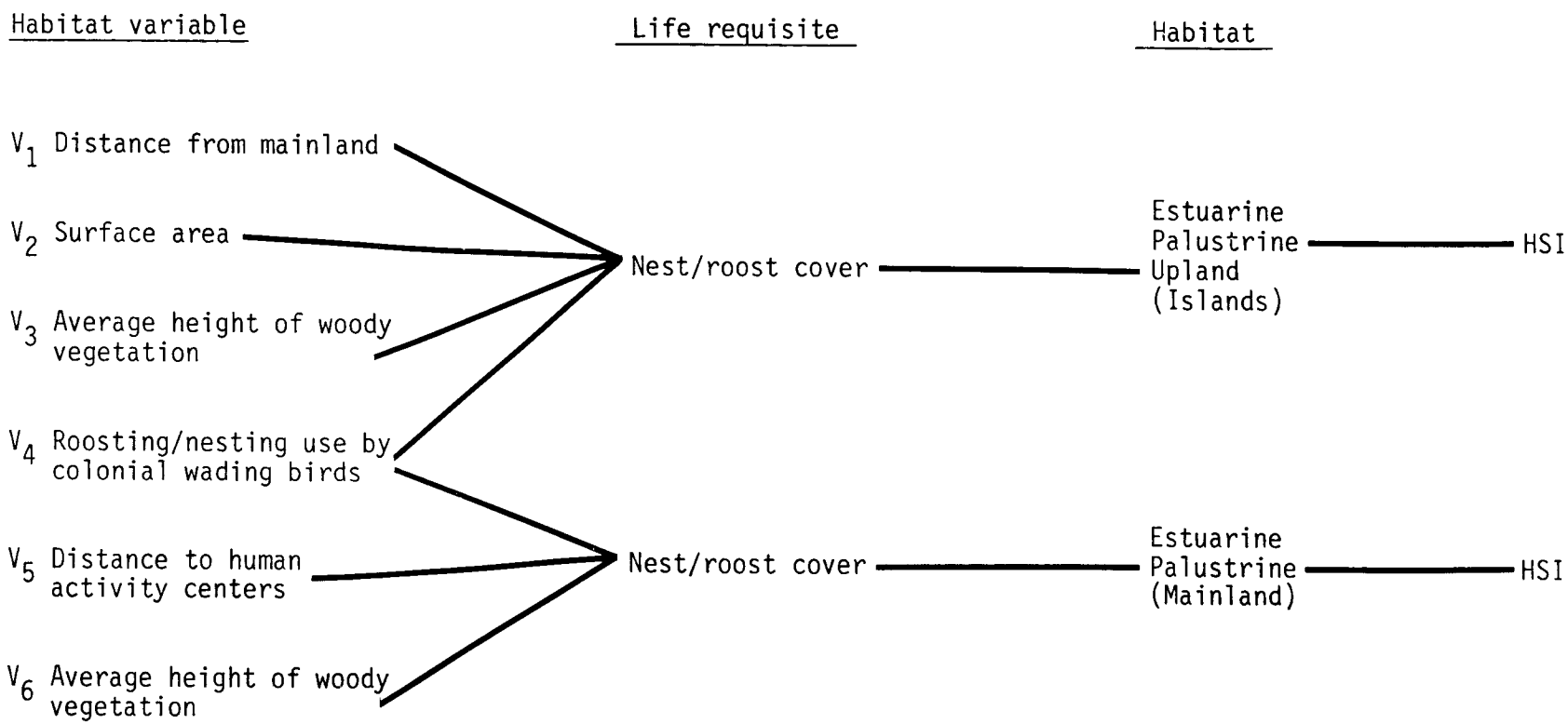


Figure 1. Relationship of habitat variables and the roost/nest life requisite to the HSI for roseate spoonbill in island and in mainland sites.

Roosting-nesting cover. An important aspect of island roost/nest sites is the distance from the island to the mainland (V_1). Those islands farther than 0.4 km (0.25 mi) from the mainland are less likely to be easily accessible to nest predators. Consequently, islands separated from the mainland by 0.4 km or more are given a higher value because nesting success there is more likely to be greater than nesting success on islands closer to the mainland.

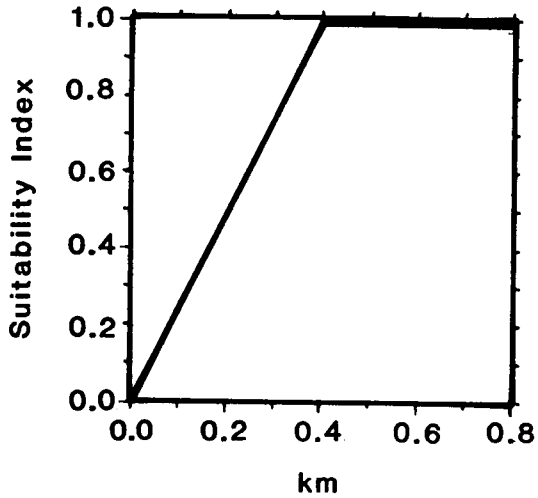
Another important variable of islands is their surface area (V_2). Large islands have a greater likelihood of being occupied by nest predators and utilized by humans for a variety of activities. Thus, a lower value is accorded to the larger islands. The height of woody vegetation (V_3) influences the suitability of an island as spoonbill nesting and roosting habitat. Low shrubs and trees are preferred by spoonbills, a preference that may exist because of the strong coastal winds that buffet barrier islands. An island that contains woody vegetation within a height range of 0.5-10 m (1.6-32.8 ft) is more suitable than islands where the woody vegetation is taller than 10 m.

As noted previously, spoonbills usually roost and nest with other colonial wading birds. Some rookeries have been in use for several decades. Spoonbills do colonize new sites, but they are more likely to colonize locations already being used by other wading birds. Consequently, areas with a history of wading bird use are given a higher value than other sites (V_4). Prior or current use is a variable employed only to derive the HSI for existing conditions. For estimating future HSI's, this variable is deleted from the formulas (see Equations).

The prior or current use of a site by wading birds is also a variable influencing the HSI of mainland roost/nest sites. The other two variables indicative of mainland site suitability are the distance to activity centers of humans (V_5) and vegetation height (V_6). The distance to human activity centers (residences, businesses, industry) is one measure of the accessibility of the roost/nest site and of the likelihood that humans will interfere with roosting or nesting. Therefore, the more secluded, inaccessible sites are more suitable for roosting and nesting. Preferred vegetation height is greater on mainland sites than on islands, perhaps because wind influence is diminished some and increased nest height presumably is a defensive measure against mammalian predators. Woody vegetation 3-20 m (9.8-65.6 ft) in height is assumed to be optimal on mainland sites.

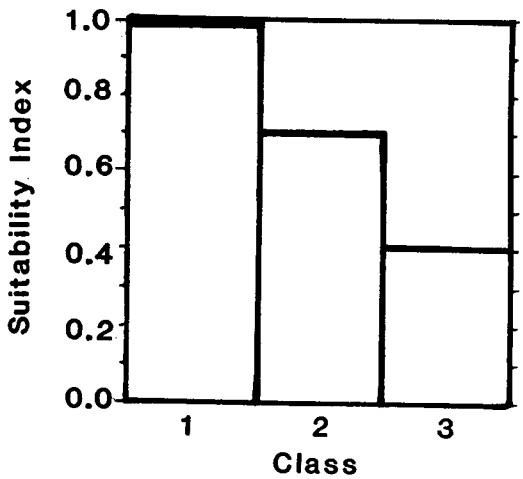
Suitability Index (SI) Graphs for Model Variables

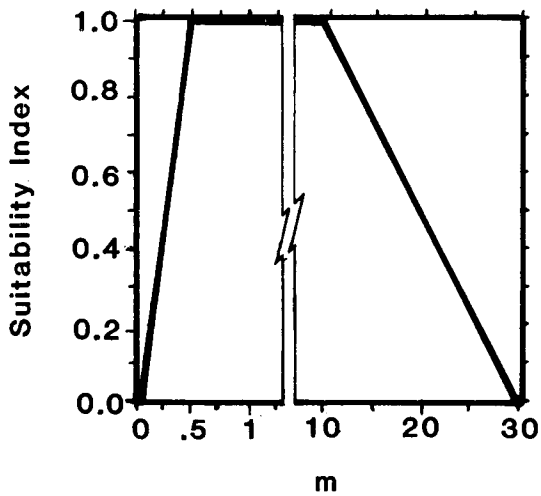
This section contains suitability index graphs that illustrate the habitat relationships described in the previous section. Data sources and assumptions for roseate spoonbill suitability indices (hereafter SI) are summarized in Table 1. The HSI will range from 0 (unsuitable habitat) to 1 (optimally suitable).

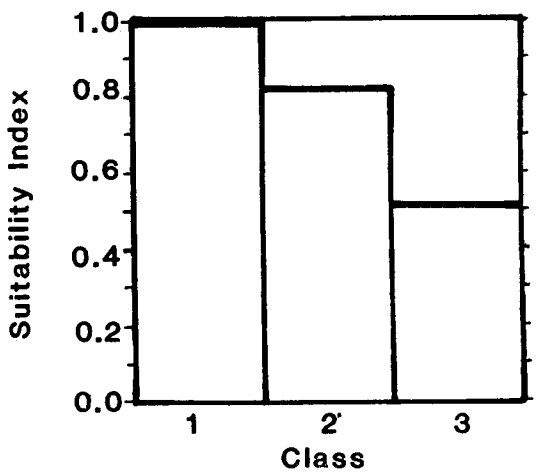
Habitat	Variable	Suitability Graph
E,P,U	V_1 Distance of island or key from mainland.	

E,P,U V_2 Surface area of island or key.

1) 0.5 - 80 ha (1.2-197.7 acres).
2) 81 - 160 ha (200.2-395.4 acres).
3) 161 ha (397.8 acres) or larger.



Habitat	Variable		Suitability Graph
E,P,U	V_3	Average height of woody vegetation on island.	

E,P,	V_4	Use of habitat as wading bird roost/ nest site. 1) Site known to be used by roseate spoonbills for roosting or nesting in prior or current year breeding season. 2) Site known to be used by other colonial wading birds for nesting/ roosting in prior or current year. 3) Site not known to have been used by roseate spoonbills or other colonial wading birds in prior or current year.	

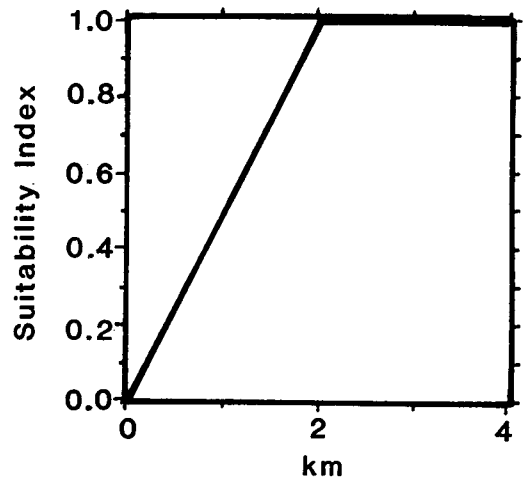
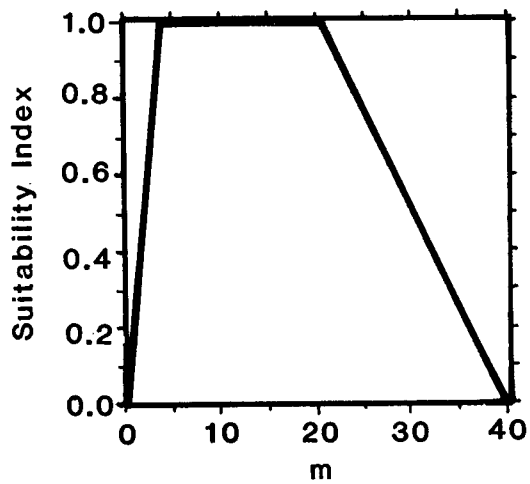
Habitat	Variable	Suitability Graph
E,P,	V_5 Distance to human activity centers.	
E,P,	V_6 Average height of woody vegetation.	

Table 1. Data sources and assumptions for roseate spoonbill suitability indices.

Variable and source		Assumption
V_1	Allen 1942 Anderson 1977	Islands or keys located at least 0.4 km (0.25 mi) from the mainland are more suitable roost/nest sites because they are less accessible to disturbance by predators and humans.
V_2	Allen 1942 Portnoy 1977 Blacklock et al. 1978 Chaney et al. 1978 Colonial Bird Register data	Islands or keys of at least 0.5 ha (1.2 acres) are large enough for a roost/nest site, and those islands or roosts larger than 80 ha (197.7 acres) are less suitable because they are more likely to be occupied by humans or nest predators.
V_3	Howell 1932 Allen 1942 Portnoy 1977 Blacklock et al. 1978 White et al. 1982 Texas Colonial Waterbird Soc. 1982	Low shrubs and trees (0.5-10 m or 1.6-32.8 ft in height) are preferred as nest/roost sites on islands or keys.
V_4	Allen 1942 Chaney et al. 1978 Colonial Bird Register data Sprunt IV, pers. comm. Slack, pers. comm.	Sites used in a prior or current year for nesting or roosting by roseate spoonbills or other wading birds have a higher probability of current or future nest/roost use than do areas without previous use.
V_5	Allen 1942 Anderson 1977	Sites at a distance from human activity centers (residences, business, industry) are more suitable than sites close (2 km, 1.2 mi) to such activity centers.
V_6	Howell 1932 Allen 1942 Portnoy 1977 Blacklock et al. 1978 White et al. 1982 Texas Colonial Waterbird Soc. 1982	Woody vegetation 3-20 m (9.8-65.6 ft) in height is most suitable for roosting or nesting on the mainland.

Habitat Suitability Index (HSI) Equations

Equations 1 and 2 are used for deriving the HSI's for present conditions. Equation 1 is for an island, key, or islet and Equation 2 is for mainland sites bordering the coast. Equations 3 and 4 are used to estimate HSI's for future conditions, Equation 3 for islands and Equation 4 for mainland sites along the coast. Islands and keys are preferred over mainland sites for roosting and nesting. This is reflected in the weighting factor (0.8) included in Equations 2 and 4.

Present Conditions

Island or key - Equation 1

$$HSI = (SI_{V1} \times SI_{V2} \times SI_{V3} \times SI_{V4})^{1/4}$$

Coastal edge site - Equation 2

$$HSI = (0.8) \times (SI_{V4} \times SI_{V5} \times SI_{V6})^{1/3}$$

Future Conditions

Island or key - Equation 3

$$HSI = (SI_{V1} \times SI_{V2} \times SI_{V3})^{1/3}$$

Coastal edge site - Equation 4

$$HSI = (0.8) \times (SI_{V5} \times SI_{V6})^{1/2}$$

Field Application of the Model

The level of detail needed for a particular application of this model will depend on time, money, and accuracy constraints. Detailed field sampling of all variables will provide the most reliable HSI values.

A potential roost/nest site is defined as a contiguous habitat type (scrub-shrub or forested wetland, scrub-shrub or forested upland) on an island, islet, key, or the mainland coastal edge. An HSI is determined for each contiguous habitat type.

The measurement techniques in Table 2 are suggested for variables used in this model. A field form can be developed from this list. Assume you are examining a coastal strip 10 x 2 km (6.2 x 1.2 mi) chosen as a potential navigation project site and you wish to determine if potential roseate spoonbill roosting-nesting habitat will be impacted. The following must be done to determine an HSI. Measure the values for each variable using the techniques suggested in Table 2. Using these values, read the SI index value from the suitability index graphs. Use the derived SI values in calculating the appropriate HSI equation(s) for each potential roost or nest site.

Table 3 provides sample data sets that have been applied to the roseate spoonbill model to calculate HSI's. The data sets represent realistic model applications. Data set 1 represents a key, estuarine, forested wetland limited by being

Table 2. Suggested measurement techniques and definitions of habitat variables used on roseate spoonbill HSI model.

Variable	(definition)	Suggested technique
V_1	Distance of island or key from mainland (distance is the straight line measurement in kilometers across the body of water that separates the island or key from the mainland).	Refer to coastal maps or aerial photos and measure the appropriate distance.
V_2	Island size (the hectares of surface area on the island, islet, or key).	Refer to coastal maps or aerial photos and measure the area with a planimeter or dot grid.
V_3,V_6	Mean height of woody vegetation (average distance in meters from ground surface to the top of 10 randomly selected trees or shrubs).	If aerial photos are suitable, measure vegetation with a stereoscope. Measure a site with a hypsometer or altimeter (Hays et al. 1981). Between 0.5 and 1 ha (1.2 and 2.5 acres) would be a suitable sample site.
V_4	Prior- or current-year colonial roosting/nesting by roseate spoonbills or other wading birds (prior is defined as existing within the decade preceding the year of the evaluation; current is defined as in calendar year of the evaluation).	The presence of subadults, adults, or young will be evidence of current use. The presence of nests or reliable reports of historical use in the past decade will suffice as evidence of prior use. Reliable reports are those from persons knowledgeable about wading birds that are colonial nesters (i.e., biologists, amateur birders, gamewardens or rangers).
V_5	Distance (km) from human activity centers (activity centers are those areas regularly occupied by humans, e.g., residences, businesses, industry).	Mark activity centers on maps or aerial photos and measure the straight line distance to the middle of the potential roost/nest site.

Table 3. Calculation of the suitability indices (SI) and the habitat suitability index (HSI) for three sample data sets.

	Data set 1		Data set 2		Data set 3	
Components	Data	SI	Data	SI	Data	SI
V_1	2 km	1.00	0.05 km	0.12		
V_2	Category 2	0.70	Category 1	1.00		
V_3	9.5 km	1.00	1 m	1.00		
V_4	Category 1	1.00	Category 3	0.50	Category 3	0.50
V_5					0.25 km	0.13
V_6					38 m	0.10
HSI	0.91		0.50		0.15	
Site	Key		Dredged island		Mainland	
Habitat	E, forested wetland		U, scrub-shrub upland		P, forested wetland	
Equation number	1		1		2	

category 2 in area. Data set 2, represents a dredged island vegetated with scrub shrub, only 0.05 km (0.03 mi) from the mainland, that has not been used for colonial roosting or nesting by wading birds. Data set 3 represents a palustrine, forested wetland along the coast, where none of the three SI's are optimum at the site.

Interpreting Model Outputs

A roseate spoonbill HSI determined by application of this model may have no relationship to actual population density. Other non-habitat factors that are not included in the model may be critical in determining species abundance. The primary value of an HSI is for comparing the potential of areas to support roseate spoonbills. If an area being evaluated has more than one potential roost/nest site, then the HSI's should be averaged. When two large areas are being compared, the mean HSI for one area and the minimum HSI and maximum HSI for individual sites are compared to similar measurements on the second area.

REFERENCES

Allen, R. P. 1942. The roseate spoonbill. Res. Rep. 2, Natl. Audubon Soc., New York. 142 pp.

Anderson, J. M. 1977. Managing nongame wildlife on private lands. Trans. N. Am. Wildl. Nat. Resour. Conf. 42:286-293.

Anderson, J. M. 1981. Protection and management of wading birds. Pages 99-103 in A. Sprunt IV, J. C. Ogden, and Suzanne Winckler, eds. Wading birds. Res. Rep. 7, Natl. Audubon Soc., New York.

Bent, A. C. 1963. Life histories of North American marsh birds. U.S. Natl. Mus. Bull. 135, Dover Publ., Inc., New York. (First published in 1926) 392 pp.

Blacklock, G. W., D. R. Blankinship, S. Kennedy, K. A. King, R. T. Paul, R. D. Slack, J. C. Smith, and R. C. Telfair II. 1978. Texas colonial waterbird census, 1973-1976. F. A. Rep. Ser. 15, Tex. Parks Wildl. Dep. 87 pp.

Chaney, A. H., B. R. Chapman, J. P. Karges, D. A. Nelson, R. R. Schmitt, and L. C. Thebeau. 1978. Use of dredged material islands by colonial seabirds and wading birds in Texas. Dredged Material Res. Program, Tech. Rep. D-78-8, U.S. Army Eng. Waterways Exp. Stn., Vicksburg, Miss. 170 pp. + appendices.

Cottam, C., and P. Knappen. 1939. Food of some uncommon North American birds. Auk 56(2):138-169.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish Wildl. Serv. Biol. Serv. Program FWS/OBS-79/31. 103 pp.

Custer, T. W., R. G. Osborn, and W. F. Stout. 1980. Distribution, species abundance, and nesting-site use of Atlantic coast colonies of herons and their allies. Auk 97(3):591-600.

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

Howell, A. H. 1932. Florida bird life. Coward-McCann, Inc., New York. 579 pp.

Mock, D. W. 1978. Introductory remarks. Pages 3-6 in A. Sprunt IV, J. C. Ogden, and Suzanne Winckler, eds. Wading birds. Res. Rep. 7, Natl. Audubon Soc., New York.

Morrison, M. L., R. D. Slack, and E. Shanley, Jr. 1978. Interspecific association of olivaceous cormorants and roseate spoonbills. Southwest. Nat. 23(4):681-709.

Mosby, H. S. 1980. Reconnaissance mapping. Pages 277-290 in S. D. Schemnitz, ed. Wildlife management techniques manual, 4th ed. The Wildlife Society, Washington, D. C.

Oberholser, H. C., and L. A. Fuertes. 1974. The bird life of Texas. University of Texas Press, Austin. 530 pp.

Ogden, J. C. 1978. Roseate spoonbill. Pages 52-54 in H. W. Kale II, ed. Rare and endangered biota of Florida. Vol. 2, Birds. University Presses of Florida, Gainesville.

Palmer, R. S. 1962. Handbook of North American birds. Vol. 1, Loons through flamingos. Yale University Press, New Haven, Conn. 567 pp.

Portnoy, J. W. 1977. Nesting colonies of seabirds and wading birds - coastal Louisiana, Mississippi, and Alabama. U. S. Fish Wildl. Serv. Biol. Serv. Program FWS/OBS-77/07.

Robertson, W. B., Jr., L. L. Breen, and B. W. Patty. 1983. Movement of marked roseate spoonbills in Florida. J. Field Ornithol. (at press).

Soil Conservation Service. 1982a. National list of scientific names. Vol. 1, List of plant names. USDA, SCS-TP-159. 416 pp.

Soil Conservation Service. 1982b. National list of scientific names. Vol. 2, Synonymy. USDA, SCS-TP-159. 438 pp.

Texas Colonial Waterbird Society. 1982. An atlas and census of Texas waterbird colonies 1973-1980. Caesar Kleberg Wildl. Res. Instit. 357 pp.

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

White, D. H., C. A. Mitchell, and E. Cromartie. 1982. Nesting ecology of roseate spoonbills at Nueces Bay, Texas. Auk 99:275-284.

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. FWS/OBS-82/10.50	2.	3. Recipient's Accession No.
4. Title and Subtitle Habitat Suitability Index Models: Roseate Spoonbill			5. Report Date September 1983
			6.
7. Author(s) J. C. Lewis			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Georgia Cooperative Wildlife Research Unit School of Forest Resources University of Georgia Athens, GA 30602			10. Project/Task/Work Unit No.
			11. Contract(C) or Grant(G) No. (C) (G)
12. Sponsoring Organization Name and Address U.S. Fish and Wildlife Service Division of Biological Services National Coastal Ecosystems Team 1010 Gause Blvd., Slidell, LA 70458			13. Type of Report & Period Covered
			14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

A review and synthesis of existing information were used to develop a model suitable for evaluating coastal habitat of roseate spoonbill (Ajaia ajaja). The model is scaled to produce an index of habitat suitability between 0 (unsuitable habitat) and 1 (optimally suitable habitat) for coastal areas of the continental United States. Habitat suitability indices are designed for use with Habitat Evaluation Procedures previously developed by the U.S. Fish and Wildlife Service. Guidelines for roseate spoonbill model applications and techniques for estimating model variables are described.

17. Document Analysis a. Descriptors

Mathematical models
Birds
Estuaries

b. Identifiers/Open-Ended Terms

Habitat
Habitat Suitability Index
Roseate spoonbill
Ajaia ajaja

c. COSATI Field/Group

Availability Statement	19. Security Class (This Report)	21. No. of Pages
Unlimited	Unclassified	vi + 16
	20. Security Class (This Page) Unclassified	22. Price

(See ANSI-Z39.18)

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce