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HABITAT SUITABILITY INDEX MODELS: LAUGHING GULL

Fish and Wildlife Service

U.S. Department of the Interior

This model is designed to be used by the Division of Ecological Services in conjunction with the Habitat Evaluation Procedures.

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MODEL EVALUATION FORM

Habitat models are designed for a wide variety of planning applications where habitat information is an important consideration in the decision process. It is impossible, however, to develop a model that performs equally well in all situations. Each model is published individually to facilitate updating and reprinting as new information becomes available. Assistance from users and researchers is an important part of the model improvement process. Please complete this form following application or review of the model. Feel free to include additional information that may be of use to either a model developer or model user. We also would appreciate information on model testing, modification, and application, as well as copies of modified models or test results. Please return this form to the following address.

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

Thank you for your assistance.

Species_______________ Geographic Location_______________________________________

Habitat or Cover Type(s)____

Type of Application: Impact Analysis____Management Action Analysis__________
Baseline_______Other____

Variables Measured or Evaluated____
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____
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Was the species information useful and accurate? Yes___ No___

If not, what corrections or improvements are needed?__________________________
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Were the variables and curves clearly defined and useful? Yes____ No____

If not, how were or could they be improved?____________________________

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Were the techniques suggested for collection of field data:

Appropriate? Yes____ No____

Clearly defined? Yes____ No____

Easily applied? Yes____ No____

If not, what other data collection techniques are needed?______________

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Were the model equations logical? Yes____ No____

Appropriate? Yes____ No____

How were or could they be improved?____________________________________

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Other suggestions for modification or improvement (attach curves, equations, graphs, or other appropriate information)________________________

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Additional references or information that should be included in the model:

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Model Evaluator or Reviewer______________________ Date________________

Agency____

Address____

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Telephone Number Comm:________________________ FTS________________

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HABITAT SUITABILITY INDEX MODELS: LAUGHING GULL

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PREFACE

The habitat suitability index (HSI) model in this report on the laughing gull is intended for use in the habitat evaluation procedures (HEP) developed by the U.S. Fish and Wildlife Service (1980) 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 involved in developing 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. 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 and suggestions you may have on the HSI model to the following address.

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CONTENTS

ACKNOWLEDGMENTS

Drafts of the habitat suitability index model for the laughing gull were expertly reviewed by Penny Bernstein, The Wetlands Institute, Stone Harbor, New Jersey; Barbara B. Black, University of Florida, Gainesville, Florida; and Brian R. Chapman, Corpus Christi State University, Corpus Christi, Texas. Thorough evaluations of the structure and functional relationships of the model were provided by personnel of the U.S. Fish and Wildlife Service's (FWS) National Coastal Ecosystems Team (NCET). Rigorous reviews of drafts were provided by Regional FWS personnel at the Albuquerque, Corpus Christi, Daphne, Houston, Lafayette, Panama City, and Vero Beach Ecological Services offices. These reviews improved considerably the quality of the final document. Funding for development and publication of the model was provided by the FWS. The cover illustration was prepared by Patrick Lynch.

LAUGHING GULL (*Larus atricilla*)

INTRODUCTION

Distribution

Laughing gulls (*Larus atricilla*) are small (150-345 g or 5-12 oz; Schreiber and Schreiber 1979), maritime gulls that nest colonially on coastal islands along the coasts of the Atlantic, Gulf of Mexico, and Caribbean. In North America they nest from southern Nova Scotia to Florida and west from there to southern Texas. They also nest along the Caribbean coast in Central America, in the West Indies, and along the northern coast of South America (AOU 1983; Clapp et al. 1983). Nesting sites along the Pacific coast are found only in northwestern Mexico (AOU 1983; Clapp et al. 1983). Although laughing gulls are common and often abundant along the U.S. gulf coast, nesting in this region is largely restricted to Florida, Louisiana, and Texas (Clapp et al. 1983). The species has nested only twice in Mississippi (Jackson et al. 1980; Keller et al. 1984) and Alabama (C.D. Cooley, Ecological Services, USFWS, Daphne, Alabama; pers. comm.).

Laughing gulls winter from North Carolina south along the Atlantic, gulf, and Caribbean coasts to the Amazon Delta in Brazil (Jackson et al. 1980; AOU 1983; Clapp et al. 1983). Along the Pacific coast, wintering birds occur from northern Peru north to southern Mexico (AOU 1983; Clapp et al. 1983). Most laughing gulls winter along the gulf and Caribbean coasts (Clapp et al. 1983). Northward migration begins in March (Southern 1980) and continues through April and May (Clapp et al. 1983).

Laughing gulls are usually found in salt marsh, bay, and beach habitats (Bent 1921; Howell 1932; AOU 1983) but are not uncommon offshore (Burleigh 1958; Shew et al. 1981; Fritts et al. 1983). Although laughing gulls have been sighted as far as 234 km (145 mi) at sea, most offshore sightings occur within 111 km (69 mi) of the coast (Fritts et al. 1983). The species rarely wanders inland (Bent 1921; Sprunt 1954; Burleigh 1958).

Life History Overview

Laughing gulls arrive at breeding sites from late February in Florida (Dinsmore and Schreiber 1974) to early May in Massachusetts (Bent 1921). First eggs are laid in mid-April in Florida (Dinsmore and Schreiber 1974; Schreiber et al. 1979), in late April or early May in Texas (Chaney et al. 1978; White et al. 1983), in mid-May in New Jersey (Bongiorno 1970; Montevecchi et al. 1979), and in early June in Massachusetts (Bent 1921). Peak egg deposition generally follows about one week later. Clutch size ranges from one to five, but most nests contain two or three eggs (Bent 1921; Dinsmore and Schreiber 1974; Chaney et al. 1978; Kepler 1978; Montevecchi 1978; Schreiber et al. 1979; White et al. 1983).

Most eggs (75%) within a colony in Florida were deposited in the first 3 weeks of the laying period (Schreiber et al. 1979). Laying extended over 2 months but only 4% of clutches were laid during the second month; many of these were probably re-layings (Schreiber et al. 1979). Burger (1979) reported a much shorter laying period in New Jersey; all eggs were laid within a 3 week period.

Incubation averaged 29, 22, and 24 days at colonies in Massachusetts (Nisbet 1976), New Jersey (Segre et al. 1968), and Florida (Schreiber et al. 1979), respectively. Laying and hatching intervals were about 2 days (Schreiber et al. 1979), and young fledged at a mean of 42.5 days (range 35-50) at a colony on the Florida gulf coast (Schreiber and Schreiber 1980). Birds leave the colony sites in August and September (Bent 1921; Dinsmore and Schreiber 1974; Chaney et al. 1978), and fall migration occurs from late August through November (Clapp et al. 1983). Age at first breeding is unknown (Clapp et al. 1983) but is generally assumed to be 3 years (P. Bernstein, The Wetlands Institute, Stone Harbor, New Jersey; pers. comm.). Maximum natural longevity recorded is 15 years (Clapp et al. 1982).

The laughing gull is the most abundant breeding marine bird in the Southeastern United States (Clapp et al. 1983). Because of its omnivorous feeding habits and abundance, it is both an important carnivore and scavenger of gulf coast habitats. While the species appears to be declining in abundance in the Northeast (Nisbet 1971), possibly due to competition from herring gulls (*Larus argentatus*) (Burger and Shisler 1978; Burger 1979, 1981b), Florida populations have increased since 1966 (Schreiber and Schreiber 1977). Breeding populations in Texas appear to be stable (Shew et al. 1981; Texas Colonial Waterbird Society 1982) but may be threatened by environmental contaminants (White et al. 1979, 1983).

SPECIFIC HABITAT REQUIREMENTS

Water

Although laughing gulls prefer to drink fresh water when available, chicks are able to subsist on brackish water (up to 50% seawater) and adults can survive on full seawater for extended periods (Harriman 1967). Water is not considered to be a limiting factor for laughing gulls.

Food and Foraging Habitats

Laughing gulls forage over a large range of available habitats and eat a variety of foods. They feed in coastal waters (Howell 1928, 1932; Wood 1949; Zusi 1962; Hatch 1970; Oberholser 1974; Nunnally et al. 1979), offshore (Burleigh 1958; Oberholser 1974; Fritts et al. 1983), on intertidal mudflats and marshes (Howell 1928; Burger 1976), on beaches (Hatch 1970; Buckley and

Buckley 1972; Botton 1984), in coastal agricultural fields (Bent 1921; Howell 1928; Wolk 1959; White et al. 1983), in sanitary landfills (Dinsmore and Schreiber 1974; Schreiber and Schreiber 1977; Burger et al. 1980; Burger 1981b; Burger and Gochfeld 1983), behind fishing boats (Bent 1921; Zusi 1962; Oberholser 1974; Chapman 1984), in shrimp mariculture ponds (Beynon et al. 1981), at wharfs (Howell 1932; Burleigh 1958), and in the vicinity of campers, picnickers, and fishermen (Chapman 1984). In Maine, laughing gulls foraged primarily on mudflats and beaches (69.3%) during the breeding season, but also aerially (22.3%), in mussel beds (4.2%), over water (3.3%), and in effluent discharges (0.9%); none were observed feeding in rocky habitats, dumps, or fields (Hunt and Hunt 1973). Because no studies have compared relative use of foraging habitats by laughing gulls to the availability of these habitats, habitat preferences of foraging laughing gulls cannot be definitively determined.

Similarly, forage preferences of laughing gulls are unknown. Howell (1932) found shrimp and crabs (47%), fish (43%), and insects (10%) in the stomach contents of 32 birds, but did not quantify the relative abundances of these foods in the environment. All other reports of laughing gull forage are entirely qualitative. Items reported include fish (Bent 1921; Howell 1928; Zusi 1962; Hatch 1970; Tolonen 1970; Oberholser 1974; Nunnally et al. 1979; Shew et al. 1981; Beynon et al. 1981), crustaceans (Howell 1928; Wood 1949; Zusi 1962; Oberholser 1974; Beynon et al. 1981), insects (Forbush 1924; Howell 1928; Mayr 1949, Zusi 1962; White et al. 1983), soil invertebrates (Bent 1921; Wolk 1959; Zusi 1962), clapper rail (Rallus longirostris) chicks (Segre et al. 1968), passerines (Wiggins 1965), royal tern (Sterna maxima) eggs (Buckley and Buckley 1972), carrion (Zusi 1962; Hatch 1970), shrimp mariculture feed (Beynon et al. 1981), and garbage (Bent 1921; Howell 1934; Burleigh 1958; Zusi 1962; Dinsmore and Schreiber 1974; Schreiber and Schreiber 1977; Burger et al. 1980; Burger 1981b; Shew et al. 1981; Burger and Gochfeld 1983).

Laughing gulls employ a variety of feeding methods. On land, they may forage by walking on the ground (Zusi 1962; Burger 1976) and also may "hover and dip" at sanitary landfills (Burger 1981b; Burger and Gochfeld 1983); the latter method is also used over deep water. Laughing gulls usually do not dive but prey almost exclusively on organisms at or near the surface of the water (Bent 1921; Zusi 1962). In shallow areas, laughing gulls may run through the water (Tolonen 1970) or stamp their feet (Wood 1949) to stir up organisms. Insects are usually taken on the wing (Forbush 1924; Mayr 1948; Hunt and Hunt 1973) but may also be gleaned from vegetation (Forbush 1924). Laughing gulls are quick to recognize feeding opportunities as they arise, including those associated with human activities, and can often be seen following plows, fishing vessels, and ferries (Bent 1921; Wolk 1959; Zusi 1962; Oberholser 1974; Clapp et al. 1983). Similarly, they readily accept scraps thrown to them (Schreiber and Young 1974; Clapp et al. 1983).

Laughing gulls regularly steal (kleptoparasitize) food from terns (Sterna spp.) (Hatch 1970, 1975), brown pelicans (Pelecanus occidentalis) (Bent 1921; Baldwin 1946; Schnell et al. 1983), black skimmers (Rynchops niger) (Zusi 1958), and other laughing gulls (Burger et al. 1980; Burger 1981b). A victim is chased, often by a group of gulls (Zusi 1958; Hatch 1970, 1975; Schnell et al. 1983), until it drops its prey. The relative proportion of a gull's diet secured through kleptoparasitism is unknown, but Hatch (1970) believed that stolen fish formed a considerable part of the diet of laughing gulls. On the other hand, laughing gulls are often similarly victimized by other species of gulls and magnificent frigatebirds (Fregata magnificens) (Burger et al. 1980; Burger 1981b; Gochfeld and Burger 1981; Burger and Gochfeld 1983).

Quantity and quality of available food are undoubtedly important factors affecting the suitability of a habitat for laughing gulls, particularly during the nesting period. Buckley and Buckley (1980) and McCrimmon and Parnell (1983) attributed differences in waterbird colony sizes and number, respectively, to possible differences in fish productivity at various locations. Hunt (1972) found that survival of herring gull chicks was lower at colonies distant from sources of edible refuse than on islands close to sanitary landfills. Therefore, increases in herring gull populations in the Northeast have been attributed to an increase in the number of sanitary landfills (Kadlec and Drury 1968; Hunt 1972). Similarly, Schreiber and Schreiber (1977) and Patton and Hanners (1984) suggested that recent increases in laughing gull populations in Florida may be related to increases in numbers of sanitary landfills.

Cover-Nesting Requirements

Laughing gulls nest on the ground; nests may range from simple scrapes dug in sand or shell substrates to bulky and elaborate structures of finely interwoven grasses (Bent 1921; Howell 1932; Dinsmore and Schreiber 1974; Portnoy 1977; Chaney et al. 1978; Thebeau and Chapman 1984). Laughing gulls along the mid-Atlantic and New England coastlines nest exclusively on tidal salt marsh islands (Bongiorno 1970; Buckley 1979; Burger and Shisler 1978, 1980; Montevecchi 1978; Erwin and Korschgen 1979). Along the gulf coast, laughing gulls tend to nest on drier dredge-spoil, salt marsh and barrier islands (Dinsmore and Schreiber 1974; Burger and Beer 1975; Portnoy 1977; Clapp et al. 1983; Keller et al. 1984; Thebeau and Chapman 1984).

Nest-site selection by laughing gulls along the gulf coast is largely determined by site-specific vegetative characteristics; the species will not nest in open areas devoid of vegetation or in habitats dominated by woody plants (Schreiber and Schreiber 1978; Soots and Landin 1978). Preferred sites are moderately to densely (> 50% cover) vegetated with short (< 1 m or 3.3 ft) herbs (e.g., oyster grass [Spartina alterniflora], marsh hay cordgrass [S. patens], salt jointgrass [Paspalum vaginatum], yankee weed [Eupatorium capillifolium], saltwort [Batis maritima]) interspersed with low (< 1 m or 3.3 ft) bushes (e.g., backbrush [Baccharis halimifolia], sea-oxeye [Borrichia frutescens]) (Dinsmore and Schreiber 1974; Portnoy 1977; Chaney et al. 1978; Schreiber and Schreiber 1978; Soots and Landin 1978; White et al. 1983). Nesting may occur in sparsely vegetated habitats (Bent 1921; Dinsmore and Schreiber 1974; Chaney et al. 1970; Keller et al. 1984; Thebeau and Chapman 1984), but nest densities there are low as nest spacing is inversely correlated with visual isolation (Burger 1977; Schreiber and Schreiber 1978; Thebeau and Chapman 1984). Because scattered bushes increase visual isolation, provide shade, and shield nests from aerial avian predators, nests tend to be clustered around bushes located within expanses of herbaceous vegetation (Dinsmore and Schreiber 1974; Chaney et al. 1978; Schreiber and Schreiber 1978). However, too many bushes will increase the relative abundance of woody vegetation and decrease site suitability.

Topographical characteristics are also important in determining the suitability of islands for laughing gull nesting. Most laughing gull colonies are on islands 1-2 m (3.3-6.6 ft) in elevation above mean high water (Colonial Bird Register data, courtesy of N. P. McGinnis and D. A. McCrimmon, Jr., National Audubon Society Research Department). Colonies on small (< 0.5 ha or 1 acre), low islands are susceptible to inundation and, therefore, reproductive failure (Bongiorno 1970; Kushlan and White 1977; Burger and Lesser 1978; Chaney et al. 1978; Landin and Soots 1978; Montevecchi 1978; Burger and Shisler 1980; White et al. 1983). At higher elevations (> 3 m or 10 ft), substrates on spoil islands are destabilized by wind erosion and vegetative colonization is inhibited (Chaney et al. 1978; Soots and Landin 1978). Because laughing gulls invariably nest on flat islands, Chaney et al. (1978) suggested that mean slopes less than 3% are optimal. Low slopes also promote desirable plant communities. Islands 2-50 ha (5-124 acres) in area, with maximum elevations of 1-2 m (3.3-6.6 ft), and mean slopes of less than 3% provide the best topographical conditions for nesting laughing gulls along the gulf coast.

Nest predation, although common, is not believed to be a major source of reproductive failure among laughing gulls (Clapp et al. 1983). Montevecchi (1977) and Schreiber et al. (1979) reported predation losses of less than 10%, inflicted primarily by avian predators such as herring gulls and crows (*Corvus* spp.). Laughing gulls avoid significant nest predation by locating colonies on islands inaccessible to, or unable to support, terrestrial predators (Kruuk 1964; Montevecchi 1977) such as raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), coyotes (*Canis latrans*), snakes (e.g., cottonmouths *Agkistrodon piscivorus*, rattlesnakes *Crotalus* spp.), and rats (*Rattus* spp.). Habitats contiguous with the mainland or large and high enough to maintain populations of terrestrial predators throughout the year are avoided by nesting laughing gulls (Burger and Lesser 1978, 1979; Landin and Soots 1978; Soots and Landin 1978). Small (< 50 ha or < 124 acres), low (< 2 m or < 6.6 ft) islands distant from the mainland and susceptible to storm-tide washouts during fall and winter are preferred for nesting by these gulls (Landin and Soots 1978; Chaney et al. 1978).

Special Considerations - Human Disturbance

Human disturbance is often a major source of egg and chick losses in laughing gulls and other colonially nesting larids (Kadlec and Drury 1968; Buckley and Buckley 1976; Portnoy 1977; Fetterolf 1979; Erwin 1980; Burger 1981a, 1982). Campers, picnickers, boaters, and others involved in recreational activities on coastal islands, particularly if accompanied by pets (Buckley and Buckley 1976), may severely reduce the reproductive success of nesting birds (Hunt 1972; Landin and Soots 1978). Breeding success and frequency of disturbance are inversely related for other species of gulls (Kadlec and Drury 1968; Hunt 1972; Robert and Ralph 1975). Intrusions may keep adults off their nests, thereby exposing chicks and eggs to avian predators (usually gulls and crows) and environmental stresses (Hunt 1972; Robert and Ralph 1975; Landin and Soots 1978; Burger 1981a). Fleeing nestlings often run into adjacent territories where they may be attacked by adults (Gillett et al. 1975). Human vandalism and egging are also sources of reproductive failure (Buckley and Buckley 1976). Human activity may preclude establishment of colonies on otherwise suitable islands, or may result in abandonment of established colonies (Landin and Soots 1978; Chaney et al. 1978; Burger 1981a). Nesting laughing gulls are not disturbed by the proximity of human activity per se. For example, Schreiber et al. (1979) reported that laughing gulls nested on an island across a 100-m (323-ft) wide channel from a housing development in Boca Ciega Bay, Florida. Disturbance occurs only when humans gain access to colony islands and enter the colonies on foot.

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

This model applies only to laughing gull nesting habitat along the gulf coast. Habitat requirements of non-nesting and foraging laughing gulls are more flexible and are considered to be less limiting. The model assumes that candidate habitats are coastal islands not connected with the mainland at low tide. Islands connected to the mainland by a land-bridge at low tide are unsuitable habitats for nesting laughing gulls due to their accessibility to terrestrial predators.

Geographic area, season, and cover types. This model is applicable to salt marsh, barrier, and spoil islands along the Gulf of Mexico coastline. The reproductive season of laughing gulls along the U.S. gulf coast extends from February through September (Dinsmore and Schreiber 1974; Chaney et al. 1978; Schreiber and Schreiber 1978). Laughing gull nesting habitat along the U.S. gulf coast is estuarine intertidal wetland (Cowardin et al. 1979) and upland surrounded by estuarine wetland (spoil islands).

Verification level. The acceptable model output is an index value between 0.0 and 1.0 with 0.0 representing unsuitable habitat and 1.0 representing optimal nesting habitat for laughing gulls. The model has not been field-tested. Hypothetical data sets were used to verify that the model output was reasonable. Reviewers' comments (see Acknowledgments) have been incorporated where possible, but the authors and NCET are responsible for the final version of this model.

Model Description

Overview. The model evaluates the suitability of laughing gull nesting habitat only. Habitat requirements of non-nesting laughing gulls overlap with those of nesting birds but can also be much more varied. Nesting habitat requirements are comparatively rigid and limiting. Water availability is not considered to be limiting and so is excluded from the model. We have not incorporated food or foraging habitat variables into this model because forage abundances and types required by laughing gulls have not been quantified adequately. Also, nesting laughing gulls may forage up to 45 km (28 mi) from colony sites (P. Bernstein, The Wetlands Institute, Stone Harbor, New Jersey; pers. comm.). As a result, adequate evaluations of available forage abundances and feeding habitats would be unmanageable from a sampling standpoint and fiscally prohibitive.

The model is comprised of eight habitat variables placed in three life requisite component groups: Topography, Cover, and Disturbance. The relationships among the habitat variables, component groups, and study area HSI are illustrated in Figure 1.

Topography component. Small islands (< 0.5 ha or < 1 acre) are likely to have a large portion of their surface area inundated by storm tides. Large islands, however, are likely to be inhabited by terrestrial predators. Islands 2-50 ha (5-124 acres) in area are assumed to be the optimal size (V_1).

Island elevation (V_2) also affects the suitability of an area for nesting laughing gulls. Islands with maximum elevations < 0.5 m (1.6 ft) are highly susceptible to inundation during the nesting season. High islands (> 3 m or 10 ft) are more likely to support resident terrestrial predators, and substrates on high spoil islands tend to be destabilized by wind erosion which inhibits vegetative colonization. Because laughing gulls invariably nest on flat islands, islands with gently sloping surfaces ($< 3\%$ slope) (V_3) are most suitable. Low slopes also promote desirable plant communities. Islands 1-2 m (3.3-6.6 ft) in elevation with gentle slopes are relatively invulnerable to inundation along the gulf coast; they also promote the growth of desirable vegetation, and inhibit residence of terrestrial predators.

Cover component. Vegetative characteristics are important determinants of habitat suitability for nesting laughing gulls. Presence of herbaceous vegetation (V_4) is mandatory for nesting. Optimal habitats are moderately to densely (50-100%) covered with short (0.1-1.0 m or 0.3-3.3 ft) herbaceous vegetation. Low cover (5-10%) of short (< 1.0 m or < 3.3 ft) bushes (V_5) improves habitat suitability for nesting, but higher densities ($> 25\%$) create unsuitable habitat. Tall bushes or trees (> 1.0 m or > 3.3 ft) decrease habitat suitability (V_6) as they are indicative of successional stages avoided by nesting laughing gulls. Habitats lacking herbaceous vegetation or dominated by woody plants are assumed to be unsuitable.

Disturbance component. Probability of predation of eggs and chicks by terrestrial predators is assumed to vary as a function of the minimum distance over water > 1 m (3.3 ft) deep from the mainland to the candidate island (V_7). Islands separated by less than 100 m (328 ft) from areas inhabited by predators are highly susceptible to predator access, whereas islands over 2 km (1.2 mi) distant are relatively inaccessible and therefore assumed most suitable. In cases where other islands occur between the candidate island and the mainland, the longest straight-line interisland or island-mainland distance should be substituted.

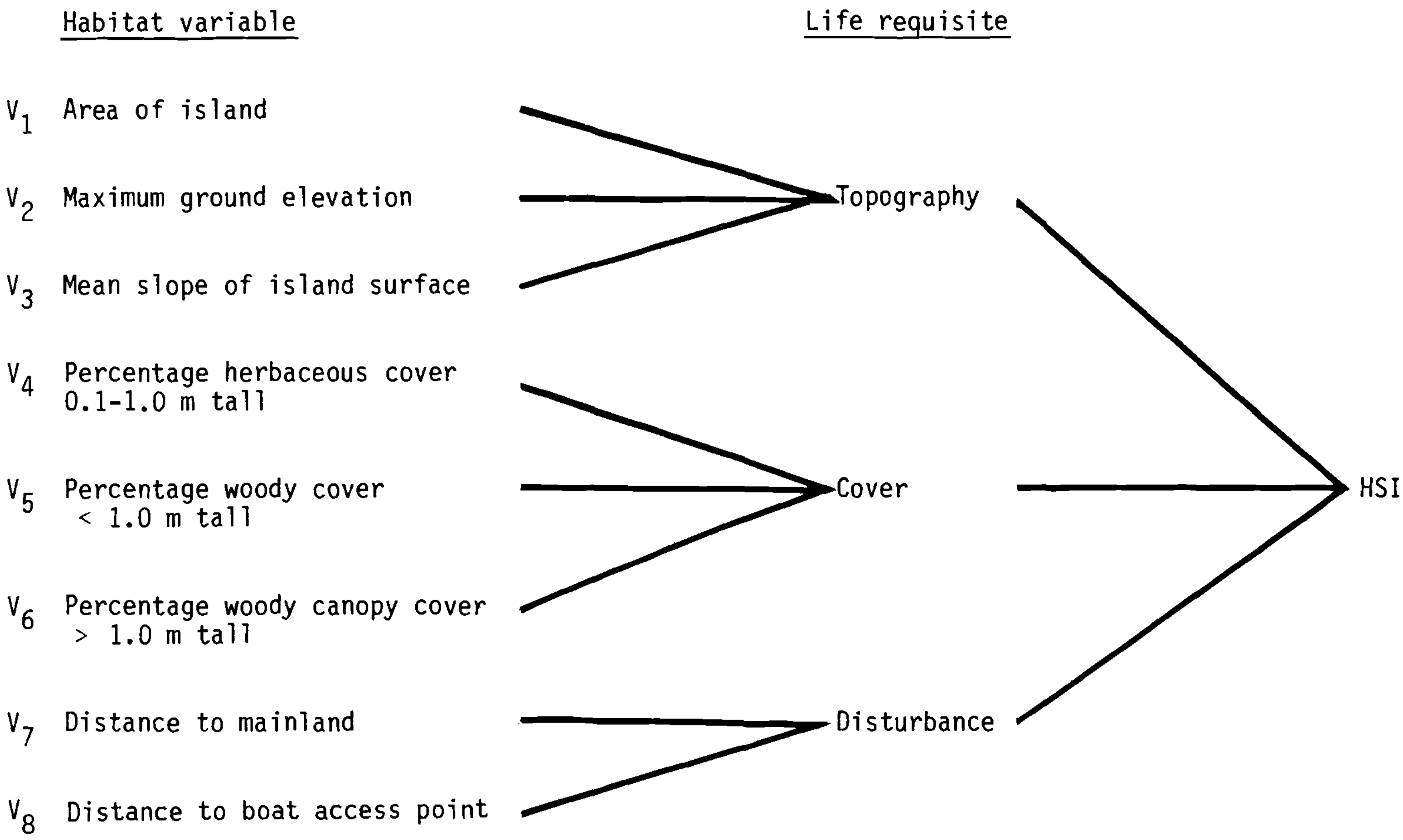
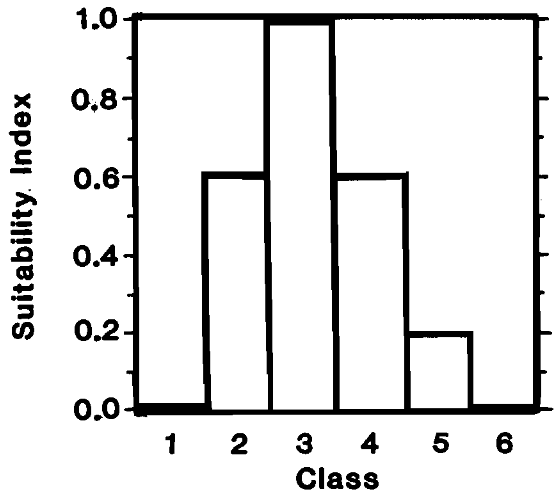


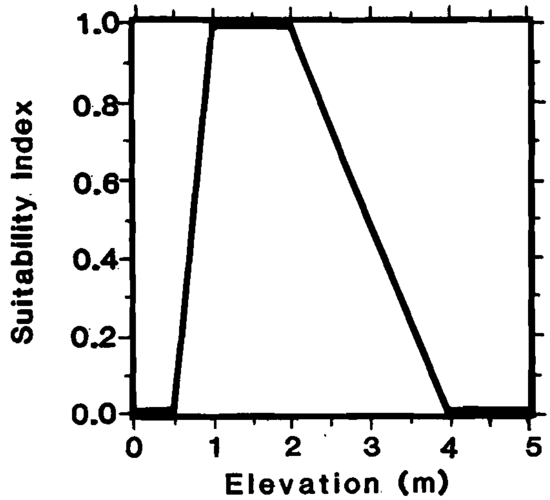
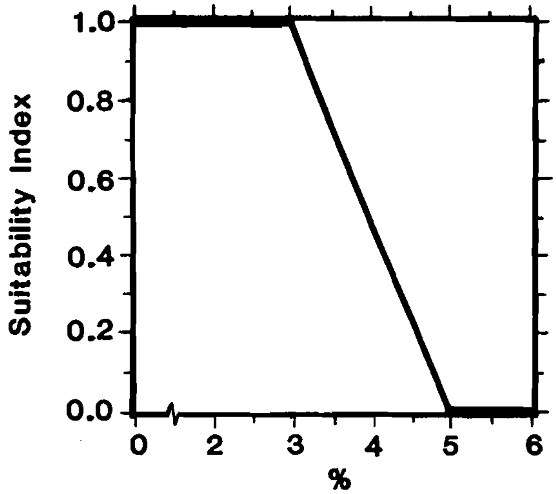
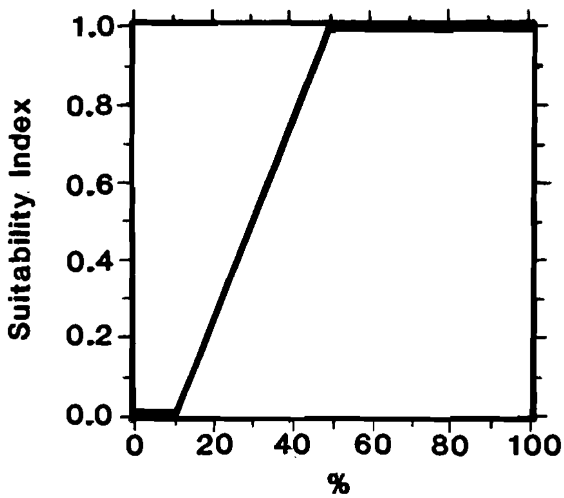
Figure 1. Relationship of habitat variables and component groups to the habitat suitability index for laughing gulls nesting in estuarine habitats.

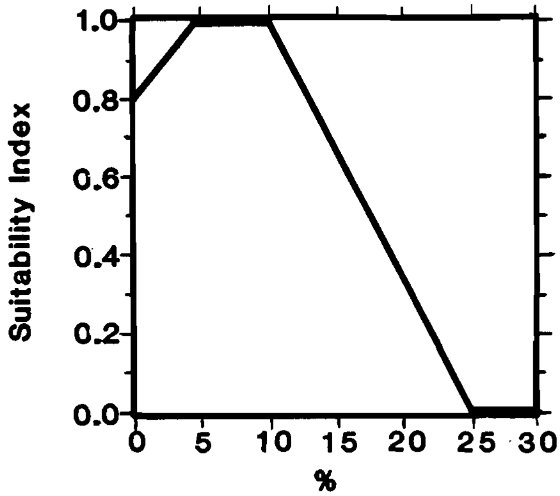
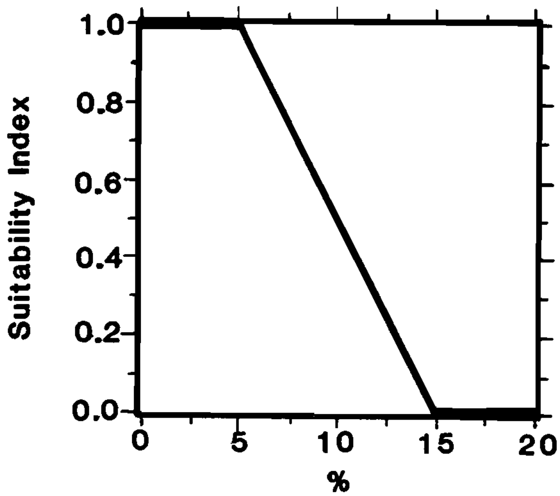
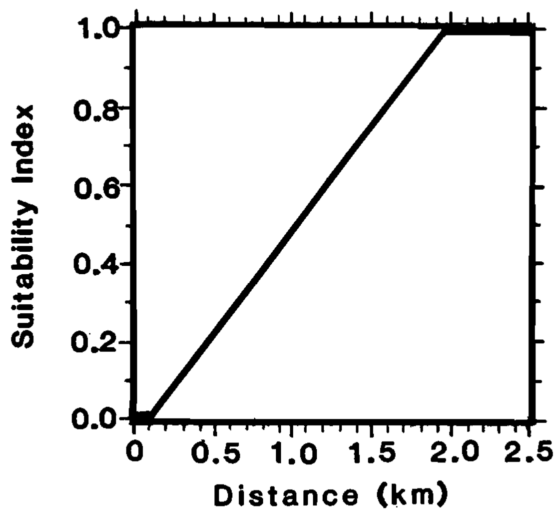
Probability of human disturbance of breeding birds will depend on the shortest navigable distance of a site from the nearest boating access point (e.g., marina, boat ramp, fish camp, etc.) (V_8). Colonies on islands within 1 km (0.6 mi) of such places will experience a high probability of human disturbance; colonies over 20 km (12.4 mi) distant from launch sites probably will receive comparatively little disturbance. These estimates are based on discussions with marina operators and personal observations made by the senior author on the gulf coast of Florida.

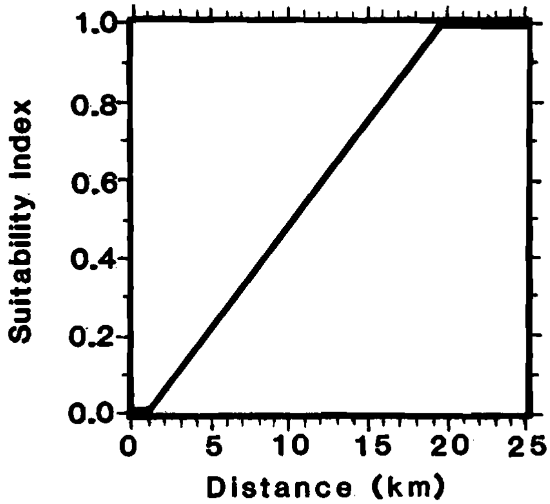
Suitability Index (SI) Graphs for Model Variables

This section presents graphic representations of the relationships between values of habitat variables and laughing gull nesting habitat quality. The SI values are read directly from the graph for any variable value. Optimum suitability is indicated by an SI value of 1.0. Unsuitable conditions are assigned a value of 0.0. The SI graphs are based on the assumption that the suitability of a particular habitat variable can be represented by a two-dimensional response surface and is independent of other variables that contribute to habitat suitability. Data sources and assumptions associated with SI graphs are listed in Table 1.

Variable	Description	Suitability Graph
V_1	Area of island. 1) < 0.5 ha 2) 0.5-2.0 ha 3) 2-50 ha 4) 50-100 ha 5) 100-200 ha 6) > 200 ha	

Variable	Description	Suitability Graph
V_2	Maximum ground elevation.	
V_3	Mean slope of island surface.	
V_4	Percentage herbaceous canopy cover 0.1-1.0 m tall.	

Variable	Description	Suitability Graph
V_5	Percentage woody canopy cover < 1.0 m tall.	
V_6	Percentage woody canopy cover > 1.0 m tall.	
V_7	Straight-line distance (km) over water > 1 m deep to mainland, or longest interisland distance in a chain of islands between the target island and the mainland.	

Variable	Description	Suitability Graph
V_8	Shortest distance by water (km) to nearest boat access point.	

Component Index (CI) Equations and HSI Determination

To obtain an HSI for laughing gull nesting habitat, the following equations are suggested for combining the SI values for the habitat variables into component indices for topography (T), cover (C), and disturbance (D):

Component	Equation
Topography (T)	$(SI_{V_1} \times SI_{V_2} \times SI_{V_3})^{1/3}$
Cover (C)	$(SI_{V_4} \times SI_{V_5} \times SI_{V_6})^{1/3}$
Disturbance (D)	$(SI_{V_7} \times SI_{V_8})^{1/2}$

$$HSI = (T^2 \times C^3 \times D)^{1/6}$$

The components are weighted according to perceived significance. The cover component (C) is weighted heaviest, followed by the topography component (T). The disturbance component (D) is weighted least. Note that an SI score of 0 for any variable will result in an HSI score of 0.

Table 1. Data sources and assumptions for laughing gull suitability indices.

Variable	and sources	Assumption
V_1	Burger and Lesser 1978 Landin and Soots 1978 Chaney et al. 1978 Soots and Landin 1978	Small islands (< 0.5 ha or < 1 acre) are likely to have a large portion of their surface inundated by storm tides; large islands (> 100 ha or > 250 acres) are more likely to be occupied by terrestrial predators.
V_2	Burger and Lesser 1978 Landin and Soots 1978 Chaney et al. 1978 Soots and Landin 1978	Islands 1-2 m (3.3-6.6 ft) in elevation are relatively invulnerable to inundation along the gulf coast during the nesting season, yet promote growth of desirable vegetation.
V_3	Chaney et al. 1978 Soots and Landin 1978	Flat or gently sloping terrain is most suitable for nesting laughing gulls.
V_4	Dinsmore and Schreiber 1978 Portnoy 1977 Chaney et al. 1978 Schreiber and Schreiber 1978 Soots and Landin 1978	Sites dominated by herbaceous vegetation (> 50% coverage) are preferred for nesting; laughing gulls will not nest in open areas devoid of herbaceous vegetation.
V_5	Dinsmore and Schreiber 1974 Burger 1977 Chaney et al. 1978 Schreiber and Schreiber 1978 Soots and Landin 1978	Low densities (5-10%) of short bushes increase visual isolation and thereby increase nest densities. High densities (> 25%) are indicative of successional stages unsuitable for nesting laughing gulls.
V_6	Portnoy 1977 Schreiber and Schreiber 1978 Soots and Landin 1978	Sites dominated by tall (> 1.0 m or > 3.3 ft) bushes or trees are not used by nesting laughing gulls.
V_7	Estimated by authors	Accessibility of an island to terrestrial predators decreases with distance from sources of predators.
V_8	Estimated by authors	Probability of human disturbance varies as a function of distance from access points.

Sample data sets representing a range of habitat suitabilities for nesting laughing gulls are presented in Table 2. The data sets are hypothetical. The HSI values generated are believed to reflect the relative potentials of such habitats to serve as colony sites for nesting laughing gulls.

Table 2. Calculations of suitability indices (SI), component indices (CI), and habitat suitability indices (HSI) for three sample data sets using the laughing gull HSI model variables (V_i) and equations.

Model variable	Data set 1		Data set 2		Data set 3	
	Data	SI	Data	SI	Data	SI
V_1	3 ha	1.00	60 ha	0.60	0.6 ha	0.60
V_2	0.75 m	0.50	3.1 m	0.45	0.25 m	0
V_3	2.4%	1.00	3.6%	0.70	0.5%	1.00
V_4	56%	1.00	35%	0.63	23%	0.33
V_5	14%	0.73	23%	0.13	0%	0.80
V_6	0%	1.00	13%	0.20	0%	1.00
V_7	1.2 km	0.58	0.4 km	0.16	0.2 km	0.05
V_8	10 km	0.47	2 km	0.05	4 km	0.16
T	0.79		0.57		0	
C	0.90		0.26		0.64	
D	0.52		0.09		0.09	
HSI	0.79		0.28		0	

Field Use of the Model

Suggested methods for measuring habitat variables used in this model are provided in Table 3. Reliability of HSI values will depend on the accuracy of habitat variable measurement. Any or all habitat variables may be estimated for preliminary application of this model, but subjective estimates should be made by experienced personnel and fully documented.

Rigid adherence to the SI graphs may lead to erroneous evaluation of habitat suitability under certain conditions. Variable V_8 (distance from access point) should be assigned an SI value of 1.0 if trespassing is totally prohibited, regardless of the location of the candidate island. Human disturbance can be effectively minimized by restricting access to colony islands in regulated areas (e.g., national wildlife refuges and parks, privately-owned property) during the nesting season. Conversely, the probability of human disturbance may be high on islands distant from access points if popular angling areas are located nearby. SI values should be adjusted accordingly.

Table 3. Suggested methods for measuring habitat variables included in laughing gull HSI model. Techniques used to measure variables V_1 to V_6 are described in Hays et al. (1981).

Variable		Technique
V_1	Area of island (ha).	Refer to maps or aerial photos and measure area with a planimeter, dot grid, or computerized graphics tablet.
V_2	Maximum ground elevation (the altitude of the island's summit in m above mean high water).	Measure using a clinometer and optical range-finder; calculate elevation trigonometrically. May also be available for some areas on charts.
V_3	Mean slope of island surface (vertical rise/horizontal run expressed as a percent).	Measure using a clinometer.
V_4	Percent herbaceous cover 0.1-1.0 m tall (forbs and grasses).	Estimate using the line transect method or by ocular estimation; the latter method may be sufficient in relatively homogeneous vegetation.
V_5	Percent woody cover $<$ 1.0 m tall (bushes).	As above.
V_6	Percent woody canopy cover $>$ 1.0 m tall (tall bushes and trees).	As above.
V_7	Straight-line distance (km) over water $>$ 1 m deep to mainland, or longest inter-island distance in a chain of islands between the target island and the mainland.	Refer to maps, navigation charts, or aerial photos and measure the appropriate distance.
V_8	Shortest distance by water (km) to nearest boat access point.	As above.

Terrestrial predators are unlikely to inhabit recently constructed spoil islands (< 5 years old) regardless of their size (C.D. Cooley, Ecological Services, FWS, Daphne, Alabama; pers. comm.). Variable V_1 (area of island) should be assigned an SI value of 1.0 for spoil islands of recent origin (< 5 years) larger than 2 ha (1 acre).

Although not included in this model, food abundance probably affects the suitability of a habitat for nesting laughing gulls. Sites near high-exchange tidal inlets and sanitary landfills may therefore provide better nesting habitat than similar sites distant from such sources of forage. Modification of the model to include the influences of food abundance and foraging habitat on nesting habitat will improve its effectiveness. As these relationships are discerned, they should be incorporated into the model. In the meantime, users of the model should acknowledge this deficiency and should temper habitat evaluations accordingly.

Interpreting Model Outputs

A laughing gull HSI reflects the potential of a habitat to serve as a colony site for nesting laughing gulls. If two sites yield different HSI scores, then the site with the higher score should be considered to have the higher capacity for supporting nesting laughing gulls (per unit area). HSI values are relative and should be used for comparison only. A laughing gull HSI generated by this model may not reflect the actual population density of this species in the habitat being evaluated; factors unrelated to habitat conditions may affect population abundances.

LITERATURE CITED

AOU (American Ornithologists' Union). 1983. Checklist of North American birds, sixth edition. Allen Press, Inc., Lawrence, Kan. 877 pp.

Baldwin, W. P. 1946. Laughing gull robs brown pelican. Auk 63:96-97.

Bent, A. C. 1921. Life histories of North American gulls and terns. U.S. Natl. Mus. Bull. 113. 345 pp.

Beynon, J. L., D. L. Hutchins, A. J. Rubino, A. L. Lawrence, and B. R. Chapman. 1981. Nocturnal activity of birds on shrimp mariculture ponds. J. World Maricul. Soc. 12:63-70.

Bongiorno, S. F. 1970. Nest-site selection by adult laughing gulls (Larus atricilla). Anim. Behav. 18:434-444.

Botton, M. L. 1984. Effects of laughing gull and shorebird predation on the intertidal fauna at Cape May, New Jersey. Estuarine Coastal Shelf Sci. 18:209-220.

Buckley, F. G. 1979. Colony site selection by colonial waterbirds in coastal New Jersey. Proc. 1978 Conf. Colon. Waterbird Group 2:17-26.

Buckley, F. G., and P. A. Buckley. 1972. The breeding ecology of royal terns Sterna (Thalasseus) maxima maxima. Ibis 114:344-359.

Buckley, P. A., and F. G. Buckley. 1976. Guidelines for the protection and management of colonially nesting waterbirds. National Park Service, North Atlantic Regional Office, Boston, Mass. 52 pp.

Buckley, P. A., and F. G. Buckley. 1980. Population and colony site trends of Long Island waterbirds for five years in the mid-1970's. Trans. Linn. Soc. N. Y. 9:23-56.

Burger, J. 1976. Daily and seasonal activity patterns in breeding laughing gulls. Auk 93:308-323.

Burger, J. 1977. Role of visibility in nesting behavior of Larus gulls. J. Comp. Physiol. Psychol. 91:1347-1358.

Burger, J. 1979. Competition and predation: herring gulls versus laughing gulls. Condor 81:269-277.

Burger, J. 1981a. Effects of human disturbance on colonial species, particularly gulls. Colon. Waterbirds 4:28-36.

Burger, J. 1981b. Feeding competition between laughing gulls and herring gulls at a sanitary landfill. Condor 83:328-335.

Burger, J. 1982. An overview of proximate factors affecting reproductive success in colonial birds: concluding remarks and summary of panel discussion. Colon. Waterbirds 5:58-65.

Burger, J., and C. G. Beer. 1975. Territoriality in the laughing gull (L. atricilla). Behaviour 55:301-320.

Burger, J., and M. Gochfeld. 1983. Behavior of nine avian species at a Florida garbage dump. Colon. Waterbirds 6:54-63.

Burger, J., and F. Lesser. 1978. Determinants of colony site selection in common terns (Sterna hirundo). Proc. 1977 Conf. Colon. Waterbird Group 1:118-127.

Burger, J., and F. Lesser. 1979. Breeding behavior and success in salt marsh common tern colonies. Bird-Banding 50:322-337.

Burger, J., and J. Shisler. 1978. Nest site selection and competitive interactions of herring and laughing gulls in New Jersey. Auk 95:252-266.

Burger, J., and J. Shisler. 1980. Colony and nest site selection in laughing gulls in response to tidal flooding. Condor 82:251-258.

Burger, J., M. Fitch, G. Shugart, and W. Werther. 1980. Piracy in Larus gulls at a dump in New Jersey. Proc. 1979 Conf. Colon. Waterbird Group 3:87-98.

Burleigh, T. D. 1958. Georgia birds. University of Oklahoma Press, Norman. 746 pp.

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

Chapman, B. R. 1984. Seasonal abundance and habitat-use patterns of coastal bird populations on Padre and Mustang Island barrier beaches [following the Ixtoc I oil spill]. U.S. Fish Wildl. Serv. FWS/OBS-83/31. 73 pp.

Clapp, R. B., M. K. Klimkiewicz, and J. H. Kennard. 1982. Longevity records of North American birds: Gaviidae through Alcidae. J. Field Ornithol. 53:81-124.

Clapp, R. B., D. Morgan-Jacobs, and R. C. Banks. 1983. Marine birds of the Southeastern United States and Gulf of Mexico. Part III: Charadriiformes. U.S. Fish Wildl. Serv. FWS/OBS-83/30. 853 pp.

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.

Dinsmore, J. J., and R. W. Schreiber. 1974. Breeding and annual cycle of laughing gulls in Tampa Bay, Florida. Wilson Bull. 86:419-427.

Erwin, R. M. 1980. Breeding habitat use by colonially nesting waterbirds in two mid-Atlantic U.S. regions under different regimes of human disturbance. Biol. Conserv. 18:39-51.

Erwin, R. M., and C. E. Korschgen. 1979. Coastal waterbird colonies: Maine to Virginia, 1977. U.S. Fish Wildl. Serv. Biol. Serv. Program FWS/OBS-79/08. 647 pp.

Fetterolf, P. M. 1979. The human artifactor: gull behavior in response to the scientist. Proc. 1978 Conf. Colon. Waterbird Group 2:48. (Abstr.)

Forbush, E. H. 1924. Gulls and terns feeding on the seventeen-year cicada. Auk 41:468-470.

Fritts, T. H., A. B. Irvine, R. D. Jennings, L. A. Collum, W. Hoffman, and M. A. McGehee. 1983. Turtles, birds, and mammals in the northern Gulf of Mexico and nearby Atlantic waters. U.S. Fish Wildl. Serv. Biol. Serv. Program FWS/OBS-82/65. 455 pp.

Gillett, W. H., J. L. Hayward, Jr., and J. F. Stout. 1975. Effects of human activity on egg and chick mortality in a glaucous-winged gull colony. Condor 77:492-495.

Gochfeld, M., and J. Burger. 1981. Age-related differences in piracy of frigatebirds from laughing gulls. Condor 83:79-82.

Harriman, A. E. 1967. Laughing gulls offered saline in preference and survival tests. Physiol. Zool. 40:273-279.

Hatch, J. J. 1970. Predation and piracy by gulls at a ternery in Maine. Auk 87:244-254.

Hatch, J. J. 1975. Piracy by laughing gulls <u>Larus atricilla</u>: an example of the selfish group. Ibis 117:357-365.

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. 1928. Birds of Alabama. Alabama Department Game Fish, Montgomery. 383 pp.

Howell, A. H. 1932. Florida bird life. Florida Department Game Fish, Tallahassee. 597 pp.

Hunt, G. L., Jr. 1972. Influence of food distribution and human disturbance on the reproductive success of herring gulls. Ecology 53:1051-1061.

Hunt, G. L., Jr., and M. W. Hunt. 1973. Habitat partitioning by foraging gulls in Maine and northwestern Europe. Auk 90:827-839.

Jackson, J. A., B. J. Schardien, and C. D. Cooley. 1980. Dispersion, phenology, and population sizes of nesting colonial seabirds on the Mississippi gulf coast. Proc. 1979 Conf. Colon. Waterbird Group 3:145-155.

Kadlec, J. A., and W. H. Drury. 1968. Structure of the New England herring gull population. Ecology 49:644-676.

Keller, C. E., J. A. Spendelow, and R. D. Greer. 1984. Atlas of wading bird and seabird nesting colonies in coastal Louisiana, Mississippi, and Alabama: 1983. U.S. Fish Wildl. Serv. FWS/OBS-84/13. 127 pp.

Kepler, C. B. 1978. The breeding ecology of sea birds on Monito Island, Puerto Rico. Condor 80:72-87.

Kruuk, H. 1964. Predators and anti-predator behaviour of the black-headed gull (Larus ridibundus L.). Behaviour Suppl. 11:1-30.

Kushlan, J. A., and D. A. White. 1977. Laughing gull colonies in extreme southern Florida. Fla. Field Nat. 5:44-46.

Landin, M. C., and R. F. Soots. 1978. Colonial bird use of dredged material islands: a national perspective. Proc. 1977 Conf. Colon. Waterbird Group 1:62-72.

Mayr, E. 1948. Gulls feeding on flying ants. Auk 65:600.

McCrimmon, D. A., Jr., and J. F. Parnell. 1983. The breeding distribution of five colonial waterbird species in coastal North Carolina. Colon. Waterbirds 6:168-177.

Montevecchi, W. A. 1977. Predation in a salt marsh laughing gull colony. Auk 94:583-585.

Montevecchi, W. A. 1978. Nest site selection and its survival value among laughing gulls. Behav. Ecol. Sociobiol. 4:143-161.

Montevecchi, W. A., M. Impekoven, A. Segre-Terkel, and C. G. Beer. 1979. The seasonal timing and dispersion of egg-laying among laughing gulls *Larus atricilla*. Ibis 121:337-344.

Nisbet, I. C. T. 1971. The laughing gull in the northeast. Am. Birds 25:677-683.

Nisbet, I. C. T. 1976. The colonization of Monomoy by laughing gulls. Cape Nat. 5:4-8.

Nunnally, S., D. Nunnally, R. Needham, and R. Lennon. 1979. Nocturnal feeding of gulls at a lighted pier. Chat 43:63.

Oberholser, H. C. 1974. The bird life of Texas, Vol. I. University of Texas Press, Austin. 530 pp.

Patton, S. R., and L. A. Hanners. 1984. The history of the laughing gull population in Tampa Bay, Florida. Fla. Field Nat. 12:49-57.

Portnoy, J. 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. 126 pp.

Robert, H. C., and C. J. Ralph. 1975. Effects of human disturbance on the breeding success of gulls. Condor 77:495-499.

Schnell, G. D., B. L. Woods, and B. J. Ploger. 1983. Brown pelican foraging success and kleptoparasitism by laughing gulls. Auk 100:636-644.

Schreiber, E. A., and R. W. Schreiber. 1977. Gulls wintering in Florida: Christmas bird count analysis. Fla. Field Nat. 5:35-40.

Schreiber, E. A., and R. W. Schreiber. 1980. Breeding biology of laughing gulls in Florida. Part 2: Nestling parameters. J. Field Ornithol. 51:340-355.

Schreiber, E. A., R. W. Schreiber, and J. J. Dinsmore. 1979. Breeding biology of laughing gulls in Florida. Part 1: Nesting, egg, and incubation parameters. Bird-Banding 50:304-321.

Schreiber, R. W., and E. A. Schreiber. 1978. Colonial bird use and plant succession on dredged material islands in Florida. Vol. I: Sea and wading bird colonies. U.S. Army Eng. Waterways Exp. Stn. Tech. Rep. D-78-14, Vicksburg, Miss. 63 pp.

Schreiber, R. W., and E. A. Schreiber. 1979. Notes on measurements, mortality, molt, and gonad condition in Florida west coast laughing gulls. Fla. Field Nat. 7:19-23.

Schreiber, R. W., and S. N. Young. 1974. Evidence for learning to feed in laughing gulls. Fla. Field Nat. 2:16-17.

Segre, A., J. P. Hailman, and C. G. Beer. 1968. Complex interactions between clapper rails and laughing gulls. Wilson Bull. 80:213-219.

Shew, D. M., R. H. Baumann, T. H. Fritts, and L. S. Dunn. 1981. Texas Barrier Islands Region ecological characterization: environmental synthesis papers. U.S. Fish Wildl. Serv. Biol. Serv. Program FWS/OBS-81/32. 413 pp.

Soots, R. F., Jr., and M. C. Landin. 1978. Development and management of avian habitat on dredged material islands. U.S. Army Eng. Waterways Exp. Stn. Tech. Rep. DS-78-18, Vicksburg, Miss. 96 pp.

Southern, W. E. 1980. Comparative distribution and orientation of North American gulls. Pages 449-498 in J. Burger, B. L. Olla, and H. E. Winn, eds. Behavior of marine animals. Vol. 4: Marine birds. Plenum Press, New York. 515 pp.

Sprunt, A., Jr. 1954. Florida bird life. Coward-McCann, Inc., and National Audubon Society, New York. 527 pp.

Texas Colonial Waterbird Society. 1982. An atlas and census of Texas waterbird colonies, 1973-1980. Caesar Kleberg Wildl. Res. Inst., Texas A & I University, Kingsville. 358 pp.

Thebeau, L. C., and B. R. Chapman. 1984. Laughing gull nest placement on Little Pelican Island, Galveston Bay. Southwest. Nat. 29:247-256.

Tolonen, K. E. 1970. Ring-billed gull and laughing gull catch fish by "ploughing" and "skimming." Wilson Bull. 82:222-223.

U.S. Fish and Wildlife Service. 1980. Habitat evaluation procedures (HEP). ESM 102. Washington, D.C. n.p.

White, D. H., K. A. King, C. A. Mitchell, E. F. Hill, and T. G. Lamont. 1979. Parathion causes secondary poisoning in a laughing gull breeding colony. Bull. Environ. Contam. Toxicol. 23:281-284.

White, D. H., C. A. Mitchell, and R. M. Prouty. 1983. Nesting biology of laughing gulls in relation to agricultural chemicals in south Texas, 1978-81. Wilson Bull. 95:540-551.

Wiggins, I. L. 1965. Galapagos finch captured in flight by laughing gull. Condor 67:82.

Wolk, R. G. 1959. Laughing gulls following the plow. Wilson Bull. 71:387-388.

Wood, H. B. 1949. Laughing gulls tread out their food. Bird-Banding 20:103.

Zusi, R. L. 1958. Laughing gull takes fish from black skimmer. Condor 60:67-68.

Zusi, R. L. 1962. Structural adaptations of the head and neck in the black skimmer, _Rynchops nigra_ Linnaeus. Publ. Nuttall Ornithol. Club 3. 101 pp.

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15. Supplementary Notes

16. Abstract (Limit: 200 words)

A review and synthesis of existing information were used to develop a habitat model for laughing gull (*Larus atricilla*). The model is scaled to produce an index of habitat suitability between 0 (unsuitable habitat) and 1.0 (optimally suitable habitat) for areas along the Gulf of Mexico coast. 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 model and techniques for measuring model variables are described.

17. Document Analysis a. Descriptors

Mathematical models
Wildlife
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b. Identifiers/Open-Ended Terms

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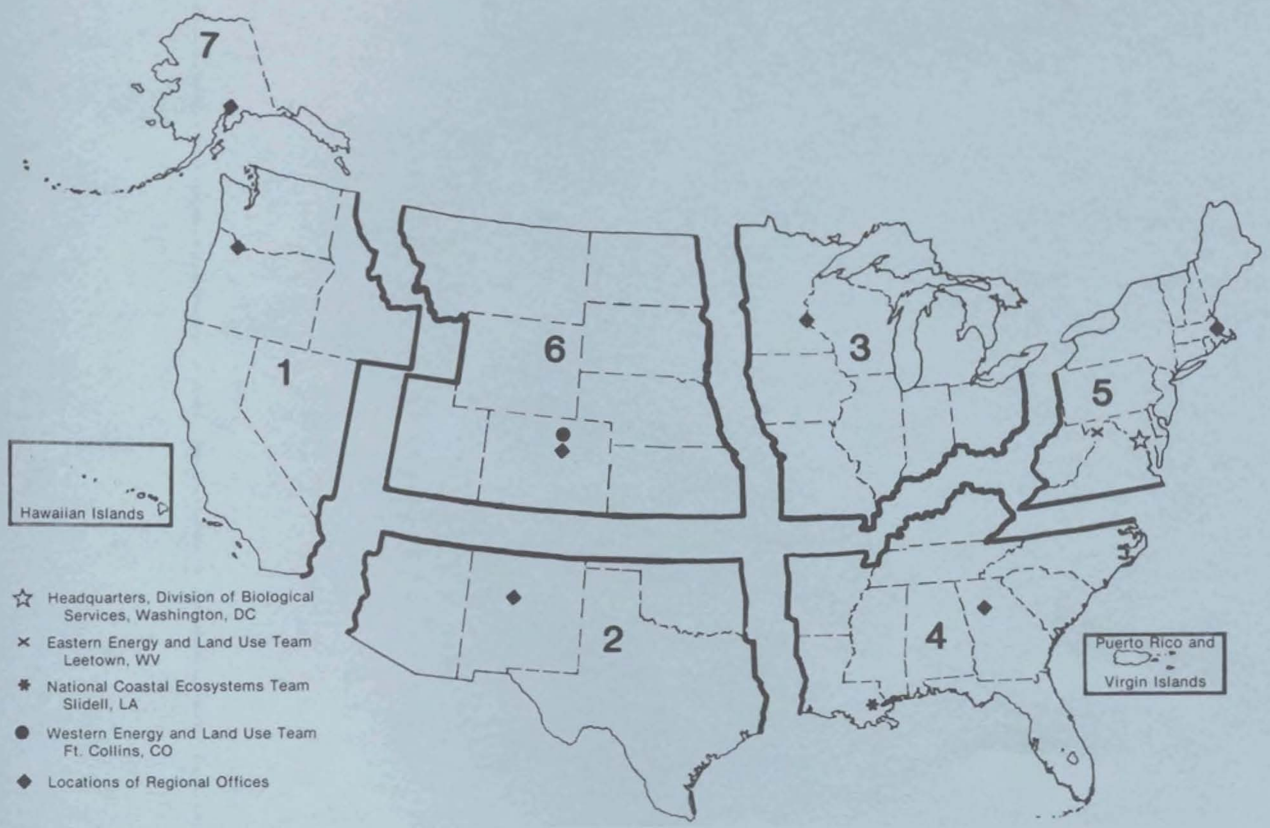

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