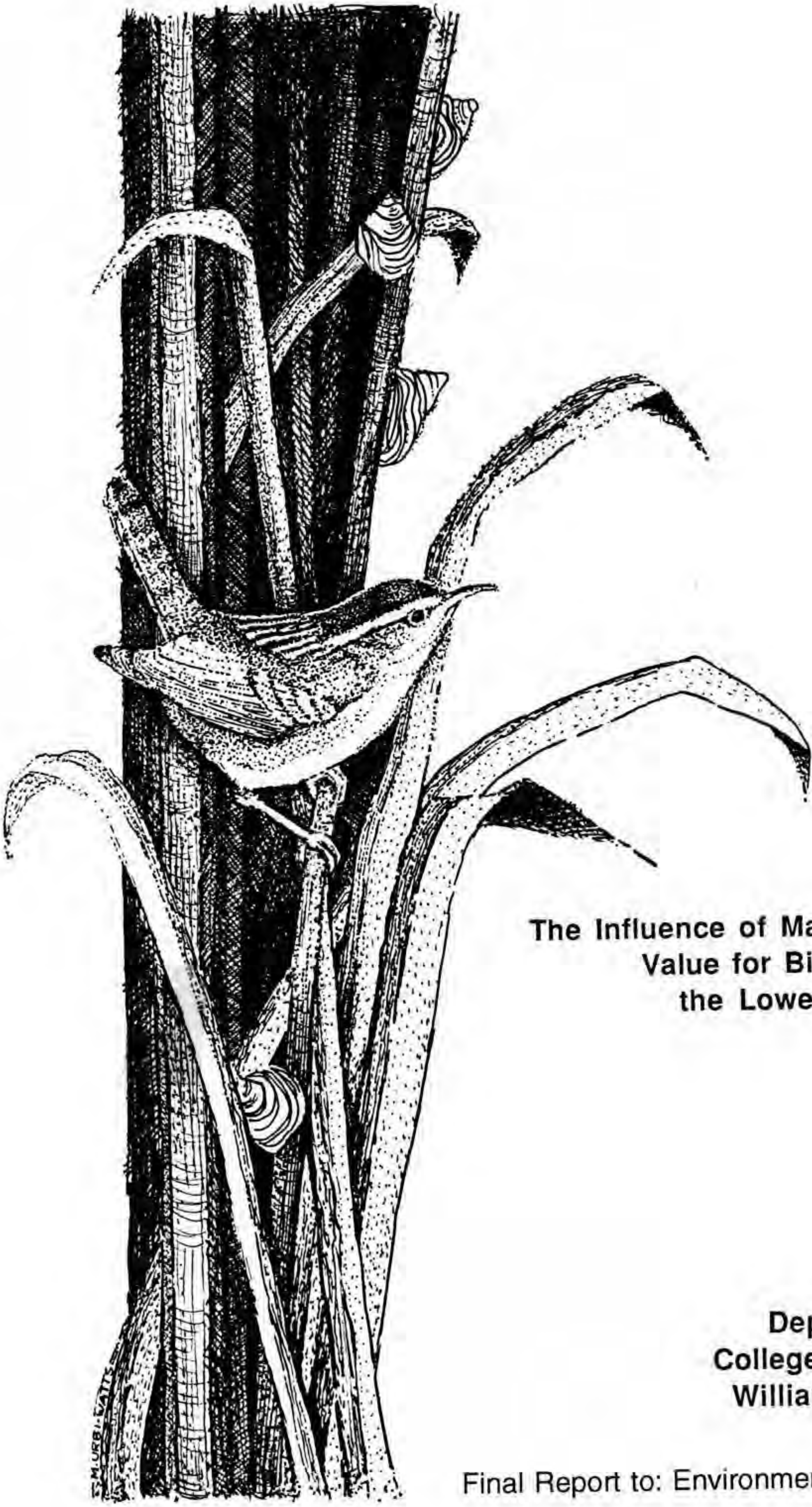
1992

The Influence of Marsh Size on Marsh Value for Bird Communities of the Lower Chesapeake Bay

B. D. Watts
The Center for Conservation Biology, bdwatt@wm.edu



The Influence of Marsh Size on Marsh Value for Bird Communities of the Lower Chesapeake Bay

Bryan D. Watts
Department of Biology
College of William & Mary
Williamsburg, VA 23185

Final Report to: Environmental Protection Agency

THE INFLUENCE OF MARSH SIZE ON MARSH VALUE FOR BIRD COMMUNITIES OF THE LOWER CHESAPEAKE BAY

November 30, 1992

Principal Investigator:

Bryan D. Watts
Department of Biology
College of William & Mary
Williamsburg, VA 23185

Project Collaborators:

Dana S. Bradshaw
Virginia Dept. of Game & Inland Fisheries
Box 11104
Richmond, VA 23230

Julie G. Bradshaw
Virginia Institute of Marine Science
College of William & Mary
Gloucester Point, VA 23062

Technical Report Number 1. Nongame and Endangered Wildlife Program. Virginia Department of Game and Inland Fisheries. Final Report to U.S. Env. Prot. Agency.

ACKNOWLEDGMENTS

We thank the U.S. Environmental Protection Agency for financially supporting this project. We also thank over two dozen private and government landowners for free access to their properties. Karen Terwilliger provided much needed administrative support for the project. Marian Watts provided field assistance and data entry expertise. Artwork and illustrations were also done by Marian Watts. A canoe was provided by the Fish Division of the Virginia Department of Game and Inland Fisheries. This report is publication number 1 of the Virginia Center for Coastal Ecology.

ABSTRACT

Bird abundance and species richness was assessed in 20 salt marshes located on the western shore of the Chesapeake Bay. Marshes were similar in vegetational composition and ranged in size from 0.1 to >100.0 ha. Over 6,800 observations were made of 105 species. Marsh area was found to be a very good indicator of species richness for all bird groups examined. The slopes of species-area relationships derived were relatively high but similar to those reported from other habitat types. The rate of species loss with decreasing marsh size was highest for those species that use the marsh directly.

Patterns of species loss were not random. Bird communities detected in small marshes were completely nested subsets of those observed in larger marshes. The obligate marsh-bird community appears to collapse between 5.0 and 1.0 ha. The frequency distribution of marsh size classes within the study area shows that large marshes are rare. This finding suggests that a fraction of the total marshes support the bulk of the individuals of certain species. However, small marshes do have value for selected species.

Bird species detected varied considerably in their use of 15 distinct marsh components. Small tidepools and saltbush supported the greatest number of species and individuals. Over 30% of all individuals detected were observed foraging in tidepools. Other marsh components also contributed to overall species richness.

TABLE OF CONTENTS

INTRODUCTION 1

STUDY SITE 4

METHODS 4

Site Establishment 6

Survey Procedure 8

Data Collected 9

Marsh Component Work 11

Marsh Composition 11

RESULTS 15

Patterns of Bird Abundance 15

Detection Type and Distance 17

Temporal Patterns 18

Effects of Marsh Size 22

Community Response 22

Species Losses and Community Nesting 28

Patterns of Vegetation Use 30

Marsh Components and Species Richness 30

Patterns in Marsh Size and Composition 38

Local Species of Special Concern 39

Sharp-tailed Sparrow ... 39
Sedge Wren ... 40
Northern Harrier ... 41

DISCUSSION ... 42
Area Effects ... 42
Marsh Components ... 45

SUMMARY ... 46
MANAGEMENT RECOMMENDATIONS ... 47
SUGGESTIONS FOR FURTHER RESEARCH ... 48
LITERATURE CITED ... 49
APPENDIX I ... 54
APPENDIX II ... 57
APPENDIX III ... 60
APPENDIX IV ... 63

INTRODUCTION

One of the primary threats to wildlife, and concomitantly, one of the leading causes of local, regional, and global extinction, is the loss of habitat due to anthropogenic activities. As the human population expands and natural areas are developed for residential, commercial and industrial use, critical wildlife habitat is rapidly being diminished and or degraded. Currently, some of the areas at most risk lie along the continental fringe. Greater than 52 percent of the U.S. human population now lives within 80 km of U.S. coastlines (Southworth 1989). Along the mid-Atlantic coast, development pressures are extremely high. For example, between 1950 and 1986, the number of people living along the shores of the Chesapeake Bay increased by 50 percent. This population is projected to increase by at least 2.6 million, or an additional 20 percent, over the next 30 years. How to conserve coastal resources in the face of increased human demands is an issue of interest to land planners and regulatory agencies.

The tidal salt marsh is one of the habitats most identified with the coastal plain. Although salt marshes are some of the most essential and productive ecosystems on earth they have also been some of the most frequently disturbed. Throughout most of this century, coastal wetlands have been viewed chiefly as potential sites for development. In the past 200 years over 50% of the coastal wetlands in the lower 48 states have been destroyed (Tiner 1984). Between 1954 and 1978, loss rates were extremely high primarily due to urban and industrial development (Gosselink and Baumann 1980). Outside of Louisiana, coastal wetland losses have been directly related to population density (Gosselink and Baumann

1980) and urbanization has accounted for over 90% of human-related losses (Frayer et al. 1983). Between 1981 and 1985, the U.S. Army Corps of Engineers received over 27,000 proposals to alter coastal wetlands in the 14 coastal states from New York to Texas (Mager and Thayer 1986).

Although coastal wetland losses have been profound in some regions, federal and state legislation enacted in the early to mid 1970's has greatly slowed loss rates. In some coastal regions, success has been dramatic. For example, before passage of the Wetlands Act in 1973, Delaware was losing nearly 450 acres of estuarine wetland annually. After implementation of protective legislation, losses have declined to just 20 acres per year (Hardisky and Klemas 1983).

Much of the wetland legislation enacted over the past 20 years has contained foremost a mandate to protect wetlands and second a mandate to accommodate necessary economic development in a manner consistent with wetland preservation. To implement both of these mandates, requires the development of a currency or system to assess the value of individual wetlands and secondly an understanding of how these values may be altered by various user scenarios. This is particularly difficult with tidal wetlands because these habitats provide many tangible as well as intangible services to society and adequate information pertinent to many of these services is lacking. One of the poorest known and least studied of these values is that of habitat for non-commercial animal species.

Tidal marshes provide foraging and breeding habitat for a large number of aquatic and terrestrial species. Birds in particular represent a visible component of marsh communities and should be considered when assessing the value of a given marsh or marsh type.

However, to include bird communities in any comprehensive functional assessment first requires an understanding of how birds utilize various marsh types. Currently, information on bird/marsh relationships is not adequate to prepare needed guidelines. This study attempts to investigate the relationship between marsh-bird communities and two of the most dominant marsh characteristics (marsh area and marsh vegetation).

The primary objectives of the study were:

1) To examine the relationship between marsh area and marsh-bird communities.
2) To investigate the use of selected wetland components by bird communitis of the lower Chesapeake Bay.
3) To begin building a working bibliography for those species that represent significant components of marsh-bird communities of the Chesapeake Bay region.

To accomplish these objectives, a field study designed to evaluate patterns of marsh occupation by bird communities relative to marsh area was executed within a series of tidal salt marshes. This report reviews some of the findings of the field data and provides an interpretation of the results relevant to wetland values and the management of marsh-bird communities. In addition to the field report, a current version of the working bibliography is provided.

STUDY SITE

This study was conducted along the western shore of the lower Chesapeake Bay between Grandview Beach (city of Hampton) and New Point Comfort (Mathews County), (see Figure 1). The broad land arc within these boundaries contains some of the most extensive wetlands remaining in the lower bay including over 1300 tidal marshes with a total area of approximately 6,200 ha. Adjoining uplands remain rural with only scattered population centers. The area was chosen for study primarily because local marshes tend to have relatively balanced flora containing vegetation types characteristic of the region and because most marshes may be readily accessed from the mainland. In addition, the avifauna of the area remains virtually undocumented.

METHODS

Four replicates of marshes were chosen for each of the following general size categories including: 0.1, 1.0, 5.0, and 10.0 ha. In addition, four control marshes (marshes in excess of 65 ha.) were chosen. Control marshes were chosen as "model" marshes and were assumed to support the full complement of marsh bird species on a local scale. Wetland inventory maps and summaries (Barnard 1975, Moore 1976, Silberhorn 1981a, 1981b) were used to screen available marshes for potential study sites. The list of total marshes was initially reduced based on compliance with the size categories outlined above. Because vegetation type is likely a primary factor in determining marsh use for many bird species, vegetational composition was controlled for in the selection process. Marshes were considered for use only if they were dominated (greater than 90% coverage) by and contained

Figure 1: Map of Chesapeake Bay region. Study area was located on the western shore of the lower Bay (reach of study area indicated in black).

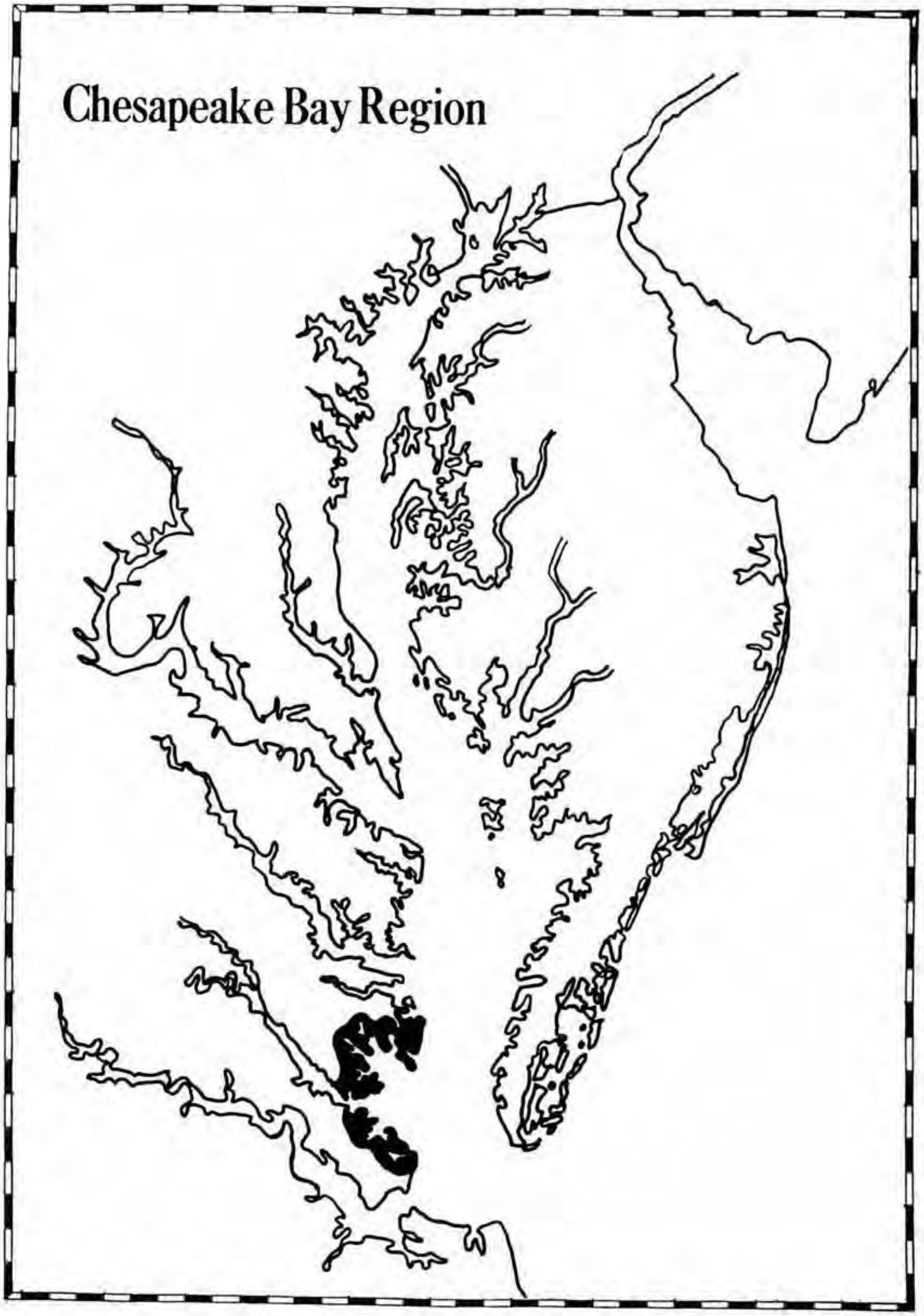


Figure 1

the five target plant forms including: smooth cordgrass (Spartina alterniflora), black needlerush (Juncus roemerianus), saltgrass (Distichlis spicata), saltmeadow hay (Spartina patens), and salt bush (either Iva frutescens or Baccharis hamilifolia). These plant forms were chosen because they were locally common and representative of marsh vegetation on a regional scale. All of the study marshes chosen met the following composition requirements: smooth cordgrass ($\geq$ 30%), black needlerush ($\geq$ 20%), saltgrass and saltmeadow hay combined ($\geq$ 15%), and salt bush ($\geq$ 10%). Controlling for vegetational composition in this way allows for the direct assessment of size effects and provides an opportunity to more closely examine bird/vegetation relationships. In addition to selecting for size and vegetational composition, an attempt was made to locate marshes on points of land extending out into the bay proper rather than along the headwaters of small tributaries.

Site Establishment

To survey birds within study marshes a combination of the line transect (Emlen 1971, 1977) and point count (Blondel et al. 1981, Morrison et al. 1981) method was used. Point counts were used to ensure even coverage of rail playbacks (see below) and to gain more accurate density estimates for appropriate passerine species. Line transect counts were used to enhance marsh coverage and to increase information relevant to bird/vegetation relationships. To set up study marshes, scale maps were first generated by tracing the outline of marshes from 1:12000 aerial photographs. Maps were then used to determine the most efficient layout of transect lines. Transect lines were established so that they extended up the elevational gradient of the marsh. This procedure ensured that all vegetational zones within the marsh were well represented within transects and point count circles. Because a standard 30 m fixed-radius point count was to be used for density estimates, a minimum distance of 70 m was maintained between all transects. Survey points were then placed at 70 m intervals along transects with the first point tangent to the low marsh edge. This procedure continued until the marsh was saturated with survey points (all marshes except controls were saturated with points). Transects and points within control marshes were established to represent available vegetation and distances between points far exceeded the minimum 70 m. Field maps were implemented on the ground using recognizable landmarks and a 100m tape. Locations of individual point circles were marked with numbered, white flags. After all points were established the most economical route through the marsh was determined. Marsh set up began on 6 April and was completed on 5 May.

The end result of transect establishment is that nearly all of the surface area within smaller marshes was included within point counts. The same is not true for large marshes. The range of total point counts within each marsh size category is as follows: 0.1 ha. 2 points, 1.0 ha. 2 points, 5.0 ha. 6 - 10 points, 10.0 ha. 10 - 12 points, control marshes 28 points (204 total point locations). Although more area was sampled within large marshes, a much higher percentage of the absolute area was sampled for smaller marshes. This coverage bias is in favor of smaller marshes so that any observed area effects should be conservative.

Survey Procedure

Playbacks have been used successfully to increase response rates during the breeding season for many marsh species (Tomlinson and Todd 1973, Glahn 1974, Repking and Ohmart 1977, Swift et al. 1988). In this study, playbacks were used to increase detection of 4 rail species (including: Black, Virginia, Clapper, and King). Survey tapes were produced that consisted of 50 sec of male advertisement calls for each species with 10 sec of quiet space between species. Study marshes were systematically surveyed for birds by walking at a fairly constant speed (approximately 50 m/min.) along transects and stopping at each point location to broadcast tape recorded calls. Each point count consisted of a 30 sec silent period, 4 min of tape recorded calls and a 30 sec listening period.

All 20 focal marshes were surveyed 4 times over the three month study period. To reduce seasonal bias, marshes were surveyed in 4 rounds where all marshes were surveyed in each round and the survey order was randomly determined. Because many of the birds of interest in this study exhibit distinctly different peaks of calling and residency, a split approach to surveys was used. Two survey rounds were conducted between 6 May and 3 June. This early period is the time when rails of interest are most vocal on territories and when many transients utilize marshes. Because many passerines have spring migration periods that extend into early June, the later survey rounds were not begun until 11 June. Late surveys were delayed until this date in an attempt to minimize the number of birds detected that really represented transients. Two survey rounds were conducted between 11 June and 10 July.

In addition to differences in the seasonal timing of breeding, rails and passerines differ in their daily activity patterns. During the breeding season, rails call most intensively from about 12:00 to 4:00 AM. However, birds also call during the early morning and late evening, and playback studies conducted during the early morning have had relatively good response rates (e.g. Glahn 1974, Repking and Ohmart 1977). Just after dawn is the optimum activity period for most passerines and other birds of interest. For this reason, all marsh surveys were conducted within the time window between dawn and 4 hrs after dawn. This time period was believed to be the best compromise for the various bird groups of interest.

Data Collected

All birds detected during formal surveys were placed in one of three "user" categories. These included: category 1 - bird in direct contact with marsh (e.g. Seaside Sparrow perched in salt bush), Category 2 - bird not in direct contact with marsh but foraging on prey just over the marsh surface (e.g. Barn Swallow foraging over marsh), category 3 - bird flying over marsh but under 50 m in altitude (e.g. Laughing Gull milling around over marsh), or associated with water within 50 m of shoreline (e.g. Osprey foraging for fish in shallows next to marsh).

Measures were taken to ensure a conservative estimate of bird numbers for each marsh survey. For category 1 species, all birds detected were plotted on field maps to reduce opportunities for recounting. The number of category 2 and 3 species observed was recorded for each point count. After the survey was completed, the highest point count for each species was used as the marsh total. In many instances this procedure resulted in a substantial underestimate of the individuals present. However, this was necessary because these species course back and forth across the entire marsh very rapidly making it difficult to track individuals.

Several descriptive parameters were recorded for each bird observation made during marsh surveys. Parameters included:

Observer Location - location of observer during observation (e.g. point 1, transect 1).

Detection Type - How bird was initially detected. Three categories were used including: aural, visual, and flushed.

Detection Distance - Estimated distance between observer and bird. Because of the difficulties with unreferenced distance estimation (Scott et al. 1981) a stratified approach was used. For birds believed to be within 30 m of the observer distances were estimated to the nearest 5 m. For birds believed to be between 30 and 100 m away, distances were estimated to the nearest 10 m and for birds greater than 100 m away distances were estimated to the nearest 50 m.

Activity - Seven categories were used to describe the activity of category 1 species. Categories included: singing, roosting, foraging, courting, incubating, feeding young, territory defense.

Before the beginning and after the completion of each survey, several environmental parameters were measured. These included: time of day, ambient temperature, estimated wind speed, percent cloud cover, and current tide height. A full analysis of these variables and their influence on survey results will not be presented here.

Marsh Component Work

In order to examine how species used the marsh and, in addition, how different marsh features contributed to overall species richness, marshes were subdivided into 15 "marsh components" (description and code name given in Table 1). Marsh components were then grouped loosely according to hydrology and topography (marsh zones and associated components shown in Table 1). It should be noted that these groupings were established as a convenience for presentation and that many marsh components may be located in various places within a specific marsh. A generalized marsh profile illustrating the approximate location of marsh zones is given in Figure 2. Figure 3 illustrates, in more detail, the various components included in each marsh zone. All observations of birds considered to be using the marsh directly were placed in 1 of the 15 marsh components.

Marsh Composition

Data concerning marsh composition were compiled for the entire study area from the various tidal wetland inventories (Barnard 1975, Moore 1976, Silberhorn 1981a, 1981b). This data base includes marsh size and the percent coverage of plant groups present. The data were used to investigate any relationships between marsh size and the 5 target plant groups. In addition to exploring trends in coverage for individual plants, a dominance index (see Simpson 1949) was calculated using values for all five plant groups. The dominance index was used to test for relationships between marsh size and the tendency for marshes to be dominated by one or a relatively few plant species. Simple linear regression was used to examine size/component relationships. It should be noted that all of the inventory data used

Table 1: Descriptions of marsh components and sections.

Marsh Section	Code/ Name	Component Description
Water Components		
	OW - Open Water:	Open water along margin of marsh.
	MF - Mudflat:	Exposed mud along margin of marsh.
	TG - Tidegut:	Narrow tidegut extending into marsh.
	TP - Tidepool:	Permanently or regularly filled depression with no direct connection to tidegut.
Low Marsh		
	TC - Tall Cordgrass:	Tall, dense form of Spartina alterniflora.
	LC - Low Cordgrass:	Low, sparse form of S. alterniflora.
	SL - Wet Slew:	Regularly inundated low depression typically surrounding a shallow tidepool or terminus of a small tidegut. Depression is dominated by sparse, mixed stands of S. patens, Distichlis spicata, and Salicornia virginica.
	BN - Black Needlerush:	Dense stands of Juncus roemerianus.
High Marsh		
	SG - Saltgrass:	Dense upper stands of D. spicata.
	SM - Saltmeadow Hay:	Dense upper stands of S. patens.
	SB - Saltbush:	Live standing plant of Iva frutescens or Baccharis hamilifolia.
	SN - Dead Pine Snag:	Dead standing pine snag.
Marsh-upland Transition Zone		
	WM - Wax Myrtle:	Shrub of Myrica cerifera.
	DS - Deciduous Saplings:	Hummock or clump of small deciduous saplings.
	LP - Live Pine:	Live pine (Pinus taeda) along marsh edge.

Figure 2: Illustration of general marsh profile showing the relationship between hydrology, topography and marsh zones.

GENERAL MARSH PROFILE

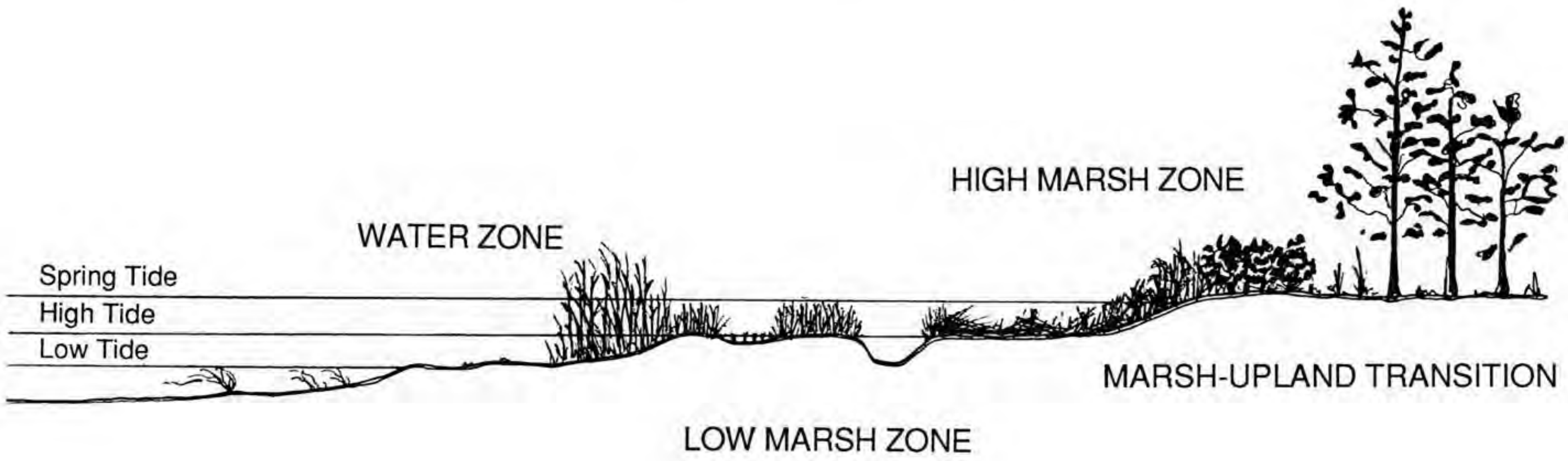


Figure 2

Figure 3: Illustration showing the 4 marsh zones and their respective marsh components. Key to marsh component codes is given in Table 1.

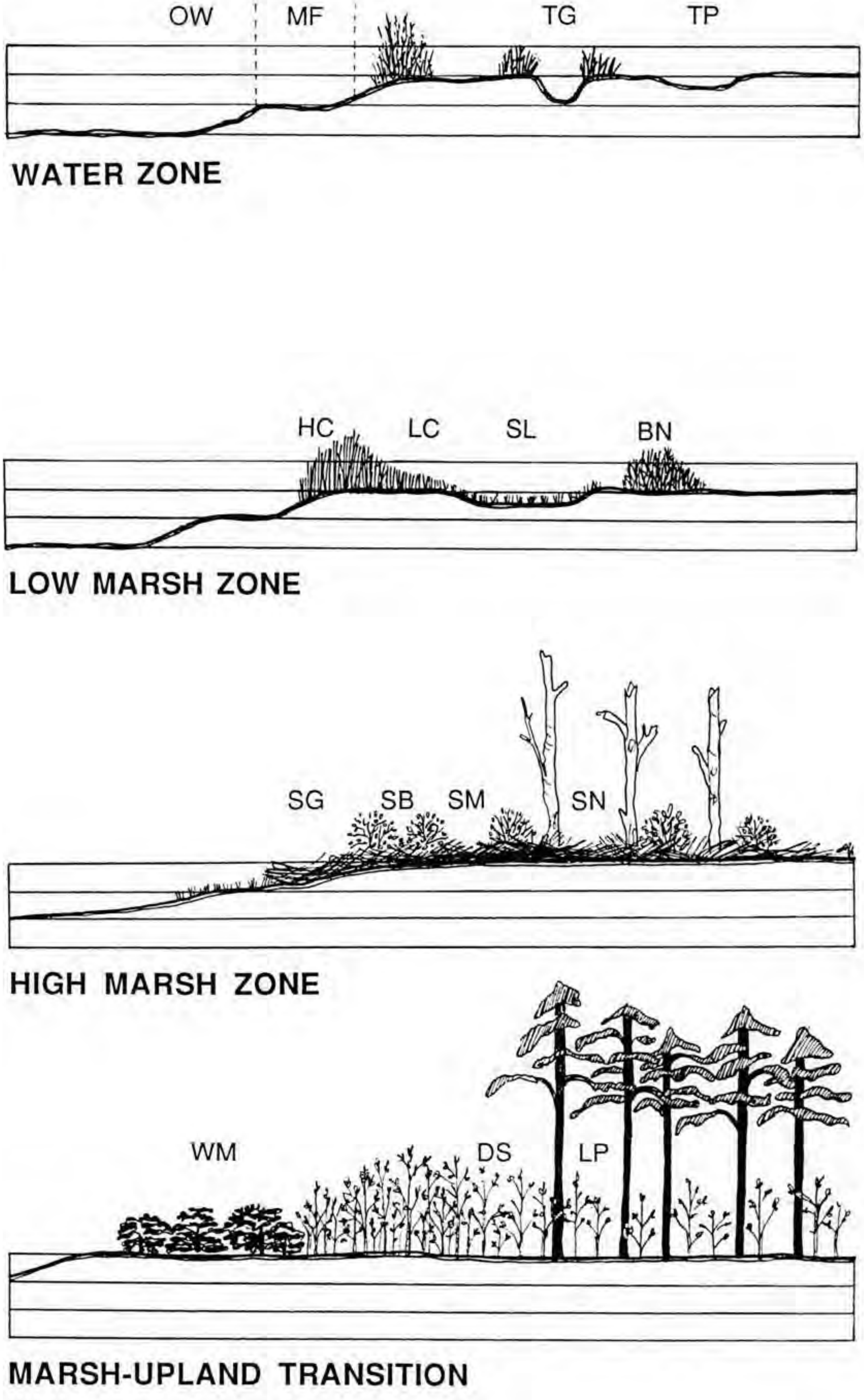

OW
MF
TG
TP
WATER ZONE
HC
LC
SL
BN
LOW MARSH ZONE
SG
SB
SM
SN
HIGH MARSH ZONE
WM
DS
LP
MARSH-UPLAND TRANSITION

Figure 3

to investigate these relationships (data available for the area included in the study area) were taken from reports presented between 1975 and 1981. Although these data may not represent the size distribution or vegetational composition of marshlands in the area today, they are adequate to examine the general size/composition relationships.

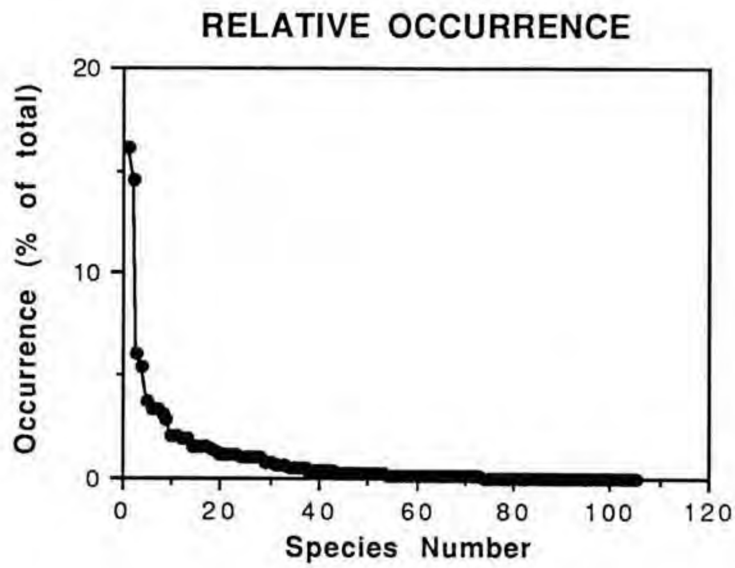
RESULTS

Patterns of Bird Abundance

Over 6,800 observations of 105 species were made during marsh surveys (full species list with associated scientific names is given in Appendix I). Frequency of occurrence varied widely among species. Figure 4a illustrates the variability between species in relative contribution to the total observations. The result of this abundance pattern is that relatively few species accounted for the majority of observations (see Figure 4b). For example, just two species accounted for over 30% of the overall observations, 7 species accounted for over 50% of the observations, and over 75% of the observations were accounted for by only 18% of the species observed.

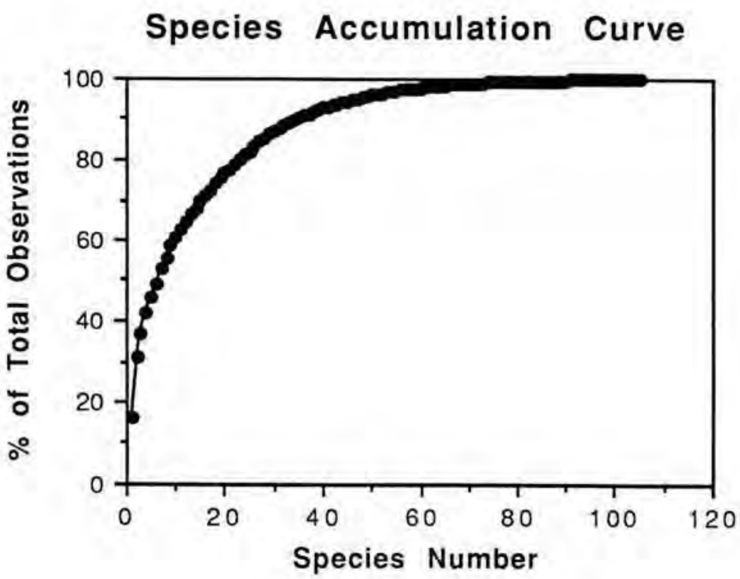
The majority of species observed used the study marshes directly (i.e. were category 1 species) as nesting and or as foraging habitat. Using a criterion of $\geq$ 50% to place species in user categories, 69.5% of the species were classified as category 1, 11.4% as category 2, and 19.1% as category 3 (Appendix II gives a complete breakdown of marsh use by species). For all species combined, 78.8% of the total observations were of birds directly contacting the

Figure 4: (a) Relative abundance of individual species arranged in descending order (N = 6800). (b) Species accumulation curve showing the relative contribution of individual species to the total observations.



RELATIVE OCCURRENCE
Occurrence (% of total)
20
10
0
0
20
40
60
80
100
120
Species Number

a



Species Accumulation Curve
% of Total Observations
100
80
60
40
20
0
0
20
40
60
80
100
120
Species Number

b

Figure 4

marsh, 5.7% were of birds foraging over the marsh surface and 15.5% were of birds associated with the marsh.

Overall abundance, temporal patterns of occurrence (see below), and user categories (given in appendix II) were used to develop lists of those species most identified with tidal marshes of the region (henceforth called "core" species). Four functionally different lists were compiled including: Resident Breeder - (those species actually breeding within the marsh), Resident User - (those species that breed locally outside the marsh but use the marsh as a foraging area), Transient User - (those species that do not generally breed locally but use the marsh during migration), and Associated - (those species that are frequently above or around the marsh but generally do not contact the marsh proper, category 3 species). Table 2 gives a listing of the individual core groups. The core species listed represent over 88% of the total observations. These core species will be the focus of much of the following analysis.

Detection Type and Distance

The majority of resident breeding species were initially detected aurally (Table 3). Most of these species attract mates and maintain territories by using advertisement songs. Clapper and Virginia rails typically called in response to broadcast calls but also gave spontaneous calls depending on time of day, season, and weather condition. In addition to these target species, other species seemed to respond positively to rail tapes. Seaside Sparrows, Marsh Wrens, Common Yellowthroats, Song Sparrows, House Wrens, and Red-winged Blackbirds were all excited by rail tapes and would often begin singing or approach the observer during broadcast periods. Virtually all species that did not breed in study marshes (e.g. resident and transient users) or do not typically maintain distinct territories were, for the most part, detected visually.

The Sharp-tailed Sparrow was the only species that was primarily detected by flushing from the ground. Most of the Sharp-tails observed within marshes of the lower Chesapeake Bay during spring and early summer are transients. Individuals forage in wet slew areas and roost in black needlerush, cordgrass, and saltbush. Males are not typically vocal during the day and most birds are detected by walking through foraging areas and flushing them from the ground.

Detection distance patterns varied considerably between species. In only 11 of 25 species were the majority of individuals detected within 30 m (see Table 3, % detected within 30 m). Larger species were rarely detected within 30 m of the observer primarily because minimum flushing distances were greater than 30m. However, for many of the more common passerines a high percentage of the individuals were within 30 m.
Median detection distance was similarly variable ranging from 15 m in Sharp-tailed Sparrows to 150 m in Great Blue Herons.

Temporal Patterns

Within the entire marsh system, species richness declined steadily over the three month study period (Figure 5a). This general decline reflects the loss of transient species from the system before early June. In fact, 32 (30.5%) of the 105 species detected were only

Table 2: Species placed within the four core groups. Species within groups are listed in descending order of abundance. Scientific names are provided in Appendix I.

Resident Breeder	Resident User	Transient User	Associated
Seaside Sparrow	Barn Swallow	Semipalmated Sandpiper	Laughing Gull
Willet	Great-blue Heron	Least Sandpiper	Fish Crow
Clapper Rail	Snowy Egret	Short-billed Dowitcher	Forster's Tern
Red-winged Blackbird	Green-backed Heron	Sharp-tailed Sparrow	Osprey
Song Sparrow	Great Egret	Dunlin	Herring Gull
Boat-tailed Grackle	Purple Martin	Greater Yellowlegs	Double-crested Cormorant
Marsh Wren			Least Tern
Common Yellowthroat			Royal Tern
Black Duck			
Virginia Rail			
Eastern Meadowlark			
Mallard			
Prairie Warbler			
Eastern Kingbird			
House Wren			

Table 3: Summary of detection information for core user groups. Data are presented for category 1 species only.

Species	Det. Type: Visual #(%)	Det. Type: Aural #(%)	Det. Type: Flush #(%)	Det. Dist: <30m (%)	Det. Dist: Med. (m)
Resident Breeder					
Mallard	54(88.5)	-------	7(11.5)	14.8	100
Black Duck	61(75.3)	-------	20(24.7)	0.0	100
Clapper Rail	8(3.2)	212(85.8)	27(10.9)	46.6	50
Virginia Rail	5(6.7)	64(85.3)	6(8.0)	46.7	40
Willet	264(71.7)	40(10.9)	64(17.4)	56.8	40
Eastern Kingbird	39(88.6)	-------	5(11.4)	50.0	40
House Wren	7(16.3)	36(83.7)	-------	25.6	50
Marsh Wren	18(13.2)	107(78.7)	11(8.1)	82.4	20
Prairie Warbler	3(6.5)	43(93.5)	-------	28.3	70
Yellowthroat	10(7.7)	119(91.5)	1(0.8)	57.9	40
Seaside Sparrow	167(15.2)	727(66.5)	200(18.3)	78.5	20
Song Sparrow	18(8.6)	187(89.0)	5(2.4)	65.2	30
Meadowlark	7(9.6)	62(84.9)	4(5.5)	26.0	60
Red-winged Blackbird	95(40.9)	110(47.4)	27(11.6)	64.7	40
Boat-tailed Grackle	148(83.1)	3(1.7)	27(15.2)	41.6	60
Resident User					
Green Heron	29(47.5)	10(16.4)	22(36.1)	39.3	60
Snowy Egret	47(85.5)	-------	8(14.5)	25.5	100
Great Egret	33(89.2)	1(2.7)	3(8.1)	0.0	100
Great Blue Heron	78(78.0)	-------	22(22.0)	0.0	150
Transient User					
Greater Yellowlegs	26(86.7)	-------	4(13.3)	60.0	40
Short-billed Dowitcher	128(100.0)	-------	-------	78.6	20
Dunlin	51(100.0)	-------	-------	60.8	20
Semipalmated Sandpiper	939(99.2)	-------	8(0.8)	24.0	40
Least Sandpiper	28(93.3)	-------	2(6.7)	39.9	25
Sharp-tailed Sparrow	8(7.5)	34(32.1)	64(60.4)	95.3	15

Figure 5: (a) Species richness for survey rounds (all marshes included). (b) Total number of individuals observed for each survey round.

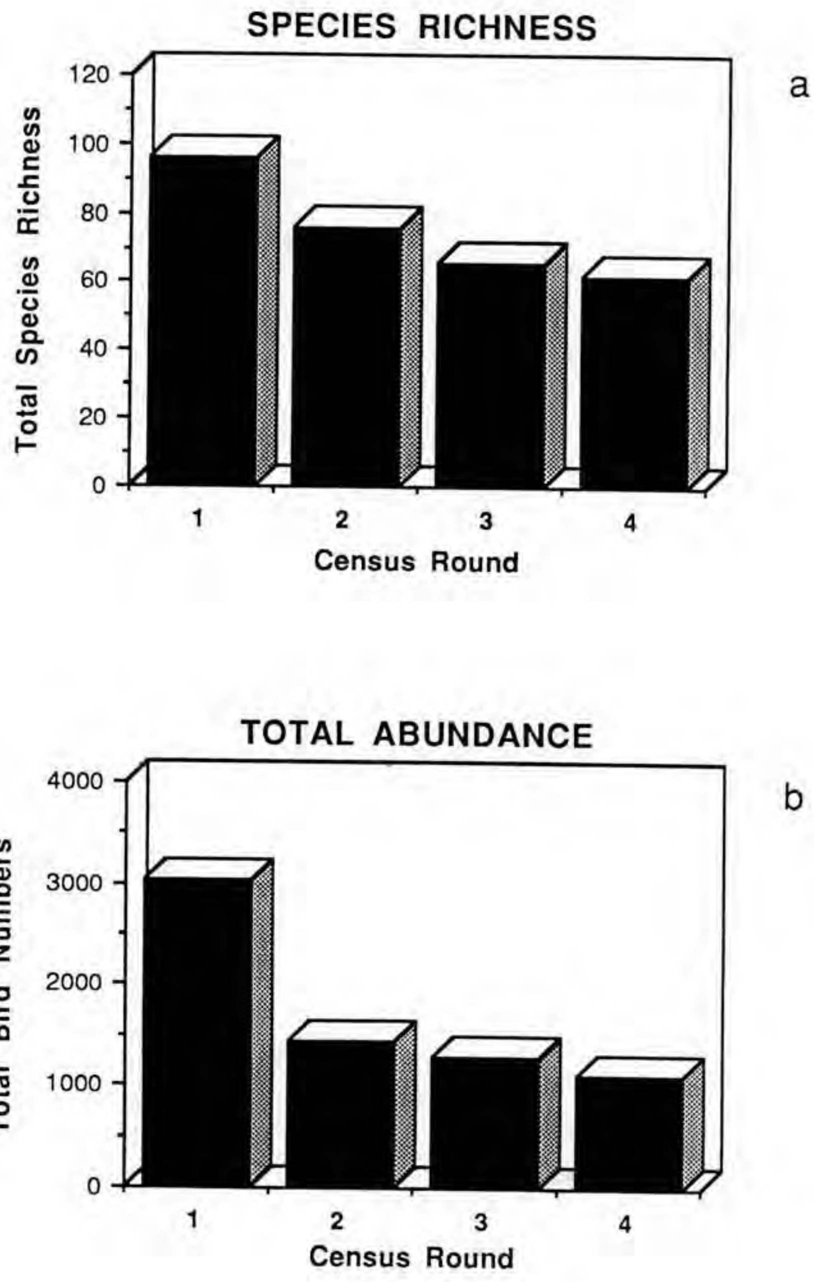

SPECIES RICHNESS
Total Species Richness
120
100
80
60
40
20
0
1
2
3
4
Census Round
a
TOTAL ABUNDANCE
Total Bird Numbers
4000
3000
2000
1000
0
1
2
3
4
Census Round
b

Figure 5

observed during the first two census periods. This is compared to only 6 (5.7%) species that were exclusive to the late census periods. However, species richness for the early period as a whole was not significantly different from that of the late period (G-statistic < 3.0, $P > 0.05$, testing the null hypothesis that early = late).

Overall bird abundance was significantly higher (G-statistic > 100, $P < 0.001$) during the early period when compared to the late period. Abundance declined over the study in a way similar to species richness (Figure 5b). This decline reflects the loss of transient species between the two time periods and, in addition, the decline of resident species.

Twelve of the locally resident species exhibited a 50% decline in numbers between the early and late time periods (complete data is given in Appendix III). This is compared to only 2 species that increased by 50% between the two periods. Species that are locally resident during the breeding season may decline on surveys for two different reasons. The first is that, early in the season, when breeding pairs are returning from wintering areas, all individuals observed within a given marsh may not actually breed there. Many of the resident species showed a decline in abundance after the first census period likely because a portion of the birds detected were transients. The second reason for a decline is that deductibility may change with season. For many species, the frequency of singing changes with breeding stage. For example, calling in rails peaks in mid spring and then declines throughout the summer months. The detection of both resident rail species declined with season. Many of the other vocal residents exhibited similar declines.

Effects of Marsh Size

Community Response

Less than 15% of the 105 species detected within the 20-marsh system were detected within or associated with the smallest (0.1 ha) marsh category. This may be compared to over 28% in 1.0 ha marshes, over 60% in 5.0 and 10.0 ha marshes and over 90% in control marshes. The general relationship between species richness and marsh size was significant for all species groups considered (Table 4), (i.e., greater species richness is found in larger marshes). As with many other communities the form of this relationship depends somewhat on the pool of potential species (see Figures 6 and 7). This effect is particularly prominent for the smaller groups of species, some of which nearly reach the full complement of species at a relatively small marsh size of 5.0 ha. However, in general, the pattern shows a relatively steep species gain up to marshes of 5.0 ha and then a gradual reduction in slope between the remaining marsh sizes.

To evaluate the species-area relationship in more detail, data for the various bird groups were fitted to a Log Log model (Figures 8 and 9). This power function is commonly used to evaluate species-area relationships. Significant models were derived for all species groups tested (i.e., number of species increased with increasing marsh size). R-squared values ranged from 0.67 to 0.92 and all slopes were significant. Model equations and statistics are presented in Table 5.

The species-area slopes found here (ranging from 0.46 to 0.25) were similar to those reported from other patch studies done with different animal communities and habitats (see Connor and McCoy 1979). As expected, slopes were much higher for species using the

Table 4: ANOVA results for species categories (testing between size categories).

Species Group	F-value	P
Total Species		
Total User Species	73.24	<0.001
Category 1 Species	66.96	<0.001
Category 2 Species	18.59	<0.001
Category 3 Species	15.87	<0.001
Core Species		
Breeding Species	117.93	<0.001
Resident Users	10.68	<0.001
Transient Users	15.14	<0.001
Associated Species	18.49	<0.001

Table 5: Results of Log/Log regressions for various species groups. Core Resident and transient users were not included because of the small species pool.

Species Group	Regression Equation	R	F	P
Total Users	LSpecies = Log2.36 + .42LogArea	.92	205.5	<.001
Category 1	LSpecies = Log2.12 + .46LogArea	.86	106.3	<.001
Category 2	LSpecies = Log0.77 + .25LogArea	.72	35.6	<.001
Category 3	LSpecies = Log1.84 + .35LogArea	.67	28.6	<.001
Core Breeders	LSpecies = Log1.71 + .29LogArea	.77	48.0	<.001

Figure 6: Average accumulated species richness for all species, broken down into species categories. Data points are means of four replicate marshes ± 1 S.E. unit. Size categories include: 1 - 0.1 ha, 2 - 1.0 ha, 3 - 5.0 ha, 4 - 10.0 ha, and 5 - > 65 ha.

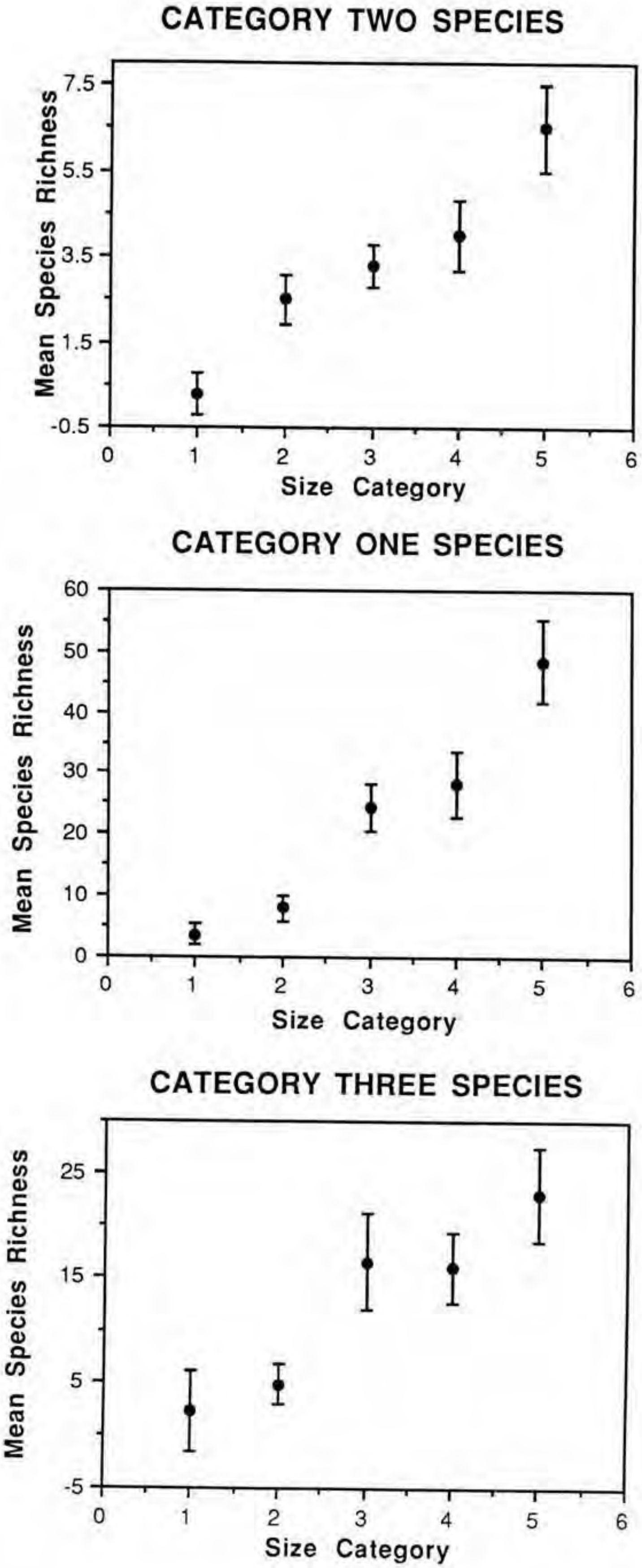

CATEGORY TWO SPECIES
Mean Species Richness
Size Category
CATEGORY ONE SPECIES
Mean Species Richness
Size Category
CATEGORY THREE SPECIES
Mean Species Richness
Size Category

Figure 6

Figure 7: Average species richness (for core species only) broken down into core groups. Data points are means of 4 replicate marshes $\pm$ 1 S.E. unit. Size categories include: 1 - 0.1 ha, 2 - 1.0 ha, 3 - 5.0 ha, 4 - 10.0 ha, and 5 - > 65 ha.

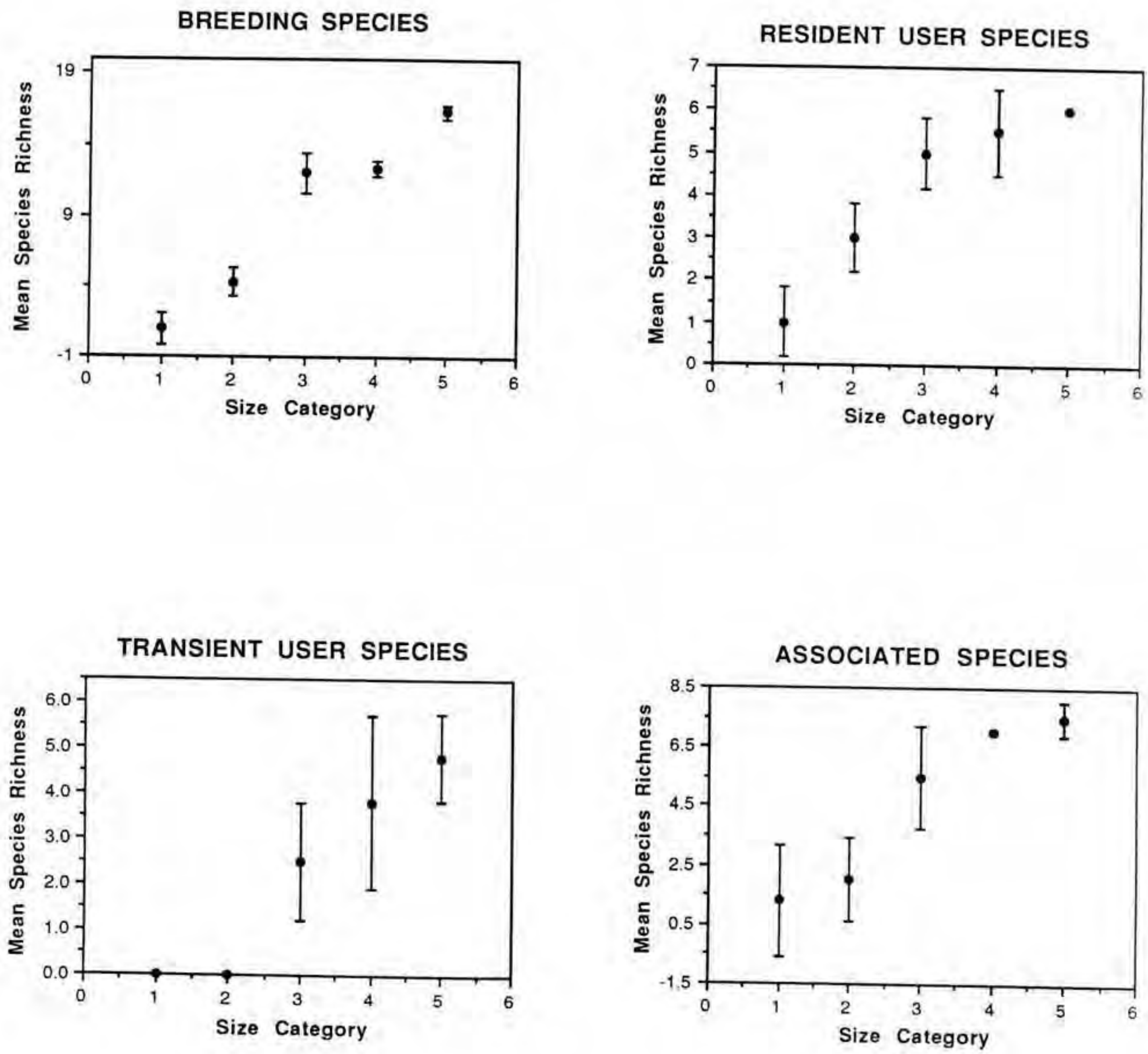

BREEDING SPECIES
RESIDENT USER SPECIES
TRANSIENT USER SPECIES
ASSOCIATED SPECIES
Mean Species Richness
Size Category

Figure 7

Figure 8: Species-area relationship for all species using study marshes (category 1 and 2 species included). Data points were derived from total accumulated species richness values for each study marshes.

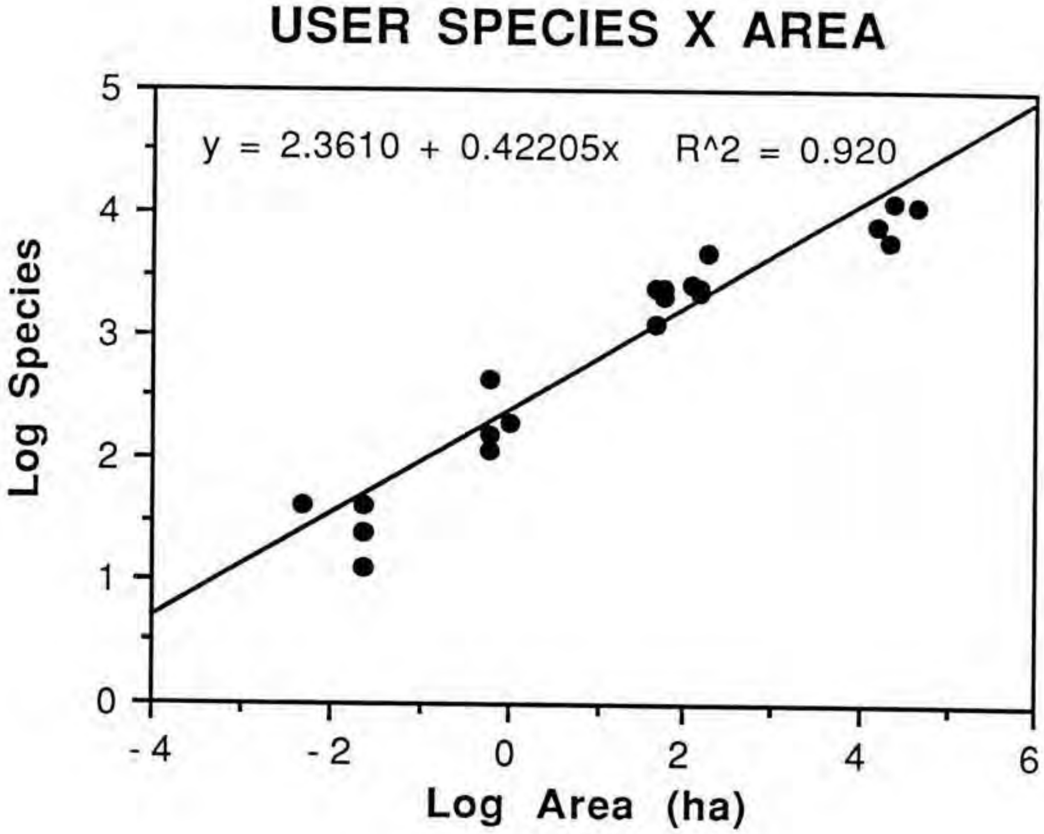

USER SPECIES X AREA
y = 2.3610 + 0.42205x   R^2 = 0.920
Log Species
Log Area (ha)
5
4
3
2
1
0
- 4
- 2
0
2
4
6

Figure 8

Figure 9: Species-area relationship for each of the user categories. Data points were derived from accumulated richness values for each user category within each study marsh.

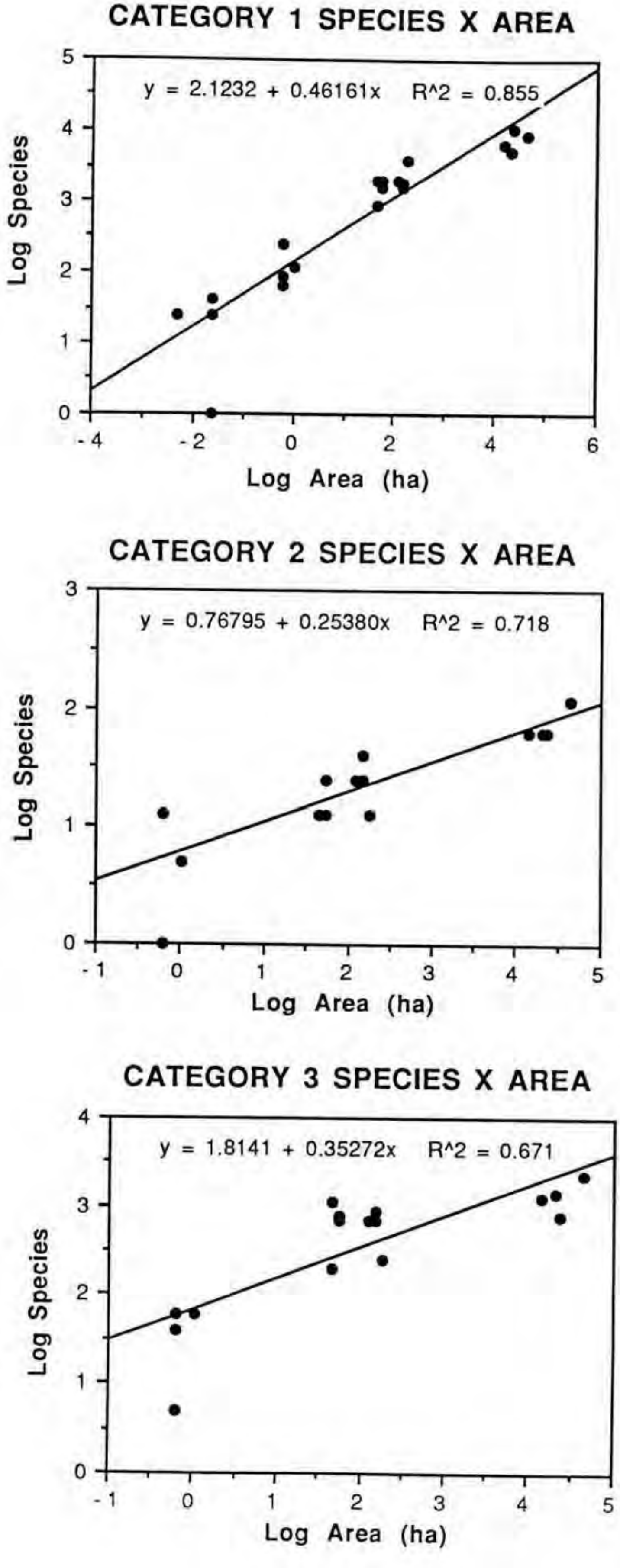

CATEGORY 1 SPECIES X AREA
y = 2.1232 + 0.46161x R^2 = 0.855
Log Species
Log Area (ha)
CATEGORY 2 SPECIES X AREA
y = 0.76795 + 0.25380x R^2 = 0.718
Log Species
Log Area (ha)
CATEGORY 3 SPECIES X AREA
y = 1.8141 + 0.35272x R^2 = 0.671
Log Species
Log Area (ha)

Figure 9

marsh directly when compared with associated species. A greater slope indicates that the rate of increase in number of species with increasing marsh size is higher. The high percentage of the variation in species numbers explained by all models suggest that community breadth for marsh birds is highly linked to marsh size (i.e., increasing species richness with increasing marsh size).

Species Losses and Community Nesting

The reduction in species richness with decreasing marsh size, does not, in and of itself, indicate a reduction in marsh function due to size effects. This is true because species losses may be directional (decline in species richness coupled with specific species or species groups systematically lost with decreasing marsh size) or nondirectional (decline in species richness coupled with no general pattern in the distribution of species between marsh sizes). A systematic loss of species with decreasing marsh size would suggest a general reduction in marsh function with marsh size for lost species. A random pattern of species loss would suggest that marsh size was unrelated to marsh function. The random pattern suggests that if we were to sample enough small marshes we would eventually observe the full complement of species seen in large marshes. A systematic loss suggests that lost species will only be observed in larger marshes because small marshes do not meet some requirements needed for occupation.

To differentiate between these alternate sources (random and directional) of species losses, the pattern of marsh occupation for core species and species groups was examined (see Table 6). Two general patterns emerge from the marsh occupation data. The first is

Table 6: Occurrence of species within marsh size categories. Numbers indicate how many marshes held birds of each species. (each size category had four replicate marshes).

Species	Marsh Size 0.1	1.0	5.0	10.0	Contr
Resident Breeder					
Red-winged Blackbird	2	4	4	4	4
Yellowthroat	2	2	4	3	4
Song Sparrow	1	4	4	4	4
Eastern Kingbird	1	1	2	3	3
Clapper Rail		3	4	4	4
Mallard		2	3	2	4
Marsh Wren		1	4	4	4
Willet			4	4	4
Seaside Sparrow			4	4	4
Boat-tailed Grackle			4	4	4
Virginia Rail			3	4	4
Black Duck			2	4	4
House Wren			2	2	4
Prairie Warbler			2	2	4
Eastern Meadowlark			2	2	4
Sedge Wren					3
Northern Harrier					2
Resident User					
Great Blue Heron	2	2	4	4	4
Barn Swallow	1	4	4	4	4
Green-backed Heron	1	1	4	4	4
Purple Martin		2	4	4	4
Great Egret		2	2	3	4
Snowy Egret			2	4	4
Transient User					
Greater Yellowlegs			3	3	4
Semipalmated Sandpiper			3	3	4
Sharp-tailed Sparrow			2	3	4
Least Sandpiper			1	3	4
Short-billed Dowitcher				2	3
Dunlin				1	2
Associated					
Laughing Gull	2	3	4	4	4
Fish Crow	1	2	4	4	4
Forster's Tern	1	1	4	4	4
Least Tern	1	1	1	1	2
Herring Gull		1	4	4	4
Osprey		1	3	4	4
Cormorant			1	4	4
Royal Tern			1	3	3

that species are systematically lost with decreasing marsh size so that species that occur in small marsh categories also were detected in all larger marsh categories. This nested pattern suggests that smaller marshes do not have the same functional significance as larger marshes. However, as indicated with the species richness patterns, the loss of species is not a simple linear function. For example, there are only minor changes in the core marsh bird community as marsh size is reduced from 10.0 to 5.0 ha. However, the marsh bird community appears to collapse as marsh size is reduced from 5.0 to 1.0 ha. This is not to say, that smaller marshes have no value to birds.

The second pattern observed is an increase in the proportion of marsh replicates occupied for most species with increasing marsh size. Although it was not of value to calculate incidence functions with so few replicates, the general pattern is fairly clear by inspection. Nearly all species in the four core groups exhibit an increase in incidence with an increase in marsh size.

Patterns of Vegetation Use

Marsh Components and Species Richness

Species richness and total bird numbers were compiled for the four marsh zones (Figure 10a). Species richness was found to be highest in the high marsh zone. Nearly 50% of the 105 species detected were found in this zone at least once. The low marsh zone had the lowest species richness (less than 25%) and the remaining two zones were relatively even. Overall, bird abundance was highest in the water zone with low and high marsh zones having nearly equal bird numbers. However, it should be noted that the high bird abundance for the water zone was the result of the very large number of shorebirds using tidepools for foraging during migration. If shorebirds were removed from the sample, the water zone would fall to third among the marsh zones in overall bird abundance.

Nearly 60% of the total species detected were associated with either tidepools or saltbush (Figure 10b). These two marsh components individually were associated with nearly 40% of the species detected. Other components with over 25% of the species were dead snags, wax myrtle, and deciduous saplings. However, these three latter components combined accounted for less than 15% of the individual birds detected. An opposite pattern was observed for black needlerush. Although only 9 species were associated with black needlerush, this marsh component accounted for the third highest number of total birds detected. This is because 4 of the most abundant, obligate marsh breeders reach their highest densities in this vegetation.

Patterns of marsh use were compiled for individual species. Information will be presented for core species only (see Figures 11 through 14). As mentioned earlier, although this group accounts for less than 25% of the species detected, they account for nearly 90% of the observations and represent the species most identified with local marshes. A gradient of marsh use was observed for those species considered to be core breeders. This gradient ranged from species that primarily used the water zone (e.g. Mallard, Black Duck) to those that exclusively used the high marsh and marsh-upland transition zone (e.g. Song Sparrow, Eastern Kingbird). Between these extremes were species that primarily used the low marsh (e.g. Clapper Rail, Marsh Wren) and those species that used nearly the entire marsh (e.g.

Figure 10: Relative species richness and abundance for individual marsh zones (a) and marsh components (b). Relative species richness values calculated as accumulated richness/105 (total species detected within marsh system). Relative abundance values calculated as total individuals/N (total individuals observed within the entire marsh system).

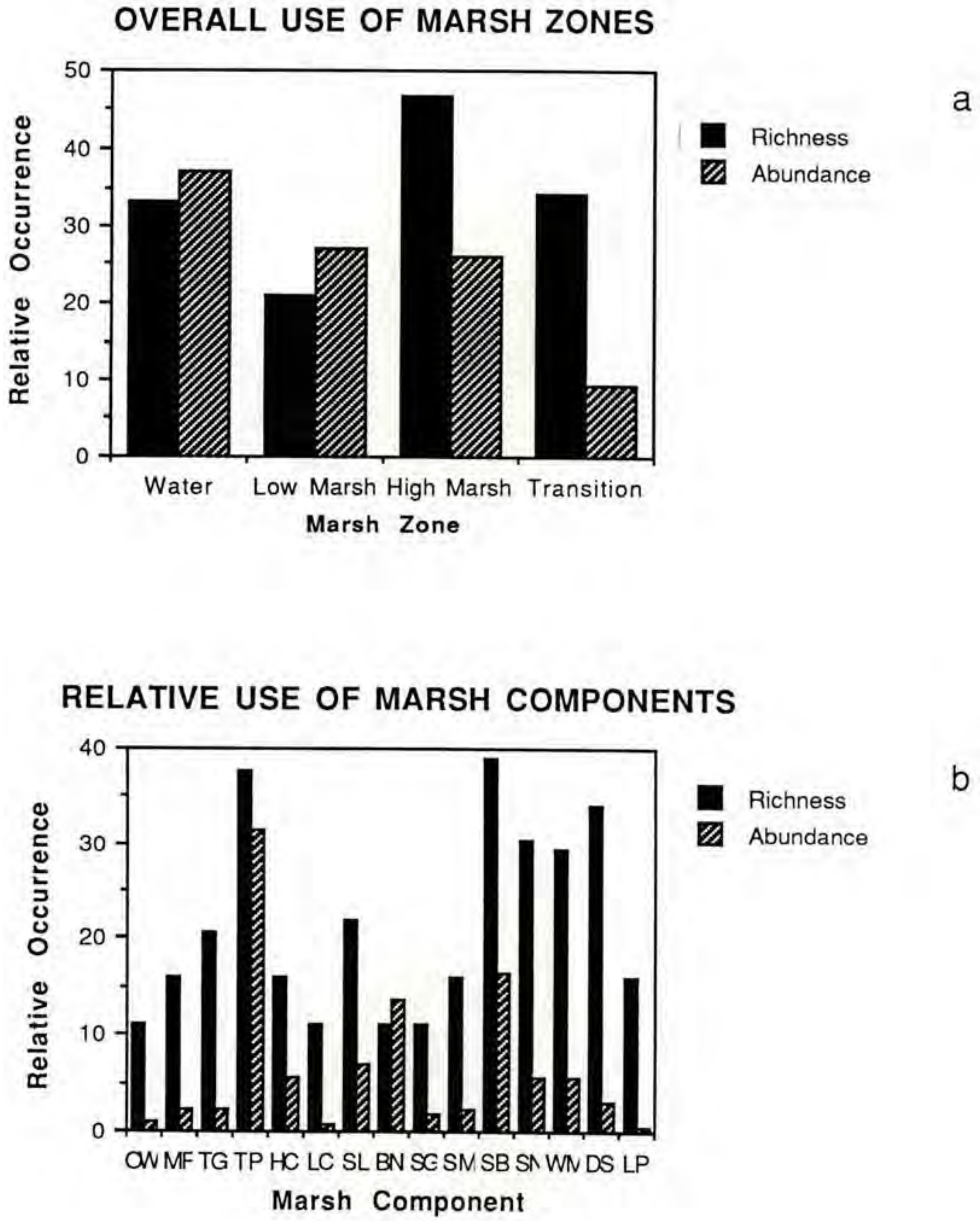

OVERALL USE OF MARSH ZONES
a
Relative Occurrence
50
40
30
20
10
0
Richness
Abundance
Water
Low Marsh
High Marsh
Transition
Marsh Zone
RELATIVE USE OF MARSH COMPONENTS
b
Relative Occurrence
40
30
20
10
0
Richness
Abundance
OW MF TG TP HC LC SL BN SG SM SB SN WM DS LP
Marsh Component

Figure 10

Figures 11 - 14: Relative occurrence of individual core species within the 15 focal marsh components. Values indicate number of individuals observed within specific marsh component/total number of individuals observed directly using study marshes. Only category 1 species (those species with greater than 50% of individuals observed directly using the marsh) are presented.

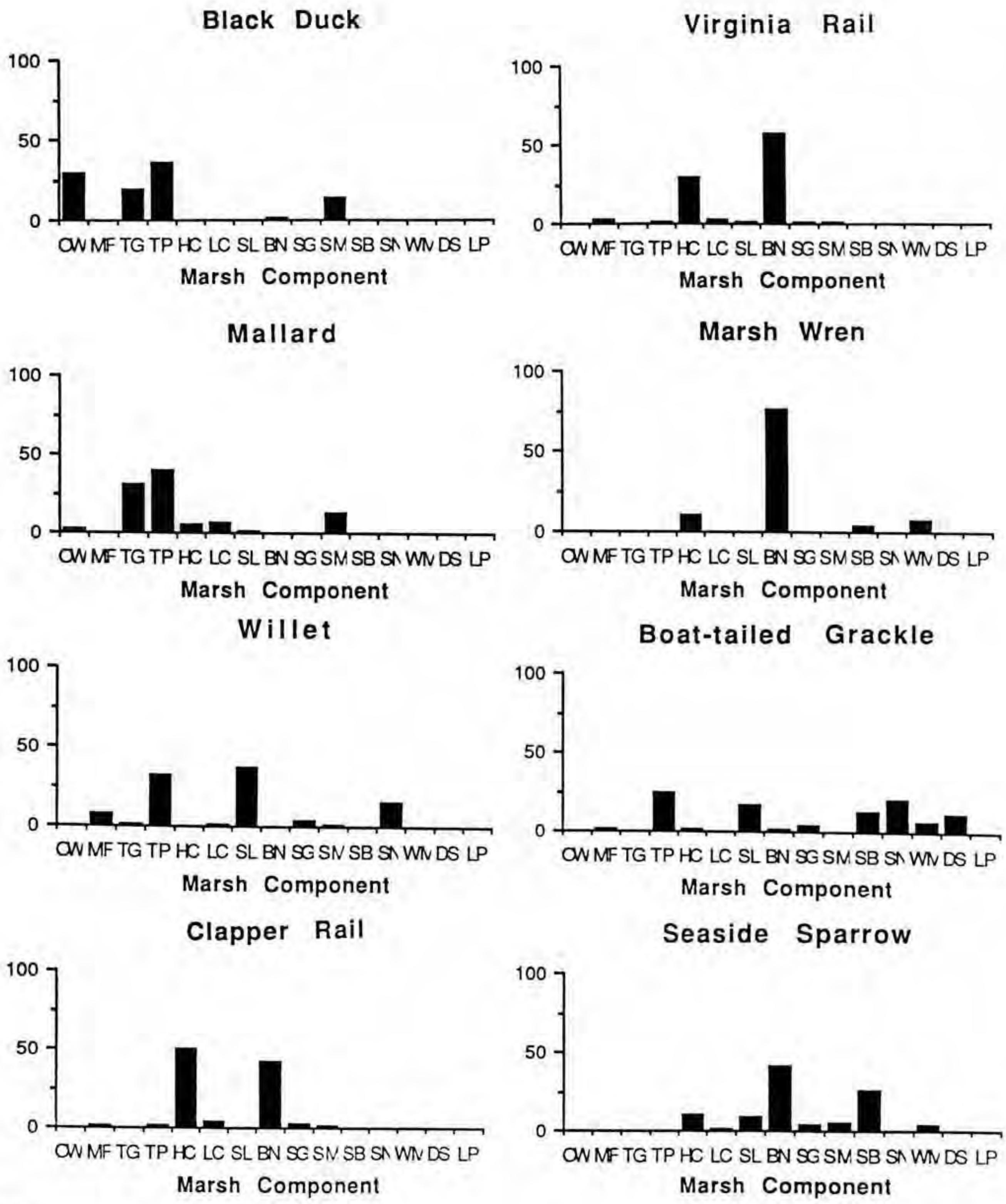

Black Duck
100
50
0
CW MF TG TP HC LC SL BN SG SM SB SN WN DS LP
Marsh Component
Virginia Rail
100
50
0
CW MF TG TP HC LC SL BN SG SM SB SN WN DS LP
Marsh Component
Mallard
100
50
0
CW MF TG TP HC LC SL BN SG SM SB SN WN DS LP
Marsh Component
Marsh Wren
100
50
0
CW MF TG TP HC LC SL BN SG SM SB SN WN DS LP
Marsh Component
Willet
100
50
0
CW MF TG TP HC LC SL BN SG SM SB SN WN DS LP
Marsh Component
Boat-tailed Grackle
100
50
0
CW MF TG TP HC LC SL BN SG SM SB SN WN DS LP
Marsh Component
Clapper Rail
100
50
0
CW MF TG TP HC LC SL BN SG SM SB SN WN DS LP
Marsh Component
Seaside Sparrow
100
50
0
CW MF TG TP HC LC SL BN SG SM SB SN WN DS LP
Marsh Component

Figure 11

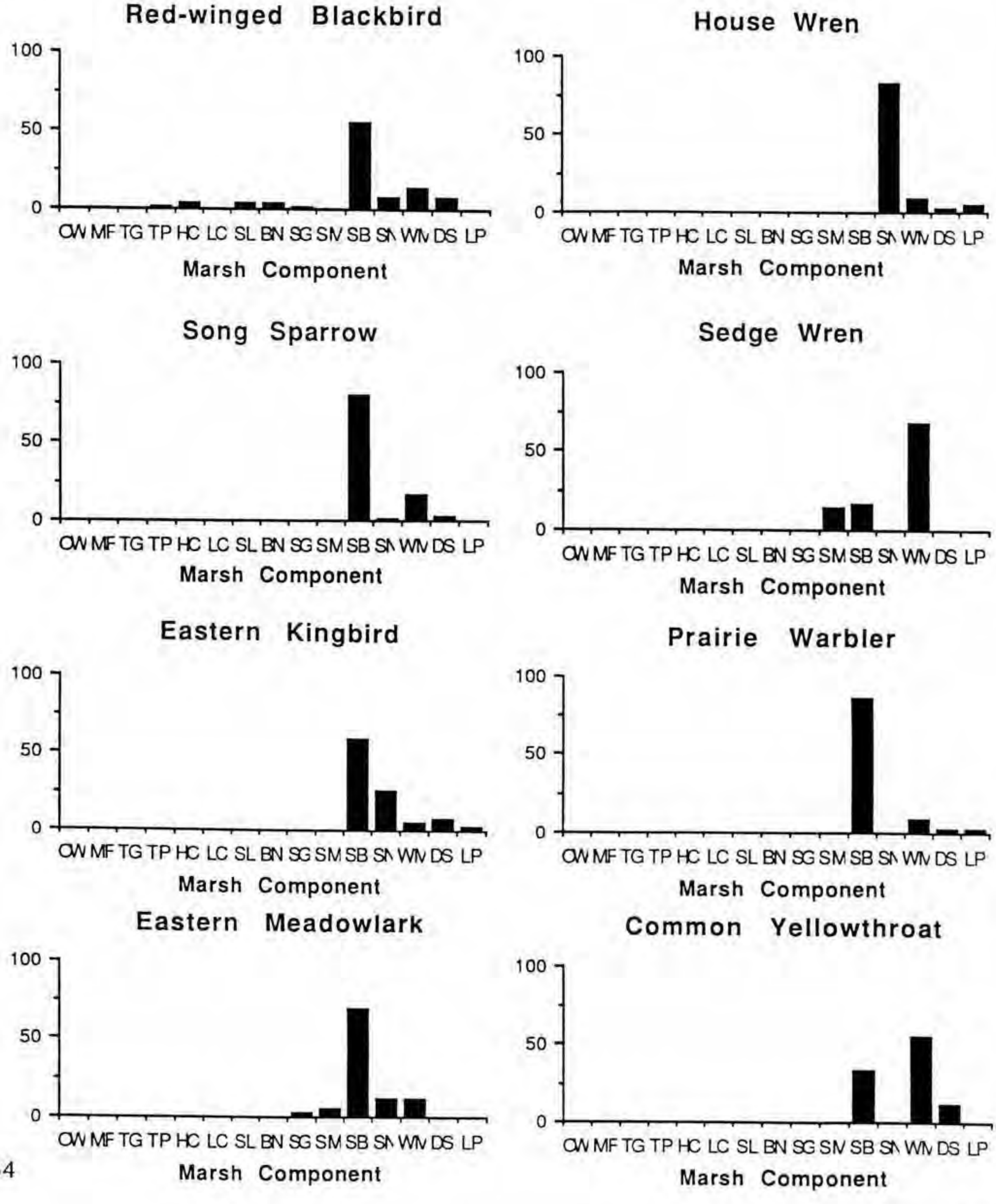

Red-winged Blackbird
House Wren
Song Sparrow
Sedge Wren
Eastern Kingbird
Prairie Warbler
Eastern Meadowlark
Common Yellowthroat
100
50
0
CW MF TG TP HC LC SL BN SG SM SB SN WN DS LP
Marsh Component

Figure 12

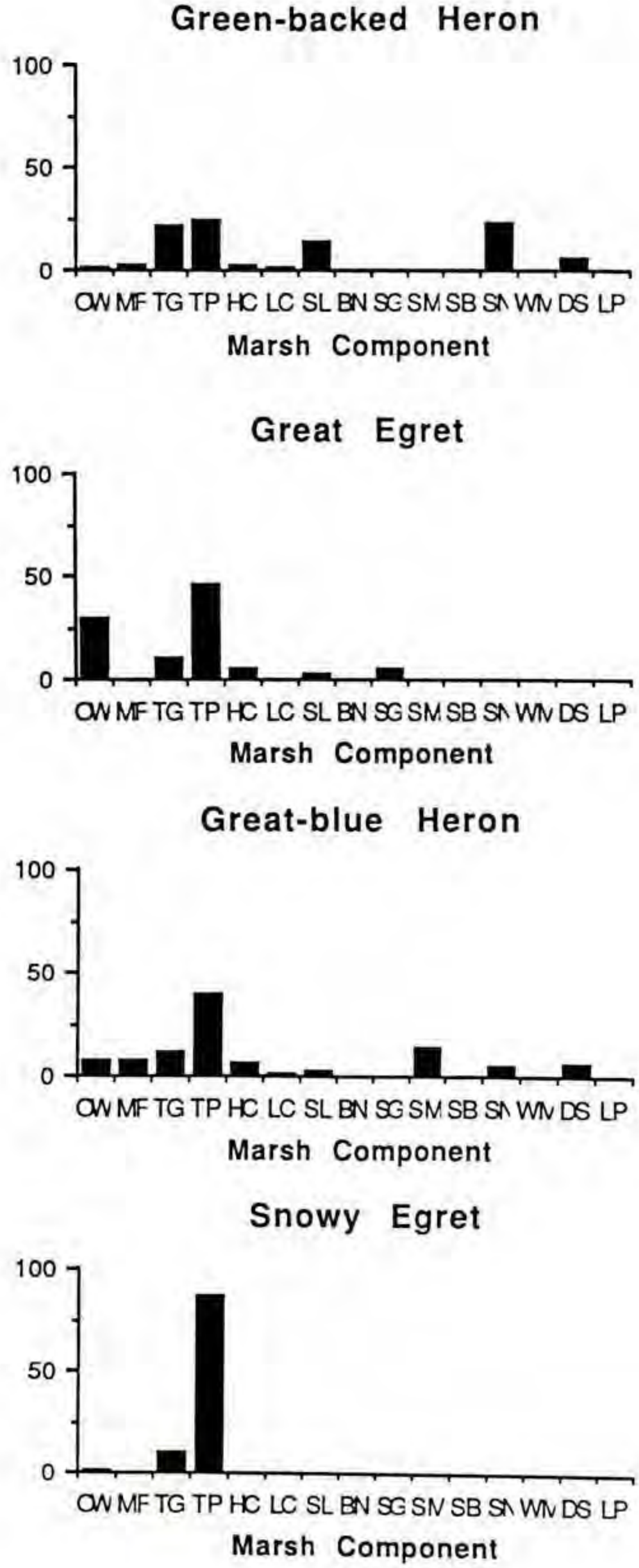
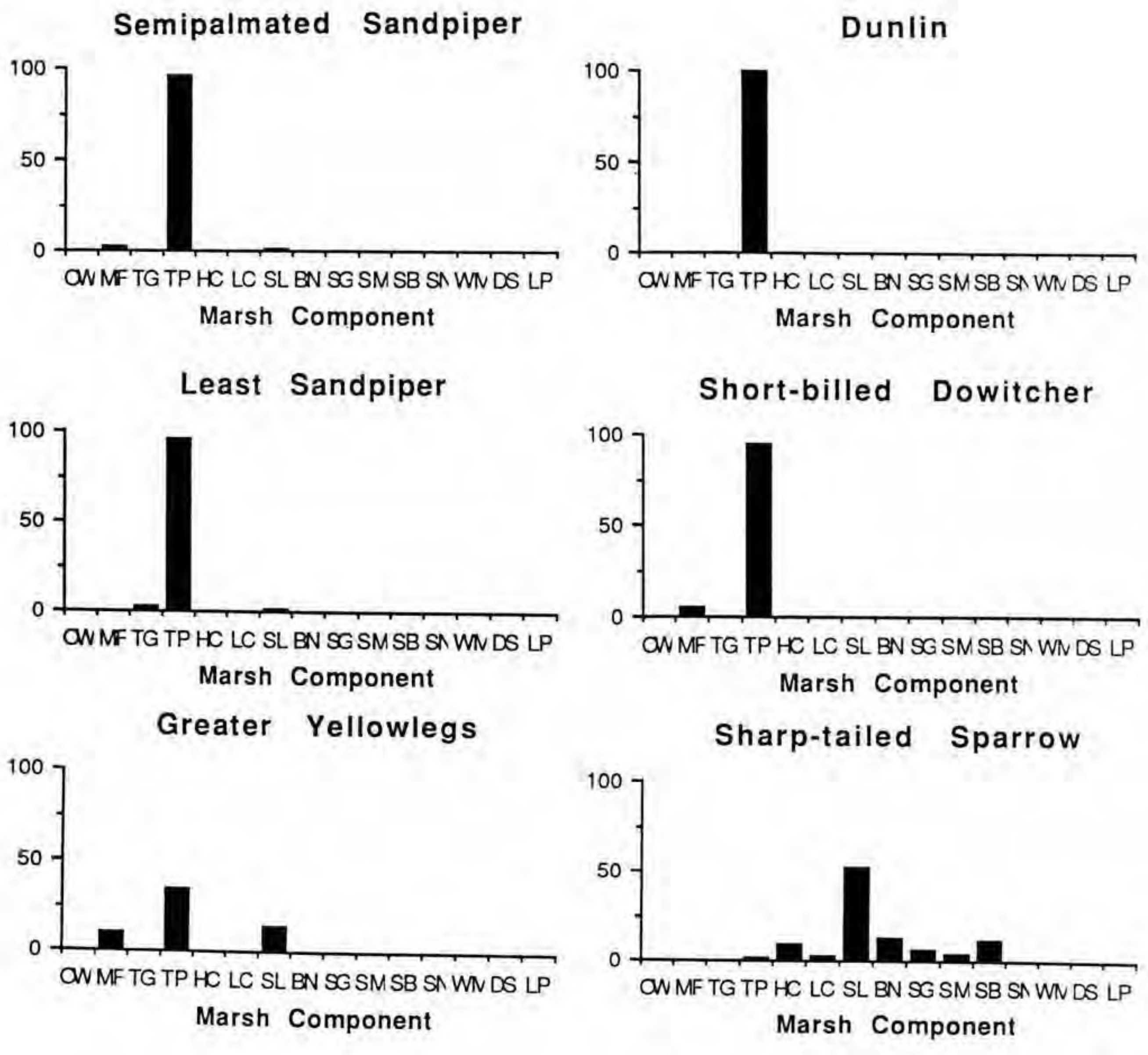

Green-backed Heron
100
50
0
OW MF TG TP HC LC SL BN SG SM SB SN WM DS LP
Marsh Component
Great Egret
100
50
0
OW MF TG TP HC LC SL BN SG SM SB SN WM DS LP
Marsh Component
Great-blue Heron
100
50
0
OW MF TG TP HC LC SL BN SG SM SB SN WM DS LP
Marsh Component
Snowy Egret
100
50
0
OW MF TG TP HC LC SL BN SG SM SB SN WM DS LP
Marsh Component

Figure 13



Semipalmated Sandpiper
Dunlin
Least Sandpiper
Short-billed Dowitcher
Greater Yellowlegs
Sharp-tailed Sparrow
100
50
0
CW MF TG TP HC LC SL BN SG SM SB SN WM DS LP
Marsh Component

Figure 14

Boat-tailed Grackle, Willet). For some wide-ranging species, dissimilar components were used for different activities. Willets, for example, typically foraged in tidepools or wet slews and roosted in dead snags. In addition, all 12 Willet nests found were located in tufts of saltmeadow hay. It is important to note that because observations were made during the day, patterns of marsh use may be biased for species with nocturnal activity periods. Marsh use by Clapper Rails was highly skewed to black needlerush and tall cordgrass because these dense plants provide nesting substrate and cover during the day. However, high marsh areas in most of the larger sites were strewn with thousands of fiddler (Uca spp.) crab claws (fiddlers are the primary summer prey of Clappers). These observations serve as evidence that Clappers use high marsh areas heavily for foraging at night.

The heron and egret species that represent the resident user group were generally concentrated within the water and low marsh zones for feeding. All observations of these species within the high marsh and transition zones were of roosting individuals. Green-backed herons typically roost in dead snags and Great Blue Herons roost frequently in saltmeadow hay and dead snags. The Snowy Egret appears to be the most specialized species of this group foraging primarily in small tidepools.

Like the Snowy Egret, all of the shorebird species foraged almost exclusively in tidepools with only a few individuals using wet slews during low tide. All of these species preferred feeding in shallow water with sparse vegetation along the edge of tidepools. During migration, Sharp-tailed Sparrows were most often flushed from the ground while foraging in wet slews. Individuals preferred slews surrounded by black needlerush, tall cordgrass or saltbush where they retreat when disturbed.

Patterns in Marsh Size and Composition

In order to better interpret the significance and implications of the marsh-use patterns observed, data on the size distribution and vegetational composition of local marshes were examined. Data on nearly 1,300 tidal marshes located within the reach of the study area were included in the analysis.

Marsh size within the study area varied from 0.1 ha to nearly 1500 ha (It should be noted that the lower limit to marsh size was constrained by the conventions of the marsh inventory. Marshes less than 0.1 ha were not included). However, marsh size was highly skewed to small marshes. Over 62% of marshes within the study area were less than 1 ha, and just over 85% of marshes were less than 5 ha. By contrast just over 8.0% of marshes were larger than 10 ha and only 1.0% of all marshes were larger than 65 ha (minimum size of control marshes). The low frequency of larger marshes in the study area has direct implications for the distribution and availability of foraging and nesting habitat for those species with apparent area requirements.

On average, marshes of the study area were dominated by saltmarsh cordgrass. Average coverage of the 5 target plant groups was: cordgrass - 52%, black needlerush - 17%, saltbush - 10%, saltgrass - 0.8%, and saltmeadow hay - 0.7%. All of these plant groups exhibited a significant, positive relationship with marsh area (F-value > 4.5, and $P < 0.05$ for all vegetation types). However, none of these relationships appear to be biologically meaningful (adjusted R-squared values range from .022 to .003). Marsh area explained so little of the overall variation in coverage by these plant species that it is not a useful indicator. A similar pattern was found for dominance. The overall regression for the area/dominance relationship was significant (F-value = 24.3, $P < 0.001$) but not predictive (adjusted R-squared = .24).

Local Species of Special Concern

Some of the observations made over the course of this study have independent significance because they deal with species for which we have very little distribution information or know little about their local breeding ecology. Below, is a summary of observations for three species of special interest.

Sharp-tailed Sparrow

Nearly all of the Sharp-tailed Sparrows observed within the study system were considered to be transients. This species has a migration period that extends relatively late into the summer. Sharp-tails were present in study marshes and in many neighboring marshes until the third week of June. The species then disappeared from marshes nearly overnight. Only one pair of birds was detected in any of the study marshes (or other local marshes) visited after the third round of surveys. This pair bred in saltmeadow hay along the edge of a tidepool in one of the control marshes. The marsh (Four Points Marsh, located at the end of Robbins Neck) is an extensive short grass marsh with numerous tidepools. This marsh contained the most extensive habitat for the species and was the location of the single highest count for the species (33 birds detected along survey route on 11 May) during this study.

The occurrence of this species in individual marshes during migration was influenced by marsh size. Sharp-tails were never detected in marshes smaller than 5.0 ha. The majority of individuals were detected feeding in wet slew areas either around shallow tidepools or around the terminus of narrow tideguts. Because of their secretive nature Sharp-tails during migration should be surveyed using line transect techniques.

Sedge Wren

The majority of Sedge Wrens detected over the study period were believed to be transients. It appeared that most transient birds moved through the marshes by late May. A high count of 22 birds was made on 20 May in the large control marsh near Poquoson (Messick Marsh adjacent to Plumtree Island). These birds were detected over an area of several hectares. Several pairs later bred in this same location. One individual was detected during a survey of Four Points Marsh on 17 May. No pairs were believed to have bred at this location. Individuals were also located in the large control marsh at New Point just outside of Bavon in Mathews County. At least 1 pair bred in this marsh.

All Sedge Wrens detected were in control marshes (3 of 4 replicate control marshes). This species appears to prefer expansive stands of saltmeadow hay with scattered shrubs (which may explain its requirement for large marshes). In two of the marshes, wrens were detected in the high marsh singing from scattered saltbush shrubs embedded in extensive areas of saltmeadow hay. In Messick Marsh where the majority of individuals were detected Sedge Wrens were located in the high marsh in scattered wax myrtle clumps interspersed with large patches of saltmeadow hay. Extensive areas with this vegetational configuration are rare within the coastal plain of Virginia (pers. obs.). Wax myrtle plants were distinctly spaced at intervals within an expansive saltmeadow.

This species may be severely impacted by marsh burning. Winter burning of high marsh areas kills scattered shrubs such as saltbush and wax myrtle. In Messick Marsh, the habitat type supporting the wrens was clearly twice as large in the recent past. A fire set in the marsh two years before the study had completely killed a large section of shrub vegetation. Marsh burning remains a common practice in some areas. Because shrub vegetation of this type takes several years to recover, burning on a short rotation may completely eliminate breeding areas.

Northern Harrier

The Harriers detected during this study were resident pairs. Of the 20 study marshes, Harriers were only detected in 2 marshes (both controls). These control marshes included the Messick Marsh and another control marsh located on Langley Air Force Base. In addition to the two pairs observed within focal marshes, 5 other breeding pairs were detected within the general study area. This includes one pair on the landward side of Plumtree Island and 4 pairs in the Guinea Marshes. Although no nest monitoring was attempted, 5 of the pairs were observed nest building and 4 pairs were observed feeding young. One female in the Guinea Marshes built three separate nests and laid three clutches before being successful (3 young hatched). The first two clutches were lost to Fish Crows.

Harriers in both marshes utilized extensive stands of black needlerush for foraging and nesting. The large area for foraging needed by this species likely explains their dependence on large marshes. All nests found in the guinea marshes were in nearly identical areas. Nests were placed in small, mounded clumps of short, black needlerush. These clumps were interspersed with open saltflats. Saltflats were either bare or covered with glasswort (Salicornia sp.). All areas were expansive with hundreds of regularly spaced needlerush mounds. This vegetational configuration is relatively rare on the western shore of the Bay. One nest found in Messick Marsh was in an area of mounded needlerush interspersed with saltmeadow hay.

DISCUSSION

Area Effects

Within the confines of the 20-marsh system, marsh area was a very good indicator of overall species richness. This finding is consistent with bird communities studied in prairie marshes (Brown and Dinsmore 1986) and various upland habitats (e.g. Forman et al. 1976, Lynch and Whigham 1984). The individual slopes of the species/area relationships derived here are all similar to others reported from area-specific studies (see Connor and McCoy 1979). Species richness for those species in direct contact with the marsh showed the most rapid declines with decreasing marsh area (Table 4). In general, the marsh-bird community observed in large marshes appears to collapse as marsh size is reduced from 5.0 to 1.0 ha. Only a small fraction of the total species observed were detected in marshes smaller than 1.0 ha and none of these species were obligate marsh breeders.

Previous studies relating patch size and bird species richness have dealt primarily with breeding bird communities. This study is unique in illustrating that non-breeding species may also show area sensitivity in marsh use or association. Marsh area was a very good predictor (though somewhat less than for direct users as a whole) of species richness for transient species, resident users, and so called associated species. These species groups clearly have less ties to the marsh proper but nonetheless exhibited patterns of area sensitivity.

The observed decline in species richness with marsh area was not due to random or sampling effects. Inspection of species loss patterns reveal that species were systematically lost with reductions in marsh size. This pattern was observed for associated species as well as all user groups. Bird assemblages within small marshes were completely nested subsets of those found within larger marshes.

Several viable explanations exist for the observed species/area relationships and, in fact, it is highly unlikely that a single factor could explain the loss patterns observed. The most obvious and straight forward explanation is that smaller marshes do not meet area requirements needed for breeding territories. For example, because of their hunting techniques, Northern Harriers require large open areas for foraging. Breeding ranges for this species have been reported to vary between just under 100 to well above 300 ha (Craighead and Craighead 1956). This large area requirement likely explains their restriction to control marshes. However, Sedge Wren territories have been reported to be less than 0.2 ha (Bent 1948) but were also restricted to control marshes. It is clear that for the majority of species, average territory sizes would permit use of even some of the smallest marshes surveyed. However, for individual species that require specific plant groups, total marsh area may not be the best estimate of habitat availability. Because marshes were chosen to contain all 5 target plant groups, small marshes contained very small patches of each vegetation type. A species that requires 1.0 ha of black needlerush may occur in a one hectare marsh dominated by needlerush but would require a 5.0 ha marsh of the types used in this study. This artifact could possibly explain the loss of some species between the very smallest marsh categories.

Another likely explanation for species losses is that larger marshes contain a greater diversity of habitats. Although vegetational composition was controlled for in the marshes selected, vegetation is not the only important marsh component. For example, tidepools were used by the most individual birds and by the second highest number of species. In general, tidepools do not occur in smaller marshes. None of the study marshes smaller than 5.0 ha contained significant tidepools. This single component likely influences patterns of marsh use for many species. Snowy Egrets are tidepool specialists when foraging and were not detected in smaller study marshes. The same pattern was observed for all of the transient shorebird species.

In addition to individual marsh components that vary with marsh size, larger marshes tend to contain more component combinations. Although vegetational composition was controlled for, how these vegetation types are associated with one another seems to be important for some species. For example, Eastern Meadowlarks were confined to the high marsh zone and prefer to sing from clumps of saltbush (70% of those observed were in salt bush). However, because they nest on the ground in saltmeadow hay they only use saltbush when it occurs in saltmeadow. Similarly, Meadowlarks typically do not occur in expansive areas of saltmeadow hay that do not contain salt bush for singing perches. Sedge Wrens appear to require a similar combination of vegetative components. In general, it appears that larger marshes tend to contain more component combinations and so have a greater diversity of habitats.

Associated species did not as a rule use the marsh surface but showed similar patterns of area sensitivity. It is possible that these species were indirectly influenced by marsh size. Nearly all of the associated species feed on aquatic prey or carrion in the shallow waters surrounding the marsh and so are likely influenced by prey populations that depend on various marsh characteristics.

Whatever the mechanisms responsible for the patterns of area sensitivity, they have implications for the distribution and management of some marsh birds. The patterns suggest that marsh size is a good indicator of marsh value for some species and species groups. The frequency distribution of marsh size categories within the study area suggest that a fraction of the total marshes support the bulk of the individuals of certain species. Larger marshes are relatively rare. The vast majority of marshes are of the size classes supporting the fewest species. The occurrence of larger marshes both on a local and regional scale should be taken into account when making decisions pertaining to proposals for wetland use and modification.

Marsh Components

The core species groups were different in their use of the four marsh zones. Core breeding species utilized the entire marsh but the high marsh supported the most species.

However, virtually none of the species breeding in the high marsh were obligate marsh breeders (species specific to tidal marshes). These species including Song Sparrow, Common Yellowthroat, Prairie Warbler, Red-winged Blackbird, etc also breed in other shrubby habitats of the coastal plain and elsewhere. Of the 7 obligate marsh breeding species (including: Seaside Sparrow, Marsh Wren, Willet, Boat-tail Grackle, Clapper Rail, Virginia Rail, and Black Duck) all but the Boat-tailed Grackle primarily used the low marsh or water components. The heron species primarily used the marsh for foraging and were concentrated in the water zone. Over 95% of the transient shorebirds detected were observed foraging in tidepools.

In general, the lower, regularly inundated areas of the marsh appear to have somewhat more value when compared to the drier marsh components. These low lying areas serve as stopover habitat for migrating shorebirds, foraging habitat for all of the resident breeding herons, and support nearly all of the marsh-endemic breeders.

SUMMARY

1. Marsh area is a good indicator of bird species richness for salt marshes of the lower Chesapeake Bay. Species groups that breed in the marsh proper, forage in the marsh (either during migration or during the breeding season), or were merely associated with the marsh, all exhibited a positive response to marsh area.

2. Species losses in smaller marshes were not due simply to random effects. Bird communities documented in smaller marshes were completely nested subsets of those found in larger marshes. In addition, the occurrence of individual species was more predictable in larger marshes.

3. Slopes of species-area relationships were relatively high but comparable to similar studies conducted in other habitats. Species groups that used the marsh directly for foraging or breeding showed the highest species loss rates.

4. The lower, regularly inundated portions of the marsh appear to have the most value for 1) species that breed exclusively in salt marshes, 2) transient shorebirds, and 3) locally resident birds that use marshes as foraging areas.

5. Small tidepools supported nearly one third of all birds observed and contained nearly 40% of the species detected. The presence or absence of tidepools may have a significant influence on species richness particularly for smaller marshes.

6. Marsh area is not a good indicator of marsh composition (with respect to the 5 target plant groups) or marsh dominance.

MANAGEMENT RECOMMENDATIONS

Marsh area should be considered when making decisions concerning proposals for marsh alteration. Many of the species observed did not occur in small marshes. Because of this, a single large marsh has more wildlife value than many small marshes even though combined they may contain more total area. In addition, it appears that larger marshes are relatively rare so that a few marshes may support most of the individuals of certain species. The availability of larger marshes, not just total marsh acreage, should be considered on a local and regional scale before considering activities proposed within large marshes.

The slopes of species-area relationships suggest that fragmentation of large marshes may result in a substantial reduction in species richness. Fragmentation of marshes within particular size categories may result in a near faunal collapse. These factors should be considered when making wetland management decisions. Creating small replacement marshes as mitigation for fragmenting mid-sized marshes may not replace lost wildlife values.

Creating productive tidepools and low-lying areas within marshes may increase species richness and enhance overall marsh value. Marsh enhancement projects may be particularly effective within small marshes.

SUGGESTIONS FOR FURTHER RESEARCH

1. This study examined species-area relationships for a fairly restricted set of marsh conditions. How well these results apply to other marsh types is unclear. Work is needed to clarify non-game wildlife values for other common marsh types in the region.

2. Marshes included in this study spanned a wide range of sizes. It appears that many of the obligate marsh users are lost as marsh area is reduced from 5.0 to 1.0 ha. However, the information gap between these two size categories is functionally very large. Further work needs to focus on this information gap to titrate where species losses are most pronounced.

3. Patterns in marsh use suggest that some marsh components contribute a great deal to overall bird abundance and diversity. The direct links between these components and the marsh-bird community should be studied in detail. An understanding

of the function provided by these components could provide insights into how best to enhance or create valuable wetlands.

4. Previous wetland-use guidelines have suggested that marshes dominated by black needlerush have relatively low wildlife value when compared to other marsh types. Results from this study suggest that this plant type supports very few species. However, those species supported tend to be marsh obligates. In addition, some of these species reach their highest densities within this habitat. Further work is needed to clarify the wildlife value of needlerush marshes.

LITERATURE CITED

Barnard, T. A. Jr. 1975. City of Hampton Tidal Marsh Inventory. Spec. Rep. No. 60. in Applied Marine Science and Ocean Engineering. Virginia Institute of Marine Science, Gloucester Point, VA..

Bent, A. C. 1948. Life histories of North American nuthatches, wrens, thrashers, and their allies. Smithsonian Institution, U.S. Natural Museum Bulletin No. 195.

Blondel, J., C. Ferry, and B. Frochot. 1981. Point counts with unlimited distance. Pp 414-420 in Estimating Numbers of Terrestrial Birds. (C. J. Ralph and J. L. Scott eds). Cooper Ornithological Society.

Brown, M., and J. J. Dinsmore. 1986. Implications of marsh size and isolation for marsh bird management. J. Wildl. Manage. 50:392-397.

Connor, E. F., and E. D. McCoy. 1979. The statistics and biology of the species-area relationship. Am. Nat. 113:791-833.

Craighead, J. J. and F. C. Craighead, Jr. 1956. Hawks, owls and wildlife. Stackpole Co., Jarrisburg, PA.

Emlen, J. T. 1971. Population densities of birds derived from transect counts. Auk 88:323-342.

_______, 1977. Estimating breeding season bird densities from transect counts. Auk 94:455-468.

Forman, R. T. T., A. E. Galli, and C. F. Leck. 1976. Forest size and avian diversity in New Jersey woodlots with some land use implications. Oecologia 26:1-8.

Frayer, W. E., T. J. Monahan, D. C. Bowden, and F. A. Graybill. 1983. Status and trends of wetlands and deepwater habitats in the conterminous United States, 1950's to 1970's. Department of Forest and Wood Sciences, Colorado State University, Ft. Collins, Colorado.

Glahn, J. F. 1974. Study of breeding rails with recorded calls in North-central Colorado. Wilson Bull. 86:206-214.

Gosselink, J. G. and R. H. Baumann. 1980. Wetland inventories: wetland loss along the United States coast. Z. Geomorph. N. F. Suppl. Bd. 34:173-187.

Hardisky, M. A. and V. Klemas. 1983. Tidal wetlands natural and human-made changes from 1973 to 1979 in Delaware: mapping techniques and results. Envir. Manage. 7(4):1-6.

Lynch, J. F. and D. F. Whigham. 1984. Effects of forest fragmentation on breeding bird communities in Maryland, USA. Biol. Conserv. 28:287-324.

Mager, A., Jr. and G. W. Thayer. 1986. National marine fisheries service habitat conservation efforts in the southeast region of the United States from 1981 through 1985. Mar. Fish. Rev. 48:1-8.

Moore, K. A. 1976. Gloucester County Tidal Marsh Inventory. Spec. Rep. No. 64 in Applied Marine Science and Ocean Engineering, Virginia Institute of Marine Science. Gloucester Point, VA.

Morrison, M. L., R. W. Mannan, and G. L. Dorsey. 1981. Effects of number of circular plots on estimates of avian density and species richness. Pp. 405-408 in Estimating

Numbers of Terrestrial Birds. (C. J. Ralph and J. M. Scott, eds). Cooper Ornithological Society.

Repking, C. F., and R. D. Ohmart. 1977. Distribution and density of Black Rail populations along the lower Colorado River. Condor, 79:486-489.

Scott, J. M., F. L. Ramsey, and C. B. Kepler. 1981. Distance estimation as a variable in estimating bird numbers from vocalizations. Pp. 334-340 in Estimating Numbers of Terrestrial Birds (C. J. Ralph and J. M. Scott, Eds). Stud. Avian Biol. No. 6.

Silberhorn, G. M. 1981a. Mathews County Tidal Marsh Inventory. Spec. Rep. No. 47, in Applied Science and Ocean Engineering, Virginia Institute of Marine Science. Gloucester Point, VA.

_______, 1981b. York County and Town of Poquoson Tidal Marsh Inventory. Spec. Rep. No. 53 in Applied Marine Science and Ocean Engineering, Virginia Institute of Marine Science. Gloucester Point, VA.

Simpson, E. H. 1949. Measurement of diversity. Nature 163:688.

Southworth, A. D. 1989. Conserving southeastern coastal wetlands. Pp. 223-257 in Audubon wildlife report - 1989/1990 (W. J. Chandler, ed.). Academic Press, New York, New York.

Swift, B. L., S. R. Orman, and J. W. Ozard. 1988. Response of Least Bitterns to tape-recorded calls. Wilson Bull. 100:496-499.

Tiner, R. W. 1984. Wetlands of the United States: current status and recent trends. U.S. Fish & Wildlife Service Report, Washington D.C..

Appendix I: List of scientific names for species detected.

Common Name	Scientific Name
Common Loon	Gavia immer
Brown Pelican	Pelecanus occidentalis
Double-crested Cormorant	Phalacrocorax auritus
Least Bittern	Ixobrychus exilis
Yellow-crowned Night-heron	Nyctanassa violacea
Green-backed Heron	Butorides striatus
Tri-colored Heron	Hydranassa tricolor
Little-blue Heron	Florida caerulea
Snowy Egret	Egretta thula
Great Egret	Casmerodius albus
Great Blue Heron	Ardea herodias
Glossy Ibis	Plegadis falcinellus
Mute Swan	Cygnus olor
Canada Goose	Branta canadensis
Mallard	Anas platyrhynchos
Black Duck	Anas rubripes
Blue-winged Teal	Anas discors
Red-breasted Merganser	Mergus serrator
Clapper Rail	Rallus longirostris
Virginia Rail	Rallus limicola
Sora	Porzana carolina
American Oystercatcher	Haematopus palliatus
Killdeer	Charadrius vociferus
Semipalmated Plover	Charadrius semipalmatus
Willet	Catoptrophorus semipalmatus
Greater Yellowlegs	Tringa melanoleuca
Lesser Yellowlegs	Tringa flavipes
Spotted Sandpiper	Actitis macularia
Short-billed Dowitcher	Limnodromus griseus
Red Knot	Calidris canutus
Dunlin	Calidris alpina
Semipalmated Sandpiper	Calidris pusilla
Least Sandpiper	Calidris minutilla
Black-necked Stilt	Himantopus mexicanus
Laughing Gull	Larus atricilla
Ring-billed Gull	Larus delawarensis
Herring Gull	Larus argentatus
Great Black-backed Gull	Larus marinus
Common Tern	Sterna hirundo
Forster's Tern	Sterna forsteri
Gull-billed Tern	Gelochelidon nilotica
Little Tern	Sterna albifrons
Royal Tern	Sterna Maxima
Black Skimmer	Rynchops niger
Bald Eagle	Haliaeetus leucocephalus
Northern Harrier	Circus cyaneus
Red-tailed Hawk	Buteo jamaicensis

Appendix I: -----continued-----

Osprey	Pandion haliaetusAmerican
Kestrel	Falco sparverius
Merlin	Falco columbarius
Peregrine Falcon	Falco peregrinus
Mourning Dove	Zenaida macroura
Great-horned Owl	Bubo virginianus
Chimney Swift	Chaetura pelagica
Ruby-throated Hummingbird	Archilochus colubris
Belted Kingfisher	Megaceryle alcyon
Red-headed Woodpecker	Melanerpes Erythrocephalus
Red-bellied Woodpecker	Melanerpes carolinus
Common Flicker	Colaptes auratus
Downy Woodpecker	Picoides pubescens
Eastern Kingbird	Tyrannus tyrannus
Great-crested Flycatcher	Myiarchus crinitus
Eastern Pewee	Contopus virens
Eastern Phoebe	Sayornis phoebe
Tree Swallow	Iridoprocne bicolor
Purple Martin	Progne subis
Bank Swallow	Riparia riparia
Rough-winged Swallow	Stelgidopteryx ruficollis
Barn Swallow	Hirundo rustica
American Crow	Corvus brachyrhynchos
Fish Crow	Corvus ossifragus
Tufted Titmouse	Parua bicolor
Carolina Chickadee	Parus carolinensis
Brown-headed Nuthatch	Sitta pusilla
House Wren	Troglodytes aedon
Carolina Wren	Thryothorus ludovicianus
Marsh Wren	Cistothorus palustris
Sedge Wren	Cistothorus platensis
Blue-gray Gnatcather	Polioptila caerulea
Eastern Bluebird	Sialia sialis
Gray Catbird	Dumetella carolinensis
Mockingbird	Mimus polyglottos
Brown Thrasher	Toxostoma rufum
European Starling	Sturnus vulgaris
White-eyed Vireo	Vireo griseus
Prairie Warbler	Dendroica discolor
Pine Warbler	Dendroica pinus
Yellow Warbler	Dendroica petechia
Common Yellowthroat	Geothlypis trichas
Yellow-breasted Chat	Icteria virens
Northern Cardinal	Cardinalis cardinalis
Indigo Bunting	Passerina cyanea
Rufous-sided Towhee	Pipilo erythrophthalmus
Sharp-tailed Sparrow	Ammospiza caudacuta
Seaside Sparrow	Ammospiza maritima
Song Sparrow	Melospiza melodia

Appendix I: -----continued-----

Field Sparrow	Spizella pusilla
Swamp Sparrow	Melospiza georgiana
Eastern Meadowlark	Sturnella magna
Red-winged Blackbird	Agelaius phoenicius
Brown-headed Cowbird	Molothrus ater
Common Grackle	Quiscalus quiscula
Boat-tailed Grackle	Quiscalus major
Orchard Oriole	Icterus spurius
American Goldfinch	Carduelis tristis

Appendix II: Breakdown of marsh use categories by species. Categories include: one - bird in direct contact with marsh, two - bird not in direct contact with marsh but foraging on prey just over or on marsh surface, three - bird flying over marsh but under 50 m in altitude and or associated with water within 50 m of shoreline.

Species	N	User Category		
		one	Two	Three
Common Loon	13	-----	-----	100.0
Brown Pelican	7	-----	-----	100.0
Double-crested Cormorant	76	7.9	-----	92.1
Least Bittern	2	100.0	-----	-----
Yellow-crowned Night-heron	10	100.0	-----	-----
Green Heron	71	85.9	-----	14.1
Tri-colored Heron	8	75.0	-----	25.0
Little-blue Heron	1	-----	-----	100.0
Snowy Egret	98	56.1	-----	43.9
Great Egret	67	55.2	-----	44.8
Great Blue Heron	102	98.0	-----	2.0
Glossy Ibis	3	100.0	-----	-----
Mute Swan	2	100.0	-----	-----
Canada Goose	21	52.4	-----	47.6
Mallard	69	89.9	-----	10.1
Black Duck	102	79.4	-----	20.6
Blue-winged Teal	7	71.4	-----	28.6
Red-breasted Merganser	1	100.0	-----	-----
Clapper Rail	249	100.0	-----	-----
Virginia Rail	75	100.0	-----	-----
Sora	3	100.0	-----	-----
American Oystercatcher	17	88.7	-----	11.3
Killdeer	6	83.3	-----	16.7
Semipalmated Plover	9	77.8	-----	22.2
Willet	415	88.7	-----	11.3
Greater Yellowlegs	37	81.1	-----	18.9
Lesser Yellowlegs	5	100.0	-----	-----
Spotted Sandpiper	2	100.0	-----	-----
Short-billed Dowitcher	128	96.9	-----	3.1
Red Knot	3	100.0	-----	-----
Dunlin	51	100.0	-----	-----
Semipalmated Sandpiper	993	98.3	-----	1.7
Least Sandpiper	138	100.0	-----	-----
Black-necked Stilt	2	100.0	-----	-----
Laughing Gull	368	15.5	-----	84.5
Ring-billed Gull	1	-----	-----	84.5
Herring Gull	77	10.4	-----	89.6
Great Black-backed Gull	2	-----	-----	100.0
Common Tern	18	5.6	-----	94.4
Forster's Tern	84	31.0	10.7	58.3
Gull-billed Tern	1	-----	-----	100.0

Appendix II: -----continued-----

Least Tern	51	17.6	58.8	23.6
Royal Tern	37	-----	5.1	94.4
Black Skimmer	24	-----	75.0	25.0
Bald Eagle	3	-----	-----	100.0
Northern Harrier	17	35.3	64.7	-----
Red-tailed Hawk	10	20.0	-----	80.0
Osprey	78	29.5	1.1	79.4
American Kestrel	2	-----	100.0	-----
Merlin	1	-----	100.0	-----
Peregrine Falcon	1	-----	100.0	-----
Mourning Dove	3	-----	-----	100.0
Great-horned Owl	1	100.0	-----	-----
Chimney Swift	21	-----	100.0	-----
Ruby-throated Hummingbird	6	100.0	-----	-----
Belted Kingfisher	1	-----	-----	100.0
Red-headed Woodpecker	1	-----	-----	100.0
Red-bellied Woodpecker	2	100.0	-----	-----
Common Flicker	18	88.9	-----	11.1
Downy Woodpecker	2	50.0	-----	50.0
Eastern Kingbird	44	100.0	-----	-----
Great-crested Flycatcher	1	100.0	-----	-----
Eastern Pewee	3	100.0	-----	-----
Eastern Phoebe	1	100.0	-----	-----
Tree Swallow	14	-----	100.0	-----
Purple Martin	36	2.8	97.2	-----
Bank Swallow	9	-----	100.0	-----
Rough-winged Swallow	20	-----	100.0	-----
Barn Swallow	226	-----	100.0	-----
American Crow	7	57.1	-----	42.9
Fish Crow	97	21.6	-----	78.4
Tufted Titmouse	1	100.0	-----	-----
Carolina Chickadee	16	100.0	-----	-----
Brown-headed Nuthatch	7	100.0	-----	-----
House Wren	43	100.0	-----	-----
Carolina Wren	5	100.0	-----	-----
Marsh Wren	136	100.0	-----	-----
Sedge Wren	29	100.0	-----	-----
Blue-gray Gnatcatcher	7	100.0	-----	-----
Eastern Bluebird	2	100.0	-----	-----
Gray Catbird	27	100.0	-----	-----
Mockingbird	10	100.0	-----	-----
Brown Thrasher	1	100.0	-----	-----
European Starling	101	60.4	-----	39.6
White-eyed Vireo	6	100.0	-----	-----
Prairie Warbler	46	100.0	-----	-----
Pine Warbler	10	100.0	-----	-----
Yellow Warbler	28	100.0	-----	-----
Common Yellowthroat	130	100.0	-----	-----
Yellow-breasted Chat	24	100.0	-----	-----

Appendix II: -----continued-----

Northern Cardinal	16	100.0	-----	-----
Indigo Bunting	13	100.0	-----	-----
Rufous-sided Towhee	2	100.0	-----	-----
Sharp-tailed Sparrow	107	100.0	-----	-----
Seaside Sparrow	1094	100.0	-----	-----
Song Sparrow	210	100.0	-----	-----
Field Sparrow	5	100.0	-----	-----
Swamp Sparrow	2	100.0	-----	-----
Eastern Meadowlark	73	100.0	-----	-----
Red-winged Blackbird	232	100.0	-----	-----
Brown-headed Cowbird	71	71.8	-----	28.2
Common Grackle	27	37.0	-----	63.0
Boat-tailed Grackle	198	89.9	-----	10.1
Orchard Oriole	4	100.0	-----	-----
American goldfinch	34	85.3	-----	14.7

Appendix III : Total frequency of birds observed during each survey period for all marshes combined (list of scientific names given in appendix I).

Species	Census Number				Total
	one	two	three	four	
Common Loon	12	1	0	0	13
Brown Pelican	7	0	0	0	7
Double-crested Cormorant	50	14	3	9	76
Least Bittern	1	1	0	0	2
Yellow-crowned Night-heron	1	4	3	2	10
Green Heron	17	12	17	25	71
Tri-colored Heron	4	3	1	0	8
Little-blue Heron	1	0	0	0	1
Snowy Egret	34	19	32	13	98
Great Egret	24	16	14	13	67
Great Blue Heron	25	22	17	38	102
Glossy Ibis	3	0	0	0	3
Mute Swan	0	2	0	0	2
Canada Goose	13	2	3	3	21
Mallard	25	22	17	5	69
Black Duck	25	22	26	29	102
Blue-winged Teal	5	2	0	0	7
Red-breasted Merganser	0	1	0	0	1
Clapper Rail	116	59	47	27	249
Virginia Rail	32	24	11	8	75
Sora	3	0	0	0	3
American Oystercatcher	3	6	5	3	17
Killdeer	1	1	4	0	6
Semi-palmated Plover	5	4	0	0	9
Willet	116	88	147	64	415
Greater Yellowlegs	31	6	0	0	37
Lesser Yellowlegs	3	2	0	0	5
Spotted Sandpiper	1	0	1	0	2
Short-billed Dowitcher	128	0	0	0	128
Red Knot	1	2	0	0	3
Dunlin	51	0	0	0	51
Semi-palmated Sandpiper	893	100	0	0	993
Least Sandpiper	131	7	0	0	138
Black-necked Stilt	2	0	0	0	2
Laughing Gull	144	67	79	78	368
Ring-billed Gull	0	1	0	0	1
Herring Gull	40	18	10	9	77
Great Black-backed Gull	1	0	0	1	2
Common Tern	0	0	5	13	18
Forster's Tern	38	12	19	15	84
Gull-billed Tern	1	0	0	0	1
Least Tern	25	13	8	5	51
Royal Tern	3	19	8	7	37
Black Skimmer	5	3	11	5	24

Appendix III : -Continued-

Bald Eagle	1	0	0	2	3
Northern Harrier	4	4	4	5	17
Red-tailed Hawk	4	3	2	1	10
Osprey	20	20	22	16	78
American Kestrel	1	0	1	0	2
Merlin	1	0	0	0	1
Peregrine Falcon	1	0	0	0	1
Mourning Dove	1	1	1	0	3
Great-horned Owl	0	0	1	0	1
Chimney Swift	1	2	6	12	21
Ruby-throated Hummingbird	2	0	2	2	6
Belted Kingfisher	0	0	0	1	1
Red-headed Woodpecker	0	0	0	1	1
Red-bellied Woodpecker	1	0	0	1	2
Northern Flicker	5	8	3	2	18
Downy Woodpecker	1	1	0	0	2
Eastern Kingbird	8	13	13	10	44
Great-crested Flycatcher	1	0	0	0	1
Eastern Wood Pewee	2	0	1	0	3
Phoebe	1	0	0	0	1
Tree Swallow	11	3	0	0	14
Purple Martin	8	13	8	7	36
Bank Swallow	4	3	0	2	9
Rough-winged Swallow	7	9	1	3	20
Barn Swallow	61	52	64	49	226
American Crow	4	3	0	0	7
Fish Crow	25	27	20	25	97
Tufted Titmouse	0	0	1	0	1
Carolina Chickadee	5	4	5	2	16
Brown-headed Nuthatch	5	1	1	0	7
House Wren	7	12	12	12	43
Carolina Wren	0	0	4	1	5
Marsh Wren	34	32	38	32	136
Sedge Wren	10	7	5	7	29
Blue-gray Gnatcatcher	4	0	2	1	7
Eastern Bluebird	1	0	1	0	2
Gray Catbird	2	10	9	6	27
Mockingbird	3	2	4	1	10
Brown Thrasher	1	0	0	0	1
European Starling	18	24	45	14	101
White-eyed Vireo	5	0	1	0	6
Prairie Warbler	23	11	8	4	46
Pine Warbler	1	8	0	1	10
Yellow Warbler	11	6	6	5	28
Common Yellowthroat	27	37	34	32	130
Yellow-breasted Chat	7	6	7	4	24
Northern Cardinal	4	6	1	5	16
Indigo Bunting	4	2	3	4	13
Rufous-sided Towhee	1	1	0	0	2

Appendix III : -Continued-

Sharp-tailed Sparrow	62	31	12	2	107
Seaside Sparrow	339	252	282	221	1094
Song Sparrow	70	52	42	46	210
Field Sparrow	4	1	0	0	6
Swamp Sparrow	1	1	0	0	2
Eastern Meadowlark	31	12	15	15	73
Red-winged Blackbird	70	64	45	53	232
Brown-headed Cowbird	32	17	4	18	71
Common Grackle	9	3	10	5	27
Boat-tailed Grackle	55	59	46	38	198
Orchard Oriole	2	1	0	1	4
American Goldfinch	7	10	8	9	34

APPENDIX IV: Working bibliography of selected marsh-bird species.

Abbott, C. C. 1907. Summer bird life of the Newark, New Jersey, marshes. Auk 24: 1-11.

Abrams, M. D., A. K. Knapp, and L. C. Hulbert. 1986. A ten-year record of above ground biomass in a Kansas tallgrass prairie: effects of fire and topographic position. Am. J. Bot. 73: 1509-1515.

Adams, D. A., and T. L. Quay. 1958. Ecology of the clapper rail in southeastern North Carolina. J. Wildl. Manage. 22: 148-156.

Adams, R. 1989. The Henslow's sparrow *Ammodramus henslowii* in Michigan. Unpubl. Rep., Kalamazoo Nat. Cent., Kalamazoo, Mich. 7pp.

Ake, L. and F.R. Scott. 1975. Saxis Marsh observations. The Raven 46: 72.

Alexander, G. R. 1977. Food of vertebrate predators on trout waters in north central Lower Michigan. Michigan Academician 10: 181-195.

Allen, A. A. 1915. The behavior of the least bittern. Bird-lore 17: 425-430.

Allen, A. A. 1923. April in the marshes. Bird-Lore 25: 145-146.

Allen, A. A. 1934. The Virginia rail and the sora. Bird-Lore 36: 196-204.

Allen, Joel A. 1888. Descriptions of two new subspecies of the seaside sparrow *Ammodramus maritimus*. Auk 5: 284-287.

Allen, Joel A. 1888. Further notes on seaside sparrows. Auk 5: 426.

Amat, J. A., and E. Aguilera. 1990. Tactics of black-headed gulls robbing egrets and waders. Anim. Behav. 39: 70-77.

American Ornithologists' Union. 1957. Check-list of North American Birds (5th edition). American Ornithologists' Union, Baltimore, Maryland. 691 pp.

American Ornithologists' Union. 1982. Thirty-fourth supplement to the American Ornithologists' Union Check-list of North American Birds. Auk 99(3): 1-16CC.

Anderson, B. W., and R. D. Ohmart. 1985. Habitat use by clapper rails in the lower Colorado River Valley. Condor 87: 116-126.

Anderson, J. M. 1977. Yellow rail *Coturnicops noveboracensis*. Pages 66-70 *in* Management of migratory shore and upland game birds in North America (G. C. Sanderson, Ed.). International Association of Fish and Wildlife Agencies, Washington, D. C.

Anderson, W. 1942. Rediscovery of the Cape Sable seaside sparrow in Collier County, Florida. Nat. 16: 12.

Andrews, D. A. 1973. Habitat utilization by soras, Virginia rails, and king rails near southwestern Lake Erie. M. S. thesis, Ohio State Univ., Columbus, Ohio.

Anes, S. L., F. Enders, and F. Heath. 1966. Breeding-bird census: ditched salt marsh. American Birds 20: 660-661.

Anonymous. 1980. Sun sets on the dusky seaside sparrow. BioScience 30: 576.

Anonymous. 1981. Yuma clapper rail survey results. U. S. Bur. Reclam., Yuma, Arizona.

Anselin, A. and P. Meire. 1985. On measuring habitat variables in avian studies with special reference to marsh-nesting birds. Biol. Jb. Dodonaea 53: 140-152.

Antonio, F. B., and J. Ellis. 1981. History and current status of the dusky seaside sparrow. Pages 57-66 *in* Amer. Assoc. of Zool. Parks and Aquariums Regional Conf. Proc. 1981.

Appleberry, E. L. 1949. Field notes and news. Chat 13: 77.

Armistead, H. T. 1974. Lower Chesapeake heronries of Maryland, Smith Island to Barren Island. Maryland Bird Life 30: 9-27.

Armstrong, E. A. 1955. The wren. Collins, London.

Arnow, I. F. 1906. The seaside sparrow nesting in bushes. Auk 23: 226.

Artmann, J. W., and E. M. Martin. 1975. Incidence of ingested lead shot in sora rails. J. Wildl. Manage. 39: 514-519.

Audubon, J. J. 1831. Ornithological Biography, Vol. 1. Adams and Charles Black, Edinburgh. 512 pp.

Audubon, J. J. 1838. Ornithological biography, Vol. 4. Adams and Charles Black, Edinburgh. 618 pp.

Audubon, J. J. 1849 [i.e. 1839]. Ornithological Biography, Vol. 5. Adam and Charles Black, Edinburgh. 664 pp.

Audubon, J. J. 1967. The birds of America, Vol. VI. Dover Publ., Inc., New York.

Audubon, J. J. 1967. The Birds of America, Vol. III. Dover Publications, Inc., New York. 233 pp.

Austin, O. L., Jr. 1966. Banding seaside sparrows in South Carolina. EBBA News 29(3): 112.

Austin, O. L., Jr. 1968. Smyrna seaside sparrow. Pages 835-838 *in* Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and allies. A. C. Bent (O. L. Austin, Jr., Ed.). U. S. Nat. Bull. 237. Washington, D. C. 1,889 pp.

Austin, O. L., Jr. 1968. Seaside sparrow: eastern Gulf Coast subspecies. Pages 838-840 *in* Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and allies, (A. C. Bent, Ed.). U. S. Nat. Mus. Bull. 237. Washington, D. C. 1,889 pp.

Austin, O. L., Jr. 1983. The seaside sparrow assemblage: a review of its history and biology. Pages 13-17 *in* The seaside sparrow, its biology and management (Quay, T. L., J. B. Funderburg, Jr., D. S. Lee, R. F. Potter, and C. S. Robbins, Eds.). Occ. Paps. North Carolina Biol. Survey 5.

Bagg, A. C., and S. A. Elliot. 1937. Birds of the Connecticut Valley in Massachusetts. Hampshire Bookshop, Northampton, Mass. 813 pp.

Bailey, H. H. 1913. The Birds of Virginia. J. P. Bell Co., Inc., Lynchburg, Va. 362 pp.

Bailey, H. H. 1925. The Birds of Florida. Williams and Wilkins Co., Inc. Baltimore, Md. 146 pp.

Bailey, H. H. 1931. A new seaside sparrow from Florida. Bull. No. 7. Bailey Mus. Nat. Hist., Miami, Fla. 1 p.

Bailey, H. H. 1936. Notes on the Atlantic Coast seaside sparrow *Thryospiza maritima*, and the eastern song sparrow *Melospiza melodia* groups, with a new subspecies. Bull. No. 11. Bailey Mus. Nat. Hist., Miami, Fla. 6 p.

Bailey, W. 1955. Birds in Massachusetts. The College Press, South Lancaster, Mass. 234 pp.

Bain, F. 1885. A blue heron's meal. Auk 2: 21.

Baird, S. F., T. M. Brewer, and R. Ridgway. 1874. North American Birds, Vol. 3: Land Birds. Little, Brown and Company. 560 pp.

Baird, S. F., and R. Ridgway. 1873. On some new forms of American birds. Bull. of the Essex Institute (Salem, Mass.) 5(12): 197-201.

Baker, B. W. 1940. Some observations of the least bittern. Jack-Pine Warbler 18: 113-114.

Baker, J. L. 1973. Preliminary studies of the dusky seaside sparrow on the St. John's National Wildlife Refuge. Proc. Conf. Southeastern Assoc. Game and Fish Commissions 27: 207-214.

Baker, J. L. 1978. Status of the dusky seaside sparrow. Georgia Dept. Nat. Res. Tech. Bull., pp. 94-99.

Baker, J. L., H. W. Kale II, and L. E. Williams. 1979. Dusky seaside sparrow recovery plan. Dusky Seaside Sparrow Recovery Team, U. S. Fish and Wildlife Serv. 15 pp.

Baker, R. H. 1940. Crow depredations on heron nesting colonies. Wilson Bull. 52: 124-125.

Balfour, E. 1957. Observations on the breeding biology of the hen harrier in Orkney. Bird Notes 27: 177-183, 216-224.

Balfour, E. 1962. The nest and eggs of the hen harrier in Orkney. Bird Notes 30: 69-73.

Bancroft, G. T. 1983. Reproductive tactics of the sexually dimorphic boat-tailed grackle (Aves.). Unpublished Ph.D. dissertation, Univ. South Florida, Tampa.

Bancroft, G. T. 1984. Growth and sexual dimorphism of the boat-tailed grackle. Condor 86: 423-432.

Bancroft, G. T. 1984. Patterns and variation in size of boat-tailed grackle eggs. Ibis 126: 496-509.

Bancroft, G. T. 1985. Nutrient content of eggs and the energetics of clutch formation in the boat-tailed grackle. Auk 102: 43-48.

Bancroft, G. T. 1985. The influence of total nest failures and partial losses on the evolution of asynchronous hatching. Am. Nat. 126(4): 495-504.

Bancroft, G. T. 1986. Nesting success and mortality of the boat-tailed grackle. Auk 103: 86-99.

Bancroft, G. T. 1987. Mating systems and nesting phenology of boat-tailed grackles. Florida Field Nat. 15: 1-18.

Banks, R. C., and R. E. Tomlinson. 1974. Taxonomic status of certain clapper rails of southwestern United States and northwestern Mexico. Wilson Bull. 86: 325-335.

Barclay, R. M. R., M. L. Leonard, and G. Friesen. 1985. Nocturnal singing by marsh wrens. Condor 87: 418-422.

Barger, N. R. 1958. Sora rail. Wisconsin Conservation Bull. 23: 35.

Barker, S. H. 1901. Does the green heron fish in deep water? Bird-lore 3: 141.

Bart, J., A. Stehn, J. A. Herrick, N. A. Heaslip, T. A. Bookout, and J. R. Stenzel. 1984. Survey methods for breeding yellow rails. J. Wildl. Manage. 48:1382-1386.

Bartholomew, G. A., Jr., and W. R. Dawson. 1954. Temperature regulation in young pelicans, herons, and gulls. Ecology 35: 466-472.

Bass, O. L., Jr., and J. A. Kushlan. 1982. Status of the Cape Sable sparrow. Nat. Park Serv., South Florida Res.Center Rept. T-672. 41 pp.

Bateman, D. 1970. Movement behavior in three species of colonial-nesting wading birds: a radio-telemetry study. Unpublished Ph.D. dissertation., Auburn University, Auburn, Alabama.

Bateman, H. A. 1965. Clapper rail *Rallus longirostris* studies on Grand Terre Island, Jefferson Parish, Louisiana. M.S. Thesis. Louisiana State University, Baton Rouge. 145pp.

Bates, R. S. P. 1943. A note on the feeding habits of the least bittern, *Ixobrychus minutus*. J. Bombay Nat. Hist. Soc. 44: 179-182.

Bayer, R. D. 1978. Aspects of an Oregon estuarine great blue heron population. Pages 213-217 *in* Wading birds (A. Sprunt, IV, J. C. Ogden, and S. Winckler, Eds.). Natl. Audubon Soc. Res. Rept. No. 7, New York.

Bayer, R. D. 1979. Bald eagle - great blue heron interactions. Murrelet 60: 32-33.

Bayer, R. D. 1979. Great blue heron attacks horned grebe. Bird-Banding 50: 264-265.

Bayer, R. D. 1981. Arrival and departure of great blue herons at two estuarine colonies. Auk 98: 589-593.

Bayer, R. D. 1981. Regional variation of great blue heron longevity. J. Field Ornith. 52: 210-213.

Bayer, R. D. 1981. Weights of great blue herons at the Yaquina estuary, Oregon. Murrelet 62: 18-19.

Bayer, R. D. 1982. Great blue heron eggshell thickness at Oregon estuaries. Wilson Bull. 94: 198-201.

Bayer, R. D. 1982. How important are bird colonies as information centers? Auk 99: 31-40.

Bayer, R. D. 1985. Bill length of herons and egrets as an estimator of prey size. Colon. Waterbirds 8: 104-109.

Bayer, R. D. 1985. Interactions between great blue herons and gulls. Wilson Bull. 97: 538-541.

Bayer, R. D. 1989. Great blue heron killed by striking an overhead power line at Coos Bay, Oregon. Oregon Birds 15: 197-198.

Baynard, O. E. 1912. Food of herons and ibises. Wilson Bull. 24: 167,169.

Baynard, O. E. 1914. The dusky seaside sparrow. Oologist 31: 130-134.

Baynard, O. E. 1932. The first eggs of Scott's seaside sparrow. Auk 49: 97-98.

Bazuin, J.B., Jr. 1991. Northern harrier. Pages 496-497 *in* Virginia's endangered species (Terwilliger, K., coord.). The McDonald and Woodward Publishing Company, Blacksburg, Virginia.

Beaver, D. L., G. Osborn, and T. W. Custer. 1980. Nest-site and colony characteristics of wading birds in selected Atlantic coast colonies. Wilson Bull. 92: 200-220.

Beckett, T. 1969. MacGillivray's seaside sparrow, *in* Briefs for the files (James F. Parnell, Ed.). Chat 33:107.

Bedell, P. A. 1987. Early fall migration of sedge wrens. Nebraska Bird Rev. 55: 86-88.

Beecher, W. J. 1955. Late Pleistocene isolation of salt marsh sparrows. Ecology 36: 23-28.

Beetham, B. 1910. The home-life of the spoonbill, the stork and some herons. Witherby and Co., London.

Bell, G. W., S. J. Hejl, and J. Verner. 1990. Proportional use of substrates by foraging birds: model considerations on first sightings and subsequent observations, *in* Stud. Avian Biol. 13 (Morrison, M. L., et al. (Eds.).

Bennett, D. 1971. Salt marshes: fish and man. Proc. N. J. Mosq. Exterm. Assoc. 58: 159-161.

Bent, A. C. 1926. Life histories of North American marsh birds. U. S. Natl. Mus. Bull. 135.

Bent, A. C. 1948. Life histories of North American nuthatches, wrens, thrashers, and their allies. U. S. Nat. Mus. Bull. 195.

Bent, A. C. 1958. Life histories of North American blackbirds, orioles, tanagers, and allies. U. S. Nat. Mus. Bull. 211.

Bent, A. C., and M. Copeland. 1927. Notes on Florida Birds. Auk 44: 371-376.

Berger, A. J. 1951. Nesting density of Virginia and sora rails in Michigan. Condor 53: 202.

Bildstein, K. L. 1979. Behavior of northern harriers on the day of nest abandonment. Inland Bird Banding 51(4): 63-65.

Bildstein, K. L. 1988. Northern harrier. Pages 251-303 *in* Handbook of North American birds, vol. 4 (R. Palmer, Ed.). Yale Univ. Press, New Haven.

Bildstein, K. L., R. L. Christy, and P. DeCoursey. 1982. Energy flow through a South Carolina salt-marsh shorebird community. Wader Study Group Bull. 34: 35-37.

Billard, R. S. 1947. An ecological study of the Virginia rail *Rallus limicola* and the sora *Porzana carolina* in some Connecticut swamps. M. S. Thesis, Iowa State College, Ames. 84pp.

Birkhead, T. R. 1973. Observations at a standing-ground adjoining a heronry. Naturalist 924: 13-19.

Bishop, R. A. 1981. Iowa's wetlands. Proc. Iowa Acad. Sci. 88: 11-16.

Bjorklund, R. G. 1975. On the death of a mid-western heronry. Wilson Bull. 87: 284-287.

Black, B. B., and M. W. Collopy. 1983. Nocturnal activity of great blue herons in a north Florida saltmarsh. J. Field Ornithol. 53: 403-406.

Blair, C. 1989. Comparitive bird counts in natural and man-made wetlands in Norfolk, Virginia. The Raven 59: 3-9.

Blandin, W. W. 1963. Renesting and multiple brooding studies of marked clapper rails. Proceedings Annual Conference Southeastern Association Game and Fish Commissions 17: 60-68.

Blus, L. J., and C. Henny. 1981. Suspected great blue heron population decline after a severe winter in the Columbian Basin. Murrelet 62: 16-18.

Blus, L. J., C. J. Henny, and T. E. Kaiser. 1980. Pollution ecology of breeding great blue herons in the Columbia Basin, Oregon and Washington. Murrelet 61: 63-71.

Blus, L. J., S. N. Wiemeyer, J. A. Kerwin, R. C. Stendall, H. M. Ohlendorf, and L. F. Stickel. 1977. Impact of estuarine pollution on birds. Pages 57-71 *in* Proc. Estuary Pollution Control Assessment Conference (R. Johnson, Ed.). Vol. 1. Washington, D.C., Government Printing Office.

Bock, W. and J. Terborgh. 1957. Breeding of the glossy ibis in Virginia. Bird-Banding 28: 98.

Boeker, H. M. 1954. Wilson's snipe and sora rail in Yampa River Valley, Colorado. Pages 67-68 *in* Investigations of Woodcock, Snipe and Rails in 1953. U. S. Dept. Interior, Fish and Wildl. Serv. Spec. Sci. Rep. Wildl. 24.

Bookhout, T. A., and J. R. Stenzel. 1988. Habitats and movements of breeding yellow rails. Wilson Bull. 99: 441-447.

Borrer, D. J., and C. R. Reese. 1954. Analytical studies of the Henslow's sparrow songs. Wilson Bull. 66: 243-252.

Bourn, W. S., and C. Cottam. 1950. Some biological effects of ditching tidewater marshes. Res. Rept. 19, Fish and Wildl. Serv., U. S. Dept. of Interior.

Bovino, R. R., and E. H. Burrt, Jr. 1979. Weather dependent foraging of great blue herons *Ardea herodias*. Auk 96: 628-630.

Bowman, R., and G. T. Bancroft. 1989. Least bittern nesting on mangrove keys in Florida Bay. Florida Field Nat. 17: 43-46.

Bradshaw, D.S. 1991. Great egret. Pages 489-491 *in* Virginia's endangered species (Terwilliger, K., coord.). The McDonald and Woodward Publishing Company, Blacksburg, Virginia.

Brandman, M. 1976. A quantitative analysis of the annual cycle of behavior in the great blue heron, *Ardea herodias*. Unpubl. Ph.D. dissertation, Univ. of California, Los Angeles.

Bray, M. P. 1984. An evaluation of heron and egret marsh nesting habitat and possible effects of burning. Murrelet 65: 57-59.

Breckenridge, W. J. An ecological study of the marsh hawks (*Circus hudsonius* L.) of a Minnesota sand plain community. M. S. Thesis, Univ. Minn. 85 pp.

Brewer, T. M. 1874. Breeding grounds of the sora rail. American Sportsman 4:339.

Brewster, W. 1890. The Acadian sharp-tailed sparrow and Scott's seaside sparrow on the coast of South Carolina. Auk 7: 212.

Brewster, W. 1902. Voices of a New England marsh. Bird Lore 4: 43-56.

Britton, R. H., and M. E. Moser. 1982. Size specific predation by herons and its effect on the sex ratio of natural populations of the mosquito fish *Gambusia affinis* (Baird and Girard). Oecologia 53: 146-151.

Brown, J. L. and G. H. Orians. 1970. Spacing patterns in mobile animals. Ann. Rev. Ecol. and Syst. 1: 239-262.

Brown, M., and J. J. Dinsmore. 1986. Implications of marsh size and isolation for marsh bird management. J. Wildl. Mgmt. 50: 392-397.

Buckley, P. A. and F. G. Buckley. 1968. Tongue-flicking by a feeding snowy egret. Auk 85: 678.

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

Buckley, P. A., M. Gochfeld, and F. G. Buckley. 1977. Efficacy and timing of aerial censuses of some colonial waterbirds on Long Island, N. Y.: a preliminary analysis. Colonial Waterbird Group 2: 48-61.

Bull, J. 1964. Birds of the New York area. Harper and Row, N.Y. 540 pp.

Bull, J. 1974. Birds of New York state. Doubleday/Natural History Press, Garden City, N.Y. 655 pp.

Burger, J. 1978. The pattern and mechanism of nesting in mixed-species heronries. Pages 45-58 *in* Wading birds (A. Sprunt, IV, J. C. Ogden, and S. Winckler, Eds.). Natl. Audubon Soc. Res. Rept. No. 7., New York.

Burger, J. 1981. A model for the evolution of mixed-species colonies of ciconiiformes. Quart. Rev. Biol. 56: 143-167.

Burger, J. 1985. Habitat selection in temperate marsh-nesting birds. Pages 253-281 *in* Habitat selection in birds (M. L. Cody, Ed.). Academic Press, Inc., New York.

Burger, J. and L.M. Miller. 1977. Colony and nest site selection in white-faced and glossy ibises. Auk 94: 664-676.

Burger, J., and J. Shisler. 1978. Nest-site selection of willets in a New Jersey marsh. Wilson Bull. 90: 599-607.

Burke, C. J. 1979. Effect of prey and land use on mating systems of harriers. M. S. Thesis, Univ. Wisconsis, Stevens Point. 46 pp.

Burleigh, T. D. 1937. Birdlife of the North Carolina coast. Auk 54: 453-460.

Burleigh, T. D. 1944. The bird life on the Gulf Coast region of Mississippi. Occas. Pap. Mus. Zool. Lousiana State Univ. 20:324-490.

Burleigh, T. D. 1958. Georgia Birds. Univ. Oklahoma Press, Norman, Oklahoma. 746 pp.

Burns, J. T. 1977. Social organization of the short-billed marsh wrens. M. S. thesis, Univ. Minnesota, Minneapolis, Minnesota.

Burns, J. T. 1982. Nests, territories, and reproduction of sedge wrens *Cistothorus platensis.* Wilson Bull. 94: 338-349.

Burt, De V. E. 1970. Habitat selection and species interactions of some marsh passerines. M. Sc. thesis, Iowa State Univ., Ames.

Burtch, V. 1917. The summer life of the Virginia rail. Bird-Lore 19:243-248.

Burton, J. F. 1956. Report on the national census of heronries, 1954. Bird Study 3: 42-73.

Butler, R. W. 1989. Breeding ecology and population trends of the great blue heron *Ardea herodias fannini* in the Strait of Georgia. Pages 112-117 *in* The ecology and status of marine and shoreline birds in the Strait of Georgia, British Columbia (Vermeer, K., and R. W. Butler, Eds.). Ottawa, ON, Can. 186 pp.

Byers, E. 1951. Feeding behavior of young American bitterns. Wilson Bull. 63: 334-336.

Byrd, M. A. 1978. Dispersal and movements of six North American Ciconiiformes. Pages 161-183 *in* Wading birds (A. Sprunt, IV, J. C. Ogden, and S. Winckler, Eds.). Natl. Audubon Soc., New York, New York.

Byrd, M.A. 1991. Glossy ibis. Pages 495-496 *in* Virginia's endangered species (Terwilliger, K., coord.). The McDonald and Woodward Publishing Company, Blacksburg, Virginia.

Caldwell, G. 1979. Social dynamics of foraging herons and egrets in tropical mixed flocks. Unpublished Ph.D. dissertation, Univ. California, Berkeley.

Caldwell, G. 1981. Attraction to tropical mixed-species heron flocks: proximate mechanisms and consequences. Behav. Ecol. Sociobiol. 8: 99-104.

California Department of Fish and Game. 1984. Upper Newport Bay management plan. Calif. Dept. Fish and Game, Long Beach, CA.

Callin, E. M. 1968. Vocalization of the Virginia rail: a mystery solved. Blue Jay 26: 75-77.

Campbell, E. G., and G. A. Wolf. 1977. Great egret predation on a Virginia rail. West. Birds 8: 64.

Canfield, R. 1941. Application of the line interception method in sampling range vegetation. J. Forestry 39: 388-394.

Cannell, P. F., and B. A. Harrington. 1984. Interspecific egg dumping by a great egret and black-crowned night herons. Auk 101: 889-890.

Carleton, G. 1958. The birds of Central and Prospect Parks. Pages 1-60 *in* Proc. Linnaean Soc. New York 66-70.

Carter, J. H., III, and J. F. Parnell. 1976. T.V. tower kills in eastern North Carolina. Chat 40:1-9.

Chabreck, R. H. 1988. Coastal marshes: ecology and wildlife management. Univ. Minn. Press., Minneapolis, Minn. 138 pp.

Chamberlain, W. D. 1978. The birds of Turtle Island, S.C. Chat 42: 3-7.

Chandler, W. J. 1985. Migratory bird protection and management. Pages 26-71 *in* Audubon wildl. report 1985 (R. L. DiSilvestro, Ed.). National Audubon Society, New York, New York.

Chapman, B. R., and R. J. Howard. 1984. Habitat suitability models: Great egret. U.S. Fish and Wildlife Service FWS/OBS - 82/10.78. Washington, DC.

Chapman, F. M. 1898. Notes on the black seaside finch *Ammodramus nigrescens*. Auk 15: 270.

Chapman, F. M. 1899. The distribution and relationships of *Ammodramus maritimus* and its allies. Auk 16: 1-12.

Chapman, F. M. 1910. Notes of the plumage of North American sparrows (Third paper). Bird-Lore 12: 113-114.

Chapman, F. M. 1927. Handbook of birds of eastern North America (rev. ed.), D. Appleton and Co., New York. 530 pp.

Choate, E. A., and J. d'Arcy Northwood. 1969. Forty years of Christmas bird counts in Cape May County [N.J.]. Cassinia 51:3-10.

Christmas, G. M. 1957. Some interspecific relations in the feeding of estuarine birds. Condor 59: 343.

Christy, R. L., K. L. Bildstein, and P. D. Coursey. 1981. A preliminary analysis of energy flow in a South Carolina salt marsh: wading birds. Colon. Waterbirds 4: 96-103.

Chubb, K. 1986. Great blue heron swallows a branch. Ontario Birds 4: 72-77.

Clark, G. A., Jr. 1969. Spread-wing postures in pelecaniformes, ciconiiformes, and falconiformes. Auk 86: 136-139.

Clark-Kennedy, A. J. 1875. The heron preying on birds. Zoologist 10: 4340.

Cody, M. L. 1968. On the methods of resource division in grassland bird communities. Amer. Nat. 102: 107-147.

Cody, M. L. 1974. Competition and the structure of bird communities. Monographs in Population Biology No. 7, Princeton Univ. Press, Princeton, New Jersey.

Coffey, W. 1966. Colonial nesting of the green heron. Migrant 37: 75.

Collazo, J. A. 1979. Breeding biology and food habits of the great blue heron at Heyburn State Park, Benewah County, Idaho. Unpubl. M. S. thesis, Univ. Idaho, Moscow.

Collazo, J. A. 1981. Some aspects of the breeding ecology of the great blue heron at Heyburn State Park. Northwest Science 55(4): 293-297.

Collopy, M. W. and K. L. Bildstein. 1987. Foraging behavior of northern harriers wintering in southeastern salt and freshwater marshes. Auk 104: 11-16.

Committee on Rare and Endangered Wildlife Species. 1966. Rare and endangered fish and wildlife of the United States. Res. Publ. 34.

Cooke, W. W. 1881. The least bittern in northwestern Minnesota. Bull. Nuttall Ornithol. Club 6:186.

Cooke, W. W. 1910. The migration of North American sparrows. Bird-Lore 12: 111-112.

Cooke, W. W. 1913. Distribution and migration of North American herons and their allies. U.S. Biol. Serv. Bull. 45.

Cooke, W. W. 1914. Distribution and migration of North American rails and their allies. U.S.D.A. Bull. No. 128.

Cooley, E. G. 1942. The nesting of a pair of green herons. Jack-Pine Warbler 20:3-9.

Cooper, A. W. 1983. The salt marsh ecosystem. Pages 7-12 *in* The seaside sparrow, its biology and management (Quay, T. L., J. B. Funderburg, Jr., D. S. Lee, R. F. Potter, and C. S. Robbins, Eds.). Occ. Paps. North Carolina Biol. Survey 5.

Cottam, C. 1938. A fatal combat between heron and snake. Wilson Bull. 50: 140.

Cottrille, W. P., and B. D. Cottrille. 1958. Great blue herons: behavior at the nest. Univ. Michigan Misc. Publ. Mus. Zool. 102: 1-15.

Craig, R. J. 1990. Historic trends in the distribution and populations of estuarine marsh birds of the Connecticut River. Connecticut (Storrs) Agric. Exp. Stn. Res. Rep. 83, 38pp.

Craighead, J. J., and F. C. Craighead. 1956. Hawks, owls, and wildlife. Stackpole Co., Harrisburg, Pennsylvania.

Crawford, R. D. 1977. Polygynous breeding of short-billed marsh wrens. Auk 94: 359-362.

Crawford, R. L., S. L. Olson, and W. K. Taylor. 1983. Winter distribution of subspecies of clapper rail *Rallus longirostris* in Florida with evidence for long-distance and overland movements. Auk 100: 198-200.

Cronin, L.E. and A.J. Mansueti. 1971. The biology of the estuary. *In* A symposium of the biological significance of estuaries. Sport Fishing Institute, Washington.

Cruickshank, A. D. 1942. Birds around New York City: Where and when to find them. Handbook Ser. No. 13, Amer. Mus. Nat. Hist., New York. 489 pp.

Curran, C. H. 1947. Speed of a great blue heron. Auk 64: 309.

Curry-Lindahl, K. 1970. Spread-wing postures in pelecaniformes and ciconiiformes. Auk 87: 371-372.

Curry, R., and G. D. Bryant. 1987. Snowy egret: a new breeding species for Ontario and Canada. Ontario Birds 5: 64-67.

Curry-Lindahl, K. 1971. Systematic relationship in herons (*Ardeidae*) based on comparative studies of behaviour and ecology, a preliminary account. Ostrict Suppl. 9: 53-70.

Custer, T. W., and P. C. Frederick. 1990. Egg size and laying order of snowy egrets, great egrets, and black-crowned night herons. Condor 92: 772-775.

Custer, T. W., and R. G. Osborn. 1977. Wading birds as biological indicators: 1975 colony survey. U. S. Fish Wildl. Serv. Spec. Sci. Rep. Wildl. 206. 28 pp.

Custer, T. W., and R. G. Osborn. 1978. Feeding habitat use by colonially breeding herons, egrets, and ibises in North Carolina. Auk 95: 733-743.

Custer, T. W., and R. G. Osborn. 1978. Feeding-site description of three heron species near Beaufort, North Carolina. Pages 355-360 *in* Wading birds (A. Sprunt, IV, J. C. Ogden, and S. Winckler, Eds.). Natl. Audubon Soc. Res. Rept. No. 7., New York.

Cutts, E. 1960. Seaside sparrow, *in* Briefs for the Files, B. R. Chamberlain, Ed. Chat 24:105.

Cypert, E. 1958. The relation of water level to populations of common egrets in the Okefenokee Swamp. Oriole 13: 9.

Cyr, A. 1981. Limitation and variability in hearing ability in censusing birds. Pages 327-333 *in* Estimating numbers of terrestrial birds (C. J. Ralph and J. M. Scott, Eds.). Stud. Avian Biol. 6. Allen Press, Inc., Lawrence, Kansas.

Daiber, F. C. 1974. Salt marsh plants and future coastal salt marshes in relation to animals. Pages 475-508 *in* Ecology of the halophytes (R. J. Reimold and W. H. Queens, Eds.). Academic Press, Inc., New York.

David, S., and M. Berrill. 1987. Siblicidal attacks by great blue heron *Ardea herodias* chicks in a southern Ontario heronry. Can. Field-Nat. 101: 105-107.

Davidson, F. S. 1944. Nesting of the least bittern. Flicker 16: 19-21.

Davidson, N. C., and P. R. Evans. 1986. The role and potential of man-made and man-modified wetlands in the enhancement of the survival of over-wintering shorebirds. Colon. Waterbirds 9: 176-188.

Davis, W. E., Jr. 1986. Effects of old nests on nest-site selection in black-crowned night herons and snowy egrets. Wilson Bull. 98(2):300-303.

Davis, W. E., Jr., and K. C. Parsons. 1982. The Clark's Island heronry. Bird Observer of Eastern Mass. 10: 125-131.

Day, H.F., III. 1991. Sedge wren. Pages 517-518 *in* Virginia's endangered species (Terwilliger, K., coord.). The McDonald and Woodward Publishing Company, Blacksburg, Virginia.

Degen, T., and L. Jenni. 1990. Habitat use by passerines in a small marsh and surrounding farmland during autumn. Ornith. Beob. 87: 295-325.

Degner, E. 1963. The sad tale of the rails. Passenger Pigeon 25:107.

DeGroot, D. S. 1927. The California clapper rail, its nesting habits, enemies and habitat. Condor 29: 259-270.

Delany, M. F., W. P. Leenhouts, B. Sauselein, and H. W. Kale, III. 1981. The 1980 dusky seaside sparrow survey. Florida Field Nat. 9(4): 64-67.

Delany, M. F., and J. A. Mosher. 1983. Habitat partitioning by seaside and song sparrows. Pages 49-53 *in* The seaside sparrow, its biology and management (Quay, T. L., J. B. Funderburg, Jr., D. S. Lee, R. F. Potter, and C. S. Robbins, Eds.). Occ. Paps. North Carolina Biol. Survey 5.

Delany, M. F., and A. R. Woodward. 1988. Great blue herons trapped in algae. Florida Field Nat. 16: 96.

Dennis, C. J. 1971. Observations on the feeding behavior of the great blue heron. Passenger Pigeon 33: 166-172.

DeRagon, W. R. 1988. Breeding ecology of the seaside and sharp-tailed sparrows in Rhode Island salt marshes. M. S. thesis, Univ. Rhode Island, Kingston, Rhode Island.

DesGranges, J-L. 1979. Adaptive value of social behaviour in the great blue heron, *Ardea herodias*. Proc. of Colonial Waterbird Group, 1978. Vol 2: 192-201.

DesGranges, J-L. 1980. A Canadian program for surveillance of great blue heron *Ardea herodias* populations. Proceedings of the Conference of the Colonial Waterbird Group, 1979. Vol 3: 59-68.

DesGranges, J-L., and P. Laporte. 1979. Second tour of inspection of Quebec heronries, 1978. Can. Wildl. Serv. Progress Note No. 105.

DesGranges, J-L., and P. Laporte. 1981. Third tour of inspection of Quebec heronries. Can. Wildl. Serv. Progress Notes No. 123. 10 pp.

DesGranges, J-L., and P. Laporte. 1983. Fourth and fifth tours of inspection of Quebec heronries., 1980-81. Canadian Wildlife Service Progress Note 139: 1-11.

DesGranges, J-L., P. Laporte, and G. Chapdelaine. 1979. First tour of inspection of Quebec heronries, 1977. Can. Wildl. Serv. Progress Note No. 93.

Deubbert, H.F., and J.T. Lakemoen. 1977. Upland nesting of American bitterns, marsh hawks, and short-eared owls. Prairie Naturalist. 9: 33-40.

Devitt, O. E. 1939. The yellow rail breeding in Ontario. Auk 56: 238-243.

Dickerman, R. W. 1966. A new Virginia rail from Mexico. Condor 68: 215-216.

Dickerman, R. W., and G. Gavino T. 1969. Studies of a nesting colony of the green heron *Butorides virescens* at San Blas, Nayarit, Mexico. Living Bird 8: 95-111.

Dickerman, R. W., and K. C. Parkes. 1969. Juvenal plumage of the spotted rail *Rallus maculatus.* Wilson Bull. 81: 207-209.

Dickey, D. B. 1923. Description of a new clapper rail from the Colorado River valley. Auk 40: 90-94.

Dickinson, J. C. 1947. Unusual feeding habits of certain herons. Auk 64: 306-307.

Dietrich, A. L. 1938. Observations of birds seen in south Florida. Florida Nat. 11: 101.

Dillon, S. T. 1959. Breeding of the least bittern in Manitoba. Auk 76: 524-525.

Dowd, E. M., and L. D. Flake. 1984. Great blue heron nesting biology on the James River in South Dakota. Prairie Nat. 16: 159-166.

Dowd, E. M., and L. D. Flake. 1985. Arrival and departure patterns of great blue herons at a South Dakota colony. Wilson Bull. 97: 374-378.

Drycz, A. 1988. Mating systems in European marsh-nesting Passeriformes. Proc. Int. Ornithol. Congr. 19: 2613-2623.

Duffield, J. M. 1986. Waterbird use of an urban stormwater wetland system in central California, USA. Colon. Waterbirds 9: 227-235.

DuMont, P. A. 1931. Summary of bird notes from Pinellas County, Florida. Auk 48:246-255.

Dunham, M. L. 1988. Habitat quality, nest density and reproductive success in female boat-tailed grackles. M. S. thesis, Univ. of South Florida, Tampa, Florida.

Dunham, M. L. 1990. Nest-site selection by boat-tailed grackles. Wilson Bull. 102: 702-706.

Dunn, E. H., D. J. T. Hussell, and J. Siderius. 1985. Status of the great blue heron, *Ardea herodius*, in Ontario. Can. Field-Nat. 99: 62-70.

Dusi, J. L. 1966. The identification and characteristics of nests, eggs, and nestlings of some herons, ibises, and anhingas. Alabama Birdlife 14: 2-8.

Dusi, J. L. 1985. Use of sounds and decoys to attract herons to a colony site. Colon. Waterbirds 8: 178-180.

Dusi, J. L., and R. T. Dusi. 1968. Ecological factors contributing to nesting failure in a heron colony. Wilson Bull. 80: 458-466.

Dusi, J. L., and R. T. Dusi. 1987. A thirty-four year summary of the status of heron colony sites in the coastal plain of Alabama, USA. Colon. Waterbirds 10: 27-37.

Dusi, J. L., R. T. Dusi, D. L. Bateman, C. A. McDonald, J. J. Stuart, and J. F. Dismukes. 1971. Ecological impacts of wading birds on the aquatic environment. Water Resour. Inst., Bull. No. 5.

Duvall, A. J. 1937. Birds observed on the coast of Virginia and North Carolina. Auk 54: 461-463.

Dwight, J., Jr. 1898. The sharp-tailed sparrow, *Ammodramus caudacutus*, and its geographical races. Auk 13:271-278.

Dwight, J., Jr. 1900. The sequences of plumages and moults of the passerine birds of New York. Ann. New York Acad. Sci. 13: 73-760.

Dwyer, M. W. 1988. Breeding biology of the great egret in Sedgwick Co., Kansas. Kansas Ornithol. Soc. Bull. 39: 21-26.

Eastwood, S. K. 1932. Notes on the feeding of the least bittern. Wilson Bull. 44: 20.

Eberhart, J. 1968. The dwindling Dusky. Sci. News 93: 501-502.

Eddleman, W. R., F. L. Knopf, B. Meanley, F. A. Reid, and R. Zembal. 1988. Conservation of North American rallidae. Wilson Bull. 100: 458-475.

Edford, L. H. 1976. Breeding biology of the great blue heron in southwestern Lake Erie. Unpubl. M. S. thesis. Columbus, Ohio State Univ.

Eifrig, C. W. G. 1915. Cory's least bittern in Illinois. Auk 32: 98-99.

Elliot, J. J. 1951. Notes on early least bitterns on Long Island. Proc. Linn. Soc. N. Y., 58-62: 67-68.

Elliot, J. J. 1962. Sharp-tailed and seaside sparrows on Long Island, New York. Kingbird 11:115-123.

Elliot, R. D., and R. I. G. Morrison. 1979. The incubation period of the yellow rail. Auk 96: 422-423.

Emlen, S. T., and H. W. Ambrose, III. 1970. Feeding interactions of snowy egrets and red-breasted mergansers. Auk 87: 164-165.

Enders, F. 1967. Breeding bird census: Ditched salt marsh and coastal scrub. Amer. Birds 21: 665.

Enders, F. 1970. The double-scratch in the seaside sparrow. Wilson Bull. 82:225.

Enders, F., and W. Post. 1971. White-spotting in the genus *Ammospiza* and other grassland sparrows. Bird-Banding 42: 210-219.

English, S. M. 1978. Distribution and ecology of the great blue heron colonies on the Williamette River, Oregon. Pages 235-244 *in* Wading birds (A. Sprunt, IV, J. C. Ogden, and S. Winckler, Eds.). National Audubon Soc. Res. Rept. No. 7., New York.

Environmental Protection Agency. 1982. Chesapeake Bay: introduction to an ecosystem. U.S. Environmental Protection Agency, Washington.

Erwin, R. M. 1979. Coastal waterbird communities: Cape Elizabeth, Maine to Virginia. U.S. Fish and Wildl. Serv. Biol. Serv. Program FWS/OBS-79/10.

Erwin, R. M. 1981. Censusing wading bird colonies: an update of the 'flight-line' count method. Colonial Waterbirds 4: 91-95.

Erwin, R. M. 1983. Feeding habitats of nesting wading birds: spatial use and social influences. Auk 100: 960-970.

Erwin, R. M. 1984. Feeding flights of nesting wading birds at a Virginia colony. Colonial Waterbirds 7: 74-79.

Erwin, R. M. 1985. Foraging decisions, patch use, and seasonality in egrets (Aves: Ciconiiformes). Ecology 66: 837-844.

Erwin, R. M., M. Coulter, and H. Cogswell. 1986. The use of natural vs. man-modified wetlands by shorebirds and waterbirds. Colon. Waterbirds 9: 137-138.

Erwin, R. M., and T. W. Custer. 1982. Estimating reproductive success in colonial waterbirds: an evaluation. Colonial Waterbirds 5: 49-56.

Erwin, R. M., and J. C. Ogden. 1979. Multiple-factor influences upon feeding flight rates at wading bird colonies. Proc. Colonial Waterbird Group 3: 225-234.

Evans, P. R. 1986. Use of herbicide 'Dalapon' for control of *Spartina* encroaching on intertidal mudflats: beneficial effects on shorebirds. Colon. Waterbirds 9; 171-175.

Evens, J. and G. W. Page. 1986. Predation on black rails during high tides in salt marshes. Condor 88: 107-109.

Evrard, J. O. 1985. Great blue heron killed by kite string. Passenger Pigeon 47: 90-91.

Ewan, J. 1928. California black rail in Los Angeles County. Condor 30: 247.

Eyles, D. 1938. A nesting study of the Tybee Island heronry. Oriole 3: 1-4.

Faber, R. A., R. W. Risebrough, and H. M. Pratt. 1972. Organochlorines and mercury in common egrets and great blue herons. Environ. Pollut. 3: 111-122.

Fables, D., Jr. 1955. Annotated list of New Jersey birds. Urner Orn. Club, Newark, N.J. 95 pp.

Fall, B. A., and R. D. Eliason. 1982. Henslow's sparrow nest, Hennepin, County. Loon 54: 192.

Fannucchi, W. A., G. T. Fannucchi, and L. E. Nauman. 1986. Effects of harvesting wild rice, *Zizania aquatica*, on soras, *Porzana carolina*. Can. Field-Nat. 100: 533-536.

Fargo, W. G. 1937. Snowy egret in southern Michigan. Auk 54: 200-201.

Fasola, M. 1986. Resource use of foraging herons in agricultural and nonagricultural habitats in Italy. Colonial Waterbirds 9: 139-148.

Fasola, M., and F. Barbieri. 1978. Factors affecting the distribution of heronries in northern Italy. Ibis 120: 537-540.

Faxon, W. 1897. What is *Fringilla macgillivraii* Aud.? Auk 14: 321-322.

Finney, D. (Ed.). 1980. Future of Dusky may depend on captive propogation. Endangered Species Tech. Bull. Special Rept., Vol. 5 (April):1-6. U.S. Fish and Wildl. Serv., Washington, D.C. 6 pp.

Forbes, L. S. 1986. The timing and direction of food flights from an inland great blue heronry. Can. J. Zool. 64: 667-669.

Forbes, L. S. 1987. Feeding behaviour of great blue herons at Creston, British Columbia. Can. J. Zool. 65: 3062-3067.

Forbes, L. S. 1987. Predation on adult great blue herons: is it important? Colon. Waterbirds 10: 120-122.

Forbes, L. S., and E. McCackin. 1984. Extreme aggression in great blue herons. Wilson Bull. 96: 318-319.

Forbes, L. S., et al. 1985. Reproductive success of great blue herons in British Columbia. Can. J. Zool. 63: 1110-1113.

Forbush, E. H. 1929. Birds of Massachussetts and other New England States, Part III. Mass. Dept. of Agric., Norwood Press, Norwood. 466 pp.

Forbush, E. H., and J. B. May. 1939. Natural history of the birds of eastern and central North America. Houghton Mifflin and Co., Boston. 554 pp.

Forth, C. M. 1978. A comparative analysis of the foraging behavior of two species of ardeids: *Egretta thula*, the snowy egret and *Casmerodius albus*, the great egret. Unpublished M.S. thesis, Univ. South Carolina, Columbia.

Foss, E. 1980. A black bear in a great blue heron colony. Murrelet 61: 113.

Frederick, P. C., and M. W. Collopy. 1989. Nesting success of five species of wading birds in relation to water conditions in the Florida Everglades. Auk 106: 625-634.

Frederick, P. C., and M. W. Collopy. 1989. The role in predation in determining reproductive success of colonially nesting wading birds in the Florida Everglades. Condor 91: 860-867.

Fredrickson, L. H., and F. A. Reid. 1986. Wetland and riparian habitats: a nongame management overview. Pages 59-96 *in* Management of nongame wildlife in the Midwest: a developing art (J. B. Hale, L. B. Best, and R. L. Clawson, Eds.). N. Cent. Sec. Wildl. Soc.

French, T. 1972. Clapper rail in downtown Atlanta. Oriole 37: 5-6.

Frost, A. 1936. The eastern least bittern. Univ. of New York School Bull., 22:124-125.

Fryer, R. 1939. The yellow rail in southern manitoba. Canadian Field Naturalist 51: 41-42.

Fuller, A. B. 1938. Yellow rail at Churchill, Manitoba. Auk 55: 671-672.

Fuller, D. G., and J. C. Johnson, Jr. 1981. Observations at the tri-state great blue heron nesting colony. Bull. Kansas Ornithol. Soc. 32: 21-23.

Funderburg, J. B., Jr. 1981. Ecological distribution of seaside sparrows along the Carolina coast. A re-evaluation. (Abstract). Southeastern Coastal and Estuarine Birds: A conference. Baruch Inst., Univ. South Carolina.

Funderburg, J. B., Jr., and T. L. Quay. 1959. Summer maritime birds of southeastern North Carolina. J. Elisha Mitchell Sci. Soc. 75:13-18.

Funderburg, J. B., Jr., and T. L. Quay. 1983. Distributional evolution of the seaside sparrow. Pages 19-27 *in* The seaside sparrow, its biology and management (Quay, T. L., J. B. Funderburg, Jr., D. S. Lee, R. F. Potter, and C. S. Robbins, Eds.). Occ. Paps. North Carolina Biol. Survey 5.

Funderburk, S. L., S. J. Jordan, J. A. Mihursky, and D. Riley, (Eds.). 1991. Habitat requirements for Chesapeake Bay living resources. A report for Living Resources Subcommittee, Chesapeake Bay Program. Chesapeake Research Consortium, Inc. Solomon's, Maryland.

Gabrielson, I. N. 1914. Ten days' bird study in a Nebraska swamp. Wilson Bull. 26: 51-68.

Gadgil, M. 1972. The function of communal roosts: relevance of mixed roosts. Ibis 114: 531-533.

Garson, P. J. 1980. Male behaviour and female choice: mate selection in the wren. Anim. Behav. 28: 491-502.

Gee, G. F., and T. J. Sexton. 1983. Seaside sparrow sperm preservation. Pages 163-165 in The seaside sparrow, its biology and management (Quay, T. L., J. B. Funderburg, Jr., D. S. Lee, R. F. Potter, and C. S. Robbins, Eds.). Occ. Paps. North Carolina Biol. Survey 5.

Gennely, R. E. 1964. Common egret preys on meadowlark. Condor 66: 247.

George, C. J., and A. Moore. 1990. Overwintering of the great blue heron at Collins Lake, Schenectady Co., New York. Kingbird 40: 75-82.

George, J. L. 1941. Great blue heron spearing fish. Wilson Bull. 53: 123.

Gersbacher, E. O. 1939. The heronries at Reelfoot Lake. J. Tenn. Acad. Sci. 14: 162-180.

Gibbs, J. P., S. Woodward, M. L. Hunter, and A. E. Hutchinson. 1987. Determinants of great blue heron colony distribution in coastal Maine. Auk 104: 38-47.

Gibbs, J. P., S. Woodward, M. L. Hunter, and A. E. Hutchinson. 1988. Comparison of techniques for censusing great blue heron nests. J. Field Ornithol. 59: 130-134.

Gill, R. E., Jr. 1979. Status and distribution of the California clapper rail, *Rallus longirostris obsoletus*. California Fish and Game 65: 36-49.

Gillette, D. C. 1897. Notes on the Virginia and sora rails. Oologist 14:21-23.

Gladstone, D. E. 1979. Breeding success of great egrets in New Jersey and Mexico. Amer. Midl. Naturalist 102: 368-373.

Glahn, J. F. 1974. Study of breeding rails with recorded calls in north-central Colorado. Wilson Bull. 86: 206-214.

Goering, D. K., and R. Cherry. 1971. Nesting mortality in a Texas heronry. Wilson Bull. 83: 303-305.

Gosner, K.L. 1979. A Field Guide to the Atlantic Seashore: from the Bay of Fundy to Cape Hatteras. Houghton Mifflin Company, Boston.

Graber, J. 1968. Western Henslow's sparrow. Pages 779-788 *in* Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and allies (A. C. Bent, Ed.). U.S. Nat. Bull. 237 Pt. 5.

Graber, R. R. 1955. Taxonomic and adaptive features of the juvenal plumages in North American sparrows. Ph.D. diss., Univ. Oklahoma, Norman.

Gray, G. R. 1960. Herons feed in deepwater. Fla. Nat. 32(2): 99-100.

Gray, P. A., J. W. Grier, G. D. Hamilton, and D. P. Edwards. 1980. Great blue heron colonies in northwestern Ontario. Can. Field-Natur. 94: 182-184.

Green, E. R. 1946. Birds of the lower Florida Keys. Quart. J. Florida Acad. Sci. 8: 198-265.

Greene, E. R., W. W. Griffin, E. P. Odum, H. L. Stoddard, and I. R. Tompkins. 1945. Birds of Georgia: A preliminary checklist and bibliography of Georgia Ornithology. Georgia Ornith. Soc. Occas. Pub. No. 2. Univ. Georgia Press, Athens. 111 pp.

Green, R. E., and C. J. Cadbury. 1987. Breeding waders of lowland wet grasslands. RSPB Conserv. Rev. 1: 10-13.

Greenlaw, J. S. 1983. Microgeographic distribution of breeding seaside sparrows on New York salt marshes. Pages 99-114 *in* The seaside sparrow, its biology and management (Quay, T. L., J. B. Funderburg, Jr., D. S. Lee, R. F. Potter, and C. S. Robbins, Eds.). Occ. Paps. North Carolina Biol. Survey 5: 99-114.

Greenlaw, J. S. 1988. On mating systems in passerine birds of American marshlands. Proc. Int. Ornithol. Congr. 19: 2597-2612.

Greenlaw, J. S., and W. Post. 1985. Evolution of monogamy in seaside sparrows, *Ammodramus maritimus*: tests of hypotheses. Anim. Behav. 33: 373-383.

Gretch, M. 1989. Attrition of nests from an abandoned great blue heron [colony]. Kingbird 39: 157.

Grey, J. H., Jr. 1941. The breeding birds of Pea Island [N.C.]. Chat 5:50-54.

Griese, H. J., R. A. Ryder, and C. E. Braun. 1980. Spatial and temporal distribution of rails in Colorado. Wilson Bull. 92: 96-102.

Grimes, S. A. 1936. On an unusual feeding habit of the snowy egret. Auk 53: 439.

Griscom, L. 1944. A second revision of the seaside sparrows. Occas. Pap. Mus. Zool., Louisiana State Univ., No. 19:313-328.

Griscom, L. 1948. Notes on Texas seaside sparrows. Wilson Bull. 60:103-108.

Griscom, L., and J. T. Nichols. 1920. A revision of the seaside sparrows. Abst. Proc. Linnaean Soc. New York. 32:18-30.

Griscom, L., and D. E. Snyder. 1955. The birds of Massachusetts: an annotated and revised checklist. Peabody Mus., Salem, Mass. 295 pp.

Hafner, H., P. J. Dugan, and V. Boy. 1986. Use of artificial and natural wetlands as feeding sites by little egrets *Egretta garzetta* L. in the Carmargue, southern France. Colon. Waterbirds 9: 149-154.

Hailman, J.P. 1959. Consolidation of northward extension of the glossy ibis breeding range. Bird-Banding. 30: 231-232.

Hamerstrom, F. 1969. A harrier population study. Pages 367-383 *in* Management of raptors (Hamerstrom, F. N., Jr., B. E. Harrell, and R. R. Olendorff, Eds.). Res. Rept. No 2., Raptor Research Foundation. 146 pp.

Hamerstrom, F. 1974. Raptor management. Pages 5-8 in Management of raptors (Hamerstrom, F. N., Jr., B. E. Harrell, and R. R. Olendorff, Eds.). Res. Rept. No. 2, Raptor Research Foundation. 146 pp.

Hamerstrom, F. 1979. Effect of prey on predators: voles and harriers. Auk 96: 370-374.

Hamerstrom, F. 1986. Harrier, hawk of the marshes. Smithsonian Institution Press, Washington, DC.

Hamerstrom, F., F. N. Hamerstrom, and C. J. Burke. 1985. Effects of voles on mating systems in a central Wisconsin population of harriers. Wilson Bull. 97: 332-346.

Hammond, M. C., amd C. J. Henry. 1949. Success of marsh hawk nests in North Dakota. Auk 66: 271-274.

Hancock, J. 1984. Aerial stretch display of the eastern race of the great white egret, *Egretta alba*. Ibis 126: 92-94.

Hancock, J., and H. Elliot. 1978. The herons of the world. London Editions, London.

Hancock, J., and J. A. Kushlan. 1984. The herons handbook. Harper and Row, New York.

Hands, H. M., R. D. Drobney, and M. R. Ryan. 1989. Status of the Henslow's sparrow in the northcentral United States. Missouri Coop. Fish Wildl. Unit Rep., 12 pp.

Hands, H. M., R. D. Drobney, and M. R. Ryan. 1989. Status of the black rail in the northcentral United States. Missouri Coop. Fish Wildl. Unit Rep., 11 pp.

Hands, H. M., R. D. Drobney, and M. R. Ryan. 1989. Status of the least bittern in the northcentral United States. Missouri Coop. Fish Wildl. Unit Rep., 13 pp.

Hands, H. M., R. D. Drobney, and M. R. Ryan. 1989. Status of the American bittern in the northcentral United States. Missouri Coop. Fish Wildl. Res. Unit Rep., 13 pp.

Hansen, S. C. 1984. Breeding of the least bittern in Pottawatomie County, Kansas. Kansas Ornithol. Soc. Bull. 35: 37-39.

Hanson, L. 1987. Final report on the Henslow's sparrow population in Minnesota, 1987. Unpubl. Rep. to Minn. Dep. Nat. Resour., St. Paul. 25pp.

Hanson, L. 1987. Preliminary report on the Henslow's sparrow in southeastern Minnesota. Loon 59: 121-124.

Hardy, J. W. 1983. Geographic variation in primary song of the seaside sparrow. Pages 95-98 *in* The seaside sparrow, its biology and management (Quay, T. L., J. B. Funderburg, Jr., D. S. Lee, R. F. Potter, and C. S. Robbins, Eds.). Occ. Paps. North Carolina Biol. Survey 5.

Harris, B. 1982. First confirmed nesting of the great egret in South Dakota. South Dakota Bird Notes 34: 39-40.

Harris, B. 1983. Whitewood Lake heron and ibis breeding surveys. South Dakota Bird Notes 35: 4-7.

Hawbecker, A. C. 1949. Green heron feeds on goldfish. Auk 66: 78-79

Haverschmidt, F. 1948. A feeding habitat of the snowy egret. Wilson Bull. 60: 187.

Heard, R. W. 1982. Observations on the food and food habits of clapper rails *Rallus longirostris* (Boddaert) from tidal marshes along the East and Gulf coasts of the United States. Gulf Res. Rept. 7: 125-135.

Hecht, W. R. 1951. Nesting of the marsh hawk at Delta, Manitoba. Wilson Bull. 66: 167-176.

Hedeen, S. 1967. Feeding behaviour of the great blue heron in Itasca State Park, Minnesota. Loon 39: 116-120.

Heinselman, M. L. 1965. String bogs and other patterned organic terrain near Seney, Upper Michigan. Ecology 46: 185-188.

Hellmayr, C. E. 1938. Catalogue of birds of the Americas and the adjacent islands. Field Mus. Nat. Hist. Zool. Ser., Vol. XIII, Part XI. 662 pp.

Henny, C. J., and M. R. Bethers. 1971. Population ecology of the great blue heron with special reference to western Oregon. Can. Field-Natur. 85: 205-209.

Henwood, K., and A. Fabrick. 1979. A quantitative analysis of the dawn chorus: temporal selection for communicatory optimization. Am. Nat. 114: 260-274.

Higgins, K. F., and R. O. Woodward. 1986. Comparison of wetland drainage during and after protection by 20-year easements. Prairie Natur. 18: 229-223.

Hjertaas, D. G. 1982. Great blue herons and raccoons at Nicolle Flats. Blue Jay 40: 36-41.

Hobbs, J. N. 1957. Feeding habits of some water birds. Emu 57: 216.

Hoffman, R. D. 1978. The diets of herons and egrets in southwestern Lake Erie. Pages 365-369 *in* Wading birds (A. Sprunt, IV, J. C. Ogden, and S. Winckler, Eds.). Natl. Audubon Soc., New York, New York.

Holder, G. L., M. K. Johnson, and J. L. Baker. 1980. Cattle grazing and management of dusky seaside sparrow habitat. Wildlife Soc. Bull. 8:105-109.

Holliman, D. C. 1977. Rails and gallinules. Pages 118-121 *in* Management of migratory shore and upland game birds in North America (G. C. Sanderson, Ed.). Internat. Assoc. Fish & Wildl. Agen., Washington, DC.

Holmes, R. P., III. 1965. Observations at an impounded salt marsh area. Chat 29:105-106.

Holmes, V. R., T. T. Cable, and V. Brack, Jr. 1986. Avifauna as indicators of habitat quality in some wetlands of northern Indiana. Proc. Indiana Acad. Sci. 95: 523-528.

Holt, E. G., and G. M. Sutton. 1926. Notes on birds observed in southern Florida. Ann. Carnegie Mus. 16:409-439.

Holt, S. F. 1961. Foot-stirring in the green heron. Wilson Bull. 73: 386.

Holway, D. A. 1990. Patterns of winter shorebird occurrence in a San Francisco Bay marsh. West. Birds 21: 51-64.

Hon, T. R., R. Odum, and D. P. Belcher. 1977. Results of Georgia's clapper rail banding program. Proc. Ann. Conf. S. E. Assoc. Fish Wildl. Agencies 31: 72-76.

Honda, K., et al. 1986. Distribution of heavy metals and their age related changes in the eastern great white egret, *Egretta alba modesta,* in Korea. Arch. Environ. Contam. Toxicol. 15: 185-197.

Hopkins, M. N., Jr., and C. W. Dopson, Jr. 1967. An aerial search for rookeries in south central Georgia. Oriole 32: 39-45.

Hopkins, M. N., Jr., and P. G. Murton. 1969. Rookery data from south Georgia. Oriole 34: 1-11.

Horak, G. J. 1964. A comparitive study of the Virginia and sora rails with emphasis on foods. M. S. Thesis. Iowa State University, Ames. 73pp.

Horak, G. J. 1970. A comparative study of the foods of the sora and Virginia rail. Wilson Bull. 82: 206-213.

Horn, H. S. 1966. Measurement of 'overlap' in comparitive ecological studies. Amer. Nat. 100: 419-424.

Horvath, E. G., and R. K. Moholt. 1986. Diurnal feeding cycle at an island great blue heron colony. Murrelet 67: 27-28.

Houck, W. J. 1967. A note on the food of the common or great egret. Murrelet 48: 51.

Howard, H. E. 1940. A waterhen's world. Cambridge Univ. Press, London, England.

Howe, M. A. 1974. Observations on the terrestrial wing displays of breeding willets. Wilson Bull. 86: 286-288.

Howe, M. A. 1987. Wetlands and waterbird conservation. Am. Birds 41: 204-209.

Howell, A. H. 1919. Description of a new seaside sparrow from Florida. Auk 36:86-87.

Howell, A. H. 1928. Birds of Alabama. Dept. of Game and Fisheries of Alabama, Birmingham. 384 pp.

Howell, A. H. 1932. Florida Bird Life. Florida Dept. of Game and Freshwater Fish. Coward-McCann, Inc., New York. 579 pp.

Howell, J. C., Jr. 1937. Early nesting of the Cape Sable seaside sparrow. Auk 54:102.

Hoyt, S. F. 1961. Foot stirring in the green heron. Wilson Bull. 73: 386.

Hubbard, J. P., and R. C. Banks. 1970. The types and taxa of Harold H. Bailey. Proc. Biol. Soc. Wash. 83(30):321-332.

Hunsaker, D. 1959. Stomach contents of the American egret *Casmerodius albus* in Travis County, Texas. Texas J. Sci. 11: 454.

Hunter, J. S. 1900. The bird fauna of Salt Basin, near Lincoln. Proc. Neb. Ornithol. Union 1: 28.

Hunter, L. E. 1937. Great blue heron using its beak as a spear. Wilson Bull. 49: 51-52.

Hunter, W. S., and T. L. Quay. 1953. An ecological study of the Helminth fauna of MacGillivray's seaside sparrow, *Ammospiza maritima macgillivraii* (Audubon). Amer. Midl. Natur. 50:407-413.

Hutt, A. P. 1960. Herons feeding in deep water. Fla. Nat. 33(3): 166.

Hyde, A. S. 1939. The life history of Henslow's sparrow, *Passerherbulus henslowi* (Audubon). Univ. Michigan Misc. Publ., Ann Arbor. 72pp.

Illinois Natural History Survey. 1983. The declining grassland birds. Ill. Nat. Hist. Surv. Rep. 337:1-2.

Imhof, T. A. 1941. Breeding-bird census: *Phragmites* and salt-marsh border. Bird-Lore 43(suppl.):482.

Imhof, T. A. 1976. Alabama Birds. Univ. Alabama Press, Univ. Alabama. 445 pp.

Imhof, T. A., and R. Imhof. 1940. Breeding-bird census: *Phragmites* and salt-marsh border. Bird-Lore 42(suppl.):475.

Ingersoll, A. M. 1909. The only known breeding ground of *Creciscus coturniculus*. Condor 11:123-127.

Ingram, W. M. 1941. American bittern eats garter snake. Auk 58: 253.

Itzkowitz, M. 1984. Foraging behavior of the snowy egret, *Egretta thula*. Biol. Behav. 9: 357-370.

Jackson, J. A. 1983. Adaptive response of nesting clapper rails to unusually high water. Wilson Bull. 95: 308-309.

Jackson, J. A. 1985. A mutualistic feeding association between boat-tailed grackles and pied-billed grebes. Condor 87: 147-148.

James, F. C. 1980. Miscegenation [sic] in the dusky seaside sparrow? Bioscience 30: 800-801.

Jenni, D. A. 1969. A study of the ecology of four species of herons during the breeding season at Lake Alice, Alachua County, Florida. Ecol. Monogr. 39: 245-270.

Johnson, D. H. 1980. The comparison of usage and availability measurements for evaluating resource preference. Ecology 61: 65-71.

Johnson, R. R., B. T. Brown, L. T. Haight, and J. M. Simpson. 1981. Playback recording as a special avian censusing technique. Pages 68-75 *in* Estimating numbers of terrestrial birds (C. J. Ralph and J. M. Scott, eds.). Stud. Avian Biol. 6. Allen Press, Inc., Lawrence, Kansas.

Johnson, R. R., and J. J. Dinsmore. 1985. Brood-rearing and post-breeding habitat use by Virginia Rails and soras. Wilson Bull. 97: 551-554.

Johnson, R. R., and J. J. Dinsmore. 1986. Habitat use by breeding Virginia rails and soras. J. Wildl. Manage. 50: 387-392.

Judd, S. W. 1901. The relationship of sparrows to agriculture. U.S. Dept. Agric. Biol. Surv. Bull. No. 15. 98 pp.

Kahl, P. M. 1963. Mortality of common egrets and other herons. Auk 80: 295-300.

Kain, T. (Ed.). 1987. Virginia's birdlife: An annotated checklist. Virginia Avifauna 3, Virginia Society of Ornithology.

Kaiser, M. S., and E. K. Fritzell. 1984. Effects of river recreationists on green-backed heron behavior. J. Wildlife Mgmt. 48: 561-567.

Kaiser, M. S., and F. A. Reid. 1987. A comparison of green-backed heron nesting in two freshwater ecosystems. Colon. Waterbirds 10: 78-83.

Kale, H. W., II. 1965. Ecology and bioenergetics of the long-billed marsh wren *Telmatodytes palustris griseus* (Brewster) in Georgia salt marshes. Publ. Nuttall Ornithol. Club No. 5.

Kale, H. W., II. 1965. Nesting predations by herons in a Georgia rookery. Oriole 39: 69-70.

Kale, H. W., II. 1977. Endangered species: dusky seaside sparrow. Florida Nat. 50: 16-21.

Kale, H. W., II (Ed). 1978. Rare and endangered biota of Florida, Vol. 2: Birds. Florida Game and Freshwater Fish Commission. Univ. Press of Florida, Gainesville. 121 pp.

Kale, H. W., II. 1981. Dusky seaside sparrow - gone forever? Florida Nat. 54(4):3-4.

Kale, H. W. II. 1983. Distribution, habitat, and status of breeding seaside sparrows in Florida. Pages 41-48 *in* The seaside sparrow, its biology and management (Quay, T. L., J. B. Funderburg, Jr., D. S. Lee, R. F. Potter, and C. S. Robbins, Eds.). Occ. Paps. North Carolina Biol. Survey. 5.

Kale, H. W., II, and V. Pantelidis. 1968. Seaside and sharp-tailed sparrows wintering at Fort Pierce Inlet. Florida Nat. 41: 36.

Kaufmann, G. W. 1971. Behavior and ecology of the sora (*Porzana carolina*) and Virginia rail (*Rallus limicola*). Unpublished Ph.D. diss., Univ. Minnesota.

Kaufman, G. W. 1977. Breeding requirements of the Virginia rail and the sora in captivity. Avicult. Mag. 83: 134-141.

Kaufman, G. W. 1983. Displays and vocalizations of the sora and Virginia rails. Wilson Bull. 95: 42-59.

Kaufman, G. W. 1987. Growth and development of sora and Virginia rail chicks. Wilson Bull. 99: 432-440.

Kaufmann, G. W. 1988. Social Preening in soras and Virginia rails. Loon 60: 59-63.

Kaufmann, G. W., and E. T. Cawley. 1986. Nesting success and feeding habits of great blue herons on the Mississippi River near Cassville, Wisconsin and East Dubuque, Illinois. Proc. Iowa Acad. Sci. 93: 184-187.

Keenan, W. J., III. 1981. Green heron fishing with mayflies. Chat 45: 41.

Keith, S. 1967. How to see a yellow rail. Linnaean News Letter 20: 8-9.

Kellogg, P. P. 1962. Vocalizations of the black rail (*Laterallus jamaicensis*) and the yellow rail (*Coturnicops noveboracensis*). Auk 79: 698-701.

Kelsall, J. P., and K. Simpson. 1980. A three year study of the great blue heron in southwestern British Columbia. Proc. of Colonial Waterbird Group, 1979. Vol. 3: 69-74.

Kent, D. M. 1986. Behavior, habitat use, and food of three egrets in a marine habitat. Colon. Waterbirds 9: 25-30.

Kent, D. M. 1986. Flushing lores of a male least bittern. Florida Field Nat. 14: 49-51.

Kent, T. 1951. The least bitterns of Swan Lake. Iowa Bird Life 21: 59-61.

Kepler, C. B., and J. M. Scott. 1981. Reducing bird count variability by training observers. Pages 366-371 *in* Estimating numbers of terrestrial birds (C. J. Ralph and J. M. Scott, Eds.). Stud. Avian Biol. 6. Allen Press, Inc., Lawrence, Kansas.

Kernes, J. M., and J. F. Howe. 1967. Factors determining great blue heron rookery movement. J. Minnesota Acad. Sci. 34: 80-83.

Kilham, L. 1984. American crows robbing great egrets and white ibis of large eel-like salamanders. Colonial Waterbirds 7: 143-145.

King, B. 1986. Body-trembling in the great egret. Florida Field Nat. 14: 21.

King, B. 1986. A great egret feeding on bread. Florida Field Nat. 14: 20.

King, K. A. 1976. Colonial wading bird survey and census techniques. Pages 155-159 *in* Wading birds (A. Sprunt, IV, et al., Eds.). Natl. Audubon Soc. Res. Rep. No. 7., New York.

Kirkpatrick, C. M. 1940. Some foods of young great blue herons. Amer. Midl. Nat. 24: 594-601.

Kleen, V. 1987. Illinois heron colony surveys, 1987 report. Illinois Birds and Banding 3: 79-82.

Knapton, R. W. 1984. The Henslow's sparrow in Ontario: A historical perspective. Ontario Birds 2: 70-74.

Knight, R. L., and A. W. Erickson. 1978. Canada goose - great blue heron - great horned owl nesting associations. Wilson Bull. 90(3): 455-456.

Kokshaisky, N. V. 1966. Morphology and behaviour (as exemplified by herons' feeding activities). *In* Mechanisms of flight and orientation of birds (S. E. Kleinenberg, Ed.) Moscow (in Russian).

Kokshaisky, N. V. 1966. The role of behaviour in forming feeding habits in herons. Nauka: 231-245 (in Russian).

Kopman, H. H. 1907. Aspects of the bird distribution in Louisiana and Mississippi. Auk 24: 169-181.

Kopman, H. H. 1915. List of the birds of Louisiana, Part VI. Auk 32:15-29.

Korschgen, C. E. 1979. Coastal waterbird colonies: Maine. U. S. Fish and Wildl. Serv. Biol. Serv. Program FWS/OBS-79/09.

Kosten, P. A. 1982. Egg retrieval by clapper rails. J. Field Ornithol. 53: 274-275.

Kosten, P. A. 1984. Dome rebuilding by clapper rails. J. Field Ornithol. 55: 386.

Kozicky, E. L., and J. V. Schmidt. 1949. Nesting habits of the clapper rail in New Jersey. Auk 66: 355-364.

Krebs, J. R. 1974. Colonial nesting and social feeding as strategies for exploiting food resources in the great blue heron (*Ardea herodias*). Behaviour 51: 99-134.

Krebs, J. R. 1978. Colonial nesting in birds, with special reference to the Ciconiiformes. Pages 299-314 *in* Wading birds (A. Sprunt, IV, J. C. Ogden, and S. Winckler, Eds.). Natl. Audubon Soc. Res. Rept. No. 7., New York.

Krebs, J. R., and B. Partridge. 1973. Significance of head tilting in the great blue heron. Nature 242: 533-535.

Kroodsma, D. E. 1979. Vocal dueling among male marsh wrens: evidence for ritualized expressions of dominance/subordinance. Auk 96: 506-515.

Kroodsma, D. E., and J. Verner. 1978. Complex singing behaviors among *Cistothorus* wrens. Auk 95: 703-716.

Kroodsma, D. E., and J. Verner. 1987. Use of song repertoires among marsh wren populations. Auk 104: 63-72.

Kroodsma, D. E., and R. A. Canady. 1985. Differences in repertoire size, singing behavior, and associated neuroanatomy among marsh wren populations have a genetic basis. Auk 102: 439-446.

Kubisz, M. A. 1989. Unusual feeding behaviour of the great blue heron. Ontario Birds 7: 111-112.

Kushlan, J. A. 1972. Aerial feeding in the snowy egret. Wilson Bull. 84: 199-200.

Kushlan, J. A. 1973. Bill-vibrating: a prey attracting behavior of the snowy egret, *Leucophoyx thula*. Amer. Midl. Naturalist 89: 509-512.

Kushlan, J. A. 1973. Least bittern nesting colonially. Auk 90: 685-686.

Kushlan, J. A. 1976. Feeding behavior of North American herons. Auk 93:86-94.

Kushlan, J. A. 1976. Wading bird predation in a seasonally fluctuating pond. Auk 93: 464-476.

Kushlan, J. A. 1977. The significance of plumage colour in the formation of feeding agressions of ciconiiforms. Ibis 119: 361-364.

Kushlan, J. A. 1978. Feeding ecology of wading birds. Pages 249-297 *in* Wading birds (A. Sprunt, IV, J. C. Ogden, and S. Winckler, Eds.) Natl. Audubon Soc. Res. Rept. No. 7., New York.

Kushlan, J. A. 1978. Nonrigorous foraging by robbing egrets. Ecology 59: 649-653.

Kushlan, J. A. 1979. Effects of helicopter censuses on wading bird colonies. J. Wildl. Manage. 43: 756-760.

Kushlan, J. A. 1979. Prey choice by tactile-foraging wading birds. Proc. Colonial Waterbird Group 3: 133-142.

Kushlan, J. A. 1981. Resource use strategies of wading birds. Wilson Bull. 93: 145-163.

Kushlan, J. A. 1986. Commentary. Colonies, sites, and surveys: the terminology of colonial waterbird studies. Colon. Waterbirds 9: 119-120.

Kushlan, J. A. 1986. The management of wetlands for aquatic birds. Colon. Waterbirds 9: 246-248.

Kushlan, J. A., and O. L. Bass, Jr. 1983. Habitat use and the distribution of the Cape Sable sparrow. Pages 139-146 *in* The seaside sparrow, its biology and management (Quay, T. L., J. B. Funderburg, Jr., D. S. Lee, R. F. Potter, and C. S. Robbins, Eds.). Occ. Paps. North Carolina Biol. Survey 5.

Kushlan, J. A., O. L. Bass, Jr., L. L. Loope, W. B. Robertson, Jr., P. C. Rosendahl, and D. L. Taylor. 1982. Cape Sable sparrow management plan. South Florida Res. Center Rept. M-660. 37 pp.

Kushlan, J. A., and D. A. White. 1977. Nesting wading bird populations in southern Florida. Fla. Sci. 40: 65-72.

Lack, D. 1954. The stability of the heron population. British Birds 47: 111-121.

Langdale, H. M. 1897. Heron choked by a frog. Zoologist 1: 572.

Laporte, P. 1982. Organochlorine residues and eggshell measurements of great blue heron eggs in Quebec. Colonial Waterbirds 5: 95-103.

Larner, Y. R. (chairman). 1979. Virginia's birdlife: An annotated checklist. Virginia's Avifauna No. 2, Virginia Soc. Ornith., Inc. 118 pp.

Lavrov, N. P. 1957. Significance of bitterns *Botaurus stellaris* L. in muskrat management. Canadian Wildlife Service translation from the original Russian report of 1951, No. 2.

Lee, D. S. 1976. How to be heard: observations on the structure of two vocal communities. J. Elisha Mitchell Sci. Soc. 92: 77.

Lee, D. S., and J. F. Parnell (Eds.). 1990. Endangered, threatened, and rare fauna of North Carolina, part III. A re-evaluation of the birds. Occas. Pap. North Carolina Biol. Surv., 52 pp.

Leonard, M. L. 1986. Female choice and the evolution of polygyny in the marsh wrens. Ph. D. dissertation, Univ. Ottawa, Ottawa, Ontario.

Leonard, M. L., and J. Picman. 1987. The adaptive significance of multiple nest building by male marsh wrens. Anim. Behav. 35: 271-277.

Leonard, M. L., and J. Picman. 1987. Nesting mortality and habitat selection by marsh wrens. Auk 104: 491-495.

Lewis, D. 1970. Summer birds at a coastal marsh impoundment in North Carolina. Chat 34: 87-92.

Lewis, J. C., and R. L. Garrison. 1983. Habitat suitability index models: clapper rail. U.S. Fish & Wildl. Serv. FWS/OBS-82/10.51.

Lingle, G. R., and P. A. Bedell. 1989. Nesting ecology of sedge wrens in Hall County, Nebraska. Nebraska Bird Rev. 57: 47-49.

Lokemoen, J. T. 1979. The status of herons, egrets, and ibises in North Dakota. Prairie Natur. 11: 97-110.

Longley, W. H. 1969. Comment on the flight distance of the great blue heron. Wilson Bull. 72: 289.

Longstreet, R. J. 1955. Dusky seaside colony endangered. Florida Nat. 26:78.

Longstreet, R. J. 1956. Ornithology of the mosquitoes. Reprinted from a series in the Florida Nat., Vol. 26-28. Burgman and Son, Daytona Beach, Florida. 70 pp.

Lopinot, A. C. 1951. Raccoon predation on the great blue heron, *Ardea herodias*. Auk 68: 235.

Lorenz, K. 1938. A contribution to the comparative sociology of colonial-nesting birds. Proc. 8th Intern. Ornithol. Congr., Oxford, 1934: 207-218.

Lovell, H. B. 1958. Baiting of fish by a green heron. Wilson Bull. 70: 280-281.

Low, G., and W. Mansell. 1983. North American marsh birds. Collins, Toronto.

Lowe, F. A. 1954. The heron. Collins: London.

Lowery, G. H., Jr. 1974. Lousiana Birds (3rd ed.) Louisiana State Univ. Press, Baton Rouge. 651 pp.

MacKensie, L. 1961. The Birds of Guilford, Connecticut. Peabody Mus. Nat. Hist., Yale Univ., New Haven, Conn. 110 pp.

Macko, S. A., and S. M. King. 1980. Weathered oil: effect on hatchability of heron and gull eggs. Bull. Environ. Contam. Toxicol. 25: 316-320.

Maehr, D. S., and J. A. Rodgers, Jr. 1985. Colonial waterbirds: an elusive definition. Colon. Waterbirds 8: 186-187.

Manci, K. M. 1989. A tape of bird calls and a cassette recorder: tools for surveying inconspicuous marsh birds. Colorado Field Ornithol. J. 23: 48-55.

Mangold, R. E. 1973. Clapper rail studies in New Jersey under the accelerated research program. Proceedings Northeastern Fish and Wildlife Conference 30, 8pp.

Mangold, R. E. 1977. Clapper rail (*Rallus longirostris* Boddaert). Pages 84-92 *in* Management of migratory shore and upland game birds in North America (G. C. Sanderson, Ed.). Internatl. Assoc. Fish and Wildl. Agencies, Washington DC.

Manolis, T. 1978. The status of the black rail in central California. West. Birds 9: 151-158.

Manser, P. 1990. The clapper rail (*Rallus longirostris*). Gosse Bird Club Broadsheet 55: 9-10.

Marion, W. R., T. E. O'Meara, and D. S. Maehr. 1981. Use of playback recordings in sampling elusive or secretive birds. Pages 81-85 *in* Estimating numbers of terrestrial birds (C. J. Ralph and J. M. Scott, Eds.). Stud. Avian Biol. 6., Allen Press, Inc., Lawrence, Kansas.

Marshall, R. M., and S. E. Reinhart. 1990. Breeding ecology of seaside sparrows in a Massachusetts salt marsh. Wilson Bull. 102: 501-513.

Martin, A. C., N. Hotchkiss, F. M. Uhler, and W. S. Bourn. 1953. Classification of the wetlands of the United States. U. S. Fish and Wildl. Serv. Spec. Sci. Rep. Wildl. 20: 1-14.

Martin, A.C., H.S. Zim, and A.L. Nelson. 1951. American wildlife and plants: A guide to wildlife food habits. Dover Publications, New York. 500 pp.

Massey, B. W., and R. Zembal. 1987. Vocalizations of the light-footed clapper rail. J. Field Ornithol. 58: 32-40.

Massey, B. W., R. Zembal, and P. D. Jorgensen. 1984. Nesting habitat of the light-footed clapper rail in southern California. J. Field Ornithol. 55: 67-80.

Maxwell, G. R., II, and H. W. Kale II. 1977. Breeding biology of five species of herons in coastal Florida. Auk 94: 689-700.

Maxwell, G. R., II, and H. W. Hale, II. 1974. Population estimate of breeding birds on a spoil island in the Indian River, Indian River County, Florida. Florida Field Nat. 2: 32-39.

Maynard, C. J. 1881. The birds of eastern North America. C. J. Maynard and Co., Newtonville, Mass. 532 pp.

McAllister, J. R., and G. R. Maywell. 1971. Locomotion, maintenance and feeding behaviour of the great blue heron in northern New York. Kingbird 21: 183-203.

McAloney, K. 1973. The breeding biology of the great blue heron on Tobacco Island, Nova Scotia. The Canadian Field-Naturalist 87: 137-140.

McAtee, W. L., T. D. Burleigh, G. H. Lowery, Jr., and H. L. Stoddard. 1944. Eastward migration through the Gulf states. Wilson Bull. 56: 152-160.

McCall, C. 1972. Manual for Maine wetlands inventory. Maine Div. Inland Fish and Game, Federal Aid Project W-62-R.

McCrimmon, D. A., Jr. 1974. Stretch and snap display of the great egret. Wilson Bull. 86: 165-167.

McCrimmon, D. A., Jr. 1978. Nest-site characteristics among five species of herons on the North Carolina coast. Auk 95: 267-280.

McCrimmon, D. A., Jr. 1980. The effect of timing of breeding, dispersion of nests, and habitat selection on nesting success of colonial waterbirds. Trans. Linnaean Soc. New York 9: 87-102.

McCrimmon, D. A., Jr. 1981. The status and distribution of the great blue heron (*Ardea herodias*) in New York state: results of a two year census effort. Colon. Waterbirds 4: 85-90.

McCrimmon, D. A., Jr. 1982. Populations of the great blue heron (*Ardea herodias*) in New York State from 1964-1981. Colonial Waterbirds 5: 87-95.

McCulloch, N. B., Jr. 1951. July banding trip to Pea Island [N.C.]. Chat 15:56-57.

McDonald, M. V. 1982. Breeding-bird census: Gulf Coast salt marsh. Amer. Birds 36: 100.

McDonald, M. V. 1983. An annotated bibliography of the seaside sparrow. Pages 77-86 *in* The seaside sparrow, its biology and management (Quay, T. L., J. B. Funderburg, Jr., D. S. Lee, R. F. Potter, and C. S. Robbins, Eds.). Occ. Paps. North Carolina Biol. Survey 5.

McDonald, M. V. 1983. Breeding bird census No. 46: Gulf Coast salt marsh. Amer. Birds 37: 100.

McDonald, M. V. 1983. Vocalization repertoire of a marked population of seaside sparrows. Pages 87-93 *in* The seaside sparrow, its biology and management (Quay, T. L., J. B. Funderburg, Jr., D. S. Lee, R. F. Potter, and C. S. Robbins, Eds.). Occ. Paps. North Carolina Biol. Survey 5.

McDonald, M. V., and W. Post. 1982. Territorial behavior and spacing of Scott's seaside sparrow (*Ammospiza maritima peninsulae*). (Abstract). Bird Behaviour 4: 52.

McDonald, N. J., and J. K. Potter. 1941. Breeding-bird census: Climax salt marsh. Bird-Lore 43(suppl.): 482-483.

McGowan, K. J., and M. L. Dinham. 1988. Intense aggression by male boat-tailed grackles. Florida Field Nat. 16: 74-75.

McIlhenny, E. A. 1937. Life history of the boat-tailed grackle in Louisiana. Auk 54: 274-295.

McLean, D. D. 1916. Nesting habits of the Virginia rail in Mariposa County, California. Condor 18: 229.

McNair, D. B. 1983. The significance of breeding season records of sedge wrens in the southeast states. Oriole 48: 49-52.

McVaugh, W., Jr. 1972. The development of four North American herons. Living Bird 11: 155-173.

McVaugh, W., Jr. 1975. The development of four North American herons, part 2. Living Bird 14: 163-184.

Meanley, B. 1952. Notes on the ecology of the short-billed marsh wren in the lower Arkansas rice fields. Wilson Bull. 64: 22-25.

Meanley, B. 1957. Notes on the courtship behavior of the king rail. Auk 74: 433-440.

Meanley, B. 1960. Fall food of the sora rail in the Arkansas rice fields. J. Wildl. Manage. 24:339.

Meanley, B. 1965. Early-fall food and habitat of the sora in the Patuxent River Marsh, Maryland. Chesapeake Science. 6: 235-237.

Meanley, B. 1969. Natural history of the king rail. United States Fish and Wildlife Service. North American Fauna, No. 67. 108pp.

Meanley, B. 1969. The marsh hen. A natural history of the clapper rail of the Atlantic coast salt marsh. Tidewater Publ., Centerville, Maryland.

Meanley, B. 1975. Birds and marshes of the Chesapeake Bay country. Tidewater Publishers, Centreville, MD.

Meanley, B. 1984. Notes on clapper rail broods at Chincoteague. Raven 54: 13.

Meanley, B. 1988. A king-clapper rail hybrid from a Rappahannock River marsh. Raven 59: 15-16.

Meanley, B. 1992. King rail. *In* The birds of North America, No. 3 (A. Poole, P. Stettenheim, and F. Gill, Eds.). The Academy of Natural Sciences, Philadelphia; The American Ornithologists' Union, Washington, DC.

Meanley, B., and A. G. Meanley. 1958. Growth and development of the king rail. Auk 75: 381-386.

Meanley, B., and R. E. Stewart. 1960. Color of the tarsi and toes of the black rail. Auk 77: 83-84.

Meanley, B., and D. K. Weatherbee. 1962. Ecological notes on mixed populations of king rails and clapper rails in Delaware Bay marshes. Auk 79: 453-457.

Meanley, B., and J. S. Webb. 1963. Nesting ecology and reproductive rate of red-winged blackbird in tidal marshes of the upper Chesapeake Bay region. Chesapeake Science 4: 90-100.

Meredith, R. 1935. The yellow rail in the Province of Quebec. Canadian Field Naturalist 49: 58-59.

Merriam, T. L. 1977. Feeding ecology and food overlap of two sympatric marsh-inhabiting sparrows (Aves: *Ammospiza*). M.S. thesis. Long Island Univ., Brooksville, N.Y. 112 pp.

Merritt, M. A. 1981. Ontongeny of behavior in the great blue heron (*Ardea herodias*). Unpubl. M. S. thesis. Ohio State Univ., Columbus.

Merrium, T. L. 1983. Food habits of nestling seaside sparrows in unaltered and ditched salt marshes on Long Island, New York. Pages 115-122 *in* The seaside sparrow, its biology and management (Quay, T. L., J. B. Funderburg, Jr., D. S. Lee, R. F. Potter, and C. S. Robbins, Eds.). Occ. Paps. North Carolina Biol. Survey 5.

Messerly, J. F. 1985. Green-backed heron feeding on dragonflies. Bull. Oklahoma Ornithol. Soc. 18: 20-21.

Meyerriecks, A. J. 1959. Foot stirring behavior in herons. Wilson Bull. 71: 153-158.

Meyerriecks, A. J. 1960. Comparative breeding behaviour of four species of North American herons. Publ. Nuttall Ornithol. Club 2: 1-158.

Meyerriecks, A. J. 1962. Diversity typifies heron feeding. Nat. His. 71: 48-59.

Meyerriecks, A. J. 1962. Pages 381-508 in Handbook of North American birds, vol. 1 (R. S. Palmer, Ed.). Yale Univ. Press, New Haven, Connecticut.

Meyerriecks, A. J. 1966. Additional observations of 'foot-stirring' feeding behavior in herons. Auk 83: 471-472.

Meyerriecks, A. J. 1971. Further observations on use of the feet by foraging herons. Wilson Bull. 83: 434-438.

Meyerriecks, A. J., and D. W. Nellis. 1967. Egrets serving as 'beaters' for belted kingfishers. Wilson Bull. 79: 236-237.

Michael, C. W. 1934. Feeding habits of herons on Mission Bay, California. Condor 36: 215-216.

Michael, C. W. 1936. Feeding habits of the snowy egret. Condor 38: 168.

Middlemiss, E. H. 1955. Food of juvenile egrets. Ostrich 26: 159.

Miller, R. F. 1944. A great blue heron colony near Philadelphia. Cassinia 33: 1-23.

Milstein, P., S. Le, and R. D. Jacka. 1970. Establishment of a large heronry. Ostrich 41: 208-210.

Mitchell, C. A. 1981. Reproductive success of great blue herons at Nueces Bay, Corpuz Christi, Texas. Bull. Texas Ornithol. Soc. 14: 18-21.

Mock, D. W. 1975. New early egg-date record for great blue herons in Texas. Tex. Ornithol. Soc. Bull. 8: 10.

Mock, D. W. 1976. Pair-formation displays of the great blue heron. Wilson Bull. 88: 185-230.

Mock, D. W. 1978. Pair-formation displays of the great egret. Condor 80: 159-172.

Mock, D. W. 1978. The comparitive approach to wading bird behavior. Pages 17-25 *in* Wading birds (A. Sprunt, IV, J. Ogden, and S. Winckler, Eds.). Natl. Audubon Soc. Res. Rept. No. 7., New York.

Mock, D. W. 1979. Display repertoire shifts and 'extra-marital' courtships in herons. Behaviour 79: 57-71.

Mock, D. W. 1980. Communication strategies of great blue herons and great egrets. Behaviour 72: 156-170

Mock, D. W., T. C. Lamey, and B. J. Ploger. 1987. Proximate and ultimate roles of food amount in regulating egret sibling aggression. Ecology 68: 1760-1772.

Mock, D. W., and G. A. Parker. 1986. Advantages and disadvantages of egret and heron brood reduction. Evolution 40: 459-470.

Moffitt, J. 1941. Notes on the food of the California clapper rail. Condor 42: 270-273.

Monson, G. 1951. Great blue heron killed by a bobcat. Wilson Bull. 63: 334.

Morris, R. O. 1905. The gadwall and yellow rail near Springfield, Massachusetts. Auk 22: 208.

Morrison, M. L., and E. Shanley, Jr. 1978. Breeding success of great egrets on a dredged material island in Texas. Bull. Texas Ornithol. Soc. 11: 17-18.

Mousley, H. 1934. A study of the home life of the short-billed marsh wren (*Cistothorus stellari*). Auk 51: 439-445.

Mousley, H. 1937. A study of a Virginia rail and sora rail at their nests. Wilson Bull. 49: 80-84.

Mousley, H. 1940. Further notes on the nesting habits of the Virginia rail. Wilson Bull. 52: 87-90.

Moxley, E. L. 1936. Blue heron colonies in northern Ohio. Wilson Bull. 48: 3-11.

Mueller, H. C., M. H. Biben, and H. F. Sears. 1972. Feeding interactions between pied-billed grebes and herons. Auk 89: 190.

Murdich, W. H. 1978. The feeding ecology of five species of herons in a north-central Florida marsh. M. S. thesis, Univ. of Florida, Gainesville.

Murkin, H. R., R. M. Kaminski, and R. D. Titman. 1982. Responses of dabbling ducks and aquatic invertebrates to an experimentally manipulated cattail marsh. Can. J. Zool. 60: 2324-2332.

Murphy, M. 1988. Status of great blue heron colonies in King County, Washington. West. Birds 19: 37-40.

Murray, B.G. 1969. A comparative study of the LeConte's and sharp-tailed sparrows. Auk 86: 199-231.

Neithammer, K. R., and M. S. Kaiser. 1983. Late summer food habits of three heron species in northeastern Louisiana. Colon. Waterbirds 6: 148-153.

Nero, R. W. 1950. Notes on a least bittern nest and young. Passenger Pigeon 12: 3-8.

Nero, R. W. 1951. Notes on nesting of the least bittern. Passenger Pigeon 13: 5-8.

Nice, M. M. 1929. Some observations on the nesting of a pair of yellow-crowned night-herons. Auk 46: 170-176.

Nice, M. M. 1954. Pr oblems of incubation periods in North American birds. Condor 56: 173-197.

Niering, M. M., and R. S. Warren. 1980. Vegetation patterns and processes in New England salt marshes. Bioscience 30: 301-307.

Nixon, S. W. 1982. The ecology of New England high salt marshes: a community profile. USF&WS, Off. Biol. Serv., FWS/OBS-81/55. 70 pp.

Norris, D. 1975. Green heron goes fishing. Fla. Wildl. 29: 16-17.

Oberholser, H. C. 1937. A revision of the clapper rails (*Rallus longirostris* Boddaert). Proceedings United States National Museum 84:313-354.

Odum, E. P. 1961. The role of tidal marshes in estuarine production. New York State Conserv., June-July: 60-63.

Odum, R. R. 1977. Sora (*Porzana carolina*). Pages 57-65 *in* Management of migratory shore and upland game birds in North America (G. C. Sanderson, Ed.). Internat. Assoc. Fish & Wildl. Agen., Washington, DC.

Ohlendorf, H. M., J. B. Elder, R. C. Stendall, G. L. Hensler, and R. W. Johnson. 1979. Organochlorine residues in young herons from the upper Mississippi River -- 1976. Pesticides Monit. J. 13: 115-119.

Ohlendorf, H. M., E. E. Klass, and T. E. Kaiser. 1979. Environmental pollutants and eggshell thickness: anhingas and wading birds in the eastern United States. U. S. Fish and Wildl. Serv. Spec. Sci. Rep. Wildl. 216. 94 pp.

Ohmart, R. D., and R. E. Tomlinson. 1977. Foods of the western clapper rails. Wilson Bull. 89: 332-336.

Oney, J. 1954. Final report: clapper rail survey and investigation study. Georgia Game and Fish Commission. 50pp.

Orians, G. H. 1961. The ecology of the blackbird (*Agelaius*) social systems. Ecol. Monogr. 31: 285-312.

Orians, G. H. 1980. Some adaptations of marsh-nesting blackbirds. Monogr. Population Biol. No. 14., Princeton Univ. Press, Princeton, New Jersey.

Orr, R. 1947. Occurrence of black rail in San Francisco. Condor 49: 41.

Osborn, R. G., and T. W. Custer. 1978. Herons and their allies: atlas of Atlantic coast colonies, 1975 and 1976. Biol. Serv. Prog., U. S. Fish Wildl. Serv. FWS/OBS-77/08.

Owen, D. F. 1959. Mortality of the great blue heron as shown by banding recoveries. Auk 76: 464-470.

Paine, J. M. 1972. A study of colonial nesting of the great blue heron (*Ardea herodias*). Unpubl. B.S. thesis, Vancouver, Univ. British Columbia.

Palmer, P. C. 1989. Great blue heron kills and carries off an eastern cottontail rabbit. Bull. Texas Ornithol. Soc. 22: 17-18.

Palmer, R. S. (Ed.). 1962. Handbook of North American Birds. Vol. I. Yale Univ. Press, New Haven, Connecticut.

Parker, J. E., and G. R. Maxwell. 1969. Selected maintenance behavior in a great blue heron on Ironsides Island. Kingbird 19: 192-199.

Parkes, K. C. 1955. Systematic notes on North American birds. 1. The herons and ibises (Ciconiiformes). Ann. Carnegie Mus. 33:287-293.

Parks, J. M. and S. L. Bressler. 1963. Observations of joint feeding activities of certain fish eating birds. Auk 80: 198-199.

Parnell, J., and R. Soots, Jr. 1979. Atlas of colonial waterirds of North Carolina estuaries. UNC Sea Grant Publ. UNC-SG-78-10.

Parris, R. W., and G. A. Grau. 1979. Feeding sites of great blue herons in southwestern Lake Erie. Proc. 1978 Conference of the Colonial Waterbird Group 2: 110-113.

Parsons, A. G. 1947. Heron feeding by probing under water. Brit. Birds 40: 313-314.

Patten, G. 1952. Inside a heronry. The Bokmakierie 4: 8-9.

Payne, R. B., and C. J. Risley. 1970. Systematic or evolutionary relationships among the herons (*Ardeidae*). Miscellaneous publications, Mus. of Zoology, University of Michigan 150: 1-115. Ann Arbor, MI.

Peabody, P. B. 1922. Haunts and breeding habits of the yellow rail. Journal Museum of Comparitive Zoology 2: 33-34.

Pearson, L. S. 1909. Breeding of the least bittern (*Ardetta exilis*) in Chester Co., Pa. Auk 26: 426-427.

Pearson, T. G. 1924. Herons of the United States. Bird-lore 25: 70-79.

Percy, L. W. 1951. Three studies in bird character: bitterns, herons, and water rails. Country Life, London.

Peterson, A. W. 1953. Great blue heron feeding on a muskrat. Wilson Bull. 65: 116.

Pettingill, O. S. 1938. Intelligent behavior in the clapper rail. Auk 55: 411-415.

Pfeiffer, W. J., and R. G. Wiegert. 1981. Grazers on *Spartina* and their predators. Pages 87-112 *in* The ecology of a salt marsh (L. R. Pomeroy and R. G. Wiegert, Eds.). Spinger Verlag, New York.

Picman, J. 1977. Interspecific nest destruction in the long-billed marsh wren (*Telematodytes palustris palustris*). Can. J. Zool. 55: 1914-1920.

Picman, J. 1980. A new trap for long-billed marsh wrens. N. Am. Bird Bander 5: 8-10.

Picman, J. 1982. Impact of red-winged blackbirds on singing activities of long-billed marsh wrens. Can. J. Zool. 60: 1683-1689.

Picman, J. 1984. Experimental study on the role of intra- and inter-specific competition in the evolution of nest-destroying behavior in marsh wrens. Can. J. Zool. 62: 2353-2356.

Picman, J. 1986. Attempted nest parasitism of the marsh wren by a brown-headed cowbird. Condor 88: 381-382.

Picman, J. 1988. Behavioral interactions between North American marsh-nesting blackbirds, and marsh wrens and their influence on reproductive strategies of these passerines. Proc. Int. Ornithol. Congr. 19: 2624-2634.

Piefer, R. W. 1979. Great blue herons foraging for small mammals. Wilson Bull. 91: 630-631.

Pierce, P. A. 1982. Behavior of fledgling great blue herons in a Michigan heronry. Jack-Pine Warbler 60: 4-14.

Pomeroy, L.R., and R.G. Wiegert, (Eds.). 1981. The ecology of a salt marsh. Springer-Verlag, New York.

Pospichal, L. B. 1952. A field study of sora rail (*Porzana carolina*) and Virginia rail (*Rallus limicola*) populations in central Minnesota. M.S. Thesis, University of Minnesota, St. Paul. 80pp.

Pospichal, L. B., and W. H. Marshall. 1954. A field study of sora rail and Virginia rail in central Minnesota. Flicker 26:2-32.

Post, W. 1974. Functional analysis of space-related behavior in the seaside sparrow. Ecology 55: 564-575.

Post, W. 1981. The influence of rice rats *Oryzomys palustrus* on the habitat use of the seaside sparrow *Ammospiza martina*. Behav. Ecol. Sociobiol. 9: 35-40.

Post, W. 1987. Boat-tailed grackle lays eggs in abandoned nest containing eggs. Wilson Bull. 99: 724.

Post, W. 1988. Reproductive success in New World marsh-nesting passerines. Proc. Int. Ornithol. Congr. 19: 2645-2657.

Post, W., and F. Enders. 1969. Reappearance of the black rail on Long Island. Kingbird 19: 189-191.

Post, W., and F. Enders. 1970. Notes on a salt marsh Virginia rail population. Kingbird 20: 61-67.

Post, W., and J. S. Greenlaw. 1975. Seaside sparrow displays: their function in social organization and habitat. Auk 92: 461-492.

Post, W., and J. S. Greenlaw. 1982. Comparative costs of promiscuity and monogamy: a test of reproductive effort theory. Behav. Ecol. Sociobiol. 10: 101-107.

Post, W., J. S. Greenlaw, T. L. Merriam, and L. A. Wood. 1983. Comparative ecology of northern and southern populations of the seaside sparrow. Pages 123-136 *in* The seaside sparrow, its biology and management (Quay, T. L., J. B. Funderburg, Jr., D. S. Lee, R. F. Potter, and C. S. Robbins, Eds.). Occ. Paps. North Carolina Biol. Survey. 5.

Post, W., and C. Seals. 1989. Common moorhen parasitizes a boat-tailed grackle nest. Wilson Bull. 101: 508-509.

Potter, J. K. 1917. Unusual nesting site of the least bittern at Camden, New Jersey. Cassinia 20: 14-17.

Powell, R. E. 1985. Summary of 1985 Yuma clapper rail surveys along the Colorado River habitats and adjacent areas. California Dept. of Fish and Game, Blythe, California.

Pratt, H. M. 1970. Breeding biology of great blue herons and common egrets in central California. Condor 72: 407-416.

Pratt, H. M. 1972. Nesting success of the great blue herons and common egrets at Audubon Canyon Ranch in 1971. Amer. Birds 26: 699-702

Pratt, H. M. 1972. Nesting success of common egrets and great blue herons in the San Francisco Bay Region. Condor 74: 447-453.

Pratt, H. M. 1973. Breeding attempts by juvenile great blue herons. Auk 90: 897-898.

Pratt, H. M. 1974. Breeding of great blue herons and great egrets at Audubon Canyon Ranch, California 1972-1973. Western Birds 5: 127-136.

Pratt, H. M. 1977. Great blue herons interrupt nest-guarding to drink. Condor 79: 501-502.

Pratt, H. M. 1980. Directions and timing of great blue heron foraging flights from a California colony: implications for social facilitation of food finding. Wilson Bull. 92: 489-496.

Pratt, H. M., and D. W. Winkler. 1985. Clutch size, timing of laying, and reproductive success of great blue herons and great egrets. Auk 102: 49-63.

Price, H. F. 1946. Food of the yellow-crowned night heron. Auk 63: 441.

Provost, M. W. 1947. Nesting birds in the marshes of Northwest Iowa. Amer. Midl. Nat. 38: 485-503.

Quinney, T. E. 1979. Reproductive success, growth of nestlings and foraging behaviour of the great blue heron. M.S. thesis, Arcadia University, Wolfville, Nova Scotia. 143 pp.

Quinney, T. E. 1982. Growth, diet, and mortality of nestling great blue herons. Wilson Bull. 94: 571-577.

Quinney, T. E. 1983. Comparison of great blue heron, *Ardea herodias*, reproduction at Boot Island and other Nova Scotia colonies. Can. Field-Natur. 97: 275-278.

Quinney, T. E., B. N. Miller, and K. R. S. Quinney. 1981. Gulls robbing prey from great blue herons (*Ardea herodias*). Can. Field-Nat. 95: 205-206.

Quinney, T. E., and P. C. Smith. 1980. Comparative foraging behaviour and efficiency of adult and juvenile great blue herons. Can. J. Zool. 58: 1168-1173.

Ralph, C. J., and C. C. Ralph. 1958. Notes on the nesting of egrets near San Rapael, California. Condor 60: 70-71.

Rapp, W. F., Jr. 1954. American bittern eats snake. Nebraska Bird Rev. 22:1.

Recher, H. F. 1972. Colour dimorphism and the ecology of herons. Ibis 114: 552-555.

Recher, H. F., and J. A. Recher. 1980. Why are there different kinds of herons? Trans Linnaean Soc. New York 9: 135-158.

Redondo, T. 1989. Avian nest defense: theoretical models and evidence. Behaviour 111: 161-195.

Reed, J. 1971. Egret dines on sparrow. Fla. Wildl. 24(12): 24.

Reese, J. G. 1973. Unusual feeding behavior of great blue herons and common egrets. Condor 75: 352.

Reher, H. F. and J. A. Recher. 1972. Herons leaving water to defecate. Auk 89: 869-897.

Reid, F.A. 1989. Differential habitat use by waterbirds in a managed wetland complex. Ph.D. diss., Univ. Missouri, Columbia.

Reinecke, O. 1910. The great blue heron. Oologist 27: 15-17.

Reinert, S. E., and F. C. Golet. 1979. Breeding ecology of the swamp sparrow in a southern Rhode Island peatland. Trans. Northeast Sec. Wildl. Soc. 36: 1-13.

Reinert, S. E., F. C. Golet, and W. R. DeRagon. 1981. Avian use of ditched and unditched salt marshes in southeastern New England: a preliminary report. Proc. Northeast. Mosq. Control Assoc. 27: 1-23.

Repking, C. F., and R. D. Ohmart. 1977. Distribution and density of black rail populations along the lower Colorado River. Condor 79: 486-489.

Reynard, G. 1974. Some vocalizations of the black, yellow, and Virginia rails. Auk 91: 747-756.

Reynard, G. B. 1972. Vocalizations of the female black rail. Cassinia 53: 24-26.

Reynard, G. B., and S. T. Harty. 1968. Ornithological 'mystery' song given by the male Virginia rail. Cassinia 50: 3-8.

Reynolds, C. M. 1979. The heronries census: 1972-77 indices and a review. Bird Study 26: 7-12.

Rice, D. W. 1954. Symbiotic feeding of snowy egrets with cattle. Auk 71: 472-473.

Ridgway, R. 1878. Studies of the American Herodiones. Bull. U.S. Geol. Geogr. Surv. Territories 4: 226-237.

Ringler, R. F. 1987. Marsh wren nest with sedge wren eggs. Maryland Birdlife 43: 30-31

Rio, D. F. 1971. Marshes, mosquitoes, and mathematics. Proc. N. J. Mosq. Exterm. Assoc. 58: 151-153.

Ripley, S. D. 1977. Rails of the world. David R. Godwine, Publ., Boston, Massachusetts.

Ripley, S. D., and B. M. Beehler. 1985. Rails of the world, a compilation of new information 1975-1983. (Aves: *Rallidae*). Smithsonian Contrib. Zool. 417, 28 pp.

Robbins, C. S. 1983. Distribution and migration of seaside sparrows. Pages 31-40 *in* The seaside sparrow, its biology and management (Quay, T. L., J. B. Funderburg, Jr., D. S. Lee, R. F. Potter, and C. S. Robbins, Eds.). Occ. Paps. North Carolina Biol. Survey 5.

Robins, J. D. 1967. Ecology of the Henslow's sparrow. M. S. thesis, Western Michigan Univ., Kalamazoo, Michigan. 95 pp.

Robins, J. D. 1971. Differential niche utilization in a grassland sparrow. Ecology 52: 1065-1070.

Robins, J. D. 1971. A study of Henslow's sparrow in Michigan. Wilson Bull. 83: 39-48.

Robins, J. D., and G. D. Schnell. 1971. Skeletal analysis of the *Ammodramus-Ammospiza* grassland sparrow complex: a numerical-taxonomic study. Auk 88: 567-590.

Robinson, J. C. 1988. Heron and egret roost discovered near Memphis [Tennessee]. Migrant 59: 118-119.

Rodgers, J. A., Jr. 1974. Aerial feeding by snowy egrets and great egrets in Louisiana waters. Wilson Bull. 86: 70-71.

Rodgers, J. A., Jr. 1975. Additional observations on hover feeding by North American ardeids. Wilson Bull. 87: 420.

Rodgers, J. A., Jr. 1980. Reproductive success of three heron species on the west coast of Florida. Fla. Field-Natur. 8: 37-56.

Rodgers, J. A., Jr. 1983. Foraging behavior of seven species of herons in Tampa Bay, Florida. Colon. Waterbirds 6: 11-23.

Rodgers, J. A., Jr. 1986. Additional observations on the reproductive success of herons on the west coast of Florida. Florida Field Nat. 14: 77-79.

Rost, F. 1988. [Breeding biology and population dynamics of marsh birds of the Haselbach Ponds near East Leipzig, Germany.] Beitr. Vogelkd. 34: 117-130.

Roth, R.R., J.D. Newsom, T. Jonan, and L.L. McNease. 1972. The daily and seasonal behavior pattern of the clapper rail (*Rallus longirostris*) in the Louisiana coastal marshes. Proc. SE Assoc. Game Fish Comm. 26: 136-159.

Rothstein, S. I. 1975. An experimental and teleonomic investigation of avian brood parasitism. Condor 77: 250-271.

Rowley, G. D. 1869. Contents of a heron's crop. Zoologist 4: 1722.

Rundle, W. D., and L. H. Fredrickson. 1981. Managing seasonally flooded impoundments for migrant rails and shorebirds. Wildl. Soc. Bull. 9: 81-85.

Rundle, W. D., and M. W. Sayre. 1983. Feeding ecology of migrant soras in southeastern Missouri. J. Wildl. Manage. 47: 1153-1159.

Russell, J. K. 1978. Effects of interspecific dominance among egrets commensally following roseate spoonbills. Auk 95: 608-610.

Russell, S. M. 1966. Status of the black rail and gray-breasted crake in British Honduras. Condor 68: 105-107.

Ryder, R. A. 1950. Great blue heron killed by a carp. Condor 52: 40-41.

Ryder, R. A. 1978. Breeding distribution, movements and mortality of snowy egrets in North America. Pages 197-205 *in* Wading birds (A. Sprunt, IV, J. C. Ogden, and S. Winckler, Eds.). Natl. Audubon Soc. Res. Rept. No. 7, New York.

Santy, D. 1964. A recollection of an encounter between a golden eagle and a great blue heron. Blue Jay 22: 55.

Saunders, A. A. 1962. The summer birds of central New York marshes. Roosevelt Wildl. Bull. 3: 335-423.

Sayre, M. W., and W. D. Rundle. 1984. Comparison of habitat use by migrant soras and Virginia rails. J. Wildl. Mgmt. 48: 599-605.

Scharf, W. C. and E. Balfour. 1971. Growth and development of nestling hen harriers. Ibis 113: 323-329.

Schipper, W. J. A., L. S. Burma, and P. Bossenbrock. 1975. Comparative study of hunting behavior of wintering hen harriers *Circus cyaneus* and marsh harriers *Circus aeruginosus*. Ardea 63: 1-29.

Schmidt, F. V., and P. D. McLain. 1951. The clapper rail in New Jersey. Proceedings Northeastern Fish and Wildlife Conference 7. 9 pp.

Scott, W. L. 1885. The great white egret and the yellow rail. Auk 2: 110.

Seabolt, T. 1984. The aggressive responses of a nesting osprey in a great blue heron colony. Loon 56: 214-215.

Seibert, H. C. 1951. Light intensity and the roosting flight of herons in New Jersey. Auk 68: 63-64.

Selander, R. K. 1958. Age determination and molt in the boat-tailed grackle. Condor 60: 355-376.

Selander, R. K. 1960. Sex ratio of nestlings and clutch size in the boat-tailed grackle. Condor 62: 34-44.

Selander, R. K., and D. R. Giller. 1961. Analysis of sympatry of great-tailed and boat-tailed grackles. Condor 63: 29-86.

Shanley, E., Jr. 1984. Snowy egrets and great egrets using foot-dragging behavior in aerial feeding. Bull. Texas Ornithol. Soc. 17: 17-18.

Sharpe, R. B. 1898. *Plataleae* (ibises and spoonbills) and *Herodiones* (herons and storks). Pages 1-328 in Catalogue of the birds in the British Museum, vol. 26 (A. Gunther, Ed.). British Museum, London.

Shaw, S. P., and C. G. Fredine. 1956. Wetlands of the United States, their extent and their value to waterfowl and other wildlife. United States Department of the Interior, Fish and Wildlife Service. Circular No. 39. 67pp.

Sheldon, F. H. 1987. Phylogeny of heron estimates from DNA-DNA hybridization data. Auk 104: 97-108.

Short, H. L., and R. J. Cooper. 1985. Habitat suitability index models: Great blue heron. U.S. Fish and Wildlife Service FWS/OBS - 82/10.99. Washington, DC.

Shufeldt, R. W. 1926. Life history of the long-billed marsh wren. Oologist 43: 154-156.

Sibley, C. G. 1955. The responses of salt-marsh birds to extremely high tides. Condor 57: 241-242.

Sills, N. 1982. The first ten years at Titchwell Marsh. Norfolk Bird and Mamm. Rept. 26: 190-195.

Simmons, E. M. 1959. Observations on effects of cold weather on nesting common egrets. Auk 76: 239-241.

Simpson, K. 1984. Factors affecting reproduction in great blue herons (*Ardea herodias*). M.S. thesis, University of British Columbia, Vancouver, B. C.

Simpson, K., J. N. M. Smith, and J. P. Kelsall. 1987. Correlates and consequences of colonality in great blue herons. Can. J. Zool. 65: 572-573.

Simpson, T. W. 1939. The feeding habits of the coot, Florida gallinule and the least bittern on Reelfoot Lake. Jour. Tenn. Acad. Sci. 14: 110-115.

Skutch, A. F. 1940. Social and sleeping habits of Central American wrens. Auk 57: 293-312.

Smith, A. B. 1955. Sora rail populations in Alberta, 1953-1954. *In* Investigations of woodcock, snipe and rails in 1954. U. S. Fish and Wildl. Serv. Spec. Rep. Wildl. 28: 51-57.

Smith, J. B. 1907. The New Jersey salt marsh and its improvement. Bull. N. J. Agr. Exp. Sta. New Brunswick. No. 207.

Smyth, J. A. 1933. The literature of the Virginia rail. M. S. Thesis, Cornell University, Ithaca, New York. 122pp.

Sprunt, A., Jr. 1939. Predatory instincts in the American egret. Auk 56: 469.

Stalheim, P. S. 1973. Behavior and ecology of the yellow rail (*Coturnicops noveboracensis*). M. S. thesis, Univ. Minnesota, Minneapolis, Minnesota.

Steffee, N. D. 1969. Yellow rail, *Coturnicops noveboracensis*, near Audubon House. Florida Naturalist 42: 134.

Stendell, R. C., J. W. Artmann, and E. Martin. 1980. Lead residues in sora rails from Maryland. J. Wildl. Manage. 44: 525-527.

Stenzell, J. R. 1982. Ecology of breeding yellow rails at Seney National Wildlife Refuge. M. S. thesis, Ohio State Univ., Columbus, Ohio.

Stephens, H. A. 1980. The great blue heron in Kansas. Trans. Kansas Acad. Sci. 83: 161-186.

Stevens, C.E. 1952. The short-billed marsh wren in Albemarle County. The Raven 23: 85-87.

Stevenson, H. M. 1962. Clapper rail in the interior of Florida - a correction. Amer. Midl. Natur. 67: 505.

Stewart, R. E. 1951. Clapper rail populations of the middle Atlantic states. Transactions North American Wildlife Conference 16:421-430.

Stewart, R. E. 1954. Migratory movements of the northern clapper rail. Bird-Banding 25: 1-5.

Stewart, R. E. 1957. Eastern glossy ibis nesting in southeastern Maryland. Auk. 74: 509.

Stoddard, H. L. 1916. The black rail (*Creciscus jamaicensis*) at Chicago, Ill. Auk 33: 433-434.

Stoll, M. J., and F. C. Golet. 1983. Status of the seaside sparrow in Rhode Island. Aud. Soc. R. I. Rep. 17: 57-61.

Sullivan, J. P. 1986. Effects of provisioning rates and number fledged on sibling aggression in great blue herons. M. S. thesis, Utah State University.

Sullivan, J. P., and S. M. Payne. 1988. Aspects of history and nestling mortality at a great blue heron (*Ardea Herodias*) colony, Quetico Provincial Park, Ontario. Can. Field-Nat. 102: 237-241.

Sutton, G. M. 1936. Food capturing tactics of the least bittern. Auk 53: 74-75.

Sutton, G. M. 1946. Great blue heron swallows large snake. Auk 63: 97.

Swales, B. H. 1896. A full set of rails. Nidiologist 3: 142.

Swales, B. H., Jr. 1912. Yellow rail. Auk 29: 100-101, 237.

Swift, B. L. 1987. An analysis of avian breeding habitats in Hudson River tidal marshes: final report. New York State Dept. Environ. Conser., Delmar, New York.

Swales, B. H., Jr. 1912. Yellow rail. Auk 29: 100-101, 237.

Swift, B. L. 1987. An analysis of avian breeding habitats in Hudson River tidal marshes: final report. New York State Dept. Environ. Conser., Delmar, New York.

Swift, B. L., S. R. Orman, and J. W. Ozard. 1988. Response of least bitterns to tape-recorded calls. Wilson Bull. 100: 496-499.

Tanner, W. D. 1953. Ecology of the Virginia and king rails and the sora in Clay County Iowa. Ph.D. Thesis. Iowa State College, Ames. 154 pp.

Tanner, W. D., Jr. and G. O. Hendrickson. 1954. Ecology of the Virginia rail in Clay County Iowa. Iowa Bird Life 24: 65-70.

Tanner, W. D., Jr. and G. O. Hendrickson. 1956. Ecology of the king rail in Clay County, Iowa. Iowa Bird Life 26: 54-56.

Tanner, W. D., Jr. and G. O. Hendrickson. 1956. Ecology of the sora in Clay County, Iowa. Iowa Bird Life 26: 78-81.

Taylor, D. L. 1983. Fire management and the Cape Sable sparrow. Pages 147-152 *in* The seaside sparrow, its biology and management (Quay, T. L., J. B. Funderburg, Jr., D. S. Lee, R. F. Potter, and C. S. Robbins, Eds.). Occ. Paps. North Carolina Biol. Survey 5.

Taylor, N. 1938. A preliminary report of the salt marsh vegetation of Long Island, New York. N. Y. State Mus. Sci. Serv. Bull. 316: 21-84.

Taylor, R. J., and E. D. Michael. 1971. Predation on an inland heronry in eastern Texas. Wilson Bull. 83: 172-177.

Teal, J. M. 1962. Energy flow in the salt marsh ecosystem of Georgia. Ecology 43: 614-624.

Teal, J. M. 1965. Nesting success of egrets and herons in Georgia. Wilson Bull. 77: 257-263.

Temple, S. A. 1969. A case of turkey vulture piracy on great blue herons. Wilson Bull. 81(1): 94.

Terrill, L. M. 1943. Nesting habits of the yellow rail in Gaspe County, Quebec. Auk 60: 171-180.

Thompson, D. H. 1979. Feeding areas of great blue herons and great egrets within the floodplain of the upper Mississippi River. Proc. Colonial Waterbird Group, 1978. Vol. 2: 202-213.

Thompson, S. P., and C. D. Littlefield. 1980. Historical review and status of colonial nesting birds on Malheur National Wildlife Refuge, Oregon. Proc. Colonial Waterbird Group, 1979. Vol. 3: 156-164.

Tiner, R. W., Jr. 1984. Wetlands of the United States: current status and recent trends. Nat. Wetlands Inventory, Washington, D.C.

Tintle, R. F. 1982. Relationship of multiple nest building of female mate choice in long-billed marsh wrens, *Cistothorus palustris.* M. A. thesis, State University of New York at Stony Brook.

Todd, R. L. 1977. Black rail, little black rail, black crake, Farallon rail (*Laterallus jamaicensis*). Pages 71-83 *in* Management of migratory shore and upland game birds in North America (G. C. Sanderson, Ed.). Internat. Assoc. Fish & Wildl. Agen., Washington, DC.

Todd, R. L. 1986. A saltwater marsh hen in Arizona. A history of the Yuma clapper rail (*Rallus longirostris yumanensis*). Completion Rept. Fed. Aid Proj. W-95-R, Arizona Game and Fish Dept., Phoenix, Arizona.

Tomkins, I. R. 1941. Notes on the Macgillivray's seaside sparrow. Auk 58: 38-51.

Tomkins, I. R. 1965. The willets of Georgia and South Carolina. Wilson Bull. 77: 151-167.

Tomlinson, D. N. S. 1974. Colour changes in the great white egret. Wild Rhodesia 5: 19.

Tomlinson, D. N. S. 1976. The breeding behaviour of the great white egret. Ostrich 47: 161-178.

Tomlinson, R. E., and R. L. Todd. 1973. Distribution of two western clapper rail races as determined by responses to taped calls. Condor 75: 177-183.

Townsend, C. W. 1926. Virginia rail, *in* Life histories of North American marsh birds (A. C. Bent, Ed.). Bull. U. S. Nat. Mus., no. 135, pp. 292-301.

Townsend, C. W. 1928. The song of the green heron *Butorides virescens.* Auk 45: 498-499.

Townsend, C. W. 1931. The post-breeding northern migration of North American herons. Proc. 7th Internat. Orn. Congr. (1930): 366-369.

Tutor, B.M. 1962. Nesting studies of the boat-tailed grackle. Auk 79: 77-84.

Tyler, H. R. 1977. Wading birds in Maine and their relevance to the Critical Areas Program. Maine State Planning Office, Plan. Rep. No. 26.

U.S. Fish and Wildlife Service. 1984. Salt marsh harvest mouse and California clapper rail recovery plan. U. S. Fish and Wildl. Serv. Region 1, Portland, Oregon.

U. S. Fish and Wildlife Service. 1985. Light-footed clapper rail recovery program (revised). U. S. Fish and Wildl. Serv., Region 1, Portland, Oregon.

U. S. Office of Endangered Species and International Activities. 1973. Threatened wildlife of the United States. Bureau of Sport Fisheries and Wildlife, Resource Publication 114. 289 pp.

Upton, J. A., and C. N. Beloso. 1984. [Observations on breeding of *Egretta alba egretta* at Punta Loberia, Chubut (Aves: *Ardeidae*).] Historia Natural 4(8): 79-80.

Van Velzen, A., and J. F. Kreitzer. 1975. The toxicity of p,p'-DDT to the clapper rail. J. Wildl. Manage. 39: 305-309.

Vermeer, K. 1969. Great blue heron colonies in Alberta. Can. Field-Natur. 83: 237-242.

Vermeer, K., and C. G. Anweiler. 1970. Great blue heron colonies in Saskatchewan in 1970. Blue Jay 28: 158-161.

Verner, J. 1963. Song rates and polygamy in the long-billed marsh wren. Proc. XIIIth Int. Ornithol. Congr.: 299-307.

Verner, J. 1965. Breeding biology of the long-billed marsh wren. Condor 67: 6-30.

Verner, J. 1965. Time budget of the male long-billed marsh wren during the breeding season. Condor 67: 125-139.

Verner, J. 1975. Interspecific aggression between yellow-headed blackbirds and long-billed marsh wrens. Condor 77: 329-331.

Verner, J. 1976. Complex song repertoire of male long-billed marsh wrens in eastern Washington. Living Bird 14: 263-300.

Verner, J., and G. H. Engelsen. 1970. Territories, multiple nest building and polygamy in the long-billed marsh wren. Auk 87: 557-567.

Verner, J., and M. E. Wilson. 1966. The influence of habitats on mating systems of North American passerine birds. Ecology 47: 143-147.

Vesall, D. B. 1940. Notes on nesting habits of the American bittern. Wilson Bull. 52: 207-208.

Vine, S. W., S. R. Humphrey, and R. W. Simons. 1989. The ecology of hydric hammocks: a community profile. U. S. Fish Wildl. Serv. Biol. Rep. 85(7.26), 81 pp.

Vogt, W. 1938. Preliminary notes on the behavior and the ecology of the eastern willet. Proc. Linn. Soc. 49. New York.

Walbeck, D. E. 1988. Solitary nesting by great blue herons in Maryland. Maryland Birdlife 44: 119-121.

Walkinshaw, L. H. 1935. Studies of the short-billed marsh wren (*Cistothorus stellaris*) in Michigan. Auk 52: 362-369.

Walkinshaw, L. H. 1935. The incubation period of the sora rail. Wilson Bull. 47: 79-80.

Walkinshaw, L. H. 1937. The Virginia rail in Michigan. Auk 54: 464-475.

Walkinshaw, L. H. 1939. The Yellow Rail in Michigan. Auk 56: 227-237.

Walkinshaw, L. H. 1940. Summer life of the sora rail. Auk 57: 153-168.

Wall, E. 1919. California black rail at San Bernardino, California. Condor 21: 238.

Walsh, J. F., J. Grunewald, and B. Grunewald. 1985. Green-backed herons (*Butorides striatus*) possibly using a lure and using apparent bait. J. Ornithol. 124: 439-442.

Walsh, L. L. 1929. Snowy egret (*Egretta candidissima candidissima*) in northern New Jersey. Auk 46: 536-537.

Warburton, F. 1948. Green heron captures flying dragonflies. Auk 65: 132.

Ward, P., and A. Zahavi. 1973. The importance of certain assemblages of birds as 'information centres' for food finding. Ibis 115: 517-534.

Warren, B. S. 1978. Nest site selection in several species of herons and the glossy ibis (Plegadis falcinellus) in three heronries in Virginia. Proc. Conf. Col. Waterbird Group, 1977. Vol. 1: 167-178.

Warren, N. M. 1979. Ecology of the great blue herons on Silver Creek, Idaho. Unpubl. M. S. thesis, Univ. Idaho, Moscow, Idaho.

Waters, A. 1987. Bird usage of heron roost in Augusta [Georgia] from 1980-1987. Oriole 52: 57-61.

Waters, E. 1967. Two herons killing a house sparrow. Brit. Birds. 60: 301.

Waterton, C. 1835. Notes on the habits of the heron. Mag. Nat. Hist. 8: 453-457.

Watson, D. 1977. The hen harrier. T. & A.D. Poyser, Berkhamstead, Herts., England.

Watts, B. D. 1988. Foraging implications of food usage patterns in yellow-crowned night herons (*Nycticorax violacea*). Condor 90: 860-865.

Watts, B. D. 1989. Nest site characteristics of yellow-crowned night herons in Virginia. Condor 91: 979-982.

Watts, B. D. 1991. Yellow-crowned night heron. Pages 493-495 *in* Virginia's endangered species (Terwilliger, K., coord.). The McDonald and Woodward Publishing Company, Blacksburg, Virginia.

Wayne, A. T. 1905. Breeding of the little black rail (*Porzana jamaicensis*) in South Carolina. Warbler 1: 33-35.

Webber, T. A., and W. Post. 1983. Breeding seaside sparrows in captivity. Pages 153-162 *in* The seaside sparrow, its biology and management (Quay, T. L., J. B. Funderburg, Jr., D. S. Lee, R. F. Potter, and C. S. Robbins, Eds.). Occ. Paps. North Carolina Biol. Survey 5.

Weber, J. A. 1909. The Virginia and sora rails nesting in New York City. Auk 26: 19-22.

Webster, C. G. 1964. Fall foods of soras from two habitats in Connecticut. J. Wildl. Manage. 28: 163-165.

Webster, J. D., and B. E. Wheeler. 1984. The Big Walnut great blue herons. Proc. Indiana Acad. Sci. 93: 461.

Weeks, J. L. 1974. Ohio wetland inventory. Ohio Dept. Nat. Resour. Div. Wildl. Fed. Aid Proj. W-104-R-16.

Weigel, R. D. 1962. Unusual death of a common egret. Auk 79: 118.

Weise, J. H. 1975. The reproductive biology of the great egret *Casmerodius albus egretta* (Gmelin). M. S. thesis, Florida State Univ., Tallahassee. 66 pp.

Weise, J. H. 1976. Courtship and pair-formation in the great egret. Auk 93: 709-723.

Weise, J. H. 1978. Heron nest-site selection and its ecological effects. Pages 27-34 *in* Wading birds (A. Sprunt, IV, J. C. Ogden, and S. Winckler, Eds.). Natl. Audubon Soc. Res. Rept. No. 7., New York.

Weller, M. W. 1961. Breeding biology of the least bittern. Wilson Bull. 73: 11-35.

Weller, M. W. 1979. Birds of some Iowa wetlands in relation to concepts of faunal preservation. Proc. Iowa Acad. Sci. 86: 81-88.

Weller, M. W. and L. H. Frederickson. 1973. Avian ecology of a managed glacial marsh. Living Bird 12: 269-291.

Weller, M. W., and C. S. Spatcher. 1965. Role of habitat in the distribution and abundance of marsh birds. Agric. Home Econ. Exp. Stn., Spec. Rep. 43, Dep. Zool. Entom., Iowa State Univ., Ames, Iowa. 31pp.

Weller, M.W., B.H. Wingfield, and J.B. Lowe. 1958. Effects of habitat deterioration on bird populations of a small Utah marsh. Condor 60: 220-226.

Welter, W. A. 1935. The natural history of the long-billed marsh wren. Wilson Bull. 47: 3-34.

Werner, H. W., and G. E. Woolfenden. 1983. The Cape Sable sparrow: its habitat, habits, and history. Pages 55-75 *in* The seaside sparrow, its biology and management (Quay, T. L., J. B. Funderburg, Jr., D. S. Lee, R. F. Potter, and C. S. Robbins, Eds.). Occ. Paps. North Carolina Biol. Survey 5.

Werschkul, D. F., E. McMahon, and M. Leitschut. 1976. Some effects of human activity on the great blue heron in Oregon. Wilson Bull. 88: 660-662.

Werschkul, D. F., E. McMahon, M. Leitschuh, S. English, C. Skibinski, and G. Williamson. 1978. Observations on the reproductive ecology of the great blue heron (*Ardea herodias*) in western Oregon. Murrelet 58: 7-12.

Weseloh, D. V. and R. T. Brown. 1971. Plant distribution within a heron rookery. Amer. Midl. Nat. 86: 57-64.

Weston, F. M., Jr. 1913. Swimming of young herons. Auk 30: 111.

White, C. P. 1982. Endangered and threatened wildlife of the Chesapeake Bay region: Delaware, Maryland, and Virginia. Tidewater Publishers, Centreville, MD.

White, R. E. (Ed.). 1985. Eldridge tide and title book. Boston, Massachusetts.

White, R. E. (Ed.). 1986. Eldridge tide and pilot book. Boston, Massachusetts.

Whitehead, P. E. 1989. Toxic chemicals in great blue heron (*Ardea herodias*) eggs in the Strait of Georgia. Pages 177-183 *in* The ecology and status of marine and shoreline birds in the Strait of Georgia, British Columbia (Vermeer, K., and R. W. Butler, Eds.). Can. Wildl. Serv., Ottawa, ON, Can. 186 pp.

Whyte, R. J., and B. W. Cain. 1979. The effect of grazing on nesting marshbird habitat at the Welder Wildlife Refuge, San Patricio County, Texas. Bull. Texas Ornithol. Soc. 12: 42-46.

Wiens, J. A. 1966. Notes on the distraction display of the Virginia rail. Wilson bull. 78: 229-231.

Wiens, J. A. 1969. An approach to the study of ecological relationships among grassland birds. A. O. U. Ornith. Monogr. No. 8. 93 pp.

Wiens, J. A. 1973. Pattern and process in grassland bird communities. Ecological Monographs 43: 237-270.

Wiese, J. H. 1978. Heron nest-site selection and its ecological effects. Pages 27-34 *in* Wading birds (A. Sprunt, IV, J. C. Ogden, and S. Winckler, Eds.) Natl. Aububon Soc. Res. Rept. No. 7., New York.

Wiese, J. H., and R. L. Crawford. 1974. Joint 'leap-frog' feeding by Ardeids. Auk 91: 836-837.

Wijnaendts, C. J. A. 1954. Coition of little bittern on nest. Brit. Birds 47: 24-25.

Wilbur, S. R. 1974. The literature of the California black rail. U.S. Fish and Wildl. Serv. Spec. Sci. Rep. Wildl. No. 179.

Wilbur, S. R., and R. E. Tomlinson. 1976. The literature of the western clapper rails. U. S. Fish Wildl. Serv. Spec. Sci. Rept. Wildl. No. 194.

Wilburn, J. W. 1979. Lincoln great blue heron rookery study 1970. Appendix to statewide heron rookery survey progress report. California Dept. of Fish and Game, Sacramento.

Wilcox, C. G. 1986. Comparison of shorebird and waterfowl densities on restored and natural intertidal mudflats at Upper Newport Bay, California, USA. Colon. Waterbirds 9: 218-226.

Wilds, C. 1991. Sharp-tailed sparrow. Pages 523-525 *in* Virginia's endangered species (Terwilliger, K., coord.). The McDonald and Woodward Publishing Company, Blacksburg, Virginia.

Willard, D. E. 1975. The feeding behavior and ecology of five species of herons at the Brigantine National Wildlife Refuge, New Jersey. Ph.D. thesis, Princeton Univ., Princeton, New Jersey.

Willard, D. E. 1976. Herons catch two fish in one strike. Auk 93: 391.

Willard, D. E. 1977. The feeding ecology and behavior of five species of herons in southeastern New Jersey. Condor 79: 462-470.

Willey, G. W. 1986. Great blue heron takes clapper rail. Maryland Birdlife 42: 4.

Williams, B. 1973. Growth rate and nesting aspects for the glossy ibis in Virginia, 1972. M. A. thesis, College of William and Mary, Williamsburg, Virginia.

Windingstad, R. M., and D. M. Swineford. 1981. Eustrongylides and pesticide levels in a great blue heron shot in Wisconsin. Prairie Naturalist 13: 61-62.

Wittenberger, J. F., and G. L. Hunt, Jr. 1985. The adaptive significance of coloniality in birds. Pages 1-78 *in* Avian biology. Vol. VIII (D. S. Farner, J. R. King, and K. C. Parkes (Eds.). Academic Press, New York.

Wolf, B. O., and S. L. Jones. 1989. Great blue heron deaths caused by predation on Pacific lampry. Condor 91: 482-484.

Wood, H. B. 1937. Incubation period of Virginia rail. Auk 54: 535-536.

Wood, N. A. 1909. Notes on the occurence of the yellow rail in Michigan. Auk 26: 1-3.

Woolfenden, G. E. 1956. Comparitive breeding behavior of *Ammospiza caudacuta* and *A. maritima*. Univ. of Kansas Publ. Nat. Hist. 10: 45-75.

Wright, E. G. 1946. Incidents of least bittern family life. Passenger Pigeon 8: 124.

Yeates, G. K. 1940. Some notes on the bittern. Brit. Birds 34: 98.

Young, C. A. 1983. The effects of a great blue heron (*Ardea herodias*) colony upon vegetation at Pine Point, Scugog Island. M.S. thesis, Trent University, Petersborough, Ontario. 89 pp.

Zedler, J. B. 1982. The ecology of southern California salt marshes: a community profile. USF&WS Biol. Serv. FWS/OBS-81/54. 110 pp.

Zembal, R., and J. M. Fancher. 1988. Foraging behavior and foods of the light-footed clapper rail. Condor 90: 959-962.

Zembal, R., M. Fancher, and C. S. Nordley. 1985. Intermarsh movements by light-footed clapper rails indicated in part through regular censusing. California Fish Game 71: 164-171.

Zembal, R., and B. W. Massey. 1981. A census of the light-footed clapper rail in California. West. Birds 12: 87-99.

Zembal, R., and B. W. Massey. 1983. To catch a clapper rail - twice. N. Am. Bird-Bander 8: 144-148.

Zembal, R., and B. W. Massey. 1983. The light-footed clapper rail: distribution, nesting strategies, and management. Cal-Neva Wildl. Trans. 1983: 97-103.

Zembal, R., and B. W. Massey. 1985. Distribution of the light-footed clapper rail in California, 1980-1984. Am. Birds 39: 135-137.

Zembal, R., and B. W. Massey. 1985. Functions of a rail 'mystery' call. Auk 102: 179-180.

Zembal, R., and B. W. Massey. 1986. Light-footed clapper rail census and study, 1986. Progr. Rept., U. S. Fish and Wildl. Serv., Laguna Niguel, California.

Zembal, R., and B. W. Massey. 1987. Seasonality of vocalizations by light-footed clapper rails. J. Field Ornithol. 58: 41-48.

Zembal, M. B., B. W. Massey, and J. M. Fancher. 1989. Movements and activity patterns of the light-footed clapper rail. J. Wildl. Manage. 53: 39-42.

Zeutenhorst, K. J. 1990. Nest sites of the great blue heron in central Iowa. Iowa Bird Life 60: 6-8.

Zimmerman, J. L. 1977. Virginia rail (*Rallus limicola*). Pages 46-56 *in* Management of migratory shore and upland game birds in North America (G. C. Sanderson, Ed.). Internat. Assoc. Fish & Wildl. Agen., Washington, DC.

Zimmerman, J. L. 1984. Distribution, habitat, and status of the sora and Virginia rail in eastern Kansas. J. Field Ornithol. 55: 38-47.

Zimmerman, J. L. 1987. Breeding season distribution and habitat of the Henslow's sparrow in Kansas. Unpubl. Rep. to Kans. Dep. Wildl. and Parks, Topeka.

Zimmerman, J. L. 1988. Breeding season habitat selections by the Henslow's sparrow (*Ammodramus henslowii*) in Kansas. Wilson Bull. 100: 17-24.