Georgia's Marsh Hammocks

A biological survey

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Southern Environmental Law Center

ABSTRACT

Between October 2001 and September 2002, the Southern Environmental Law Center, in conjunction with the Georgia Conservancy and the Altamaha Riverkeeper, conducted a series of biological inventories of marshland hammocks in the coastal region of Georgia. The surveys represent the first comprehensive investigation of these unique and threatened coastal resources. Marsh hammocks support maritime forests, a disappearing natural community. Many hammocks provide roosting and nesting areas for wading birds (including the endangered Wood Stork), as well as habitat for Diamondback Terrapin and other wildlife. Hammocks are facing increasing development pressure, and lack of information about these resources is hampering conservation efforts of state agencies and private conservation organizations. Preliminary data analyses have revealed that small hammocks (5-10 acres in size), support a significant diversity of plant and bird species. Yet because of their differing locations, sizes, and origins, marsh hammocks exhibit widely varied characteristics. Only through additional investigation can we gain a sound understanding of marsh hammocks and the dynamic role they play in our marshland ecosystem.

FOREWORD

Along the Georgia coast, small islands rise out of a lush carpet of seemingly endless marsh grass. The watery pathways to these islands meander through the quiet, almost mysterious landscape inhabited by a wide variety of native birds, animals, and plants. Along the eastern seaboard, few places retain such a vast and wild character. Many Georgians consider this landscape to be an important part of their natural heritage.

Georgia's marsh hammocks provide a secluded sanctuary for wildlife, away from the coastal mainland that has become increasingly congested with development, traffic, and noise. Hammocks serve as roosting grounds for birds as they rest while feeding in the marsh. They also serve as nesting grounds for colonies of Ibises, Herons, Wood Storks and other colonial nesters. Through their behavior, the birds reveal that the marshland – including the hammocks – is a single habitat.

Indeed, the late Dr. Eugene P. Odum, Distinguished Professor Emeritus, Institute of Ecology, University of Georgia, believed that Georgia's marsh hammocks are an integral part of the coastal marshland ecosystem. He felt that together, the hammocks and surrounding marshes function as one continuous ecological system.

Many Georgians feel a sense of urgency to protect this extraordinary place. Mounting pressure to change the landscape through the construction of bridges providing access to hammocks for new development has been met with a rising tide of resistance.

This survey provides new information that may help us to make better decisions about the future of Georgia's marsh hammocks.

INTRODUCTION

Georgia's unique marsh hammocks are a subset of back barrier islands – areas of upland embedded in Georgia's vast tidal marshes and ranging in size from less than one acre to over 1,000 acres. Approximately 1,200 hammocks comprising over 17,000 acres are now identified and mapped on the Georgia coast. Most marsh hammocks support maritime forests, a disappearing natural community. The Partners in Flight program, a U.S. Fish and Wildlife Service bird conservation initiative, has identified maritime forests as one of three priority habitats for conservation of migratory songbirds in the South Atlantic coastal region.

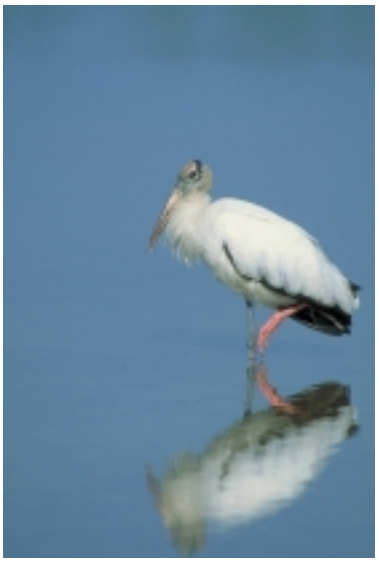
Many hammocks provide roosting and nesting areas for wading birds (including the endangered Wood Stork), as well as habitat for Diamondback Terrapin, and other wildlife. Although these general ecological attributes are recognized, no systematic biological surveys of Georgia's marsh hammocks have been published, and there is little site-specific information about the ecological significance of hammocks.

Georgia's marsh hammocks are under increasing development pressure. Because of this pressure, the Georgia Department of Natural Resources (DNR) established a Coastal Marsh Hammock Advisory Council and a subsequent stakeholder group to review issues associated with the development of marsh hammocks in coastal Georgia. Specifically, the advisory council was charged with identifying the ecological importance of marsh hammocks, evaluating the impact of their continued development, and recommending a range of solutions to mitigate the effects of development of coastal marsh hammocks.

The council identified a critical need to obtain information on the ecological communities of marsh hammocks:

> *At the present time, we know little about the ecological communities and individual organisms (e.g., birds, reptiles, mammals, insects, plants) that are characteristic of marsh hammocks. This information is fundamental to any attempt to manage back-barrier environments. Until we know the importance of these habitats to biota, we cannot seek an acceptable balance between conservation and development.*

The Southern Environmental Law Center (SELC), in conjunction with the Georgia Conservancy and the Altamaha Riverkeeper, addressed this need in part by conducting an inventory of a sample group of publicly owned marsh hammocks in the coastal marshlands of Georgia. Three surveys were conducted with a group of volunteer scientists in the fall of 2001, spring of 2002, and fall of 2002.



Wood Stork © Bill Lea

The surveys have revealed that, because of their varying locations, sizes, and origins, marsh hammocks exhibit widely diverse characteristics. In fact, many hammocks include a complex of upland and wetland habitats. The survey results indicate that even small hammocks provide valuable habitat for a wide diversity of plant and bird species. Additional investigation will yield a more complete understanding of hammocks and their role in Georgia's marshland ecosystem, allowing for the best possible conservation strategies.

SURVEY METHODS

The objective of the surveys was to collect, analyze, and publish information about the ecological communities and individual species found on marsh hammocks. During 2001, SELC worked closely with the Georgia Conservancy to determine the best way to gather scientific

information about the biological characteristics of marsh hammocks. We determined that we could achieve the most cost-effective and comprehensive study of hammock biota through an intensive biological inventory, or "Bioblast." In a Bioblast, a group of scientists takes a biological snapshot of an area, listing kinds, commonness, and locations of all of the flora and fauna found during a given time period. This methodology is currently being used by the U.S. Geological Survey to characterize the biological status of the Shenandoah National Park, the Blue Ridge Parkway, and other areas.

SELC conducted the first marsh hammock bio-inventory in October 2001 with a group of volunteer scientists. The hammocks surveyed included a diverse group of publicly owned hammocks in the northern and central regions of the coast. In June of 2002, we conducted a survey that focused on the use of hammocks by nesting birds. Approximately 40 scientists from the University of Georgia, U.S. Fish and Wildlife Service, Georgia Department of Natural Resources, conservation organizations, and other agencies and institutions assisted in the June survey. Local citizens, conservation organizations, and commercial fishermen provided boat transportation. In addition to the volunteer scientists, fishermen and local citizens, we worked in partnership with the Georgia Conservancy, which arranged a film crew to record the bio-inventory process for a public education video. In September 2002, we conducted the third full-scale bio-inventory during the fall bird migration season.

Site Selection Procedure

Bioblast volunteer scientists sampled hammocks that were selected using a methodology that yields a range of hammocks of different sizes, shapes, and origins (man-made and natural). We identified the hammocks using aerial photography, U.S. Geological Survey topographic maps, local county fishing maps, and Geographic Information Systems (GIS). The sample set contained all publicly owned marsh hammocks. Within this set, we grouped the hammocks into categories of large (> 50 acres), medium (10-50 acres) and small (<10 acres) hammocks. Hammocks were further categorized by northern and central coastal Georgia regions. The southern region was excluded due to an insufficient number of publicly accessible hammocks.

From these categories, we selected a sample of hammocks of varying origins from each category. For each of the bio-inventories, SELC assembled four teams of scientists. At a minimum, each team included scientists from the major disciplines of interest: 1) botanists experienced with local vegetation; 2) field ornithologists; and 3) trained naturalists who could identify evidence of mammal usage. In June, our teams included scientists from each of the three specialties listed above as well as a hydrologist who investigated groundwater availability and a wetland scientist who noted soil characteristics. For the survey conducted in the fall of 2002, an archeologist also participated.

Field Surveys

To gain access to the hammocks, we engaged small boats with licensed captains at local marinas and public dock facilities to transport scientists to and from the hammocks. The protocol was for the teams to collect data over a two- to four-day period. The average number of observers per hammock (or hammock section for large hammocks) was fairly consistent among surveys (fall 2001 = 5, spring 2002 = 7, and fall 2002 = 6). Team members generally spent between one to three hours on each hammock, collecting data on standardized data sheets. On these forms, the survey participants listed the species they identified and observed, and made notations about such things as species commonness, behavior, and unusual characteristics. Bioblast leaders noted general information, such as time of day and weather conditions. In the fall of 2002, we designated one team to record specific data gathered along a perpendicular line transect on each hammock. Within a one meter swath on either side of the transect, we recorded all species observed, tree diameters, and vegetation height.

Data Compilation

Following each inventory, data were compiled and evaluated to determine if there were patterns of similarity among hammocks within similar regions, size ranges, and common origins. The results of these biological surveys may help those involved in hammock conservation evaluate the impacts of hammock development and identify solutions to mitigate those impacts. It is hard to predict how much of the nearly 17,000 acres of hammocks may become the subject of permanent protection plans – either public or private – but these data analyses can play an important role in whatever protections are achieved.

While not directed at privately owned hammocks, the bio-inventories have nevertheless uncovered important information about the characteristics of hammocks in different regions of the coast. This information can be used to help target acquisition resources for small hammocks that play an important role in bird migration not originally recognized. In these ways, the results of this project, along with future studies, can support all three aspects of hammock conservation – acquisition, management, and data generation.

RESULTS

Overview

The specific objectives of the Bioblast data analyses were to:

1. Describe the biodiversity of plant and bird species found on all marsh hammocks surveyed;
2. Compare plant and bird assemblages by hammock size;
3. Compare plant and bird assemblages between northern and centrally located hammocks; and
4. Compare bird assemblages between migration and non-migration seasons.

We also intended to compare plant and bird assemblages between natural and man-made hammocks. However, because only three small dredge-spoil hammocks were surveyed, we did not have sufficient data to make these comparisons.

A total of 23 marsh hammocks were inventoried as part of the three surveys. The hammocks ranged in size from 0.5 to 375 acres with 16 of the 23 hammocks under 40 acres in size. Three of the smallest hammocks were of man-made origin (dredge spoil islands). A total of 203 plant species were observed. There appears to be some correlation between hammock size and diversity of plants with the strongest relationship at smallest hammock sizes. Hammocks of less than 5 acres (n = 7) had an average of 20 plant species. Hammocks larger than 5 acres (n = 15) had an average of 50 plant species. Hammocks between 10 and 50 acres (n = 8) and hammocks larger than 50 acres (n = 7) had similar average numbers of plant species (48 and 52, respectively).

The total number of bird species observed was 113 and included song birds, raptors, shore and wading birds. In addition, Painted Buntings and endangered Wood Storks were observed on hammocks. The diversity of bird species appears to increase with hammock size until a threshold of 5 acres is reached. Beyond this size, bird species diversity appears unrelated to further increases in hammock size. Hammocks less than 5 acres (n = 8) had an average of 10 bird species, while hammocks greater than 5 acres (n = 15) had an average of 35 bird species observed.

In addition, the diversity of bird species appears to be associated with time of year (migration v. non-migration). The fall 2002 survey was conducted September 17, 18 and 19 during the fall migration season. A greater number of bird species were observed on all hammocks during this time than during each of the previous surveys. A cumulative total of 56 and 57 bird species were counted on all of the hammocks during the fall 2001 and the spring 2002 surveys, respectively. By contrast, a cumulative total of 74 bird species were observed during the fall 2002 migration season. However, only hammocks larger than 10 acres in size were surveyed in the fall of 2002, thereby contributing in part to the greater average bird diversity. Considering only hammocks greater than 10 acres in size, more bird species were observed on average (29, n = 10) during the fall 2002

migration period than during the fall 2001 and spring surveys (17 and 21, n = 5 and 9, respectively).

DATA ANALYSES

A total of 23 marsh hammocks were inventoried as part of the three surveys (see Appendix A for a listing of hammock locations). The hammocks ranged in size from 0.5 to 375 acres with 16 of the 23 hammocks under 40 acres in size. Three of the smallest hammocks were of man-made origin (dredge spoil islands) (Table 1).

Table 1. Bioblast hammocks surveyed.

Hammock	Size (acres)	Fall 2001	Spring 2002	Fall 2002
Dead Man	0.4	x		
Sandy Farris*	0.6		x	
Cheryl*	1.2		x	
Monkey*	1.2		x	
Hammock near Mary's	2.3	x		
Gayle	2.4		x	
Fishing	3.8		x	
Little Moses	4.5		x	
Pumpkin	9.5	x	x	
Decent	10.1	x		x
Jack	20.3	x	x	x
Bear	25		x	
Moses	25.7			x
Pine near Ossabaw	38.2		x	
Mary	38.9	x	x	x
Pigeon	39.1		x	x
Beach	67			x
Two	70.1	x		
Long Island	92			x
Pine near Wassaw	95.8		x	x
Little Sapelo	103.5		x	x
Flora	228.4		x	
Little Tybee - Long Island	375.2			x

* indicates dredge spoil hammock

During each survey period, plant and bird species observed on each hammock were recorded (Appendix B and C) and summarized (Table 2, 3). Some of the most common bird species, observed on more than 10 hammocks, were: Northern Cardinal, Carolina Chickadee, Carolina and Marsh Wren, Pine and Yellow-throated Warbler, Yellow-bellied Sapsucker, Blue-gray Gnatcatcher, Downy and Red-bellied woodpeckers, Boat-tailed Grackle, and Great Egret. In addition, Painted Buntings were observed on 10 hammocks but only during the spring survey in 2002. Wood Storks were also observed on 8 of the 23 hammocks surveyed. Two state-listed species of plants designated threatened in Georgia were observed during the biological surveys. These were *Ceratiola ericoides* (Rosemary or Sandhill Rosemary), and *Sageretia miutiflora* (Climbing Buckhorn).

Although only some of the observers recorded the number of individual birds of each species per hammock, we still estimated the relative abundance of species based on the subset of observations where the number of birds was recorded. The easiest way to view this information is a cumulative count of the number of birds by species observed during the three survey periods. American Redstart, Blue-gray Gnatcatcher, Carolina Chickadee, Carolina Wren, Great Egret, Northern Cardinal, Painted Bunting, Red-bellied Woodpecker, Red-winged Blackbird, Summer Tanager, and Yellow-throated Warbler were among the species recorded in the highest numbers (Figure 1).

Species Diversity

On all hammocks, a total of 203 plant species were observed (Appendix B). The total number of bird species observed was 113 and included song birds, raptors, shore and wading

birds as well as the endangered Wood Stork. Birds were identified as either permanent residents, summer or winter migrants (Appendix C).

Species Diversity by Hammock Size

Overall there is a trend of increasing biodiversity with increasing size of hammocks. In Figure 2 hammocks are arranged in order of increasing size with Dead Man Hammock at 0.4 acres and Little Tybee's Long Island at 375 acres. Dead Man Hammock and Little Moses Hammock are less than 5 acres in size.

Table 2. Total number of plant species observed per hammock.

Hammock	Fall 2001	Spring 2002	Fall 2002	Overall Number of Plant Species
Beach				74
Bear		48		48
Cheryl		21		21
Dead Man	15			15
Decent	28		55	76
Fishing		9		9
Flora		33		33
Gayle		25		25
Hammock near Mary's	0			0
Jack	14	32	7	41
James'		33		33
Little Sapelo		57	8	58
Little Tybee - Long Island			62	62
Long Island			56	56
Mary	20	43	9	62
Monkey		13		13
Moses			9	9
Pigeon		38	57	77
Pine / OSS		37		37
Pine / WAS		34	55	66
Pumpkin	22	23		41
Sandy Farris		25		25
Two	15			15

Plant Diversity by Hammock Size

The number of plant species observed on a hammock increases with increasing hammock size (Table 4, Figure 3). However, this relationship is not constant over the entire range of hammock sizes. The largest two hammocks, Flora and Little Tybee's Long Island, do not have significantly greater plant diversity than smaller hammocks. For example, hammocks of less than 5 acres (n = 7) had an average of 20 plant species while hammocks larger than 5 acres (n = 15) had an average of 50 plant species. Yet medium sized hammocks between 10 and 50 acres (n = 8) had similar average numbers of plant species as the largest hammocks above 50 acres (n = 7).

Table 3. Total number of bird species observed per hammock.

Hammock	Fall 2001	Spring 2002	Fall 2002	Overall Number of Bird Species
Beach			36	36
Bear		17		17
Cheryl		0		0
Dead Man	10			10
Decent	24		24	41
Fishing		3		3
Flora		31		31
Gayle		9		9
Hammock near Mary's	18			18
Jack	15	22	24	45
James'		18		18
Little Sapelo		17	24	32
Little Tybee - Long Island			26	26
Long Island			32	32
Mary	11	30	22	46
Monkey		12		12
Moses			32	32
Pigeon		24	27	44
Pine / OSS		32		32
Pine / WAS		18	41	47
Pumpkin	14	27		35
Sandy Farris		8		8
Two	23			23

Figure 1. Cumulative count of birds observed during Bioblast.

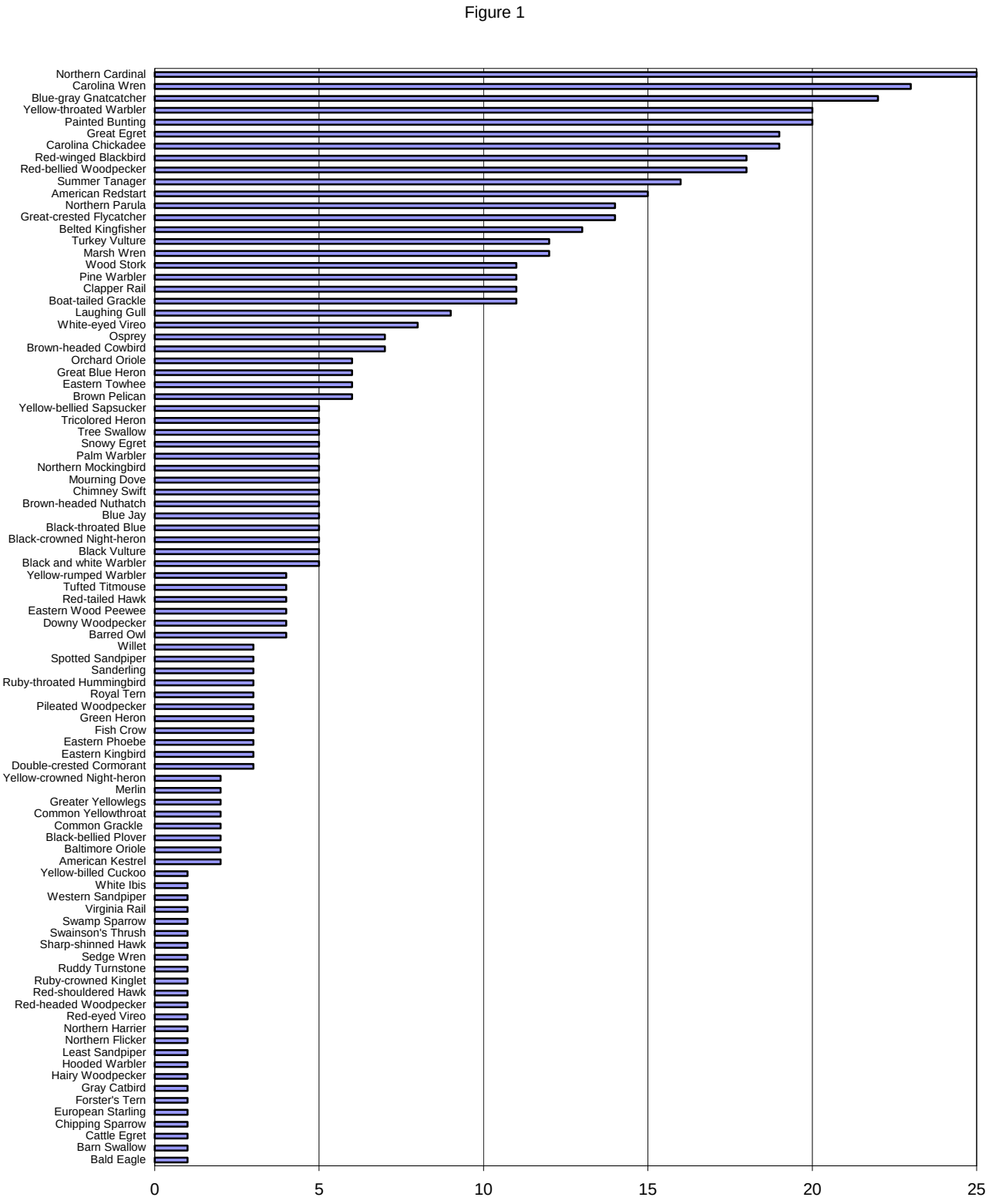


Figure 2. Plant and bird richness by hammock.

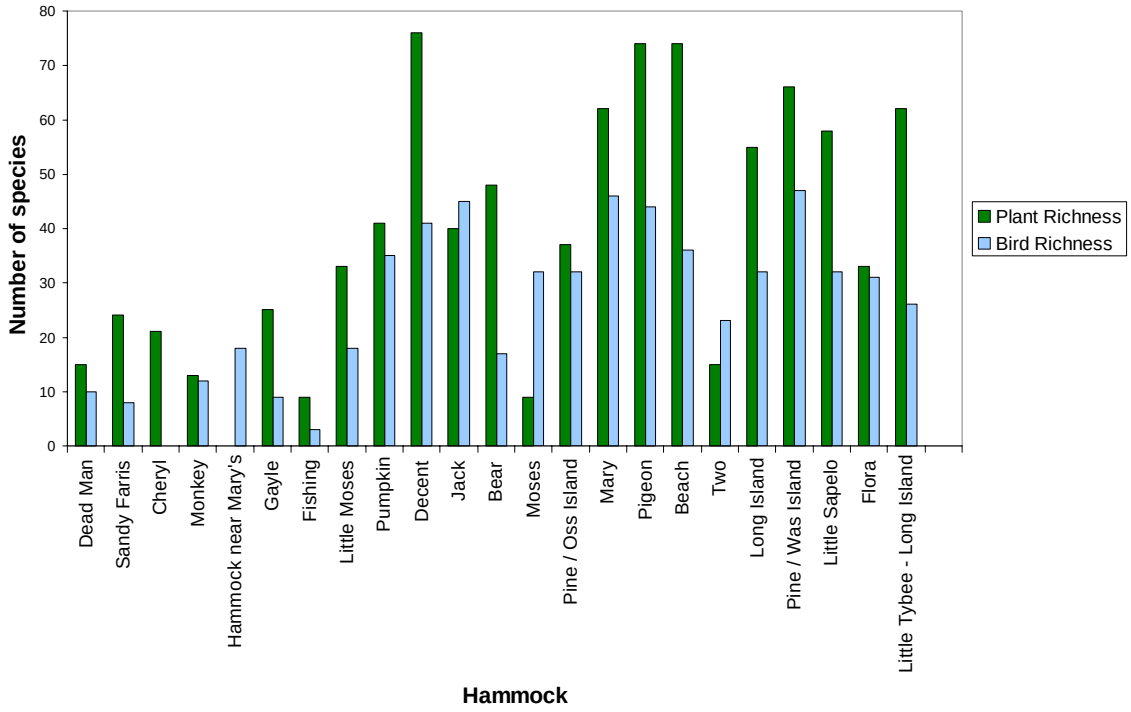
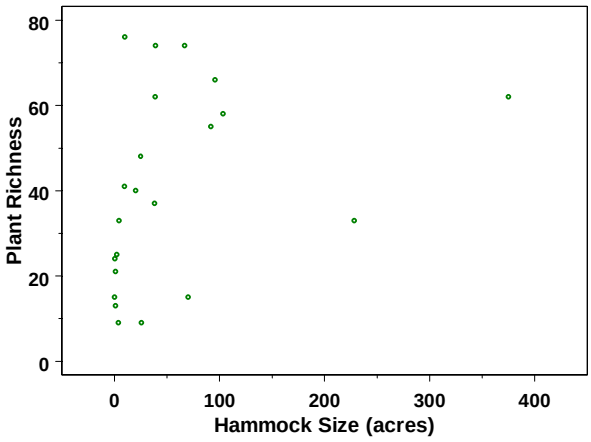


Figure 3. Plant species and hammock size plotted.



If we remove the largest two hammocks and restrict a regression analysis to the remaining 21 hammocks over the range of size from a 0.5 to 100 acres, there is a significant positive linear relationship between hammock size and plant richness such that with every 30-acre increase in hammock size there is an associated increase of roughly ten plant species with a 95% confidence interval of between 1.99 and 18.8 species (p-value = 0.0182 for a two sided t-test of slope equal to zero) (Figure 4).

We cannot, however, describe the relationship between hammock size and plant richness above 100 acres. The smaller plant diversities evident on Flora and Little Tybee suggest that there could be some type of maximum level of plant diversity; however, with so few hammocks greater than 50 acres in the sample set, it is difficult to make such a characterization.

*(Estimated mean plant number given hammock size (acres) = 28.5 + 0.3465 * size*

(6.2721) (0.1334)

Estimated standard error of mean plant number = 20.29, 18 d.f.)

Bird Diversity by Hammock Size

Similar to plant diversity, the number of bird species is positively related to hammock size when considering all hammocks surveyed (Table 5, Figure 5). This can be most easily seen if we log hammock size on the x-axis (Figure 6).

A regression model of all hammocks indicates a significant positive relationship between hammock size and bird richness such that a doubling of hammock size is associated with an increase of 3.5 birds, yet there is still high variability in the estimate of this slope such that

the 95% confidence interval is between 1.86 and 5.25 species (p-value = 0.0003 for a two sided t-test of slope equal to zero).

It is interesting to note, however, that there appears to be a clustering of values at hammock sizes below 5 acres (average number of birds = 9.75) and a clustering of values above 5 acres (average number of birds = 34.6) with significantly different means (p-value<0.000).

Therefore, if we restrict our analysis to the relationship between hammock size and bird richness to only those hammocks of greater than 5 acres in size, we see that there is no significant increase in species number with increasing hammock size beyond this apparent threshold of 5 acres.

Examining a regression model restricted to only those hammocks above 5 acres in size, we see that there is no significant relationship between hammock size and bird richness (p-value = 0.3604 for a two sided t-test of slope equal to zero, 13 d.f.), and if we look at only those hammocks less than 5 acres in size, there is not a significant relationship between hammock size and bird richness (p-value = 0.5799 for a two sided t-test of slope equal to zero, 8 d.f.).

In summary, the diversity of bird species appears to increase with hammock size until a threshold of 5 acres is reached. Beyond this size, bird species diversity appears unrelated to further increases in hammock size.

Table 4. Plant richness and hammock size.

Hammock	Size	Plant Richness
Dead Man	0.4	15
Sandy Farris	0.6	24
Cheryl	1.2	21
Monkey	1.2	13
Hammock near Mary's	2.3	N/A
Gayle	2.4	25
Fishing	3.8	9
Little Moses	4.5	33
Pumpkin	9.5	41
Decent	10.1	76
Jack	20.3	40
Bear	25	48
Moses	25.7	9
Pine / Oss Island	38.2	37
Mary	38.9	62
Pigeon	39.1	74
Beach	67	74
Two	70.1	15
Long Island	92	55
Pine / Was Island	95.8	66
Little Sapelo	103.5	58
Flora	228.4	33
Little Tybee - Long Island	375.2	62

Figure 4. Relationship between plant species diversity and hammock size.

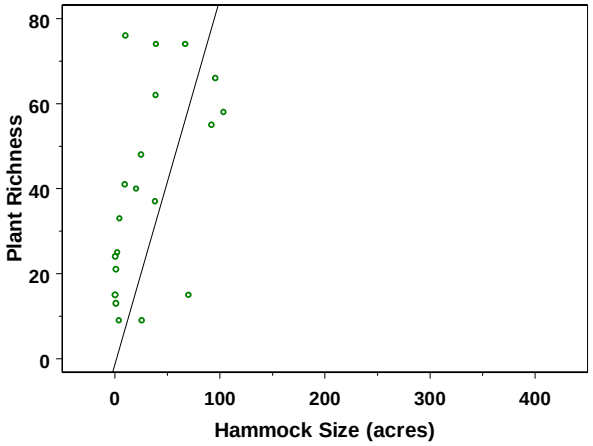


Figure 5. Bird richness plotted according to hammock size.

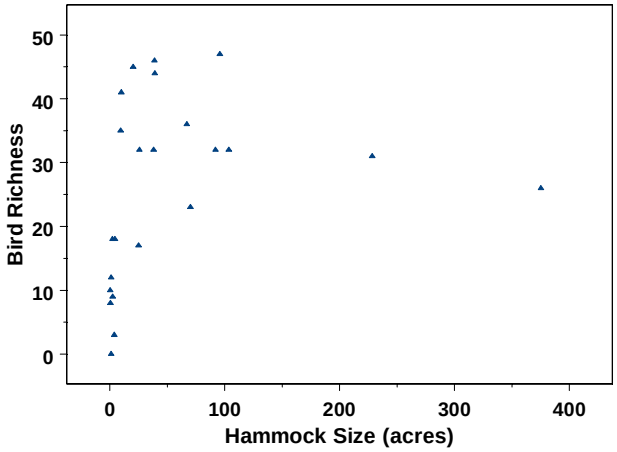


Table 5. Bird richness and hammock size.

Hammock	Size	Bird Richness
Dead Man	0.4	10
Sandy Farris	0.6	8
Cheryl	1.2	0
Monkey	1.2	12
Hammock near Mary's	2.3	18
Gayle	2.4	9
Fishing	3.8	3
Little Moses	4.5	18
Pumpkin	9.5	35
Decent	10.1	41
Jack	20.3	45
Bear	25	17
Moses	25.7	32
Pine / Oss Island	38.2	32
Mary	38.9	46
Pigeon	39.1	44
Beach	67	36
Two	70.1	23
Long Island	92	32
Pine / Was Island	95.8	47
Little Sapelo	103.5	32
Flora	228.4	31
Little Tybee - Long Island	375.2	26

Bird Diversity by Migration Season

In addition to hammock size, diversity of bird species appears to be associated with time of year (migration v. non-migration). The fall 2002 survey was conducted on September 17, 18 and 19, and captured observations during the fall migration season for that year. A greater number of bird species was observed on all hammocks during this time than during each of the previous surveys (Appendix C). A cumulative total of 56 and 57 bird species was counted on all of the hammocks during the fall 2001 and the spring 2002 surveys respectively. By contrast, a cumulative total of 74 bird species was observed during the fall 2002 migration season. Most of the additional birds observed during fall migration were warblers and thrushes.

In Figure 7, we examine the difference in average number of bird species observed by hammock for each survey period. We see an average of roughly 17 birds per hammock for non-migration periods and 29 birds per hammock for the fall migration period. However, only hammocks larger than 10 acres in size were surveyed in the fall of 2002, thereby possibly contributing to the higher average bird diversity. Considering only hammocks greater than 10 acres in size, more bird species were observed on average (29, n = 10) during the fall 2002 migration period than during the fall 2001 and spring surveys (17 and 21, n = 5 and 9, respectively).

Figure 6. Relationship between bird richness and hammock size.

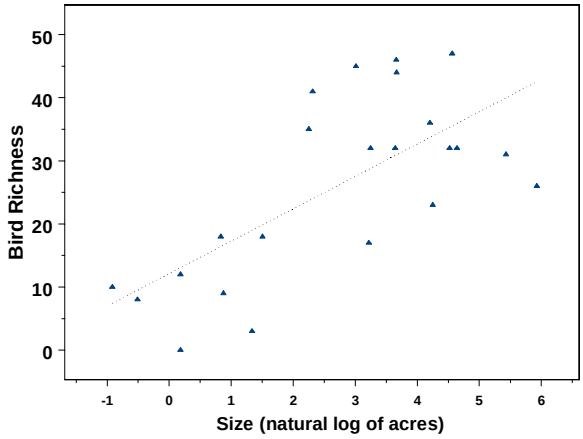


Figure 7. Average number of bird species for hammocks surveyed.

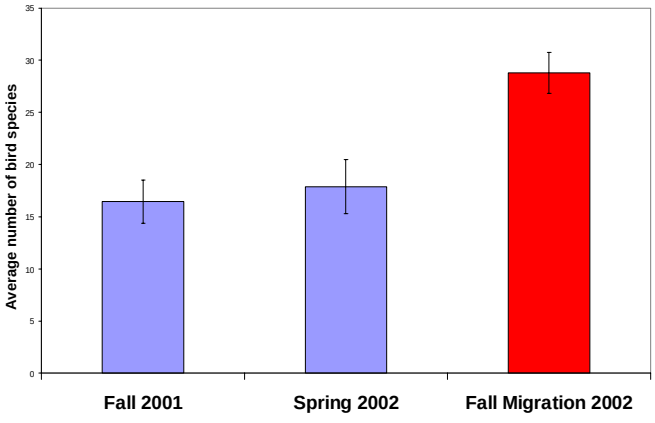
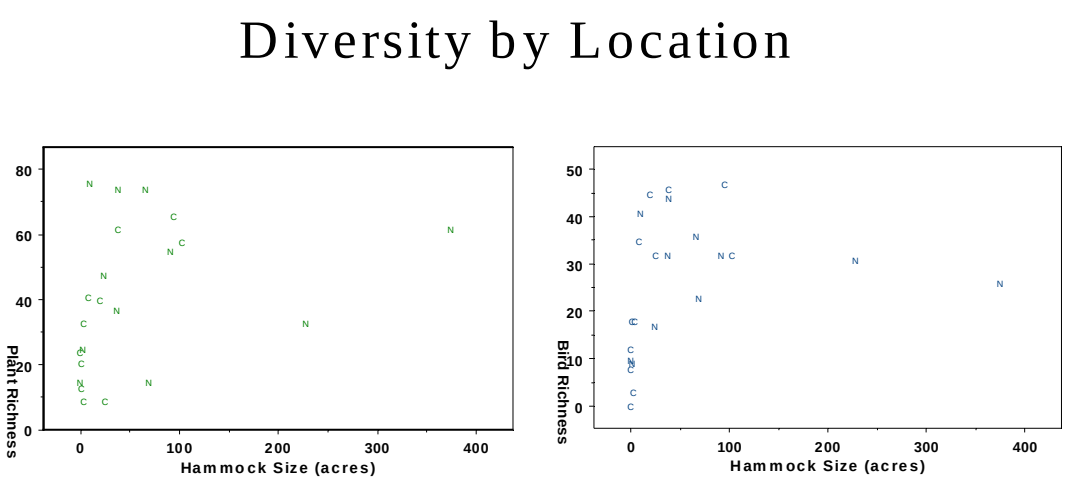


Figure 8. Diversity compared between regions.



Diversity by Location

After taking into account hammock size, no clear pattern exists to detect differences in species diversity between northern and centrally located hammocks along the Georgia coast (Figure 8). Average plant richness for northern hammocks = 46.72 and for central hammocks = 34.18, but the difference is not significant (p-value = 0.1198). This is probably due to the average size of hammocks in each grouping such that central hammocks were smaller on average than northern hammocks (average of northern hammocks = 86.17 acres and average for central hammocks = 25.61, difference in means p-value = 0.0982).

Birds of Conservation Priority

Marsh hammocks provide habitat to sixteen bird species of "high" or "highest" conservation priority. Fifteen bird species found on marsh hammocks during the surveys are ranked of "high conservation priority" in the South Atlantic Coastal Plain by the U.S. Fish and Wildlife Service's Partners in Flight program. These species are the endangered Wood Stork, Brown-headed Nuthatch, Black-throated Blue Warbler, Brown Pelican, White Ibis, Northern Parula, Hooded Warbler, Clapper Rail, Short-billed Dowitcher, Sedge Wren, Yellow-throated Warbler, Prairie Warbler, Louisiana Waterthrush, Veery, and Worm-eating Warbler. The Painted Bunting is ranked of "highest conservation priority" in the South Atlantic Coastal Plain. Painted Buntings were found on ten of the fifteen marsh hammocks surveyed during the breeding season survey in Spring 2002. Marsh hammocks appear to be important habitats for the imperiled Painted Bunting.

CONCLUSION

One of the most important discoveries made through the analysis of Bioblast data is that small hammocks support a great diversity of plant and bird species. Prior to conducting the Bioblast surveys, there was a perception that larger hammocks, those on the order of 100 acres or more in size, would prove to be the most ecologically important for conservation and protection priorities. A review of the Bioblast data indicates that much smaller hammocks, those just 5 to 10 acres in size, provide valuable habitat for bird and plant species. The fact that smaller hammocks support a rich assemblage of species is an important consideration, and conservation and protection strategies should be designed accordingly.

Common Yellowthroat © Lynda Richardson

A strategy that focuses on the conservation of only large hammocks will fall short of protecting the important habitat values that Georgia's marsh hammocks provide.

We also know that hammocks are an important resource deserving additional attention and research. This project fits into the larger program of hammock conservation and research efforts. It is important that we continue these undertakings to document the importance of marsh hammocks and gain greater insight into their values. The Coastal Resources Division of the Georgia Department of Natural Resources has completed a Geographic Information System (GIS) database of marsh hammocks that includes information such as ownership and origin. The information generated during Bioblast is an important complement to the GIS data. This tool can help decision-makers gain a better understanding of the resource and implications for distinctions drawn among hammocks in devising hammock conservation strategies.

Proposals for hammock protection recommended by the DNR marsh hammocks stakeholder group include prohibiting bridge access to smaller hammocks. As we continue to gather information about hammocks and the important role they play in the ecology of Georgia's coastal marshlands, it is our hope that our increased understanding will enable us to become better stewards of this valuable resource.

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Partners in Flight, U.S. Fish and Wildlife Service, *South Atlantic Coastal Plain Bird Conservation Plan*, http://www.blm.gov/wildlife/pl_03sum.htm.

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Blue Ridge Parkway Bioblitz, U.S. Geological Survey, http://www.mp1-pwrc.usgs.gov/blitz/blue/blue99.html; http://www.im.nbs.gov/blitz.html.

Facilitating Human Dimensions Research on the Future Management of Coastal Marsh Hammock Development, Final Interim Report of the Coastal Marsh Hammocks Stakeholders Group, June 2003.

~ APPENDIX A ~
Listing of Hammock Locations

Hammock Name	Size (Acres)	GIS Coordinates (obtained from CRD's GIS hammock database)	
Beach Hammock	67.0	*	*
Bear Island	25.0	486573.97	3522762.92
Cheryl Hammock	1.2	469472.27	3466363.33
Dead Man Hammock	0.4	502649.1	3531321.36
Decent Hammock	10.1	507598.46	358823.68
Fishing Hammock	3.8	472620.3	3479171.13
Flora Hammock	228.4	498279.59	3528840.54
Gayle Hammock	2.4	487518.66	3520273.30
Hammock near Mary's	2.3	472044.44	3478211.72
Jack Hammock	20.3	472647.35	3480929.15
Little Moses Hammock	4.5	4673999.67	3482416.70
Little Sapelo Island	103.5	471768.99	3477271.22
Little Tybee Island - Long Island	375.2	508470.58	3537802.67
Long Island	92.0	493894.54	3535550.59
Mary Hammock	38.9	472046.09	3479019.81
Monkey Hammock	1.2	469226.12	3466469.62
Moses Hammock	25.7	474243.08	3482714.21
Pigeon Island	39.1	492339.09	3533702.66
Pine / Ossabaw Island	38.2	487250.38	3519367.64
Pine / Wassaw Island	95.8	499031.09	3526241.67
Pumpkin Hammock	9.5	472701.44	3480069.57
Sandy Farris	0.6	469226.12	3466469.62
Two Hammock	70.1	501968.42	3530252.70

*Beach Hammock is not included in the Coastal Resources Division's GIS database of marsh hammocks because it has an ocean facing beach. For the purposes of Bioblast, we considered it to be a hammock because the hammock is partially sheltered from the ocean by an island. Beach Hammock is clearly marked on most maps including the Chatham County Fishing Map. It is adjacent to Little Tybee Island.

~ APPENDIX B ~
Listing of plant species

Combined plant species list for all three surveys.

Aesculus pavia
Aesculus sylvatica
Amorpha fruticosa
Ampelopsis arborea
Andropogon capillipes
Andropogon glomeratus
Andropogon virginicus
Aralia spinosa
Arenaria lanuginosa
Aristida lanosa
Arundinaria gigantea
Ascliepius sp
Aspelenium platyneuron
Aster tortifolius
Atriplex arenaria
Atriplex patula
Aureolaria laevigata
Baccharis angustifolia
Baccharis halmilifolia
Batis maritima
Bignonia capreolata
Boltonia asteroides
Borrichia frutescens
Bumelia tenax
Callicarpa americana
Campsis radicans
Carya illinoinensis
Cassia fasciculata
Celeria triglomerata
Celtis laevigata
Celtis occidentalis
Cenchrus tribuloides
Centrosema virginiana
Ceratiola ericoides
Cercis canadensis
Chamaesyce bombensis
Chasmanthium ambrosioides
Chasmanthium laxum
Chasmanthium sessiflorum
Cinnanomum camphora
Cirsium horridulum
Cladina subtenuous
Cladonia leporina
Cladonia rangiferina
Clematis sp
Clitoria mariana
Clitoria sp
Cnidoscolus stimulosus
Cocculus carolinus
Commelina erecta
Croton punctatus
Cuthbertia sp
Cynanchium angustifolium
Cyperus arularis
Cyperus haspan
Cyperus odoratus
Cyperus polystachias
Desmodium sp
Dicanthellium ariculare
Dichondra caroliniensis
Dicranum condensarum
Digitaria filiformis
Diodia teres
Dioscorea villosa
Distichilus spicata
Erechtites hieracifolia
Erythrina herbacea
Eupatorium capillifolium
Eupatorium compositifolium
Eustachys glauca
Eustachys petraea
Fimbristylis caroliniana
Fimbristylis castanea
Forestiera segregata
Galactia volubilis
Galactia elliotti
Galactia regularis
Galium sp
Gelsemium sempervirens
Gnaphalium obtusifolium
Gnaphalium purpureum
Heterothara subavillanis
Hydrocotyle bonariensis
Hypericum hypericoides
Ilex cassine
Ilex opaca
Ilex vomitoria
Indigofera caroliniana
Ipomoea imperati
Ipomoea pandurata
Ipomoea pes-caprea
Iva frutescens
Iva imbricata
Juncus roemerianus
Juncus tenuis
Juniperus virginiana
Lagerstroemia indica
Lepidium virginica
Leucobryum albidum
Liatris graminifolia
Limonium carolinianum
Limonium nashii
Liquidambar styraciflua
Littoraria irrorata
Littorina littorina
Lonicera sempervivens
Ludwigia sp
Lyonia lucida
Magnolia grandiflora
Magnolia virginiana
Matelea caroliniensis
Melia azedarach
Melica mutica
Melothria pendula
Mitchella repens
Morus rubra
Myrica cerifera
Nyssa sylvatica
Opuntia pusilla
Opuntia drummondii
Opuntia fusiformis
Opuntia humifusa
Osmanthus americanus
Panicum amarum
Panicum virgatum
Parthenocissus quinquefolia
Paspalum setaceum
Passiflora incarnata
Persea borbonia
Phyllostachys aurea
Physalis viscosa
Phytolacca americana
Phytolacca erecta
Phytolacca rigida
Pinus elliotti
Pinus taeda
Pinus thunbergii
Pityopsis graninifolia
Pluchea purpurascens
Polypodium polypodiodes
Prunus caroliniana
Prunus serotina
Pteridium aquilinum
Quercus laurifolia
Quercus nigra
Quercus pagnda
Quercus virginiana
Rhus copallina
Rhynchosia difformis
Rhynchostegium serrulatum

~ Appendix B Continued ~

Robinia pseudoacacia
Rubus trivialis
Rumex bastatulus
Sabal minor
Sabal palmetto
Sageretia minutiflora
Salicornia bigelowii
Salicornia europaca
Salicornia virginica
Sapindus saponaria
Sapindus sp
Sapium sebiferum
Sassafras albidum
Scleria glomeratus
Scleria triglomerata
Sectaria glauca
Serenoa repens
Sesurium portulacastrum
Seymeria pectinata
Smilax auriculata
Smilax bona nox
Smilax laurifolia
Smilax pumila
Smilax rotundifolia
Solidago sempervirens
Sorghum halepense
Spartina bakkeri
Spartina cynosuroides
Spartina alterniflora
Spartina patens
Sporobolis virginicus
Stenotaphrum secundatum
Strophostyles helvula
Supatorium serotinum
Symplocus tinctoria
Tamarix parviflora
Tameriscus gallica
Tillandsia usneoides
Toxicodendron radicans
Trichostema setaceum
Triplasis purpurea
Ulva lactuca
Uniola paniculata
Vaccinium arboretum
Verbesina occidentalis
Vigna luteola
Vitis aestivalis
Vitis labrusca
Vitis rotundifolia
Wisteria sinensis
Xanthoxylum clava hercules
Yucca aloifolia
Yucca flaccida
Yucca gloriosa

To find common names for these plants, visit the Natural Heritage Program of the Georgia Department of Natural Resources on the web at http://www.georgiawildlife.com

~ APPENDIX C ~
Listing of Bird Species

Year-round Resident
Summer Resident
Winter Resident
Migrant

	Fall 2001 (mid October)	Spring 2002 (late May)	Fall Migration 2002
Pelicans	Brown Pelican	Brown Pelican	Brown Pelican
Cormorants	Double-crested Cormorant	Double-crested Cormorant	Double-crested Cormorant
Darters	Anhinga		
Herons	Cattle Egret	Black-crowned Night-Heron	Black-crowned Night-Heron
	Great Blue Heron	Great Blue Heron	Great Blue Heron
	Great Egret	Great Egret	Great Egret
	Snowy Egret	Green Heron	Snowy Egret
	Tricolored Heron	Snowy Egret	Tricolored Heron
		Tricolored Heron	Yellow-crowned Night-Heron
		Yellow-crowned Night-Heron	
Ibis		White Ibis	
Storks	Wood Stork	Wood Stork	Wood Stork
Vultures	Black Vulture	Black Vulture	Turkey Vulture
	Turkey Vulture	Turkey Vulture	
Hawks	Bald Eagle	Osprey	Bald Eagle
	Northern Harrier	Red-shouldered Hawk	Cooper's Hawk
	Osprey	Red-tailed Hawk	Osprey
	Sharp-shinned Hawk		
Falcons	American Kestrel		
	Merlin		
Rails	Clapper Rail	Clapper Rail	Clapper Rail
	Virginia Rail		
Plovers	Black-bellied Plover		Black-bellied Plover
Sandpipers	Greater Yellowlegs		Greater Yellowlegs
	Ruddy Turnstone		Least Sandpiper
	Short-billed Dowitcher		Ruddy Turnstone
	Spotted Sandpiper		Sanderling
	Willet		Spotted Sandpiper
			Western Sandpiper
			Willet
Gulls and Terns	Caspian Tern	Forster's Tern	Laughing Gull

~ Appendix C Continued ~

	Herring Gull	Laughing Gull	Ring-billed Gull
	Laughing Gull	Royal Tern	Royal Tern
Doves		Mourning Dove	Mourning Dove
Cuckoos	Yellow-billed Cuckoo		Yellow-billed Cuckoo
Owls	Barred Owl	Barred Owl	Great Horned Owl
			Screech Owl
Swifts		Chimney Swift	
Hummingbirds		Ruby-throated Hummingbird	Ruby-throated Hummingbird
Kingfisher	Belted Kingfisher		Belted Kingfisher
Woodpeckers	Hairy Woodpecker	Downy Woodpecker	Downy Woodpecker
	Red-bellied Woodpecker	Northern Flicker	Hairy Woodpecker
	Yellow-bellied Sapsucker	Pileated Woodpecker	Pileated Woodpecker
		Red-bellied Woodpecker	Red-bellied Woodpecker
		Red-headed Woodpecker	Yellow-bellied Sapsucker
		Yellow-bellied Sapsucker	
Flycatchers		Eastern Wood Pewee	Eastern Wood Pewee
	Eastern Phoebe	Great-crested Flycatcher	Great-crested Flycatcher
		Eastern Kingbird	Eastern Kingbird
Vireos	White-eyed Vireo	Red-eyed Vireo	Red-eyed Vireo
		White-eyed Vireo	White-eyed Vireo
Jays and Crows	Fish Crow	Fish Crow	Blue Jay
Swallows	Tree Swallow	Barn swallow	
Tits	Carolina Chickadee	Carolina Chickadee	Carolina Chickadee
		Tufted Titmouse	Tufted Titmouse
Nuthatches		Brown-headed Nuthatch	Brown-headed Nuthatch
Wrens	Carolina Wren	Carolina Wren	Carolina Wren
	Marsh Wren	Marsh Wren	
	Sedge Wren		
Kinglets	Ruby-crowned Kinglet	Blue-gray Gnatcatcher	Blue-gray Gnatcatcher
Thrushes	Swainson's Thrush	Eastern Bluebird	Eastern Bluebird
			Swainson's Thrush
			Veery

~ Appendix C Continued ~

Mimids	Gray Catbird		Gray Catbird
	Northern Mockingbird		Northern Mockingbird
Starlings		European Starling	
Warblers	Common Yellowthroat	Northern Parula	American Redstart
	Hooded Warbler	Pine Warbler	Black-and-white Warbler
	Palm Warbler	Yellow-throated Warbler	Black-throated Blue Warbler
	Yellow-rumped Warbler		Common Yellowthroat
			Kentucky Warbler
			Louisiana Waterthrush
			Magnolia Warbler
			Northern Parula
			Northern Waterthrush
			Ovenbird
			Palm Warbler
			Pine Warbler
			Prairie Warbler
			Worm-eating Warbler
			Yellow Warbler
			Yellow-throated Warbler
Tanagers		Summer Tanager	Summer Tanager
Cardinals and Sparrows	Chipping Sparrow	Eastern Towhee	Eastern Towhee
	Eastern Towhee	Northern Cardinal	Northern Cardinal
	Swamp Sparrow	Painted Bunting	
	Northern Cardinal		
Blackbirds and Orioles	Red-winged Blackbird	Boat-tailed Grackle	Baltimore Oriole
	Boat-tailed Grackle	Brown-headed Cowbird	Boat-tailed Grackle
		Common Grackle	Brown-headed Cowbird
		Orchard Oriole	Red-winged Blackbird
		Red-winged Blackbird	
	56	**57**	**74**

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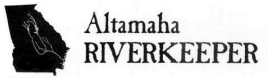

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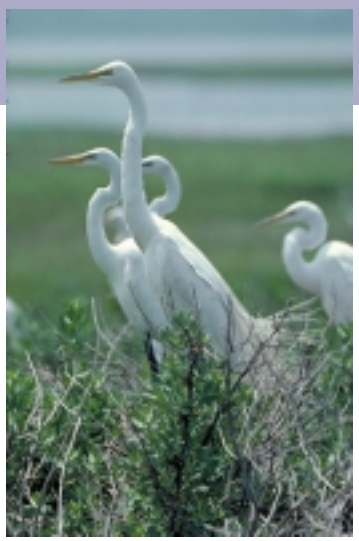

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