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RESULTS OF A FALL AND SPRING BIOBLITZ AT GRASSY POND RECREATIONAL AREA, LOWNDES COUNTY, GEORGIA

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ABSTRACT

Two 24 h BioBlitzes were conducted in September, 2018, and April, 2019, at Grassy Pond Recreational Area in Lowndes County, Georgia. Teams of scientists, students, and public participants surveyed plants, insects, amphibians and reptiles, birds, mammals, fungi, lichens, and aquatic microorganisms. Both events included educational programs with informational walks and activities targeted to youth. In the fall, 654 species and 55 additional genera were recorded. In the spring, there were 581 species and 54 additional genera recorded. Two fungi and 38 lichens were first reports for Lowndes County; one fungus was a first for Georgia. One lichen may be a first for North America. One snake and 5 bat species were notably first reports for Grassy Pond Recreational Area.

Keywords: BioBlitz, survey, species richness, iNaturalist

INTRODUCTION

BioBlitz events have become a popular way to compile biological records and engage citizen scientists around the globe. The term "BioBlitz", first coined for a United States National Park Service event in 1996 (Post 2003), refers to a biological survey at a specified location over a short period of time that promotes citizen science through public participation. Many BioBlitzes also include outreach and educational activities related to biodiversity. A recent internet search of the terms *BioBlitz* and *Georgi*a provided evidence of 24 BioBlitz events in Georgia between 2007 and 2019; fourteen of these highlighted educational programs as part of the event. Ten were taxon-specific, focusing on butterflies, dragonflies, amphibians and reptiles, or plants. The BioBlitz model has contributed to the species richness knowledge in Georgia. A 2-day BioBlitz focusing on amphibians and reptiles in a three county area in northern Georgia resulted in 10 new county records (Pierson et al. 2014). Although a 1-day, plant-focused BioBlitz at a Boy Scouts of America camp in Screven County did not add to the region's list of vascular plants, it was the first inventory of flora at the site (Hewitt 2015).

Two 24-h BioBlitzes were held at Grassy Pond Recreational Area in Lowndes County, Georgia, September 28–29, 2018, (fall) and April 12–13, 2019, (spring). These were organized by the Department of Biology at Valdosta State University, a comprehensive, regional university located 35 km north of Grassy Pond Recreational Area. Teams of scientists, students, and public participants surveyed plants, insects, amphibians and reptiles, birds, mammals, fungi, lichens, and aquatic microorganisms. Both events included educational programs with informational walks and activities targeted to youth.

Grassy Pond Recreational Area covers 198 ha and contains two lakes: Grassy Pond (88 ha) and Lot Pond (18 ha). The property was acquired by the United States government in 1928 for use as a fish hatchery and transferred to the United States Air Force in 1954 for recreational use. Facilities at Grassy Pond Recreational Area include a concrete boat ramp, multiple fishing docks, rental boats, a campground with 19 cabins, 39 RV or tent sites, covered picnic shelters, playgrounds, a children's wading pool, and basketball and volleyball courts. Additionally, Grassy Pond Recreational Area boasts three nature trails that follow the perimeter of each pond, with one trail encircling Lot Pond and two out-and-back trails around Grassy Pond (2.9 km and 4.8 km trails).

The natural communities present at Grassy Pond Recreational Area include lowland broadleaf evergreen forest and upland broadleaf evergreen forest with live oak, laurel oak, pignut hickory, American holly, and southern magnolia, as well as remnant native pine forest (Wharton 1998). A steep slope along the eastern boundary of Grassy Pond is believed to be a remnant of the original sink formation of the area and creates a dramatic change in vegetation from the top of the slope to the edge of the lake. Another factor contributing to the ecology of Grassy Pond Recreational Area is a county wastewater spray field immediately adjacent to the eastern boundary. Because of the steep slope and the movement of groundwater through the slope to the lake, eutrophic conditions and high nutrient levels exist in Grassy Pond. This has caused an overabundance of aquatic weeds, primarily water hyacinth and hydrilla. Other disturbed landscapes surrounding Grassy Pond Recreational Area include residential areas, agricultural fields, and intensively managed pine forests. As such, Grassy Pond Recreational Area may be an ecological sink for some species, including birds that use the area for nesting.

Prior to these BioBlitzes, limited-scope surveys of plants and animals were conducted by Moody Air Force Base biologists, Valdosta State University scientists, and others to produce basic taxonomic lists of flora and fauna and to assist in natural resources management at the site. Fish species in the ponds have been surveyed multiple times by the University of Georgia, Georgia Department of Natural Resources, and Air Force environmental contractors beginning in 1998. Surveys also evaluated foraging and nesting habitat for bald eagles. The results of these surveys are included in the Moody Air Force Base Integrated Natural Resources Management Plan (Gregory Lee, unpublished data). They have not been published in any outside journals or presented at meetings.

The objective of this report is to summarize the biological records collected during the two BioBlitz events at Grassy Pond Recreational Area. These records, including photographic documentation, are archived on iNaturalist, an online biodiversity reporting platform, in the fall project folder (BioBlitz at Grassy Pond - Fall 2018) and spring project folder (BioBlitz at Grassy Pond - Spring 2019).

RESULTS & DISCUSSION

At the fall BioBlitz, there were 1212 reported observations with 654 species and 55 additional genera identified. At the spring event, there were 1164 observations with 581 species and 54 additional genera. Most specimen identifications were completed during the 24 h event periods, however, many insects and aquatic microorganisms required additional time to be characterized. Two fungi and 38 lichens were first reports for Lowndes County; 1 fungus was a first for Georgia. One lichen is being investigated as a possible first for the state and perhaps the USA. One snake and 5 bat species were notably first reports for Grassy Pond Recreational Area. Details about these and other observations are provided in each section.

Nearly half of the species records at both events were insects or arachnids, with plants representing the next most frequently identified taxon (Table I). Third place went to lichens at the fall event and birds at the spring event. Intensive sampling of aquatic microorganisms resulted in over 200 distinct taxa being identified, but species frequency was relatively low for this group as few could be identified to species (Supplemental Table VII).

Table I. Percentage of species identified from each taxonomic group at the fall and spring BioBlitzes

	Percentage of identified species by taxon	
Taxon	**Fall**	**Spring**
Amphibians and reptiles	3.20	2.11
Birds	8.81	12.72
Mammals	1.60	1.24
Plants	19.23	28.27
Insects and arachnids	44.23	45.41
Fungi	6.65	6.01
Lichens	12.15	---
Aquatic organisms	4.13	4.24

Amphibians and Reptiles

Most amphibian and reptile observations occurred during guided walks with the public near Grassy Pond and along the trails. Over the two BioBlitz events, 10 amphibians in the order Anura and 13 reptiles in the orders Crocodilia, Squamata, Testudines, and Serpentes were observed (Table II). Temperatures were warmer during the fall event than in the spring, which may explain the fewer observations at the spring event. All species observed were common to Lowndes County; however, the eastern coral snake (*Micrurus fulvius fulvius*), observed in both the fall and spring, was a first report for Grassy Pond Recreational Area (Gregory Lee, unpublished data).

Birds

There were 70 species of birds observed during the fall and spring events. Carolina Wren, Tufted Titmouse, and White-eyed Vireo were the 3 most abundant resident songbirds for both events (Supplemental Table I); Blue Jay, Northern Cardinal, and Northern Parula (the latter a summer-only resident) were in a second tier of common

Table II. Herptile lists for the fall and spring BioBlitz events. Scientific names are based on Jensen et al. (2008) and SREL (2019).

Order	Scientific name	Common name	Fall	Spring
Anura	*Acris gryllus*	Southern Cricket Frog	X	X
	Anaxyrus quercicus	Oak Toad		X
	Anaxyrus terrestris	Southern Toad	X	
	Buff terrestris	Southern Toad	X	
	Gastrophryne carolinensis	Eastern Narrow-mouth Toad	X	
	Hyla cinerea	Green Tree Frog		X
	Hyla squirella	Squirrel Tree Frog	X	
	Hyla versicolor	Gray Tree Frog	X	
	Lithobates catesbeianus	Bull Frog		X
	Lithobates planirostris	Greenhouse Frog	X	X
	Lithobates sphenocephalus	Southern Leopard Frog	X	
Crocodilia	*Alligator mississippiensis*	American alligator	X	X
Squamata	*Anoles carolinensis*	Green Anole	X	X
	Plestiodon fasciatus	Five-lined Sink	X	
	Plestiodon laticeps	Broadheaded Skink	X	X
	Scincella lateralis	Little or Ground Skink	X	
Testudines	*Pseudemys nelson*	Florida Redbelly Turtle	X	
	Terrapene carolina carolina	Eastern Box Turtle	X	
	Trachemys scripta scripta	Yellow-bellied Slider	X	
Serpentes	*Coluber constrictor*	Black Racer		X
	Micrurus fulvius fulvius	Eastern coral snake	X	X
	Pantherophis spiloides	Gray Rat Snake	X	X

birds. These species occur in a wide variety of habitats, including forest and forest edge, which—in addition to open-water and wetland habitats—characterizes the Grassy Pond property. White Ibis and Glossy Ibis, drawn to the aquatic habitats, were recorded each on a separate count date in large numbers, but in each case this constituted a single flock. Other flocking birds (ducks, coots, grebes, gulls, pelicans) can be found in large numbers on and around Grassy Pond during the winter months but were not recorded on our fall or spring dates (Brad Bergstrom, pers. obs.). Double-crested Cormorant is a species that can form large flocks on Grassy Pond in winter (eBird.org) but is found in lower numbers throughout the year (Brad Bergstrom, pers. obs.).

The avian community fit a common pattern where most species were rare to uncommon, with only a few abundant species (Whitlock and Schluter 2015, 34–35). Of the 53 species observed in the Fall, 8 species accounted for 57% of the total individuals counted. In the spring, after excluding an unusually large flock of Rock Pigeons that flew over, 11 of the remaining 55 species recorded accounted for 64% of the total individuals.

For the 11 species whose status is summer-only, 8 were observed only during the spring sample, which occurred near the beginning of the breeding season for returning Neotropical migrants. By the fall event, most of these long-distance migrants had likely dispersed or already migrated southward (e.g. Summer Tanager; see Schneider et al. 2010). Six of the 9 nonbreeding species (mostly winter residents) also were recorded only

during the spring sample. Most of these are short-distance migrants that winter in the Lower Coastal Plain of Georgia and breed farther north in North America (e.g. White-throated Sparrow), but many do not arrive for the winter until October or November (Table III). Both sampling days potentially occurred within the spring/fall migration period during which we could expect to record transients—i.e., those bird species that winter in the tropics and breed only farther north (and not in the Lower Coastal Plain). However, the spring sampling date was 1–3 weeks before the peak of northward migration for warblers, tanagers, thrushes, among others, which may partly explain why there were no transient-only species recorded in the spring. There were 3 transient-only species of birds recorded in the fall (e.g., American Redstart), which occurred very near to the peak southward fall migration (see eBird for relative abundances by species and by season). Interestingly, Black-bellied Whistling-Ducks were recorded on both fall and spring counts; this species is gradually increasing in abundance in the region and moving its breeding range northward after it first colonized southwestern Florida from Mexico or Texas many decades ago (Bergstrom 1999).

Mammals

In the aggregate, 9 species of bats were recorded on the two BioBlitz dates, with 6 of those being recorded on both dates (Table III). All of these were previously known to occur commonly in the area, at least seasonally (Cryan 2003), although the Mexican Free-tailed, Hoary, Northern Yellow, Big Brown, and Tricolored Bats were first reports for Grassy Pond Recreational Area (Gregory Lee, unpublished data). *Lasiurus borealis,* the Eastern Red Bat, is a winter-only resident of the Lower Coastal Plain, and the April sample is late in the wintering season for this species, whereas this bat has yet to migrate away from more northerly breeding areas in September (Cryan 2003; Simmons 2005, 458–459). Other mammal observations were few and included *Sciurus carolinensis* (Eastern Gray Squirrel), *Didelphis virginiana* (Virginia Opossum), and *Dasypus novemcinctus* (Nine-banded Armadillo).

Table III. Bat species identified by audiospectograms of foraging calls recorded during evenings of September 28, 2018, (fall) and April 11, 2019 (spring)[1]

Scientific Name	Common name	Fall	Spring
Eptesicus fuscus	Big Brown Bat	X	X
Lasiurus borealis	Eastern Red Bat		X
Lasiurus cinereus	Hoary Bat	X	X
Lasiurus intermedia	Northern Yellow Bat		X
Lasiurus seminolus	Seminole Bat	X	X
Myotis austroriparius	Southeastern Myotis	X	
Nycticeus humeralis	Evening Bat	X	X
Perimyotis subflavu)	Tricolored Bat	X	X
Tadarida brasiliensis	Mexican Free-tailed Bat	X	X

[1]Foraging call recordings were made by Echo Meter 2 ultrasonic module and version 2.7.7 App for iPhone, and species identifications were confirmed by Kaleidoscope version 4.3.2 software (Wildlife Acoustics, Inc.) and with information in Clement et al. (2014).

Plants

BioBlitz observers identified a cumulative 160 plant species at the Grassy Pond Recreational Area site (Supplemental Table II). Species recorded belonged to 75 families, of which there were 66 angiosperms, 6 ferns, 2 gymnosperms, and a solitary bryophyte. Herbaceous plants made up about 70% of all plant species recorded, while the remaining 30% were trees, woody vines, and shrubs combined. Although no state listed rare plants were found, an aquatic orchid, *Habenaria repens*, was observed. The last herbarium collection date for this population at Grassy Pond is from over 25 years ago (Sernec 2019). Eleven species recorded were identified as invasive plants from the Georgia invasive plants list. Four were ranked a category 1 (1: most harmful, 4: least harmful; Georgia Exotic Pest Council, 2018). Among the category 1 species are the aquatic invasive plants present at Grassy Pond. These plants are actively managed in order to protect native species.

For both the spring and the fall BioBlitz, the majority of species recorded were unique to each specific event. For example, 59 of 90 species identified during the fall event were not observed again at the spring BioBlitz. Only 31 of the 160 plant species were found at both events. One reason for this may be that plants are more conspicuous and easier to identify during blooming and fruiting periods. While some plants bloom throughout the year, many have species-specific environmental requirements that induce blooming such as temperature changes or increasing daylight hours. These results may indicate a need for seasonal BioBlitz events in order to gain a truer understanding of species richness at a certain site.

Insects and Other Arthropods

Terrestrial arthropods, primarily insects, were collected using insect nets, killing jars, Berlese funnels, and traps designed to collect mosquitoes and nocturnal Lepidoptera (primarily moths). The Lepidoptera traps, described in more detail below, accounted for most of the insects observed at both events (95 families in 15 orders). Arthropod species were likely grossly underestimated as they are difficult to identify to species. Most commonly used taxonomic keys do not go below the level of family and include only the adult stage of the life history (e.g., Triplehorn and Johnson 2005). Despite these limitations, 410 of 442 unique insect specimens were identified to at least the level of genus during the two BioBlitzes (Supplemental Tables III & IV). In addition to insects, other arthropods documented included 20 spider species (Arachnida: Araneae), 1 harvestman (Arachnida: Opiliones), 1 centipede (Chilopoda) and 1 sow bug (Malacostraca: Isopoda). More detailed results for the two insect taxa that were specifically targeted during the BioBlitzes (i.e., mosquitoes & Lepidoptera) are provided below.

Adult mosquitoes (Diptera: Culicidae) were collected using four types of traps: CDC miniature light traps baited with dry ice; Reiter gravid traps with hay infusion; BG-Sentinel traps with BG Lure attractant, and BG-GAT passive traps (Biogents AG). Each sampling device targets adult female mosquitoes of different species and stages of the gonotrophic cycle. A total of 10 species in 7 genera were collected in the two BioBlitzes. During the fall event, traps were checked at 6 h intervals to assess diel activity patterns, and activity showed peaks in the twilight and predawn periods. Six species were collected: *Anopheles crucians* s.l., *Coquillettidia perturbans*, *Culex erraticus, Culex nigripalpus,*

Mansonia titillans, and *Uranotaenia sapphirina*. *Culex nigripalpus* was the predominant species and most of these were captured in gravid traps. For the spring BioBlitz, only CDC light traps with CO_2 and gravid traps were used to collect mosquitoes. During that event 7 species were collected: *Aedes vexans*, *Anopheles crucians* s.l., *Anopheles quadrimaculatus* s.l., *Coquillettidia perturbans*, *Culex erraticus, Culex salinarius*, and *Culiseta melanura*. Three of the species collected (*Coquillettidia perturbans*, *Culiseta melanura* and *Culex quinquefasciatus*) can be vectors in the transmission cycles of Eastern equine encephalitis virus and West Nile virus, respectively. Both viruses are endemic in Lowndes County.

Thirty-five species of butterflies were recorded during the two BioBlitz events (Supplemental Table IV). More butterfly species were seen during the fall than the spring event (30 vs. 16), because of the greater availability of nectar sources during the fall. No unusual butterfly species were observed at either event. The spring was notable for the total lack of spring specialty species. Some species seen in the fall are typical for that season (*Urbanus proteus, Lerema accius, Agraulis vanillae*), although there is no reason that these typically southern species could not be found in the spring as well, considering the location of Grassy Pond in very southern Georgia.

Although a few moth larvae were found during the daytime survey in the fall (*Eumorpha fasciatus, Selenisa sueroides, Bellura obliqua*), most moths were adults captured with black light traps that used ethyl acetate as a dispatching agent and a lawn mower trailer battery as a power source, or on sheets illuminated by blacklights. A total of 262 moth species were identified, with 150 species found during the fall and 181 during the spring (Supplemental Table IV). There were 69 species observed during both events. The total moth numbers do not reflect the species richness expected at Grassy Pond Recreational Area, because some of the very small moths collected were not identified and the events were limited to 24 h each. Fall-specific species encountered during the fall event include the sphingid *Enyo lugubris*, most *Mocis* species, *Anticarsia gemmatalis*, *Schinia* spp. and *Spodoptera*. Moths that were sampled during the spring (that also occur into the summer but not late September) include most of the limacodids, *Malacosoma*, saturniids, most notodontids, *Hypsoropha monilis*, and a greater variety of *Panopoda* and *Zale*. None of the species sampled could be considered truly rare, though a few local or uncommon species were encountered, particularly during the spring BioBlitz. *Zanclognatha atrilineella*, whose larvae are litter feeders, has been collected fewer than 20 times in the state. In Georgia, *Dahana atripennis*, a Spanish Moss (*Tillandsia usneoides*) feeder in the larval stages, is localized and restricted to the coastal plain. *Bagisara repanda* is a local but broadly-distributed species, whose larvae feed on various Malvaceae; 13 specimens of this species were found during the spring blitz. *Fagitana littera*, a fern specialist, has been taken only a handful of times in Georgia; one was taken during the spring blitz. Three species of the genus *Bellura* were found during both blitzes, although only larval damage of the cattail-feeding *B. obliqua* was evident in the fall. The larvae of these are borers in plants, with *B. obliqua* being restricted to cattails (*Typha*) and *B. gortynoides* being restricted to Pond Lily (*Nuphar*) species. Both plants occur in or along the two lakes at Grassy Pond, which explains the presence of these two localized species in the area. Several species of expected aquatic crambids (*Elophila* spp.) were also common during both blitzes.

Fungi

Cumulatively, 58 fungi were identified to species and 10 identified to genus (Supplemental Table V). Most belonged to the Basidiomycota. While the vast majority of fungi collected were general saprotrophs or wood decay fungi, 8 specimens in the genera *Amanita*, *Hortiboletus, Laccaria, Lactifluus*, *Russula*, *Scleroderma*, and *Tylopilus*, are plant mutualists (mycorrhizal); 4 specimens, *Coleosporium ipomoeae*, *Cronartium strobilinum, Puccinia sorghi,* and *Taphrina caerulescens,* are plant pathogens; and 2 specimens, *Cordyceps cylindrica* on a spider and an *Isaria* sp. on an unidentified host, are entomopathogenic.

Five fungal specimens from the fall event were added to the Valdosta State University fungus collection in the university's herbarium and DNA barcoded using the universal barcode region for fungi, nrITS (Schoch et al. 2012). Of these, *Sarcoscypha occidentalis* and *Leucocoprinus cepistipes* were first reports for South Georgia (Mycoportal 2019). The spider pathogen, *Cordyceps cylindrica,* identified to species with DNA barcoding, was a first report for Georgia and second for the United States (Mycoportal 2019). These firsts are more likely due to the few scientific surveys of fungi in South Georgia, and the difficulties inherent in identifying species of *Cordyceps*, than rarity of species.

Lichens

Lichens were only surveyed during the fall BioBlitz. Of the 83 lichen species and related fungi detected, 80 were identified to species and 3 to genus (Supplemental Table VI). All were typical of the subtropical mesic forest lichen suite expected for Grassy Pond Recreational Area. Most were observed growing on bark substrates, with smaller numbers found on wood, plastic fencing, and concrete. A remarkable 38 species were not among the 120 lichens previously recorded in Lowndes County, Georgia, likely due to differences in habitat types (Malcolm Hodges, unpublished data). Among interesting species observed were *Anisomeridium tuckerae*, a southeast coastal plain endemic previously known in Georgia only from a single record on Sapelo Island, and *Coenogonium implexum*, previously observed in Ware County only. A species of *Leptogium* may be new to the state and possibly North America. Further investigation is in progress (Laurel Kaminsky, pers. observation).

Aquatic Microorganisms

To assess the biodiversity of aquatic microorganisms, periphyton and net plankton (25-µm mesh) samples were collected from both Grassy Pond and Lot Pond. The samples were surveyed on-site using light microscopy, and additional observations were made of the live material in the laboratory.

Overall, 206 morphologically distinct taxa were observed: 37 cyanobacteria, 136 eukaryotic microalgae, 17 protozoans, and 16 microinvertebrates (Supplemental Table VII). Numerically important taxa included the cyanobacteria *Microseira wollei* (=*Lyngbya wollei*) and *Microcystis aeruginosa*, and the green algae *Botryococcus braunii* and *B. protuberans. Microseira wollei* formed an extensive mat on the bottom of Grassy Pond, where it was associated with epiphytic cyanobacteria (*Chamaesiphon incrustans* and *Leibleinia* sp.) and diatoms (*Achnanthidium* sp., *Cocconeis* sp., and *Gomphonema* sp.). *Microseira wollei* is widely considered to be a nuisance alga, and some strains produce a variety of toxins, including saxitoxin, a neurotoxin, and

cylindrospermopsin, a hepatotoxin (Hudon et al. 2014). Massive numbers of *Microcystis aeruginosa*, *Botryococcus braunii*, and *B. protuberans* dominated phytoplankton collections from Grassy Pond in the fall. However, by the spring assessment, their numbers were much reduced and only a few colonies were observed.

Seasonal changes were also apparent in the composition of the phototrophic association as a whole. In general, more taxa were observed in spring than fall (124 vs. 90), including three times the number of desmids (40 vs. 13). Not only did the number of taxa change, but there were significant differences in the species present. Only 41 of a total of 173 taxa of cyanobacteria and eukaryotic microalgae were observed in both collections, yielding a Jaccard similarity index (Mueller-Dombois and Ellenberg 1974, 212–215) of only 0.237. This was true of both cyanobacteria (9 of 37, Jaccard index = 0.230) and eukaryotic microalgae (32 of 136, Jaccard index = 0.235). As might be expected given the increase in the number of taxa, the largest differences were seen among the desmids (7 of 46, Jaccard index 0.152). Seasonal changes of this magnitude are common among aquatic microorganisms; the unicellular forms that form the majority of this group are capable of rapid reproduction and quickly respond to (and influence) changes in physical or chemical environment (Reynolds 1984). While the BioBlitz approach provides the framework and the impetus, it is very difficult to assess the biodiversity of these groups through a single 24-h snapshot.

The number of species recorded at each Grassy Pond Recreational Area BioBlitz (654 in fall and 581 in spring) was relatively high compared to other 24 h BioBlitzes in the United States with published results. BioBlitzes conducted in Indiana by Karns et al. (2010) and Ruch et al. (2010) reported 260 species and 545 species, respectively. Although much of the Grassy Pond Recreational Area BioBlitz counts can be attributed to the overnight insect collections and expertise of the entomology team, the high species richness of Georgia also likely contributed. For example, more amphibian and reptile species were reported at each Grassy Pond Recreational Area event than by Karns et al. (2010) or Ruch et al. (2010), even though no traps were used and public education was the primary goal.

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