Distribution and Species Richness of Odonate at Brookhaven National Laboratory

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August 11, 2004

Prepared in partial fulfillment of the requirements of the Office of Science, DOE Science Undergraduate Laboratory Internships (SULI) Program under the direction of Dr. Timothy M. Green in the Environmental and Waste Management Services Division (EWMS) at Brookhaven National Laboratory.

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ABSTRACT

Distribution and Species Richness of Odonate at Brookhaven Laboratory. SUSAN M. COSTA (Community College of Rhode Island, Warwick, RI 02886) DR. TIMOTHY M. GREEN (Brookhaven National Laboratory, Upton, New York 11973-5000).

Odonate research was conducted at Brookhaven National Laboratory during the summer of 2004. The purpose for the research was to continue the Odonata research that began in the summer of 2003, which consisted of identifying and cataloging the specimens found at the Laboratory. Identification was to species level when ever possible. In addition the 2004 goal was to survey the bodies of water at the Lab primarily for adult odonates, to observe species richness, and catalog and preserve the specimens collected in support of the New York Odonate Atlas. To date a total of forty-six species have been identified at Brookhaven National Laboratory between the two summers of research. Twenty-five adults and twelve larvae were identified during the summer of 2003 and fifteen different adults species were found and identified during the summer of 2004. Future research may continue at the ponds in order to expand cataloging of Odonates; to possibly look at a link between species richness and pH of ponds; and to continue the larger on going biotic inventory of the Lab.

INTRODUCTION

Research conducted during the summer of 2004 was a continuation of the Qualitative Odonate identification and cataloging research conducted during the summer of 2003. The research for 2004 focused mainly on the adult population of odonates with an emphasis on the species richness (number of species) of the aquatic insects found at Brookhaven National Laboratory (BNL) [2] [3]. The goal was to survey all the ponds at the Lab, catalog, and preserve one male and female of every species found supporting the Odonate Atlas Project that was started in 2002 by New York State Department of Environmental Conservation. Part of the research project was also to continue looking for the three species of damselflies on the New York State list of threatened and endangered species [1].

The Order Odonata arose and flourished about 250 to 300 million years ago during the Carboniferous period and during which time they were gigantic with wingspans that reached approximately 70 cm (27.5 inches) [4][5]. It is believed that atmospheric oxygen played a major role in the increase and decrease in size of these organisms. Research recently done reinforces the idea that oxygen concentrations during the Paleozoic Era were about 35 percent in comparison to the approximate 21 percent found in air today and this may have allowed larger insects to evolve [4]. These ancient giant Odonates eventually diverged into three Suborders, Anisoptera (dragonflies), Zygoptera (damselflies), and one rare group found only in Nepal and Japan called Anisozygoptera [6].

Odonates are hemimetabolous insects, which means they have 3 stages of life, egg => larvae => adult; unlike moths and butterflies which have 4 stages of life, egg => larvae => pupa => adult [7]. Odonates are extremely beneficial aquatic insects both as adults and larvae. Once

larvae have hatched they begin their aquatic life as a ferocious predator of mosquito larva, fresh water invertebrates, small tadpoles and fish, as well as their own species [6]. Odonates have an exoskeleton as do all other invertebrates and must molt periodically in order to grow. These molting phases are called instars and Odonates have approximately 10 to 20 of these phases [6]. The final molting phase is referred to as emerging in which the larvae crawl out of the water, molts and sheds its exoskeleton. The exoskeleton is called an exuviae and the newly emerged adult is called the exuviant. Once its wings and body have expanded to there full length, this ferocious predator begins it life of hunting on the wing (in flight) feeding on mosquito, gnats, aphids, moths, butterflies, and smaller odonates [6], in turn they are prayed upon by parasites, frogs, toads, spiders, and birds [14].

The two main Suborders of Odonata, Anisoptera (dragonflies) and Zygoptera (damselflies), look a lot alike except for some of their basic physical traits that make them distinguishable by site from one another. Adults have excellent site while flying due to their compound eyes that make up a major part of their heads. The visible difference between the two suborders include, dragonflies' eyes touching on the top of their very round head and damselfly's eyes being separate with their head being more football shaped. They both have large delicate membranous wings, but dragonflies fore and hind wings are different in shape where as damselflies fore and hind wing are uniform in shape. Some other differences in their wings are strength and position in which they are held at rest. Dragonflies have much stronger wings that allow them to make transoceanic journeys [6], [8]. They hold them at a 180 degree angle from their body when they rest were as damselflies have weaker more fluttery wings while flying and hold them over their abdomen when at rest [8] The last characteristic difference between the two suborders is the difference in their long slender abdomens. Dragonflies have thick, and some

even have swollen segments at the end of the abdomen, which can be seen in groups such as clubtails, and spiketails. Damselflies have a more delicate slender abdomen. During their larval stage odonates live in the water and are truly aquatic with a closed respiratory system, while in the water dragonflies breath through gills found in their anus, where as damselflies have gills at the tip of their abdomen that look like feathers [7].

MATERIALS AND METHODS

Fieldwork was conducted with the aid of a variety of tools and materials, including two 15” insect nets one mesh and the other canvas with mesh bottom, dip net, chest waders, field vest, zip-lock sandwich bags, a digital camera, and a cooler containing ice. The chest waders were worn while wading in or around the ponds where odonates could be found. The insect nets were used to catch adult specimens while they were in flight or perched on vegetation. Once specimens were caught they were placed in the zip-lock bags and placed in the cooler to slow down their metabolism, keeping them alive and maintaining their vibrant coloration. The digital camera was used to take pictures of odonates in there natural settings. An aquarium was used to rear larvae in order to key to species [9].

A 7x Bausch & Lomb dissecting microscope, dissecting tweezers, metric ruler, specimen trays, petri dishes, gel filled petri dishes, and mounting pins were the tools used to examine the specimens. The dissecting microscope was use to magnify features specified in the taxonomic keys and field guides ([7], [9], [10], [11], [12], and [13]). Once larval specimens were identified large larvae were placed in an aquarium and reared until they emerged. One male and one female from each species were preserved by first euthanizing them in kill jars using acetone vapors. They were then placed in transparent specimen envelopes, labeled the with the individual’s data,

then placed in a jar with enough acetone to cover the envelope and allowed to sit over night to reduce any fats with-in the specimens [10]. The next day they were removed and dried for an hour or so and stored in a file box.

RESULTS

During the summer of 2004, twenty-eight ponds and the Peconic River were surveyed or resurveyed at the Lab, including the nine surveyed during the summer of 2003 (P-1, P-2, P-6, P-7, P-9, P-10, 9 O'clock pond at the RHIC Ring, as well as the Recharge Basins 6a, 6b, 6c,and 6d at the RHIC Ring, and the Peconic River). Due to low precipitation during the ten weeks of the summer internship of 2004, a total of 4.44 inches (precipitation total) during the months of June and July, several of the vernal ponds had dried up before they were surveyed [15]. A total of fifteen new species were found at the Lab, nine new damselflies, and six new dragonflies. To date a total of forty-six species have been found at Brookhaven National Laboratory. Table 1 shows the distribution for each species and Figure 1 shows the species richness of each location surveyed at BNL. Pond 7 for the second year in a row was found to have the highest species richness with a total number of 24 species followed by Pond 10 with 19 species, 9 O'clock Pond with 18, Lower Peconic River with 16, and Upper Peconic River with 13. Table 2 shows the species abundance found at each pond at BNL. Three ponds; P-W6b, p-12-E, and vp-10 were found to have 0 species possibly due to the fact they had dried up. Coincidently the first three ponds with the highest species richness were also found to have high pH ranging between 8.0-9.0. This coincidence warrants further investigation.

DISCUSSION AND CONCLUSION

The purpose for the odonate research at the Lab during the summer of 2004 was to continue research started during the summer of 2003 and to continue identifying as many of the species as possible that could be found at Brookhaven National Laboratory, to begin looking at the species richness, and to continue looking for the three species of *Enallagma* (damselflies) listed as threatened on the New York State list of threatened and endangered species [1].

A total of 28 ponds and the Peconic River were surveyed at Brookhaven National Laboratory in Upton, New York (Figure 1 shows the location of all the ponds surveyed and Figure 2 shows the vegetation found at BNL). To date a total of 46 odonate species have been found to inhabit various wetlands at the Laboratory. Thirty-one species of odonates were found during the summer of 2003 and another 15 species of odonate were found during the summer of 2004, 9 damselflies and 6 dragonflies, none were the threatened species of *Enallagma.* It appears that several of the ponds that were found to have high species richness are found in areas of Pitch Pine-White Oak, Mixed Oak, Successional, or Scarlet Oak Forests. The shaded cells in Table 1 indicate, which of the species were found in 2004. A continuing trend from summer 2003 research was the high species richness found at P-7 and the 9 O'clock pond as well as P-10. All three of these ponds are found in open areas. Another coincidence was that all three were found to have a pH between 8.0-9.0. Although odonates can tolerate a fairly wide range of pH, this coincidence could be related to vegetation, and fish populations, in any case the coincidence warrants further investigation in the future [16]. The Upper Peconic River and The Lower Peconic River were found to have more than a dozen species. No samples were obtained from, P-W6b, p-12-E, and one other vernal pool. This could be due to the fact that they do not retain water long enough to sustain nymphs that remain in nymphal form for 1-3 years [14].

Distribution of the different species varied as they did with the 2003 research. The Common Green Darner (*Anax junius*) was found at seventeen locations. While several other species of dragonflies have only been found at one location, Williamson's Emerald (*Somatochlora williamsoni*), Ashy Clubtail (*Gomphus lividus*), Unicorn Clubtail (*Arigomphus villosipes*), Blue Corporal (*Libellula deplanta*), Calico Pennant (*Celithemis elisa*), Halloween Pennent (*Celithemis eponina*), and Sot-winged Glider (*Pantala flavescens*). In the damselflies the Azure Bluet (*Enallagma aspersum*) was found at nine locations, where as the Ebony Jewelwing (*Calopteryx maculata*) was only found at the Peconic River, which is the only body of water found at the lab that fulfills the species environmental requirements of slow moving water. Table 1 summarizes the distribution among the odonate species found at the Lab.

Twenty-one of the species found over the past two summers come from the Family *Libellulidae.* Six of them are found at 11-16 location and another four are found at 6-7 locations.

Due to the time constraints of the project, there are still many species likely to be found at the Lab that still have not been identified. In order to get a better record of the odonate species found at the lab further investigations would need to be conducted.

At times it was difficult to catch some of the larger specimens for preserving and cataloging especially the quick aerial dragonflies such as the Common Green Darner (*Anax junius*). The best method used to obtain the larger specimens was to rear the larvae in an aquarium until they emerged as an adult. While in the field, it was easier to take several macro pictures of a single specimen, log the pond they were taken at, then return to the office, download the photos and identify the specimen using field guides. In many instances the specimens were also caught and analyzed under the dissection microscope.

ACKNOWLEDGEMENTS

I would like to thank the Department of Energy for the opportunity to participate in the Science Undergraduate Laboratory Internship (SULI) Program. I would especially like to thank Dr. Timothy M. Green my mentor for allowing me to continue the odonate research that I began during the summer of 2003, helping to expand on the research and giving me the guidance to accomplish it. Thanks also go to all the staff of the Environmental and Waste Management Services Division for a wonderful work experience, and especially Jeremy Feinberg the "Herp Man" of the U.S. Fish & Wildlife Service for taking me out into the field and allowing me to help with some of his research. I would also like to thank Mark Davis for his help when Tim was out of the office and for all his help and participation in our weekly Day Camp Program. A thanks also goes to Gail Donoghue and Kathleen Nasta for giving us the opportunity to work with the kids. Thanks also go to Jennifer Higbie for the beautiful and informative maps of the BNL property, and to Doug Paquette for his generosity in letting me use his dissecting microscope. Many thanks go to all my fellow interns Kristine Hoffmann, Wendy Finn, Esperanza Florendo, Frank Smith, Stephen Goodyear, Jenn Sears, Elisa Bosshart, and Ivan Suarez for sharing their knowledge of their projects with me. A very special thank you goes to Mr. Mel Morris, the Educational Programs Administrator at the Office of Educational Programs, for all his dedication to his interns for stopping in our department just to see how we were doing. Last but not least, I would like to thank my professors Donald S. Fontes and Dr. Jean Billerbeck for guiding me in my college career and for making me realize the important of conducting hands on research in order to become a well rounded educator. I wouldn't be here it wasn't for the two of them.

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Table 1		
Species Distribution Table		
Dragonflies		
Family Aeshnidae	**Scientific Name**	**Distribution**
Comet Darner	*Anax lonipes*	3
Common Green Darner	*Anax junius*	17
Shadow Darner	*Aeshna umbrosa*	2
Swamp Darner	*Epiaeschna heros*	4
Family Corduliidae		
Williamson's Emerald	*Somatochlora williamsoni*	1
Family Gomphidae		
Ashy Clubtail	*Gomphus lividus*	1
Unicorn Clubtail	*Arigomphus villosipes*	2
Family Libellulidae		
Band-winged Meadowhawk	*Sympetrum semicinctum*	4
Bar-winged Skimmer	*Libellula axilena*	3
Black Saddlebags	*Tramea lacerata*	14
Blue Corporal	*Libellula deplanta*	2
Blue Dasher	*Pachydiplax longipennis*	17
Calico Pennant	*Celithemis elisa*	1
Carolina Saddlebags	*Tramea carolina*	11
Cherry-Faced Meadowhawk	*Sympetrum internum*	11
Common Whitetail	*Libellula lydia*	15
Eastern Amberwing	*Perithemis tenera*	2
Eastern Pondhawk	*Erythemis symplicicollis*	6
Great Blue Skimmer	*Libellula vibrans*	6
Halloween Pennent	*Celithemis eponina*	1
Painted Skimmer	*Libellula semifasciata*	7
Setwing	*Dythemis*	1
Slaty Skimmer	*Libellula incesta*	7
Spot-winged Glider	*Pantala hymenaea*	1
Twelve-Spotted Skimmer	*Libellula pulchella*	15
Wandering Glider	*Pantala flavescens*	3
White-faced Meadowhawk	*Sympetrum obtrusum*	4
Widow Skimmer	*Libellula luctuosa*	2
Damselflies		
Family Calopterygidae		
Ebony Jewelwing	*Calopteryx maculata*	1
Family Coenagrionidae		
Azure Bluet	*Enallagma aspersum*	9
Big Bluet	*Enallagma durum*	1
Citrine Forktail	*Ischnura hastata*	6
Eastern Forktail	*Ischnura verticalis*	8
Familiar Bluet	*Enallagma civile*	4
Fragile Forktail	*Ischnura posita*	3
Marsh Bluet	*Enallagma ebrium*	1
Northern Bluet	*Enallagma cyathigerum*	3
Rambur's Forktail	*Ischnura ramburii*	3
Skimming Bluet	*Enallagma geminatum*	1
Variable Dancer	*Argia fumipennis violacea*	1
Family Lestidae		
Amber-winged Spreadwing	*Lestes eurinus*	3
Common Spreadwing	*Lestes disjunctus disjunctus*	1
Elegant Spreadwing	*Lestes inaequalis*	1
Slender Spreadwing	*Lestes rectangularis*	5
Sweetflag Spreadwing	*Lestes forcipatus*	5
Lyre-tipped Spreadwing	*Lestes unguiculatus*	5
	Indicates the species found in 2004	

Figure 1

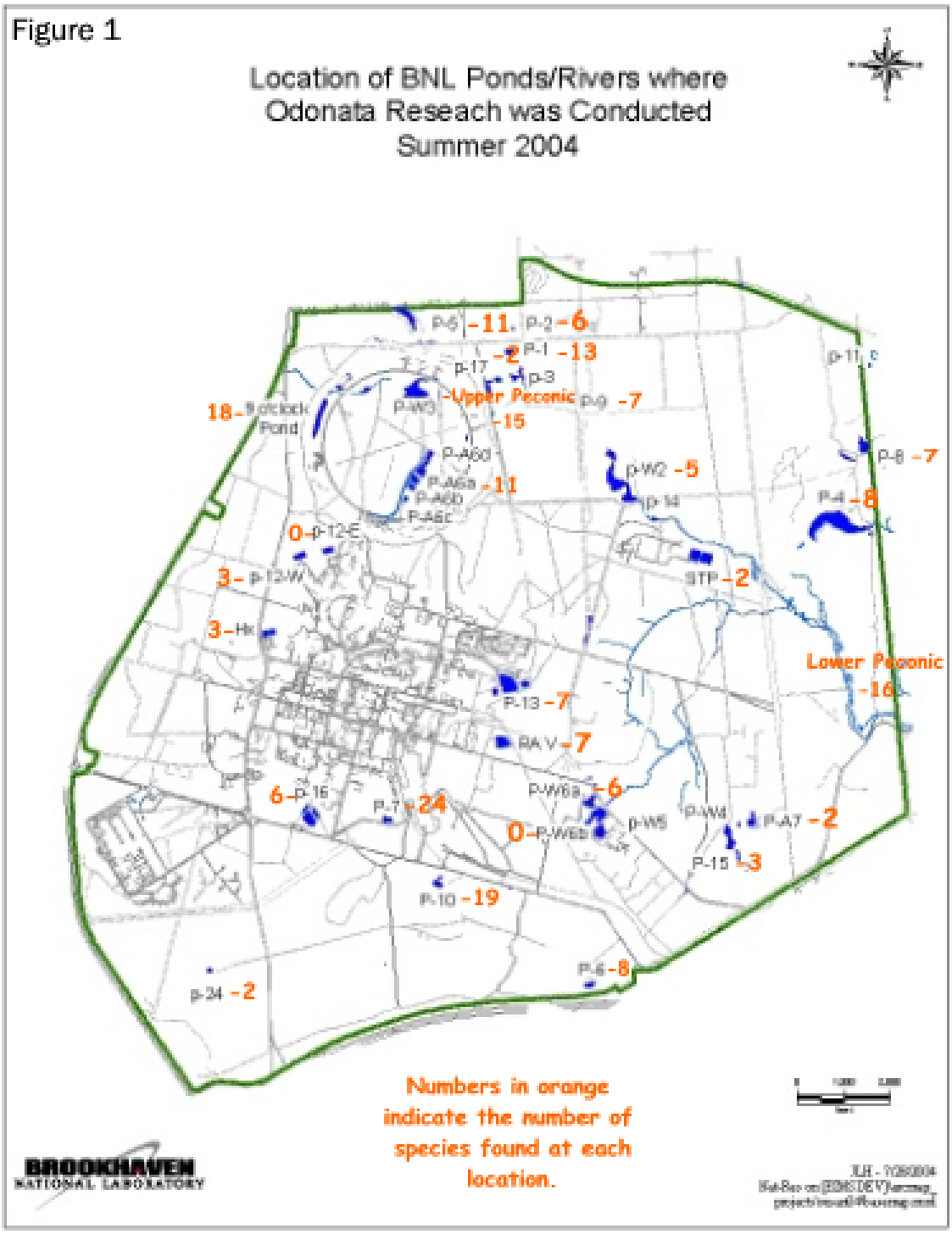
Location of BNL Ponds/Rivers where
Odonata Reseach was Conducted
Summer 2004
P-6 -11
P-2 -6
P-1 -13
-2
P-17
p-3
Upper Peconic
p-9 -7
-15
18- 9 o'clock Pond
P-W3
P-A6d
P-A6a -11
P-A6b
P-A6c
p-W2 -5
p-14
P-8 -7
P-4 -8
0-p-12-E
3- p-12-W
STP -2
3-Hx
Lower Peconic
-16
P-13 -7
RA V -7
6-P-16
P-7 -24
P-W6a -6
0-P-W6b
p-W5
P-W4
P-A7 -2
P-15 -3
P-10 -19
P-6 -8
p-34 -2
Numbers in orange indicate the number of species found at each location.
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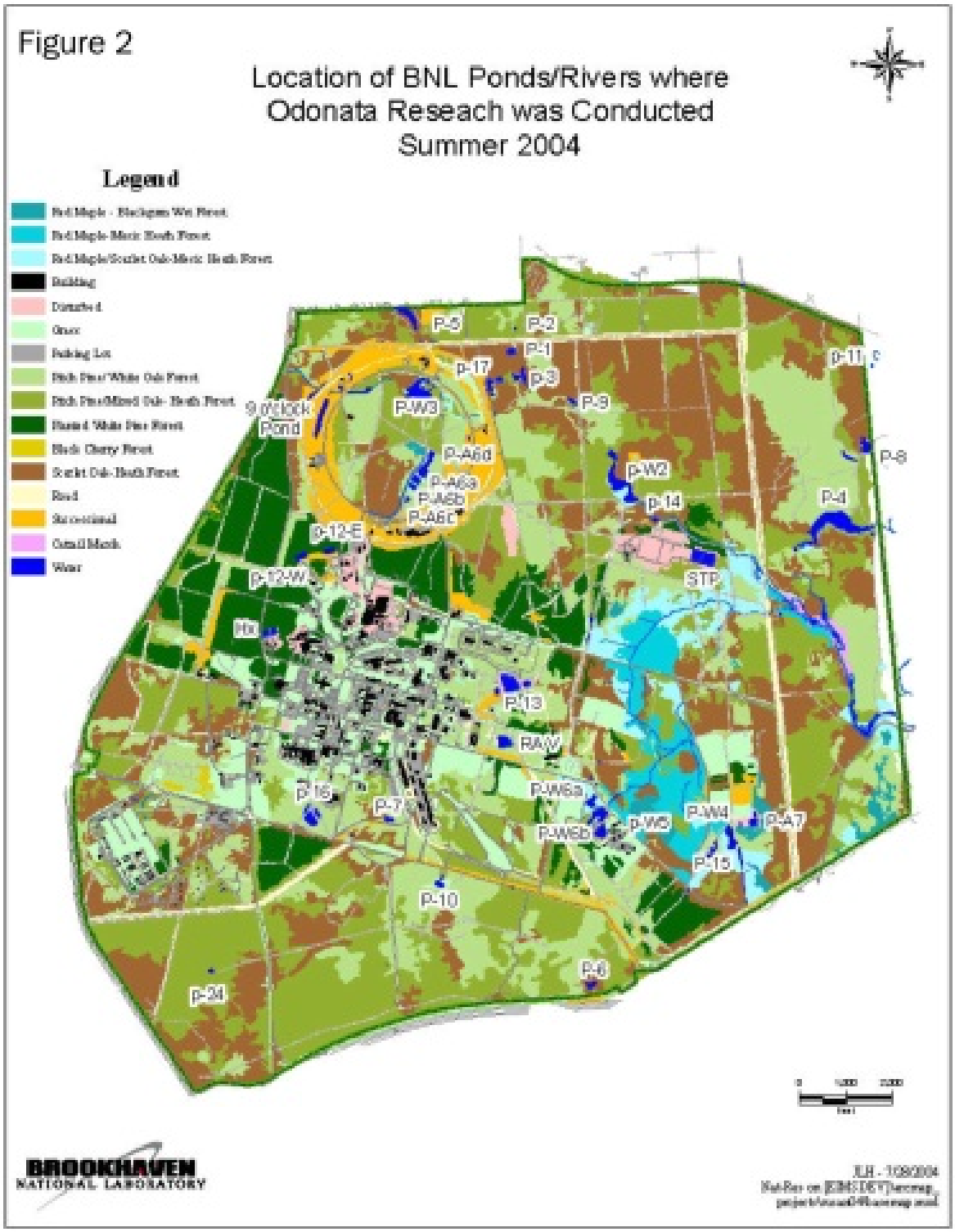
Figure 2


Location of BNL Ponds/Rivers where
Odonata Reseach was Conducted
Summer 2004
Legend
Red Maple - Blackgum Wet Forest
Red Maple-Mesic Heath Forest
Red Maple/Scarlet Oak-Mesic Heath Forest
Building
Disturbed
Grass
Parking Lot
Pitch Pine/White Oak Forest
Pitch Pine/Mixed Oak- Heath Forest
Planted White Pine Forest
Black Cherry Forest
Scarlet Oak-Heath Forest
Reed
Successional
Cattail Marsh
Water
P-5
P-2
P-1
P-17
P-3
P-11
P-W3
P-9
9 O'Clock Pond
P-A6d
P-W2
P-8
P-A6a
P-A6b
P-A6c
P-14
P-4
P-12-E
STP
P-12-W
Hx
P-13
RA-V
P-16
P-7
P-W6a
P-W4
P-A7
P-W6b
P-W5
P-15
P-10
P-6
P-34
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