

National Arboretum

The US Department of Agriculture National Arboretum (NAR) is a 170 hectare botanic park containing managed meadows, managed flower and shrub beds, managed hardwood and pine forests, and unmanaged forests. The habitat is patchy and varied. There are several ponds that support odonata, the largest of which is Beech Pond (NBP). It is an artificial 0.5 ha pond with an earthen berm around half of its shoreline. It is surrounded by managed forests, meadows, a road and a small creek. The shoreline is dominated by *Salix*, *Quercus* and *Taxodium* species, while the rest is mowed grass and invasive *Alliolaria brevipedunculata* (porcelainberry vine). The second site at NAR is the Fern Valley and Meadow area (NFV). This is a forested stream valley that USNA cultivates as a native plant display. The area contains poplar-oak forest, meadows, a small stream and two small ponds. One pond is located at the forest edge, in the meadow, and the other is within the canopy of the forest. In FY10 a new site was established in one of the natural meadows that the Arboretum staff maintains. This 3.25 hectare meadow on Holly Springs Road is dominated by non-native grasses, native forbs and blackberry brambles (NHM). The final transect site at USNA follows a path along two large vernal pools near the azalea display (NAP). There are two ponds that dry out completely in the late summer. They are fed by runoff from roads and higher elevation sites, and support breeding populations of *Ambystoma maculatum* (spotted salamander) and *Rana sylvatica* (wood frog). The ponds are forested and the transect includes a managed meadow adjacent to the ponds.

Chesapeake and Ohio Canal Park

The Chesapeake and Ohio Canal Park (COC) is a 295 km long national park that follows the canal from Georgetown in the District to Cumberland, Maryland. The FWD surveyed three sites in C&O. South of Fletcher's Cove, there are several vernal pools; biologists surveyed one long, thin vernal pool in this area (CFP). The habitat is forested but with an open canopy around the pools. The dominant plants are *Acer negundo* (box elder) and various grasses such as *Chasmanthium latifolium* (Indian wood oat). The vernal pool is 200m by 5m, with varying amounts of emergent vegetation. It also supports breeding populations of *Ambystoma maculatum* (spotted salamander) and *Rana sylvatica* (wood frog). Biologists also established transects in the Potomac Gorge on the riparian flats below Chain Bridge (CBF) and at riparian pools south of Chain Bridge (CBV). The Chain Bridge flats are a riparian plain that is seasonally flooded and has large river-fed ponds and flat rocky terrain. FWD biologists walked transects along the ponds north of Chain Bridge. The CBV transect followed stream- and river-fed pools in forest and meadows south of Chain Bridge in habitat that is intermediate between the CBF and CFP transects.

Anacostia Park

FWD surveyed four sites along the upper Anacostia River in Anacostia Park (ANA). The first site was a meadow adjacent to Kingman Lake and the Robert F. Kennedy Stadium Parking lot (ARM). There is a thin strip of riparian forest between the meadow and the lake and there are reconstructed emergent freshwater wetlands in Kingman Lake. The meadow is not mowed regularly and is dominated by non-native grasses and small trees. The second site, River Terrace Wetlands (ART) is a reconstructed freshwater tidal wetland in the main stem of the Anacostia

River. This is a 3 ha site dominated by cattail, phragmites and arum species. Kenilworth Park is a former landfill containing four soccer fields and a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remediation site. The edges of the soccer fields and the CERCLA site are unmanaged meadows, such that a 6 ha meadow with native plants has become established. The site is adjacent to the Anacostia River and Kenilworth Aquatic Gardens, separated from both by riparian forests. FWD biologists walked transects in the Kenilworth soccer fields (AKF) and CERCLA site (AKC).

Table 1. Distance and area of transects surveyed in 2010.

Location	Location Code	Site	Site Code	Transect Length (m)	Transect Area (m ²)
Anacostia Park	ANA	RFK Meadow	ARM	600	6000
		River Terrace Wetland	ART	300	3000
		Kenilworth Ballfields	AKF	550	5500
		Kenilworth Landfill	AKC	900	9000
Oxon Run Park	OXO	Stream	OXS	450	4500
		Bog	OXB	550	5500
C&O Canal Park	COC	Chain Bridge Flats	CBF	350	3500
		Chain Bridge Vernal Pools	CBV	450	4500
		Fletcher's Vernal Pools	CFP	300	3000
Rock Creek Park	RCP	Picnic Area 10	RPT	350	3500
		Picnic Area 7	RPS	350	3500
		Oregon Avenue Meadow	ROM	400	4000
		Rock Creek Fall Line	RFL	250	2500
		Pierce Mill	RPM	200	2000
		Tompson's Boathouse	RTB	250	2500
Theodore Roosevelt Island	TRI	North Shore	TNS	500	5000
		Forested Wetlands	TFW	350	3500
National Arboretum	NAR	Fern Valley	NFV	200	2000
		Beech Pond	NBP	350	3500
		Holly Springs Meadow	NHM	250	2500
		Azalea Ponds	NAP	300	3000

Rock Creek Park

Rock Creek Park (RCP) is a large forested park in the center of Washington DC. It surrounds the stream valley of Rock Creek, which crosses the fall line as it passes through the park towards the Potomac River. Three transect sites were placed in habitats above the geologic fall line. Two were adjacent to the creek at Picnic Areas 10 (RPT) and 7 (RPS). These sites are open canopy forest with mature oak and poplar. The creek bank is vegetated, often with non-native invasive plants. The other transect site above the fall line was established at a meadow at Oregon Avenue (ROM), outside of the stream valley and approximately 600 meters west of Rock Creek. The

meadow is composed of native and non-native grasses and forbs and is mowed once a year to eliminate woody vegetation. Another transect was located along the creek at the rocky rapids (RFL) present at the geologic fall line. The creek is wide and unshaded by tree canopy and the floodplain is narrow. A transect was also established at Pierce Mill (RPM) below the fall line. At this site the creek is wider and deeper due to the presence of a dam associated with a historic millhouse. The floodplain is broad and the forest canopy is open. A final transect was established at the mouth of Rock Creek, where it meets the Potomac River at Thompson's Boathouse (RTB). The creek is surrounded by steep banks in a highly urbanized part of the District. The creek passes old canal locks and a modern boathouse.

Theodore Roosevelt Island

Theodore Roosevelt Island (TRI) is a large forested bedrock island in the Potomac River that was enlarged with dredge material in the early 20th century. It is composed of upland bedrock forests, rock and mud shorelines, forested wetlands and emergent wetlands. Transects were established along the north shoreline (TNS) and within the forested wetland adjacent to an emergent wetland (TFW).

Oxon Run Park

Oxon Run Park (OXO) is a forested park adjacent to the District's southern border. The park is transected by Oxon Run, a degraded, channelized stream. The forest surrounding the stream contains locally rare and unique habitats including a gravel terrace plant community and a globally rare acidic magnolia bog (Simmons et al 2008). Transects were walked along the stream (OXS) and within the bog (OXB).

Results

Summary

Forty-three Odonata and 40 Lepidoptera species were recorded at the six locations during the 2010 survey. The highest Odonata species richness (29 species) occurred at C&O, and the lowest (10 species) was at OXO. The highest Lepidoptera species richness (29 species) was at ANA, and the lowest (8 species) was at TRI. Highest Odonata abundance was at C&O and the lowest was at TRI. Highest Lepidoptera abundance was at ANA and lowest was at OXO. See Table 1 for summary data.

Species of Greatest Conservation Need and Potential Indicator Species

Six species of greatest conservation need were recorded during this survey. One dragonfly species, *Arigomphus villosipes* (Unicorn Clubtail), was found at the Beech Pond at USNA. Five butterfly SGCN were recorded. *Danaus plexippus* (Monarch), *Euptoieta Claudia* (Variegated Fritillary), *Polygonia comma* (Eastern Comma), *Polygonia interrogationis* (Question Mark), *Vanessa atalanta rubria* (Red Admiral) were recorded at several locations. Table 3 shows the

SGCN that FWD has recorded and those that are being targeting for inventory in this and in future surveys.

Table 2. Abundance and richness of Odonata and Leipodoptera from six surveys sites in Washington D.C in 2010

Location	Number of Odonata species	Number of Lepidoptera Species	Total Insect Richness (No. Species/Location)	Total Odonata Abundance	Total Lepidoptera Abundance
Anacostia Park	17	29	46	418	414
C&O Canal Park	29	22	51	900	219
National Arboretum	26	21	47	476	216
Rock Creek Park	24	13	37	300	141
Theodore Roosevelt Island	13	9	22	220	38
Oxon Run Park	11	10	21	414	62

Table 3. Locations of insect Species of Greatest Conservation Need from the District of Columbia's Wildlife Action Plan recorded in 2010

SGCN	Common Name	Location
<i>Arigomphus villosipes</i>	Unicorn Clubtail	National Arboretum
<i>Danaus plexippus</i>	Monarch	Anacostia Park C&O Canal National Arboretum Rock Creek Park
<i>Euptoieta claudia</i>	Variegated Fritillary	Anacostia Park National Arboretum Oxon Run Rock Creek Park
<i>Polygonia comma</i>	Eastern Comma	C&O Canal
<i>Polygonia interrogationis</i>	Question Mark	Anacostia Park
<i>Vanessa atalanta rubria</i>	Red Admiral	Anacostia Park C&O Canal National Arboretum Rock Creek Park Theodore Roosevelt Island
<u>Other insect SGCN (not observed in 2010 or previous surveys):</u>		
<i>Cordulegaster erroneus</i>	Tiger Spiketail	
<i>Ischnura kellicotti williamsoni</i>	Lilypad Forktail*	*recorded in 2008 & 2009
<i>Lestes dryasa</i>	Emerald Spreadwing	
<i>Nehalennia irene</i>	Sedge Sprite	
<i>Nehalennia gracilis</i>	Sphagnum Sprite	
<i>Somatochlora linearis</i>	Mocha Emerald	
<i>Tachopteryx thoreyi</i>	Grey Petaltail	
<i>Callophyrus irus</i>	Great Spangled Fritillary	
<i>Erynnis martialis</i>	Mottled Duskywing	
<i>Polites origenes</i>	Crossline Skipper	
<i>Pompeius verna</i>	Little Glassywing	
<i>Pyrgu wyandot</i>	Appalachian Grizzled Skipper	
<i>Satyrrium edwardsii</i>	Edward's Hairstreak	

Several of the species seen in 2010 were very common. Two dragonfly species, *Pachydiplax longipennis* Blue Dasher and *Plathemis lydia* Common Whitetail, and two butterfly species, *Papilio glaucus* Tiger Swallowtail and *Epargyreus clarus* Silver-sided Skipper were found at every location, and at more than half of the sites. Odonata *Tramea lacerata* Black Saddlebags, *Pantala hymenaea* Spot-winged Glider, *Ischnura posita* Fragile Forktail and *Perithemis tenera* Eastern Amberwing, were found at five of the locations throughout the study period. Lepidoptera species *Pieris rapae* Cabbage White, *Phyciodes tharos* Pearl Crescent, *Junonia coenia* Common Buckeye, *Cupido comyntas* Eastern Tailed-blue and *Papilio troilus* Spicebush Swallowtail were all recorded at five sites. *Plathemis lydia* was seen at the most sites, 15, and was seen most often. *Pachydiplax longipennis* was most abundant, with 514 records. Table 4 contains the summary of the most common and abundant species.

Table 4. Summary of abundance and distribution of common Odonata and Lepidoptera species in the District of Columbia in 2010.

Species	Occasions Seen	No. Locations/6	No. Sites/17	Individuals Seen
Common Whitetail	39	6	15	153
Blue Dasher	36	6	14	514
Black Saddlebags	23	5	11	66
Spot-winged Glider	19	5	10	65
Common Green Darner	21	4	10	58
Fragile Forktail	16	5	8	51
Eastern Amberwing	21	5	7	197
Violet Dancer	18	4	7	305
Tiger Swallowtail	25	6	17	45
Cabbage White	26	5	16	60
Pearl Crescent	27	5	14	136
Common Buckeye	18	5	13	145
Silver-sided Skipper	16	6	12	38
Eastern Tailed Blue	15	5	12	63
Spicebush Swallowtail	18	5	10	30
Monarch	15	4	9	43
Clouded Sulfur	15	4	7	50

Some species were rarely recorded, or seem to have smaller ranges than others. These are species that were recorded at only one site throughout the survey or were recorded more than once, but seen in low numbers. These species and locations are listed in Table 5. *Enallagma daeckii* Attenuated Bluets, *Libellula semifasciata* Painted Skimmer, *Ischnura ramburii* Rambur's Forktail, *Enallagma traviatum* Slender Bluets, *Lestes rectangularis* Slender Spreadwing and *Arigomphus villosipes* Unicorn Clubtail were all seen at only one site in summer 2010. Three of these species, *Libellula semifasciata*, *Ischnura ramburii* and *Lestes rectangularis*, had one individual observed. *Tramea carolina* Carolina Saddlebags, *Archilestes grandis* Great Spreadwing and *Libellula semifasciata* Painted Skimmer are new Odonata species that have not been recorded in previous years of this study.

Table 5. Rare Odonata and Lepidoptera species from sites surveyed in 2010. Species recorded at only one site and species with few records but found at >1 site.

Common Name	Location	Site	Records
Attenuated Bluet	National Arboretum	Beech Pond	9
Carolina Saddlebags	Kenilworth Athletic Fields	Soccer Fields	2
	Oxon Run	Stream	1
Dragonhunter	National Arboretum	Beech Pond	2
	Rock Creek Park	Peirce Mill	1
Dusky Dancer	Rock Creek Park	Picnic Area 10	9
Familiar Bluet	National Arboretum	Fern Valley and Meadow	1
	Rock Creek Park	Thompson's Boathouse	4
Great Spreadwing	Oxon Run	Bog	1
	Oxon Run	Stream	1
Painted Skimmer	Kenilworth Athletic Fields	CERCLA site	1
Rambur's Forktail	Anacostia Park	River Terrace Wetland	1
Slender Bluet	National Arboretum	Beech Pond	31
Slender Spreadwing	C&O Canal	Chain Bridge Vernal Pools	1
Unicorn Clubtail	National Arboretum	Beech Pond	3
American Lady	National Arboretum	Holly Springs Meadow	1
Checkered White	C&O Canal	Chain Bridge Flats	4
Comma	C&O Canal	Chain Bridge Flats	2
		Chain Bridge Vernal Pools	3
Common Checkered-skipper	Anacostia Park	Kenilworth Soccer Fields	4
		RFK Meadow	1
Fiery Skipper	Anacostia Park	Kenilworth CERCLA	1
Northern Pearly-eye	C&O Canal	Chain Bridge Vernal Pools	1
Question Mark	Anacostia Park	Kenilworth Soccer Fields	1
Sleepy Orange	National Arboretum	Holly Springs Meadow	1
Wild Indigo Duskywing	Anacostia Park	Kenilworth CERCLA	1

Diversity

The measurements of Odonata species richness, diversity and evenness for the locations surveyed in 2009 are listed in Table 6. These indices are presented by site in Table 7. The greatest number of individuals and species were recorded at C&O, but this location did not have the highest Shannon-Wiener diversity index (H). NAR with a three fewer species and half as many records, had the highest H of all locations. Evenness was similar (0.72-0.79) at ANA, C&O, NAR and RCP. OXO had the lowest evenness and lowest H, probably due to the dominance of two species. TRI also had low evenness and H, due to the dominance of one species during one visit.

The diversity indices for individual sites are broken out in Table 7. Two sites had the highest H, CBV (2.34) and NBP (2.32). TNS had the lowest evenness and lowest H (0.55), due to the dominance of one species, *Enallagma durum* Big Bluet. OXS had the second highest abundance, but also the second lowest H and evenness, due to the dominance of *Argia*

Table 6. Diversity indices of Odonata species for survey locations in Washington DC in 2010.

Anacostia Park	C&O Canal	National Arboretum	Oxon Run	Rock Creek Park	Theodore Roosevelt Island
Shannon-Wiener Diversity Index					
2.09	2.44	2.57	1.01	2.46	1.24
Species Richness (S)					
17	29	26	11	24	13
Total Abundance					
418	900	476	414	300	220
Evenness					
0.74	0.72	0.79	0.42	0.77	0.48

Table 7. Diversity indices of odonata species for survey sites in Washington DC.

Anacostia Park				C&O Canal			National Arboretum			
RFK Meadow	River Terrace Wetland	CERCLA Site	Soccer Fields	Chain Bridge Flats	Chain Bridge Vernal Pools	Fletcher's Vernal Pools	Azalea Ponds	Beech Pond	Fern Valley and Meadow	Holly Springs Meadow
Species Richness (S)										
10	10	8	9	22	20	5	7	21	13	4
Total Abundance										
181	108	21	108	508	350	42	56	354	45	21
Shannon-Wiener Index										
1.53	2.00	1.67	1.68	2.09	2.34	1.37	1.48	2.32	2.15	1.24
Evenness										
0.67	0.87	0.81	0.77	0.68	0.78	0.85	0.76	0.76	0.84	0.89
Oxon Run		Rock Creek Park						Theodore Roosevelt Island		
Bog	Stream	Fall Line Rapids	Oregon Avenue Meadow	Peirce Mill	Picnic Area 10	Picnic Area 7	Thompson's Boathouse	Forested/ Emergent Wetland	North Shore	
Species Richness (S)										
6	9	3	5	12	10	4	8	8	7	
Total Abundance										
15	399	39	47	44	100	26	44	49	171	
Shannon-Wiener Index										
1.43	0.97	1.06	1.32	1.98	1.59	0.88	1.79	1.37	0.55	
Evenness										
0.80	0.44	0.97	0.82	0.80	0.69	0.64	0.86	0.66	0.28	

Table 8. Diversity indices of Lepidoptera species for survey locations in Washington DC in 2010.

Anacostia Park	C&O Canal	National Arboretum	Oxon Run	Rock Creek Park	Theodore Roosevelt Island
Species Richness (S)					
29	22	21	10	13	9
Total Abundance					
414	219	216	62	141	38
Shannon-Wiener Diversity Index					
2.57	2.55	2.37	1.82	2.30	1.88
Evenness					
0.76	0.82	0.78	0.79	0.90	0.86

Table 9. Diversity indices of Lepidoptera species for survey sites in Washington DC.

Anacostia Park				C&O Canal			National Arboretum			
Kenilworth CERCLA	Kenilworth Soccer Fields	RFK Meadow	River Terrace Wetland	Chain Bridge Flats	Chain Bridge Vernal Pools	Fletchers Vernal Pool	Azalea Ponds	Beech Pond	Fern Valley and Meadow	Holly Springs Meadow
Species Richness (S)										
17	18	14	14	16	13	9	7	9	10	14
Total Abundance										
51	130	129	104	108	82	29	28	39	34	115
Shannon-Wiener Diversity Index										
2.43	2.29	2.09	1.99	2.36	2.12	1.73	1.73	1.45	1.98	2.19
Evenness										
0.86	0.79	0.79	0.75	0.85	0.83	0.79	0.89	0.66	0.86	0.83

Oxon Run		Rock Creek Park						Theodore Roosevelt Island	
Bog	Stream	Fall Line Rapids	Oregon Avenue Meadow	Peirce Mill	Picnic Area 10	Picnic Area 7	Thompson's Boathouse	Forested Wetland	North Shore
Species Richness (S)									
2	10	3	7	8	7	8	2	8	4
Total Abundance									
9	53	9	43	20	32	34	3	32	6
Shannon-Wiener Diversity Index									
0.35	1.82	1.10	1.32	1.98	1.60	0.88	1.79	1.75	1.24
Evenness									
0.50	0.79	0.77	0.74	0.92	0.90	0.72	0.92	0.84	0.90

fumipennis violacea Violet Dancer. The highest evenness was at RFL (0.97), but nine sites had evenness of 0.80 or higher. These values indicate that the riparian floodplain in the Potomac Gorge (CBV) and an artificial pond adjacent to the Anacostia River (NBP) contain the highest species diversity in the District.

The measurements of Lepidoptera species richness, diversity and evenness for the locations surveyed in 2009 are listed in Table 8. These indices are presented by site in Table 9. The highest H (2.57), species richness and abundance were at ANA, although C&O, NAR and RCP all had H of 2.30 or higher. ANA had a diversity of habitats, from riparian meadows to emergent wetlands and upland meadows. OXO and TRI both had low H values, but TRI also had the second highest evenness of all locations. The highest evenness was at RCP (0.90), and the lowest was at ANA (0.76).

The diversity indices for individual sites are broken out in Table 9. Three sites had high species richness, AKC, AKF and CBF. Highest abundance was at AKF and ARM. Lowest species richness, lowest abundance and lowest H were at OXB and at RTB. The highest H was at AKC (2.43), although AKF (2.29) and CBF (2.36) had high diversity values as well. These values indicate that wet and dry meadows contain the highest butterfly species diversity, while forested sites, including forested wetlands have the lowest diversity and lowest butterfly abundance.

Seasonal Abundance

The graphs in Figure 1 represent a time series of the normalized relative Odonata species richness found at each site. Relative species richness was low and constant at through the study period sites at ANA, OXO and TRI, although ART had an early peak that declined into midsummer. Species richness was higher in site at C&O, NAR, and RCP, but at all three locations the species richness generally tapered off after mid-July and then held steady through late summer. The sites, CFP, NHN, RFL and ROM at these locations showed low relative diversity throughout the study period. The highest relative richness was at sites NBP, NFV and CBF. In several cases the species diversity begins high and tapers off. The typical springtime rise in species richness that was reported in previous years may have been missed due to lack of data collection from mid-April to late May.

Figure 2 shows the similar time series graphs displaying the normalized relative Odonata abundance recorded at each site. All sites at ANA and RCP had steady low abundance, as did CFP, NAP, NFV and NHM. TRI and OXO both had low abundance coupled with a spike in abundance driven by one species. High numbers of *Argia fumipennis violacea* Violet Dancer were recorded for several visits at OXS, and high numbers of *Enallagma durum* Big Bluet were recorded on submerged aquatic vegetation (*Hydrilla*) along the transect at TNS on one visit. The highest relative abundance was recorded at NBP and at CBF. Abundance at these sites was highest in early June and tapered off through mid-July.

The graphs in Figure 3 represent a time series of the normalized relative Lepidoptera species richness found at each site. Two locations, TRI and OXO, did not receive sufficient visits during the study period, so data are not reported from those locations. The graphs show a general upward trend in species richness throughout the study period that is may be due to observer bias

Figure 1. Time series graphs of Odonata species richness at each of 19 sites in six locations in Washington DC. Data were relativeized by transect length and normalized to one to compare across different transect lengths. X-axis = date; Y-axis = normalized relative species richness.

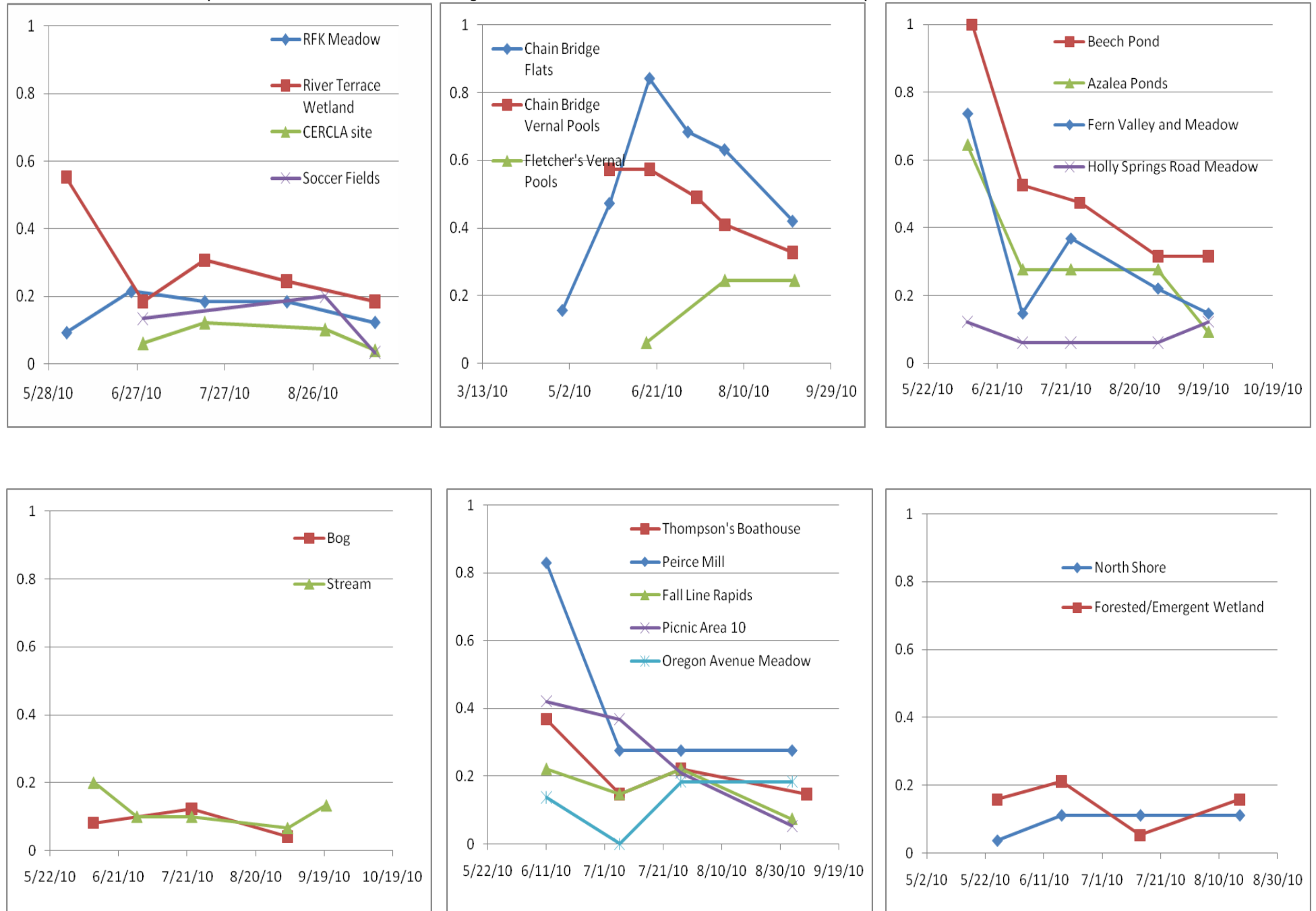


Figure 2. Time series graphs of total Odonata records (abundance of all species pooled) at each of 19 sites in six locations in Washington DC. Data were relativeized by transect length and normalized to one to compare across different transect lengths. X-axis = date; Y-axis = normalized relative abundance.

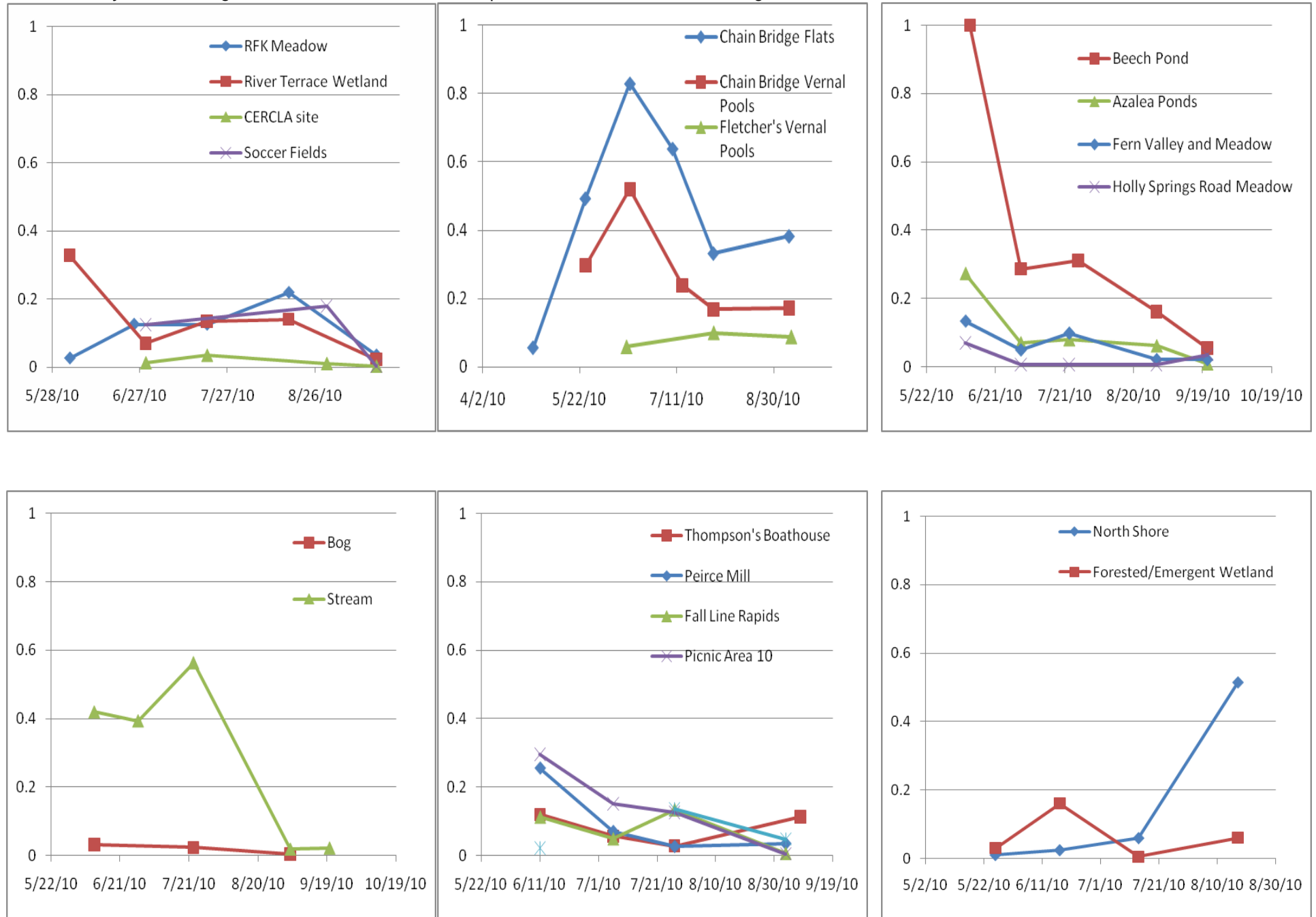


Figure 3. Time series graphs of butterfly species richness at each of 14 sites in four locations in Washington DC. Data were relativeized by transect length and normalized to one to compare across different transect lengths. X-axis = date; Y-axis = normalized relative species richness.

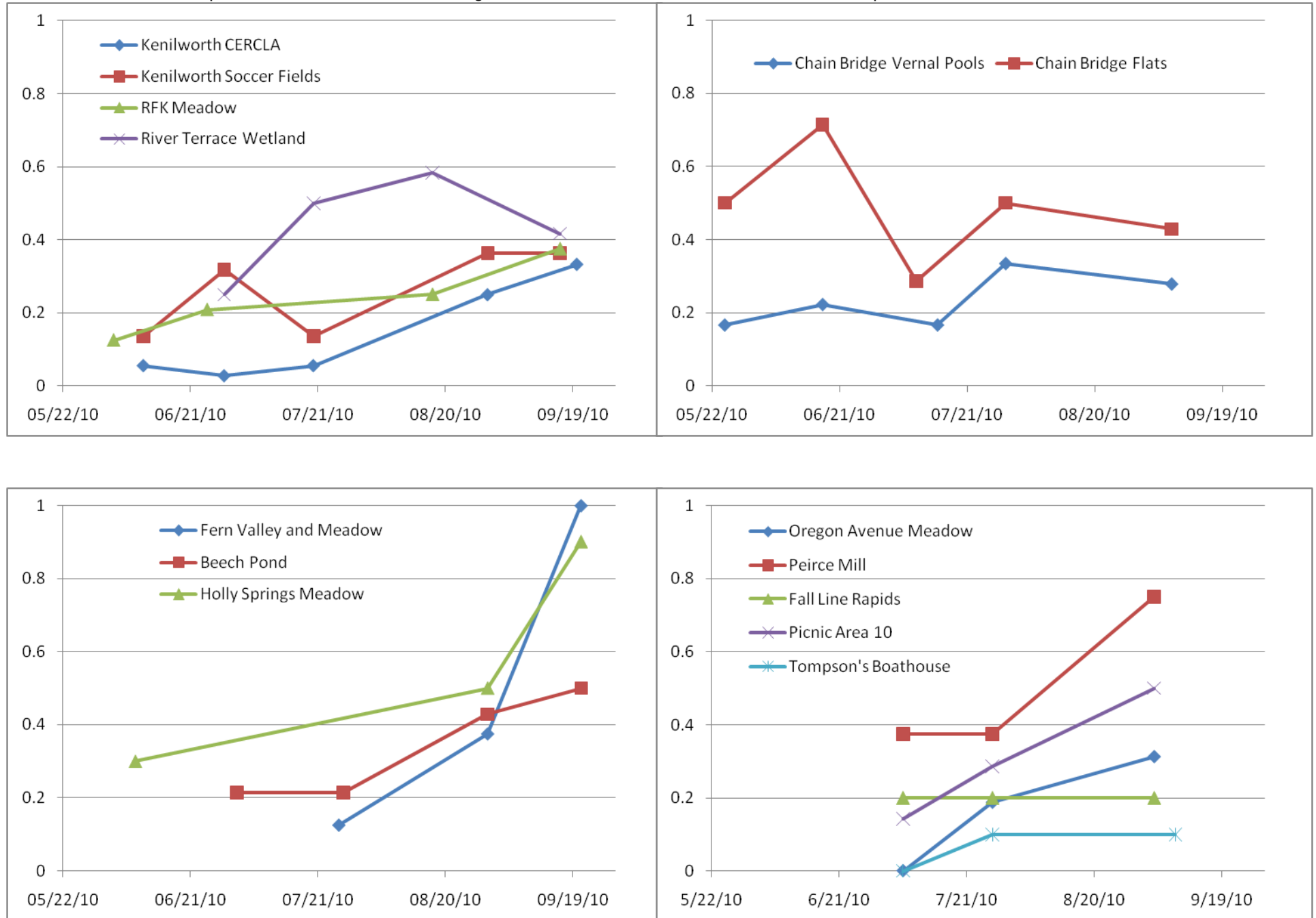
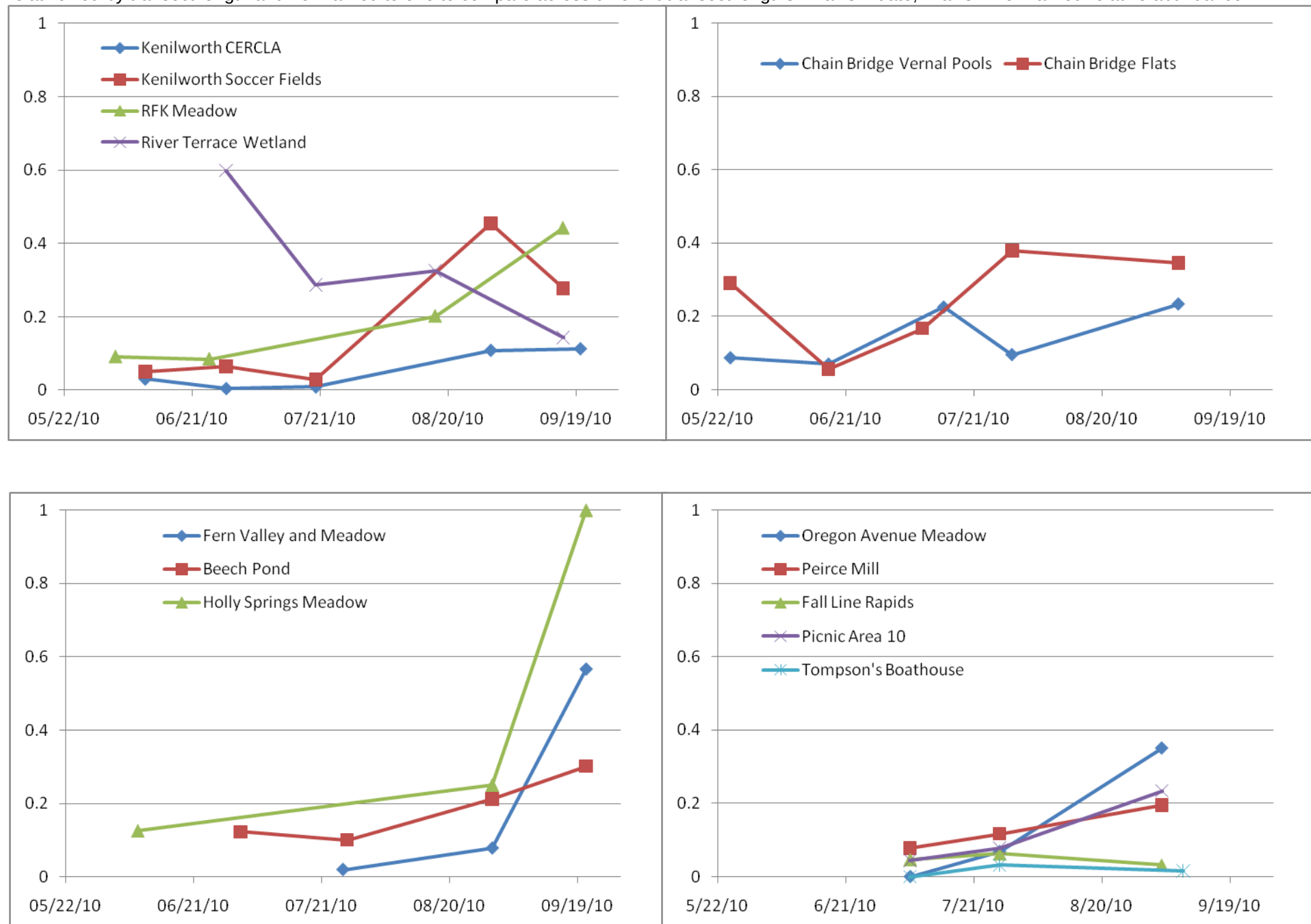


Figure 4. Time series graphs of total butterfly records (abundance of all species pooled) at each of 14 sites in four locations in Washington DC. Data were relativeized by transect length and normalized to one to compare across different transect lengths. X-axis = date; Y-axis = normalized relative abundance.



– the observer became more adept at identifying new species as the study period advanced. The data from C&O does not display this trend, but remain steady throughout the study period, except for a spike in mid-June at CBF. The highest relative species richness was seen at NAR at site NHM and NFV. Both sites are unmanaged meadows rich in native grasses and forbs.

Figure 4 shows the similar time series graphs displaying the normalized relative Lepidoptera abundance recorded at each site. Relative abundance was highest in late summer at NHM and lowest in mid-summer at all sites at RCP, at AKC and AKF. In general, abundance was lower in mid-summer when temperatures are highest. Meadow sites with native grasses and forbs (AKF, NHM, NFV and ROM) showed the highest relative abundance, while sites associated with forests and water (RTB, RFL and NBP), showed lower abundance.

NACE Purpose

The District of Columbia's Wildlife Action Plan (WAP) calls for inventories and surveys of invertebrate populations to establish baseline data on populations and species abundance trends. For the past several years the DDOE-Fisheries and Wildlife Division has been implementing the WAP with surveys of dragonflies and damselflies (Odonata). In 2010 FWD expanded these surveys to include butterflies (Lepidoptera) and by adding two survey locations. These studies are improving the knowledge base about local insect populations and will inform a long-term monitoring strategy for other invertebrates in the city. The goal of these studies is to collect data about the abundance and diversity of the invertebrate species in the District, and to examine species composition in various habitats in the city in relation to physical and biological habitat variables.

There were three main research objectives: 1) To target various habitats to find SGCN; 2) to find species that might function as environmental indicators. When learning the species composition is a research goal, targeted searches are necessary to find rare species and to create a picture of species assemblages in critical habitats and 3) to sample across habitats to determine the spatial distribution of species within the city and the correct scale for future sampling, and to survey throughout the summer to determine peak flight periods for various species of adult odonata.

Surveys began on 14 April and continued through 19 October. Site visits were rotated semi-weekly to ensure at least one visit every three weeks. Biologists walked along established transects in typical habitat and counted individuals as they were encountered. The method is similar to a Pollard walk where all individuals within five meters of the transect were recorded. Some species tend to patrol over long distances so attempts were made to avoid double counting individuals. Unknown individuals were photographed to have a record for identification. Surveys were conducted during the late morning and afternoon hours when most dragonflies, damselflies and butterflies are more active. At the beginning of each survey local weather data including ambient temperature, cloud cover and wind speed was recorded.

The analysis was qualitative and limited to descriptive statistics and measurements. Instead of performing randomized site selection, specific habitats were targeted to yield SGCN. Species richness, species evenness, relative abundance and diversity indices were calculated for each survey site and for the overall region. The Shannon-Wiener diversity index is a measure of site diversity, can be used to compare diversity between sites. It takes into account the relative abundance of each species at each site surveyed. It increases as the relative abundance of all species increases, but it can also be reduced by a single dominant species. The index is the sum of the relative abundances, but the total number of species is not used in the calculation.

Finally, relative species richness and relative abundance for every site visit were calculated and graphed against time. To calculate the relative richness and relative abundance from each visit to each site, the species or total abundance recorded was divided by the length of that transect at that site and normalized to one by dividing each by the highest relative abundance.

FWD surveyed four transects sites in Anacostia Park: a meadow adjacent to the RFK Stadium parking lot, the River Terrace wetlands and two meadows adjacent to the Kenilworth Park soccer fields and former landfill. Two sites in Oxon Run Park were surveyed: along the creek and within the forested bog.

NACE Results

There were 17 Odonata species and 29 Lepidoptera species observed at Anacostia Park and 11 Odonata and 10 Lepidoptera species at Oxon Run Park. No Odonata Species of Greatest Conservation Need (SGCN) were seen. Four Lepidoptera SGCN were seen: *Danaus plexippus*, *Euptoieta claudia*, *Polygonia interrogationis*, and *Vanessa atalanta rubria*. Several Odonata species were seen at only one site: *Archilestes grandis* at the Oxon Run Stream; *Ischnura ramburii* and the River Terrace wetland, *Libellula semifasciata* at the Kenilworth Landfill site. Several Lepidoptera species were seen at only one site: *Pyrgus communis* at the Kenilworth Soccer Fields, *Hylephila phyleus* at the Kenilworth Landfill site, *Polygonia interrogationis* at the Kenilworth Soccer Fields and *Erynnis baptisiae* at the Kenilworth landfill site.

Perithemis tenera (155 records), *Libellula needhami* (67) and *Pantala hymenaea* (32) were the most commonly recorded Odonata species in Anacostia Park. *Argia fumipennis violacea* (231) and *Calopteryx maculata* (153) were the most commonly recorded Odonata species in Oxon Run Park. *Junonia coenia* (100) *Phyciodes tharos* (45) and *Colias philodice* (29) were the most common butterfly species recorded in Anacostia Park. There were too few site visits to Oxon Run to report data on the most common butterflies.

Shannon-Wiener index (H) for Odonata was 2.09 in Anacostia Park and 1.01 in Oxon Run. The diversity index at Oxon Run was the lowest of all six locations in the survey. Highest H in the survey was at the National Arboretum (2.57). Total Odonata abundance was similar at the two locations (418 & 414), but Oxon Run was dominated by high abundance of two species, *Argia fumipennis violacea* and *Calopteryx maculata*. Broken out by site, the River Terrace wetland had the highest H, 2.00, and the RFK meadow had the lowest, 1.53. Between eight and ten species were seen at all four Anacostia sites. The Oxon Run stream site had an H of 0.97 and the bog site had H of 1.43. The bog site had very low species richness and abundance, 6 species, and 15 records.

Shannon-Wiener index (H) for Lepidoptera was 2.57 at Anacostia Park, the highest of all six locations in the survey. H was 1.82 at Oxon Run, the lowest of all six locations in the survey. Total abundance was 414 records at Anacostia Park and 62 records at Oxon Run. Neither site was dominated by one common species. Broken out by site, the Kenilworth landfill meadow had the highest H, 2.43, and the River Terrace wetland had the lowest, 1.99. Between 14 and 17 species were seen at the four Anacostia sites. The Oxon Run stream site had an H of 1.82 and the bog had 0.35. The bog site had very low species richness, 2 species, and low abundance, 9 records. These values indicate that wet and dry meadows contain the highest butterfly species diversity, while forested sites, including forested wetlands have the lowest diversity and lowest butterfly abundance.

In Anacostia Park relative Odonata species abundance was highest at River Terrace wetland in late May, at which point it began dropping slowly. Species abundance remained highest at River Terrace and lowest at the Kenilworth Landfill meadow throughout the study period. At the other sites species abundance was low but stable throughout the study period, and began dropping off in mid-August. Total relative abundance followed a similar pattern.

Relative butterfly species abundance increased at all sites in Anacostia Park over the study period. This pattern may reflect observer bias as the observer became more adept at identifying butterfly species. The most species were seen at the River Terrace wetland in mid August, and the fewest were at the Kenilworth Landfill meadow in late June. Total individual abundance was

low in late May and increased at all sites except the River Terrace wetland. At this site abundance was highest in June and decreased throughout the study period.

CHOH Purpose

The District of Columbia's Wildlife Action Plan (WAP) calls for inventories and surveys of invertebrate populations to establish baseline data on populations and species abundance trends. For the past several years the DDOE-Fisheries and Wildlife Division has been implementing the WAP with surveys of dragonflies and damselflies (Odonata). In 2010 FWD expanded these surveys to include butterflies (Lepidoptera) and by adding two survey locations. These studies are improving the knowledge base about local insect populations and will inform a long-term monitoring strategy for other invertebrates in the city. The goal of these studies is to collect data about the abundance and diversity of the invertebrate species in the District, and to examine species composition in various habitats in the city in relation to physical and biological habitat variables.

There were three main research objectives: 1) To target various habitats to find SGCN; 2) to find species that might function as environmental indicators. When learning the species composition is a research goal, targeted searches are necessary to find rare species and to create a picture of species assemblages in critical habitats and 3) to sample across habitats to determine the spatial distribution of species within the city and the correct scale for future sampling, and to survey throughout the summer to determine peak flight periods for various species of adult odonata.

Surveys began on 14 April and continued through 19 October. Site visits were rotated semi-weekly to ensure at least one visit every three weeks. Biologists established and walked transects in a variety of habitats and counted individuals within five meters of the transect. Some species tend to patrol over long distances so attempts were made to avoid double counting individuals. Unknown individuals were photographed to have a record for identification. Surveys were conducted during the late morning and afternoon hours when most dragonflies, damselflies and butterflies are more active. At the beginning of each site visit, local weather data including ambient temperature, cloud cover and wind speed was recorded.

The analysis was qualitative and limited to descriptive statistics and measurements. Instead of performing randomized site selection, specific habitats were targeted to yield SGCN. Species richness, species evenness, relative abundance and diversity indices were calculated for each transect site and for the overall location. The Shannon-Wiener diversity index is a measure of site diversity, and can be used to compare diversity between sites. It takes into account the relative abundance of each species at each transect surveyed. It increases as the relative abundance of all species increases, but it can also be reduced by a single dominant species. The index is the sum of the relative abundances, but the total number of species is not used in the calculation.

Finally, relative species richness and relative abundance for every site visit were calculated and graphed against time. To calculate the relative richness and relative abundance from each visit to each transect, the species or total abundance recorded was divided by the length of that transect at that site and normalized to one by dividing each by the highest relative abundance.

FWD surveyed three transect sites in CHOH: on the riparian flats just north of Chain Bridge (CBF), at the riparian pools just south of Chain Bridge (CBP), and at a vernal pool south of Fletcher's Cove (CFC).

CHOH Results

There were 29 Odonata species and 22 Lepidoptera species recorded in 2010. No Odonata Species of Greatest Conservation Need (SGCN) were seen, but three Lepidoptera SGCN were seen: *Danaus plexippus* (Monarch), *Polygonia comma* (Comma), and *Vanessa atalanta rubria* (Red Admiral). Several species were seen at only one transect site: *Lestes rectangularis* (Slender Spreadwing) at CBP; *Pontia protodice* (Checkered White) and *Polygonia comma* at CBF. *Pachydiplax longipennis* (Blue Dasher, 353 records), *Erythemis simplicicollis* (Eastern Pondhawk, 87 records) and *Libellula lydia* (Common Whitetail, 65 records) were the most commonly recorded Odonata species in CHOH. *Ancyloxypha numitor* (Least Skipper, 60 records), *Vanessa atalanta rubria* (25 records) and *Epargyreus clarus* (Silver-spotted Skipper, 13 records) were the most common butterfly species.

Shannon-Wiener index (H) for Odonata was 2.44 in CHOH, second highest to six locations in the District. The highest H was at the National Arboretum (2.57). Total Odonata abundance was 900 records, the highest of all locations. Broken out by transect, CBP had the highest H, 2.34. CBF had an H of 2.09 and CFC had an H of 1.37. Twenty-two species and 508 individuals were recorded at CBF; 20 species and 350 individuals were recorded at CBP. Only five species and 42 individuals were recorded at CFC.

Shannon-Wiener index (H) for Lepidoptera was 2.55 at CHOH, the second highest of all six locations in the survey (H at Anacostia Park was 2.57). Total abundance was 219 records. Broken out by transect, CBF had the highest H, 2.36. CBP had an H of 2.12 and CFC had an H of 1.73. Sixteen species and 108 individuals were recorded at CBF; 13 species and 82 individuals were recorded at CBP. Only 9 species and 29 individuals were recorded at CFC.

At the CBF transect the relative species abundance rose rapidly from late April to mid June, at which point it dropped slowly. By mid September the species abundance was half of its June value. This peak was the highest of the three CHOH transects, and represented the second highest species abundance of all transects in the District. Relative species abundance at CBP followed a similar pattern, but did not peak as high. Species abundance at CFC remained low throughout the study period. Total abundance followed a similar pattern, peaking at CBF and CBP in mid June, falling through summer and leveling off in early August.

Relative butterfly species abundance increased to late June then fell steadily through the summer at CBF. Butterfly species abundance was low but stable at CBP. No butterfly data was collected at CFC. Total butterfly abundance at both transects started low at both sites, rose through early August, then dropped through late September.

GWMP Purpose

The District of Columbia's Wildlife Action Plan (WAP) calls for inventories and surveys of invertebrate populations to establish baseline data on populations and species abundance trends. For the past several years the DDOE-Fisheries and Wildlife Division has been implementing the WAP with surveys of dragonflies and damselflies (Odonata). In 2010 FWD expanded these surveys to include butterflies (Lepidoptera) and by adding two survey locations. These studies are improving the knowledge base about local insect populations and will inform a long-term monitoring strategy for other invertebrates in the city. The goal of these studies is to collect data about the abundance and diversity of the invertebrate species in the District, and to examine species composition in various habitats in the city in relation to physical and biological habitat variables.

There were three main research objectives: 1) To target various habitats to find SGCN; 2) to find species that might function as environmental indicators. When learning the species composition is a research goal, targeted searches are necessary to find rare species and to create a picture of species assemblages in critical habitats and 3) to sample across habitats to determine the spatial distribution of species within the city and the correct scale for future sampling, and to survey throughout the summer to determine peak flight periods for various species of adult odonata.

Surveys began on 14 April and continued through 19 October. Site visits were rotated semi-weekly to ensure at least one visit every three weeks. Biologists established and walked transects in a variety of habitats and counted individuals within five meters of the transect. Some species tend to patrol over long distances so attempts were made to avoid double counting individuals. Unknown individuals were photographed to have a record for identification. Surveys were conducted during the late morning and afternoon hours when most dragonflies, damselflies and butterflies are more active. At the beginning of each site visit, local weather data including ambient temperature, cloud cover and wind speed was recorded.

The analysis was qualitative and limited to descriptive statistics and measurements. Instead of performing randomized site selection, specific habitats were targeted to yield SGCN. Species richness, species evenness, relative abundance and diversity indices were calculated for each transect site and for the overall location. The Shannon-Wiener diversity index is a measure of site diversity, and can be used to compare diversity between sites. It takes into account the relative abundance of each species at each transect surveyed. It increases as the relative abundance of all species increases, but it can also be reduced by a single dominant species. The index is the sum of the relative abundances, but the total number of species is not used in the calculation.

Finally, relative species richness and relative abundance for every site visit were calculated and graphed against time. To calculate the relative richness and relative abundance from each visit to each transect, the total number of species or total number of observed individuals recorded at each site visit was divided by the length of that transect at that site. The resulting values were then normalized to one by dividing each by the value of the highest relative abundance.

FWD surveyed two transect sites in GWMP: Along the north shoreline of Theodore Roosevelt Island (TRI) and within the forested and emergent wetlands on TRI.

GWMP Results

There were 13 Odonata species and 9 Lepidoptera species recorded in 2010. No Odonata Species of Greatest Conservation Need (SGCN) were seen, but one Lepidoptera SGCN was seen: *Vanessa atalanta rubria* (Red Admiral). *Perithemis tenera* (Eastern Amberwing, 15 records), *Libellula vibrans* (Great Blue Skimmer, 29 records) and *Enallagma durum* (Big Bluet) were the most commonly recorded Odonata species at TRI. There were 148 *Enallagma durum* individuals recorded, 129 on one date in June. These individuals were flying and perching on *Hydrilla* that was floating in the water adjacent to the north shoreline. *Papilio glaucus* (Tiger Swallowtail, 12 records) was the most common butterfly species.

Shannon-Wiener index (H) for Odonata was 1.24 at TRI, second lowest of six locations in the District. The highest H was at the National Arboretum (2.57) and lowest was at Oxon Run Park. The total Odonata abundance was 220 individuals recorded, the lowest abundance of all locations. Broken out by transect, the wetland transect had an H of 1.37 and 49 total records. The north shore transect had an H of 0.55 and 171 total records. This is a result of the dominance of *Enallagma durum* along this transect.

Shannon-Wiener index (H) for Lepidoptera was 1.88 at TRI and total abundance was 38 records. This was the second lowest of the six locations surveyed in 2010. The highest H was seen at Anacostia Park (2.57). Broken out by transect, H was 1.24 for the north shore and was 1.75 for the wetland. Only six individuals were recorded in four surveys along the north shore transect.

The relative Odonata species richness was low throughout the study period at both sites. (The highest relative richness and the highest relative total abundance were seen at a transect in the National Arboretum.) The wetland transect at TRI reached 20% relative species abundance in mid June, then was lower at subsequent visits. The north shore transect peaked at 10% of the Arboretum transect in mid-June and was steady for the rest of the study period. Total Odonata relative abundance was below 10% from May to late July on the north shore transect. After July the relative abundance rose to nearly 50% of the highest site, due to the presence of large numbers of one species. In the wetland transect the relative abundance peaked at 15% in mid-June and then fell to less than 5% for the rest of the period.

Lepidoptera time-abundance data are not reported due to too few site visits in the study period.

The District of Columbia's Wildlife Action Plan (WAP) calls for inventories and surveys of invertebrate populations to establish baseline data on populations and species abundance trends. For the past several years the DDOE-Fisheries and Wildlife Division has been implementing the WAP with surveys of dragonflies and damselflies (Odonata). In 2010 FWD expanded these surveys to include butterflies (Lepidoptera) and by adding two survey locations. These studies are improving the knowledge base about local insect populations and will inform a long-term monitoring strategy for other invertebrates in the city. The goal of these studies is to collect data about the abundance and diversity of the invertebrate species in the District, and to examine species composition in various habitats in the city in relation to physical and biological habitat variables.

There were three main research objectives: 1) To target various habitats to find SGCN; 2) to find species that might function as environmental indicators. When learning the species composition is a research goal, targeted searches are necessary to find rare species and to create a picture of species assemblages in critical habitats and 3) to sample across habitats to determine the spatial distribution of species within the city and the correct scale for future sampling, and to survey throughout the summer to determine peak flight periods for various species of adult odonata.

Surveys began on 14 April and continued through 19 October. Site visits were rotated semi-weekly to ensure at least one visit every three weeks. Biologists established and walked transects in a variety of habitats and counted individuals within five meters of the transect. Some species tend to patrol over long distances so attempts were made to avoid double counting individuals. Unknown individuals were photographed to have a record for identification. Surveys were conducted during the late morning and afternoon hours when most dragonflies, damselflies and butterflies are more active. At the beginning of each site visit, local weather data including ambient temperature, cloud cover and wind speed was recorded.

The analysis was qualitative and limited to descriptive statistics and measurements. Instead of performing randomized site selection, specific habitats were targeted to yield SGCN. Species richness, species evenness, relative abundance and diversity indices were calculated for each transect site and for the overall location. The Shannon-Wiener diversity index is a measure of site diversity, and can be used to compare diversity between sites. It takes into account the relative abundance of each species at each transect surveyed. It increases as the relative abundance of all species increases, but it can also be reduced by a single dominant species. The index is the sum of the relative abundances, but the total number of species is not used in the calculation.

Finally, relative species richness and relative abundance for every site visit were calculated and graphed against time. To calculate the relative richness and relative abundance from each visit to each transect, the total number of species or total number of observed individuals recorded at each site visit was divided by the length of that transect at that site. The resulting values were then normalized to one by dividing each by the value of the highest relative abundance.

FWD surveyed six transect sites along Rock Creek: at Picnic Areas 10 (RPT) and 7 (RPS), at the geologic fall line (RFL), at Peirce Mill (RPM) and at Thompson's Boathouse (RTB). Another transect was surveyed at the meadow at Oregon Avenue (ROM) near the Park's Nature Center.

ROCR Results

There were 24 Odonata species and 13 Lepidoptera species recorded in Rock Creek Park in 2010. No Odonata Species of Greatest Conservation Need (SGCN) were seen, but three

Lepidoptera SGCN were seen: *Danaus plexippus* (Monarch), *Euptoieta Claudia* (Variegated Fritillary) and *Vanessa atalanta rubria* (Red Admiral). *Argia tibialis* (Blue-tipped Dancer, 78 records), *Argia apicalis* (Blue-fronted Dancer, 48 records), *Enallagma exulans* (Stream Bluet, 41 records) and *Pantala flavescens* (Wandering Glider, 20 records) were the most commonly recorded Odonata species. *Junonia coenia* (Common Buckeye, 24 records), *Everes comyntas* (Eastern Tailed Blue, 20 records) and *Papilio glaucus* (Tiger Swallowtail, 15 records) were the most common butterfly species. One species was seen at one site (of all locations surveyed in 2010): *Argia translata* (Dusky Dancer) was seen at Picnic Area 10.

The Shannon-Wiener index (H) for Odonata was 2.46 at Rock Creek Park. The highest H of all locations in 2010 was at the National Arboretum (2.57) and lowest was at Oxon Run Park (1.01). The total Odonata abundance was 300 individuals, 1/3 of the highest (900 individuals at the C&O Canal). Broken out by transect, H was 1.98 at RPM (44 records), 1.79 at RTB (44 records), 1.60 at RPT (100 records), 1.32 at ROM (47 records) and 1.10 at RFL (39 records). The lowest H was at RPS (0.88, 26 records).

Shannon-Wiener index (H) for Lepidoptera was 2.30 at Rock Creek Park and total abundance was 141 records. This was nearly as high as the highest H, which was seen at Anacostia Park (2.57). Broken out by transect, H for butterflies was 1.90 at RPM (20 records), 1.76 at RPT (32 records), 1.50 at RPS (34 records) and 1.44 at the ROM (43 records). The lowest diversity values were at RFL (H=0.85, 9 records) and RTB (H=0.64, 3 records).

The relative Odonata species richness in Rock Creek Park was highest at RPM in early June, where it reached 80% of the highest site in the District (Beech Pond at the National Arboretum). It fell to just below 30% by early July and remained at that level throughout the study period. The next highest relative diversity (40%) was seen at RPT in early June. Diversity at this site fell steadily through the study period, ending at 5% in early September. Relative diversity followed a similar pattern at the RFL transect and at the RTB transect. Conversely at the ROM transect, diversity was lower in the early summer and rose to 20% by late July.

Total Odonata relative abundance (all species and records from each visit were pooled) ranged from 5% to 30% at Rock Creek Park transects in early June. Relative abundance at all sites, with one exception, fell throughout the study period. Abundance at the ROM transect fell through late July, but rose early September, due to the presence of high numbers of two species, *Pantala flavescens* and *Pantala hymenaea*.

The relative butterfly species richness in Rock Creek Park was highest late in the study period at all transects. This may be the result of observer bias, as the observer became more proficient at identifying butterfly species over the course of the study. The highest relative richness of all locations was seen at a meadow in the National Arboretum. The highest richness in Rock Creek Park was at 80%, at RPM in early September. Richness at this site started at 40% and rose through mid-summer. The second highest relative richness was at RPT (50%) in early September. The lowest relative species richness was at RTB (10% at its highest in late August). Relative total abundance at all sites in Rock Creek Park never rose above 35% of the highest site. Abundance at ROM, RPM and RPT rose throughout the study period, while abundance at the RFL and RTB transects remained low and level throughout the summer.