

Community-based Dragonfly & Damselfly Monitoring in Johnson Creek Watershed



Tule Bluets (Enallagma carunculatum), Brookside Wetland; C.A. Searles Mazzacano

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Executive Summary

In 2018, Johnson Creek Watershed Council worked with CASM Environmental, LLC to conduct community-based research monitoring populations of odonates (dragonflies and damselflies) in the Johnson Creek watershed. This was the third year of surveys at Westmoreland Park (Crystal Springs Creek) and Brookside Wetland (Johnson Creek), and the second year of surveys at Centennial Pond (Mitchell Creek). Volunteers received classroom and field training in odonate ecology, life history, identification, survey protocols, and data reporting, and returning volunteers (mentors) teamed with people who were new to the project. Self-assembled teams signed up for surveys on dates set at two-week intervals from June through October. Teams walked transects at each site and recorded odonate species, abundance, genders, and behaviors (mating, egg-laying, etc.). Volunteers were encouraged to net specimens for in-hand identification and take photo vouchers when possible. All data were reported on iNaturalist (<http://www.inaturalist.org/projects/dragonfly-surveys-in-johnson-creek-watershed>). CASM Environmental conducted multiple surveys at each site throughout the season to ensure quality control. A mid-season field session was held in late July to provide a refresher in techniques and identification and an opportunity for volunteers to socialize.

During the 2018 field season, 195 observations of 21 odonate species were reported among three sites (15 dragonfly, six damselfly). Diversity was greatest at Brookside Wetlands, where 19 species were sighted (14 dragonfly, 5 damselfly); Westmoreland Park and Centennial Pond both had 13 species (9 dragonfly, 4 damselfly), though the species list at the two sites was not identical (Jaccard Similarity Index = 0.625). The community at Brookside was more similar to that at Centennial (Jaccard Similarity Index = 0.600) than to Westmoreland (Jaccard Similarity Index = 0.524). Four of the five main migratory species in North America were observed using habitat at these sites: Common Green Darner (*Anax junius*; all sites); Variegated Meadowhawk (*Sympetrum corruptum*; Westmoreland, Centennial); Black Saddlebags (*Tamea lacerata*; Brookside, Centennial); and Spot-Winged Glider (*Pantala hymenaea*; Brookside). *P. hymenaea* is a rare visitor in our region, and this sighting added a new species to the project list in 2018.

The number of species seen among all sites in each month was lower in 2018 compared to previous years, and by mid-summer many common species were either absent, or present in much lower abundances than expected. Differences in weather are likely driving some community differences in 2018, as the average monthly temperatures in four of the five months from January through May were several degrees warmer in 2018 than in 2017. The habitat conditions at Brookside Wetland and Centennial Pond have changed little over the course of the project, and with the exception of the probable influences of annual climate conditions, the odonate community at those sites reflects this. The habitat conditions at Westmoreland Park have changed greatly in the last two years, however, with much of the channel covered by thick mats of vegetation, and banks destabilized by nutria activity and inundation by stacked-up water. Changes in the odonate community reflect a loss of habitat at Westmoreland, as overall diversity in 2018 was almost half that of previous years. Fewer migratory species were seen at Westmoreland in 2018, and there was less evidence of the habitat sustaining their egg-to-adult development.

Background

Although odonates are among the better-known insects, there is still much to be learned about their distribution, life history, and ecology. Long-term studies with regular observations made at the same site are needed to detect changes in the composition and seasonality of local odonate populations. Such consistent monitoring over the course of several years can also reveal the impacts of changes in habitat quality. In addition, there is a paucity of knowledge about the phenomenon of dragonfly migration in North America. Four of our five main migratory species have now been observed mating, laying eggs, patrolling, and/or emerging at project wetlands, and these observations are helping to inform what we know about dragonfly migration patterns. Dragonflies and damselflies are also excellent subjects for studying the long-term impacts of climate change. Extensions of early and late flight dates are already being noted for many species in the U.S. (Abbott, 2006-2017), and several tropical species once considered vagrants in the southwest have recently established breeding populations (Bailowitz et al., 2016).

Characterizing odonate diversity and abundance at the regional scale aids in discovering stressors impacting local populations, incorporating odonate habitat needs into restoration plans, and learning the effects of restoration projects on different species. This systematic study of odonates in the Johnson Creek watershed has already added to our knowledge of local populations. New species have been added to the list of odonates known from Multnomah County, and rare visitors to our region have been recorded. Climatic stressors appear to be influencing seasonal patterns of abundance and diversity, and changes in habitat quality at one site (Westmoreland Park) have been accompanied by changes in the associated odonate community.

The protocols, training techniques, and survey methodologies used in this project support self-organizing volunteer teams that survey local odonates on a regular basis during the majority of the flight season at three sites in the Johnson Creek watershed. Volunteers can make huge contributions to science; their participation greatly increases the frequency and scope of observations and data collection, and they can collect useful, high-quality data (McKinley et al., 2017; Dennis et al., 2017). These insects are compelling, beautiful, and easy to observe, and learning to identify local species is fairly straightforward. Volunteers are enthusiastic about what they are learning, and many volunteers from previous season return and act as mentors to project newcomers.

Methods

Volunteer Training

Volunteers are provided with resources developed by CASM Environmental including a detailed Protocols Manual, and a Quick Guide to Dragonfly and Damselfly Families to help volunteers home in on the appropriate section of the field guide (Kerst & Gordon, 2011) to use. JCWC staff maintain a Volunteer Toolkit on their web site that includes an interactive scheduling document, surveyor checklist, equipment checkout, contact information for volunteers and staff of JCWC and CASM Environmental, and links to additional resources.

JCWC reached out to their extensive network of volunteers to participate in the project, and several volunteers who participated in prior years returned as peer mentors. A full day of training was done on 2 June 2018; a pre-training social period in the morning gave volunteers a chance to get acquainted. The first half of the day was a classroom session where volunteers learned about odonate ecology, life history, and behaviors; how to recognize common species in Multnomah County; key components for species identification; and how to use the monitoring protocol and reporting methods. The remainder of the day was spent in the field at one of the project sites (Westmoreland Park), where volunteers learned how to walk transects and net and identify individuals.

Volunteers signed up for survey dates spanning every 14 days in June-October at three different sites: Brookside Park, off of Johnson Creek (11201-11243 SE Brookside Dr, Portland, OR); Westmoreland Park, off of Crystal Springs Creek (7530 SE 22nd Ave, Portland, OR); and Centennial Pond, off of Mitchell Creek (SE Foster & SE Dahlquist Rd., Pleasant Valley, OR). They used a GoogleSheets document in the Volunteer Toolkit to sign up for surveys, with each site and date covered by at least two surveyors and one or two substitutes. Volunteers used additional columns to note whether the surveyors had contacted each other, the date each survey was actually done, and the date their observations were entered into the iNaturalist project. Teams signed out nets, field guides, maps, data sheets, sunglasses, and hand lenses from the JCWC office. A mid-season field session and social gathering was held at Westmoreland Park on 21 July 2018 to provide refresher training in survey and identification techniques and address questions from volunteers.

Survey techniques

The flight season for odonates in the Portland area generally runs from early May through early November. Volunteer surveys do not begin until June, so CASM Environmental surveys project sites as soon as weather conditions are conducive to odonate activity, to ensure capture of first flight dates and the return of migratory species. The goal is for volunteers to survey each site once every 14 days, but due to weather conditions and volunteer availability, survey dates were often shifted slightly, such that in practice they occurred once every 8-16 days.

Surveys were done on days when weather conditions were optimal for odonate activity (Table 1). Volunteers survey a transect that runs along the water's edge, allowing them to view the water and adjacent vegetation. Teams were given maps to guide their transect walks (Figure 1). Volunteers were encouraged to take photos and capture odonates for in-hand examination whenever possible. Observers filled out their data sheet (Appendix A) upon arriving at the site with start time, observer names, and weather conditions (sun, cloud cover, wind, precipitation). Surveyors slowly walked their transects and noted the following:

- **Species:** Volunteers were encouraged to capture specimens for in-hand examination and to take photographic vouchers of perched or in-hand specimens whenever possible. The method of identification was noted on the data sheet (visual, captured, photographed).

- Gender: Males and females are differentiated based on coloration, markings, and genitalia (structures on the terminal abdominal segment).
- Abundance category: uncommon (1-4 individuals seen), frequent (5-20), common (21-100), or abundant (>100)
- Reproductive stage: wheel (mating pair), tandem pair (male still holding female but not engaged in copulation), ovipositing (laying eggs), and teneral adult (newly-emerged)

Volunteers kept tallies of species abundances while conducting the survey; when finished, they recorded the final abundance categories, stop time, and weather conditions.

Table 1. Survey decision matrix for weather conditions conducive to odonate activity

Time range	10:00 am - 4:00 pm			9:30 am - 4:30 pm	
	<59°F (15°C)	59-65°F (15-18°C)	65-75°F (18-24°C)	>75°F (24°C)	>88°F (31°C)
Temperature	<59°F (15°C)	59-65°F (15-18°C)	65-75°F (18-24°C)	>75°F (24°C)	>88°F (31°C)
Cloud cover >60%	No	No	Yes	Yes	No
Cloud cover <60%	No	Yes	Yes	Yes	No
Moderate to strong wind (tree branches swaying)	No	No	No	No	No
Rain	No	No	No	No	No

Data reporting

All data were entered into the iNaturalist project “Dragonfly Surveys in Johnson Creek Watershed (<http://www.inaturalist.org/projects/dragonfly-surveys-in-johnson-creek-watershed>). Data fields on the iNaturalist project site are identical to each entry on the data sheet. Data can also be entered in the field via the iNaturalist mobile app. iNaturalist was chosen for data reporting because it is easy to use, there is a free app for iOS and Android, and it is easy to export data for analysis and reporting. Its crowdsourcing method of identification and verification provides a useful image gallery for volunteers (from the large numbers of identified, vetted photos in the iNaturalist database) and a way to confirm volunteers’ identification of their uploaded photos. Volunteers also e-mailed CASM Environmental with questions about survey and reporting protocols and species identification.

QA/QC

CASM Environmental conducted 15 surveys at project sites from early March through the end of October to compare expert- and volunteer-collected data. These data were also entered in the iNaturalist project site. The additional field session on 21 July helped volunteers who had not yet done a survey and/or those who wished to

Figure 1. Survey transects for Westmoreland Park (left), Centennial Pond (right), and Brookside Park (bottom).



refresh their skills. To provide information for adaptive management, volunteer feedback is solicited at the annual end-of-season potluck (January 2019), where a season summary is presented and volunteers are encouraged to share their impressions of the project and discuss challenge and strengths of the training, resources, and

reporting. Project feedback is also solicited via the annual JCWC online survey to volunteers to capture input from those unable to attend the potluck.

Data analysis

Jaccard similarity indices were calculated on species presence/absence matrices using PAST 3 software (Hammer et al., 2001). The Jaccard Index is used to measure similarity and diversity between samples; values range from 0 (no species in common between two samples) to 1 (identical species composition between two samples).

Results & Discussion

Species diversity

Volunteers conducted surveys between 16 June and 13 October 2018. Additional surveys by CASM Environmental between 20 March and 8 November established ranges for first and last flight dates at the sites (around the 1st week of April and first week of November, respectively). Surveys were done on 15 days at Westmoreland Park (8 volunteer, 7 CASM), 11 days at Brookside Wetland (5 volunteer, 6 CASM), and seven days at Centennial Pond (5 volunteer, 2 CASM). The lower number of surveys at Centennial is likely because this site is the furthest east, has more difficult access (parking along a busy road, a longer walk in, and an abundance of blackberry around the pond), and is somewhat isolated.

A total of 21 species (15 dragonfly, 6 damselfly) was seen among all sites in 2018, which is similar to previous years (22 species in 2016 and 23 species in 2017), but the numbers seen at individual sites differed. Brookside had the highest diversity with 19 species (14 dragonfly, 5 damselfly), followed by Westmoreland Park and Centennial Pond, which both had 13 species (9 dragonfly, 4 damselfly). Nine species have been found at all sites in all survey years: Common Green Darner (*Anax junius*), Cardinal Meadowhawk (*Sympetrum illotum*), Eight-spotted Skimmer (*Libellula forensis*), Common Whitetail (*Plathemis lydia*), Blue Dasher (*Pachydiplax longipennis*), Blue-eyed Darner (*Rhionaeschna multicolor*), Pacific Forktail (*Ischnura cervula*), Western Forktail (*I. perparva*), and Tule Bluet (*Enallagma carunculatum*). These species are all common in the region and are frequently found in urban areas (Paulson, 2009; Kerst & Gordon, 2011).

Three species that were seen at all sites in 2016 and 2017 were absent from at least one site in 2018: Variegated Meadowhawk (*Sympetrum corruptum*; not seen at Brookside), Twelve-spotted Skimmer (*L. pulchella*; not seen at Westmoreland), and Vivid Dancer (*Argia vivida*; not seen at Westmoreland). These three are also common, widespread species that are well-adapted to urban conditions, and their absence from single sites in the 2018 dataset may simply be due to chance; insect populations vary greatly from year to year, and it is always possible that the snapshot of species presence provided by these intermittent surveys could miss sighting a species that is actually there. However, two of the three species were absent only from Westmoreland Park, where overall

diversity was also much lower compared to 2016 and 2017. This, combined with the preference of *Argia vivida* for flowing water, suggests that changing habitat conditions as well as chance is operating at that site.

Twenty-seven species have been recorded for the project since 2016, which represents 64% of species currently known in Multnomah County (Abbott, 2006-2018); the project itself increased that county species list by one in 2016. A new species was added to the project list this year, with the first sighting of a Spot-winged Glider (*Pantala hymenaea*) at Brookside Wetland on 24 June 2018. This species is a far-ranging migrant; much of Oregon is considered to be in its range (Kerst & Gordon, 2011) and it is known from Multnomah County, but it is a rare visitor and uncommon in the Portland area. The sighting is something of a testament to the power of community-based science. The observation was made by a team that included several experienced volunteers, who, while unable to make a definitive identification, were by then familiar enough with the local fauna to realize it was something they'd never seen before and they captured a photo that enabled definitive identification on iNaturalist. Spot-winged Gliders cannot overwinter in northern latitudes and must disperse from the south each year, laying eggs in still waters (including temporary ponds) as they go. It is possible that increasing drought and wildfires may be pushing some individuals northwards into Oregon from California, but only time and continued observations will tell.

Seasonality and abundance

Twenty-one species and 195 observations were reported for the 2018 flight season. The greatest number of observations were of Tule Bluet and Pacific Forktail, species that are reliably the most abundant and have the most extended flight season in our area. The migratory species Common Green Darner and Variegated Meadowhawk were also among the earliest sightings, as adults that developed in the southern overwintering grounds press northwards with warming weather. Skimmers dominated the summer months among the dragonflies, with an abundance of meadowhawks, pondhawks, skimmers, dashers, and whitetails; among the damselflies, Tule Bluet and Pacific Forktail were often too numerous to count. Species that appeared in late summer include California Spreadwing (*Archilestes californicus*) and Shadow Darner (*Aeshna umbrosa*).

The appearance and disappearance of species at all sites generally followed the known seasonality for this region. However, the number of species seen among all sites in each month was markedly lower in 2018 compared to previous years (Figure 2), and by mid-summer many of the common species were either absent or present in much lower abundances than expected. Overall, the most species were seen in each month during the 2016 survey season, and in each subsequent year, the mean number of species per month has been lower. Cold wet weather in spring 2017 (Figure 3) helps explain the low mean species numbers in early months of that year, while lower numbers of species through summer of both 2017 and 2018 could be due to increasingly hot dry summers as well as the impacts of widespread forest fires, including reduced air quality, overcast skies, and increased particulate matter, which could affect odonate activity as well as the activity and abundance of their prey.

Figure 2. Mean number of species per month across all sites, 2016-2018.

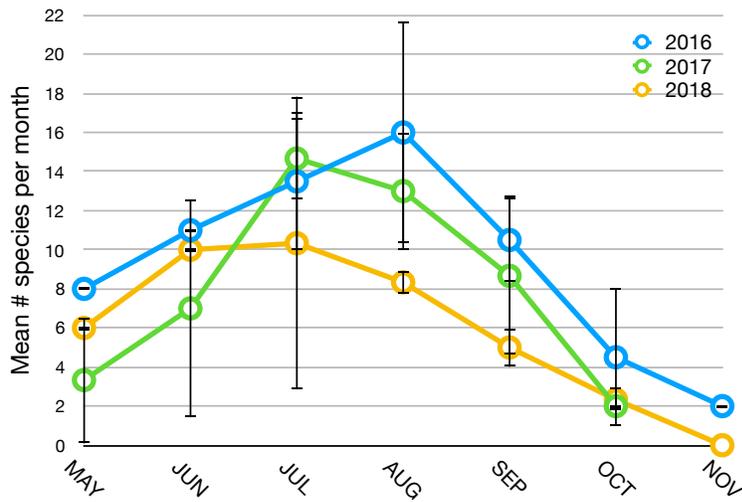
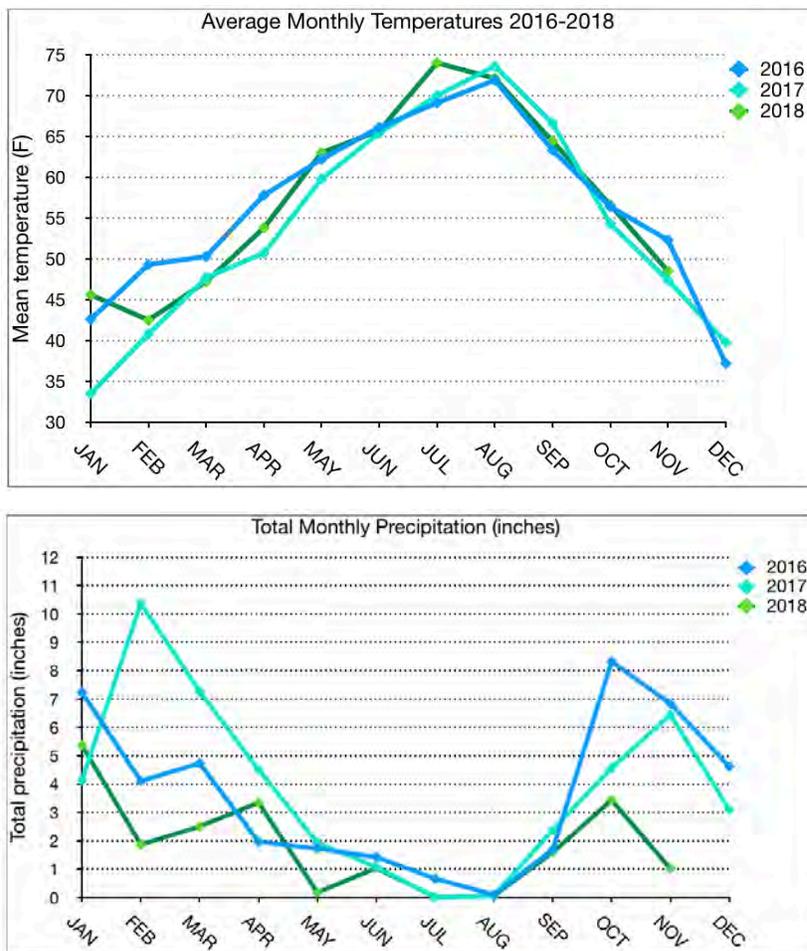


Figure 3. Average monthly temperature and total precipitation in Portland, 2016-2018. Data for 2018 through 11/23.

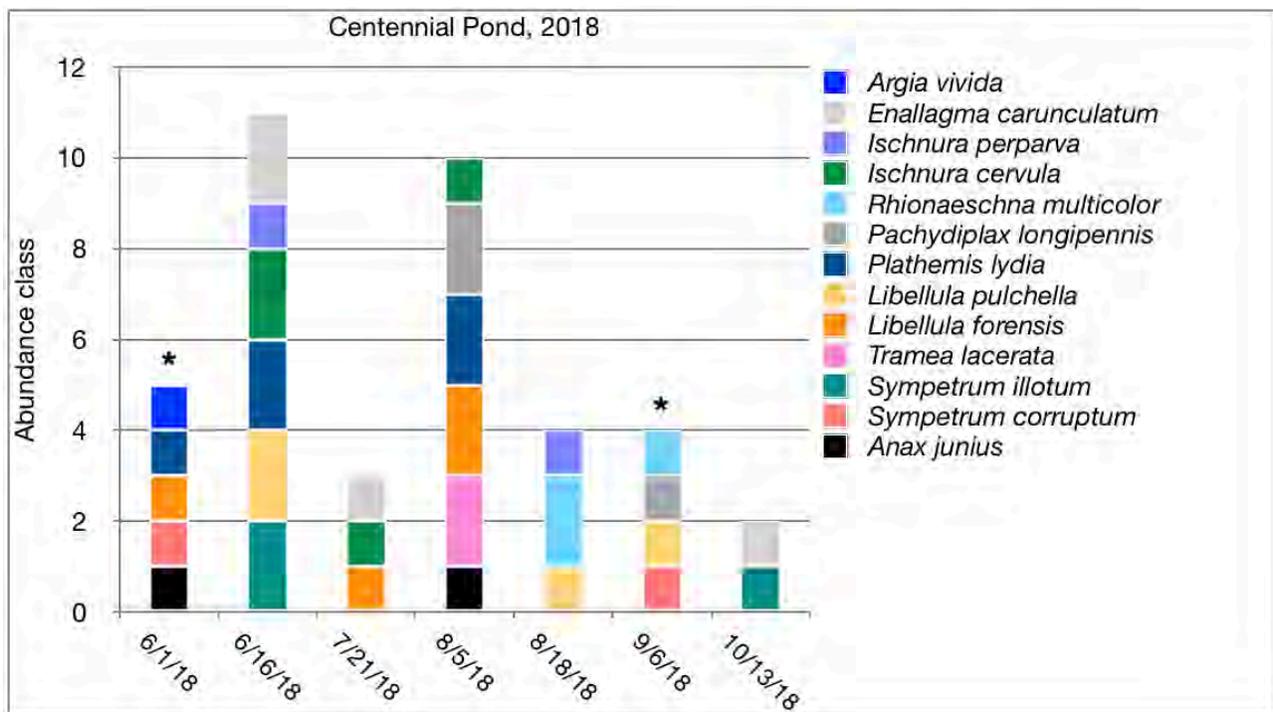


Odonate community at individual sites

Centennial Pond

Centennial Pond was to be removed in 2018 as part of ongoing restoration in the Johnson Creek watershed, but that work was delayed until 2019. Volunteer monitoring has thus provided a second year of baseline odonate community data against which future changes following restoration can be measured. Thirteen species were seen at Centennial Pond in 2018 (Figure 4). This number is comparable to the 2017 species count (15 total), and the community was similar in both years (Jaccard Index = 0.867). All species seen here in 2018 were also present at Brookside and/or Westmoreland.

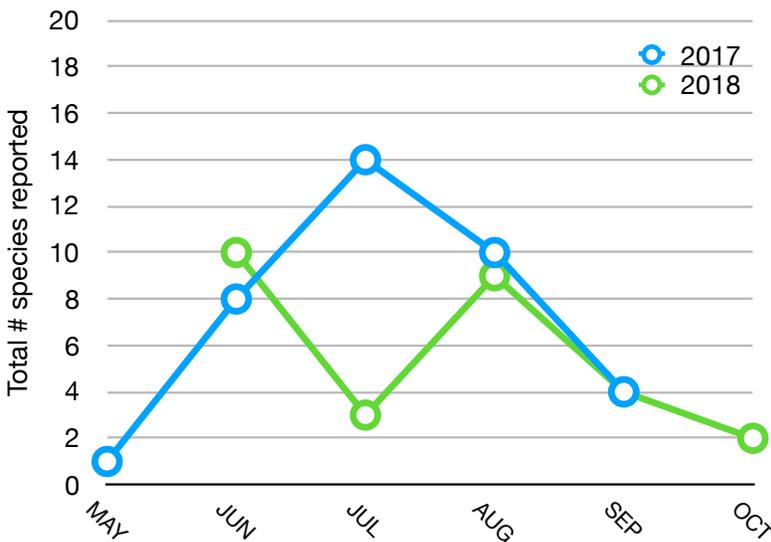
Figure 4. Odonate seasonality and relative abundance at Centennial Pond in 2018. Species abundances are in categories: 1 (uncommon, 1-4 individuals); 2 (frequent, 5-20); 3 (common, 21-100); 4 (abundant, >100). Asterisks indicate surveys done by CASM Environmental.



The number of species seen in each month during both years of monitoring was almost identical, with the notable exception of July 2018 (Figure 5). Volunteers reported only three species on this date, which was less than 25% of the species total reported in July 2017, and only a third of the total seen in June and August of the same year. Abundances were also anomalous for the observed species in mid-summer, as each was “uncommon” (1-4

individuals). The iNaturalist report indicates that the survey started in the morning, and that it warmed up and the clouds cleared by the time they had finished. It is likely that the report for that date under-represents the actual diversity. Centennial is difficult to access and species are most obvious when they are in flight, so if clouds delayed morning flight and surveyors did not go down to the pond edge, they may have missed individuals that were resting in the vegetation and not yet on the wing.

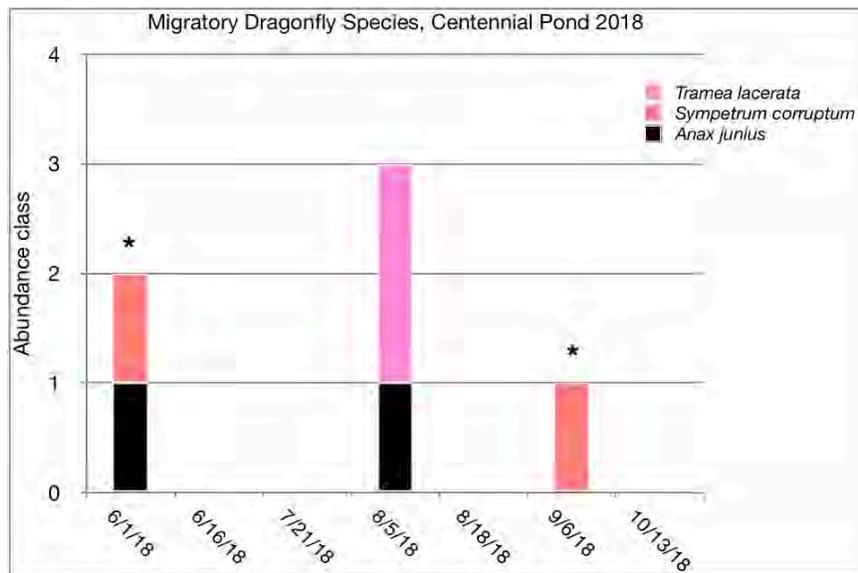
Figure 5. Total number of species observed in each month at Centennial Pond, 2017-2018.



Despite the overall community similarity between years, there were fewer observations of migratory species at Centennial Pond in 2018 (Figure 6), although the same species were seen in both years. Migratory species were observed on only 43% of survey days, whereas in 2017 they were seen on 67% of survey days. Common Green Damers (*Anax junius*) and Variegated Meadowhawks (*Sympetrum corruptum*) were both seen on two surveys at low abundances. Black Saddlebags (*Tramea lacerata*) was only seen once (5 August), but at higher abundances. The presence of *S. corruptum* on only the first and last survey dates suggests that the site is visited by spring and fall migrants, and that nymphal development and adult emergence is not occurring here. In contrast, all three migratory species were observed at higher abundances during the 2017 season (June through September).

The habitat at Centennial Pond has shown little change in the two years of surveys. The consistently lower number of species seen here compared to other sites is likely due to the fact that this habitat is lower-quality, with little to no emergent or floating vegetation, an upland largely composed of blackberry and an old gravel road, and an adjacent narrow ditched creek reach that lacks a riparian buffer. This site is also more difficult to survey closely, as the ponds are deep depressions ringed by blackberry and most species must be observed in flight, so individuals resting on vegetation at the edge of the pond may not be noted.

Figure 6. Migratory species at Centennial Pond in 2018. Species abundances are in categories: 1 (uncommon, 1-4 individuals); 2 (frequent, 5-20); 3 (common, 21-100); 4 (abundant, >100). Asterisks indicate surveys done by CASM Environmental.



Brookside Wetland

The greatest odonate diversity in 2018 was at Brookside, where 19 species were found (14 dragonfly, 5 damselfly; Figure 7); this site also had the most species observed on a single date (14 species on 27 July). Although the number of species at this site has been consistent over the duration of this project (18 species in 2016 and 2017), this is the highest diversity ever reported at Brookside. Between-year similarity of the odonate community was highest for 2016 and 2017 (Jaccard Similarity Index = 0.800), and the 2018 community was more similar to that found in 2017 (Jaccard Similarity Index = 0.682) than in 2016 (Jaccard Similarity Index = 0.609). Although species abundance increased to its maximum in July, as expected, the pattern differed from previous years, with many more species present at the site early in the season compared to 2017, and only about half as many species in mid- to late summer compared to 2016-2017 (Figure 8).

Migratory species continue to use the habitat at Brookside, but the timing and species identity differed in 2018. In 2017, the three main migratory species in our area (*A. junius*, *S. corruptum*, and *T. lacerata*) were observed on 53% of the surveys done from May through September and were seen in every month except June, in abundance classes of Uncommon to Frequent. In 2018, migratory species were seen on 46% of surveys, but only from late June to late July, and the usually cosmopolitan *S. corruptum* was not reported; this was the only site and year in which that species was not seen. However, an unexpected sighting of the migratory Spot-winged Glider (*Pantala hymenaea*) was made on 24 June, when a single male perched in a tree was photographed. This species is rare in our area; this is one of only five observations of *P. hymenaea* on iNaturalist, and all of the others are from the coast. This record is one of 16 recorded in Oregon on OdonataCentral.org; the majority of those are located in the western third of the state from north through south, with a single record from the interior (Harney County).

Figure 7. Odonate seasonality and relative abundance at Brookside in 2018. Species abundances are in categories: 1 (uncommon, 1-4 individuals); 2 (frequent, 5-20); 3 (common, 21-100); 4 (abundant, >100). Asterisks indicate surveys done by CASM Environmental.

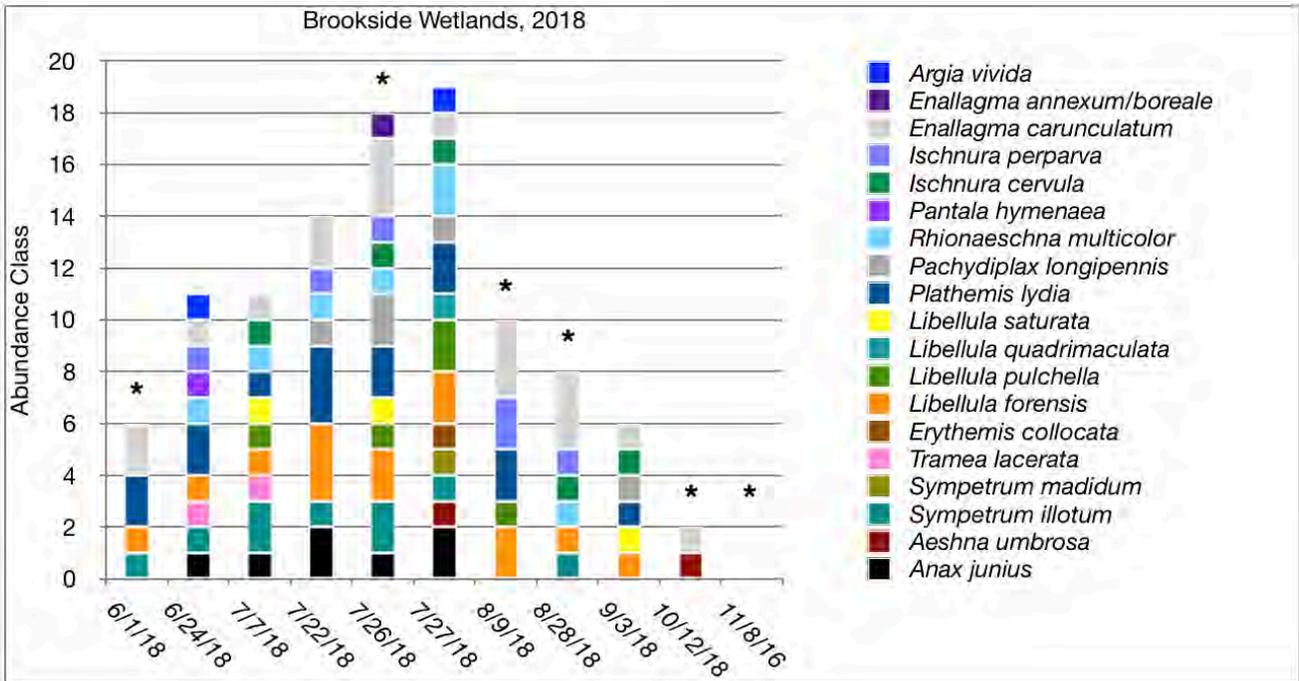
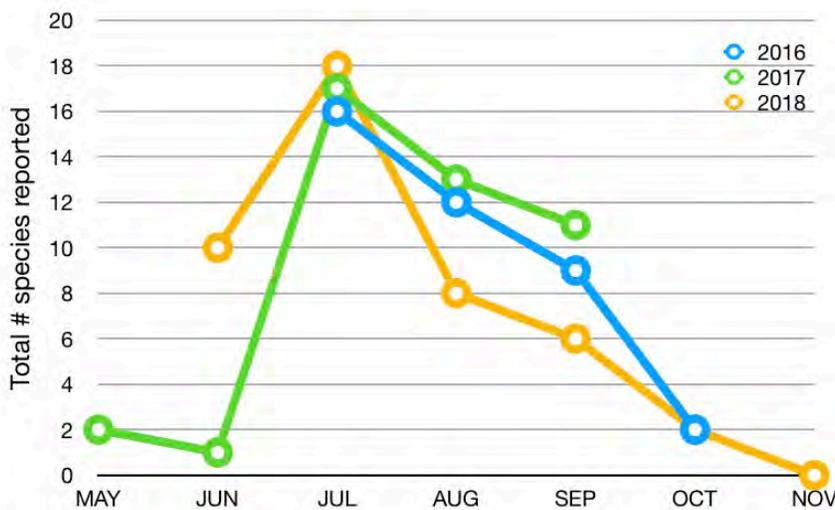


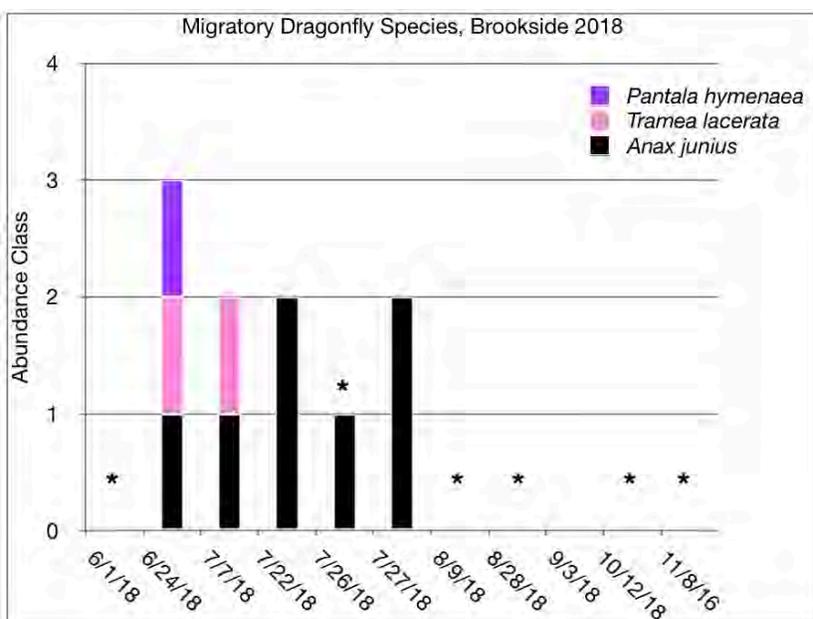
Figure 8. Total number of species observed in each month at Brookside Wetland, 2016-2018.



Differences in weather are likely behind much of the observed community difference in 2018. The average monthly temperatures in four of the five months from January through May were several degrees warmer in 2018 than in 2017; a warmer winter and spring would speed development of overwintering nymphs to adults in spring and

could also see earlier northward movement of migratory species. The total monthly precipitation from February through May was much lower in 2018 compared to 2017, and the water levels at Brookside were unusually low this summer compared to past years. Insect development rates are strongly influenced by temperature, and if warmer weather and lower water increased water temperatures in the site, faster development from nymph to adult could explain the lower number of species seen on the wing this year in late summer.

Figure 9. Migratory species at Brookside Wetland in 2018. Abundance categories: 1 (uncommon, 1-4 individuals); 2 (frequent, 5-20 individuals); 3 (common, 21-100 individuals); 4 (abundant, >100 individuals). Asterisks indicate surveys done by CASM Environmental.



Westmoreland Park

Only 13 species were reported at Westmoreland Park from March through November (Figure 10). This is a dramatic reduction in diversity compared to previous years (22 species in 2016 and 21 species in 2017) and represents the lowest diversity for any site and year in the project, except for Centennial Pond in 2018, which also had 13 species. Species diversity peaked in July, as was seen at the other sites. Pacific Forktail (*Ischnura cervula*) was once again both the earliest and latest observed species, and the community throughout the summer was dominated by Pacific Forktail and Tule Bluet (*Enallagma carunculatum*)—a similar situation to what was seen in the odonate community at the park prior to the restoration of Crystal Springs Creek (C.A. Searles Mazzacano, pers. obs.).

Figure 10. Odonate seasonality and relative abundance at Westmoreland Park in 2018. Species abundances are in categories: 1 (uncommon, 1-4 individuals); 2 (frequent, 5-20); 3 (common, 21-100); 4 (abundant, >100). Asterisks indicate surveys done by CASM Environmental.

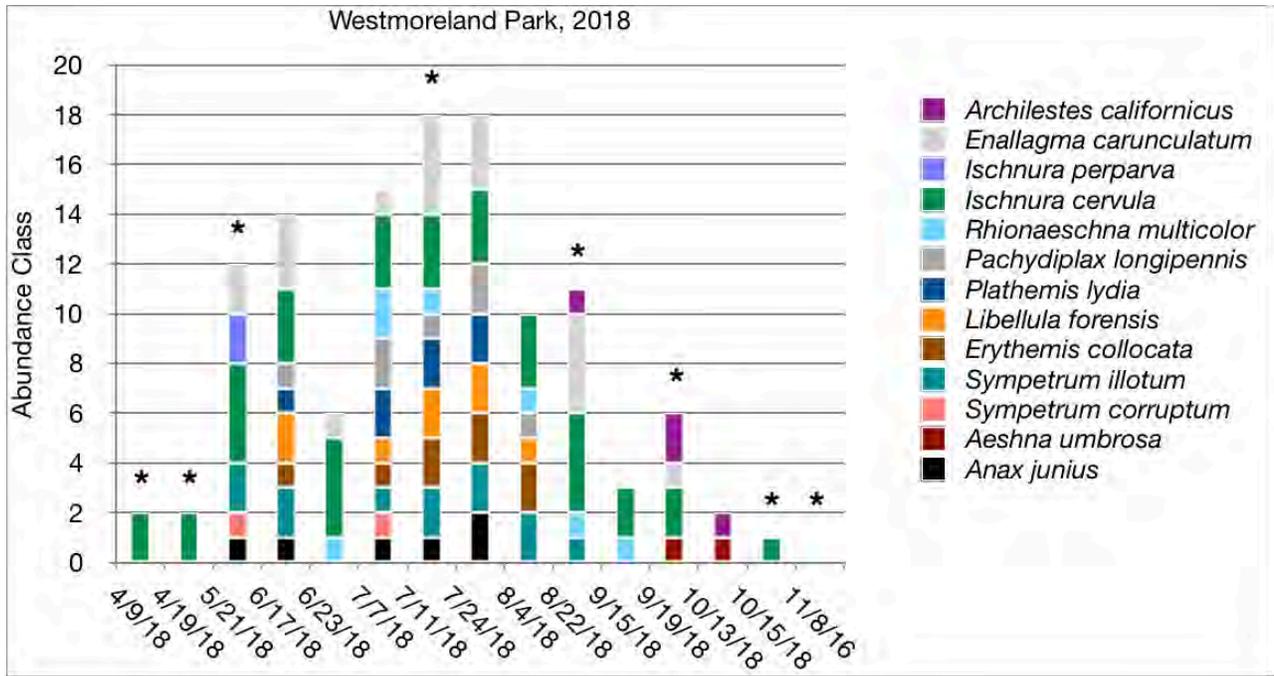
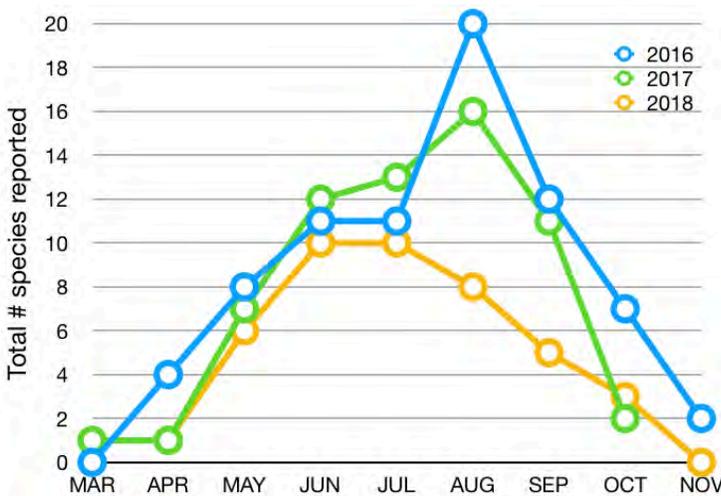


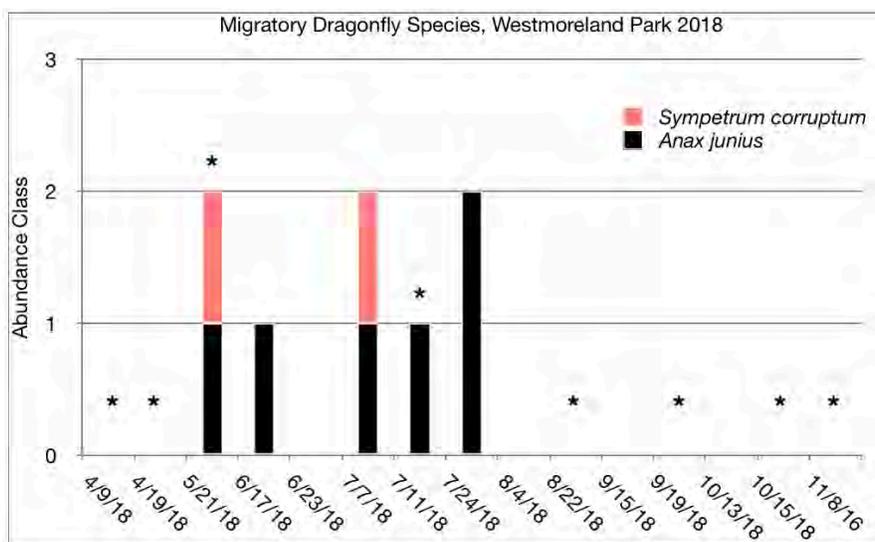
Figure 11. Total number of species observed in each month at Westmoreland Park, 2016-2018.



Between-year similarity of the odonate community was lower at Westmoreland compared to that at the other two monitoring sites. The odonate community in 2017 already differed from that seen in 2016 (Jaccard Similarity Index = 0.654), and the 2018 community was slightly more similar to the community in 2017 (Jaccard Similarity Index = 0.619) than to 2016 (Jaccard Similarity Index = 0.591). The total number of species per month in 2018 was also lower in most of the survey months than it was in 2016 and 2017 (Figure 11).

Only two of the three main migratory species, Common Green Darner and Variegated Meadowhawk, were reported at Westmoreland in 2018 (Figure 12); Black Saddlebags (*Tamea lacerata*), which has been reported at Brookside and Centennial in every monitoring year, was only seen at Westmoreland in 2016. This species prefers to patrol over large expanses of open water, and the dense vegetative growth at the park in recent years has likely reduced the appeal of this habitat. Common Green Darner and Variegated Meadowhawk were reported in 2018 from May through July; in contrast, they were found in every month from May through September in 2017. While spring migrants of Common Green Darner have been observed in the past laying eggs in decaying logs in the stream, no females were noted in 2018, again suggesting that a reduction of oviposition substrate reduced the habitat appeal. Furthermore, the expected late-summer emergence of large numbers of teneral adult Variegated Meadowhawks (Paulson, 2009) that was noted at Westmoreland in 2015 (C.A. Searles Mazzacano, pers. obs.) and 2016 did not occur in 2017 or 2018.

Figure 12. Migratory species at Westmoreland Park in 2018. Abundance categories: 1 (uncommon, 1-4 individuals); 2 (frequent, 5-20 individuals); 3 (common, 21-100 individuals); 4 (abundant, >100 individuals). Asterisks indicate surveys done by CASM Environmental.



While they are far from pristine, habitat conditions at Brookside Wetland and Centennial Pond have changed little over the course of the project, and with the exception of the probable influences of annual climate conditions, the odonate community at those sites reflects this. Habitat conditions at Westmoreland Park have changed greatly in the last two years, however, and the area looks very different than it did after restoration of Crystal Springs Creek was completed in 2014 (Figure 13). Invasive species noted in 2017, such as teasel, reed canary grass, and Himalayan blackberry, have continued to spread through the “naturalized” planting areas at the park. Dense growth of jewelweed in the upland area was joined by explosive growth of thick mats of emergent vegetation in and along the creek itself. These mats spread out through half the channel width or more, slowing the creek,

inundating the banks, and dispersing more water into the wetlands. Water levels around the creek were the highest they have been since 2014, coming up all the way to the split rail fence on the west side of the creek around SE Knapp St. Constant higher water levels combined with the tunneling activities of a large number of resident and reproducing nutria have eroded and collapsed the banks on both sides, and removed any bank or barrier between the creek and the large wetland adjacent to the east.

Figure 13. Channel alteration of Crystal Springs Creek at Westmoreland Park due to heavy aquatic plant growth.

A. Dense thickets obscuring much of the channel. Taken from the edge of the west bank, 19 September 2018.



B. Permanent connection between creek and large wetland on the east, 15 October 2018.



Working with volunteers

Changes made in 2018 based on feedback from participants in 2017 included inviting returning volunteers to attend part of the training session for new participants so the two groups could meet, and ensuring that an experienced volunteer was part of the team when new volunteers conducted surveys. Increased time spent during training on using iNaturalist appeared to be effective, as CASM Environmental received fewer inquiries from people having problems with the site and the majority of records were properly submitted. Additional changes included improving quality control by not allowing anyone who had not participated in the training to be a volunteer surveyor, and asking volunteers not to bring extraneous people to their surveys. Volunteers also appeared well able to navigate the GoogleDocs sign-up sheet and communicate among themselves regarding survey dates and communicating with substitutes when needed.

Volunteers were also encouraged to submit as many photo vouchers as possible, even if they were confident of their identification, in order to have a verifiable record. Some photos of captured specimens were photographed in such a way that identification to species was not possible; for example, a bluet (*Enallagma*) damselfly record was submitted with only a photo of the underside of the abdomen. This suggests that additional emphasis is needed during training on the body regions required for definitive identification, and should perhaps also be added to the Quick Guide to Families that the volunteers receive.

Most of the volunteer survey data were similar to the QA/QC surveys done by CASM Environmental. In some cases, records that were not accompanied by a voucher photo and not made by a team that included an experienced volunteer were discarded due to either a lack of necessary detail (i.e., “darker” without any accompanying photo), or because of the likelihood of error from sight-only identification (i.e., Northern/Boreal Bluet). However, such records comprised a small proportion of the total records submitted.

Conclusions

This project continues to be an effective way to engage watershed council volunteers in new activities while providing outreach and education about wildlife within the watershed and generating new data about odonate populations. In three years of surveys, volunteers have added new species records at both the county level and the site level. The northward expansion of the Flame Skimmer (*Libellula saturata*) continues to be documented, and observations of infrequent visitors to our region, such as *Pantala hymenaea*, may reflect the short-term impacts of severe climate and wildfire events. Consistent site-level monitoring has also revealed large changes in the odonate community at Westmoreland Park, which increased rapidly in diversity and abundance following restoration activities in 2014 (Searles Mazzacano, 2015), but which is now responding to deteriorating habitat conditions.

Survey data are also being used on a broader level, as observations over the course of the project have been incorporated into updates of early and late flight records and county species lists, and as supporting documentation in publications (Johnson, 2017). This project continues to generate needed data about an understudied but charismatic group and is expanding our knowledge of local biodiversity, impacts of site restoration and habitat conditions on local biota, and effects of climate change on local life-history of both resident and migratory dragonfly species.

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Appendix A. JCWC Dragonfly and Damselfly Community-based Monitoring Project Datasheet

DATE _____ SITE NAME _____ START TIME _____ END TIME _____

OBSERVER NAME(S) _____

WEATHER: Temperature _____ °C / °F Wind (calm, light, moderate, strong) % cloud cover _____

NOTES _____

Species List: Record the species observed; circle 'M' and/or 'F' to indicate whether males or females were seen. Record abundance category and all ID methods and reproductive stages observed using the appropriate letter codes.

Identification method
(record all that apply)

V (visual)
C (captured)
P (photograph)

Abundance category

U (uncommon, 1-4)
F (frequent, 5-20)
C (common, 21-100)
A (abundant, >100)

Reproductive stage
(record all that apply)

W (wheel)
TP (tandem pair)
O (ovipositing)
TA (teneral adult)

Species Name	ID Method	Abundance	Reproductive stages
	M F		
	M F		
	M F		
	M F		
	M F		
	M F		
	M F		

Appendix B. Species presence/absence for all survey sites, 2016-2018. For ease of visualization, sites where species were present are highlighted.

Species name	Common name	Westmoreland Park			Brookside Wetland			Centennial Pond	
		2018	2017	2016	2018	2017	2016	2018	2017
<i>Anax junius</i>	Common Green Darner	Y	Y	Y	Y	Y	Y	Y	Y
<i>Aeshna palmata</i>	Paddle-tailed Darner	N	Y	Y	N	N	Y	N	N
<i>A. umbrosa</i>	Shadow Darner	Y	Y	Y	Y	N	N	N	N
<i>Sympetrum corruptum</i>	Variigated Meadowhawk	Y	Y	Y	N	Y	Y	Y	Y
<i>S. costiferum</i>	Saffron-winged Meadowhawk	N	Y	N	N	N	N	N	N
<i>S. danae</i>	Black Meadowhawk	N	N	Y	N	N	N	N	N
<i>S. illotum</i>	Cardinal Meadowhawk	Y	Y	Y	Y	Y	Y	Y	Y
<i>S. madidum</i>	Red-veined Meadowhawk	N	Y	N	Y	N	N	N	N
<i>S. pallipes</i>	Striped Meadowhawk	N	Y	N	N	Y	N	N	N
<i>S. vicinum</i>	Autumn Meadowhawk	N	N	Y	N	N	N	N	N
<i>Tramea lacerata</i>	Black Saddlebags	N	N	Y	Y	Y	Y	Y	Y
<i>Erythemis collocata</i>	Western Pondhawk	Y	Y	Y	Y	N	Y	Y	Y
<i>Libellula forensis</i>	Eight-spotted Skimmer	Y	Y	Y	Y	Y	Y	Y	Y
<i>L. luctuosa</i>	Widow Skimmer	N	N	Y	N	N	Y	N	Y
<i>L. pulchella</i>	Twelve-spotted Skimmer	N	Y	Y	Y	Y	Y	Y	Y
<i>L. quadrimaculata</i>	Four-spotted Skimmer	N	N	Y	Y	N	N	N	N
<i>L. saturata</i>	Flame Skimmer	N	Y	Y	Y	Y	Y	N	N
<i>Plathemis lydia</i>	Common Whitetail	Y	Y	Y	Y	Y	Y	Y	Y

Species name	Common name	Westmoreland Park			Brookside Wetland			Centennial Pond	
		2018	2017	2016	2018	2017	2016	2018	2017
<i>Pachydiplax longipennis</i>	Blue Dasher	Y	Y	Y	Y	Y	Y	Y	Y
<i>Pantala hymenaea</i>	Spot-winged Glider	N	N	N	Y	N	N	N	N
<i>Rhionaeschna multicolor</i>	Blue-eyed Darter	Y	Y	Y	Y	Y	Y	Y	Y
<i>Ischnura cervula</i>	Pacific Forktail	Y	Y	Y	Y	Y	Y	Y	Y
<i>I. perparva</i>	Western Forktail	Y	Y	Y	Y	Y	Y	Y	Y
<i>Enallagma carunculatum</i>	Tule Bluet	Y	Y	Y	Y	Y	Y	Y	Y
<i>E. annexum/boreale</i>	Northern/Boreal Bluet	N	Y	N	Y	Y	N	N	N
<i>Archilestes californicus</i>	California Spreadwing	Y	Y	Y	N	Y	Y	N	N
<i>Argia vivida</i>	Vivid Dancer	N	Y	Y	Y	Y	Y	Y	Y