2016-2017
LOWER DESCHUTES RIVER MACROINVERTEBRATE HATCH ACTIVITY SURVEY RESULTS

DESCHUTES RIVER ALLIANCE

Prepared for Deschutes River Alliance
by Rick Hafele - February 2018

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A thing is right when it trends to preserve the integrity, stability and beauty of the biotic community. It is wrong if it trends otherwise.

Aldo Leopold in "Meditations from the Wilderness" edited by Charles A.E. Brandt

INTRODUCTION

Throughout 2016 and 2017 the Surface Water Withdrawal (SWW) tower above Round Butte Dam continued to release 100% surface water from Lake Billy Chinook (LBC) reservoir for the majority of the year (approximately November 1st through early June). One result of surface water releases has been higher water temperatures in the lower Deschutes River from late winter through early summer compared to the temperatures that occurred prior to the SWW tower when water released from LBC was 100% bottom water (Figures 1 & 2). As a result, since the SWW tower became operational in December 2009, shifts in the timing of adult aquatic insect emergence and a decline in their abundance have been observed by anglers on the lower 100 miles of the Deschutes River below the Pelton-Round Butte three-dam complex (hereafter called the PRB complex).

The only other study to evaluate the effects of the SWW tower on aquatic life in the lower Deschutes River, a study funded by PGE, focused on benthic (bottom dwelling) aquatic macroinvertebrates and algae (Nightengale 2016)*. While sampling benthic macroinvertebrates is the most common approach used to monitor changes in aquatic macroinvertebrates, it fails to assess changes in adult emergence timing or abundance. To address this shortcoming, the Deschutes River Alliance (DRA) implemented a program in 2013 where river guides could document the presence and abundance of the major adult aquatic insect hatches during their guide trips on the river. Data were entered through a smart phone app, and then uploaded to an online database. Reports covering the results of guide surveys from 2013, 2014, and 2015 can be found on DRA's website (http://deschutesriveralliance.org/science-new/). This report covers guide survey data collected in 2016 and 2017.

**Note: The Nightengale 2016 study was funded by PGE and performed by R2 Resource Consultants. The final report released in March 2016, was rejected by the Oregon Dept. of Environmental Quality (ODEQ) due to flawed statistical analysis. ODEQ requested a reanalysis of the results. As of January 2018, that reanalysis had not yet been released. To ensure an adequate analysis of this important study, the DRA hired Dr. Patrick Edwards, at Portland State University to complete a thorough statistical analysis of the R2 data. That report is available on DRA's website by clicking here.*

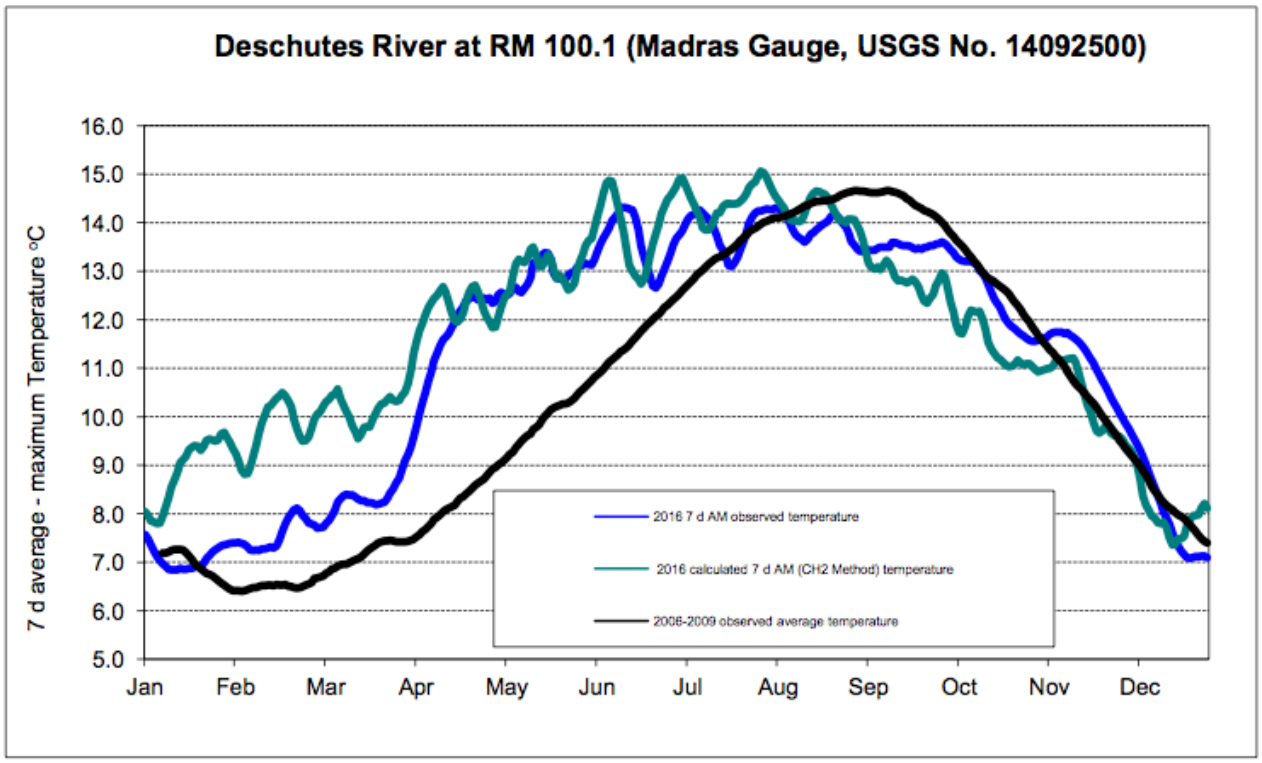

Figure 1. Comparison of the observed, modeled and pre-tower water temperature at the Reregulating Dam tailrace for 2016. (From PGE 2016 water temperature data report)

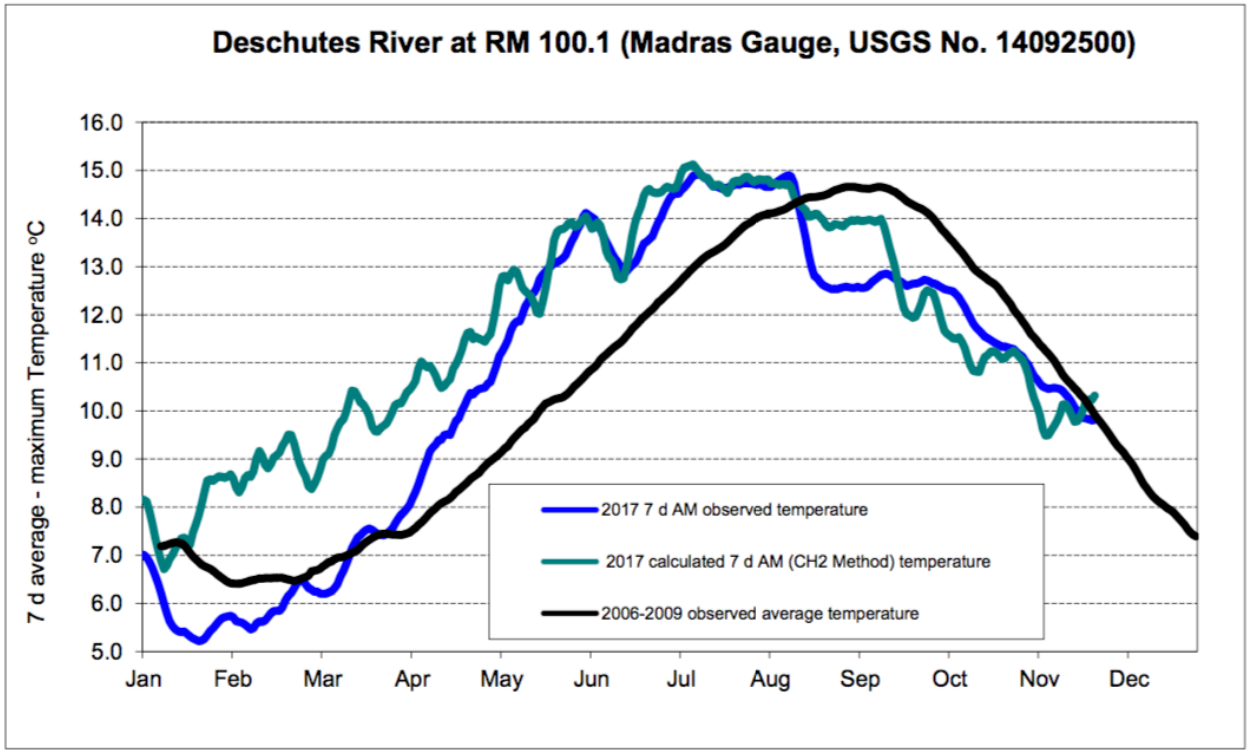

Figure 2. Comparison of the observed, modeled and pre-tower water temperature at the Reregulating Dam tailrace for 2017. (From PGE 2017 water temperature data report)

In addition to the warmer temperatures in the late winter, spring, and early summer, the change from the year-round release of 100% bottom water has resulted in other water quality changes in the lower Deschutes River. The three tributaries that enter LBC - the Crooked River, upper Deschutes River, and Metolius River - all have very different water quality conditions. Studies by Oregon Department of Environmental Quality (ODEQ) in the Crooked, Deschutes, and Metolius basins identified water quality in the Crooked and Deschutes rivers above LBC as "poor" and in the Metolius River as "excellent" (DEQ 2011). Since Crooked River water is warmer than the Metolius or upper Deschutes, surface water in LBC is primarily the poor quality Crooked River water, while the colder, high quality Metolius River water stays along the bottom of the reservoir (DRA 2016).

It is well known that algal and aquatic invertebrate communities respond to changes in water quality (Bellinger & Sigee 2010, Hauer & Lamberti 2006). Therefore, we would expect the release of warmer, lower quality water from LBC to have some effect on the algal and insect communities in the lower Deschutes River. One change widely observed by guides and anglers of the Deschutes River since the SWW began operation is the prolific growth of algae, which includes two species of stalked diatoms that both degrade macroinvertebrate habitat and reduce their available food (Figure 3).

Figure 3: Example of prolific algal growth on substrate in lower Deschutes River. Photo taken 1-mile below Rereg dam on April 1, 2016.

The ongoing observations of adult aquatic insect activity by highly experienced guides continue to document adult insect activity from April through October, and provide a qualitative assessment of changes in timing and abundance of major insect hatches in the lower Deschutes River. These results not only provide information about changes to the insect community, but, because aquatic insects are a critical part of the food chain for both aquatic and terrestrial wildlife, they also provide important insights about the overall health of the lower Deschutes River ecosystem.

SURVEY METHODS

In 2016, the surveys continued to use the online app "Formhub" developed in 2014 for recording and reporting survey results. In 2017, however, Formhub, a free open source web application, was no longer supported and could not be used. As a result a similar survey form was created using Google Forms. Unfortunately, Google Forms can only be opened and used while phones have a cell connection, something rarely possible in the Deschutes River canyon. This meant that guides had to fill out paper forms while on the river and enter the data online once back in town and in cell phone or internet coverage. This proved to be a significant restriction and the number of surveys collected in 2017 dropped as a result. In 2016, guides uploaded a total of 139 surveys. In 2017, a total of 87 surveys were reported. Table 1, shows the total number of surveys collected by stream reach and month for 2016 and 2017.

TABLE 1. Number of surveys collected in 2016 & 2017 by stream reach and month.

Reach & Month	2016	2017
Total Surveys Reported/Year	**139**	**87**
Warm Springs to Trout Creek	26	8
Trout Creek to Whitehorse	5	6
Whitehorse to Harpham	7	6
Harpham to Sandy Beach	48	41
Pine Tree to Mack's Canyon	54	26
April	10	3
May	62	51
June	19	22
July	17	9
August	19	1
September	4	1
October	8	0

It is interesting to note that in both 2016 and 2017, the number of surveys reported in May far exceeded any other month (Table 1). We believe this reflects the shift in emergence timing of most of the major hatches, including the salmonfly and golden stone hatches, to earlier in the year. The result is that fishing activity, including guided fishing trips reported here, has also become concentrated in May and early June when the best opportunity for fishing the peak hatches (and thus fishing success) occurs. When adult insect activity declines in mid to late June, angler fishing trips also decline substantially. As a result, fishing guides, and both fly fishing shops in Maupin, have experienced sharp declines in business starting in mid to late June that continues throughout the rest of the fishing season when insect hatches are largely over (Personal comm. John Hazel and John Smeraglio).

Observations were recorded for 17 different adult insects found on the lower Deschutes River (Table 2). The level of abundance for each insect taxa observed was recorded as either a "0" indicating none were observed, "1" as low numbers observed, "2" as moderate numbers seen, or "3" indicating high

TABLE 2. Major hatches covered by surveys

MAYFLIES	STONEFLIES	CADDISFLIES	DIPTERA
Baetis sp. (Blue-winged Olive)	*Pteronarcys californica* (Salmonfly)	Brachycentridae (American Grannom)	Chironomidae (Midges)
Ephemerella excrucians (Pale Morning Duns)	*Hesperoperla pacifica* (Golden Stone)	*Rhyacophila* sp. (Green Rock Worms)	*Antocha* sp. (Crane Fly)
Heptagenia sp. (Pale Evening Duns)	Perlodidae (Yellow Sallies)	*Glossosoma* sp. (Saddle-case Caddis)	
Drunella grandis (Green Drake)		*Hydropsyche sp.* (Net-spinning Caddis)	
Paraleptophlebia sp. (Mahogany Duns)		Hydroptilidae (Micro Caddis)	
Rhithrogena morrisoni (March Brown)		*Dicosmoecus* sp. (October Caddis)	

numbers were observed. Additional information covering date, location, weather, temperature (air and water if available), and fish activity was also recorded.

We recognize that these surveys do not provide *quantitative* data on adult insect abundance. Gathering such quantitative information would require complex sampling methods and funding beyond the reach of the DRA. However, the survey data shown here still provide valuable information over extended periods of time, and represent the only attempt that we know about to systematically document changes in adult emergence timing and abundance.

A more quantitative study of the benthic, or stream bottom, invertebrate community was completed for PGE by R2 Resource Consultants, Inc. in 2016 (Nightengale et.al. 2016). A re-analysis of the results, however, was requested by Oregon DEQ in April of 2016, and that re-analysis had not yet been released at the time this report was written. Like all benthic studies, the R2 study assessed only the nymphal and larval stages of aquatic invertebrates, and only in the spring (April/May) and fall (October). Benthic studies, when implemented and analyzed correctly, can provide important information about stream conditions and water quality (Rosenberg & Resh 1993). They do not, however, evaluate changes in adult insect emergence timing, or adult insect abundance over an extended period of time. That is the strength and importance of the adult insect survey data described in this report.

To maximize the accuracy and consistency of information gathered for these surveys, the surveys were completed only by guides with extensive experience fishing and observing hatch activity on the lower Deschutes River. In addition an identification training session was held for guides in March of both years, and an identification guide for the Deschutes River (Hafele 2015) was provided for reference after the training session.

RESULTS & DISCUSSION

MAJOR ORDERS

The overall abundance ratings for the four major orders are shown in Table 3 (2016) and Table 4 (2017). Each order is composed of several individual species or hatches (Table 2); thus, the number of observations in Tables 3 and 4 equal the total number of observations for all hatches in that order. The maximum possible number of observations for each individual hatch is the total number of surveys recorded for each year (2016=139 - 2017=87). Because different species are present as adults for only part of the year, however, only the observations made during each hatch's known emergence period are counted. For example, the total number of observations recorded for the six hatches of mayflies in 2016 was 506 (Table 3), out of a possible 834 (6 hatches x 139 surveys = 834 observations) if all hatches were present for all 139 surveys reported. The total number of observations recorded with low abundance (1's) for all six species of mayflies was 119, or 24% of the 506 total number of observations. Thus, the number of hatches within each order, and their expected emergence period, determines the total number of observations for each order.

TABLE 3. 2016 Summary table of adult abundance for the four major insect orders.
0 = none observed 1 = low abundance 2 = moderate abundance 3 = high abundance

	Mayfly Adults	Stonefly Adults	Caddis Adults	Diptera Adults
Total # of observations	506	252	446	256
# of observations with 0's recorded	310 = 61%	71 = 28%	226 = 51%	159 = 62%
# of observations with 1's recorded	119 = 24%	98 = 39%	86 = 19%	31 = 12%
# of observations 2's recorded	61 = 12%	71 = 28%	87 = 20%	45 = 18%
# of observations with 3's recorded	16 = 3%	14 = 5%	47 = 10%	21 = 8%

TABLE 4. 2017 Summary table of adult abundance for the four major insect orders.
0 = none observed 1 = low abundance 2 = moderate abundance 3 = high abundance

	Mayfly Adults	Stonefly Adults	Caddis Adults	Diptera Adults
Total # of observations by Order	402	172	310	169
# of observations with 0's recorded	229 = 57%	31 = 18%	145 = 47%	83 = 49%
# of observations with 1's recorded	86 = 21%	47 = 27%	74 = 24%	28 = 17%
# of observations 2's recorded	74 = 18%	75 = 44%	73 = 23%	46 = 27%
# of observations with 3's recorded	13 = 3%	19 = 11%	18 = 6%	12 = 7%

Both years show a similar pattern (Tables 3 & 4). With the exception of stonefly adults, the greatest percentage of adult hatches were recorded as "0" (none observed). The percent of hatches recorded as "3s" (high abundance) was 11% or less for all four orders in both 2016 and 2017. Compared to 2013-2015 results, in 2016 and 2017, stoneflies showed an increase in low and moderate abundance (1s & 2s), while caddisflies decreased in abundance with a higher percentage of "0" (none observed) observations recorded (Figures 4 & 5 respectively). It is likely that part of the reason for this shift is the greater proportion of surveys (i.e. guide trips) occurring in May and June in 2016 and 2017, compared to previous years. This is an unfortunate result of the fact that guide trips, and fishing activity for trout overall, is now concentrated from late April to mid June, when insect activity for many of the hatches now peaks. After mid June, insect emergence activity quickly declines along with fishing activity. Many fly shops from Maupin to Portland depend on guiding and fishing trips on

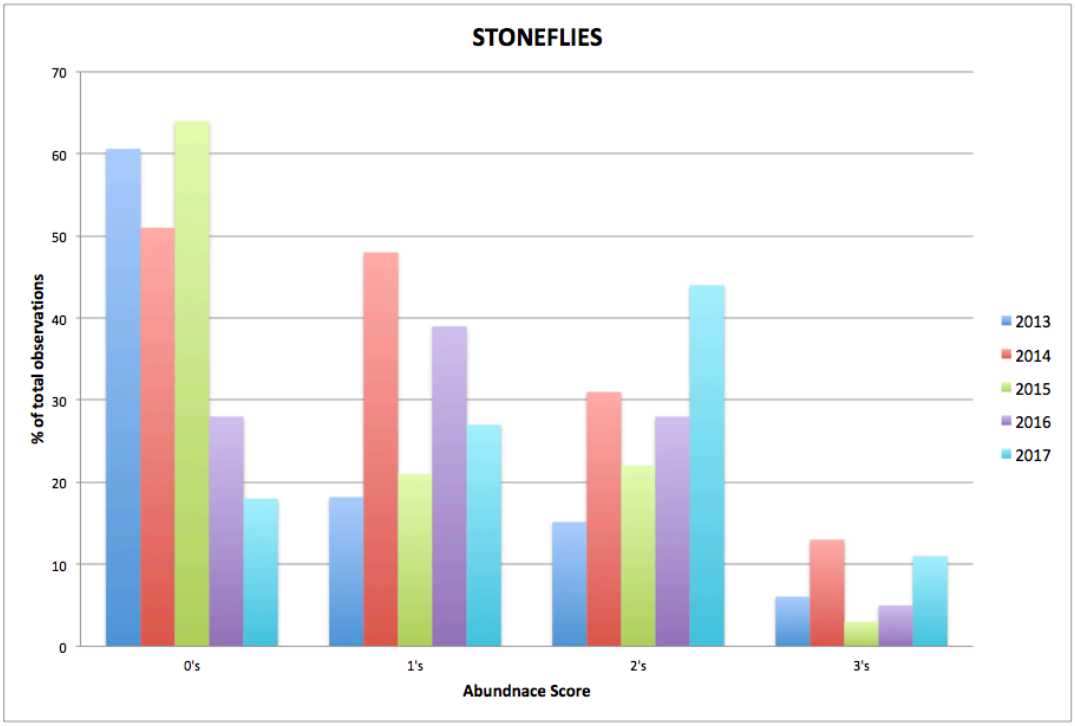

Figure 4. Adult stonefly abundance from 2013-2017.
0 = none observed 1 = low abundance 2 = moderate abundance 3 = high abundance

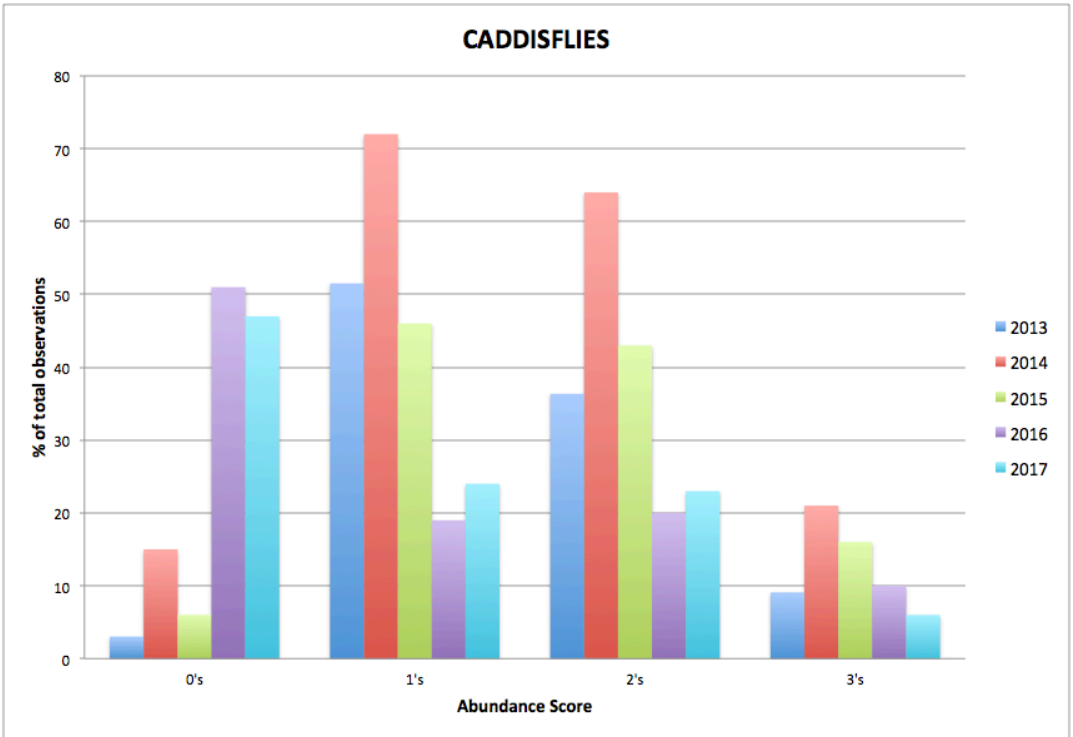

Figure 5. Adult caddisfly abundance from 2013-2017.
0 = none observed 1 = low abundance 2 = moderate abundance 3 = high abundance

the Deschutes for a major part of their income. Over the past five years they have seen business decline, particularly in the summer months (Personal Comm. Deschutes River Anglers and Deschutes Canyon Fly Shop). A video about the economic impacts of these changes in the lower Deschutes River due to changes in water quality can be found at the following link on the DRA website: A River Worth Fighting For.

Adult mayfly abundance over the past five years has seen a steady decline. Figure 6 shows the percentage of observations reporting no adult mayflies (0s) has increased throughout the five-year period of 2013-2017, while low and moderate abundance observations have decreased. The percent of observations with high abundance (3s), has remained below 5% throughout the past five years.

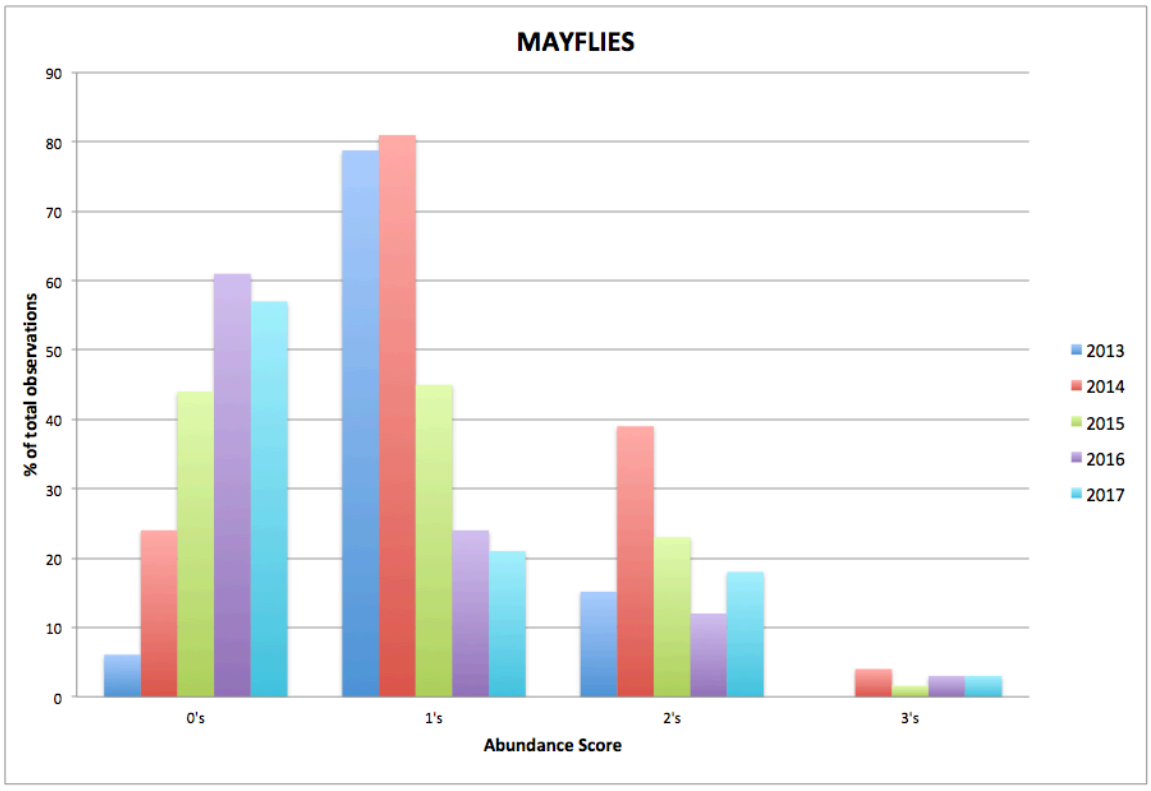

Figure 6. Adult mayfly abundance from 2013-2017.
0 = none observed 1 = low abundance 2 = moderate abundance 3 = high abundance

Adult abundance of Diptera has remained relatively constant over the past five years, with the highest percentage of observations showing no adults present (33-62%), and only 15-7% recorded as high abundance (Figure 7).

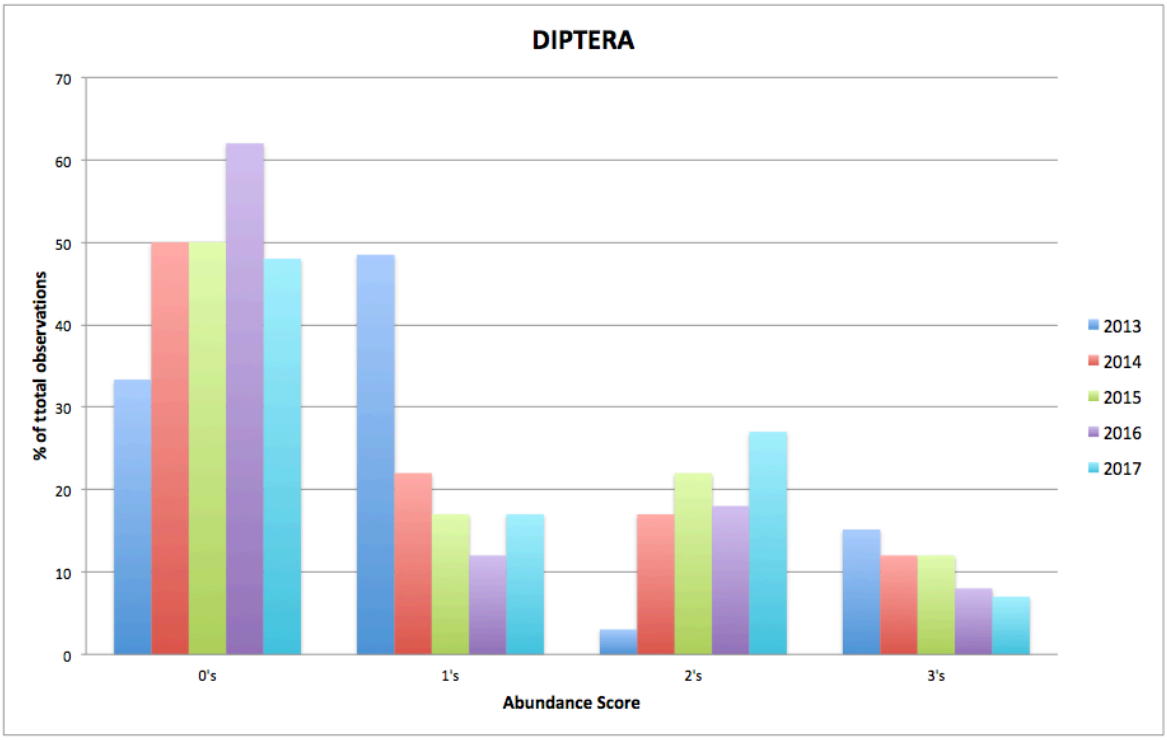

Figure 7. Adult Diptera abundance from 2013-2017.
0 = none observed 1 = low abundance 2 = moderate abundance 3 = high abundance

While information about the different insect orders provides a broad picture of insect activity, the adult abundance of specific insect hatches within each order provides a more detailed understanding of changes in adult insect numbers since SWW operations started.

The following discussion summarizes the results for each of the major hatches within each order.

MAYFLIES (EPHEMEROPTERA)

A diverse community of mayfly species occur in the lower Deschutes River. Benthic surveys of the aquatic insects at multiple sites on the lower Deschutes River have found around 30 mayfly taxa (Nightengale 2016). However, most of these are relatively uncommon. Six major mayfly taxa have historically produced the largest hatches of adults, and these have been recorded on the guide survey forms. Tables 5 & 6 show the results of the six important mayfly hatches for 2016 and 2017, respectively.

In both years pale morning duns (PMDs) had the highest percent of observations recorded as 3s (high abundance). However, the high abundance of PMDs was only 6% of all surveys in 2016 and 13% in 2017. Moderate abundance ranged between 28 and 26%, while low abundance was between 23 and 14% of all surveys. The percent of surveys with no PMDs observed (0s) ranged from 43% in 2016, to 47% in 2017.

TABLE 5. 2016 summary table of mayfly hatch abundance.
0 = none observed 1 = low abundance 2 = moderate abundance 3 = high abundance

	Blue-winged Olives	Pale Morning Duns	Pale Evening Duns	Green Drakes	Mahogany Duns	March Browns
Feeding Guild	Collector/ gatherer	Collector/ gatherer	Scrapers	Scrapers	Collector/ gatherer	Scraper
Total # of surveys with expected presence	139	117	98	72	40	40
% of surveys with none recorded	94 = 67%	50 = 43%	46 = 47%	47 = 65%	39 = 98%	34 = 85%
% with low #'s (1)	29 = 21%	27 = 23%	35 = 36%	22 = 31%	1 = 2%	5 = 13%
% with moderate #'s (2)	12 = 9%	33 = 28%	13 = 13%	2 = 3%	0	1 = 2%
% with high #'s (3)	4 = 3%	7 = 6%	4 = 4%	1 = 1%	0	0

TABLE 6. 2017 summary table of mayfly hatch abundance.
0 = none observed 1 = low abundance 2 = moderate abundance 3 = high abundance

	Blue-winged Olives	Pale Morning Duns	Pale Evening Duns	Green Drakes	Mahogany Duns	March Browns
Feeding Guild	Collector/ gatherer	Collector/ gatherer	Scrapers	Scrapers	Collector/ gatherer	Scraper
Total # of surveys with expected presence	87	85	73	47	56	54
% of surveys with none recorded	43 = 49%	40 = 47%	30 = 41%	27 = 57%	50 = 89%	39 = 72%
% with low #'s (1)	26 = 30%	12 = 14%	19 = 26%	14 = 30%	6 = 11%	9 = 17%
% with moderate #'s (2)	18 = 21%	22 = 26%	22 = 30%	6 = 13%	0	6 = 11%
% with high #'s (3)	0	11 =13%	2 = 3%	0	0	0

Pale morning dun is the common name for *Ephemerella excrucians*. *E. excrucians* is a common species of mayfly throughout the western region of North America. The family Ephemerellidae is under near constant taxonomic revision and *E. excrucians* was previously identified as *E. inermis*. *E. excrucians* is found in a wide range of stream types (large to small streams) and habitats (fast to moderately slow currents with gravel to aquatic vegetation). Historically, adult emergence of PMDs began in late May and continued into mid July. With the changes in water temperature following the start of surface water release, PMD emergence now begins in late April and ends in early June. In 2017 a very unusual emergence of PMDs was observed below Maupin in late September and early October. The exact species was not confirmed, but if it was *E. excrucians* it would represent a very unusual shift in its life cycle pattern.

Photo by Rick Hafele

Pale Morning Dun (*Ephemerella excrucians*)

Adult Mahogany duns (genus *Paraleptophlebia*) were observed in the lowest abundance of the six mayfly hatches recorded. The percent of surveys during potential Mahogany dun emergence with no adults observed ranged from 98% in 2016, to 89% in 2017 (Tables 5 & 6). In both years there were no observations of moderate (2s) or high (3s) abundance levels recorded. Such low abundance was also observed in 2015.

Photo by Rick Hafele

Mahogany Dun (*Paraleptophlebia* sp.)

Mahogany dun nymphs typically migrate to slower, shallow water near the shore before crawling out on exposed rocks for dun emergence. This near-shore habitat is often the same habitat with the greatest growth of nuisance algae and stalked diatoms. If the extensive algal growth interferes with the nymph migration or emergence success, that would help explain the sparse number of Mahogany dun adults observed.

The four remaining mayfly hatches recorded by the guide surveys all had the greatest percentage of observations recorded as 0s, or not present (Tables 5 & 6). In 2016, the percent of surveys with no adults observed ranged from 47% to 85%, while in 2017, it ranged from 41% to 72%. At the same time the percent of observations noted with high abundance of adults (3s), ranged from only 1% to 3% in 2016, while in 2017, there were no high abundance observations noted for three of the hatches, and only 3% with high abundance for the fourth hatch, pale evening duns.

Overall, mayfly hatches were found to be present in low to moderate abundance when seen at all, with the greatest percentage of surveys observing no adult mayflies. These results are similar to the guide survey results reported in 2015, but with lower overall abundance compared to 2014 (DRA 2014 and 2015).

STONEFLIES (PLECOPTERA)

Tables 7 and 8 show the results for the three stonefly hatches recorded on the guide surveys for 2016 and 2017, respectively. Though more than 25 stonefly taxa have been identified in the lower Deschutes, most are rare or emerge outside the sample period of the guide surveys. The salmonfly (*Pteronarcys californica)* and golden stone (*Hesperoperla pacifica)* produce the most famous and important hatches on the lower Deschutes River, creating excellent dry-fly fishing opportunities and drawing anglers from across the country.

Photos by Rick Hafele

Salmonfly (*Pteronarcys californica*)

Golden Stone (*Hesperoperla pacifica*)

As a result of warmer water temperatures throughout the late winter and spring months due to surface water releases, the salmonfly and golden stone hatches have consistently occurred four to five weeks earlier than pre-SWW tower adult emergence. But besides earlier emergence, which anglers have been adjusting to by fishing earlier in the year, the overall abundance of these two species has remained relatively low. In 2016, only between 8 and 10% of the surveys collected during their emergence period recorded high abundance (Table 7). In 2017, high abundance of salmonflies was again recorded as 8%, while 20% of golden stones observations were noted as high (Table 8). Benthic samples collected before and after SWW tower operations began show a decline in the relative abundance of both salmonfly and golden stonefly nymphs after tower operations started (Edwards 2018).

Yellow sally hatches consist of multiple species within the family Perlodidae. In 2016 and 2017, adults were observed from May through July with peak adult activity noted in late May and early June. Prior to SWW operations yellow sally adults were common from late June through mid-August with peak

TABLE 7. 2016 summary table of stonefly hatch abundance.

0 = none observed 1 = low abundance 2 = moderate abundance 3 = high abundance

	Salmonfly	Golden Stone	Yellow Sallies
Feeding Guild	Shredder	Predator	Predator
Total # of surveys with expected presence	77	77	98
% of surveys with none recorded	7 = 9%	12 = 16%	52 = 53%
% with low #'s (1)	44 = 57%	32 = 42%	22 = 21%
% with moderate #'s (2)	20 = 26%	25 = 32%	26 = 26%
% with high #'s (3)	6 = 8%	8 = 10%	0

TABLE 8. 2017 summary table of stonefly hatch abundance.

0 = none observed 1 = low abundance 2 = moderate abundance 3 = high abundance

	Salmonfly	Golden Stone	Yellow Sallies
Feeding Guild	Shredder	Predator	Predator
Total # of surveys with expected presence	60	60	82
% of surveys with none recorded	14 = 23%	13 = 22%	34 = 42%
% with low #'s (1)	16 = 27%	13 = 22%	18 = 22%
% with moderate #'s (2)	25 = 42%	22 = 36%	28 = 34%
% with high #'s (3)	5 = 8%	12 = 20%	2 = 2%

adult abundance typically in mid July. In both 2016 and 2017, the majority of guide survey results for yellow sallies indicated no adults present (53% in 2016; 42% in 2017) (Tables 7 & 8). The percent of observations noting high abundance was 0% in 2016 and only 2% in 2017. Moderate and low abundance were similar in both years ranging between 34 and 21% of all observations during the period of yellow sally emergence (Tables 7 & 8).

Photo by Rick Hafele

Typical Yellow Sally adult (family Perlodidae) from the lower Deschutes River.

CADDISFLIES (TRICHOPTERA)

Caddisflies are a diverse and important component of the aquatic insect fauna in the lower Deschutes River. Benthic studies have found almost 40 different caddisfly taxa in the lower Deschutes River (Nightengale 2016). Most of these taxa are neither abundant or common, and do not create large adult hatches. Tables 9 and 10 show the guide survey results for 2016 and 2017, respectively, for the six most important caddisfly hatches.

Prior to SWW operation, net-spinning caddis (family Hydropsychidae) typically produced the largest caddis hatches in the lower river. Compared to the other five caddis hatches, net-spinning caddis still occur in the greatest

TABLE 9. 2016 summary table of caddisfly hatch abundance.

0 = none observed 1 = low abundance 2 = moderate abundance 3 = high abundance

	Green Rock Worms	Net-spinning Caddis	Saddle-case Caddis	Micro Caddis	October Caddis
Feeding Guild	Predator	Filterer	Scraper	Scraper	Scraper
Total # of surveys with expected presence	108	116	93	117	12
% of surveys with none recorded	67 = 62%	14 = 12%	60 = 65%	82 = 70%	3 = 25%
% with 1's recorded	14 = 13%	24 = 21%	29 = 31%	11 = 9%	8 = 67%
% with 2's recorded	25 = 23%	41 = 35%	4 = 4%	17 = 15%	0
% with 3's recorded	2 = 2%	37 = 32%	0	7 = 6%	1 = 8%

TABLE 10. 2017 summary table of caddisfly hatch abundance.

0 = none observed 1 = low abundance 2 = moderate abundance 3 = high abundance

	Green Rock Worms	Net-spinning Caddis	Saddle-case Caddis	Micro Caddis	October Caddis
Feeding Guild	Predator	Filterer	Scraper	Scraper	Scraper
Total # of surveys with expected presence	64	82	76	87	1
% of surveys with none recorded	21 = 33%	19 = 23%	41 = 54%	63 = 72%	1
% with 1's recorded	29 = 45%	18 = 22%	20 = 26%	7 = 8%	0
% with 2's recorded	14 = 22%	31 = 38%	15 = 20%	13 = 15%	0
% with 3's recorded	0	14 = 17%	0	4 = 5%	0

abundance. In 2016, adult net-spinning caddis were noted as present in high abundance in 32% of the surveys reported during their emergence period (Table 9). This was the largest percent of adults reported in high abundance out of all hatches recorded in 2016 and 2017. In 2017, the percent of net-spinning caddis adults recorded as high abundance dropped to 17% (Table 10), which was still greater than all other hatches except for golden stoneflies (20%) reported in 2017.

Before the SWW tower began releasing surface water in 2010, net-spinning caddis adults produced large numbers of adults throughout June, July, and August, and provided a consistent food source for birds and other wildlife along the river corridor, and often produced aggressive fish feeding behavior while emerging or laying eggs. With the shifts in emergence timing that have occurred since the SWW tower began operating, net-spinning adult activity is now concentrated in May and June, with sporadic adult activity seen in July and August. This change is one of the main factors contributing to low adult insect numbers now seen during the summer months, especially in July and August.

Net-spinning Caddis (*Hydropsyche* sp.)

Two other important caddisfly hatches are the green rock worms (genus *Rhyacophila*) and saddle-case caddis (genus *Glossosoma*). Survey results for these caddis show low abundance of adults in both 2016 and 2017 (Tables 9 & 10). In 2016, the percent of observations showing no adults present was 62% for green rock worms and 65% for saddle-case caddis. The numbers were somewhat better in 2017, with 33% of observations seeing no adults green rock worms present and 54% observing no saddle-case caddis. The percent of observations noting high abundance of adults was 0% for both hatches in 2017, 0% for saddle-case caddis in 2016, and only 2% high abundance of green rock worms reported in 2016.

Photos by Rick Hafele

Green Rock Worm caddis (*Rhyacophila* sp.)

Saddle-case Caddis (*Glossosoma* sp.)

Micro caddis (family Hydroptilidae) is a group of very small caddis that has historically been abundant in the lower Deschutes River. The main genus found in the Deschutes is *Leucotrichia*. The larvae of this caddisfly live on the clean surface of large cobble and boulders where they hide under a silk-formed cover and feed on the periphyton layer covering the substrate. The growth of the mat-like algae, now common and covering the rocky substrate in the lower Deschutes River, appears to be reducing the amount of suitable habitat and food for *Leucotrichia* caddisflies. In 2016 and 2017, surveys reported no adult micro caddis present for 70% and 72% of all possible observations, respectively (Tables 9 & 10). High abundance of micro caddis was recorded in 6% of surveys in 2016 and 5% in 2017.

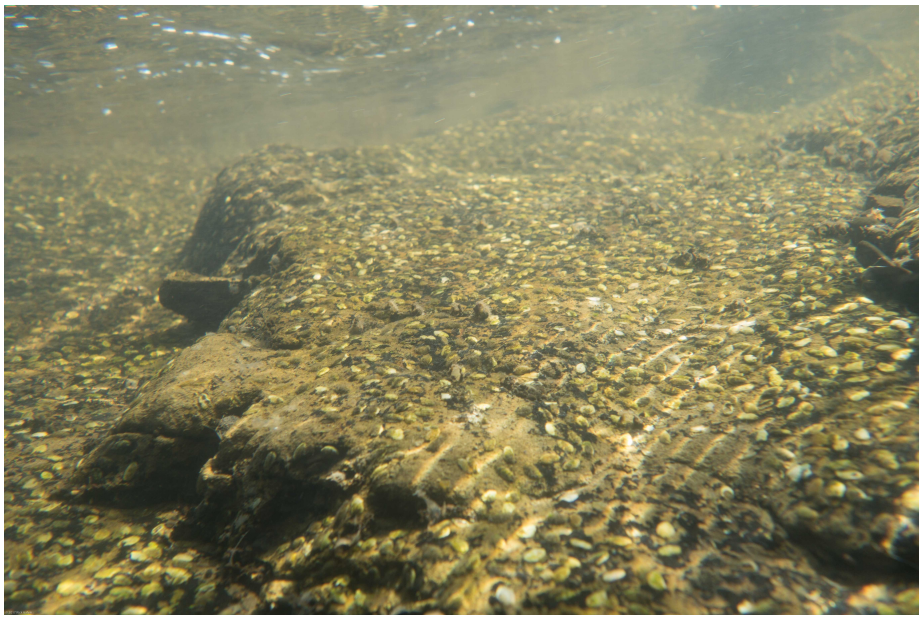

Photo by Rick Hafele

A large concentration of *Leucotrichia* larvae on the surface of rocks in the North Fork of the John Day River in early September 2017. Such large numbers were once commonly seen in the lower Deschutes River, but no longer occur where the mat-like algae now grows.

The last caddisfly adult recorded by the guide surveys is the October caddis (genus *Dicosmoecus*). This is the largest caddisfly adult found in the Deschutes River, and adult emergence generally occurs from mid-September through October, hence the common name October caddis. Very few surveys were completed by guides during the period of the October caddis emergence (12 surveys in 2016 and only 1 survey in 2017). Such few data records make it impossible to make any assessment of their abundance.

TRUE FLIES (DIPTERA)

The order Diptera, commonly known as true flies, is comprised of many species both aquatic and terrestrial. In aquatic systems the family Chironomidae typically dominates the Diptera fauna in both diversity and abundance (Ferrington et al. 2008). While easy to recognize at the family level, identification of specific genera and species within the family Chironomidae requires specific expertise and extra effort, so the level of identification often varies between labs. As a result the number of taxa reported for Diptera depends in large part on the level of taxonomy the analytical labs are able to identify chironomids and other Diptera. Two Diptera hatches were tracked in the guide surveys reported here; the family Chironomidae or midges, and the crane fly of the genus *Antocha*. Tables 11 and 12 show the results for these taxa for 2016 and 2017, respectively.

Chironomid adults are present throughout the entire year including the middle of the winter. Therefore, all surveys were included in the assessment of chironomid abundance. A few genera and species of Chironomidae are considered sensitive to poor water quality, but the family includes many genera and species that are tolerant to poor water quality, and the family as a whole often increases in relative abundance as water quality in streams decline (DeShon 1995).

Results for 2016 and 2017 are very similar (Tables 11 & 12). In both years, the highest percent of observations recorded no chironomid adults present (58% in 2016 to 45% in 2017). Moderate abundance (2s) were reported as the second most common level of abundance with 25% noted as moderate abundance in

2016 and 33% in 2017. High abundance of chironomid adults were reported as 7% of the total in 2016, and 10% in 2017.

TABLE 11. 2016 summary table of Diptera hatch abundance.
0 = none observed 1 = low abundance 2 = moderate abundance 3 = high abundance

	Chironomids	**Crane Flies (*Antocha* sp)**
Feeding Guild	Varied	Collector/gatherer
Total # of surveys with expected presence	139	117
% with none recorded	81 = 58%	78 = 67%
% of 1's recorded	14 = 10%	17 = 15%
% of 2's recorded	34 = 25%	11 = 9%
% of 3's recorded	10 = 7%	11 = 9%

TABLE 12. 2017 summary table of Diptera hatch abundance.
0 = none observed 1 = low abundance 2 = moderate abundance 3 = high abundance

	Chironomids	**Crane Flies (*Antocha* sp)**
Feeding Guild	Varied	Collector/gatherer
Total # of surveys with expected presence	87	82
% with none recorded	39 = 45%	44 = 53%
% of 1's recorded	10 = 12%	18 = 22%
% of 2's recorded	29 = 33%	17 = 21%
% of 3's recorded	9 = 10%	3 = 4%

Prior to SWW tower operations and surface water releases, the *Antocha* crane fly was a common and very abundant adult observed on the lower Deschutes River from mid June through August. In the years following surface water releases, *Antocha* adults have been rarely observed. Guide surveys in 2014 and 2015 only observed adult *Antocha* only three times. In 2016 and 2017 a greater number of adult *Antocha* observations were reported (Tables 11 & 12). In 2016, 9% of observations reported high abundance, with 4% high abundance reported in 2017. The number of observations reporting no *Antocha* adults present was 67% in 2016 and 53% in 2017. Nearly all adult *Antocha* observations in 2016 and 2017 were downstream from Mack's Canyon (river mile 23 to the mouth).

It is not known why *Antocha* has shown such a large decline in abundance following implementation of surface water releases, or why they increased in abundance in 2016 and 2017 downstream from Macks Canyon. *Antocha* lays its eggs in the splash zone of boulders and cobble protruding just above the water's surface. This habitat has been impacted by stalked diatoms as well as the dense growth of other algal species such as *Cladophora* following the start of surface water release after the SWW tower started operating. These changes may be preventing successful egg laying or egg development by *Antocha*. The greater abundance of *Antocha* adults in 2016 and 2017 could indicate some change in habitat conditions for these crane flies, at least below Macks Canyon.

Photo by Rick Hafele

Crane Fly (*Antocha* sp)

It should be noted that the R2 study (Nightengale et. al. 2016) found a decline in *Antocha* numbers in both the Crooked River and Deschutes River above LBC in 2014-2016 when compared to 1999-2001, while no such decline was

observed in the Metolius River. The R2 report concludes, "Most likely, this change is a result of a broader environmental pattern as opposed to a project-related effect" (page 100). An alternative conclusion is that the conditions that caused a decline of *Antocha* in the Crooked and Deschutes rivers upstream of Lake Billy Chinook have now been passed downstream with the surface water into the lower Deschutes River. In addition, another macroinvertebrate study from Whychus Creek (a tributary to the Deschutes River above LBC) that collected samples in 2005, 2009, and from 2011-2014, found *Antocha* present throughout the study (Mazzacano 2015). The continued presence of *Antocha* in the Metolius River and Whychus Creek suggests that the large decline in the Crooked River and Deschutes River above LBC, and decline in the lower Deschutes River, is due to factors occurring in the Crooked and Deschutes rivers rather than a result of a broader environmental pattern.

SUMMARY

Deschutes River guides submitted a total of 139 surveys in 2016, and 87 surveys in 2017. The decrease in survey responses in 2017 appears to be due to the change in reporting methods required in 2017. In 2016, guides continued to use Formhub, which allowed surveys to be filled out on smart phones while on the river and the data uploaded once guides returned to areas with cell coverage. In 2017, Formhub (an open source software) was no longer available, so guides had to fill out paper forms while on the river then re-enter the results on cell phones or computers after they finished their trips. This extra step was difficult to complete at the end of long days guiding resulting in fewer surveys.

Results from 2016 and 2017 continue to show the same trend observed in the results from 2013-2015. Again, with only a few exceptions, the greatest percentage of observations reported "no adults present" or only low abundance of adults for all of the major hatches. The two hatches with higher abundance reported were net-spinning caddis in 2016 (32% high abundance) and 2017 (17%

high abundance), and the golden stone in 2017 (20% high abundance). Five of the six mayfly hatches showed low abundance, with all but pale-morning duns reporting only 0 to 6% high abundance of adults for both 2016 and 2017 (Tables 5 & 6). The best percentage of high abundance for mayfly adults was for pale-morning duns, which reached 13% in 2017. Finally, the two hatches of Diptera (Chironomidae and *Antocha* crane flies) also showed low numbers of adults, with most surveys in both 2016 and 2017 reporting no adults present (Tables 11 & 12).

In addition to the generally low numbers of adult aquatic insects observed, the timing of adult emergence continues to occur four to six weeks earlier in the year for most of the hatches recorded. This has created a distinct peak in adult emergence activity from late April to early June for most of the major hatches. As a result anglers have been adjusting their fishing trips to coincide with the narrow window of adult insect activity and better fishing opportunities. Thus, from late April through early June the river is busy with guide trips and anglers fishing from Warms Springs to Maupin. However, by late June insect activity has decreased substantially and angling success has also declined. Based on the level of business at the two fly shops in Maupin it is clear that fewer and fewer anglers are returning to the lower Deschutes to fish through the summer (Personal comm. John Hazel and John Smeraglio).

The information gathered by the DRA adult hatch surveys is not sufficient to link the low numbers of observed adults to a specific cause. However, notable changes in the algal community have also been observed since SWW tower implementation, in particular the proliferation of two previously unreported species of stalk-forming diatoms. These diatoms appear to negatively impact both habitat and food resources for many of the aquatic insects. The continued growth of these algae appears to be linked to surface water withdrawal through the SWW tower, and likely changes in nutrient levels and other water quality parameters in the lower Deschutes River. PGE is still analyzing data from a two-year study to assess water quality in the lower Deschutes River, but has yet to complete the analysis and report any findings.

To better understand changes in water quality, the Deschutes River Alliance began monitoring several important water quality parameters (pH, dissolved oxygen, temperature, turbidity, conductivity, and chlorophyll-a) one mile downstream from the Reregulation Dam tailrace. These data are being collected every hour using a state-of-the-art continuous data sonde that was purchased through a generous gift from a concerned landowner. The results from the first year of this work is available on DRA's website at: 2016 Lower Deschutes Water Quality Report.

Finally, the overall condition of the river and wildlife along the river continues to concern many users of the lower Deschutes River. The widespread disappearance of insect feeding birds such as swallows and nighthawks, as well as bats, did not change in 2016 or 2017. Before surface water withdrawal through the SWW tower began, swallows were such a common sight from spring through the summer that one gave them little thought, and their nests often formed crowded colonies on cliffs near the river. In recent years, however, swallows have become rare enough that one is pleasantly surprised to see a few feeding over the river. The evening call of nighthawks, or the darting flight of bats at dusk, have become rare events, and the song of the canyon wren has all but disappeared from the lower river corridor. Such changes remind one of how important the health of the river's aquatic life is to the entire ecosystem.

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