Using single-species and whole community stream mesocosm exposures for identifying major ion effects in doses mimicking resource extraction wastewaters: Supplemental Materials

Additional specifics on mesocosm set-up

The mesocosm tiles were each 110 cm^2 and situated in two rows of 44. Gravel for the mesocosm's lower gravel section was prepared from a nominal 2.54 cm washed and dried river rock. The cleaned gravel filled rectangular plastic baskets were fabricated onsite from clear polycarbonate sheeting, 0.12 cm thick. Basket dimensions were 13.5 cm W x 23.5 cm L x 4.7 cm D. All sides of each basket were perforated with several 1.86 cm diameter holes to allow for free water exchange through the gravel and between adjacent baskets. The mesocosm gravel section consisted of 2 rows of 10 baskets snugged together without gaps between them or the side walls to form a concentric gravel surface.

In the head tank feeding a pair of mesocosms a mixed inflow of river and reverse osmosis water is split equally between receiving mesocosms by a partition at the top of the head tank, overflowing a sharp crested weir. The head tank sits atop a leveling platform to ensure equal distribution of inflow to each mesocosm.

Inflow mixing volumes: The mesocosms scheduled for the control treatment received 2.37 l min^{-1} RO flow, while those scheduled for the 500, 1000, and 2000 TDS treatments of both major ion recipes were set to receive 1.89, 1.14 and 0.95 l min^{-1}, respectively. For the 750 TDS treatment the RO inflow was set to 1.32 l min^{-1}.

ESF river water delivery: Two 20.32 cm pipes extend from the sump in the riverbank into the river, situated just above the bed: one situated at approximately 3.048 m (10 ft) from the bank and the other at 6.1 m (20 ft). Each intake pipe is screened with 0.318 cm mesh. River water flows passively between the riverbed and the sump by hydrostatic pressure. Screw-drive pumps in the sump deliver the river water to the ESF over 300 m (984 ft) and a flow rate of 1893 l·min^{-1} (500 gal·min^{-1}) through a 20.32 cm (8 in) buried pipe. The river water enters an 1893 l (500 gal) supply tank inside the ESF. From there it flows by hydrostatic pressure through separate 7.62 cm (3 in) PVC pipes to the headworks of the mesocosms.

RW/RO source mixing: The difference in inflow RW/RO source mixing also produced differences in the concentrations of background major ions and nutrients among scheduled treatments. These differences were expected to be of little consequence to the mesocosm communities. For example, during the colonization period the average reactive phosphorus concentrations were between 35 and 61 ug l-1, while nitrite-nitrate ($NO_{2\text{-}3}$) was between 218 and 382 ug l^{-1} for the most to the least RO-diluted inflows, respectively (Table 1). Based on nutrient targets for Ohio streams and other studies conducted at ESF these ranges were not considered broad enough to have significant consequences for stream primary producers under the light limiting conditions designed for the experiment.

Supplemental information on recipe preparation

The DWB and MTM dosing recipes were configured based on data sources provided by our colleagues in the EPA Region 3 Office in Wheeling, WV (i.e., Amy Bergdale, Maggie Passmore, Greg Pond, and Louis

Reynolds through personal communications). The targeted major ion concentrations and relative composition was decided by consensus and favored the DWB recipe for maximizing the number of doses tested because at the time these discussions were occurring the most relevant risk management question was regarding DWB wastewaters discharging from permitted WWTPs in the region. The data considered included values from the literature as well as unpublished information collected by Region 3 staff during site visits, or was obtained from state officials or industry professionals. All data were screened for specificity to the Central Appalachians, and included well, effluent, or instream data from sources in Pennsylvania, West Virginia, eastern Ohio, and eastern Kentucky. For the DWB recipe, the data sources included chemistry analyses done on flowback, produced, and treated prior to discharge wastewaters from deep wells. At the time, instream data was minimal or unverifiable. The original complement included data from 60 sources. These were screened to 28 sources of data most applicable to the Marcellus shale and potential for discharge to surface waters. Relevant references included: Dresel and Rose [1], Osborn and McIntosh [2], Hayes [3], Stout*, et al.* [4], Breen*, et al.* [5], and USEPA [6]. Since these represent the parent sources and have higher concentrations of TDS and major ions than would be expected after they are mixed with receiving waters, we determined the average TDS and the average fraction of TDS contributed by specific ions from this data (Table S2).

We then conducted an analysis of facilities permitted to discharge oil and gas (O&G) wastewaters to determine design flows. We paired this information with an analysis of each facility's receiving water's streamflow using USGS's Streamstats online tool (https://streamstats.usgs.gov/ss/). We estimated the in-stream TDS concentration after the mixing with stream baseflows and WWTP discharge assuming the average TDS from source analysis. 37 WWTPs were considered applicable in this analysis and estimated average TDS after mixing was 1104 mg/l with a range of 175 to 8707 mg/l, with nearly half of facilities discharges resulting in an instream TDS near or over 500 mg/l (Table S3). These conditions were taken as a concern for the protection of aquatic life. We used this exercise to define a range of environmentally relevant TDS concentrations in streams receiving discharges of DWB wastewaters and set our target doses for the DWB recipe at 100, 500, 750, 1000, and 2000 mg/l TDS.

The 100 to 2000 range of TDS for the DWB recipe was considered relevant also for streams receiving MTM leachates. The basis for this came from the analysis of information, in this case mostly published (or in review), provided again by Region 3 colleagues (Table S2). Relevant references included Kunz*, et al.* [7], USEPA [8], Pond*, et al.* [9], Fritz*, et al.* [10], Hartman*, et al.* [11], and Bryant*, et al.* [12]. Next, we used the fraction of TDS comprised by specific major ions from the well data, the instream data collected from reaches receiving MTM leachates, and the complement of industrial salts that could be obtained at reasonable cost that could be combined to meet the target TDS concentrations and specific ion composition desired.

Each recipe's target ion composition comes from averaging multiple data sources. For the DWB recipe, it is derived from the average ion fractions of an average TDS from 28 wells. For the MTM recipe, the ion composition was meant to approximate the average among nine published sources, many of which included statistics from multiple streams. The chemical formula and the relative solubilities of the industrial salts constrained the extent to which the realized concentrations were able to directly reflect our targeted average concentrations. Namely, in pre-dosing bench scale tests and early in the dosing period MTM stock solutions were sparged with CO_2 gas to increase the solubility of the calcium salts used. This, however, became intractable in terms of the amount of CO_2 required and considering that some precipitation and scale development occurred regardless when the stock solutions mixed with the other inflows and interacted with the mesocosm benthos. The inability to achieve complete calcium dissolution resulted in lower in-stream calcium and bicarbonate concentrations during the dosing period than was nominally targeted (Table S2). Because of difficulty in getting powdered calcium carbonate into solution at the meso-scale, we increased the levels of calcium chloride and sodium bicarbonate combined with the other MTM salts (Table S1). We did not allow these adjustments to skew the ionic composition or relative proportions of major ions so as not to be reflective of MTM sources generally. Comparing the realized average concentrations in Table 1 of the main text and those given in Table S2, suggest that our recipes generally reflected the concentration and ion composition of DWB and MTM sources across the region. Table S4 includes osmolarities and the concentrations of the major ions analyzed expressed as activities (mM) as supporting information to Table 1 in the main text.

Supplemental methods for assessing mesocosm biota

Periphyton: The periphyton slurry was prepared by selecting 5 pieces of surficial gravel from each one among two gravel baskets selected randomly for sampling on each event (weekly to biweekly). Among the 10 pieces of gravel, each was scrubbed with a stiff brush and rinsed with DI water until visually clean of biofilm over a plastic container where all the material was pooled. The resulting slurry was diluted to a consistent volume and gently homogenized with a hand mixer while aliquot sampling took place. Slurry aliquots used for dry mass and AFDM, and Chl-a were filtered separately. Dry mass and AFDM were determined by drying to constant weight the contents on the filter paper and, then combusting at 550 ^{o}C for 3 hr and reweighing, respectively. The Chl-a filter was frozen immediately, and within 28 d was processed through an acetone extraction procedure, followed by spectrometric determination of pigment concentration following USEPA Method 445.0. Algae I&E occurred at the genus level (Palmer cell on inverted microscope) at 400x magnification. Average cell dimensions were obtained for each genus so that the enumerated periphytic algae could be expressed in term of cell density (CD, $\#\cdot cm^{-2}$) or biovolume density (BD, $\mu m^{3}\cdot cm^{-2}$). All periphyton metrics were normalized to the surface area of gravel sampled. Each piece of gravel was individual wrapped with tinfoil. Half the weight of the tinfoil was used in a calibration equation that regressed known surface areas of tinfoil pieces to their weight.

Invertebrates: For emergence sampling, The UV light emitted by the lamp attracts emerging insects where the vaporized ethanol anesthetizes them, and they collect in the dish. The emergence traps are hung 0.61 m above the water surface flowing over the gravel in the middle of the section. A temporary wall is erected to separate adjacent mesocosms. Cables spanning the length of the gravel section support the emergence trap and an opaque shroud that is used to enclose the entire gravel section. The shrouds eliminate the potential for emergers to escape or be attracted to an adjacent mesocosm's UV light trap.

Drift: Invertebrates entrained in each drift net were rinsed into the net's cod bucket attachment that was then elutriated over a 250 μm sieve. Contents retained on the sieve were preserved in 70% ethanol until I&E. Drift was sampled at the same frequency as emergence except that an additional sampling event took place during the 24 hr period immediately after dosing began. This event, which occurred at ETD=2 (i.e., 24hr after dosing began) took place to determine if there was a significant and immediate drift response to the excess TDS (see figure S3).

QA: 90% quality control (QC) criteria established that the 10th sample processed for gravel, drift, emergence, and soft algae by an individual analyst be verified by a different analyst before proceeding to the next set of 10. One sample of every 20 was re-identified to QC the taxonomy.

Bench test protocols: The *C. dubia* Pre Dose- and During Dosing-Bench tests were maintained at 25 °C on a 16 hr light/ 8 hr dark cycling and recording fecundity over 7 d or until 60% of control females had three broods, but no longer than 8 d. One individual < 24 hr old was placed per 30 ml test chamber and 15 ml solution volume, which was replicated 10 times. A moderately hard reconstituted water (MHRW) internal control was also used. Feeding took place daily with 0.1 ml FFAY and 0.1 ml algae. The *P. promelas* tests followed the same format except that 10 individual, < 24 hr old, larvae were placed in a 300 ml test chamber with 250 ml solution volume that was replicated 4 times. Larvae were fed 0.15 ml of newly hatched brine shrimp twice daily. The *N. triangulifer* tests differed in that they were 14 d tests. One, < 24 hr old, larvae was added to each of ten 30 ml test chambers filled with 15 ml solution. Feeding took place daily with the addition of mixed diatoms: fed 0.2 mL mixed diatom suspension/slurry per test chamber for Day 0 to 9 and 0.4 mL mixed diatom suspension/slurry for the remainder of the test duration (14 d). The *H. azteca* tests were 10 d at 23 °C. Ten, 7 to 10 d old individuals were added to 300 ml chambers with 200 ml solution, replicated 4 times. A 5.08 cm (2 in) dia. disc of 400 um Nitex® mesh was added to each chamber as substrate for the organisms. Feeding of 1 ml of FFAY took place daily.

Ex situ format: 2 L plastic containers screened with a 500 μm mesh lid receive water via a line plumbed into the recirculating flow of the mesocosm. Flow rate was regulated manually with a ball valve and split to supply up to four ex situ tanks per mesocosm. Valves were positioned to approximate a 20 min ex situ tank residence time. Under these hydraulic conditions there was no detectable change in dissolved oxygen, water temperature, or pH from that fluxing through the mesocosms. Water free flowed after discharge from the delivery line through the mesh lid and entered behind an internal baffle that forced circulation to the bottom of the container before existing through a screened overflow near the top. The overflow from the ex situ tank collected in a plastic tub that held the tanks and acted as a water bath to buffer temperature fluctuations. Water from the outer holding tub overflowed back to the mesocosm, so that there was no net loss of water from the mesocosms as the result of feeding water to the ex situ tanks. Any solutes and particulate material or biota entrained in the mesocosm recirculation flow and smaller than 500 μm could enter the ex situ tank. A tile colonized with biofilm/periphyton in the mesocosm was added to each tank prior to adding the test species.

N. triangulifer: Twenty < 5 d old individuals were added to each of 4 replicate ex situ tanks per mesocosm for 21 d. Other than making sure that the screens on the inflow and overflow were kept from clogging with detritus no other manipulation was done to the tanks during the test. The test ended when the contents of each tank were passed through a 250 μm sieve to retrieve individuals.

P. promelas: Two replicate ex-situ tanks for each mesocosm were used for larvae from each culture. Ten individuals were added to each tank. After a 7 d exposure time the larval fish were recovered by sieving. Survivors were added to a weigh boat that was dried to constant weight at 80 °C and then weighed.

Bivalve cages: Cages housing the bivalves were made from stainless steel mesh; 14.7 cm W x 25 cm L with 3.32 mm diameter circular perforations every 1.68 mm were used to hold the bivalve species. Each cage was partitioned with a plastic insert and 20 individuals of each species were added to separate halves of the partitioned cage.

Supplemental materials for data analyses

Redundancy analysis (RDA) is a constrained principal components analysis (PCA) and is carried out by performing a PCA on the fitted values from a multivariate regression model [13]. The results characterize changes in the community assemblage with dose. The primary and secondary axis scores from the RDA performed at each individual time point were used in a dose response modeling (DRM) framework to further investigate changes in communities with dose. The RDA was used initially to explore the effect of dose on the community. Following the RDA, a DRM was fit to the estimated axis scores to further characterize the relationship between the community and dose. Lastly, the significant community-level ED_{50}s were aggregated into a community-level RSD.

The principal response curve (PRC) analysis, described in Van den Brink and Braak [14] estimates community effects over both time and dose. The species loadings displayed on the right side of the PRC plots in figures 7 and S2 can be interpreted as follows: Species with negative loadings have relatively small abundances in the control dose, and species with positive loadings have relatively large abundances at the control dose. If the plot indicates a positive effect from control, the species with positive loadings are estimated to be more abundant than the control dose, and species with negative loadings are estimated to be less abundant than the control dose. If the plot indicates a negative effect, the species with negative loadings are estimated to be more abundant than the control dose, and species with positive loadings are estimated to be less abundant than the control dose. An estimated effect of 0 indicates little difference in species abundances from the control dose. Dose and time are both treated as categorical variables in the PRC analysis. The PRC plot displays a significance star when the results of a permutation test indicate at least one difference in community assemblage across dose. The estimated relationship between the community assemblage and dose is not obvious, however, without looking closely at each line on the PRC plot and the dose level it represents.

Evaluating DRM fits: Rules for evaluating the automated DRM fits using LL2.4 model and making final selections of inclusion for the taxa, community, and system-level RSDs are as follows:

1. Split single taxa, community, and system measures for RSD analysis
2. RA variables should not be considered applicable for single taxa because response pattern could be a product of changing proportions of other taxa. So, only use straight counts, CD or BD.
3. Check for redundancies: e.g., if ETD 56 has a good DRM fit and significant response as does ETD 4356 for a given variable then choose the lowest EC50 and smallest confidence bounds if EC50s are very similar.
4. A measure's response that is significant on multiple sampling events can be included in the RSD for community and system-level responses. For the taxa-level measures, if multiple sampling dates are significant select the event with the lowest sensitivity. If sensitivities are similar, then prioritize the model with smallest confidence interval. The communities are dynamic with respect to assemblage make-up, taxa importance, phenology, and re-colonization rate. The more consistent a response is across sampling events the more evidence of a true effect, but if the effect is such that a taxa's population is seriously impacted, then dose-responses in the future may not be significant. With the stages of taxa life histories not being in synch with the time course of the experiment (i.e., not all taxa start at the same life stage at the same time the experiment begins, in contrast to the tests with culturable species) it is rational to think that significant responses could 'come-and-go', as it were, and as the experiment progresses. Furthermore, with spatial heterogeneity of taxa presence and absence, individuals present in one event may not necessarily be present in the next pending on their evenness across space and where the randomized selections for sample locations determine where samples are taken from.
5. Select only one CD or BD of an algal periphyton taxa-level response by date; don't use both. Most of the time when both are significant the $EC_{50s,}$ and CLs are similar. Chose BD over CD in these cases because BD is contextually more a reflection of the extent of taxa occupancy, but at the taxa-level if one has a significant model fit so should the other as the biovolume is computed from a

constant multiplier. However, the multiplier can produce order of magnitude conversions and for marginal model fits this scale-up can affect the modeling result.

6. For community and system-level measures:

    a. when the same one is significant for both BD or CD and RA choose the lowest EC_{50}, and smallest confidence bounds if EC_{50s} are similar.

    b. Use distance instead of similarity. When a significant model can be fit to one, so is the case for the other. This rule just says use distance to be consistent.

    c. Although multiple distance measures are used for estimating relative distance from controls and RDA axis scores are tested. We found the Hellinger transformation equivalent to representing the community as proportions (i.e., RA). We also explored differences in RSD fits using measures based on Bray-Curtis and Euclidean transformations: They were negligible. So, we chose to use distances and axis scores based on the Bray-Curtis transformation for consistency.

    d. Consider algal community-level BD and CD -based measures as separate community responses. We do this because some algal groups will have much greater biovolume to cell size ratios than others, so this captures both aspects.

    e. Community-level RA variables are considered for inclusion.

    f. This rule is based on the appropriateness of using both a community-level variable's RDA axis scores as well as the variable's distance-based responses when two or more DRMs are significant in the same RSD. The former represents the relative distances among samples in species ordination space and tests if those relative distances fit a dose response relationship, while the latter is a measure of how dissimilar a sample's taxa assemblage is to the control and fits a DRM to the dissimilarity, which is fitting a curve to one less data point. We choose to use only one when both are significant for the same response by ETD, and that is the one with lowest EC_{50} and/or smallest confidence interval. These measures are somewhat redundant. The dissimilarity is more straightforward and intuitive to interpret. However, axis scores have an advantage of providing species loading and thus interpretation of the species contribution to community changes with dose. There's also precedent for fitting models to linear combinations of responses, while there is less precedent for fitting dose response models to distances, although still legitimate.

Table S1. Table of industrial salts chemical purchases used for dosing recipes

Chemicals	Chemical Name	Total (kg or gal)	Total (lbs or gal)	ship	ship unit	Total Units
Mountain top mine recipe's chemicals						
$MgSO_4 . 7H_2O$	Magnesium Sulfate Heptahydrate	1164	2564	50	lbs	52
K_2SO_4	Potassium Sulfate	40	88	50	lbs	2
$CaCl_2$	Calcium Chloride	23	23	55	gal	2
$CaCO_3$	Calcium Carbonate	176	388	50	lbs	9
NaHCO3	Sodium Bicarbonate	62	136	50	lbs	3
$CaSO_4 . 2H_2O$	Calcium Sulfate Dihydrate	37	82	50	lbs	2
Deep well brine recipe's chemicals						
NaCl	Sodium Chloride	685	1509	50	lbs	30
$CaCl_2$	Calcium Chloride, 32% solution	69	152	55	gal	3
$SrCl_2 . 6H_2O$	Strontium Chloride	49	107	50	lbs	2
$BaCl_2 . 2H_2O$	Barium Chloride	18	40	50	lbs	1
$MgCl_2 . 6H_20$	Magnesium Chloride	70	155	50	lbs	3
NaBr	Sodium Bromide, 40% solution	1	3	55	gal	1
KCl	Potassium Chloride	8	17	50	lbs	1

Table S2. Targeted in-stream nominal TDS and major ion concentrations for the experimental dosing period along with statistical summaries of data used to design the relative ionic composition of each recipe. All values are mg/l.

Analyte	Control	DWB recipe targeted doses				DWB data statistical sumary*					MTM recipe targeted doses			MTM in streams statistical summary*			
						Mean	StDev	Min	Max	Fraction of TDs				Mean	StDev	Min	Max
TDS	100	500	750	1000	2000	180554	31579	117994	281832		500	1000	2000	895	56	847	2040
Cl^-	1	268	406	547	1115	100547	16068	71200	128369	0.631	29	52	127	30	37	3	91
SO_4^{2-}	6	7	8	9	10	207	599	40	1460	0.001	219	438	1156	880	424	366	1490
HCO_3^-	42	48	59	65	71	nd	nd	nd	nd	nd	126	236	258	157	90	39	309
Br^-	*trace*	2	3	4	8	836	205	479	1150	0.005	*trace*	*trace*	*trace*	nd	nd	nd	0.65
Na^+	1	120	179	239	478	37977	6295	30100	50000	0.238	19	40	97	77	124	5	341
Ca^{2+}	9	45	67	89	178	14248	3870	10000	22283	0.089	47	95	220	125	57	67	246
Mg^{2+}	1	5	7	9	18	1406	544	572	2682	0.009	49	96	257	137	90	16	262
Sr^{2+}	*trace*	7	11	14	28	2175	1043	675	4000	0.014	*trace*	*trace*	*trace*	nd	nd	0.02	0.07
K^+	1	2	3	4	8	640	397	130	1300	0.004	17	33	85	14	7	8	25
Ba^{2+}	*trace*	5	7	9	18	1513	2559	4.87	8730	0.009	*trace*	*trace*	*trace*	nd	nd	0.03	0.05

*Discriptive statistics from combining unpublished data provided by USEPA Region III staff and relevant published literature (see supplemental text).

Table S3: Estimates of mixing zone total dissolved solids from PA NPDES permits and stream flow statistics.

Plant Type	#	Drainage Area Above Point Source (mi^2)	Mixing Zone - Two yr, low flow TDS (mg/l)	Mixing Zone - Ten yr, low flow TDS (mg/l)	Mixing Zone - Ten yr, base flow TDS (mg/l)	Potentially problematic
Treating or Proposed to Treat Marcellus O&G WW (as of 10/2010)	12	5194	175	175	175	
	15	5134	175	175	175	
	17	5213	175	175	175	
	14	133	179	182	175	
	18	11582	180	182	176	
	13	42	186	192	177	
	47	18441	182	186	177	
	11	5413	213	239	181	
	48	501	215	240	183	
	46	5687	216	244	184	
	44	5977	224	251	185	
	6	5220	252	308	187	
	39	310	286	360	197	
	37	1548	282	344	198	
	43	3130	301	380	201	
	2	4531	392	557	208	
	41	114	383	556	216	
	19	702	334	417	217	
	40	90	442	619	232	
	16	139	1530	2554	373	1
	3	191	1282	2075	392	2
	8	1365	1681	3235	452	3
	5	1360	1482	2271	454	4
	10	51	992	1093	481	5
	42	1113	1628	2268	546	6
	7	200	5568	11090	721	7
	38	37	1727	1823	1074	8
	4	14	7883	15783	1444	9
	20	191	6455	15302	1488	10
	35	45	21371	43799	2511	11
	50	45	18082	27200	3274	12
	22	9	3847	3082	4722	13
	21	80	47627	79174	7272	14
	45	12	47920	98014	8707	15
	1	4	87719	121564	13356	detention ponds
	9	11	117731	149178	40719	will treat wRO
	49	3	110914	142575	44629	reuse/recycle
Treating Coal Bed Methane WW	30	1737	276	371	194	
	29	1724	277	373	194	
	25	758	616	902	276	1
	33	1310	981	1459	348	2
	27	200	2118	3809	493	3
	32	396	2452	3954	607	4
	23	410	2953	4779	701	5
	24	6	8276	21534	716	6
	28	14	7940	17342	1269	7
	26	2	37705	82668	2831	8
	31	29	32882	64224	4284	9
	36	51	41259	75679	5815	10
	34	18	31724	59929	7160	11

Table S4. Table 1′s constituent concentrations expressed as activity determined from

Period	Mesocosm	Recipe	Nominal TDS Target (mg/l)	Observed TDS (mg/l)	Specific Conductivity (µS/cm)	Ionic Strength (mM)	Osmolarity (mOsM)	Alkalinity (mg/l)	Hardness (mg/l)	pH	Temp	Cl^- (mM)	SO_4^{2-} (mM)	HCO_3^- (mM)	Br^- (mM)	$N\_NO_{2\text{-}3}^-$ (mM)	P_PO4^{3-} (mM)	Na^+ (mM)	Ca^{2+} (mM)	Mg^{2+} (mM)	Sr^{2+} (mM)	K^+ (mM)	Ba^{2+} (mM)	NH_4^+ (mM)
Colonization	E06.1,2	NA	100	87	118	1.20	1.29	30.4	35.0	7.7	22.8	0.17	0.06	0.58	0.00	0.01	0.000	0.16	0.15	0.09	0.00	0.03	0.000	0.001
	E04.1,2	NA	100	73	130	1.34	1.49	37.1	43.0	7.6	22.6	0.19	0.06	0.70	0.00	0.02	0.000	0.17	0.16	0.09	0.00	0.04	0.000	0.001
	E05.1,2	NA	100	106	167	1.69	1.94	45.6	55.0	7.2	22.8	0.26	0.08	0.87	0.00	0.02	0.000	0.22	0.19	0.12	0.00	0.05	0.000	0.001
	E07.1,2	NA	100	116	167	1.89	2.08	52.3	63.0	7.6	22.8	0.27	0.08	0.98	0.00	0.02	0.000	0.24	0.22	0.13	0.00	0.06	0.000	0.001
	E08.1,2	NA	100	141	198	2.15	2.35	58.0	74.0	7.5	22.4	0.31	0.09	1.09	0.00	0.03	0.000	0.27	0.25	0.15	0.00	0.06	0.000	0.001
	E01.1,2	NA	100	68	136	1.49	1.59	39.6	49.0	7.7	23.2	0.20	0.06	0.75	0.00	0.02	0.000	0.18	0.20	0.10	0.00	0.04	0.000	0.001
	E02.1,2	NA	100	109	177	1.97	2.10	52.8	61.0	7.6	23.1	0.26	0.08	0.99	0.00	0.02	0.000	0.24	0.25	0.13	0.00	0.05	0.000	0.001
	E03.1,2	NA	100	113	195	2.24	2.43	60.5	69.0	7.5	22.9	0.31	0.09	1.14	0.00	0.03	0.000	0.27	0.28	0.15	0.00	0.06	0.000	0.001
Dosing	E06.1,2	Control	100	73	114	1.34	1.40	33.4	41.7	7.5	22.3	0.15	0.04	0.63	0.00	0.03	0.000	0.14	0.22	0.09	0.00	0.04	0.000	0.001
	E04.1,2	DWB	500	540	798	7.89	10.46	39.1	144.3	7.4	22.3	5.23	0.04	0.70	0.03	0.03	0.000	3.26	0.64	0.19	0.05	0.17	0.015	0.001
	E05.1,2	DWB	750	855	1265	11.80	15.23	47.4	209.4	6.6	22.2	8.10	0.04	0.83	0.04	0.05	0.000	4.09	1.01	0.25	0.07	0.17	0.022	0.001
	E07.1,2	DWB	1000	1063	1543	15.60	20.01	53.4	297.1	6.9	22.2	10.28	0.05	0.92	0.05	0.05	0.000	6.46	1.23	0.25	0.10	0.22	0.024	0.001
	E08.1,2	DWB	2000	2405	3505	34.40	42.34	58.3	561.7	7.4	21.8	25.29	0.04	0.93	0.12	0.05	0.000	12.19	2.15	0.40	0.17	0.47	0.040	0.001
	E01.1,2	MTM	500	458	612	8.93	5.58	59.1	252.0	7.9	22.8	0.70	1.11	1.03	0.00	0.03	0.000	0.67	0.40	1.00	0.00	0.28	0.000	0.001
	E02.1,2	MTM	1000	799	1074	17.10	10.04	91.1	468.6	7.9	22.8	1.19	1.95	1.52	0.01	0.04	0.000	1.43	0.43	1.89	0.00	0.59	0.000	0.001
	E03.1,2	MTM	2000	1677	2307	39.10	21.09	138.4	1188.0	7.6	22.5	2.39	3.66	2.17	0.01	0.04	0.000	3.37	0.45	3.97	0.00	1.66	0.000	0.000
Pre-Dose Bench Toxicity Assay	E06.1,2	Control	100	72	136	1.81	1.87	41.0	50.0	7.2	22.6	0.21	0.06	0.77	0.00	0.05	0.000	0.21	0.30	0.10	0.00	0.04	0.000	0.000
	E04.1,2	DWB	500	754	1136	10.80	13.98	70.7	202.0	7.8	22.9	6.68	0.07	1.23	0.03	0.08	0.000	4.49	0.87	0.21	0.05	0.13	0.019	0.001
	E05.1,2	DWB	750	1102	1562	15.30	20.22	70.9	264.0	7.7	22.2	10.25	0.06	1.21	0.04	0.08	0.000	6.85	1.06	0.23	0.07	0.16	0.027	0.001
	E07.1,2	DWB	1000	1491	2080	19.50	25.80	70.7	330.0	7.7	22.1	13.30	0.06	1.18	0.06	0.07	0.000	9.08	1.23	0.26	0.09	0.20	0.036	0.001
	E08.1,2	DWB	2000	2869	3800	35.60	46.09	69.8	570.0	7.7	22.5	25.39	0.05	1.10	0.11	0.07	0.000	16.15	1.86	0.36	0.16	0.30	0.033	0.001
	E01.1,2	MTM	500	506	742	11.10	6.70	74.5	342.0	6.7	22.8	0.35	1.50	1.31	0.00	0.05	0.000	0.42	0.50	1.18	0.00	0.25	0.000	0.000
	E02.1,2	MTM	1000	937	1241	19.50	11.38	131.6	616.0	6.7	22.9	0.54	2.43	2.22	0.00	0.06	0.000	0.87	0.84	1.71	0.00	0.42	0.000	0.001
	E03.1,2	MTM	2000	1853	2240	38.90	21.06	209.2	1246.0	6.5	23.0	0.89	3.97	3.32	0.00	0.06	0.000	1.58	1.27	3.24	0.00	0.81	0.000	0.001

Table S5. Algae periphyton taxa and DRM/ANOVA results. BG=Blue Green Algae (i.e., Cyanobacteria). Ukn=Unknown; ns= not significant; -- = not applicable, and ETD=elapsed time during dosing period. All responses as SpCond μS/cm).

Periphyton algae Taxa1	Periphyton Division	Rare Taxon? (≤2 occurences in all samples)	DWB								MTM							
			ETD	EC_{50}	EC_{50}_ lower	EC_{50}_ upper	ANOVA_ pval	LOEC	NOEC	Effect (+ve or -ve)	ETD	EC_{50}	EC_{50}_ lower	EC_{50}_ upper	ANOVA_ pval	LOEC	NOEC	Effect (+ve or -ve)
Achananthes	Bacillariophyta	No	8	144.5	28.48	733.2	0.039808	1265	798	+ve	4356	953.1	384.5	2363	0.107389	2307	1074	-ve
Amphipleura	Bacillariophyta	No	ns	ns	ns	ns	ns	ns	ns	ns	1529	617.4	522.8	729.1	0.032282	1074	612	+ve
Amphora	Bacillariophyta	No	15	3469	3459	3478	8.55E-06	3505	1543	+ve	ns	ns	ns	ns	ns	ns	ns	ns
Anabaena	Cyanophycota	Yes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ankistrodesmus	Chlorophyta	Yes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BasalCellsBG	Cyanophycota	No	ns	ns	ns	ns	ns	ns	ns	ns	1529	2187	1987	2408	0.002554	2307	1074	+ve
Chroococcus	Cyanophycota	No	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Cladophora	Chlorophyta	No	43	3070	2058	4579	0.030965	3505	1543	+ve	4356	1218	913.5	1625	0.00012	1074	612	+ve
Closterium	Chlorophyta	Yes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cocconeis	Bacillariophyta	No	ns	ns	ns	ns	ns	ns	ns	ns	8	639.7	150.2	2724	0.033402	1074	612	+ve
Compsopogon	Rhodophyta	No	4356	1624	1157	2280	0.009234	3505	1543	+ve	56	1231	721	2100	0.039514	2307	1074	+ve
Cosmarium	Chlorophyta	Yes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyclotella	Bacillariophyta	Yes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cymbella	Bacillariophyta	No	1529	1286	1006	1644	0.005512	1543	1265	+ve	ns	ns	ns	ns	ns	ns	ns	ns
Fragilaria	Bacillariophyta	No	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Gomphonema	Bacillariophyta	No	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Gyrosigma	Bacillariophyta	No	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Homoeothrix	Cyanophycota	No	ns	ns	ns	ns	ns	ns	ns	ns	4356	258.4	53.78	1241	0.109616	612	114	-ve
Melosira	Bacillariophyta	No	15	1174	938	1470	2.56E-03	1265	798	+ve	15	1038	790.2	1364	0.047153	1074	612	+ve
Merismopedia	Cyanophycota	No	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Navicula	Bacillariophyta	No	15	1812	1222	2686	1.04E-02	3505	1543	+ve	43	2233	1885	2645	0.04823	2307	1074	+ve
Nitzschia	Bacillariophyta	No	15	1305	1151	1479	9.77E-04	1543	1265	-ve	15	1444	316.3	6594	0.002323	2307	1074	+ve
Oedogonium	Chlorophyta	Yes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Oscillatoria	Cyanophycota	No	ns	ns	ns	ns	ns	ns	ns	ns	56	ns	ns	ns	ns	ns	ns	ns
Pediastrum	Chlorophyta	Yes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phormidium	Cyanophycota	Yes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pleurosira	Bacillariophyta	Yes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Rhoicosphenia	Bacillariophyta	No	4356	1578	1467	1697	0.000181	1543	1265	+ve	1529	594.6	197.7	1788	1.04E-05	612	114	+ve
Scenedesmus	Chlorophyta	No	8	1216	760	1946	1.09E-02	ns	3505	+ve	ns	ns	ns	ns	ns	ns	ns	ns
Sellaphora	Bacillariophyta	Yes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Stigeoclonium	Chlorophyta	No	29	1486	1073	2058	1.27E-01	ns	3505	+ve	ns	ns	ns	ns	ns	ns	ns	ns
Surirella	Bacillariophyta	No	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Synedra	Bacillariophyta	No	15	924	532	1606	2.35E-02	1543	1265	+ve	1529	606.6	574.9	640.1	0.017719	612	114	+ve
Tryblionella	Bacillariophyta	No	ns	ns	ns	ns	ns	ns	ns	ns	15	1084	338.5	3469	0.1077	2307	1074	+ve
UknColonialCoccoidBG	Cyanophycota	Yes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UknFilamentousBG	Cyanophycota	No	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
UknFilamentousGreen	Chlorophyta	Yes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cyanophycota	Yes	4356	809.2	630.6	1039	0.12232	NA	3505	+ve	1529	133.6	28.03	636.5	0.016687	612	114	+ve

Table S6. Taxa identified and enumerated in gravel and drift samples. Ukn=unknown.

Taxon_Base	Gravel Occurrences	Rare Gravel Taxon (≤2 Instances, All Samples)	Drift Occurrences	Rare Drift Taxon (≤2 Instances, All Samples)	Taxon_1	Taxon_2	Major_Groups	Common names
Anisoptera	1	Yes	1	Yes	Anisoptera	Odonata	Other Insects	dragonfly (Infraorder)
Antocha	5	No	1	Yes	Limoniidae	Diptera	Other Insects	crane fly (Limoniidae)
Baetidae	71	No	80	No	Baetidae	Ephemeroptera	EPT Insects	small minnow mayfly (family)
Berosus	6	No	1	Yes	Hydrophilidae	Coleoptera	Other Insects	water scavenger beetle (Hydrophilidae)
Brachycentridae	0	Yes	1	Yes	Brachycentridae	Trichoptera	EPT Insects	humpless casemaker caddisfly (family)
Brachycera	1	Yes	0	Yes	Brachycera	Diptera	Other Insects	Brachyceran fly (Suborder)
Caenis	14	No	24	No	Caenidae	Ephemeroptera	EPT Insects	mayfly (Caenidae)
Calopteryx	1	Yes	0	Yes	Calopterygidae	Odonata	Other Insects	damselfy (Calopterygidae)
Ceratopogonidae	12	No	8	No	Ceratopogonidae	Diptera	Chironomids	biting midge (family)
Ceratopsyche	85	No	24	No	Hydropsychidae	Trichoptera	EPT Insects	net-spinning caddisfly (Hydropsychidae)
Cheumatopsyche	94	No	31	No	Hydropsychidae	Trichoptera	EPT Insects	net-spinning caddisfly (Hydropsychidae)
Chimarra	76	No	15	No	Philopotamidae	Trichoptera	EPT Insects	finger-net caddisfly (Philopotamidae)
Chironomini	85	No	85	No	Chironomidae	Chironomidae	Chironomids	non-biting midge (tribe)
Cladocera	16	No	26	No	Diplostraca	Crustacea	Crustaceans	water flea (Class- Brachiopoda)
Coenagrionidae	68	No	14	No	Coenagrionidae	Odonata	Other Insects	damselfly (family)
Copepoda	85	No	62	No	Copepoda	Crustacea	Crustaceans	copepod (Subclass)
Corbicula	64	No	2	Yes	Cyrenidae	Bivalvia	Bivalves	asian clam (Cyrenidae)
Corydalus cornutus	4	Yes	1	Yes	Corydalidae	Megaloptera	Other Insects	dobsonfly (Corydalidae)
Crangonyx	1	Yes	1	Yes	Crangonyctidae	Crustacea	Crustaceans	amphipoda (Crangonyctidae)
Dolichopodidae	1	Yes	1	Yes	Dolichopodidae	Diptera	Other Insects	long-legged fly (family)
Elmidae	99	No	31	No	Elmidae	Coleoptera	Other Insects	riffle beetle (family)
Empididae	11	No	2	Yes	Empididae	Diptera	Other Insects	dance fly (family)
Ferrissia	46	No	24	No	Planorbidae	Gastropoda	Gastropods	limpet (Planorbidae)
Fossaria	5	No	10	No	Lynaeidae	Gastropoda	Gastropods	snail -air breathing (Lymnaeidae)
Gerridae	1	Yes	5	Yes	Gerridae	Hemiptera	Other Insects	water strider (family)
Glossosomatidae	1	Yes	0	Yes	Glossosomatidae	Trichoptera	EPT Insects	saddle-case maker caddisfly (family)
Helicopsyche borealis	18	No	7	No	Helicopsychidae	Trichoptera	EPT Insects	caddisfly -speckled peter (Helicopsychidae)
Heptageniidae	66	No	28	No	Heptageniidae	Ephemeroptera	EPT Insects	flat-headed mayfly (family)
Hetaerina americana	1	Yes	0	Yes	Calopterygidae	Odonata	Other Insects	american rubyspot damselfly (Calopterygidae)
Hydra	12	No	8	No	Hydridae	Anthoathecata	Other	Hydridae (family)
Hydropsychidae	44	No	14	No	Hydropsychidae	Trichoptera	EPT Insects	net-spinning caddisfly (family)
Hydroptila	43	No	64	No	Hydroptilidae	Trichoptera	EPT Insects	microcaddislfy (Hydroptilidae)
Leptoceridae	4	No	26	No	Leptoceridae	Trichoptera	EPT Insects	long-horned caddisfly (family)
Leptophlebiidae	3	Yes	1	Yes	Leptophlebiidae	Ephemeroptera	EPT Insects	prong-gilled mayfly (family)
Leuctra	1	Yes	0	Yes	Leuctridae	Plecoptera	EPT Insects	rolled-winged stonefly (Leuctridae)
Lirceus	5	No	0	Yes	Asellidae	Crustacea	Crustaceans	isopod (Asellidae)
Lutrochus	1	Yes	0	Yes	Lutrochidae	Coleoptera	Other Insects	water beetle (Lutrochidae)
Menetus	10	No	21	No	Planorbidae	Gastropoda	Gastropods	ram's horn snail (Planorbidae)
Mooreobdella	4	No	0	Yes	Erpobdellidae	Worm	Worms	Leech - Annelida (Erpobdellidae)
Naididae	96	No	99	No	Naididae	Worm	Worms	Worm- Annelida (family)
Nematoda	59	No	18	No	Nematoda	Worm	Worms	roundworms (Phylum)
Neureclipsis	7	No	0	Yes	Polycentropodidae	Trichoptera	EPT Insects	tube maker caddisfly (Polycentropodidae)
Oecetis	7	No	7	Yes	Leptoceridae	Trichoptera	EPT Insects	long-horned caddisfly (Leptoceridae)
Orconectes	0	Yes	1	Yes	Cambaridae	Crustacea	Crustaceans	crayfish (Cambaridae)
Orthocladiinae	75	No	78	No	Chironomidae	Chironomidae	Chironomids	non-biting midge, orthoclads (Chironomidae)
Ostracoda	68	No	63	No	Ostracoda	Crustacea	Crustaceans	seed shrimp (class)
Pericoma	0	Yes	1	Yes	Psychodidae	Diptera	Other Insects	moth fly (Psychodidae)
Perlidae	16	No	0	Yes	Perlidae	Plecoptera	EPT Insects	common stonefly (family)
Perlodidae	1	Yes	0	Yes	Perlodidae	Plecoptera	EPT Insects	stripetail stonefly (family)
Petrophila	1	Yes	1	Yes	Crambidae	Lepidoptera	Other Insects	grass moth (Crambidae)
Physa	79	No	78	No	Physideae	Gastropoda	Gastropods	left-handed snail, air-breathing (Physidae)
Planorbidae	28	No	20	No	Planorbidae	Gastropoda	Gastropods	ram's horn snail, air-breathing (family)
Pleidae	2	Yes	0	Yes	Pleidae	Hemiptera	Other Insects	pygmy backswimmer (family)
Pleuroceridae	29	No	1	Yes	Pleuroceridae	Gastropoda	Gastropods	pleurocerid, gilled snail (family)
Polycentropodidae	5	Yes	0	Yes	Polycentropodidae	Trichoptera	EPT Insects	trumpet-net caddisfly (family)
Prostoma	28	No	1	Yes	Tetrastemmatidae	Worm	Worms	proboscis worm (Tetrastemmatidae)
Psephenus herricki	57	No	9	Yes	Psephenidae	Coleoptera	Other Insects	water penny beetle (Psephenidae)
Pseudochironomus	0	Yes	1	Yes	Chironomidae	Chironomidae	Chironomids	non-biting midge (Chironomidae)
Psychoda	0	Yes	1	Yes	Psychodidae	Diptera	Other Insects	moth fly (Psychodidae)
Simulium	19	No	17	No	Simuliidae	Diptera	Other Insects	black fly (Simuliidae)
Sphaeriidae	12	No	1	Yes	Sphaeriidae	Bivalvia	Bivalves	fingernail clam (family)
Stenelmis	112	No	56	No	Elmidae	Coleoptera	Other Insects	riffle beetle (Elmidae)
Synurella	1	Yes	1	Yes	Crangonyctidae	Crustacea	Crustaceans	amphipoda (Crangonyctidae)
Tanypodinae	88	No	83	No	Chironomidae	Chironomidae	Chironomids	non-biting midge (Chironomidae)
Tanytarsini	107	No	119	No	Chironomidae	Chironomidae	Chironomids	non-biting midge (Chironomidae)
Tricorythodes	91	No	46	No	Leptohyphidae	Ephemeroptera	EPT Insects	little stout crawler mayfly (Leptohyphidae)
Turbellaria	55	No	23	No	Turbellaria	Worm	Worms	flatworm (class)
Ukn Chironomidae	35	No	90	No	Chironomidae	Chironomidae	Chironomids	non-biting midge (family)
Ukn Diptera	0	Yes	5	No	Diptera	Diptera	Other Insects	fly (order)
Ukn Ephemeroptera	7	No	53	No	Ephemeroptera	Ephemeroptera	EPT Insects	mayfly (order)
Ukn Gastropoda	3	Yes	2	Yes	Gastropoda	Gastropoda	Gastropods	snails (class)
Ukn Plecoptera	0	Yes	1	Yes	Plecoptera	Plecoptera	EPT Insects	stonefly (order)
Ukn Trichoptera	2	Yes	24	No	Trichoptera	Trichoptera	EPT Insects	caddisfly (order)

Table S7: Rank ordering of invertebrate taxa-level responses comprising SpCond RSDs.

Taxon	ETD	EC_{50}	EC_{50}_ lower	EC_{50}_ upper	ANOVA_ pval	LOEC	NOEC	Effect (+ve or -ve)
DWB-Gravel								
Prostoma	29	348	295	410.33	0.0000	798	114	-ve
Other Insects	2	760	221	2616.4	0.0906	1265	798	-ve
Crustacea	56	833	432	1604.9	0.0694	1265	798	+ve
Copepoda	56	836	286	2441.7	0.0601	1265	798	+ve
Orthocladiinae	43	953	108	8375.2	0.0149	1543	1265	-ve
Heptageniidae	856	1331	575	3083.1	0.0404	1543	1265	-ve
Turbellaria	856	1465	1115	1925.4	0.0931	3505	1543	+ve
Naididae	856	1555	1241	1948	0.0481	798	114	-ve
Physa	43	1613	1000	2600.8	0.1292	ns	3505	+ve
DWB-Drift/Emergence								
Ostracoda	56	742	432	1276.1	0.0161	1265	798	-ve
Drift_EPT	856	815	414	1607.9	0.0391	1265	798	+ve
Turbellaria	856	877	215	3579.3	0.1172	ns	3505	+ve
Emerge_Trichoptera	23	883	190	4113.2	0.0102	3505	1543	+ve
Emerge-Chironomids	57	905	359	2278.2	0.0228	1543	1265	+ve
Other Insects	856	970	356	2641.9	0.1680	ns	3505	+ve
Copepoda	43	1153	563	2361.7	0.1526	ns	3505	+ve
Coenagrionidae	856	1285	1046	1577.1	0.1211	ns	3505	+ve
Drift_Chironomidae	8	1304	738	2305.7	0.0348	1543	1265	-ve
Emerge_Ephemeroptera	957	1537	1426	1656.3	0.0003	1265	798	-ve
Physa	56	1568	1520	1617.6	0.0005	3505	1543	+ve
Ukn Ephemeroptera	8	1646	1293	2095.3	0.0008	3505	1543	+ve

Table S7 continued.

Taxon	ETD	EC_{50}	EC_{50}_ lower	EC_{50}_ upper	ANOVA_ pval	LOEC	NOEC	Effect (+ve or -ve)
MTM-Gravel								
Fossaria	43	310.9711	258.9478	373.446	3.24E-62	612	114	-ve
Menetus	56	540.2493	32.54503	8968.17	0.013189	612	114	-ve
Hydropsychidae	29	585.7057	120.0335	2857.962	0.003037	612	114	+ve
Hydroptila	2	597.1813	130.7847	2726.815	0.147599	ns	2307	+ve
Ceratopsyche	43	611.9992	459.8064	814.5668	0.281268	ns	2307	-ve
Tanytarsini	29	620.4003	180.769	2129.218	0.042767	1074	612	-ve
Tricorythodes	29	633.3675	220.8825	1816.144	0.090089	1074	612	+ve
Trichoptera	56	690.5903	141.7602	3364.238	0.047065	2307	1074	-ve
Crustacea	29	771.6133	448.4444	1327.672	0.011872	1074	612	-ve
Copepoda	29	982.209	202.559	4762.733	0.007242	612	114	-ve
Elimdae	56	1008.295	282.2021	3602.594	0.066392	2307	1074	-ve
Turbellaria	56	1026.023	330.6944	3183.371	0.06782	2307	1074	-ve
Orthocladiinae	2	1093.699	504.6005	2370.542	0.0629	ns	2307	+ve
MTM Drift/Emergence								
Emerge_Trichoptera	43	299.7355	28.59747	3141.584	0.00657	612	114	-ve
Drift_Planorbidae	43	310.9711	258.9478	373.446	3.24E-62	612	114	-ve
Emerge-Chironomids	37	456.6114	168.9795	1233.842	0.001524	612	114	-ve
Menetus	43	611.9995	501.6726	746.5892	1.21E-01	ns	2307	-ve
Hydroptila	43	611.9999	528.9019	708.1537	0.049895	1074	612	-ve
Tricorythodes	22	614.881	167.212	2261.074	0.029979	1074	612	+ve
Copepoda	856	628.4351	267.3289	1477.321	0.007898	1074	612	+ve
Chimarra	856	643.2093	266.5282	1552.25	0.049093	1074	612	+ve
Emerge_Ephemeroptera	37	863.83	199.6786	3737.017	0.008612	612	114	-ve
Physa	856	869.5122	518.7413	1457.473	0.011411	1074	612	+ve
Drift_Chironomidae	2	1050.841	465.1452	2374.028	0.062451	NA	2307	+ve
Ostracoda	22	1095.554	238.9483	5023.009	0.01297	612	114	-ve
Naididae	15	1097.146	434.6123	2769.665	0.125549	NA	2307	-ve
Chironomini	2	1109.225	383.1313	3211.379	0.11861	NA	2307	+ve
Coleoptera	29	1575.269	1497.764	1656.784	7.07E-48	2307	1074	+ve
Ceratopsyche	8	1589.675	1527.227	1654.677	6.4E-63	2307	1074	+ve

Table S8: Community and system Level measures modeled. Bray= Bray-Curtis distance measure, MDS1=Axis 1 scores from nonmetric multidimensional scaling, RDA1=Axis1 scores from redundancy analysis, and Sum=Summed over all sampling events after dosing begins. Other abbreviations are defined in main text.

Community-level Response	System-level Response
DriftCommunity_Mgroup_brayDistance	AFDM (Periphyton Ash Free Dry Mass)
DriftCommunity_Mgroup_RA_brayDistance	Chla (Periphyton Chlorophyll)
DriftCommunity_Mgroup_RA_RDA1_bray	TotalBP (Periphtyon Dry Weight)
DriftCommunity_Mgroup_RA_RDA2_bray	OM (Periphyton organic content, %)
DriftCommunity_Mgroup_RDA1_bray	DeadDiatoms
DriftCommunity_Mgroup_RDA2_bray	Drift_Sum_Total
DriftCommunity_Taxa1_brayDistance	Drift_Total
DriftCommunity_Taxa1_RA_brayDistance	DriftCommunity_Mgroup_Sum_brayDistance
DriftCommunity_Taxa1_RA_RDA1_bray	DriftCommunity_Mgroup_Sum_RA_brayDistance
DriftCommunity_Taxa1_RA_RDA2_bray	DriftCommunity_Mgroup_Sum_RA_RDA1_bray
DriftCommunity_Taxa1_RDA1_bray	DriftCommunity_Mgroup_Sum_RA_RDA2_bray
DriftCommunity_Taxa1_RDA2_bray	DriftCommunity_Mgroup_Sum_RDA1_bray
EmergeCommunity_Mgroup_brayDistance	DriftCommunity_Mgroup_Sum_RDA2_bray
EmergeCommunity_Mgroup_RA_brayDistance	DriftCommunity_Taxa1_Sum_brayDistance
EmergeCommunity_Mgroup_RA_RDA1_bray	DriftCommunity_Taxa1_Sum_RA_brayDistance
EmergeCommunity_Mgroup_RA_RDA2_bray	DriftCommunity_Taxa1_Sum_RA_RDA1_bray
EmergeCommunity_Mgroup_RDA1_bray	DriftCommunity_Taxa1_Sum_RA_RDA2_bray
EmergeCommunity_Mgroup_RDA2_bray	DriftCommunity_Taxa1_Sum_RDA1_bray
GravelCommunity_Mgroup_brayDistance	DriftCommunity_Taxa1_Sum_RDA2_bray
GravelCommunity_Mgroup_RA_brayDistance	Emerge_Sum_Total
GravelCommunity_Mgroup_RA_RDA1_bray	Emerge_Total
GravelCommunity_Mgroup_RA_RDA2_bray	EmergeCommunity_Mgroup_Sum_brayDistance
GravelCommunity_Mgroup_RDA1_bray	EmergeCommunity_Mgroup_Sum_RA_brayDistance
GravelCommunity_Mgroup_RDA2_bray	EmergeCommunity_Mgroup_Sum_RA_RDA1_bray
GravelCommunity_Taxa1_brayDistance	EmergeCommunity_Mgroup_Sum_RA_RDA2_bray
GravelCommunity_Taxa1_RA_brayDistance	EmergeCommunity_Mgroup_Sum_RDA1_bray
GravelCommunity_Taxa1_RA_RDA1_bray	EmergeCommunity_Mgroup_Sum_RDA2_bray
GravelCommunity_Taxa1_RA_RDA2_bray	Gravel_Sum_Total
GravelCommunity_Taxa1_RDA1_bray	Gravel_Total
GravelCommunity_Taxa1_RDA2_bray	GravelCommunity_Mgroup_Sum_brayDistance
PalmerAlgaeCommunity_Div_BD_brayDistance	GravelCommunity_Mgroup_Sum_RA_brayDistance
PalmerAlgaeCommunity_Div_BD_Halves_brayDistance	GravelCommunity_Mgroup_Sum_RA_RDA1_bray
PalmerAlgaeCommunity_Div_BD_Halves_RA_brayDistance	GravelCommunity_Mgroup_Sum_RA_RDA2_bray
PalmerAlgaeCommunity_Div_BD_Halves_RA_RDA1_bray	GravelCommunity_Mgroup_Sum_RDA1_bray
PalmerAlgaeCommunity_Div_BD_Halves_RA_RDA2_bray	GravelCommunity_Mgroup_Sum_RDA2_bray
PalmerAlgaeCommunity_Div_BD_Halves_RDA1_bray	GravelCommunity_Taxa1_Sum_brayDistance
PalmerAlgaeCommunity_Div_BD_Halves_RDA2_bray	GravelCommunity_Taxa1_Sum_RA_brayDistance
PalmerAlgaeCommunity_Div_BD_RA_brayDistance	GravelCommunity_Taxa1_Sum_RA_RDA1_bray
PalmerAlgaeCommunity_Div_BD_RA_RDA1_bray	GravelCommunity_Taxa1_Sum_RA_RDA2_bray
PalmerAlgaeCommunity_Div_BD_RA_RDA2_bray	GravelCommunity_Taxa1_Sum_RDA1_bray
PalmerAlgaeCommunity_Div_BD_RDA1_bray	GravelCommunity_Taxa1_Sum_RDA2_bray
PalmerAlgaeCommunity_Div_BD_RDA2_bray	
PalmerAlgaeCommunity_Div_CD_brayDistance	
PalmerAlgaeCommunity_Div_CD_Halves_brayDistance	
PalmerAlgaeCommunity_Div_CD_Halves_RA_brayDistance	
PalmerAlgaeCommunity_Div_CD_Halves_RA_RDA1_bray	
PalmerAlgaeCommunity_Div_CD_Halves_RA_RDA2_bray	
PalmerAlgaeCommunity_Div_CD_Halves_RDA1_bray	
PalmerAlgaeCommunity_Div_CD_Halves_RDA2_bray	
PalmerAlgaeCommunity_Div_CD_RA_brayDistance	
PalmerAlgaeCommunity_Div_CD_RA_RDA1_bray	
PalmerAlgaeCommunity_Div_CD_RA_RDA2_bray	
PalmerAlgaeCommunity_Div_CD_RDA1_bray	
PalmerAlgaeCommunity_Div_CD_RDA2_bray	
PalmerAlgaeCommunity_Taxa1_BD_brayDistance	
PalmerAlgaeCommunity_Taxa1_BD_Halves_brayDistance	
PalmerAlgaeCommunity_Taxa1_BD_Halves_RA_brayDistance	
PalmerAlgaeCommunity_Taxa1_BD_Halves_RA_RDA1_bray	
PalmerAlgaeCommunity_Taxa1_BD_Halves_RA_RDA2_bray	
PalmerAlgaeCommunity_Taxa1_BD_Halves_RDA1_bray	
PalmerAlgaeCommunity_Taxa1_BD_Halves_RDA2_bray	
PalmerAlgaeCommunity_Taxa1_BD_RA_brayDistance	
PalmerAlgaeCommunity_Taxa1_BD_RA_RDA1_bray	
PalmerAlgaeCommunity_Taxa1_BD_RA_RDA2_bray	
PalmerAlgaeCommunity_Taxa1_BD_RDA1_bray	
PalmerAlgaeCommunity_Taxa1_BD_RDA2_bray	
PalmerAlgaeCommunity_Taxa1_CD_brayDistance	
PalmerAlgaeCommunity_Taxa1_CD_Halves_brayDistance	
PalmerAlgaeCommunity_Taxa1_CD_Halves_RA_brayDistance	
PalmerAlgaeCommunity_Taxa1_CD_Halves_RA_RDA1_bray	
PalmerAlgaeCommunity_Taxa1_CD_Halves_RA_RDA2_bray	
PalmerAlgaeCommunity_Taxa1_CD_Halves_RDA1_bray	
PalmerAlgaeCommunity_Taxa1_CD_Halves_RDA2_bray	
PalmerAlgaeCommunity_Taxa1_CD_RA_brayDistance	
PalmerAlgaeCommunity_Taxa1_CD_RA_RDA1_bray	
PalmerAlgaeCommunity_Taxa1_CD_RA_RDA2_bray	
PalmerAlgaeCommunity_Taxa1_CD_RDA1_bray	
PalmerAlgaeCommunity_Taxa1_CD_RDA2_bray	

Table S9: Rank order of EC_{50} community level measures used in RSD. Bray= Bray-Curtis Distance Measure, RDA1=Axis1 scores from redundancy analysis, and Sum=Summed over all sampling events after dosing begins. Other abbreviations are defined in main text.

Community-level Response	ETD	EC_{50}	EC_{50}_lower	EC_{50}_upper	ANOVA_pval	LOEC	NOEC
DWB							
PalmerAlgaeCommunity_Taxa1_BD_RDA1_bray	56	599.2143	187.7255	1912.674	0.010912	798	114
PalmerAlgaeCommunity_Taxa1_CD_RDA1_bray	56	751.3518	355.2692	1589.019	0.001985	798	114
GravelCommunity_Mgroup_RA_RDA1_bray	2	755.3934	213.1884	2676.596	0.011095	1265	798
PalmerAlgaeCommunity_Taxa1_BD_RDA1_bray	29	982.6889	569.2335	1696.452	0.069264	1543	1265
EmergeCommunity_Mgroup_RA_RDA1_bray	23	999.4701	512.4594	1949.307	0.010985	1265	798
PalmerAlgaeCommunity_Div_CD_Halves_RA_RDA1_bray	1529	1128.987	738.0862	1726.915	0.007276	1543	1265
GravelCommunity_Taxa1_brayDistance	29	1134.023	564.6562	2277.505	0.037238	1265	798
PalmerAlgaeCommunity_Div_BD_RA_brayDistance	15	1140.06	612.8154	2120.925	0.015887	798	114
EmergeCommunity_Mgroup_RA_brayDistance	16	1187.599	713.2198	1977.498	0.006018	798	114
PalmerAlgaeCommunity_Taxa1_BD_Halves_RA_brayDistanc	1529	1242.535	1056.854	1460.84	0.006424	798	114
EmergeCommunity_Mgroup_RA_RDA2_bray	37	1259.225	1158.029	1369.265	0.0216	1543	1265
PalmerAlgaeCommunity_Taxa1_CD_RA_brayDistance	15	1277.057	1158.945	1407.206	0.001903	798	114
DriftCommunity_Taxa1_RA_brayDistance	56	1286.845	849.6957	1948.899	0.094428	3505	1543
PalmerAlgaeCommunity_Taxa1_CD_RDA2_bray	29	1323.56	1159.616	1510.682	0.001751	1543	1265
PalmerAlgaeCommunity_Div_BD_RA_brayDistance	56	1361.882	1233.718	1503.36	0.000414	1265	798
PalmerAlgaeCommunity_Taxa1_CD_RA_RDA2_bray	8	1382.862	1198.934	1595.007	0.008249	1543	1265
EmergeCommunity_Mgroup_RA_brayDistance	30	1527.762	1209.078	1930.445	0.011282	798	114
PalmerAlgaeCommunity_Taxa1_BD_RDA2_bray	15	1537.853	1398.371	1691.247	0.03574	3505	1543
DriftCommunity_Mgroup_brayDistance	56	1555.225	1255.468	1926.551	0.03057	1265	798
EmergeCommunity_Mgroup_RDA1_bray	43	1556.953	1439.176	1684.367	0.00134	3505	1543
PalmerAlgaeCommunity_Div_CD_brayDistance	56	1567.008	1082.845	2267.65	0.010218	1543	1265
GravelCommunity_Taxa1_brayDistance	43	1604.559	1205.155	2136.329	0.014414	1543	1265
GravelCommunity_Mgroup_RA_RDA1_bray	29	1619.186	795.4485	3295.954	0.016102	3505	1543
DriftCommunity_Mgroup_RDA2_bray	43	2178.795	876.4661	5416.237	0.012789	3505	1543
MTM							
GravelCommunity_Mgroup_RA_RDA2_bray	56	556.2375	80.20551	3857.593	0.025115	612	114
PalmerAlgaeCommunity_Div_BD_RA_RDA1_bray	56	587.158	471.2469	731.5793	0.00222	612	114
EmergeCommunity_Mgroup_RA_RDA1_bray	16	616.0894	540.5876	702.1362	0.058422	1074	612
GravelCommunity_Taxa1_RA_RDA2_bray	56	657.5516	399.2231	1083.039	0.020965	1074	612
PalmerAlgaeCommunity_Taxa1_CD_RDA1_bray	56	674.1751	477.0711	952.7134	0.001474	612	114
PalmerAlgaeCommunity_Taxa1_BD_RDA1_bray	56	746.0674	543.19	1024.718	0.002215	612	114
DriftCommunity_Taxa1_RDA2_bray	29	775.7756	136.5578	4407.129	0.099393	2307	1074
GravelCommunity_Taxa1_RDA2_bray	29	867.8985	468.5276	1607.691	0.015917	1074	612
PalmerAlgaeCommunity_Div_CD_RDA2_bray	56	1041.183	461.8856	2347.034	0.006603	612	114
EmergeCommunity_Mgroup_RDA1_bray	23	1052.648	291.4533	3801.868	0.031338	1074	612
PalmerAlgaeCommunity_Div_CD_RA_RDA1_bray	43	1056.809	412.0622	2710.381	0.024141	612	114
DriftCommunity_Taxa1_RA_RDA2_bray	43	1065.09	765.9983	1480.964	0.01298	2307	1074
GravelCommunity_Taxa1_RDA1_bray	43	1072.329	610.5126	1883.482	0.09288	2307	1074
PalmerAlgaeCommunity_Taxa1_CD_RDA2_bray	15	1077.934	661.287	1757.091	0.06556	NA	2307
DriftCommunity_Mgroup_RA_RDA2_bray	43	1083.729	677.8648	1732.601	0.024548	2307	1074
EmergeCommunity_Mgroup_RDA1_bray	37	1099.934	406.733	2974.569	0.001711	612	114
GravelCommunity_Mgroup_RA_RDA2_bray	15	1100.509	373.5922	3241.821	0.012178	612	114
DriftCommunity_Taxa1_RDA1_bray	2	1103.997	569.2081	2141.238	0.00425	612	114
DriftCommunity_Taxa1_RDA2_bray	15	1131.562	397.4081	3221.961	0.042448	2307	1074
PalmerAlgaeCommunity_Div_BD_RA_RDA1_bray	43	1197.58	357.9805	4006.36	0.080867	2307	1074
PalmerAlgaeCommunity_Taxa1_BD_RDA2_bray	43	1327.934	890.6888	1979.825	0.000114	612	114
DriftCommunity_Mgroup_RA_RDA2_bray	29	1360.526	470.0729	3937.755	0.013661	2307	1074
EmergeCommunity_Mgroup_RDA1_bray	30	1369.95	450.1112	4169.553	0.01585	2307	1074

Table S10: Rank order of EC_{50} system Level measures used in RSD. Bray= Bray-Curtis Distance Measure, MDS1= RDA1/2=Axis1/2 scores from redundancy analysis, and Sum=Summed over all sampling events after dosing begins. Other abbreviations are defined in main text.

System-level Response	ETD	EC_{50}	EC_{50}_lower	EC_{50}_upper	ANOVA_pval	LOEC	NOEC
		DWB					
DriftCommunity_Taxa1_Sum_RDA1_bray	856	780.4385481	196.8095	3094.791	0.0240224	1543	1265
OM (Periphyton organic content, %)	15	826.1573305	336.1654	2030.358	0.0047039	1265	798
DeadDiatoms	15	877.9492151	507.347	1519.266	0.0246981	1543	1265
Emerge_Total	57	890.5666958	517.0206	1533.999	0.0051312	1265	798
AFDM (Periphyton Ash Free Dry Mass)	15	1033.917231	684.6852	1561.279	0.0243556	1543	1265
Ave_OM	4356	1273.705855	1113.739	1456.649	0.0532101	NA	3505
Emerge_Total	43	1455.082308	1067.541	1983.31	0.0390334	NA	3505
GravelCommunity_Mgroup_Sum_RA_RDA2_bray	856	1477.877164	886.5241	2463.691	0.00245	798	114
TotalBP (Periphtyon Dry Weight)	15	1557.029517	1441.735	1681.544	0.0047239	3505	1543
GravelCommunity_Taxa1_Sum_RA_RDA1_bray	856	1606.218881	1078.983	2391.085	0.000523	798	114
EmergeCommunity_Mgroup_Sum_brayDistance	957	1617.686392	980.6421	2668.567	0.0128011	1543	1265
Chla (Periphyton Chlorophyll)	4356	1620.578053	1065.838	2464.045	0.0003648	798	114
Drift_Total	56	1692.653058	644.8153	4443.248	0.0206436	3505	1543
		MTM					
Drift_Total	22	355.8513648	28.94474	4374.895	2.18E-03	612	114
Emerge_Sum_Total	957	437.454934	65.37209	2927.348	0.0043628	612	114
Emerge_Total	37	459.2617966	155.8627	1353.251	0.0017455	612	114
GravelCommunity_Taxa1_Sum_RDA1_bray	856	512.8102267	84.96645	3095.037	0.0008569	612	114
EmergeCommunity_Mgroup_Sum_RA_RDA1_bray	957	555.0780317	168.2684	1831.072	0.0034249	612	114
AFDM (Periphyton Ash Free Dry Mass)	1529	572.8924869	80.73202	4065.373	0.0059468	612	114
Emerge_Total	16	605.6249135	150.8561	2431.333	0.0407376	1074	612
TotalBP	2	613.3016791	443.4295	848.2497	0.0277831	1074	612
Emerge_Total	30	667.1517541	141.6382	3142.452	0.0026337	612	114
OM (Periphyton organic content, %)	29	883.50588	657.5539	1187.101	0.0007306	612	114
Emerge_Total	23	949.5244055	405.8624	2221.434	0.0335795	1074	612
Chla (Periphyton Chlorophyll)	1529	956.5418621	293.1926	3120.721	0.0636126	2307	1074
Drift_Total	2	1065.543739	686.3337	1654.273	0.0447	2307	1074
Gravel_Total	56	1071.995764	723.5831	1588.173	0.1856877	NA	2307
DriftCommunity_Taxa1_Sum_RA_RDA1_bray	856	1101.836558	700.5867	1732.896	0.0020471	1074	612
DriftCommunity_Mgroup_Sum_RA_RDA1_bray	856	1131.934639	690.0058	1856.906	0.0029318	1074	612
TotalBP (Periphtyon Dry Weight)	1529	1273.66012	872.8017	1858.624	0.0002201	612	114

Table S11. Hazard concentrations estimated at the 5th, 10th, and 20th percentiles of respective RSDs with 95% confidence intervals based on best fit distribution function by recipe and level of ecological organization. All results are based on fits of gamma distribution function except Log logistic was used for DWB Taxa-level SpCond and IS, and lognormal was selected for MTM System level IS. Best fits based on log likelihood.

RSD	HCx	SpCond (µS/cm)		IS (mM)	
		DWB	MTM	DWB	MTM
Taxa-level	HC_5	561 (440, 710)	308 (230, 412)	7.149 (5.896, 8.659)	3.540 (2.087, 6.028)
	HC_10	679 (558, 823)	392 (310, 500)	8.270 (7.096, 9.719)	5.107 (3.377, 7.839)
	HC_20	835 (711, 977)	514 (426, 625)	9.686 (8.573, 11.050)	7.629 (5.489, 10.742)
Community-Level	HC_5	777 (646, 934)	603 (507, 734)	7.660 (6.432, 9.277)	10.302 (8.392, 13.116)
	HC_10	870 (742, 1018)	673 (576, 797)	8.566 (7.361, 10.098)	11.678 (9.768, 14.277)
	HC_20	993 (872, 1132)	764 (678, 883)	9.760 (8.571, 11.152)	13.509 (11.624, 15.926)
System-Level	HC_5	763 (577, 997)	372 (271, 527)	7.564 (5.801, 10.079)	7.012 (5.301, 10.352)
	HC_10	857 (676, 1073)	439 (338, 589)	8.476 (6.807, 10.726)	8.412 (6.499, 11.813)
	HC_20	982 (808, 1184)	531 (427, 676)	9.679 (8.110, 11.785)	10.487 (8.284, 13.995)

Table S12. PRC analyses' taxa loading (in parentheses) ranked largest to smallest. Loadings correspond with taxa effects plotted on secondary y-axes in Figures 7, S2 and S3.

Periphtic Algae_DWB	Periphytic Algae_MTM	Gravel Invertebrates_DWB	Gravel Invertebrates_MTM	Drift Invertebrates_DWB	Drift Invertebrates_MTM	Emergence_DWB	Emergence_MTM
Melosira (0.724)	Melosira (0.563)	Tanytarsini (0.501)	Physa (0.487)	Tanytarsini (0.4493)	Physa (1.1047)	OtherInsect (-0.0048)	Chironomids (1.2532)
Cocconeis (0.574)	Oscillatoria (0.414)	Physa (0.381)	Stenelmis (0.296)	Copepoda (0.302)	Elmidae (0.1677)	Diptera (-0.1131)	Ephemeroptera (0.8594)
Rhoicosphenia (0.347)	Cocconeis (0.371)	Corbicula (0.144)	Copepoda (0.156)	Physa (0.2944)	Copepoda (0.1512)	Trichoptera (-0.3918)	Trichoptera (0.8473)
Navicula (0.226)	Rhoicosphenia (0.277)	Tanypodinae (0.101)	Cheumatopsyche (0.121)	Ukn Chironomidae (0.2072)	Chironomini (0.1225)	Chironomids (-0.7573)	Diptera (0.0352)
Synedra (0.206)	Synedra (0.197)	Stenelmis (0.074)	Tricorythodes (0.1)	Tanypodinae (0.1581)	Turbellaria (0.1172)	Ephemeroptera (-1.2541)	OtherInsect (0)
Amphora (0.094)	Navicula (0.164)	Hydropsychidae (0.066)	Elmidae (0.098)	Chironomini (0.093)	Ukn Ephemeroptera		
UknFilamentousBG	Amphora (0.049)	Chironomini (0.043)	Hydra (0.091)	Ukn Trichoptera (0.074)	Ukn Trichoptera (0.0829)		
Oscillatoria (0.071)	Gomphonema (0.045)	Elmidae (0.042)	Coenagrionidae (0.069)	Elmidae (0.0721)	Tanypodinae (0.0766)		
Cymbella (0.056)	Cymbella (0.044)	Pleuroceridae (0.041)	Corbicula (0.064)	Hydroptila (0.0559)	Stenelmis (0.0759)		
Gomphonema (0.056)	Homoeothrix (0.029)	Chimarra (0.04)	Psephenus (0.041)	Ukn Ephemeroptera (0.051)	Ceratopsyche (0.0674)		
Homoeothrix (0.054)	UknFilamentousBG (0.020)	Ukn Chironomidae (0.04)	Lirceus (0.036)	Ceratopsyche (0.0336)	Cheumatopsyche (0.0521)		
Gyrosigma (0.049)	Nitzschia (0.018)	Coenagrionidae (0.025)	Caenis (0.032)	Nematoda (0.0308)	Ukn Chironomidae (0.0467)		
Stigeoclonium (0.027)	Stigeoclonium (0.014)	Turbellaria (0.022)	Perlidae (0.032)	Stenelmis (0.0265)	Heptageniidae (0.0428)		
Nitzschia (0.023)	Achnanthes (0.011)	Cheumatopsyche (0.017)	Ceratopogonidae (0.032)	Caenis (0.0176)	Orthocladiinae (0.0364)		
Achnanthes (0.016)	Fragilaria (0.005)	Hydroptila (0.01)	Petrophila (0.024)	Baetidae (0.0135)	Coenagrionidae (0.0291)		
Tryblionella (0.005)	BasalCellsBG (0.003)	Tricorythodes (0.009)	Nematoda (0.022)	Ukn Diptera (0.0126)	Hydropsychidae (0.0209)		
Scenedesmus (0.003)	Scenedesmus (0.000)	Nematoda (0.007)	Antocha (0.019)	Hydropsychidae (0.0124)	Helicopsyche borealis (0.0191)		
BasalCellsBG (0.002)	Merismopedia (-0.0003)	Oecetis (0.004)	Oecetis (0.012)	Ceratopogonidae (0.0062)	Simulium (0.0174)		
Fragilaria (0.0007)	Chroococcus (-0.0004)	Mooreobdella (0.001)	Neureclipsis (0.007)	Heptageniidae (0.0004)	Chimarra (0.0171)		
Chroococcus (0.0002)	Surirella (-0.001)	Hydra (0.001)	Ukn Chironomidae (0.005)	Pleidae (0)	Ukn Diptera (0.0158)		
Merismopedia (0.0002)	Tryblionella (-0.005)	Petrophila (0)	Cladocera (0.002)	Turbellaria (-0.0053)	Caenis (0.0098)		
Surirella (-0.0003)	Gyrosigma (-0.012)	Neureclipsis (-0.003)	Berosus (0)	Coenagrionidae (-0.0063)	Nematoda (0.0098)		
Amphipleura (-0.003)	Amphipleura (-0.015)	Ceratopogonidae (-0.004)	Helicopsyche (-0.004)	Helicopsyche borealis (-	Baetidae (0.0092)		
Compsopogon (-0.643)	Cladophora (-0.438)	Antocha (-0.006)	Ukn Ephemeroptera (-0.008)	Tricorythodes (-0.0082)	Tricorythodes (0.0043)		
Cladophora (-1.159)	Compsopogon (-1.247)	Simulium (-0.006)	Empididae (-0.01)	Simulium (-0.0106)	Hydra (0.0041)		
		Empididae (-0.007)	Tanypodinae (-0.011)	Leptoceridae (-0.0156)	Pleidae (0)		
		Lirceus (-0.007)	Simulium (-0.015)	Chimarra (-0.0232)	Leptoceridae (-0.002)		
		Perlidae (-0.01)	Sphaeriidae (-0.015)	Cheumatopsyche (-0.0239)	Ceratopogonidae (-0.0039)		
		Caenis (-0.011)	Mooreobdella (-0.017)	Cladocera (-0.0261)	Fossaria (-0.0079)		
		Berosus (-0.012)	Ceratopsyche (-0.029)	Fossaria (-0.0265)	Hydroptila (-0.0129)		
		Ukn Ephemeroptera (-0.013)	Pleuroceridae (-0.034)	Hydra (-0.0355)	Planorbidae (-0.0202)		
		Sphaeriidae (-0.017)	Fossaria (-0.037)	Planorbidae (-0.0431)	Ferrissia (-0.0356)		
		Baetidae (-0.02)	Chimarra (-0.039)	Menetus (-0.0527)	Tanytarsini (-0.0389)		
		Helicopsyche (-0.024)	Leptoceridae (-0.043)	Ferrissia (-0.0681)	Menetus (-0.039)		
		Cladocera (-0.027)	Heptageniidae (-0.044)	Orthocladiinae (-0.0735)	Cladocera (-0.0774)		
		Psephenus (-0.029)	Tanytarsini (-0.044)	Ostracoda (-0.1759)	Ostracoda (-0.1523)		
		Leptoceridae (-0.029)	Baetidae (-0.05)	Naididae (-0.9519)	Naididae (-1.2248)		
		Fossaria (-0.037)	Orthocladiinae (-0.051)				
		Planorbidae (-0.043)	Hydropsychidae (-0.054)				
		Menetus (-0.043)	Hydroptila (-0.067)				
		Heptageniidae (-0.066)	Chironomini (-0.072)				
		Copepoda (-0.093)	Planorbidae (-0.076)				
		Ceratopsyche (-0.116)	Menetus (-0.096)				
		Orthocladiinae (-0.131)	Prostoma (-0.123)				
		Prostoma (-0.142)	Turbellaria (-0.211)				
		Ostracoda (-0.162)	Ferrissia (-0.306)				
		Ferrissia (-0.229)	Ostracoda (-0.316)				
		Naididae (-0.899)	Naididae (-0.801)				

Table S13. HC_x equivalences estimated based on the observed ionic composition of each of the dosed recipes.

RSD	HCx	SpCond (µS/cm)		IS (mM)		TDS (mg/l)		Cl^- (mg/l)		SO_4^{2-} (mg/l)		HCO_3^- (mg/l)		Ca^{2+} (mg/l)		Na^+ (mg/l)		Mg^{2+} (mg/l)	
		DWB	MTM	DWB	MTM	DWB	MTM	DWB	MTM	DWB	MTM	DWB	MTM	DWB	MTM	DWB	MTM	DWB	MTM
Taxa-level	HC_5	561	308	7.14	3.54	364	196	115	15.6	8.83	55.9	55.02	65.84	27.59	23.99	43.26	11.18	5.82	11.01
	HC_10	679	392	8.27	5.10	444	264	147	19.0	8.80	93.1	55.02	70.15	33.13	25.21	55.59	14.43	6.36	16.27
	HC_20	835	514	9.68	7.62	550	362	191	23.6	8.80	147.1	55.02	76.41	40.46	26.97	71.89	18.13	7.08	25.39
Community-Level	HC_5	777	603	7.66	10.3	511	433	174	26.7	8.79	186.5	55.02	80.98	37.74	28.25	65.83	20.18	6.81	33.05
	HC_10	870	673	8.56	11.6	574	490	200	29.1	8.80	217.5	55.02	84.58	42.10	29.26	75.55	21.47	7.24	39.62
	HC_20	993	764	9.76	13.5	658	563	235	32.0	8.80	257.8	55.02	89.25	47.88	30.57	88.40	22.80	7.80	48.81
System-Level	HC_5	763	372	7.56	7.01	501	247	171	18.2	8.81	84.3	55.02	69.13	37.08	24.92	64.37	13.71	6.75	14.93
	HC_10	857	439	8.47	8.41	565	302	197	20.8	8.80	113.9	55.02	72.57	41.49	25.88	74.19	15.99	7.18	19.58
	HC_20	982	531	9.67	10.4	650	376	232	24.2	8.80	154.6	55.02	77.29	47.37	27.21	87.25	18.56	7.75	26.79
Single-Species Tests	Lowest EC_{50}	1098	683	10.72	12.56	729	498	265	29.4	8.77	221.9	55.02	85.09	52.81	29.40	99.37	21.63	8.28	40.60
	Low LOEC	883	479	9.00	8.00	583	334	204	22.3	8.79	131.6	55.02	74.62	42.72	26.46	76.91	17.18	7.30	22.60

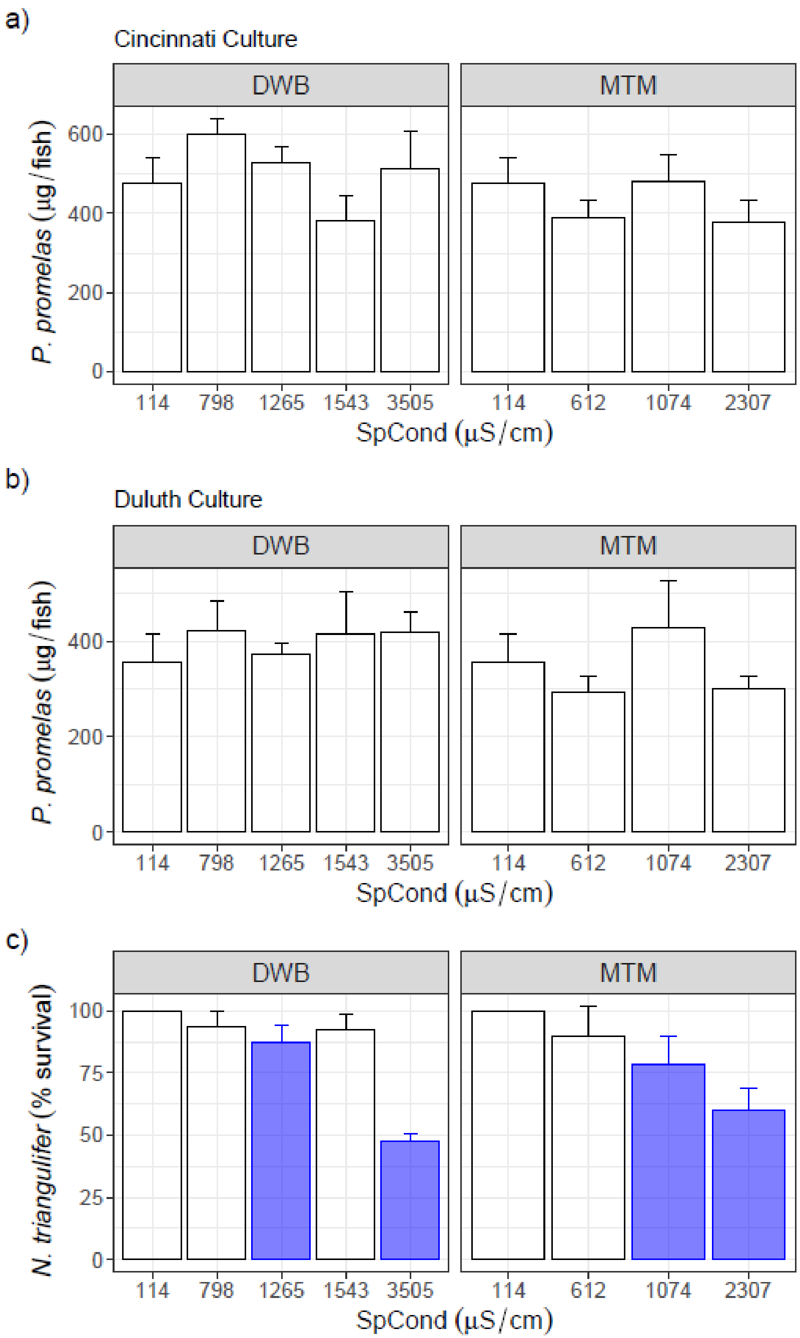

Figure S1. Single-Species ex situ tests. Growth rate responses for *P. promelas* from Cincinnati(a) and Duluth (b) cultures. And *N. triangulifer* % survival results (c). Colored bars denote significant difference from control (*p<0.05*). N=four per dose.

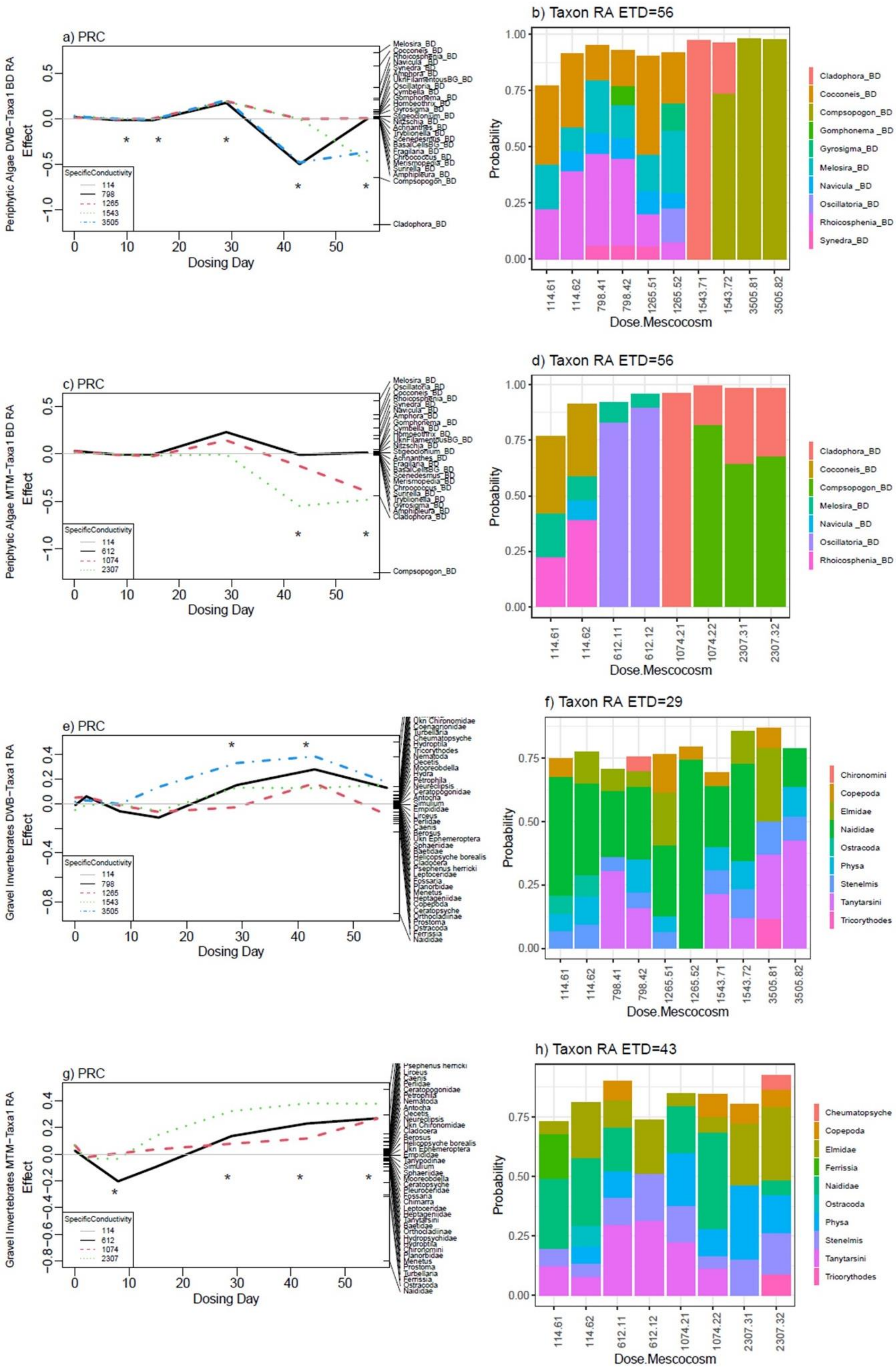
a) PRC
Periphytic Algae DWB-Taxa1 BD RA
Effect
Dosing Day
SpecificConductivity
114
798
1265
1543
3505
Cladophora_BD
Compsopogon_BD
b) Taxon RA ETD=56
Probability
Dose.Mescocosm
Cladophora_BD
Cocconeis_BD
Compsopogon_BD
Gomphonema _BD
Gyrosigma_BD
Melosira_BD
Navicula _BD
Oscillatoria_BD
Rhoicosphenia_BD
Synedra_BD
114.61
114.62
798.41
798.42
1265.51
1265.52
1543.71
1543.72
3505.81
3505.82
c) PRC
Periphytic Algae MTM-Taxa1 BD RA
Effect
Dosing Day
SpecificConductivity
114
612
1074
2307
Compsopogon_BD
d) Taxon RA ETD=56
Probability
Dose.Mescocosm
Cladophora_BD
Cocconeis_BD
Compsopogon_BD
Melosira_BD
Navicula _BD
Oscillatoria_BD
Rhoicosphenia_BD
114.61
114.62
612.11
612.12
1074.21
1074.22
2307.31
2307.32
e) PRC
Gravel Invertebrates DWB-Taxa1 RA
Effect
Dosing Day
SpecificConductivity
114
798
1265
1543
3505
f) Taxon RA ETD=29
Probability
Dose.Mescocosm
Chironomini
Copepoda
Elmidae
Naididae
Ostracoda
Physa
Stenelmis
Tanytarsini
Tricorythodes
114.61
114.62
798.41
798.42
1265.51
1265.52
1543.71
1543.72
3505.81
3505.82
g) PRC
Gravel Invertebrates MTM-Taxa1 RA
Effect
Dosing Day
SpecificConductivity
114
612
1074
2307
h) Taxon RA ETD=43
Probability
Dose.Mescocosm
Cheumatopsyche
Copepoda
Elmidae
Ferrissia
Naididae
Ostracoda
Physa
Stenelmis
Tanytarsini
Tricorythodes
114.61
114.62
612.11
612.12
1074.21
1074.22
2307.31
2307.32

Figure S2. PRC results in the graphs in the left column plot the same data as shown in Figure 7, main text for the periphytic algae (**a**, **c**) and gravel invertebrate communities (**e**, **g**). In the right column are bar graphs of dominant taxa relative abundance (**b**, **d**, **f**, and **h**), i.e., one example of taxa dominance distributions across doses from one of the sampling dates during the experiment, and when the permutation tests provided evidence for at least one difference in the RDA axis among the different doses on the day sampled (asterisks in plots in the left column). Relative rankings of taxa loadings on secondary y-axis (See Table 12). ETD = elapsed days since dosing began. Taxa less than 5% of RA were

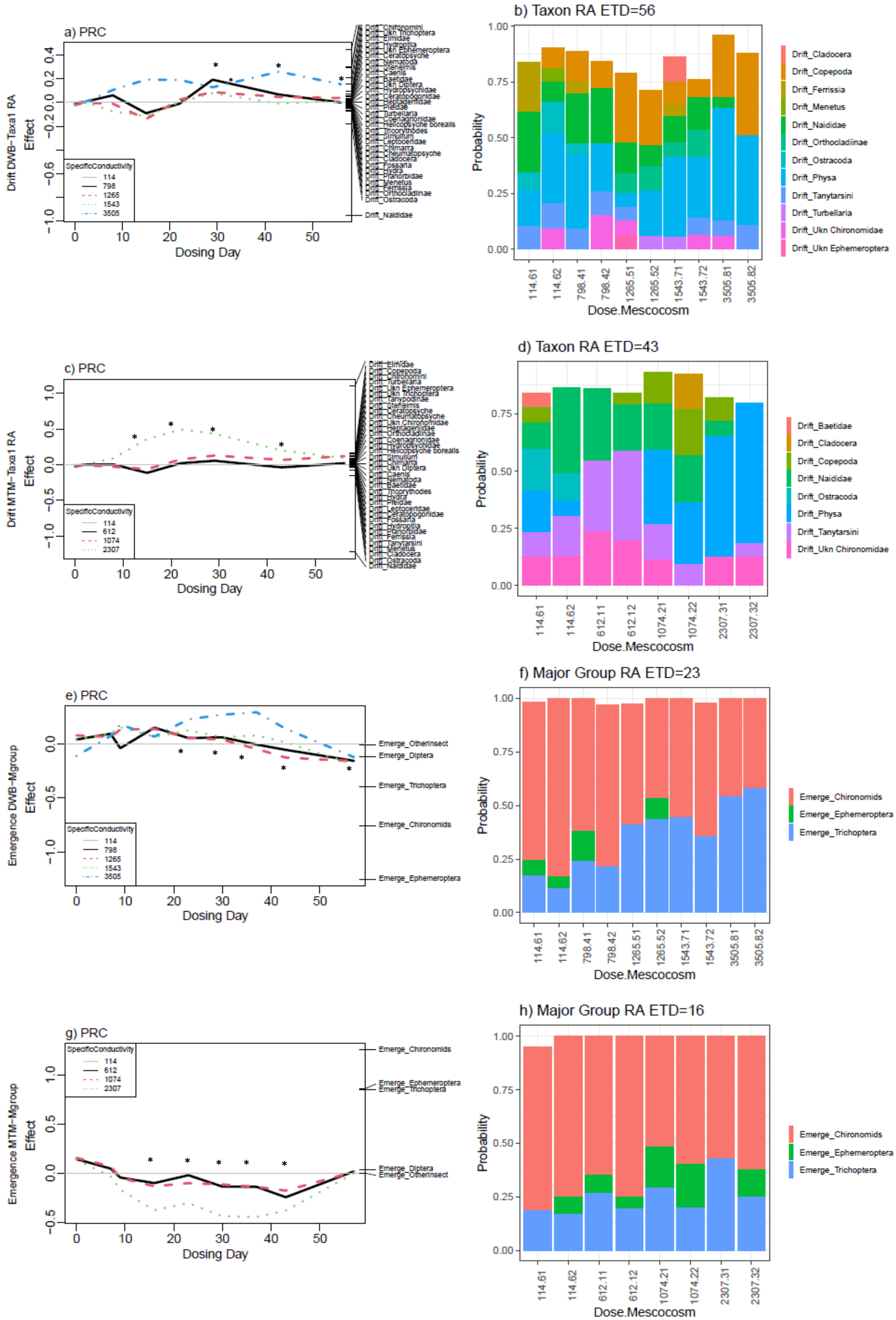
a) PRC
Drift DWB-Taxa1 RA
Effect
Dosing Day
SpecificConductivity
114
798
1265
1543
3505
Drift_Naididae
b) Taxon RA ETD=56
Probability
Dose.Mescocosm
114.61
114.62
798.41
798.42
1265.51
1265.52
1543.71
1543.72
3505.81
3505.82
Drift_Cladocera
Drift_Copepoda
Drift_Ferrissia
Drift_Menetus
Drift_Naididae
Drift_Orthocladiinae
Drift_Ostracoda
Drift_Physa
Drift_Tanytarsini
Drift_Turbellaria
Drift_Ukn Chironomidae
Drift_Ukn Ephemeroptera
c) PRC
Drift MTM-Taxa1 RA
Effect
Dosing Day
SpecificConductivity
114
612
1074
2307
d) Taxon RA ETD=43
Probability
Dose.Mescocosm
114.61
114.62
612.11
612.12
1074.21
1074.22
2307.31
2307.32
Drift_Baetidae
Drift_Cladocera
Drift_Copepoda
Drift_Naididae
Drift_Ostracoda
Drift_Physa
Drift_Tanytarsini
Drift_Ukn Chironomidae
e) PRC
Emergence DWB-Mgroup
Effect
Dosing Day
SpecificConductivity
114
798
1265
1543
3505
Emerge_OtherInsect
Emerge_Diptera
Emerge_Trichoptera
Emerge_Chironomids
Emerge_Ephemeroptera
f) Major Group RA ETD=23
Probability
Dose.Mescocosm
114.61
114.62
798.41
798.42
1265.51
1265.52
1543.71
1543.72
3505.81
3505.82
Emerge_Chironomids
Emerge_Ephemeroptera
Emerge_Trichoptera
g) PRC
Emergence MTM-Mgroup
Effect
Dosing Day
SpecificConductivity
114
612
1074
2307
Emerge_Chironomids
Emerge_Ephemeroptera
Emerge_Trichoptera
Emerge_Diptera
Emerge_OtherInsect
h) Major Group RA ETD=16
Probability
Dose.Mescocosm
114.61
114.62
612.11
612.12
1074.21
1074.22
2307.31
2307.32
Emerge_Chironomids
Emerge_Ephemeroptera
Emerge_Trichoptera

Figure S3. PRCs for community-level measures of drift and emergence for DWB and MTM recipes in the left column of graphs: DWB and MTM drift (**a** and **c**, respectively) and emergence (**e** and **g**, respectively). Examples of dominant taxa abundance distributions plotted as bar graphs in right column (**b**, **d**, **f** and **h**). Content and treatment of data same as in Figure S2.

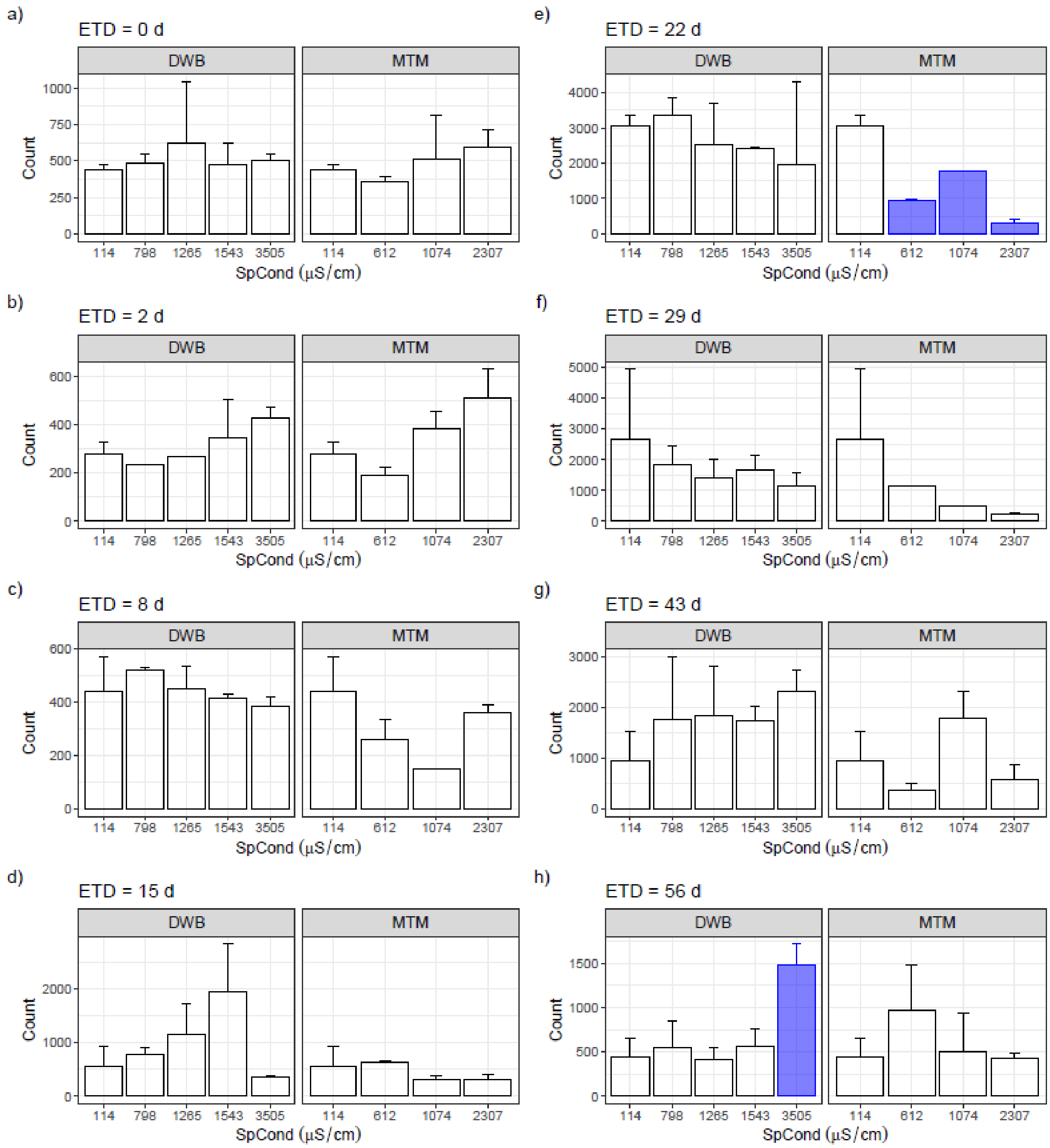

Figure S4. Drifting invertebrate results (total count) collected at different time points, graphs **a – h**. Colored bars denote significant difference from control (*p<0.05*). N=two per dose. ETD = 2 is equivalent to 24hr drift collection.

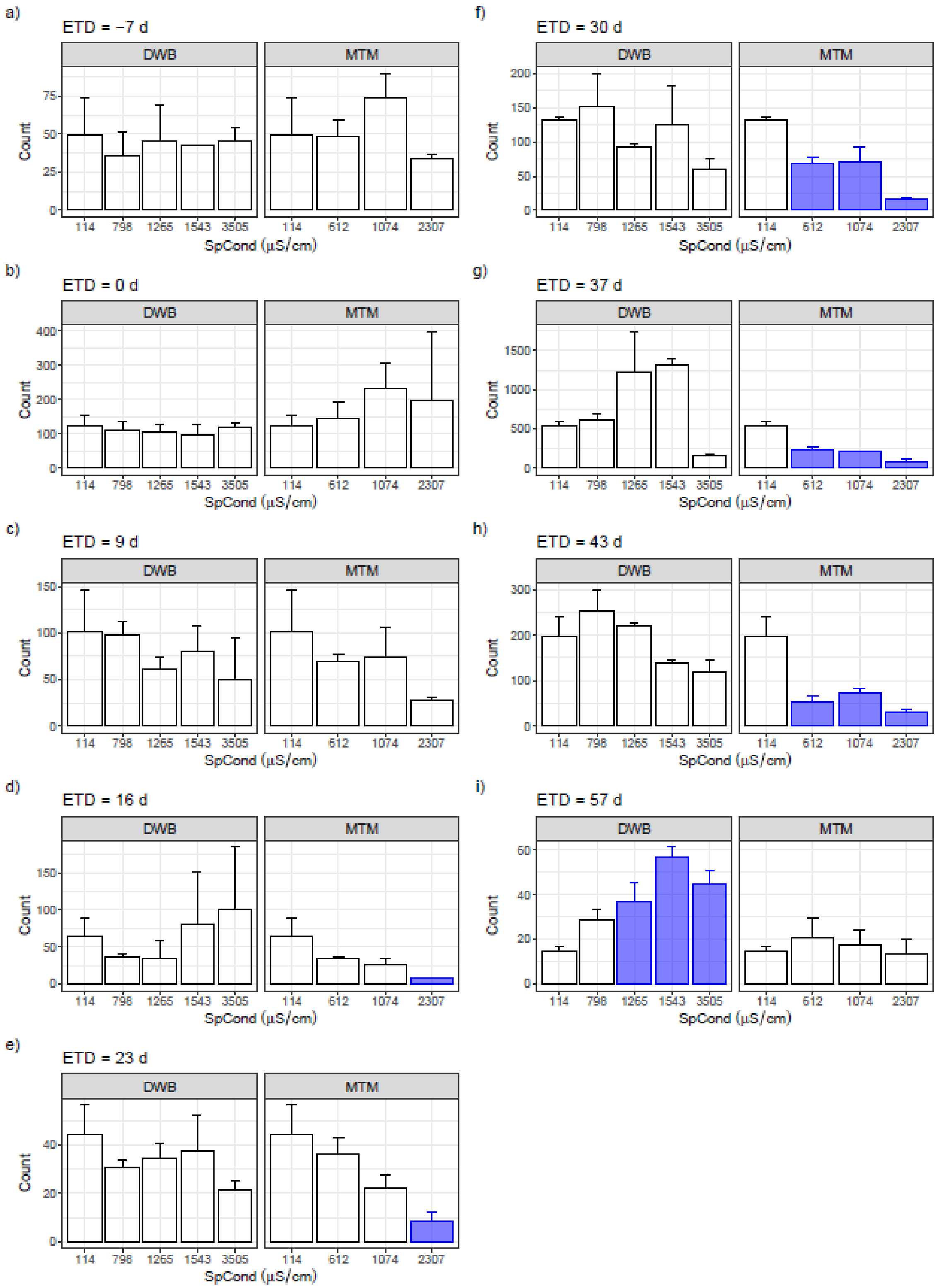

Figure S5. Adult Insect Emergence results (total count) collected at different time points: graphs **a – i**. Colored bars denote significant difference from control (*p<0.05*). N=two per dose. ETD = −7 denotes 7 days prior to the beginning of dosing.

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