

Recognition of stream drying based on benthic macroinvertebrates: a new tool in Central Europe

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1 Abstract

2 Many streams in the extensive Central European region have an intermittent flow regime.
3 Conventional hydrological methods used to identify zero-flow conditions, and in particular
4 drying events, have limited use when assessing large areas dominated by low-order streams.
5 We developed a novel multimetric index to recognise antecedent stream drying based on
6 the analysis of benthic macroinvertebrate communities. The data used to develop the index
7 were collected in pristine streams with different flow permanence regimes between 2012
8 and 2014, using standard sampling methods for ecological status assessment. The data
9 include 64 perennial, 19 near-perennial and 27 intermittent benthic macroinvertebrate
10 samples. Metrics considered for the index included variables based on (i) the occurrence of
11 indicator taxa, (ii) the proportion of biological and ecological traits, and (iii) structural
12 community metrics. Linear discriminant analysis identified the metric combinations that best
13 discriminated among the three flow permanence categories. Different metrics were used in
14 the final multimetric index calculation for the autumn and spring season that followed
15 stream drying. In both seasons, the index included the proportion of indicator taxa and the
16 proportion of taxa with high body flexibility. In addition, the autumn index included the
17 proportion of taxa with a preference for organic substrates, whereas in spring the index
18 included total abundance. Independent data from regulatory monitoring activity were used
19 to validate the accuracy of the index. The correct classification of independent samples was
20 92% and 96% for samples from perennial and non-perennial sites, respectively. The index
21 can be calculated using data collected by routine monitoring programmes used to assess
22 ecological status and provides information about stream intermittence where conventional
23 hydrological monitoring is limited. As intermittent streams increase in extent in global
24 regions including Central Europe, the tool may be of particular interest to those who use
25 invertebrates to monitor or manage these ecosystems.

26

27 1. Introduction

28 Intermittent rivers and ephemeral streams (i.e. streams with periodic flow cessation and/or
29 drying; IRES) are mostly associated with arid and semi-arid regions. However, they are also
30 common and widespread in temperate and continental regions with cooler, wetter climates
31 (Datry, et al. 2014a; Stubbington et al., 2017). IRES are typically managed using methods
32 developed for perennial waterways, or as if they were part of the terrestrial ecosystems
33 (Acuña et al., 2014; Stubbington et al., 2018), and the need for more effective policies and
34 management strategies has been highlighted around the world (Datry et al., 2017; Marshall
35 et al., 2018). In the European Union, a major objective for water management is the
36 assessment of ecological status in water bodies, to meet the legislative requirements of the
37 EU Water Framework Directive (European Commission, 2000). The characterisation of
38 'biological quality elements' such as benthic macroinvertebrates is one important approach
39 used to evaluate ecological status.

40

41 Aquatic macroinvertebrates are routinely used as indicator organisms for determining
42 ecological status and diagnosing specific environmental pressures (e.g. Rosenberg and Resh,
43 1993; Birk et al., 2012). However, even short-term (i.e. days to weeks) stream drying can
44 substantially alter benthic macroinvertebrate community composition (Datry et al., 2014b;

45 Hille et al., 2014; Lancaster and Ledger, 2015). The interpretation of ecological status based
46 on metrics developed in perennial streams can thus be misleading (Munné and Prat, 2009;
47 Menció and Mas-Pla, 2010; Wilding et al., 2018). Information about flow permanence is
48 crucial to accurately interpret data used to evaluate status and thus inform effective IRES
49 management. In addition, knowledge about stream intermittence is needed, to anticipate
50 the effects of climate change, to assess human pressures such as water abstraction and to
51 manage protected species and habitats (Wilby et al., 2010).

52 Using flow gauging stations to monitor the flow permanence of small streams is expensive
53 and technically impractical, because small streams (Strahler orders 1-4) comprise a
54 substantial part of the stream network length (e.g. 92% in Czech Republic; Zahrádková et al.,
55 2015). Moreover, even where hydrological data are collected, they may not distinguish
56 between lentic and dry zero-flow conditions, and alternative methods are therefore needed
57 to recognize IRES and characterize their water regimes (Gallart et al., 2016; Beaufort et al.,
58 2018), for example using stream biota. Loss of surface water acts as an ecological filter (Poff
59 1997) and benthic macroinvertebrates have taxon-specific quantitative responses to drying
60 (Datry et al., 2014b; Leigh and Datry, 2017). Dry phases can therefore be detected through
61 both structural (i.e. taxonomic) and functional (i.e. trait-based) changes in community
62 composition (Bogan et al., 2013; Schriever et al., 2015; Leigh et al., 2016; Chadd et al., 2017).
63 Presence/absence of indicator taxa of benthic invertebrates has also been used to recognize
64 stream flow duration (NC Division of Water Quality, 2010; Nadeau, 2015), and both
65 taxonomic structure and species trait information have been used to assess flow
66 connectivity in Mediterranean regions (Cid et al., 2016). Such tools may enable the data
67 routinely collected during biomonitoring programmes to provide information about flow
68 intermittence, even if hydrological data are absent. However, no method to detect drying
69 events has been developed for the extensive continental-climate region of Central Europe.

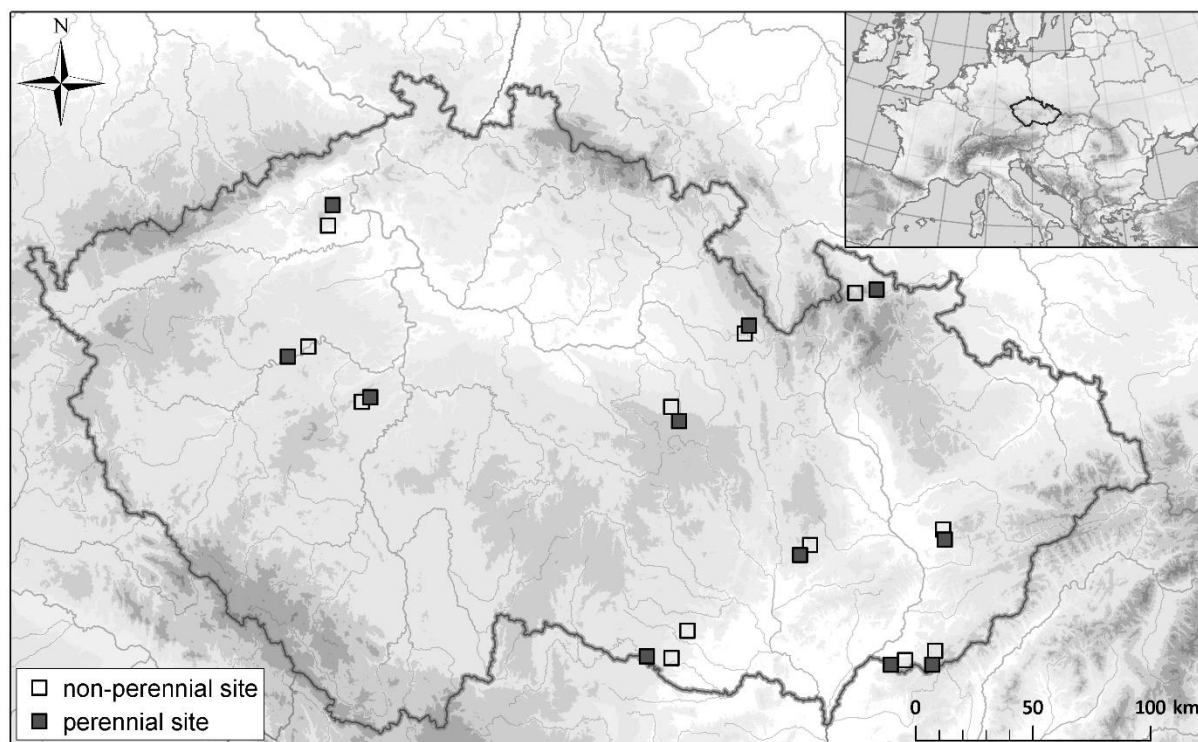
70 Different metrics can be sensitive to different aspects of stream drying, and a combination of
71 structural, functional and indicator-taxa metrics may therefore provide robust and sensitive
72 insight into the responses of an assemblage to drying (Li et al., 2010). Here, our aim was to
73 develop and test a new multimetric index to identify antecedent stream drying events based
74 on the structural and functional composition of benthic macroinvertebrate communities. We
75 evaluated three groups of metrics as indicators of stream drying: (i) the occurrence of
76 indicator taxa; (ii) the proportion of biological and ecological traits; and (iii) structural
77 community metrics. We identified the metrics and metric combinations that most effectively
78 indicated antecedent stream drying.

79 **2. Materials and Methods**

80 **2.1. Study area**

81 The study was conducted in 23 small (order 2-4) streams in the Czech Republic (Fig. 1). All
82 were classified as reference streams, i.e. exposed to minimal anthropogenic impacts.
83 Catchment land use was dominated by woodland, with smaller proportions of agricultural
84 land, and with at least 10-m riparian buffer strips of deciduous bushes and trees. The study
85 area has a warm-summer humid continental climate (Köppen-Geiger classification *Dfb*; Peel
86 et al., 2007) and spans the Hercynian (17 streams) and West-Carpathian (6 streams)
87 biogeographical subprovinces (Culek, 2013), which approximately correspond with

88 ecoregions 9 (Central Highlands) and 10 (Carpathians; Illies, 1967). To facilitate comparison
 89 of macroinvertebrate communities from different sites, streams were paired, with each pair
 90 comprising one non-perennial and one perennial stream of comparable altitude, size,
 91 geology and hydromorphology. In one case, a single perennial stream was paired with two
 92 non-perennial streams. A sampling site representative of typical conditions was selected in
 93 each stream. The altitude of the sampling sites ranged from 250 m to 560 m a.s.l. and the
 94 maximum distance between paired sites was 13 km.



95

96 **Fig. 1.** Location of the study sites in the Czech Republic. Open squares represent non-
 97 perennial (i.e. near-perennial and intermittent) sites and filled squares represent perennial
 98 sites.

99 2.2. Sampling strategy

100 Benthic macroinvertebrate assemblages were sampled in spring (March-April) in 2013 and
 101 2014 and in autumn (September-October) in 2012, 2013 and 2014. Proportional multi-
 102 habitat three-minute kick samples were collected with a hand net (25 × 25 cm aperture, 0.5-
 103 mm mesh size) according to the standard method used for ecological status assessments in
 104 the Czech Republic (Kokeš et al., 2006; Kokeš and Němejcová, 2006). Samples were
 105 preserved in 4% formaldehyde and processed in the laboratory. All macroinvertebrates were
 106 identified to the lowest possible taxonomic level: 292 out of 421 to species level, 117 to
 107 genus level, and the remaining 12 to a higher taxonomic level.

108

109 Sites were classified as non-perennial or perennial a priori, based on expert knowledge. In
 110 addition, observed instream conditions were recorded from summer 2012 to autumn 2014,
 111 including determination of the dry period duration using a water-level logger (Solinst
 112 Levelogger Edge) and photo-trap (Acorn 5310MG) installed at each site. Each water-level

113 logger was placed in the lowest part of the streambed, to account for the persistence of
114 surface water in isolated pools. Photo-traps were installed in trees in the adjacent riparian
115 zone (at 3 m height) and were facing a water-level gauge board. Logger and photo-trap data
116 were collected every 15 minutes and every 4 hours, respectively.

117
118 We divided individual samples into three intermittence categories: *perennial*, *intermittent*
119 and an intermediate *near-perennial* category. The allocation of samples into the three
120 categories was based primarily on the dry period duration: i) perennial sites were defined as
121 those which experienced more than one year of continuous flow prior to sample collection;
122 ii) near-perennial sites lost surface water for hundreds of meters for <7 d in the summer
123 prior to sampling, with disconnected pools occasionally present; and iii) intermittent sites
124 dried for >1 km for 7-86 d before sampling. The cut-off between near-perennial and
125 intermittent sites was arbitrary, reflecting the gradual nature of stream drying. In total, we
126 collected 27 perennial, 7 near-perennial and 12 intermittent samples in spring and 34
127 perennial, 12 near-perennial and 15 intermittent samples in autumn. Spring samples from
128 intermittent and near-perennial streams were taken 175-224 d after flow resumption and
129 autumn samples were taken 2-63 d after flow resumption.

130 **2.3. Identification of perennial flow indicators and flow intermittence tolerant taxa**

131 To identify taxa associated with either perennial or intermittent streams, we performed
132 Indicator Species Analysis (IndVal; Dufrêne and Legendre, 1997) using samples from spring
133 2013 and autumn 2012 and 2013. IndVal was performed using the `multipatt` function in the
134 R package `indicpecies` (Cáceres and Legendre, 2009), which identifies taxa with a strong
135 association with each group based on their abundance and frequency. The calculated
136 indicator value (IV) of a given taxon for its preferred group ranges from zero (no affinity) to
137 one (strongest affinity). Best-matching patterns were tested for statistical significance of the
138 associations. Taxa significantly associated with either perennial or intermittent and near-
139 perennial samples were considered as reliable indicators and were assigned a reliability
140 value of 2 (see “Proportion of indicator taxa” section). Taxa with non-significant IV but found
141 exclusively in either perennial or intermittent and near-perennial streams in at least 10% of
142 samples were considered as indicators with lower reliability and were assigned a reliability
143 value of 1.

144 To support the IndVal analyses, we conducted a literature review of primary research papers
145 comparing macroinvertebrate assemblages at perennial and non-perennial sites during
146 flowing phases. From these studies, a taxon was identified as indicative of perennial flow if it
147 was absent from intermittent stream assemblages. A taxon was considered as intermittence
148 tolerant if it was found in intermittent stream assemblages. Literature sources describing the
149 autecology of macroinvertebrate taxa were also reviewed to explore taxon-specific
150 responses to intermittence. If a taxon’s relationship with stream intermittence was
151 described once in data-based published sources then the species was assigned a reliability
152 value of 1, and if it was published two or more times, a value of 2 was assigned. The review
153 focused on taxa living in the Czech Republic area; consulted literature is listed in Appendix A.
154 If information in different published sources were contradictory or unclear, then a
155 taxonomic expert decided the reliability of the taxa based on the available evidence.

156 2.4. Metrics used for index development

157 Three groups of potential metrics that indicate flow intermittence were calculated, to inform
158 subsequent development of the multimetric index:

159 i) Proportion of indicator taxa

160 The proportion of indicator taxa was calculated as the sum of the reliability values of
161 perennial flow indicators present in a sample divided by the sum of the reliability values of
162 all (perennial + intermittence-tolerant) indicators present. The proportion of indicators was
163 rescaled to zero and the resultant values are within the range -1 to +1.

$$164 \text{ Proportion of indicator taxa} = \left(\frac{\sum \text{ values of perennial flow indicators}}{\sum \text{ values of all indicators}} \times 2 \right) - 1$$

165 ii) Proportion of macroinvertebrate traits in community

166
167 The macroinvertebrate community was characterized using traits extracted from available
168 databases (IS ARROW, 2014; Schmidt-Kloiber and Hering, 2015), supplemented by
169 information from the literature review and from experts in different taxonomic groups.
170 Information about fine-sediment-sensitive invertebrates was taken from Extence et al.
171 (2013). To describe the ability to penetrate substrata, taxonomic experts assigned each
172 taxon to one of three body flexibility modalities: (i) none, body flexibility is limited by shell or
173 exoskeleton, e.g. molluscs, adult beetles; (ii) low, body is flexible but cannot turn around,
174 e.g. mayflies, stoneflies; (iii) high, body can turn 360 degrees, e.g. Oligochaetes,
175 Chironomidae (Omesová et al. 2008). Preferences for organic substrate were calculated as
176 preferences for pelal (organic mud) and particulate organic matter. For each trait coded in a
177 single-category assignment system or presence/absence assignment system (Schmidt-
178 Kloiber and Hering, 2015), the community-level trait value was calculated as the number of
179 individuals within the trait modality divided by the total macroinvertebrate abundance of a
180 sample. The community-level trait value of traits coded in ten-point assignment system
181 (Schmidt-Kloiber and Hering, 2015) was calculated as the sum of the trait values multiplied
182 by the abundance of each taxon and divided by the total abundance (Schmera et al., 2014).

183 iii) Community structure metrics

184
185 The number of taxa, $\ln(x+1)$ -transformed total abundance, and abundances and proportion
186 in the community of the most abundant higher taxonomic units was calculated for each
187 sample. This was done also for three drying-sensitive taxonomic groups (Bonada et al., 2007;
188 Datry et al., 2014b): the family Heptageniidae, ET taxa (Ephemeroptera and Trichoptera) and
189 EPT taxa (Ephemeroptera, Plecoptera and Trichoptera).

191 2.5. Index development

192 We performed exploratory data analysis to inform later identification of metrics that
193 discriminate among intermittence classes. We used dot charts to assess metric distribution,
194 and pair plots to assess their collinearity. We used nonmetric multidimensional scaling
195 (NMDS) of a Bray-Curtis distance matrix calculated using $\ln(x+1)$ -transformed abundance
196 data to visualize variability in community composition in relation to year, season,
197 subprovince and intermittence. We used the adonis function from the vegan package
198 (Oksanen et al., 2017) to run permutational multivariate ANOVA (PERMANOVA; Anderson,

201) to identify differences in community composition between seasons (*spring, autumn*),
subprovinces (*Hercynian, West-Carpathian*) and intermittence categories (*intermittent, near-*
perennial, perennial). Because only autumn samples were available for 2012, the difference
between years was not tested. One-way ANOVA was used to examine differences in total
abundance and taxa richness between perennial, near-perennial, and intermittent samples.

To reduce the number of potential metrics selected for inclusion in the final multimetric
index (hereafter, the *Biodrought index*) a pre-selection process was conducted. To identify
candidate metrics, values of each potential metric were plotted against intermittence
categories. Those that effectively discriminated between intermittent and perennial samples
were retained as candidate metrics (Table 1), with Mann-Whitney U tests used to identify
differences in metric values between perennial and intermittent samples.

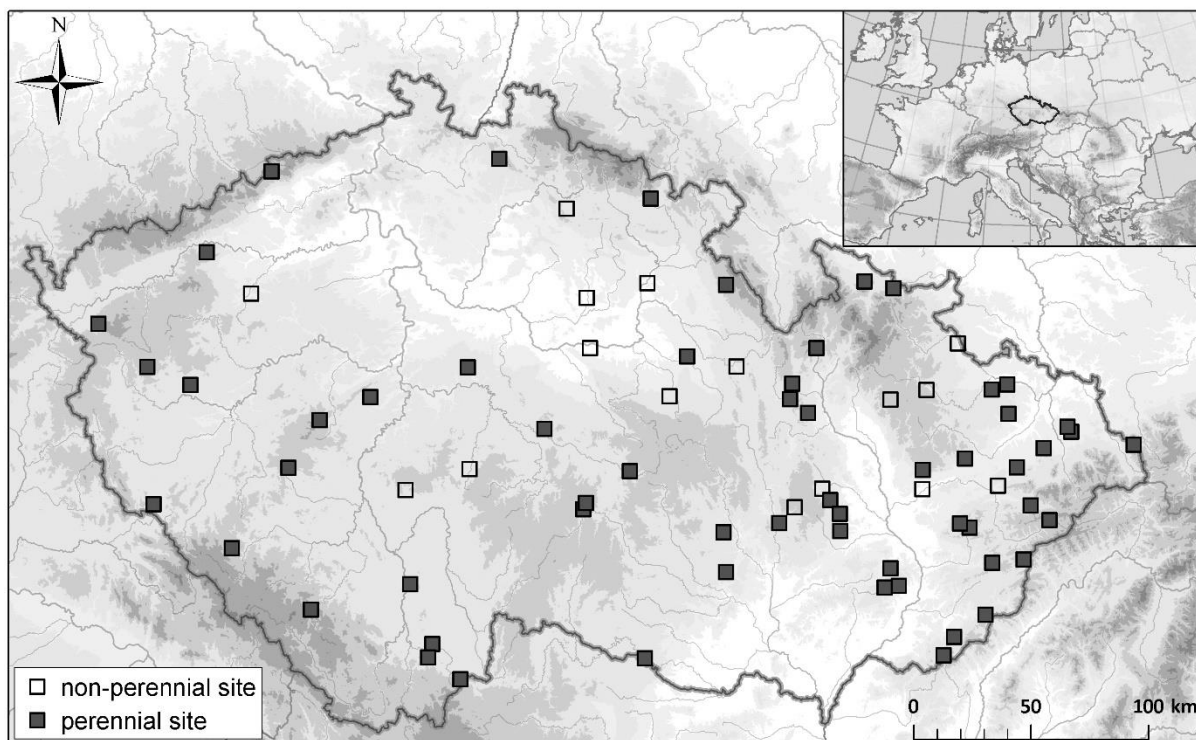
To identify the metric combination that best discriminated among perennial, near-perennial
and intermittent sites, we identified linear combinations of candidate metrics using a
sequence of linear discriminant analyses (LDA). Because macroinvertebrate community
composition differs among seasons (e.g. Straka et al., 2012) we expected different metrics to
reflect stream intermittence in autumn and spring. Therefore, all possible combinations of 2-
4 metrics were tested for their discriminatory power using the leave-one-out cross-
validation procedure (lda function, MASS package; Venables and Ripley, 2002) in each
season. The combination of metrics with the best discrimination power was selected and its
equation noted. The final index is this equation centred to zero and can be used to calculate
a 'discrimination score' for an independent sample. To relate the discrimination score to the
intermittence categories, we calculated discrimination scores for all samples and fitted
probability density functions of a normal distribution to each category, from which the
probability of belonging to each category could be derived. Normality of distribution of LDA
discriminant scores for each sample category was tested by Shapiro-Wilk tests. The effects of
season and sample category on LDA discriminant score were tested using ANOVA. All
statistical analyses and graphs were performed using R open-source software version 3.4.4
(R Core Team, 2018).

2.6. Validation by independent samples

The ability of the index to identify antecedent stream drying was tested on an external
dataset, provided by the former Czech Agricultural Water Management Authority, and
collected using the same method as the original dataset (Kokeš and Němejcová, 2006). The
dataset comprised 117 (59 autumn + 58 spring) samples from 59 perennial sites and 26 (16
autumn + 10 spring) samples from 16 non-perennial sites. We could not distinguish between
intermittent and near-perennial sites, and all samples for at which stream drying was
observed were therefore classified as non-perennial. Samples were taken from 2nd to 4th
order streams distributed across the Czech Republic (Fig. 2), at an altitude of 210 to 460 m
a.s.l. The streams were not polluted or morphologically modified and monthly observations
of hydrological instream conditions in the summer prior to sampling were available. The
value of the Biodrought index was calculated for each sample and the probability of its
classification as intermittent, near-perennial or perennial was calculated using the
probability density function of the normal distribution. The sample was assigned to the
category with the highest probability.

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244

245 **Fig. 2.** Location of the sites used for validation within the Czech Republic. Open squares
 246 represent non-perennial sites and filled squares represent perennial sites.

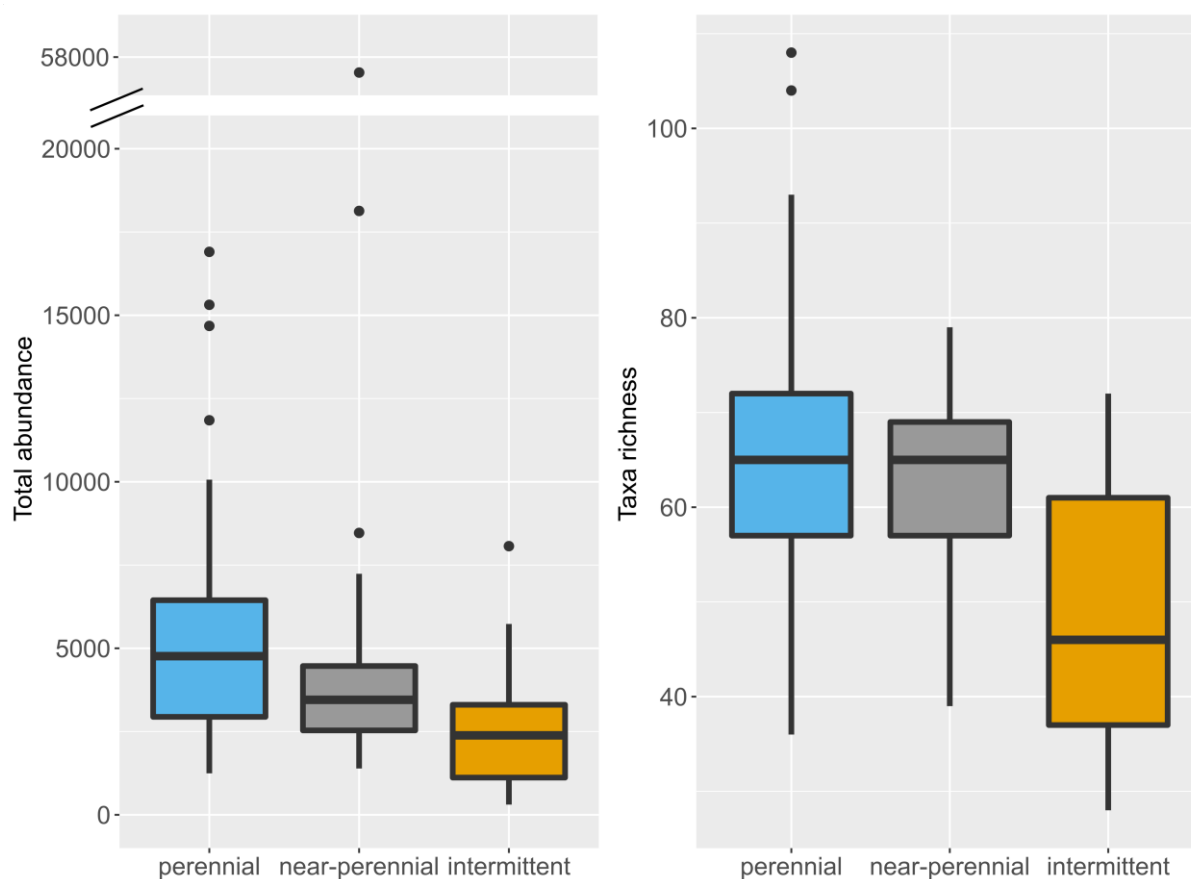
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3. Results

248

3.1 Community structure across years, seasons, and regions

249 In total, 532 552 benthic macroinvertebrate individuals from 421 taxa were collected
 250 (Appendix B). Individual sample abundance values ranged from 307 to 57 581 (mean \pm SE,
 251 4997 ± 591) individuals per sample and taxa richness values from 28 to 108 (60.7 ± 1.5) taxa
 252 per sample. Macroinvertebrate abundance decreased with increasing flow intermittence
 253 (Fig. 3), with significant differences among intermittence categories (one-way ANOVA, $F_{2,104}$
 254 $= 3.71$, $p = 0.028$). Taxa richness was also lowest in intermittent samples ($F_{2,104} = 15.11$, $p <$
 255 0.001). The five most abundant taxa were *Gammarus fossarum* (30% of all individuals),
 256 *Micropsectra atrofasciata*-Gr. (9.5%), *Nemoura* sp. (3.5%), *Baetis rhodani* s.l. (3.1%) and
 257 *Habroleptoides confusa* (2.9%). Twenty-six taxa were identified as significant indicators of
 258 intermittent and near-perennial samples and 33 were identified as significant indicators of
 259 perennial samples (Appendix A). The five taxa with the highest IV were *Eiseniella tetraedra*,
 260 *Brachyptera risi*, *Parametriocnemus stylatus*, *Paraphaenocladus* sp. and *Marionina* sp. for
 261 non-perennial sites and *Dugesia gonocephala*, *Baetis muticus*, *Baetis rhodani* s.l., *Leuctra* sp.
 262 and *Hydropsyche* sp. for perennial sites.



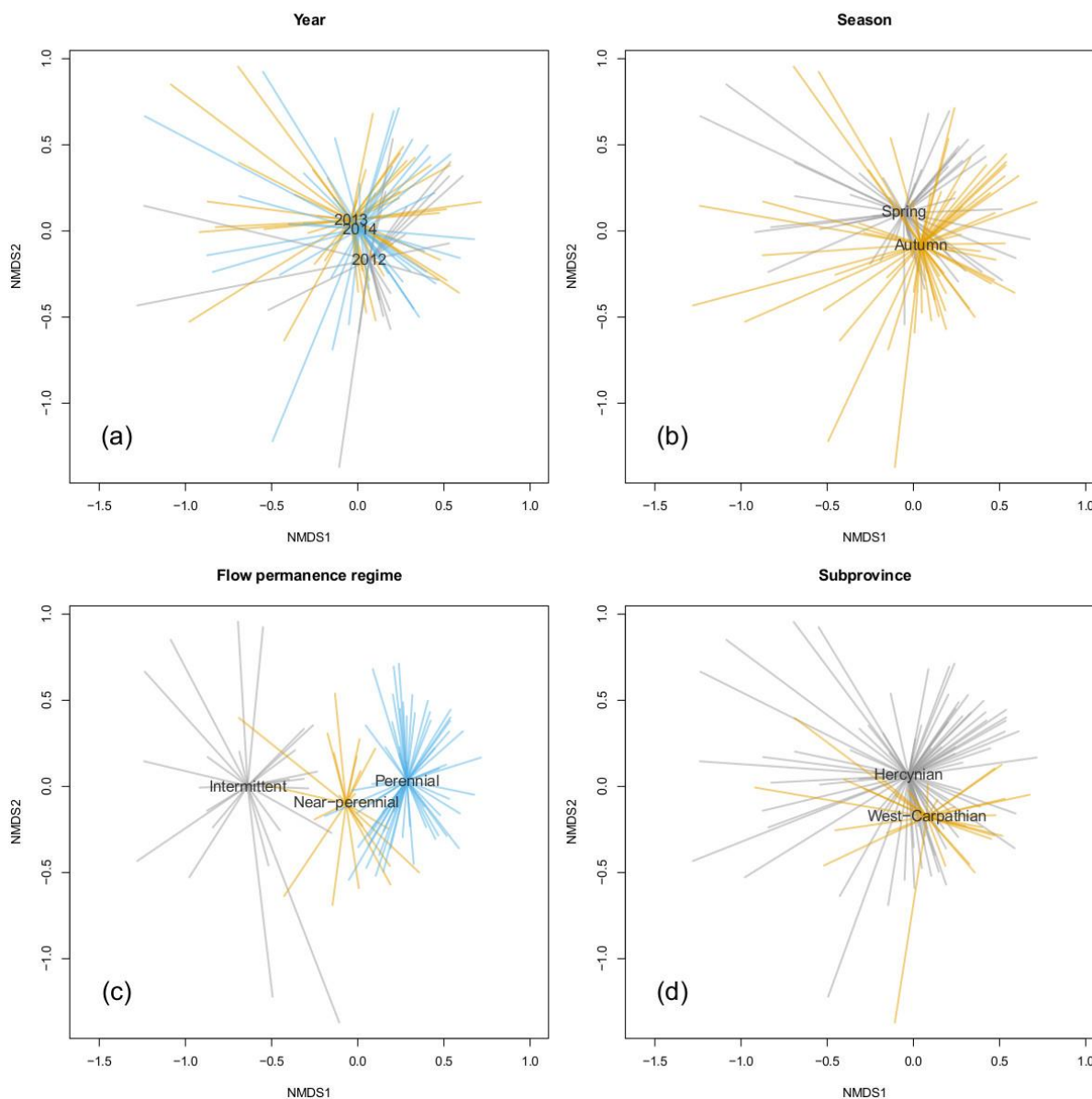
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264 Fig. 3. (colour figure) Total invertebrate abundance (number of individuals) and taxa richness
 265 (number of taxa) in samples classified into three flow intermittence categories: i) perennial;
 266 ii) near-perennial; iii) intermittent. The box area indicates the first and third quartiles, the
 267 central line indicates the median, whiskers represent 95% confidence intervals and circles
 268 indicates outliers.

269 Non-metric multidimensional scaling analyses produced a two-dimensional solution (stress =
 270 0.1998; Fig. 4). Community composition differed among perennial, near-perennial and
 271 intermittent samples (PERMANOVA; $F_{2,104} = 7.4$, $p < 0.001$). Despite considerable overlap, we
 272 detected differences in community composition both between seasons (PERMANOVA; $F_{1,105}$
 273 = 6.0, $p < 0.001$) and subprovinces ($F_{1,105} = 5.6$, $p < 0.001$).

274

275



276

277 Fig. 4. (colour figure) Non-metric multidimensional scaling ordinations of all samples,
 278 showing differences in community composition between: (a) years (2012, 2013, 2014); (b)
 279 seasons (autumn, spring); (c) intermittence categories (intermittent, near-perennial,
 280 perennial); and (d) biogeographical subprovinces (Hercynian, West-Carpathian). Each point
 281 (sample) is connected to the group centroid.

282 3.2. Discrimination of samples from each intermittence category

283 Because PERMANOVA identified differences in community composition among perennial,
 284 near-perennial and intermittent samples, we investigated the metrics that most effectively
 285 discriminated between these intermittence categories. Because many potential metrics
 286 differed between intermittent and perennial samples, we plotted all calculated potential
 287 metrics and selected a subset of candidate metrics based on their ability to discriminate
 288 between categories (Table 1).

289

290 Table 1: Candidate metrics tested as discriminators of macroinvertebrate communities from
 291 sites in different intermittence categories. Differences between perennial/intermittent
 292 samples were tested with Mann-Whitney U-tests. ***<0.001, **<0.01, *<0.05

Metrics selected for index development	Autumn	Spring	Observed state at intermittent sites
% of lithal preference	***	***	lower
% of organic substrate preference	**	**	higher
% of rheophilic preference	***	n.s.	lower
% taxa with respiration with gills	***	***	lower
% taxa with high body flexibility	***	**	higher
% of rhithral preference	***	*	lower
% of epirhithral preference	***	*	lower
Weighted mean of sediment-sensitive invertebrates	***	n.s.	higher
Number of taxa	**	**	lower
Number of ET taxa	***	***	lower
Number of EPT taxa	***	***	lower
Total abundance	***	*	lower
Abundance of Heptageniidae	***	***	lower
Abundance of EPT	***	n.s.	lower
Proportion of Heptageniidae	***	***	lower
Proportion of Oligochaeta	***	n.s.	higher
Proportion of indicator taxa	***	***	lower

293 From the set of candidate metrics (Table 1), successive LDA revealed important metrics for
 294 sample separation. Three metrics were selected for discrimination in autumn: the
 295 proportion of indicator taxa, the proportion of individuals with high body flexibility, and the
 296 proportion of taxa with a preference for organic substrates. The formula for calculating the
 297 autumn index is:

$$298 \text{ Biodrought index} = (4.23 * \text{Proportion_of_indicator_taxa}) + (-1.69 * \text{Proportion_of_high_body_flexibility}) + (-$$

$$299 \text{ 2.94} * \text{Proportion_of_organic_sediment_preference}) - 0.26$$

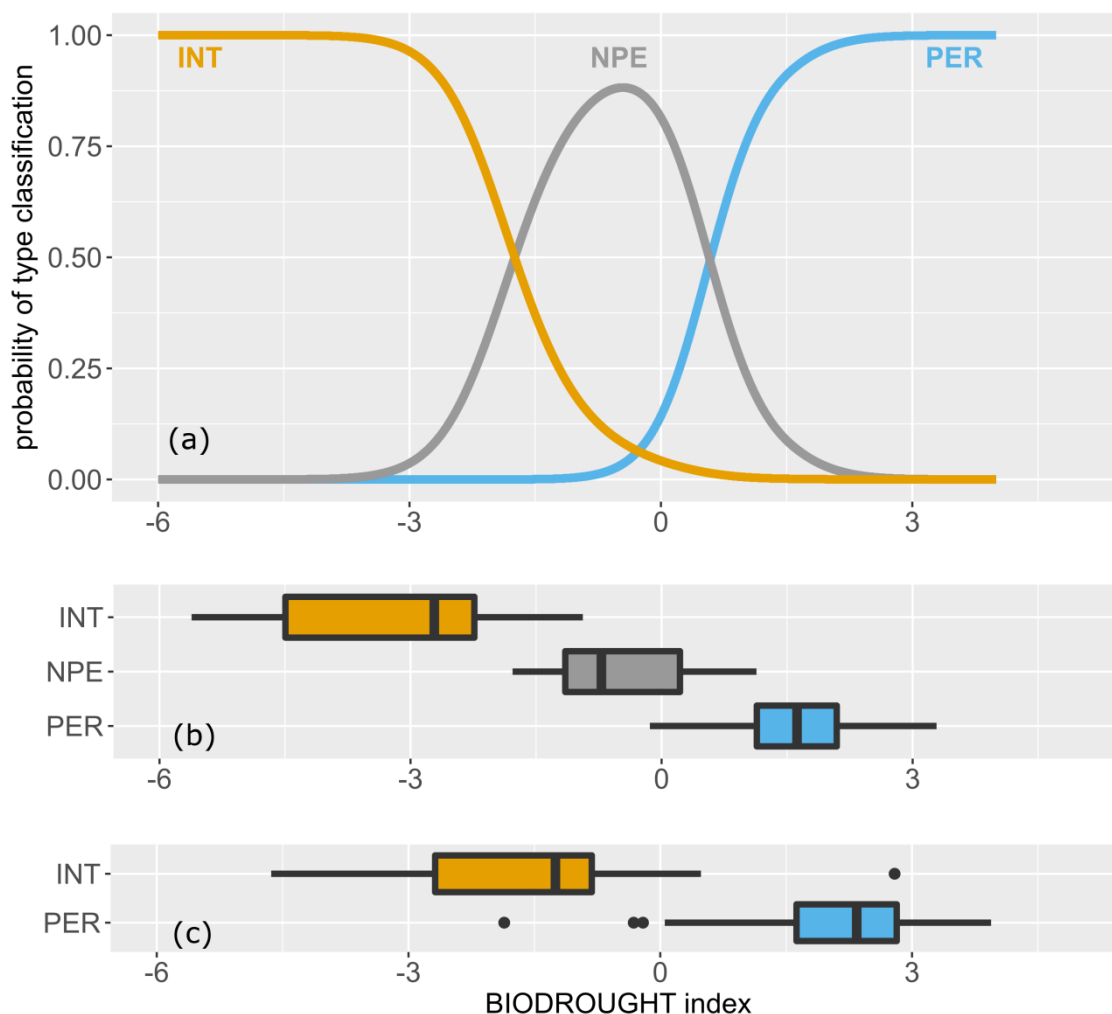
300 Three metrics were also selected as discriminators of spring samples: the proportion of
 301 indicator taxa, the proportion of individuals with high body flexibility, and the total
 302 abundance. The formula for calculating the spring season index is:

$$303 \text{ Biodrought index} = (4.09 * \text{Proportion_of_indicator_taxa}) + (-1.76 * \text{Proportion_of_high_body_flexibility}) +$$

$$304 (0.47 * \text{Total_abundance}) - 4.01$$

305 The Biodrought index was calculated for each sample (Fig. 5b) and the probability function
 306 for perennial, near-perennial and intermittent samples was approximated based on the
 307 distribution of index values within the intermittence categories. LDA discriminant scores (i.e.
 308 the Biodrought index) for each category were normally distributed (Shapiro-Wilk tests, $p >$

309 0.05). Mean discriminant scores varied between samples in the three intermittence
 310 categories ($F_{2, 101} = 215.9$; $p < 0.001$) but not between spring and autumn samples ($F_{1, 101} =$
 311 0.009 ; $p = 0.926$), and there was no interaction between intermittence category and season
 312 ($F_{2, 101} = 0.328$, $p = 0.721$). Because there was no difference in the distribution of sample
 313 discriminant scores between spring and autumn, it was possible to calculate probability
 314 functions independently of season (Fig. 5a). Values for the probability function were derived
 315 from the dataset for intermittent (mean = -3.36, SD = 1.398), near-perennial (mean = -0.231,
 316 SD = 0.926) and perennial (mean = 1.559, SD = 0.777) sites.



317

318 Fig. 5. (colour figure) Biodrought index values for each flow intermittence category: (a)
 319 Probability of classification to each category according to the index; index values for each
 320 category, for (b) samples used for index development and (c) independent samples used for
 321 index validation. INT – intermittent, NPE – near-perennial, PER – perennial.

322 3.3. Validation by independent samples

323 To evaluate the performance of the method, we calculated the Biodrought index values for a
 324 dataset not used for index development (Fig. 5c). Of 117 perennial samples, 108 (92%) had a
 325 probability >50% of being classified correctly by the index, with eight and one samples
 326 classified as near-perennial and intermittent, respectively. The index classified 1 of 26

327 samples from non-perennial streams incorrectly, with 15 and 10 correctly classified as near-
328 perennial and intermittent, respectively. Because it was not possible to distinguish between
329 intermittent and near-perennial categories in this independent dataset, the correct
330 classification of non-perennial samples was 96%.

331 **4. Discussion**

332 Our results agree with previous research demonstrating that benthic macroinvertebrate
333 community composition reflects stream flow intermittence (Arscott et al., 2010; Datry, 2012;
334 Soria et al., 2017) and that the effects of relatively short (7-86 day) drying events can be
335 detected even after seven months after flow resumption (Ledger and Hildrew, 2001; Chester
336 and Robson, 2011). Previous studies from other regions have distinguished perennial and
337 non-perennial streams using the proportional representation of different macroinvertebrate
338 taxonomic groups (Mazzacano and Black, 2009; Nadeau, 2015; Cid et al., 2016; Cañedo-
339 Argüelles et al., 2016) and using traits (Serra et al., 2017; Kelso and Entekin, 2018). Our
340 results confirm that macroinvertebrate communities in Central Europe can also be explored
341 to identify stream intermittence, and specifically drying events. Our Biodrought index
342 provides a new tool to identify antecedent drying events, which may facilitate interpretation
343 of ecological data including the results of ecological status assessments, especially when
344 hydrological data are missing. The method was developed and validated using Czech
345 Republic data, but it has considerable potential for wider uptake due to the extensive
346 distribution of the continental climate zone across Central Europe

347 **4.1. Metrics used for index calculations**

348 Biotic responses to environmental stress (e.g. water loss) can be species-specific (Lake, 2003)
349 and we examined available information about responses to flow continuity mainly at the
350 species level, and summarized the most sensitive/tolerant indicator taxa (Appendix A). The
351 proportion of these indicator taxa was one of the most effective metrics to distinguish
352 among intermittence categories. Flow intermittence tolerant taxa usually possess
353 behavioural, morphological, physiological and/or life-history adaptations to survive dry
354 phase (Lytle and Poff, 2004). For example, one species strongly associated with intermittent
355 streams in this study was *Brachyptera risi*. This stonefly has the eggs with summer diapause,
356 allowing the species to remain in the sediments in a viable egg stage during dry phases
357 (Khoo, 1964). However, the selective loss of taxa sensitive to flow intermittence (and
358 specifically drying) rather than selection for desiccation-resistant specialists is the primary
359 driver of differences in community composition between perennial and non-perennial sites
360 (Datry, 2012; Vidal-Abarca et al., 2013; Cid et al., 2016).

361
362 Although high body flexibility is not typically reported as a crucial trait in relation to stream
363 drying (e.g. Bonada et al., 2007; Díaz et al., 2008; Walters, 2011) our results indicated its
364 relevance. Organisms with flexible body shapes can respond to drying by moving into the
365 subsurface interstices, which may maintain high humidity and can thus act as refuge for
366 aquatic invertebrates during dry phases (Stubbington, 2012; Strachan et al., 2015).
367 Moreover, a highly flexible body enables organisms including oligochaetes and leeches to
368 form globular, desiccation-tolerant cysts (Montalto and Marchese, 2005; Shikov, 2011).
369 Intermittent streams also supported a higher proportion of invertebrates with a preference

370 for organic substrates, which may reflect their dry-phase survival in moisture-retaining
371 patches of organic matter (Stubbington et al., 2009). Invertebrates that use such organic-rich
372 habitats during flowing conditions can therefore persist in this substrate, which acts as a
373 refuge that limits desiccation during dry phases (Boulton, 1989).

374

375 The Biodrought index calculated for the spring season also included total abundance. The
376 relationship between total abundance and flow permanence in streams has previously been
377 indicated by several studies (Rüegg and Robinson, 2004; Fenoglio et al., 2007; Datry, 2012).
378 The lower abundance in our study was caused in particular by high mortality of *Gammarus*
379 species, known to be sensitive to stream drying (Meyer and Meyer, 2000; Smith et al., 2003;
380 Pařil et al., 2019).

381 **4.2. Utility of the developed tool**

382 Our index addresses the recognized need (Datry et al., 2011; Cid et al., 2016) for methods to
383 identify antecedent drying events using biological metrics, and thus without using gauging
384 stations or other prohibitively costly infrastructure. Even where gauging station data are
385 available, biotic approaches such as our index complement the continuous, long-term
386 hydrological information by distinguishing dry from lentic zero-flow states (Gallart et al.,
387 2012). Sampling and processing of benthic invertebrate samples is methodologically well-
388 managed and is routinely practised within the scope of monitoring programmes (Smith et
389 al., 1999; Birk et al., 2012; Hill et al., 2017). The method used for taking samples (Kokeř et
390 al., 2006) is comparable to other commonly used European methods such as AQEM/STAR
391 method (Lorenz and Clarke, 2006), and the Biodrought index therefore has high potential for
392 testing and use in other countries within the extensive continental climate zone that spans
393 Central and Eastern Europe. The study dataset spans two biogeographical subprovinces
394 (Hercynian and West-Carpathian; Culek, 2013) and the discriminatory power of the index
395 was sufficient to correctly classify evaluated samples from the independent dataset from
396 whole Czech Republic with high probability. Although working at a finer geographical
397 resolution (e.g. within one subprovince) may achieve higher levels of correct assignment, we
398 also recommend testing of our index in other Central European countries to explore the
399 geographical limits of its reliability. A saprobic system based on common taxa is used in
400 many Central and Eastern European countries (Rolauuffs et al., 2004) and the Biodrought
401 index may therefore be useable in Central European region without extensive taxonomic
402 adjustment.

403 Our index was developed in pristine streams where only a single, natural stressor (drying)
404 was known to influence macroinvertebrate community composition. Elsewhere, factors that
405 may affect index performance include interactions between the hydrological stressor of
406 drying (both natural and anthropogenic) with other human pressures, interactions which can
407 have antagonistic or additive effects on biological communities (Folt et al., 1999; Matthaai et
408 al., 2010; Ormerod et al., 2010). In particular, the typical sequence of hydrological conditions
409 from low flows, to flow cessation and gradual drying can reduce oxygen concentrations, and
410 intermittence and organic pollution can therefore have comparable effects by eliminating
411 sensitive invertebrates (Pardo and Garcia, 2016). Moreover, a reduction in oxygen
412 availability and low flow can have synergistic effects on benthic invertebrates (Calapez et al.,
413 2017). Disentangling the effects of stream drying and anthropogenic stressors (including

414 organic pollution) is therefore challenging, but consideration of the Biodrought index
415 alongside physico-chemical quality elements may improve the accuracy of ecological status
416 assessments that might otherwise incorrectly classify IRES as polluted. Wider testing is
417 needed to explore how the index performs in streams exposed to human stressors.

418 The spatial distribution of intermittent reaches in relation to perennial reaches and other
419 refuges may have a considerable influence on the rate and extent of community recovery
420 after drying events (Sedell et al., 1990; Bogan et al., 2017; but see Datry et al., 2014b). The
421 spatial proximity of extensive refuges, in particular upstream perennial reaches, may enable
422 rapid recolonization and community reestablishment within weeks to obscure the
423 occurrence of an antecedent dry phase (Fowler, 2004; Fritz and Dodds, 2004; Pařil et al.,
424 2019). In our dataset, the intermittent sites were at least 0.5 km downstream of a perennial
425 reach and the samples were taken at most 7 months after flow resumed. However, recovery
426 at highly isolated sites (e.g. >10 km from perennial refuges) may take multiple years with
427 repeated drying events often preventing aquatic communities from reaching a stable state
428 (Bogan and Lytle, 2011; Bogan et al., 2017). Our index and comparable tools thus have
429 higher potential for strong performance in IRES with relatively short dry phases, compared
430 to those which may remain dry for years.

431 **4.3. Conclusions and recommendations for index use**

432 We developed the Biodrought index: a novel index to characterize the effect of stream
433 drying on aquatic invertebrate communities. The index enable calculation of the probability
434 of the antecedent stream drying, based on benthic invertebrates sampled using standard
435 methods. We demonstrated the index as robust at national scale. The robustness of our
436 index is evidenced by its registration by the Ministry of Environment of the Czech Republic,
437 and we recommend its testing and adoption (with required adaptation) in other European
438 countries within continental-climate region. In particular, the Biodrought index is intended
439 for use by those with responsibility for monitoring and management of river ecosystems,
440 including water management boards, environmental agencies and private water companies.
441 We recommend adoption of the Biodrought index by such managers, to improve their
442 interpretation of the macroinvertebrate assemblage data collected during ecological status
443 assessments. The index can help avoid misinterpreting a deviation of community
444 composition from reference status caused by a preceding dry phase (Reyjol et al., 2014; Cid
445 et al., 2016; Stubbington et al., 2018). Environmental agencies could employ this tool for
446 characterization of dry phase effects on macroinvertebrate communities in protected areas
447 or for evaluation of the effectiveness of projects intended to restore naturally perennial flow
448 at sites impacted by water resource pressures such as over-abstraction. The index can also
449 be useful when identifying the impacts of water resource use in naturally perennial streams.
450 However, since the method was developed in naturally intermittent streams, its use in non-
451 natural IRES must be carefully assessed and the performance of Biodrought index in such
452 conditions remains to be tested.

453 Our approach was essentially qualitative, identifying if a drying event had or had not
454 occurred in the the one-year period preceding sample collection. Further research is needed
455 to explore variability within 'intermittent', 'near-perennial' and other flow intermittence
456 categories, in particular to identify species-specific responses to dry phases of differing

457 durations. Identification of such thresholds is crucial to predict biotic responses to increasing
 458 intermittence in the context of ongoing climate change, which is interacting with increasing
 459 water resource pressures.

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468

469 6. References

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767 **Appendix A**

768 Table A.1: List of flow intermittence tolerant taxa and the reasons for their inclusion in the list. The
 769 reliability of indicators is based on stronger (value 2) or weaker (value 1) evidence. Indicator values
 770 (IV) and their significance are shown separately for spring and autumn seasons for taxa that were
 771 associated with intermittent and near-perennial samples in Indicator Species Analysis. The frequency
 772 of taxa at intermittent and near-perennial samples is shown. Published sources in which information
 773 was found is shown. * - $p < 0.05$, ** - $p < 0.01$, *** - $p < 0.001$, n.s. – not significant

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Taxon	Reliability	IV Spring/Autumn	Significance of IV Spring/Autumn	Frequency Spring/Autumn	References
Platyhelminthes					
<i>Mesostoma lingua</i>	1				Young, 2001
Nematomorpha					
Gordiidae Gen. sp.	1	-/0.06	-/n.s.	0/0.06	Clifford, 1966
<i>Gordius</i> sp.	1				Clifford, 1966
Mollusca					
<i>Anisus leucostoma</i>	2				Piechocki, 1979; Jurkiewicz-Karnkowska, 2011; Costil et al., 2001
<i>Anisus septemgyratus</i>	2				Jurkiewicz-Karnkowska, 2008; Jurkiewicz-Karnkowska, 2011
<i>Anisus</i> sp.	1				Costil et al., 2001
<i>Anisus spirorbis</i>	1				Jurkiewicz-Karnkowska, 2008
<i>Aplexa hypnorum</i>	2				Jurkiewicz-Karnkowska, 2008; Costil et al., 2001
<i>Bathyomphalus contortus</i>	1				Jurkiewicz-Karnkowska, 2011
<i>Bithynia leachii</i>	2				Jurkiewicz-Karnkowska, 2008; Piechocki, 1979
<i>Bythinella austriaca</i> agg.	2	0.44/0.46	*/*	0.45/0.56	
<i>Galba truncatula</i>	2	0.24/0.18	n.s./n.s.	0.27/0.19	Meyer and Meyer, 2000; Acuña et al., 2005; Stubbington et al., 2009; Costil et al., 2001; Falkner et al., 2001
<i>Gyraulus riparius</i>	1				Jurkiewicz-Karnkowska, 2008
<i>Musculium lacustre</i>	1				Piechocki, 1993
<i>Pisidium casertanum</i>	1				Piechocki, 1993
<i>Pisidium obtusale</i>	1				Piechocki, 1993
<i>Pisidium personatum</i>	1				Piechocki, 1993
<i>Planorbarius corneus</i>	1				Jurkiewicz-Karnkowska, 2011
<i>Planorbis planorbis</i>	2				Jurkiewicz-Karnkowska, 2011; Falkner et al., 2001
<i>Potamopyrgus antipodarum</i>	1	0.09/-	n.s./-	0.09/0.06	Costil et al., 2001
<i>Radix peregra</i>	2	-/0.06	-/n.s.	0/0.06	Costil et al., 2001; Extence, 1981
<i>Segmentina nitida</i>	2				Jurkiewicz-Karnkowska, 2011; Falkner et al., 2001
<i>Stagnicola fuscus</i>	1				Falkner et al., 2001
<i>Stagnicola occultus</i>	1				Falkner et al., 2001
<i>Stagnicola palustris</i>	1				Jurkiewicz-Karnkowska, 2011
<i>Valvata cristata</i>	2				Jurkiewicz-Karnkowska, 2008; Jurkiewicz-Karnkowska, 2011; Falkner et al., 2001.
<i>Valvata macrostoma</i>	2				Jurkiewicz-Karnkowska, 2008; Jurkiewicz-Karnkowska, 2011; Falkner et al., 2001
Oligochaeta					

<i>Eiseniella tetraedra</i>	2	0.54/0.64	n.s./*	0.82/0.75	Fenoglio et al., 2007; Hynes, 1958; Dumnicka and Kozsalka, 2005
<i>Enchytraeus</i> sp.	2	0.24/0.25	n.s./*	0.27/0.25	
<i>Epirodriulus pygmaeus</i>	1	0.18/0.2	n.s./n.s.	0.18/0.25	
<i>Haplotaxis gordioides</i>	2	0.29/0.32	n.s./*	0.36/0.38	
<i>Marionina</i> sp.	2	0.61/0.12	*/n.s.	0.73/0.13	
<i>Nais elinguis</i>	2	0.18/0.3	n.s./**	0.18/0.31	
<i>Stylodrilus heringianus</i>	2	0.56/0.52	n.s./n.s.	0.64/0.63	Dumnicka and Koszalka, 2005; Nijboer et al., 2004
Hirudinea					
<i>Dina lineata</i>	1				Elliott and Mann, 1979
<i>Haemopis sanguisuga</i>	2	0.18/0.19	n.s./*	0.18/0.19	Elliott and Mann, 1979
Crustacea					
<i>Asellus aquaticus</i>	2	0.07/0.04	n.s./n.s.	0.09/0.06	Iversen et al., 1978; Extence, 1981
Ephemeroptera					
<i>Cloeon dipterum</i> s. lat.	1	0.09/0.13	n.s./n.s.	0.09/0.13	
<i>Ecdyonurus picteti</i>	1	0.18/-	n.s./-	0.18/0	
<i>Habrophlebia fusca</i>	2	-/-	-/-	0.09/0.06	Bohle, 2000; Řezníčková et al., 2010
<i>Metreletus balcanicus</i>	2	0.09/-	n.s./-	0.09/0	Bauernfeind and Soldán, 2012; Soldán and Zahrádková, 2000; Bohle, 2000
<i>Paraleptophlebia weneri</i>	1				Soldán and Zahrádková, 2000
<i>Siphonurus aestivalis</i>	2	0.25/-	n.s./-	0.27/0	Bauernfeind and Soldán, 2012; Řezníčková et al., 2010
<i>Siphonurus armatus</i>	2	0.09/-	n.s./-	0.09/0	Bauernfeind and Soldán, 2012; Soldán and Zahrádková, 2000; Bohle, 2000
<i>Siphonurus lacustris</i>	2				Fenoglio et al., 2007; Hynes, 1958
Odonata					
<i>Pyrrhosoma nymphula</i>	1				Opatrilova et al., 2005
Plecoptera					
<i>Brachyptera risi</i>	2	0.76/0.06	*/n.s.	0.82/0.06	Bohle, 2000; Hynes, 1941; Wagner et al., 2011; Mackereth, 1957
<i>Capnia bifrons</i>	2	0.45/0.5	*/n.s.	0.45/0.56	Bohle, 2000
<i>Isoperla tripartita</i>	2	0.55/0.19	**/n.s.	0.55/0.25	
<i>Nemoura cinerea</i>	2				Bohle, 2000; Malicky, 1989; Meyer and Meyer, 2000; Iversen et al., 1978; Hynes, 1958
Coleoptera					
<i>Agabus guttatus</i>	2	0.36/0.54	*/**	0.36/0.56	Bohle, 2000; Hynes, 1958
<i>Agabus</i> sp.	2				Bohle, 2000; Hynes, 1958; Meyer and Meyer, 2000
<i>Anacaena globulus</i>	2	-/0.25	-/*	0/0.25	Bohle, 2000; Hynes, 1958
<i>Cyphon</i> sp.	1	-/0.13	-/n.s.	0/0.13	
<i>Esolus angustatus</i>	2	0.15/0.25	n.s./*	0.27/0.25	
<i>Helophorus aquaticus</i>	1				Bohle, 2000
<i>Helophorus brevipalpis</i>	2				Bohle, 2000; Smith and Wood, 2002; Stubbington et al., 2009
<i>Helophorus flavipes</i>	1				Hynes, 1958
<i>Helophorus grandis</i>	1				Bohle, 2000
<i>Helophorus</i> sp.	2				Wood et al., 2005
<i>Hydraena melas</i>	1	-/-	-/-	0/0.06	Fenoglio et al., 2007
<i>Hydraena nigrata</i>	1	0.3/0.19	n.s./n.s.	0.55/0.38	Bohle, 2000
<i>Hydroporus planus</i>	1	-/0.06	-/n.s.	0/0.06	Opatrilova et al., 2005
<i>Hydroporus pubescens</i>	1				Opatrilova et al., 2005
<i>Limnebius truncatellus</i>	2	-/-	-/-	0/0.06	Bohle, 2000; Jackson, 1973

<i>Platambus maculatus</i>	2	0.18/0.53	n.s./*	0.18/0.63	Bohle, 2000; Hynes, 1958; Meyer and Meyer, 2000
Trichoptera					
<i>Agrypnia varia</i>	1				Moretti et al., 1976
<i>Beraea pullata</i>	1				Bohle, 2000
Beraeidae Gen. sp.	1				Fenoglio et al., 2007
<i>Beraeodes minutus</i>	2	0.09/0.19	n.s./*	0.09/0.19	Bohle, 2000
<i>Glyptotaelius pellucidus</i>	2	0.25/0.19	n.s./n.s.	0.27/0.19	Bohle, 2000; Acuña et al., 2005; Svensson, 1974
<i>Grammotaulius nigropunctatus</i>	2				Novák and Sehnal, 1963; Hiley, 1978
<i>Chaetopteryx villosa</i>	1	0.18/0.15	n.s./n.s.	0.18/0.19	
<i>Ironoquia dubia</i>	2	0.09/-	n.s./-	0.09/0	Bohle, 2000; Sommerhäuser et al., 1995
<i>Leptocerus tineiformis</i>	1				Moretti et al., 1976
<i>Limnephilus affinis</i>	1				Hiley, 1978
<i>Limnephilus auricula</i>	2				Novák and Sehnal, 1963; Hiley, 1978; Bohle, 2000; Smith et al., 2003; Pastuchová, 2008; Sommerhäuser et al., 1995; Svensson, 1974
<i>Limnephilus bipunctatus</i>	2				Novák and Sehnal, 1963; Moretti et al., 1976; Bohle, 2000; Meyer and Meyer, 2000
<i>Limnephilus centralis</i>	2				Hiley, 1978; Bohle, 2000; Smith et al., 2003; Wood et al., 2005; Svensson, 1974
<i>Limnephilus coenosus</i>	1				Hiley, 1978
<i>Limnephilus flavicornis</i>	1				Novák and Sehnal, 1963
<i>Limnephilus griseus</i>	2				Novák and Sehnal, 1963; Hiley, 1978; Svensson, 1974; Gislason, 1993
<i>Limnephilus incisus</i>	1				Hiley, 1978
<i>Limnephilus lunatus</i>	2				Bohle, 2000; Meyer and Meyer, 2000; Smith et al., 2003
<i>Limnephilus sparsus</i>	2				Novák and Sehnal, 1963; Hiley, 1978; Moretti et al., 1976; Bohle, 2000; Svensson, 1974
<i>Limnephilus stigma</i>	2				Novák and Sehnal, 1963; Hiley, 1978; Svensson, 1974
<i>Limnephilus vittatus</i>	2				Novák and Sehnal, 1963; Hiley, 1978; Moretti et al., 1976; Svensson, 1974
<i>Micropterna lateralis</i>	2				Bohle, 2000; Smith et al., 2003; Wood et al., 2005; Pastuchová, 2008; Sommerhäuser et al., 1995
<i>Micropterna nycterobia</i>	2	0.49/-	*/-	0.55/0	Pastuchová, 2008; Meyer and Meyer, 2000; Moretti et al., 1976
<i>Micropterna sequax</i>	2				Bohle, 2000; Meyer and Meyer, 2000; Smith et al., 2003; Wood et al., 2005
<i>Micropterna testacea</i>	1				Meyer and Meyer, 2000
<i>Oligostomis reticulata</i>	1				Sommerhäuser et al., 1995
<i>Rhadicleptus alpestris</i>	1				Hiley, 1978
<i>Stenophylax permistus</i>	2				Bohle, 2000; Meyer and Meyer, 2000; Smith et al., 2003; Wood et al., 2005
<i>Trichostegia minor</i>	2				Novák and Sehnal, 1963; Svensson, 1974
Diptera					
<i>Diplocladius cultriger</i>	2	0.34/0.55	n.s./**	0.36/0.56	
<i>Eukiefferiella claripennis</i>	1	-/0.13	-/n.s.	0/0.13	
<i>Hydrobaenus</i> sp.	1	0.27/-	n.s./-	0.27/0	
<i>Chironomus</i> sp.	2	-/0.31	-/**	0/0.31	
<i>Krenosmittia camptophleps</i>	1	0.27/-	n.s./-	0.27/0	
<i>Macropelopia</i> sp.	2	0.45/0.08	*/n.s.	0.45/0.13	
<i>Micropsectra atrofasciata</i> -Gr.	2	-/0.89	-/*	1/0.94	
<i>Natarsia</i> sp.	2	0.58/0.42	*/*	0.64/0.5	
<i>Orthocladus rivicola</i> -Gr.	2	0.28/0.19	n.s./*	0.36/0.19	
<i>Parametriocnemus stylatus</i>	1	0.71/0.35	n.s./n.s.	0.91/0.63	Rüegg and Robinson, 2004
<i>Paraphaenocladus</i> sp.	2	0.64/0.25	*/*	0.82/0.25	

<i>Paratrichocladius rufiventris</i>	1	-/-	-/-	0.18/0	Moller Pillot, 2013
<i>Procladius</i> sp.	1	0.18/0.24	n.s./n.s.	0.18/0.25	
<i>Rheocricotopus atripes</i>	1	0.27/0.13	n.s./n.s.	0.27/0.13	
<i>Rheocricotopus effusus</i>	2	0.44/0.3	*/*	0.45/0.31	
<i>Rheocricotopus effusus</i>	2	0.44/0.3	*/*	0.45/0.31	
<i>Rhypholophus haemorrhoidalis</i>	1	0.41/0.13	n.s./n.s.	0.45/0.13	
<i>Simulium noelleri</i>	1	0.09/0.19	n.s./n.s.	0.09/0.19	
<i>Zavrelimyia</i> sp.	2	0.7/-	**/-	0.82/0	Opatrilova et al., 2005

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776

777 Table A.2: List of perennial flow indicators and the reasons for their inclusion in the list. The reliability
 778 of indicators is based on stronger (value 2) or weaker (value 1) evidence. Indicator values (IV) and
 779 their significance are shown separately for spring and autumn seasons for taxa that were associated
 780 with perennial samples in Indicator Species Analysis. The frequency of taxa at perennial samples is
 781 shown. Published sources in which information was found are shown. * - $p < 0.05$, ** - $p < 0.01$, *** -
 782 $p < 0.001$, n.s. – not significant

Taxon	Reliability	IV Spring/Autumn	Significance of IV spring/autumn	Frequency spring/autumn	References
Platyhelminthes					
<i>Crenobia alpina</i>	2				Fenoglio et al., 2007; Rüegg and Robinson, 2004; Hynes, 1958
<i>Dugesia gonocephala</i>	2	0.82/0.73	**/**	0.83/0.74	Meyer and Meyer, 2000
<i>Dugesia</i> sp.	1				Fenoglio et al., 2007
<i>Phagocata vitta</i>	1				Hynes, 1958
<i>Polycelis nigra</i>	1				Sarriquet et al., 2007
<i>Polycelis</i> sp.	1				Fenoglio et al., 2007
<i>Polycelis tenuis</i>	1	-/-	-/-	0/0.04	Sarriquet et al., 2007
Mollusca					
<i>Ancylus fluviatilis</i>	2	0.46/0.25	*/n.s.	0.5/0.26	Meyer and Meyer, 2000; Wood et al., 2005; Stubbington et al., 2009; Fenoglio et al., 2007
<i>Lithoglyphus naticoides</i>	2				Jurkiewicz-Karnkowska, 2008; Falkner et al., 2001
<i>Lymnaea stagnalis</i>	1				Falkner et al., 2001
<i>Myxas glutinosa</i>	1				Falkner et al., 2001
Oligochaeta					
<i>Aulodrilus japonicus</i>	1	0.17/0.12	n.s./n.s.	0.17/0.15	
<i>Nais alpina</i>	2	0.33/0.47	n.s./*	0.33/0.48	
<i>Ophidonais serpentina</i>	1	0.25/0.11	n.s./n.s.	0.25/0.11	
<i>Pristinella rosea</i> Gr.	1	0.17/0.35	n.s./n.s.	0.17/0.37	
<i>Propappus volki</i>	2	0.25/0.3	n.s./*	0.25/0.3	
<i>Rhyacodrilus coccineus</i>	1	0.25/0.05	n.s./n.s.	0.25/0.15	
Hirudinea					
<i>Erpobdella octoculata</i>	2	0.17/0.14	n.s./n.s.	0.17/0.15	Meyer a Meyer, 2001; Sarriquet et al., 2007
<i>Glossiphonia complanata</i>	1				Sarriquet et al., 2007
<i>Piscicola geometra</i>	2				Wood et al., 2005; Elliott and Mann, 1979
Acari					
Hydracarina	2	0.56/0.53	n.s./*	0.58/0.59	
Crustacea					
<i>Gammarus fossarum</i>	1	-/0.46	-/n.s.	0.75/0.78	Meyer and Meyer, 2000
Ephemeroptera					
<i>Baetis alpinus</i>	1				Rüegg and Robinson, 2004
<i>Baetis muticus</i>	2	0.87/0.8	**/**	0.92/0.81	Řezníčková et al., 2010
<i>Baetis niger</i>	1	0.17/0.17	n.s./n.s.	0.17/0.19	
<i>Baetis rhodani</i> s.l.	2	0.96/0.87	**/**	1/0.93	Iversen et al., 1978; Pastuchová, 2008; Morrison, 1990
<i>Baetis</i> sp.	2				Bohle, 2000; Wood et al., 2005; Stubbington et al., 2009; Pastuchová, 2008
<i>Baetis vernus</i>	1	-/0.11	-/n.s.	0/0.22	Pastuchová, 2008
<i>Centroptilum luteolum</i>	1	0.5/-	n.s./-	0.75/0.67	Fenoglio et al., 2007

<i>Ecdyonurus austriacus</i>	1	-/0.11	-/n.s.	0.08/0.11	
<i>Ecdyonurus starmachi</i>	1				Řezníčková et al., 2010
<i>Ecdyonurus subalpinus</i>	1	0.16/0.26	n.s./n.s.	0.17/0.3	Pastuchová, 2008
<i>Ecdyonurus torrentis</i>	2	0.33/0.48	n.s./*	0.33/0.48	
<i>Ecdyonurus venosus</i>	1	-/0.04	-/n.s.	0/0.04	Hynes, 1958
<i>Epeorus assimilis</i>	1	0.33/0.22	n.s./n.s.	0.33/0.22	
<i>Ephemera danica</i>	2	0.65/0.63	*/**	0.75/0.78	Meyer and Meyer, 2000; Pastuchová, 2008; Řezníčková et al., 2010
<i>Ephemerella mucronata</i>	1	0.17/0.07	n.s./n.s.	0.17/0.07	
<i>Habroleptoides confusa</i>	2	0.55/0.7	n.s./*	0.67/0.81	Řezníčková et al., 2010; Pastuchová, 2008
<i>Habrophlebia lauta</i>	2	0.69/0.63	*/*	0.92/0.81	Řezníčková et al., 2010; Meyer and Meyer, 2000
<i>Heptagenia sulphurea</i>	1				Wood et al., 2005
<i>Leptophlebia marginata</i>	1				Opatrilova et al., 2005
<i>Paraleptophlebia submarginata</i>	2	0.48/0.59	*/n.s.	0.5/0.67	
<i>Rhithrogena carpatoalpina</i>	2	0.21/0.19	n.s./n.s.	0.25/0.19	Pastuchová, 2008; Řezníčková et al., 2010
<i>Rhithrogena iridina</i>	2				
<i>Rhithrogena iridina/picteti</i>	2	0.76/0.63	*/**	0.83/0.63	
<i>Rhithrogena picteti</i>	2				Meyer and Meyer, 2000; Pastuchová, 2008
<i>Rhithrogena semicolorata</i>	2	0.17/0.07	n.s./n.s.	0.17/0.07	Pastuchová, 2008; Řezníčková et al., 2010; Hynes, 1958
<i>Serratella ignita</i>	2				Meyer and Meyer, 2000; Stubbington et al., 2009; Pastuchová, 2008; Hynes, 1958
<i>Torleya major</i>	2	0.25/0.33	n.s./*	0.25/0.33	Meyer and Meyer, 2000
Plecoptera					
<i>Amphinemura</i> sp.	1	0.41/0.22	n.s./n.s.	0.42/0.22	
<i>Dinocras cephalotes</i>	2	0.08/0.07	n.s./n.s.	0.08/0.07	Fenoglio et al., 2007; Hynes, 1941
<i>Dinocras</i> sp.	2				Fenoglio et al., 2007; Hynes, 1941
<i>Diura bicaudata</i>	2	-/0.04	-/n.s.	0/0.04	Stubbington et al., 2009; Hynes, 1958
<i>Chloroperla</i> sp.	2				Fenoglio et al., 2007; Hynes, 1941
<i>Chloroperla tripunctata</i>	2				Fenoglio et al., 2007; Hynes, 1941
<i>Isoperla oxylepis</i>	1	0.25/0.17	n.s./n.s.	0.25/0.22	
<i>Isoperla rivulorum</i>	1	0.06/0.11	n.s./n.s.	0.08/0.11	
<i>Leuctra digitata</i>	1				Pastuchová, 2008
<i>Leuctra fusca</i>	1				Wood et al., 2005; Hynes, 1941
<i>Leuctra handlirschi</i>	1				Hynes, 1941
<i>Leuctra inermis</i>	2				Hynes, 1958
<i>Leuctra pseudosignifera</i>	1	0.08/0.11	n.s./n.s.	0.08/0.11	
<i>Leuctra</i> sp.	2	0.5/0.87	n.s./**	0.5/0.89	Stubbington et al., 2009
<i>Perla</i> sp.	2				Fenoglio et al., 2007; Hynes, 1941; Mackereth, 1957
<i>Perlodes microcephalus</i>	1	0.17/0.11	n.s./n.s.	0.17/0.11	
<i>Protonemura</i> sp.	2	0.38/0.44	n.s./**	0.42/0.44	Pastuchová, 2008
<i>Siphonoperla</i> sp.	1	0.17/0.25	n.s./n.s.	0.17/0.26	
Heteroptera					
<i>Velia saulii</i>	1	-/0.11	-/n.s.	0/0.11	
Coleoptera					
<i>Elmis aenea</i>	2	0.49/0.44	*/*	0.5/0.44	Wood et al., 2005; Stubbington et al., 2009
<i>Elodes marginata</i>	2	0.33/0.3	n.s./*	0.33/0.3	
<i>Esolus parallelepipedus</i>	1	0.08/0.15	n.s./n.s.	0.08/0.15	
<i>Hydraena saga</i>	1	-/0.11	-/n.s.	0/0.11	
<i>Hydraena schuleri</i>	1	0.17/0.09	n.s./n.s.	0.17/0.11	
<i>Hydroporus nigrita</i>	1				Opatrilova et al., 2005
<i>Limnius perrisi</i>	2	0.5/0.33	*/*	0.5/0.33	
<i>Limnius volckmari</i>	1	0.27/0.46	n.s./n.s.	0.33/0.74	Wood et al., 2005
<i>Orectochilus villosus</i>	2	0.17/0.11	n.s./n.s.	0.17/0.11	Meyer and Meyer, 2000
<i>Oreodytes sanmarkii</i>	1	-/0.07	-/n.s.	0/0.07	Fenoglio et al., 2007
<i>Riolus subviolaceus</i>	1	0.07/0.09	n.s./n.s.	0.08/0.11	Wood et al., 2005

Trichoptera

<i>Agapetus fuscipes</i>	2	0.25/-	n.s./-	0.25/0	Sommerhäuser et al., 1995; Wood et al., 2005
<i>Anabolia nervosa</i>	1				Sommerhäuser et al., 1995
<i>Athripsodes aterrimus</i>	2				Hiley, 1978; Sommerhäuser et al., 1995
<i>Athripsodes bilineatus</i>	1	0.18/0.21	n.s./n.s.	0.25/0.3	Sommerhäuser et al., 1995
<i>Athripsodes cinereus</i>	1				Sommerhäuser et al., 1995
<i>Cyrnus flavidus</i>	1				Bohle, 2000
<i>Drusus annulatus</i>	1	0.16/-	n.s./-	0.25/0.04	Stubbington et al., 2009
<i>Ecclisopteryx madida</i>	1	0.17/-	n.s./-	0.17/0	
<i>Goera pilosa</i>	2				Iversen et al., 1978; Sommerhäuser et al., 1995
<i>Hagenella clathrata</i>	1				Opatrilova et al., 2005
<i>Halesus digitatus</i>	2				Pastuchová, 2008; Sommerhäuser et al., 1995
<i>Halesus radiatus</i>	2				Hiley, 1978; Pastuchová, 2008; Sommerhäuser et al., 1995
<i>Hydropsyche angustipennis</i>	2				Iversen et al., 1978; Sommerhäuser et al., 1995
<i>Hydropsyche bulbifera</i>	1				Pastuchová, 2008
<i>Hydropsyche contubernalis</i>	1				Sommerhäuser et al., 1995
<i>Hydropsyche fulvipes</i>	1				Pastuchová, 2008
<i>Hydropsyche instabilis</i>	1				Pastuchová, 2008
<i>Hydropsyche pellucidula</i>	2				Meyer and Meyer, 2000; Sommerhäuser et al., 1995; Pastuchová, 2008
<i>Hydropsyche saxonica</i>	2				Sommerhäuser et al., 1995; Pastuchová, 2008
<i>Hydropsyche siltalai</i>	1				Sommerhäuser et al., 1995
<i>Hydropsyche</i> sp.	2	0.87/0.89	**/**	0.92/0.93	
Hydropsychidae Gen. sp.	1				Bohle, 2000
Hydroptilidae Gen. sp.	2				Fenoglio et al., 2007; Wallace et al., 2003
<i>Chaetopteryx fusca/villosa</i>	1				Pastuchová, 2008
<i>Lasiocephala basalis</i>	2	0.08/0.11	n.s./n.s.	0.08/0.11	Sommerhäuser et al., 1995
<i>Lepidostoma hirtum</i>	1	0.17/0.07	n.s./n.s.	0.17/0.07	
<i>Lype phaeopa</i>	1				Sommerhäuser et al., 1995
<i>Lype reducta</i>	1				Sommerhäuser et al., 1995
<i>Lype</i> sp.	1	0.46/0.31	n.s./n.s.	0.5/0.41	Sommerhäuser et al., 1995
<i>Micrasema longulum</i>	1	-/0.11	-/n.s.	0/0.11	
<i>Molanna angustata</i>	1				Sommerhäuser et al., 1995
<i>Mystacides azurea</i>	2	0.08/0.09	n.s./n.s.	0.08/0.11	Sommerhäuser et al., 1995
<i>Neureclipsis bimaculata</i>	1				Sommerhäuser et al., 1995
<i>Notidobia ciliaris</i>	1				Sommerhäuser et al., 1995
<i>Odontocerum albicorne</i>	2	0.55/0.64	*/**	0.67/0.67	Pastuchová, 2008; Meyer and Meyer, 2000; Fenoglio et al., 2007
<i>Oecismus monedula</i>	1	0.21/0.19	n.s./n.s.	0.25/0.19	
Philopotamidae Gen. sp.	1				Bohle, 2000
<i>Philopotamus montanus</i>	2	0.33/0.22	n.s./n.s.	0.33/0.22	Pastuchová, 2008
<i>Polycentropus flavomaculatus</i>	2	0.57/0.5	*/*	0.58/0.56	Meyer and Meyer, 2000; Wood et al., 2005
<i>Polycentropus irroratus</i>	2	0.17/0.11	n.s./n.s.	0.17/0.11	Sommerhäuser et al., 1995
<i>Potamophylax cingulatus</i>	2				Hiley, 1978; Sommerhäuser et al., 1995
<i>Potamophylax luctuosus</i>	1				Sommerhäuser et al., 1995
<i>Potamophylax nigricornis</i>	2				Pastuchová, 2008; Meyer and Meyer, 2000
<i>Potamophylax rotundipennis</i>	2				Sommerhäuser et al., 1995; Pastuchová, 2008
<i>Potamophylax</i> sp.	2	0.44/0.4	n.s./*	0.75/0.41	
<i>Psychomyia pusilla</i>	1				Meyer and Meyer, 2000
Psychomyiidae Gen. sp.	1				Fenoglio et al., 2007
<i>Rhyacophila dorsalis</i>	2				Wood et al., 2005; Hynes, 1958
<i>Rhyacophila fasciata</i>	2				Pastuchová, 2008; Sommerhäuser et al., 1995
<i>Rhyacophila nubila</i>	2	0.25/-	n.s./-	0.25/0	Meyer and Meyer, 2000
<i>Rhyacophila obliterateda</i>	1				Hynes, 1958

<i>Rhyacophila polonica</i>	1	0.14/-	n.s./-	0.17/0	Pastuchová, 2008
<i>Rhyacophila</i> sp.	1				Bohle, 2000
<i>Rhyacophila tristis</i>	1	0.25/-	n.s./-	0.25/0	
<i>Sericostoma personatum</i>	2				Pastuchová, 2008; Sommerhäuser et al., 1995
<i>Sericostoma</i> sp.	2	0.52/0.64	n.s./*	0.83/0.81	Meyer and Meyer, 2000
<i>Silo pallipes</i>	1	0.44/-	n.s./-	0.58/0	Pastuchová, 2008
<i>Silo piceus</i>	1				Pastuchová, 2008
<i>Synagapetus iridipennis</i>	1	-/-	-/-	0.08/0	Pastuchová, 2008
<i>Tinodes assimilis</i>	1				Sommerhäuser et al., 1995
<i>Tinodes pallidulus</i>	1				Sommerhäuser et al., 1995
<i>Tinodes rostocki</i>	1				Pastuchová, 2008
<i>Tinodes waeneri</i>	1				Sommerhäuser et al., 1995
<i>Wormaldia occipitalis</i>	1				Pastuchová, 2008
Diptera					
<i>Ablabesmyia</i> sp.	1	0.17/-	n.s./-	0.17/0.04	
<i>Atherix ibis</i>	2	-/0.11	-/n.s.	0/0.11	Meyer and Meyer, 2000
<i>Berdeniella</i> sp.	2	0.42/0.15	*/n.s.	0.42/0.15	
<i>Brillia longifurca</i>	1	0.22/0.15	n.s./n.s.	0.33/0.15	
Ceratopogonidae Gen. sp.	1	0.33/-	n.s./-	0.33/11	
<i>Dicranota</i> sp.	2	0.82/0.47	**/n.s.	0.92/0.67	Meyer and Meyer, 2000
<i>Eloephila</i> sp.	1	-/0.41	-/n.s.	0.67/0.7	Meyer and Meyer, 2000
<i>Eukiefferiella devonica/ilkleysensis</i>	1	0.17/0.04	n.s./n.s.	0.17/0.04	
<i>Hemerodromia</i> sp.	2	0.5/0.24	**/n.s.	0.5/0.26	Opatrilova et al., 2005
<i>Ibisia marginata</i>	2	0.57/0.44	**/*	0.58/0.44	
<i>Microtendipes rydalensis-Gr.</i>	1	0.25/0.19	n.s./n.s.	0.25/0.19	
<i>Paratrissocladius excerptus</i>	1	0.27/0.19	n.s./n.s.	0.42/0.19	
<i>Peripsychoda</i> sp.	1	0.17/0.04	n.s./n.s.	0.17/0.04	
<i>Pilaria</i> sp.	1	-/0.15	-/n.s.	0/0.15	
<i>Polypedilum albicorne</i>	1	0.13/0.11	n.s./n.s.	0.25/0.11	
<i>Polypedilum convictum-Gr.</i>	2	-/0.49	-/*	0.25/0.56	
<i>Polypedilum pedestre-Gr.</i>	1	-/0.15	-/n.s.	0/0.15	
<i>Potthastia longimana</i>	2	0.25/0.37	n.s./*	0.25/0.37	
<i>Prosimulium hirtipes</i>	1	0.33/-	n.s./-	0.33/0	
<i>Rheotanytarsus</i> sp.	2	0.17/0.22	n.s./n.s.	0.17/0.22	Meyer and Meyer, 2000
<i>Scleroprocta</i> sp.	1	0.17/0.1	n.s./n.s.	0.17/0.11	
<i>Simulium angustitarse</i>	1	0.17/-	n.s./-	0.17/0.07	
<i>Simulium variegatum</i>	1	0.25/0.11	n.s./n.s.	0.25/0.11	
<i>Stempellinella brevis</i>	1	0.3/0.15	n.s./n.s.	0.67/0.15	
Stratiomyidae Gen. sp.	1				Fenoglio et al., 2007
<i>Thienemanniella</i> sp.	2	0.58/0.24	*/n.s.	0.58/0.3	
<i>Thienemannimyia</i> sp.	2	0.42/0.12	*/n.s.	0.42/0.15	
<i>Tvetenia bavarica/calvescens</i>	2	0.44/0.41	n.s./*	0.5/0.41	Moller Pillot, 2013

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785 **References for Appendix A**

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889 **Appendix B**

890 Table B.1: List of benthic macroinvertebrates collected during the study and their frequency of
 891 occurrence and mean density in three flow intermittence categories.

	Frequency			Density		
	Perennial	Near-perennial	Intermittent	Perennial	Near-perennial	Intermittent
Coelenterata						
<i>Hydra</i> sp.	0.02	0.00	0.00	0.13	0.00	0.00
Turbellaria						
<i>Crenobia alpina</i>	0.02	0.05	0.04	0.33	0.11	0.07
<i>Dendrocoelum lacteum</i>	0.02	0.05	0.00	0.02	0.42	0.00
<i>Dugesia gonocephala</i>	0.80	0.26	0.07	42.82	1.89	0.15
<i>Dugesia polychroa</i>	0.10	0.00	0.00	2.66	0.00	0.00
<i>Polycelis tenuis</i>	0.02	0.05	0.00	0.03	0.42	0.00
Mollusca						
<i>Ancylus fluviatilis</i>	0.31	0.32	0.07	12.79	6.11	0.19
<i>Bythinella austriaca</i> agg.	0.16	0.42	0.56	2.51	2.58	29.22
<i>Galba truncatula</i>	0.11	0.16	0.33	0.36	3.16	5.81
<i>Gyraulus albus</i>	0.02	0.05	0.00	0.13	0.11	0.00
<i>Gyrinus substriatus</i>	0.03	0.00	0.00	0.11	0.00	0.00
<i>Musculium lacustre</i>	0.00	0.00	0.04	0.00	0.00	0.04
<i>Pisidium</i> sp.	0.77	1.00	0.89	113.05	254.16	76.67
<i>Potamopyrgus antipodarum</i>	0.05	0.16	0.04	0.89	0.84	6.56
<i>Radix ovata</i>	0.08	0.05	0.00	6.90	0.26	0.00
<i>Radix peregra</i>	0.00	0.00	0.11	0.00	0.00	5.67
Nematoida						
Nematoda	0.31	0.26	0.26	1.89	0.95	3.04
Nematomorpha	0.02	0.00	0.04	0.02	0.00	0.11
Oligochaeta						
<i>Achaeta</i> sp.	0.00	0.00	0.07	0.00	0.00	0.22
<i>Aulodrilus japonicus</i>	0.15	0.16	0.04	2.57	10.53	0.30
<i>Aulodrilus limnobius</i>	0.00	0.05	0.00	0.00	0.11	0.00
<i>Aulodrilus plurisetia</i>	0.00	0.00	0.04	0.00	0.00	0.04
<i>Bryodrilus</i> sp.	0.00	0.00	0.04	0.00	0.00	1.04
<i>Cernosvitoviella</i> sp.	0.07	0.11	0.04	0.43	1.26	0.59
<i>Cognettia glandulosa</i>	0.13	0.16	0.33	1.15	1.74	6.52
<i>Cognettia sphagnetorum</i>	0.23	0.00	0.19	2.82	0.00	7.70
<i>Eiseniella tetraedra</i>	0.57	0.79	0.89	5.34	6.74	41.30
<i>Enchytraeus</i> sp.	0.05	0.11	0.22	0.39	0.21	22.59
<i>Epirodilus pygmaeus</i>	0.08	0.32	0.15	0.36	4.21	3.33
<i>Haplotaxis gordioides</i>	0.20	0.16	0.41	0.46	0.42	1.85
<i>Henlea/Fridericia</i> sp.	0.52	0.47	0.89	6.48	4.05	56.63
<i>Limnodrilus claparedeanus</i>	0.05	0.00	0.00	0.48	0.00	0.00
<i>Limnodrilus hoffmeisteri</i>	0.38	0.37	0.22	7.69	9.16	3.89
<i>Limnodrilus profundicola</i>	0.00	0.05	0.00	0.00	0.05	0.00

	Frequency			Density		
	Perennial	Near-perennial	Intermittent	Perennial	Near-perennial	Intermittent
<i>Limnodrilus udekemianus</i>	0.03	0.05	0.00	0.16	0.16	0.00
Lumbricidae Gen. sp.	0.26	0.21	0.52	0.57	0.32	1.89
<i>Lumbriculus variegatus</i>	0.33	0.37	0.11	4.10	2.26	0.93
<i>Marionina</i> sp.	0.13	0.26	0.33	1.48	1.58	6.44
<i>Mesenchytraeus armatus</i>	0.10	0.00	0.33	0.72	0.00	2.48
<i>Nais alpina</i>	0.38	0.16	0.04	17.67	10.26	0.07
<i>Nais barbata</i>	0.02	0.00	0.00	0.07	0.00	0.00
<i>Nais bretscheri</i>	0.10	0.05	0.00	0.92	0.95	0.00
<i>Nais communis</i>	0.36	0.32	0.30	6.02	20.37	5.63
<i>Nais elinguis</i>	0.18	0.37	0.33	11.13	22.58	122.59
<i>Nais christinae</i>	0.02	0.00	0.00	0.07	0.00	0.00
<i>Nais pardalis</i>	0.02	0.05	0.00	0.13	1.00	0.00
<i>Nais stolci</i>	0.05	0.00	0.00	2.56	0.00	0.00
<i>Nais variabilis</i>	0.02	0.16	0.07	0.03	14.53	2.74
<i>Ophidonais serpentina</i>	0.16	0.05	0.04	3.77	0.32	1.19
<i>Pristina aequisetata</i>	0.03	0.11	0.00	0.13	1.05	0.00
<i>Pristinella rosea</i> Gr.	0.25	0.16	0.22	3.74	1.00	0.81
<i>Propappus volki</i>	0.28	0.00	0.00	33.89	0.00	0.00
<i>Psammoryctides barbatus</i>	0.26	0.32	0.11	7.39	16.84	3.00
<i>Rhyacodrilus coccineus</i>	0.15	0.16	0.00	2.00	4.26	0.00
<i>Rhyacodrilus falciformis</i>	0.23	0.26	0.26	1.08	0.58	1.59
<i>Rhyacodrilus subterraneus</i>	0.05	0.00	0.00	0.79	0.00	0.00
<i>Rhypholophus haemorrhoidalis</i>	0.03	0.05	0.37	0.10	0.42	1.19
<i>Slavina appendiculata</i>	0.05	0.05	0.00	3.84	0.42	0.00
<i>Spirosperma ferrox</i>	0.02	0.00	0.00	0.07	0.00	0.00
<i>Stylodrilus brachystylus</i>	0.28	0.26	0.07	47.69	82.42	38.67
<i>Stylodrilus heringianus</i>	0.64	0.53	0.67	48.97	37.63	289.52
<i>Trichodrilus</i> sp.	0.23	0.05	0.15	6.74	0.63	0.59
<i>Trichodrilus strandi</i>	0.11	0.11	0.04	12.98	3.26	0.89
<i>Tubifex tubifex</i>	0.54	0.63	0.22	72.00	7.00	2.89

Hirudinea

<i>Erpobdella octoculata</i>	0.13	0.11	0.07	0.87	0.16	0.19
<i>Erpobdella vilnensis</i>	0.20	0.21	0.07	0.54	0.47	0.19
<i>Glossiphonia complanata</i>	0.03	0.11	0.04	0.10	0.16	0.07
<i>Glossiphonia nebulosa</i>	0.02	0.05	0.00	0.07	0.11	0.00
<i>Glossosoma conformis</i>	0.05	0.00	0.00	0.34	0.00	0.00
<i>Haemopsis sanguisuga</i>	0.02	0.11	0.11	0.03	0.21	0.48
<i>Helobdella stagnalis</i>	0.02	0.00	0.00	0.02	0.00	0.00

Acari

Hydracarina	0.43	0.32	0.15	9.43	1.21	0.48
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Crustacea

<i>Asellus aquaticus</i>	0.05	0.16	0.07	0.21	8.32	0.26
Copepoda	0.07	0.00	0.11	0.56	0.00	1.07

	Frequency			Density		
	Perennial	Near-perennial	Intermittent	Perennial	Near-perennial	Intermittent
<i>Gammarus fossarum</i>	0.79	0.89	0.63	1811.13	2533.32	43.26
<i>Gammarus roeselii</i>	0.10	0.16	0.11	3.39	3.37	0.96
<i>Niphargus aquilex</i>	0.02	0.00	0.19	0.02	0.00	4.89
Ephemeroptera						
<i>Baetis alpinus</i>	0.02	0.00	0.00	0.15	0.00	0.00
<i>Baetis buceratus</i>	0.03	0.00	0.00	0.18	0.00	0.00
<i>Baetis fuscatus</i>	0.02	0.11	0.00	0.03	1.37	0.00
<i>Baetis liebenauae</i>	0.02	0.00	0.00	0.07	0.00	0.00
<i>Baetis muticus</i>	0.84	0.47	0.11	83.92	9.68	1.70
<i>Baetis niger</i>	0.16	0.16	0.00	3.95	0.37	0.00
<i>Baetis rhodani</i>	0.97	0.89	0.44	229.98	103.63	11.93
<i>Baetis vernus</i>	0.11	0.26	0.07	3.07	9.47	0.48
<i>Caenis luctuosa</i>	0.00	0.00	0.04	0.00	0.00	0.07
<i>Caenis macrura</i>	0.02	0.05	0.04	0.13	0.05	0.15
<i>Caenis pseudorivulorum</i>	0.02	0.00	0.00	0.03	0.00	0.00
<i>Centroptilum luteolum</i>	0.64	0.53	0.44	26.44	58.63	43.44
<i>Centroptilum pennulatum</i>	0.02	0.00	0.00	0.03	0.00	0.00
<i>Cloeon dipterum</i> s. lat.	0.00	0.05	0.11	0.00	0.68	11.19
<i>Ecdyonurus aurantiacus</i>	0.02	0.05	0.00	0.28	0.21	0.00
<i>Ecdyonurus austriacus</i>	0.07	0.00	0.07	0.66	0.00	1.07
<i>Ecdyonurus dispar</i>	0.00	0.00	0.04	0.00	0.00	0.04
<i>Ecdyonurus helveticus</i> -Gr.	0.07	0.05	0.04	0.80	0.21	0.04
<i>Ecdyonurus macani</i>	0.02	0.00	0.00	0.03	0.00	0.00
<i>Ecdyonurus picteti</i>	0.05	0.05	0.04	0.75	0.37	0.04
<i>Ecdyonurus starmachi</i>	0.00	0.00	0.04	0.00	0.00	0.11
<i>Ecdyonurus subalpinus</i>	0.36	0.26	0.22	50.46	13.63	1.78
<i>Ecdyonurus submontanus</i>	0.02	0.00	0.00	0.20	0.00	0.00
<i>Ecdyonurus torrentis</i>	0.43	0.32	0.00	24.41	2.95	0.00
<i>Ecdyonurus venosus</i>	0.07	0.00	0.00	0.57	0.00	0.00
<i>Electrogena lateralis</i>	0.05	0.11	0.00	0.62	0.21	0.00
<i>Electrogena quadrilineata</i>	0.03	0.00	0.07	6.64	0.00	1.30
<i>Electrogena ujhelyii</i>	0.57	0.58	0.26	87.93	118.37	2.81
<i>Epeorus assimilis</i>	0.28	0.00	0.00	7.72	0.00	0.00
<i>Ephemera danica</i>	0.75	0.63	0.04	40.80	26.68	0.44
<i>Ephemerella mucronata</i>	0.10	0.00	0.00	5.02	0.00	0.00
<i>Ephemerella notata</i>	0.02	0.00	0.04	0.33	0.00	0.07
<i>Habroleptoides confusa</i>	0.79	0.74	0.44	211.72	120.89	16.96
<i>Habrophlebia fusca</i>	0.11	0.32	0.15	1.95	5.84	5.15
<i>Habrophlebia lauta</i>	0.87	0.79	0.30	78.84	72.63	16.48
<i>Leptophlebia marginata</i>	0.02	0.00	0.00	0.02	0.00	0.00
<i>Metreletus balcanicus</i>	0.00	0.00	0.07	0.00	0.00	0.63
<i>Paraleptophlebia submarginata</i>	0.56	0.53	0.22	18.00	7.11	10.19
<i>Rhithrogena carpatoalpina</i>	0.28	0.32	0.04	29.02	1.68	0.04

	Frequency			Density		
	Perennial	Near-perennial	Intermittent	Perennial	Near-perennial	Intermittent
<i>Rhithrogena iridina/picteti</i>	0.70	0.32	0.30	121.93	1.16	1.89
<i>Rhithrogena semicolorata</i>	0.08	0.00	0.04	5.61	0.00	0.07
<i>Siphonurus aestivalis</i>	0.05	0.05	0.19	0.25	0.68	18.52
<i>Siphonurus armatus</i>	0.00	0.00	0.04	0.00	0.00	0.07
<i>Siphonurus lacustris</i>	0.00	0.05	0.00	0.00	0.21	0.00
<i>Torleya major</i>	0.26	0.00	0.00	11.51	0.00	0.00

Odonata

<i>Aeshna cyanea</i>	0.00	0.00	0.04	0.00	0.00	0.07
<i>Calopteryx virgo</i>	0.15	0.05	0.07	0.66	0.11	0.26
<i>Cordulegaster bidentata</i>	0.00	0.05	0.00	0.00	0.11	0.00
<i>Cordulegaster boltonii</i>	0.13	0.11	0.00	0.66	0.11	0.00

Plecoptera

<i>Amphinemura</i> sp.	0.30	0.16	0.07	21.28	0.53	1.44
<i>Brachyptera risi</i>	0.28	0.21	0.41	8.03	26.63	83.52
<i>Brachyptera seticornis</i>	0.03	0.00	0.00	1.00	0.00	0.00
<i>Capnia bifrons</i>	0.26	0.37	0.41	11.39	44.58	94.26
<i>Dinocras cephalotes</i>	0.08	0.00	0.00	2.84	0.00	0.00
<i>Diura bicaudata</i>	0.05	0.00	0.00	0.08	0.00	0.00
<i>Isoperla grammatica</i>	0.11	0.16	0.19	6.64	7.00	27.19
<i>Isoperla oxylepis</i>	0.23	0.21	0.00	11.70	20.42	0.00
<i>Isoperla rivulorum</i>	0.10	0.05	0.00	1.77	0.47	0.00
<i>Isoperla tripartita</i>	0.11	0.37	0.41	4.61	16.63	35.85
<i>Leuctra braueri</i>	0.05	0.00	0.04	0.18	0.00	0.07
<i>Leuctra nigra</i>	0.15	0.11	0.04	1.11	0.68	0.22
<i>Leuctra pseudosignifera</i>	0.10	0.00	0.00	0.46	0.00	0.00
<i>Leuctra</i> sp.	0.72	0.79	0.33	163.98	7.74	2.56
<i>Nemoura</i> sp.	0.84	1.00	0.74	179.26	188.84	152.00
<i>Nemurella picteti</i>	0.02	0.00	0.00	0.15	0.00	0.00
<i>Perla burmeisteriana</i>	0.07	0.00	0.00	0.25	0.00	0.00
<i>Perla marginata</i>	0.03	0.00	0.00	0.13	0.00	0.00
<i>Perlodes microcephalus</i>	0.10	0.00	0.00	0.13	0.00	0.00
<i>Protonemura</i> sp.	0.48	0.11	0.11	47.62	0.63	1.93
<i>Siphonoperla</i> sp.	0.20	0.16	0.00	7.59	1.79	0.00
<i>Taeniopteryx</i> sp.	0.02	0.00	0.00	0.03	0.00	0.00

Heteroptera

<i>Aquarius paludum</i>	0.02	0.00	0.00	0.02	0.00	0.00
<i>Gerris lacustris</i>	0.05	0.05	0.00	0.18	0.05	0.00
<i>Gerris odontogaster</i>	0.00	0.00	0.04	0.00	0.00	0.07
<i>Micronecta</i> sp.	0.07	0.05	0.04	2.44	1.58	0.11
<i>Velia caprai</i>	0.03	0.05	0.04	0.07	0.05	0.04
<i>Velia saulii</i>	0.05	0.05	0.07	0.07	0.26	0.30

Neuroptera

<i>Osmylus fulvicephalus</i>	0.02	0.00	0.00	0.02	0.00	0.00
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	Frequency			Density		
	Perennial	Near-perennial	Intermittent	Perennial	Near-perennial	Intermittent
Megaloptera						
<i>Sialis fuliginosa</i>	0.49	0.63	0.26	4.30	10.32	2.44
Trichoptera						
<i>Agapetus fuscipes</i>	0.08	0.00	0.00	4.79	0.00	0.00
<i>Allogamus auricollis</i>	0.00	0.05	0.00	0.00	0.05	0.00
<i>Allogamus uncatu</i>	0.00	0.00	0.04	0.00	0.00	0.07
<i>Athripsodes bilineatus</i>	0.26	0.21	0.19	3.98	1.47	0.33
<i>Beraeodes minutus</i>	0.00	0.16	0.15	0.00	0.32	0.22
<i>Brachycentrus montanus</i>	0.08	0.00	0.00	1.02	0.00	0.00
<i>Crunoecia irrorata</i>	0.00	0.00	0.07	0.00	0.00	0.19
<i>Cyrnus trimaculatus</i>	0.07	0.05	0.00	0.21	0.11	0.00
<i>Drusus annulatus</i>	0.08	0.26	0.11	0.61	1.58	0.22
<i>Ecclisopteryx dalecarlica</i>	0.07	0.00	0.07	0.79	0.00	0.07
<i>Ecclisopteryx madida</i>	0.05	0.05	0.00	1.34	0.11	0.00
<i>Glyphotaelius pellucidus</i>	0.05	0.05	0.30	0.16	0.05	2.30
<i>Halesus</i> sp.	0.31	0.32	0.22	12.25	5.26	1.78
<i>Hydatophylax infumatus</i>	0.02	0.00	0.00	0.02	0.00	0.00
<i>Hydropsyche</i> sp.	0.93	0.63	0.19	93.03	11.63	0.96
<i>Chaetopteryx fusca</i>	0.02	0.05	0.00	0.02	3.63	0.00
<i>Chaetopteryx major</i>	0.16	0.05	0.11	3.20	5.53	0.96
<i>Chaetopteryx villosa</i>	0.07	0.11	0.30	0.46	0.21	0.48
<i>Ironoquia dubia</i>	0.00	0.00	0.07	0.00	0.00	0.11
<i>Lasiocephala basalis</i>	0.11	0.00	0.00	0.48	0.00	0.00
<i>Lepidostoma hirtum</i>	0.10	0.00	0.00	7.30	0.00	0.00
<i>Limnephilus lunatus</i>	0.00	0.05	0.00	0.00	0.11	0.00
<i>Limnephilus rhombicus</i>	0.02	0.05	0.00	0.13	0.05	0.00
<i>Limnephilus</i> sp.	0.02	0.11	0.04	0.07	0.16	0.04
<i>Lithax obscurus</i>	0.03	0.00	0.00	0.05	0.00	0.00
<i>Lype</i> sp.	0.43	0.32	0.04	2.75	1.47	0.07
<i>Micrasema longulum</i>	0.05	0.00	0.00	0.30	0.00	0.00
<i>Micrasema minimum</i>	0.02	0.00	0.00	0.07	0.00	0.00
<i>Micropterna nycterobia</i>	0.02	0.26	0.26	0.07	1.32	1.41
<i>Micropterna</i> sp.	0.02	0.05	0.26	0.03	0.42	12.37
<i>Mystacides azurea</i>	0.10	0.05	0.00	1.05	0.21	0.00
<i>Odontocerum albicorne</i>	0.62	0.32	0.07	8.33	1.16	0.30
<i>Oecismus monedula</i>	0.21	0.00	0.04	1.16	0.00	0.15
<i>Oligostomis reticulata</i>	0.02	0.00	0.00	0.02	0.00	0.00
<i>Philopotamus ludificatus</i>	0.08	0.00	0.00	2.03	0.00	0.00
<i>Philopotamus montanus</i>	0.26	0.00	0.00	20.95	0.00	0.00
<i>Plectrocnemia brevis</i>	0.00	0.00	0.04	0.00	0.00	0.07
<i>Plectrocnemia conspersa</i>	0.18	0.32	0.30	7.97	12.53	8.11
<i>Polycentropus flavomaculatus</i>	0.49	0.37	0.04	14.56	4.84	0.07
<i>Polycentropus irroratus</i>	0.11	0.05	0.00	1.13	0.42	0.00

	Frequency			Density		
	Perennial	Near-perennial	Intermittent	Perennial	Near-perennial	Intermittent
<i>Potamophylax</i> sp.	0.59	0.37	0.15	8.95	2.53	0.89
<i>Psychomyia pusilla</i>	0.02	0.00	0.00	0.03	0.00	0.00
<i>Ptilocolepus granulatus</i>	0.02	0.00	0.00	0.03	0.00	0.00
<i>Rhyacophila</i> cf. <i>fasciata</i>	0.21	0.11	0.04	1.77	0.84	0.07
<i>Rhyacophila nubila</i>	0.11	0.05	0.00	1.66	0.79	0.00
<i>Rhyacophila polonica</i>	0.08	0.00	0.07	0.69	0.00	0.22
<i>Rhyacophila tristis</i>	0.11	0.05	0.00	2.33	0.05	0.00
<i>Sericostoma</i> sp.	0.82	0.68	0.19	21.85	15.63	0.41
<i>Silo nigricornis</i>	0.02	0.00	0.00	0.07	0.00	0.00
<i>Silo pallipes</i>	0.21	0.11	0.00	1.93	1.05	0.00
<i>Stenophylax permistus</i>	0.00	0.11	0.11	0.00	0.26	0.19
<i>Synagapetus iridipennis</i>	0.03	0.00	0.04	0.26	0.00	0.15
<i>Synagapetus moselyi</i>	0.07	0.11	0.22	0.23	1.89	18.67
<i>Tinodes</i> sp.	0.46	0.37	0.04	7.34	2.79	0.15

Coleoptera

<i>Agabus guttatus</i>	0.03	0.32	0.67	0.13	1.21	12.22
<i>Anacaena globulus</i>	0.02	0.11	0.11	0.03	0.16	0.19
<i>Contacyphon</i> sp.	0.00	0.00	0.11	0.00	0.00	1.11
<i>Deronectes latus</i>	0.05	0.00	0.00	0.10	0.00	0.00
<i>Elmis aenea</i>	0.46	0.37	0.15	25.64	1.16	1.19
<i>Elmis latreillei</i>	0.00	0.00	0.04	0.00	0.00	0.07
<i>Elmis maugetii</i>	0.93	0.84	0.67	86.97	138.89	14.37
<i>Odeles</i> sp.	0.25	0.00	0.04	1.34	0.00	0.15
<i>Elodes</i> sp.	0.43	0.84	0.26	5.74	19.16	0.48
<i>Esolus angustatus</i>	0.11	0.21	0.22	2.07	1.84	7.78
<i>Esolus parallelepipedus</i>	0.16	0.00	0.15	1.72	0.00	0.30
<i>Haliphus lineatocollis</i>	0.00	0.00	0.04	0.00	0.00	0.04
<i>Haliphus</i> sp.	0.00	0.00	0.04	0.00	0.00	0.07
<i>Hydraena belgica</i>	0.05	0.00	0.00	1.20	0.00	0.00
<i>Hydraena dentipes</i>	0.11	0.00	0.04	4.23	0.00	0.07
<i>Hydraena excisa</i>	0.23	0.32	0.41	3.20	13.63	5.04
<i>Hydraena gracilis</i>	0.89	0.79	0.52	71.30	58.37	13.33
<i>Hydraena melas</i>	0.05	0.00	0.07	0.46	0.00	0.15
<i>Hydraena nigrita</i>	0.23	0.42	0.41	2.36	5.00	2.00
<i>Hydraena paganettii</i>	0.00	0.05	0.00	0.00	0.21	0.00
<i>Hydraena pygmaea</i>	0.05	0.00	0.00	0.38	0.00	0.00
<i>Hydraena riparia</i>	0.41	0.32	0.26	9.13	5.37	1.93
<i>Hydraena rufipes</i>	0.02	0.00	0.04	0.07	0.00	0.07
<i>Hydraena saga</i>	0.13	0.00	0.00	0.66	0.00	0.00
<i>Hydraena schuleri</i>	0.11	0.05	0.00	0.74	0.21	0.00
<i>Hydraena subimpressa</i>	0.03	0.00	0.00	0.15	0.00	0.00
<i>Hydraena truncata</i>	0.00	0.00	0.04	0.00	0.00	0.04
<i>Hydrocyphon deflexicollis</i>	0.02	0.00	0.00	0.03	0.00	0.00

	Frequency			Density		
	Perennial	Near-perennial	Intermittent	Perennial	Near-perennial	Intermittent
<i>Hydroporus palustris</i>	0.00	0.05	0.00	0.00	0.05	0.00
<i>Hydroporus planus</i>	0.00	0.00	0.04	0.00	0.00	0.04
<i>Ilybius</i> sp.	0.02	0.05	0.00	0.07	0.32	0.00
<i>Laccobius bipunctatus</i>	0.02	0.00	0.00	0.07	0.00	0.00
<i>Laccobius obscuratus</i>	0.02	0.00	0.00	0.07	0.00	0.00
<i>Limnebius truncatellus</i>	0.13	0.00	0.04	0.49	0.00	0.04
<i>Limnius perrisi</i>	0.39	0.11	0.07	54.25	0.37	0.96
<i>Limnius volckmari</i>	0.82	0.79	0.33	34.20	49.63	4.48
<i>Orectochilus villosus</i>	0.15	0.05	0.00	2.57	0.32	0.00
<i>Oreodytes sanmarkii</i>	0.03	0.00	0.00	0.05	0.00	0.00
<i>Oulimnius tuberculatus</i>	0.28	0.21	0.04	3.41	1.58	0.11
<i>Platambus maculatus</i>	0.33	0.68	0.44	2.80	26.74	7.07
<i>Riolus cupreus</i>	0.02	0.05	0.00	0.07	1.58	0.00
<i>Riolus subviolaceus</i>	0.08	0.16	0.00	3.72	4.53	0.00

Diptera (excl. Chironomidae)

<i>Acanthocnema glaucescens</i>	0.02	0.00	0.00	0.03	0.00	0.00
<i>Antocha</i> sp.	0.10	0.05	0.00	0.62	0.11	0.00
<i>Atherix ibis</i>	0.05	0.00	0.00	0.34	0.00	0.00
<i>Berdeniella</i> sp.	0.15	0.00	0.00	2.21	0.00	0.00
<i>Beris vallata</i>	0.02	0.00	0.00	0.03	0.00	0.00
<i>Bezzia</i> sp.	0.51	0.47	0.33	6.18	10.84	3.33
Ceratopogonidae	0.21	0.16	0.19	1.54	0.84	1.37
<i>Clinocera/Wiedemannia</i> sp.	0.11	0.05	0.00	1.87	0.53	0.00
<i>Clytocerus</i> sp.	0.00	0.00	0.07	0.00	0.00	0.37
<i>Dicranomyia</i> sp.	0.00	0.00	0.04	0.00	0.00	0.30
<i>Dicranota</i> sp.	0.70	0.63	0.30	20.48	11.21	0.81
<i>Dixa</i> sp.	0.28	0.21	0.07	1.48	1.32	0.15
Dolichopodidae	0.10	0.11	0.04	0.49	0.21	0.07
<i>Eloeophila</i> sp.	0.69	0.63	0.19	8.95	14.26	0.59
Ephydriidae	0.03	0.00	0.00	0.10	0.00	0.00
<i>Erioptera</i> sp.	0.02	0.00	0.00	0.07	0.00	0.00
<i>Fannia</i> sp.	0.00	0.00	0.04	0.00	0.00	0.07
<i>Gonomyia</i> sp.	0.03	0.00	0.00	0.10	0.00	0.00
<i>Hemerodromia</i> sp.	0.28	0.11	0.04	11.26	0.37	0.15
<i>Hexatoma</i> sp.	0.36	0.16	0.37	2.49	3.05	3.30
<i>Chelifera</i> sp.	0.44	0.42	0.37	11.87	7.95	15.63
<i>Chrysopilus auratus</i>	0.10	0.05	0.26	0.48	0.11	0.74
<i>Chrysops</i> sp.	0.38	0.47	0.33	3.05	9.47	1.89
<i>Ibisia marginata</i>	0.46	0.16	0.07	47.87	0.42	0.26
<i>Jungiella</i> sp.	0.02	0.00	0.00	0.46	0.00	0.00
<i>Limnophila</i> sp.	0.03	0.00	0.07	0.20	0.00	0.11
<i>Limonia</i> sp.	0.03	0.00	0.11	0.16	0.00	0.30
<i>Molophilus</i> sp.	0.11	0.26	0.26	0.54	1.16	22.56

	Frequency			Density		
	Perennial	Near-perennial	Intermittent	Perennial	Near-perennial	Intermittent
Muscidae	0.08	0.05	0.11	0.46	0.11	0.56
<i>Nemotelus</i> sp.	0.00	0.00	0.04	0.00	0.00	0.07
<i>Neolimnomyia</i> sp.	0.05	0.11	0.00	0.13	0.21	0.00
<i>Orimarga</i> sp.	0.00	0.00	0.04	0.00	0.00	0.07
<i>Oxycera</i> sp.	0.10	0.11	0.22	0.31	1.42	6.89
<i>Pedicia</i> sp.	0.31	0.53	0.19	1.90	3.95	1.00
<i>Pericoma</i> sp.	0.11	0.37	0.19	2.18	6.26	0.56
<i>Peripsychoda</i> sp.	0.07	0.05	0.00	0.59	0.84	0.00
<i>Pilaria</i> sp.	0.11	0.11	0.11	0.46	0.26	0.41
<i>Pneumia</i> sp.	0.07	0.11	0.00	0.52	0.16	0.00
<i>Prosimulium hirtipes</i>	0.10	0.00	0.00	19.67	0.00	0.00
<i>Prosimulium latimucro</i>	0.00	0.00	0.04	0.00	0.00	1.96
<i>Prosimulium rufipes</i>	0.00	0.00	0.04	0.00	0.00	1.04
<i>Prosimulium tomosvaryi</i>	0.33	0.42	0.37	130.51	65.21	86.96
<i>Psychoda</i> sp.	0.02	0.00	0.04	0.03	0.00	0.04
<i>Ptychoptera</i> sp.	0.41	0.32	0.04	13.93	17.58	0.07
Sciomyzidae	0.00	0.00	0.07	0.00	0.00	0.15
<i>Scleroprocta</i> sp.	0.20	0.16	0.04	0.85	0.32	0.04
<i>Simulium angustipes</i>	0.15	0.26	0.19	7.20	6.11	4.63
<i>Simulium angustitarse</i>	0.08	0.05	0.11	0.28	0.84	0.30
<i>Simulium argyreatum</i>	0.08	0.05	0.07	5.84	0.11	0.11
<i>Simulium brevidens</i>	0.02	0.00	0.00	1.05	0.00	0.00
<i>Simulium carpathicum</i>	0.00	0.00	0.04	0.00	0.00	0.04
<i>Simulium costatum</i>	0.10	0.05	0.04	2.48	0.05	0.15
<i>Simulium cryophilum</i>	0.16	0.11	0.07	3.89	1.16	12.78
<i>Simulium equinum</i>	0.02	0.00	0.00	0.03	0.00	0.00
<i>Simulium noelleri</i>	0.00	0.11	0.11	0.00	1.16	1.33
<i>Simulium ornatum</i>	0.28	0.42	0.19	3.10	131.68	0.63
<i>Simulium reptans</i>	0.05	0.00	0.00	1.44	0.00	0.00
<i>Simulium trifasciatum</i>	0.00	0.00	0.04	0.00	0.00	0.33
<i>Simulium variegatum</i>	0.11	0.00	0.04	7.67	0.00	0.11
<i>Simulium venum</i>	0.31	0.58	0.37	7.54	10.11	5.26
<i>Tabanus miki</i>	0.00	0.00	0.04	0.00	0.00	0.07
<i>Tabanus</i> sp.	0.03	0.00	0.04	0.05	0.00	0.07
<i>Tipula lateralis</i>	0.00	0.05	0.00	0.00	0.21	0.00
<i>Tipula maxima</i>	0.28	0.68	0.44	1.66	9.37	1.41
<i>Tipula saginata</i>	0.20	0.16	0.07	0.82	1.89	0.15
<i>Tipula unca</i>	0.02	0.00	0.07	0.07	0.00	0.15
<i>Tipula vittata</i>	0.00	0.00	0.04	0.00	0.00	0.19
Chironomidae						
<i>Ablabesmyia</i> sp.	0.08	0.05	0.07	1.41	0.47	0.37
<i>Apsectrotanypus trifascipennis</i>	0.39	0.53	0.15	3.28	51.00	0.78
<i>Brillia bifida</i>	0.62	0.89	0.78	25.57	69.26	29.11

	Frequency			Density		
	Perennial	Near-perennial	Intermittent	Perennial	Near-perennial	Intermittent
<i>Brillia longifurca</i>	0.21	0.11	0.07	0.87	0.32	0.15
<i>Bryophaenocladus</i> sp.	0.02	0.05	0.00	0.13	0.11	0.00
<i>Cladotanytarsus vanderwulpi</i> -Gr.	0.03	0.00	0.00	0.26	0.00	0.00
<i>Conchapelopia</i> sp.	0.74	0.74	0.48	24.93	36.63	10.96
<i>Corynoneura coronata</i> -Gr.	0.02	0.00	0.04	0.23	0.00	0.07
<i>Corynoneura lobata</i>	0.31	0.37	0.37	2.95	5.21	4.41
<i>Cricotopus albiforceps</i>	0.00	0.05	0.00	0.00	0.11	0.00
<i>Cricotopus bicinctus</i>	0.03	0.00	0.04	0.30	0.00	0.15
<i>Cricotopus patens/flavocinctus</i>	0.02	0.00	0.00	0.26	0.00	0.00
<i>Cricotopus</i> sp.	0.10	0.05	0.00	1.66	0.11	0.00
<i>Cricotopus sylvestris</i> -Gr.	0.00	0.00	0.04	0.00	0.00	0.07
<i>Cricotopus tremulus</i> -Gr.	0.07	0.11	0.00	1.21	0.47	0.00
<i>Cricotopus trifascia</i>	0.02	0.00	0.00	0.79	0.00	0.00
<i>Cryptochironomus</i> sp.	0.03	0.00	0.00	0.10	0.00	0.00
<i>Demicrochironomus</i> sp.	0.03	0.00	0.00	0.20	0.00	0.00
<i>Diamesa cinerella</i> -Gr.	0.20	0.26	0.30	30.69	21.68	51.41
<i>Dicrotendipes</i> sp.	0.00	0.00	0.04	0.00	0.00	0.59
<i>Diplocladius cultriger</i>	0.16	0.53	0.52	0.97	19.95	24.37
<i>Epoicocladus ephemerae</i>	0.51	0.32	0.00	5.10	9.32	0.00
<i>Eukiefferiella brevicar</i>	0.34	0.32	0.30	7.11	5.84	5.52
<i>Eukiefferiella claripennis</i>	0.00	0.21	0.04	0.00	2.42	0.37
<i>Eukiefferiella cf. clypeata</i>	0.03	0.00	0.00	0.08	0.00	0.00
<i>Eukiefferiella devonica/ilkeleyensis</i>	0.10	0.16	0.00	0.98	1.37	0.00
<i>Eukiefferiella gracei</i> -Gr.	0.07	0.05	0.04	0.39	0.95	0.15
<i>Eukiefferiella minor/fittkai</i>	0.00	0.00	0.04	0.00	0.00	0.30
<i>Eukiefferiella rectangularis</i> -Gr.	0.03	0.05	0.00	0.23	0.11	0.00
<i>Eukiefferiella similis</i>	0.02	0.00	0.00	0.20	0.00	0.00
<i>Georthocladus luteicornis</i>	0.02	0.00	0.00	0.03	0.00	0.00
<i>Gymnometriocnemus</i> sp.	0.00	0.00	0.04	0.00	0.00	0.07
<i>Heleniella ornaticollis</i>	0.33	0.32	0.11	7.54	2.47	2.30
<i>Heterotrissocladus cf. scutellatus</i>	0.00	0.00	0.04	0.00	0.00	0.15
<i>Heterotrissocladus marcidus</i>	0.18	0.16	0.19	3.13	2.42	4.93
<i>Hydrobaenus</i> sp.	0.00	0.00	0.11	0.00	0.00	1.85
<i>Chaetocladus dentiforceps</i> -Gr.	0.02	0.00	0.04	0.07	0.00	0.11
<i>Chaetocladus piger</i> -Gr.	0.05	0.11	0.19	0.67	1.16	1.59
<i>Chaetocladus vitellinus</i> -Gr.	0.03	0.00	0.00	0.16	0.00	0.00
<i>Chironomus</i> sp.	0.05	0.11	0.15	0.21	0.68	47.89
<i>Krenopsectra</i> sp.	0.11	0.05	0.19	6.49	1.58	28.78
<i>Krenosmittia camptophleps</i>	0.00	0.00	0.15	0.00	0.00	4.44
<i>Limnophyes</i> sp.	0.11	0.26	0.30	0.62	0.84	5.00
<i>Macropelopia</i> sp.	0.05	0.21	0.26	0.43	0.89	15.30
<i>Metriocnemus fuscipes</i> -Gr.	0.00	0.05	0.00	0.00	0.42	0.00
<i>Micropsectra apposita</i> -Gr.	0.13	0.21	0.44	3.21	14.74	13.93

	Frequency			Density		
	Perennial	Near-perennial	Intermittent	Perennial	Near-perennial	Intermittent
<i>Micropsectra atrofasciata</i> -Gr.	0.80	0.89	0.89	161.33	1816.00	223.70
<i>Microtendipes pedellus</i> -Gr.	0.59	0.63	0.30	19.36	54.00	19.48
<i>Microtendipes rydalensis</i> -Gr.	0.13	0.05	0.00	11.80	0.11	0.00
<i>Monodiamesa bathyphila</i>	0.05	0.00	0.00	0.20	0.00	0.00
<i>Nanocladius parvulus/rectinervis</i>	0.05	0.11	0.07	0.16	0.95	0.15
<i>Natarsia</i> sp.	0.25	0.42	0.59	0.90	3.74	4.44
<i>Nilotanypus dubius</i>	0.02	0.00	0.00	0.07	0.00	0.00
<i>Orthocladus lignicola</i>	0.10	0.05	0.19	0.36	0.42	0.63
<i>Orthocladus obumbratus/oblidens</i>	0.34	0.37	0.33	69.77	21.16	25.07
<i>Orthocladus rivicola</i> -Gr.	0.11	0.26	0.26	6.31	2.42	39.56
<i>Orthocladus rivulorum</i>	0.07	0.11	0.04	4.57	0.63	0.22
<i>Orthocladus rubicundus</i>	0.11	0.26	0.11	3.31	5.05	0.37
<i>Paracladopelma</i> sp.	0.02	0.00	0.00	0.02	0.00	0.00
<i>Paracricotopus niger</i>	0.02	0.00	0.00	0.07	0.00	0.00
<i>Parakiefferiella</i> sp.	0.02	0.11	0.00	0.03	0.47	0.00
<i>Paramerina</i> sp.	0.03	0.05	0.00	0.10	0.42	0.00
<i>Parametriocnemus stylatus</i>	0.80	0.95	0.70	41.02	60.05	193.67
<i>Paraphaenocladus</i> sp.	0.05	0.21	0.48	2.00	3.47	14.44
<i>Parasmittia</i> sp.	0.00	0.00	0.04	0.00	0.00	0.04
<i>Paratendipes albimanus</i> -Gr.	0.03	0.00	0.04	0.08	0.00	0.15
<i>Paratrichocladius rufiventris</i>	0.13	0.21	0.07	5.70	0.95	0.44
<i>Paratrissocladius excerptus</i>	0.25	0.16	0.22	3.43	3.58	1.63
<i>Parorthocladius</i> sp.	0.00	0.00	0.07	0.00	0.00	3.74
<i>Phaenopsectra</i> sp.	0.07	0.05	0.11	0.15	0.16	1.70
<i>Polypedilum albicorne</i>	0.18	0.11	0.26	1.25	0.53	3.26
<i>Polypedilum convictum</i> -Gr.	0.48	0.42	0.33	27.10	10.95	5.48
<i>Polypedilum cultellatum</i>	0.02	0.00	0.00	0.07	0.00	0.00
<i>Polypedilum laetum</i> -Gr.	0.00	0.05	0.00	0.00	0.68	0.00
<i>Polypedilum pedestre</i> -Gr.	0.10	0.05	0.07	0.38	0.11	0.52
<i>Polypedilum scalaenum</i> -Gr.	0.28	0.21	0.11	1.67	2.11	0.44
<i>Potthastia longimana</i>	0.26	0.00	0.00	2.46	0.00	0.00
<i>Procladius</i> sp.	0.08	0.26	0.22	0.28	6.16	1.52
<i>Prodiamesa olivacea</i>	0.33	0.42	0.41	5.34	4.11	17.52
<i>Psectrocladius</i> sp.	0.00	0.00	0.04	0.00	0.00	0.07
<i>Pseudorthocladius</i> sp.	0.05	0.11	0.07	0.15	0.63	0.74
<i>Pseudosmittia</i> sp.	0.00	0.00	0.04	0.00	0.00	0.22
<i>Rheocricotopus atripes</i>	0.02	0.05	0.19	0.07	0.21	1.41
<i>Rheocricotopus effusus</i>	0.07	0.26	0.63	0.23	5.00	9.48
<i>Rheocricotopus fuscipes</i>	0.62	0.79	0.63	19.79	35.89	13.19
<i>Rheocricotopus chalybeatus</i>	0.00	0.05	0.00	0.00	0.11	0.00
<i>Rheotanytarsus</i> sp.	0.20	0.11	0.04	6.97	0.16	0.04
<i>Smittia</i> sp.	0.00	0.00	0.04	0.00	0.00	0.07
<i>Stempellinella brevis</i>	0.48	0.26	0.37	24.36	41.47	2.22

	Frequency			Density		
	Perennial	Near-perennial	Intermittent	Perennial	Near-perennial	Intermittent
<i>Stictochironomus</i> sp.	0.15	0.11	0.00	0.84	2.37	0.00
<i>Synorthocladius semivirens</i>	0.20	0.11	0.11	3.38	0.53	0.30
<i>Tanytarsus brundini/curticornis</i>	0.11	0.11	0.04	4.23	0.32	0.07
<i>Tanytarsus</i> sp.	0.48	0.74	0.22	27.61	50.58	3.07
<i>Thienemannia</i> sp.	0.02	0.11	0.00	0.03	0.84	0.00
<i>Thienemanniella</i> sp.	0.34	0.21	0.19	7.20	8.53	0.70
<i>Thienemannimyia</i> sp.	0.21	0.11	0.04	5.02	0.63	0.15
<i>Trissopelopia</i> sp.	0.13	0.26	0.19	2.25	34.42	4.63
<i>Tvetenia bavarica/calvescens</i>	0.39	0.32	0.07	40.90	7.79	2.89
<i>Tvetenia discoloripes</i> -Gr.	0.49	0.42	0.22	17.28	19.26	2.00
<i>Zavreliomyia</i> sp.	0.43	0.47	0.59	7.07	22.89	19.15

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