Suivi multitaxons des habitats alluviaux d'un fleuve dynamique : test d'un protocole de suivi pour la Loire, premiers résultats

Multitaxa monitoring in floodplain habitats of a dynamic river: test of a monitoring protocol for the Loire river and its floodplain - first results

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RÉSUMÉ

Les gestionnaires des milieux aquatiques et alluviaux de grands cours d'eau encore dynamiques sont confrontés d'une part à une **très grande variabilité des conditions abiotiques**, notamment hydrologiques, d'une année sur l'autre, et, d'autre part, à la **modification progressive et simultanée de plusieurs facteurs environnementaux dans la durée**, par exemple dues au changement climatique. Il est extrêmement difficile de distinguer de manière simple ce qui relève de la fluctuation « habituelle » d'un site géré, ce qui est le résultat d'une mesure de gestion ou de restauration, et ce qui s'inscrit dans une tendance à plus long terme et qui nécessiterait une adaptation des pratiques de gestion (Kuemmerlen et al. 2016). L'interprétation d'une telle variabilité spatiale et temporelle nécessite le suivi des milieux et de leur biodiversité sur des séries temporelles longues (Haase et al. 2016), avec des protocoles qui documentent, à des échelles spatiales et temporelles pertinentes, les paramètres clé du fonctionnement écologique des milieux, couplés à une observation de la biodiversité. Dans le cadre du réseau d'observation de la biodiversité de la Loire et de ses affluents (OBLA) de la Zone Atelier Loire, un protocole de suivi des milieux aquatiques et alluviaux de la Loire a été développé et testé durant trois années (2018-2020). Nous présentons ce protocole, ses premiers résultats, une évaluation du protocole et des réflexions concernant sa mise en place à une échelle plus large.

ABSTRACT

Management of floodplain habitats and aquatic habitats of still dynamic large rivers is challenged by a high interannual variability of abotic conditions, in particular hydrological ones, and by a progressive and simultaneous change of several environmental parameters over time (e.g. resulting from climate change). It is extremely difficult to distinguish patterns caused by "usual" fluctuations, those resulting from management or restoration and those due to long-term tendencies that require an adaptation of management practices (Kuemmerlen et al. 2016). Analysis of such variable conditions will need long-term monitoring of habitats and biodiversity (Haase et al. 2016) based on protocols that link key parameters of floodplain functioning and observation of biodiversity at relevant spatial and temporal scales. A monitoring protocol for aquatic and alluvial habitats of the Loire river has been developed and tested over three years (2018-2020) as part of Loire LTESR observation network "biodiversity of the Loire River and its tributaries" (OBLA). This communication presents the protocol, its first results, an assessment of the accuracy of data and reflections on its implementation of the protocol at a larger scale.

MOTS CLES

Loire River, pionner habitats, alluvial grasslands, floodplain forest, former river channels, macrophytes, phytoplankton, temperature, water chemistry, spiders, Carabidae

1 INTRODUCTION

Floodplain habitats along dynamic rivers are biodiversity hotspots. The conservation of this biodiversity represents a special challenge for nature managers for several reasons. First, abiotic conditions, such as hydrological regime, are highly variable on the intra and interannual scale. Second, several environmental factors are changing simultaneously on the longterm scale such as the quantity of pollutants, and, consequence of climate change, temperature, rainfall level etc. Under such conditions it is especially difficult to know whether habitat or biodiversity dynamics are a consequence of management or restoration, or if they reflect long term tendencies due to external drivers (Kuemmerlen et al. 2016).

The Loire river is one of the very rare large rivers in Western Europe that still presents a dynamic floodplain with a large range of habitats including fluvial pioneer habitats, softwood shrubs, softwood forest, hardwood forests, alluvial grasslands and partly disconnected former river channels. Despite this exceptional situation, no continuous monitoring programme for the whole range of habitats and their biodiversity has yet been set up. Researchers and managers involved in Loire LTSER have recently developed a monitoring protocol for major habitats of the Loire and its floodplain, combining monitoring of abiotic parameters and simultaneous monitoring of several taxonomic groups. This protocol was tested in the field during three years. The present communication aims (i) to present the monitoring protocol, (ii) to present some outcomes of the monitoring, (iii) to evaluate the precision of data *vs.* the time and resources necessary to implement it. We moreover aim to discuss a monitoring strategy on a wider scale.

2 MATERIAL AND METHODS

2.1 Study sites

The study took place in the middle reaches of the Loire River, several kilometres downstream of the city of Orleans: most habitats were monitored within the site “Rives de Beaugency”, complemented for fluvial pioneer habitats at the site “Mareau islands”, situated respectively at 15 and 10 kilometres downstream of Orleans. Both sites are protected and managed by environmental NGO’s.

2.2 Monitoring protocol biodiversity

The montoring took place between Mai 2018 and November 2020 and was financed by the region “Centre Val de Loire” as part of the project “BPO Loire”. Five types of habitats, representing major succession stages, were taken into account: the main river channel, pioneer sand and gravel bars along the main channel, softwood shrubs, softwood forest, hardwood forest, a disconnected side channel (aquatic stage), dryfalling river channels as well as grassland. The monitored taxa were phytoplankton, aquatic macrophytes, benthic invertebrates, terrestrial vascular plants, ground beetles and spiders. In the aquatic habitats we adapted existing and largely used sampling protocols, i.e. transects for macrophytes and macrozoobenthos and a unique sampling point for phytoplankton. In terrestrial habitats we sampled random 2m x 2m plots in each habitat type rather than using permanent plots, since habitat dynamics, especially close to the river, can be very fast. Vegetation was recorded on these plots using a 4-class abundance index. Two wider spatial scales were added for comparison of results: 28 m² (each habitats) and 100 m² (forest only). Carabidae and spiders were sampled in the centre of each 2m x 2m plot using pitfall traps, supplemented by sweep-net sampling for spiders. Frequency of sampling was once every two weeks (beginning and end of the growth season) to once every week for phytoplankton. It was once per season for vascular plants and twice per season for all other taxa.

2.3 Monitoring protocol abiotic parameters

In aquatic habitats we monitored temperature, pH, conductivity, oxygen concentration and major nutrients at each phytoplankton sampling, as well as water depths and sediment types. In terrestrial habitats we monitored temperature at ground level (2h intervals), light intensity, surficial sediment texture, vegetation structure and flooding events. Hydrological data concerning the Loire river and weather data were obtained from state data providers (Banque Hydro, Météo France).

3 RESULTS

3.1 Abiotic characterisation of monitoring years

Hydrological patterns differed strongly from each other during the three monitoring years: while 2018 presented continuously high water levels in winter and spring, and lower than median water levels thereafter, 2019 was especially dry with no winter flood occurring, very low summer water levels and long lasting, unusually high temperatures during summer months. 2020 was characterized by lower than median water levels in summer and several short flood peaks occurring mainly in winter and spring.

3.2 Aquatic habitats

3.2.1. Major abiotic differences

Both habitat types differed clearly in their water chemistry. The main channel had constantly higher temperature (difference around 2°C), higher pH (8.2 vs. 7.5), and higher oxygen levels. It had lower conductivity levels (around 300 µS/cm vs. around 500µS/cm in the former channel) and tended to have lower nutrient levels. The differences between both habitats were strongest during summer months, indicating an independent functioning of both habitats despite the downstream connection of the former river channel and the active channel. There were no significant differences between years.

3.2.2. Major biotic differences - examples phytoplankton and macrophytes

A total of 325 taxa were recorded, 262 in the former channel and 258 in the active channel. Abundances differed greatly between monitoring dates and years. Amounts of phytoplankton were particularly low in 2019 (a maximum of 10 000 cell.ml^{-1}), compared to peaks of 80 000 cells/ml and 40 000 cell.ml^{-1} respectively in 2018 and 2020. Communities differed in both habitats and with regard to monitoring years. In the active channel (see first ordination axis, Fig. 1a) plankton communities in 2018 were different from those of the other monitoring years and were characterized by a strong dominance of Chlorophyceae, particularly *Actinastrum hantzschii* var. *subtile*. The former channel acted in 2019 as a nursery of a rare Dinoflagellate *Unrudinium penardii* var*. robustum* (Kenneth Mertens et al., 2021) and in 2020 it showed a particular pattern (Fig. 1b), due to Chrysophyceae, specially *Ochromonas* spp.

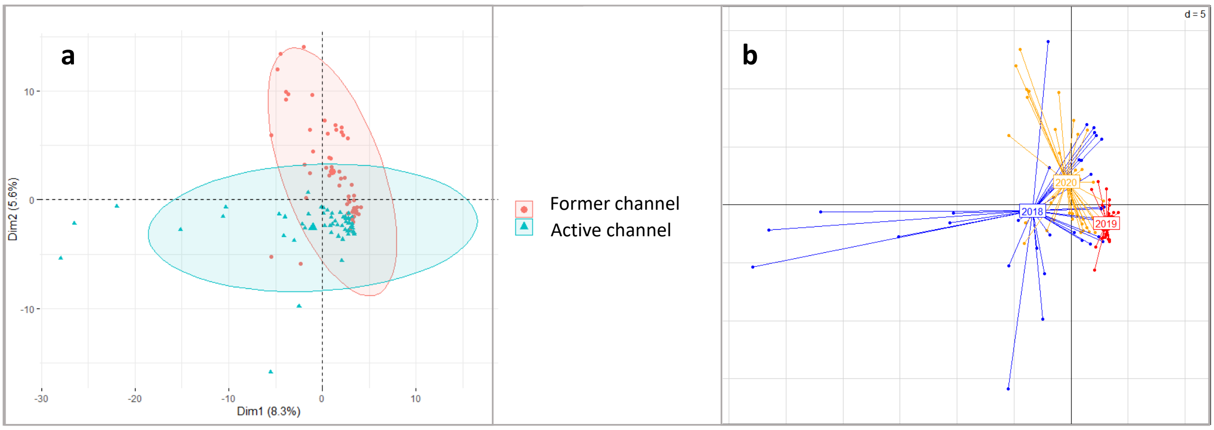

Fig. 1: Ordination (PCA) of phytoplankton communities sampled in 2018-2020 in the former river channel and in the active channel. a) Projection of sample dates grouped by habitats; b) Projection of sample dates grouped by year.

Macrophyte diversity was significantly lower than that of phytoplankton since only 15 species were recorded during the monitoring period. The active channel hosted 13 macrophyte species and was dominated by *Ranunculus penicillatus.* 11 species occurred within the former channel and macrophyte communities therein were dominated by invasive species: by *Ludwigia grandiflora* in 2018 and 2020 and by *Elodea nuttallii* in 2019. Biomass development of macrophytes was particularly high in 2019, i.e. the inverse pattern to that of phytoplankton.

3.3 Terrestrial habitats

3.3.1. Major abiotic differences – example temperatures

Temperature profiles varied greatly according to habitats. These differences concerned amplitude of temperatures and extreme temperatures rather than average temperatures (Fig. 2). The greatest amplitudes and extreme temperatures were found on sediment banks and, surprisingly, grasslands, with average maxima of more than 50°C and extremes up to 80°C in summer.

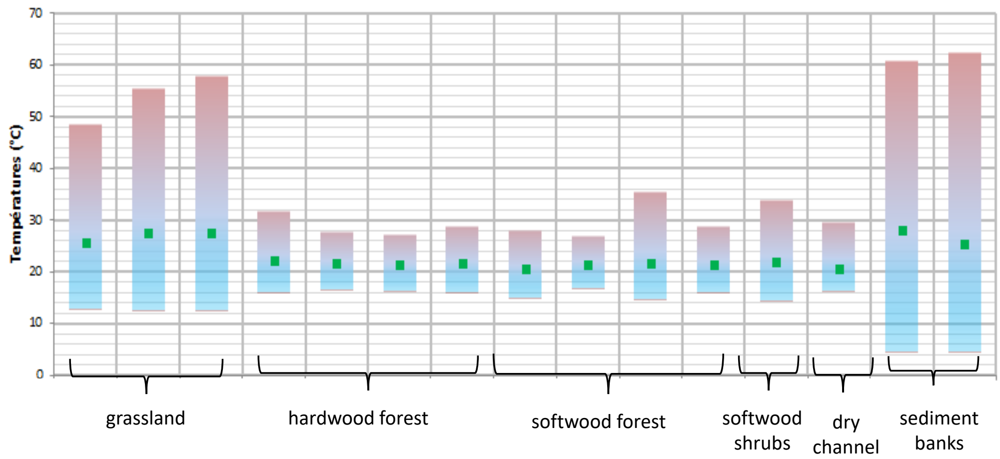

Fig. 2: Average temperatures and average daily minima and maxima on sampling plots during summer 2018 (June to end of August).

3.3.2. Major biotic differences - example vegetation and spiders

During the three years of monitoring we recorded a total of 241 plant taxa and 140 spiders. Observed species richness in plants was highest in grasslands (124 taxa) while for spiders it was highest in softwood shrubs (81 taxa). Each habitat had its very distinct plant community, while a great amount of taxa overlap among habitats existed in spiders. Exceptions were grasslands and sand banks. While the first ones hosted species with different ecological profiles, the latter were characterized by specialist communities with rather low species richness.

5 DISCUSSION

The three years of monitoring allowed to quantify a range of abiotic parameters at the scale of major floodplain habitats. Concerning biodiversity, it allowed to obtain records for rather seldomly monitored groups (i.e. spiders) and habitats (i.e. partly disconnected rive channels) that may greatly contribute to the overall biodiversity of the Loire River system. Species area curves showed however that sampling was not sufficient to monitor the whole range of species occurring in the different habitats. It was also not possible yet to isolate the main drivers for community composition, since interannual variability was high, the monitoring period short and unforeseen difficulties in field sampling resulted in partly missing information. A general discussion on precision of data *vs.* the time and resources necessary to collect them, as well as a strategy to implement monitoring on more sampling sites and at a longer time scale is needed.

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