EUROPONDS

OVERSEEN ECOSYSTEM SERVICES OF PONDS AND THEIR INSECTS – THEIR ROLE FOR SUPPORTING TERRESTRIAL CONSUMERS AND BIODIVERSITY

FINAL PROJECT REPORT

Project:FreshProject 3.0

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The EUROPONDS project was awarded as the 3rd fresh project by the European Federation of Freshwater Sciences (**EFFS**), European Fresh and Young Researchers (**EFYR**), and representatives of the Fresh Blood for Fresh Water (**FBFW**), and funded by contributions of the following ten EFFS societies:

- Association Française de Limnologie (**AFL**);
- Association of Austrian SIL Members (**SIL Austria**);
- AssociazioneItaliana di Oceanologia e Limnologia (**AIOL**);
- Asociación Ibérica de Limnología/Associação Ibérica de Limnologia (**AIL**);
- Deutsche Gesellschaft für Limnologie e.V. (**DGL**);
- Freshwater Biological Association (**FBA**);
- Hrvatsko Udruženje Slatkovodnih Ekologa (**HUSEK**);
- Magyar Hidrológiai Társaság (**MHT**);
- Polskie Towarzystwo Hydrobiologiczne (**PTH**);
- Schweizerische Gesellschaft für Hydrologie und Limnologie/Société Suisse d'Hydrologie et de Limnologie/SocietàSvizzera di Idrologia e Limnologia (**SSHL**)

The **EUROPONDS** project was selected as the **3rd Fresh Project** in the joint call of the European Federation of Freshwater Sciences (**EFFS**) board and the EFFS Societies as well as the European Fresh and Young Researchers (**EFYR**) and representatives of the Fresh Blood for Fresh Water (**FBFW**), which aims to foster collaboration among young scientists across Europe. Since the project started in June 2020, **EUROPONDS** gathered about 80 international early career researchers who have been carrying out research on ponds.

This final report describes the overall project realisation, achievements and output so far, preliminary scientific results, and expected publications. Overall, the project has achieved its main goals and has officially ended in July 2022. A review paper, establishing the base for further publications within the EUROPONDS project framework, was already accepted for publication in Inland Waters. More scientific publications containing the results of the project are being prepared for submission in peer-reviewed journals.

Table of Contents

TABLES:

FIGURES:

1. PROJECT STRUCTURE AND OBJECTIVES

1.1 TEAM FORMATION AND ORGANISATION

The **EUROPONDS** project was established to investigate ponds - small permanent water bodies - across Europe under the aspect of ecosystem services (ES) delivered by those often overlooked systems, especially the ES of provision of dietary energy and essential nutrients via emergent insects to the adjacent environment. The teams collected biomass, did taxonomic identifications and fatty acids analysis of emergent insects was done on almost 300 samples across an unprecedented geographical gradient.

TABLE 1 ASSEMBLED TEAMS OF THE EUROPONDS PROJECT. ORDERED BY TEAM ID. Pond ID = Numeration of the ponds sampled; Country = Country of residence of the team/country where sampled ponds are located.

Team ID	Pond ID	Country
1	1p1	Austria
	1p2	Austria
	1p3;	Austria
2	2p1; *not sampled*	North Macedonia
3	3p1	Germany
4	4p1	Romania
5	5p1	Germany
	5p2	Germany
6	6p1	Spain
7	7p1	Italy
8	8p1	Italy
	8p2	Italy
9	9p1	Portugal (Azores Islands)
	9p2	Portugal (Azores Islands)
	9p3	Portugal (Azores Islands)
10	10p1	Italy

Team ID	Pond ID	Country
18	18p1	Poland
	18p2	Poland
	18p3	Poland
19	*dropped out before sampling*	
20	20p1	Spain
	20p2	Spain
21	*dropped out before project start*	
22	22p1	Spain
23	23p1	Poland
	23p2	Poland
24	24p1	Sweden
	24p2	Sweden
	24p3	Sweden
25	25p1	UK
	25p2	UK
26	26p1;	Ireland

	10p2	Italy		**27**	27p1;	Poland
11	*became part of Team 30*				27p2;	Poland
12	12p1	Spain		**28**	*dropped out*	
13	*dropped out before project start*			**29**	29p1	Italy
14	14p1	Switzerland		**30**	30p1	France
	14p2	Switzerland			30p2	France
15	15p1	Italy		**31**	31p2	Spain
16	16p1	Czech Republic			31p2	Spain
	16p2	Czech Republic		**32**	32p1	Serbia
17	17p1	Portugal		**33**	33p1	Hungary
	17p2; not sampled	Portugal			33p2	Hungary

Figure 1. Distribution map of the sampled ponds across Europe.

After the project was nominated (late spring 2020) teams were gathered by the early summer of 2020. Mostly contacts were established via the EFFS affiliated societies who

reached out to their members and through contacting universities/institutes directly. Most teams were from Italy and Spain (***5 teams*** *per country*), and we managed to assemble teams with ECRs affiliated with each of the funding societies. Now at the end of the project, we had 61 active participants, 53% female ECRs and 47% male ECRs. During the period of team gathering we received applications from more experienced researchers that do not fit within the project rules for young researchers (master, PhD students and researchers with less than 2 years after obtaining their PhD), so we gathered a team of ***supporting committee*** (5 researchers) that joined our project mostly as advisors.

Regular **Zoom Meetings** were held from the beginning of the project, to keep everyone informed of the project progress, distribute information and assign tasks. Especially in the beginning of the project the organisational challenge was big, since some teams had to build the emergence traps, following protocols that were provided by us PIs. We established a shared **Google Drive** to be able to distribute protocols (how to build emergence traps, sampling, identification), literature and important information easily. Since the academic backgrounds of participants were quite diverse, a lot of additional information was made accessible or shared, to gain knowledge in areas of less expertise for the individual researcher.

Slack was used as a communication and team management tool to enable faster communication and allow for collection of information in "threads" which can be accessed at all times of everyone with an access link. **Dropbox** was used to collect e.g. the sampling protocols or data and drafts of the publications that were written or are being prepared together, every participant got an access link to the shared folder. A shared **Zotero** folder was established during the course of the manuscript writing, to enable everyone with access to relevant literature. We maintained a **webpage** from the beginning of the project (created via jimdofree) and various social media channels (**Twitter, Facebook, Instagram)**, which were fed with content by us PIs but also we encouraged project members to join us, since social media channels have a certain value regarding science communication and outreach and skills with these platforms will prove useful in the future.

1.2 AIMS of the EUROPONDS project

Emergence of insects is highly variable and depends on factors such as productivity of the water body, light availability, air and water temperature. Aquatic insects provide an important food source for various consumers such as birds, bats, spiders or lizards and consumers have even been shown to solely rely on emergent aquatic insects e.g. during winter when terrestrial insect productivity is generally low. Studies investigating those fluxes of aquatic insects to the terrestrial environment have been conducted for lakes, streams and ponds. For terrestrial consumers, not only the amount of food (quantity of biomass) but also the quality is important, thus, EUROPONDS set out to explore the nutritional value of the emergent insects measured in lipids and fatty acids. Whilst the biomass of emergent insects from ponds has been subject of studies in the past, there is comparatively little knowledge on the nutritional aspects of this flux. In short, **EUROPONDS** was investigating (a) the taxonomy ('biodiversity') and biomass and (b) the energy content and dietary quality, as measured by total lipids and their fatty acids ('nutritional value for subsequent consumers'), of emergent insects from ponds across Europe.

1.3 HYPOTHESES

EUROPONDS will test the hypothesis that (**i**) the nutritional value of emerging insects will be higher in ponds with lower trophic status, and (**ii**) that the biomass of insects will be higher in ponds with higher trophic status.

1.4 METHODS, DATA COLLECTION AND ANALYSES

Methods and organisation:

All participants of **EUROPONDS** were asked to **measure** the same **parameters**, following provided protocols. **Ponds** were **selected** based on the criteria that the water body needs to be **permanent** and **not more than 3 meters deep**. Ponds could be **near natural or artificial**, concerning this there were no limitations.

1. **Trophic state** of ponds was assessed by Chlorophyll-a and Phosphorus measurements. Physicochemical measurements (turbidity, conductivity, temperature, oxygen, Secchi depth, …) were done at every sampling event when possible;
2. **Taxonomy of insects:** using emergence traps and pond-netting, the **taxonomy** of these invertebrates and the **biomass** leaving the ponds was assessed; traps were deployed for one week during each of the seasons of the year (Autumn - Winter - Spring - Summer);
3. **Nutritional value** of emergent insects was determined as total lipids and their fatty acids analysed in the WasserClusterLunz LIPTOX laboratory;
4. **Additional parameters** taken into account were **land use** in the surrounding environment (categories), **substrate** of the pond (categories), **weather conditions**, **fish**

presence (presence/absence; if possible species), **macrophytes** (presence/absence; if possible species); **riparian** vegetation/zone description.

This project provides valuable insights into the role of ponds as providers of dietary energy via emergent insects and gathers additional knowledge on these frequently overlooked water bodies which are ubiquitous in European landscapes.

TIME SCHEDULE:

All the project activities are presented in ***Figure 2***. Since the official project started in July 2020, we managed in time to gather the team assemblages, to unify the sampling methodology for data collection, to choose the ponds (with ponds ID) most suitable for the project aims and provide instructions for emergence traps building. During the sampling period, mainly as result of the ongoing COVID 19 pandemic, some ponds were not accessible/or due to national restrictions the sampling periods were missed. At the end we sampled a total of **47 permanent ponds**. Due to extreme droughts, some ponds that usually were permanent water bodies dried out during the sampling period which led to unexpected missed samplings/no retrieved biomass.

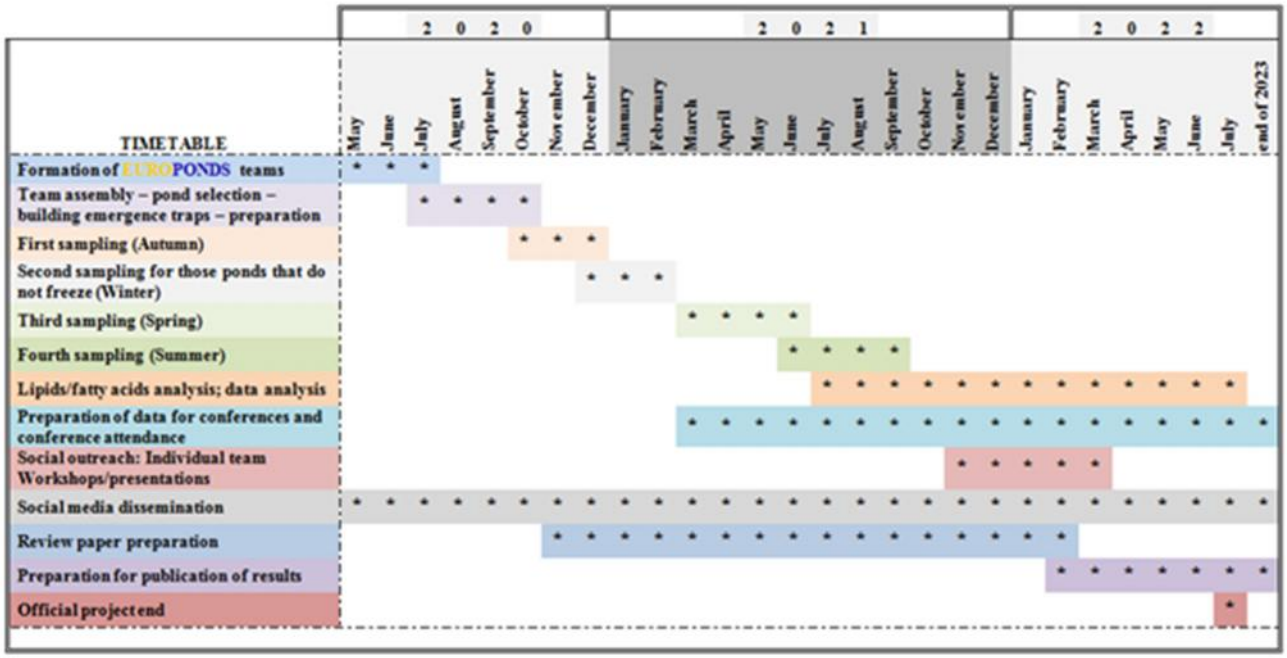

Figure 2. Timeline of the project activities during 2020-2022 period.

The rest of the project activities were achieved as shown in the planned timeline. According to the planning by the **end of 2023** we hope to submit the project results for publication in a peer reviewed scientific journal.

1.5 BUDGET AND FINANCES

We received a total budget of 8.300€ from the funding societies. For account management, the bank took a total of 1% until the end of the project in July 2022. So far, we spent money mainly for conference participations, fuel to reach the sampling sites, transport of samples per DHL or other companies and emergence trap building totaling 52% from planned project budget (Figure 3). At the official end of the project as per July 2022 we remain with a budget resto of 47%, which will be dedicated to (**i**) conference Pl's participation at **SEFS13** in 2023 where the project results will be presented, and (**ii**) publication costs of the upcoming publications of the EUROPONDS project. For this, we might apply for additional funding or use other possibilities of journals which enable ECRs without a lot of project funding to publish.

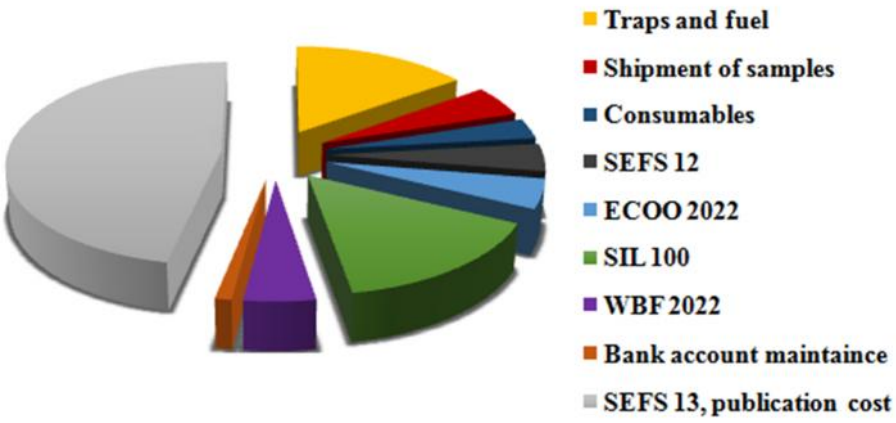

Figure 3. Total cost of budget (in %) per planned project activities.

2. SCIENTIFIC RESULTS (PREVIEW)

2.1 FATTY ACID DATA

We sampled 47 permanent ponds across Europe during 2020-2021, with one sampling per season. Land use was categorised and included in the analysis. Those are only very preliminary results which we presented at SIL Congress in the summer of 2022. Further analysis will be done and included in the manuscript containing fatty acids results of EUROPONDS.

Our preliminary results pointed out that overall biomass exports did not show any clear difference across the latitudes (Figure 4). Although we noticed a trend where some ponds in agricultural areas exported much greater biomass compared to ponds in forested areas which instead had overall lowest emergence. Moving on to the total lipids (total energy exported), agricultural areas still seem to export more than the other surroundings (Figure 4).

Looking at the PUFA to biomass ratio, ponds all over the European continent seem to differ in quality independent of latitude. However, when comparing the surrounding land use, it seems that the three categories are more comparable with trends of agricultural areas bringing overall the highest quality (Figure 4).

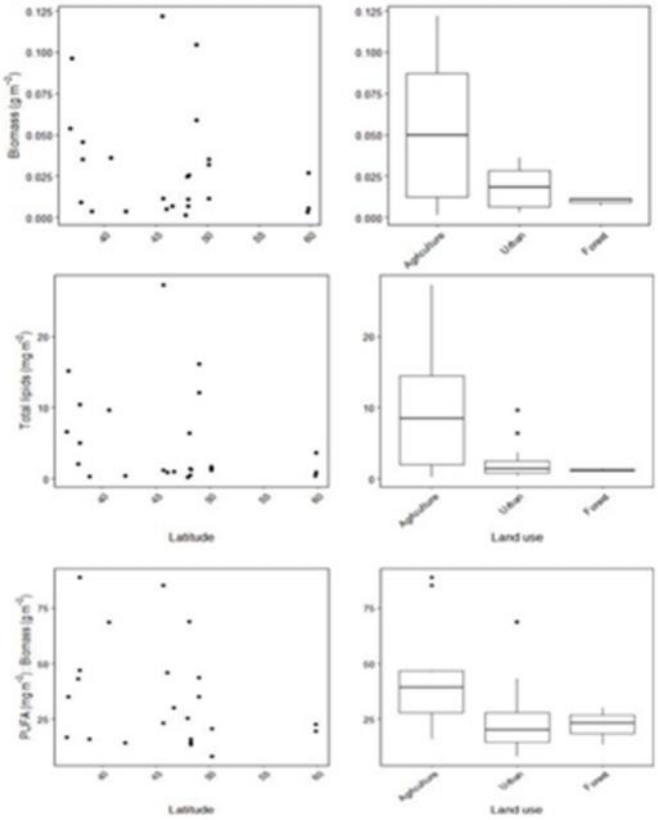

Figure 4. Representation of the results for Biomass, Total lipids and PUFA compared to the types of ponds.

3. PROJECT DISSEMINATION

3.1 PUBLIC MEDIA

We encouraged the participants of EUROPONDS from the beginning to talk about the project in various different ways, e.g. radio webcasts or blog postings. Thankfully, the project members showed a great deal of enthusiasm and we can proudly share a variety of appearances of the EUROPONDS project in different forms of media.

We share some of the relevant publications and appearances:

- Social media release about EUROPONDS teams at University home site (A. Haba and K. Kuczyńska), 13.08.2020, POLAND

- Radio (UVM 95,5 fm) presentation of the EUROPONDS project (M. Zawadzka & D. Dąbrowski), 21.09.2020, POLAND
  http://www.uwmfm.pl/news/126/czytaj/6536/doktoranci-z-uwm-w-projekcie-europonds.html
- Lecture in the Silesian Botanical Garden (D. Halabowski), 18.09.2021, Mikołów, POLAND
- Blog piece about EUROPONDS (L. Nash), 2020 (last accessed on 10.09.22), https://fothcp.org/the-purpose-of-ponds/ , for information of the audience of this nature reserve in London's East End, which used to be a cemetery before, London, UNITED KINGDOM

3.2 CONFERENCE AND SYMPOSIUM PARTICIPATION

The participants of EUROPONDS were encouraged to participate in national and international conferences and symposia to share information about the EUROPONDS project. Thanks to our motivated project members, we can share some of the most relevant presentations of the project:

- World Biodiversity Forum (**WBF**), 26.06.2022 - 01.07.2022 Davos, SWITZERLAND
  EUROPONDS (talk title: "EUROPONDS Fresh Project - Ecological Contributions Of Ponds To Their Landscapes") was presented by ***L. Fehlinger (PI and Team 1 member)*** at the WBF as part of the session "*The importance of being small: biodiversity conservation in ponds and other small freshwater systems*".

- European Congress on Odonatology (**ECOO 2022**), 26.06.-01.07.2022, Kamnik, SLOVENIA
  EUROPONDS talk titled "Odonata fauna across European ponds - a case study from the EUROPONDS project", presented by ***B. Rimcheska (PI and Team 2 member)*** and poster presentation titled "Dragonflies and damselflies comparative analyze within selected ponds across Hungary" presented by ***J. Fekete (Team 33)***

- 36th Congress of the International Society of Limnology (**SIL 100**), 07-10.08. 2022, Berlin, GERMANY.
  The EUROPONDS project was presented by ***E. Jakobsson (Team 24)*** with a talk titled "*Lipid export from water to land: Results from the pan-European project EUROPONDS*".

- Symposium for European Freshwater Sciences (**SEFS 12**), 25-30. 07. 2021. Dublin, IRELAND
  The EUROPONDS project was presented with a talk titled "*Preliminary results of EUROPONDS: early researchers shedding light on overlooked water bodies"* by ***L. Fehlinger (PI and Team 1 member)*** and with a poster titled "*Ecological assessment*

of a renaturalised pond in the quarries of Alpedrete (Spain)" by ***M. Tomás Martín*** *and* ***P. Soto García (Team 12)***. Marina & Pablo's great presentation received ***an award for best poster presentation.***

- XV. Makroszkopikus Vizi Gerinctelenek Kutataási Konferencia és Szakmai Taláikozó, 18-19.11.2021, Agárd/Gödöllö, HUNGARY.
  Poster presentation titled "*EUROPONDS – A European Federation of FreshwaterSciences 3rd fresh project bemutatása"* presented by ***J. Fekete (Team 33)***.

- 5th **BalkanBio** Conference on biology, 15.-16.04. 2021, Plovdiv, BULGARIA
  EUROPONDS talk titled *"Overseen ecosystem services of ponds and their insects – their role for supporting terrestrial consumers and biodiversity "EUROPONDS""* presented by ***B. Rimcheska (PI and Team 2 member****).*

- *IX Simposio de Investigación en Ciencias Experimentales, November 2020, Almeria, SPAIN*
  EUROPONDS members ***J. Rubio Ríos*** and ***E. Fenoy (Team 20)*** prepared a poster (*3rd European FreshProject "EUROPONDS"*) for the participation in the Symposium at the University in Almeria.

- Hydrobiologia w epoce Antropocenu - Jubileuszowy **XXV Zjazd Hydrobiologów Polskich**, 07. - 09.09.2022, Łódź, POLAND
  EUROPONDS poster presentation titled "*Preliminary research results of the EUROPONDS project - a first look at biodiversity of benthic macroinvertebrates and emerging insects from ponds in Poland*", presented by ***A. Sowa*** and D. Halabowski ***(Team 18***): https://zjazdhydrobiologow.wixsite.com/2022

SPECIAL SESSION HOSTING

- 36th Congress of the International Society of Limnology (**SIL 100**), 07. - 10.08 2022.
  Berlin, GERMANY, **L. Fehlinger & B. Rimcheska**, Co-Hosts and -Chairs of Special Session *SS03* "*The future of small water bodies in the context of global change*".

- Symposium for European Freshwater Sciences (**SEFS 12**), 25. - 30.07.2021.
  Dublin, IRELAND, **L. Fehlinger & B. Rimcheska**, Co-Hosts and -Chairs of Special Session *SS03* "*The role of small water bodies in the landscape*".

3.3 PRESENTATIONS AND WORKSHOPS

- Presentation EUROPONDS project for Humboldt Day 2020 (**L. Fehlinger**; PI and Team 1 member), 09.2020 online, Balaton Limnological Institute, Tihany, HUNGARY

- Presentation of EUROPONDS for citizens in Vienna (**L. Fehlinger**; PI and Team 1 member), 09.06.2021, Vienna, Parapluieteich, AUSTRIA

- Educational presentation of EUROPONDS project (**A. Scotti & M. Vanek**, Team 7) at Eurac Research auditorium, 02.11.2021, South Tyrol, ITALY

- Inter-institutional workshop presentation (**V. Kolář**, Team 20 member), 22.11.2021, about ponds, the insect communities and preliminary results from EUROPONDS project, CZECH REPUBLIC

- Presentation EUROPONDS project for the members of PONDERFUL H2020 Project at UVic (**L. Fehlinger**; PI and Team 1 member), November 2021, Universitat de Vic, Catalonia, SPAIN

- Educational presentation in school (1 Liceum Ogólnokształcące im. Maria Skłodowskiej-Curie) for high school students (**A. Haba & K. Kuczyńska**), 16.12.2021, Szczecin, POLAND

- Presentation of EUROPONDS to the department colleagues (**J. Fahy**; Team 14 member), 2021, University of Applied Sciences and Arts – Western Switzerland; HEPIA, Nature management, SWITZERLAND

- Presentation of the EUROPONDS project (**M. Tomás Martín & P. Soto García**, Team 12), February 2022, "About the sampling method and the results we had obtained, as well as highlight the importance of wetlands for terrestrial systems, biodiversity and threats and conservation measures", 11F (International Day of Women and Girls in Science) located *on site* of the same sampled pond (Alpedrete) meant for Clara Campoamor school's 6th grade kids, Alpedrete, SPAIN

- Educational presentation of EUROPONDS project (**A. Scotti & M. Vanek**, Team 7) at Nature Museum of South Tyrol, 09.02.2022, South Tyrol, ITALY

- Presentation EUROPONDS project (**A. Escobar**, Team 9 member), February 2022, "Inhabitants of the pond" (organisms in the pond, sampling methods of emergent insects, aims of the project), Living Science Center "Expolab", São Miguel Island, SPAIN

3.4 EXPECTED AND SUBMITTED SCIENTIFIC PUBLICATIONS

During the first year of our project, we already started writing a review paper, to establish a common knowledge base within our project among all ECRs working on EUROPONDS but also to provide a comprehensive overview of the current knowledge about permanent ponds, their history, their usages, the ecosystem services they deliver and specifically about the role of permanent ponds in regards to dietary energy export via emerging insects. This paper was accepted for publication at Inland Waters Journal in August 2022. The article can be found via DOI: 10.1080/20442041.2022.2111180 and the full article citation is: "**The ecological role of permanent ponds in Europe: a review of dietary linkages to terrestrial ecosystems via emerging insects**, (*2022*): L. Fehlinger, B. Misteli, D. Morant, N. Juvigny-Khenafou, D. Cunillera-Montcusí, F. Chaguaceda, O. Stamenković, J. Fahy, V. Kolář, D. Halabowski, L. N. Nash, E. Jakobsson, V. Nava, P. Tirozzi, P. Urrutia Cordero, J. Mocq, A. Camacho Santamans, J. Manuel Zamora, P. Marle, T. Chonova, L. Bonacina, M. Mathieu-Resuge, E. Suarez, S. E. Osakpolor, P. Timoner, V. Evtimova, D. Nita, B. M. Carreira, K. Tapolczai, J. Martelo, R. Gerber, V. Dinu, J. Henriques, G. B. Selmeczy & B. Rimcheska (2022): Inland Waters, *Published online 16th August 2022*"

Currently we are planning at least 2 (two) more manuscripts, one of them including our fatty acids data and research relating to the dietary energy export and another one including the results of our additional research done concerning the benthic communities in the sampled ponds.

5. Acknowledgements

We would like to thank all members of the EUROPONDS consortium and the supporting committee for their efforts and commitments, as well as their supervisors and affiliated institutions.

We thank the EFFS, EFYR and FBFW for being awarded with this project, having the possibility to learn a lot and to realise our research ideas in a phantastic network. Also thank you for the continuous support throughout the 2 years of the project.

Finally, we express our sincerest gratitude to the staff from INRAE and WasserCluster Lunz institutes that provided us additional resources for conducting laboratory work (eDNA [INRAE] and Fatty acids analysis [WasserCluster Lunz]). Especially without the support and possibilities that were provided at WasserCluster Lunz (LIPTOX group and lab. supervisor: Dr. Martin Kainz) the project (and costly analysis) could not have been realised in the manner it was.

SUPPLEMENTARY MATERIAL

Figure 1. *EUROPONDS team pond localities with representation of some of the sampled ponds across Europe. Sampled permanent ponds varied from natural, artificial in the landscape, to man-made urban ponds.*

Figure 2. *Outreach activities - presentation of the project from part of our teams. The social activities gained on the positive attitudes towards implementations of our project goals and young researchers network interaction.*