We assess and enhance ecosystem services provided by diadromous fishes in a climate change context

03

IN THIS ISSUE

www.diades.eu

#DiadESproject

INSIDER NEWS FROM DIADES

In recent years, human societies have been more frequently faced with global issues, with decisions or events throughout the planet impacting global ecosystems at an uncommonly fast rate. In this global context, the idea pushed forward by the DiadES partnership of a need for more homogeneous and climate-ready management of diadromous fish populations across the Atlantic Area makes a lot of sense.

Against this challenging background, DiadES partners have worked hard over the last twelve months to deliver the baseline findings that will support the envisaged management tools i.e. the Interactive Web Atlas, DiadESland serious game, and management guidelines. Species distribution models were finalized and run, ecosystem services valuation methods were applied, biological samples were processed using innovative tools and techniques, data were centralized in the Atlas, and the role-playing game design was initiated. DiadES partners also invested time in producing two new video clips presenting the project's main objectives with stakeholder views coming from across Western Europe.

Following the partnership's dedicated commitment to the conservation and sustainable exploitation of diadromous species, DiadES partners applied to the EU Interreg Atlantic Area 3rd call for extension in October 2021 and was one of the 23 lucky projects to be funded. For the one year extension, a major effort will be put into current and additional DiadES outputs capitalization to increase the awareness and knowledge among policymakers, managers, and the wider public about the need for a long-term and large-scale management of diadromous species.

In parallel, the DiadES consortium is organizing a conference in Bordeaux (France) in July 2022. This event is an opportunity to make serious progress on the development of management guidelines with the help of external and internal stakeholders.
Recent months have been particularly productive for DiadES and its partnership. We hope it will show in this newsletter!

5 Countries

70 People involved

30 Participant Institutions

OUR ACHIEVEMENTS

- A semi-quantitative ranking of Ecosystem Services, according to the economic value they provide, has been obtained for the different case studies and species inhabiting these rivers;
- The design of hybrid models for diadromous species distribution (integrating habitat suitability, and dispersal and population dynamics) is now completed and presented in a data paper and a modelling publication.
- New biological data derived from microchemistry, hybridization and eDNA analyses have been acquired and are in the process of being interpreted by the partnership;
- First sessions of the Serious Game have been organized to train the future Game Masters and Observers;
- Finalisation of the Atlas website was accomplished with three different pages: 1) Present distribution of diadromous species in the Atlantic Area; 2) Semi-quantitative valuation of Ecosystem Services provided by the diadromous species in the case studies; 3) Projections of fish abundances in relation to climate change.

ZOOM ON THE BIOLOGICAL DATA COLLECTION AND ANALYSES

Shad Ageing Workshop

IFI contribution; Ciara O'Leary

We are working with shad specimens from France, Spain, Portugal, UK and Ireland. While compiling the variables we wish to review for the analysis of microchemistry and hybridisations, the project partners discussed the importance of shad age and growth variables in the interpretation of the signals we have captured. All ageing results are subject to verification in order to determine the precision (reproducibility) of age data. Given the level of uncertainty of age estimation from scales and its variability, comparative readings by scale readers (for QC purposes) are recommended to understand the correct (accurate) age based on the level of precision between readers.

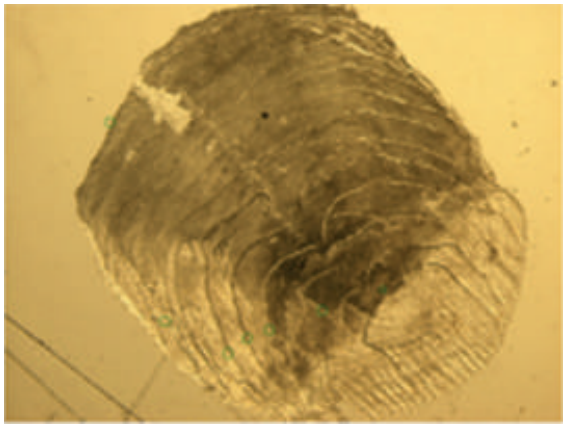

Photo 1: *Alosa alosa* scale (Éric Quinton, INRAE)

Why is this important? The age profile of a fish stock can be indicative of its general health, with a broader range of ages signalling a healthier population. It can also highlight pressure points when age classes are missing from a cohort. ICES works with many institutions to ensure accuracy and high quality of data in relation to age and growth as many stock assessments require these variables. ICES has a working group dedicated to ensuring best practice in this regard; Working Group on Biological Parameters (WGBIOP).
To ensure that data from the different regions and institutes are compatible we have scheduled a shad ageing workshop to ensure accuracy and to quality check the data.

Ecological and isotopic niches of diadromous fishes in the Sélune estuary (Brittany, France)

MNHN contribution; Anne Lizé (MNHN), Alexandre Carpentier (MNHN, University of Rennes), Thomas Trancart (MNHN), Jean-Marc Roussel (INRAE-UMR DECOD), Eric Feunteun (MNHN)

Diadromous fishes migrate either from the sea to freshwater (catadromous) or the reverse (anadromous) to grow. We focused on several catadromous fish species such as the European eel (*Anguilla anguilla*), juveniles of flounder (*Platichthys flesus*) and of the Mugilidae family, and anadromous ones as adult lampreys (*Lampetra fluviatilis and Petromyzon marinus*) and adults and juveniles of salmonids (*Salmo salar and S. trutta*).

Using $\delta^{13}C$ and $\delta^{15}N$ isotopic ratios, we ran mixing models with fishes as consumers and small fishes and invertebrates as food sources (MixSIAR package, R). These models allowed to delineate each species isotopic and ecological niche width in the Sélune estuary (France).

Interestingly, both ecological and isotopic niches are wider for catadromous than anadromous species. Catadromous species appear to exploit more habitats from the Mont Saint Michel Bay to freshwater sites of the river and their ^{13}C ^{15}N sources tend to also be more generalist than anadromous species as demonstrated by their wider isotopic niche. This has to be confronted to specific life-history traits and notably semelparity level and fat storage to spawn (marine vs freshwater origin of storage).

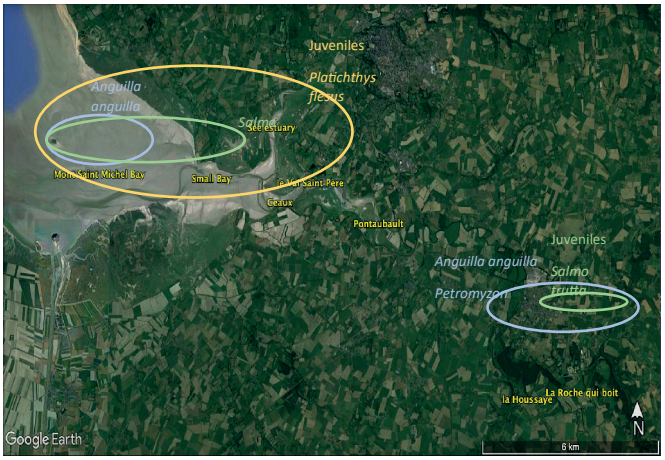

Figure 1: Satellite map of the Sélune river estuary and the Mont Saint Michel Bay (France), showing the different habitat locations (yellow) used by catadromous fishes.

FINAL SPRINT FOR DIADESLAND THE SERIOUS GAME OF THE DIADES PROJECT

INRAE contribution; Margaux Herschel

DiadESland is the serious game of the DiadES project that will be played at the final conference in July 2022 in Bordeaux (France). With the event only a few weeks away, it is the final stretch for the organization of the official game sessions throughout the Atlantic Area.

Within the framework of this collaborative and multidisciplinary project, DiadES partners joined forces and expertise to create a tool that is as fun as it is useful for stakeholders. To that end, from April to June 2022, several official game sessions have taken place in the five countries of the Atlantic Area, inviting stakeholders to discover DiadESland.

This role-playing game aims at exploring alternative management strategies for diadromous species and associated Ecosystem Services, integrating global change over time and on a large scale. DiadESland is the name of an imaginary continent made up of five catchments, interconnected from north to south, home for three fictional diadromous species.
This tool provides a safe game space for discussion amongst stakeholders and an opportunity to discuss the research issues of the DiadES project without fear of real-life consequences. The discussions emerging from these sessions will feed into the writing of policy guidelines and management recommendations on diadromous species in a globally changing environment.

All participants of the final conference will receive a box of the game, in order to keep the discussion of diadromous species management and Ecosystem Services going beyond the lifetime of the project.

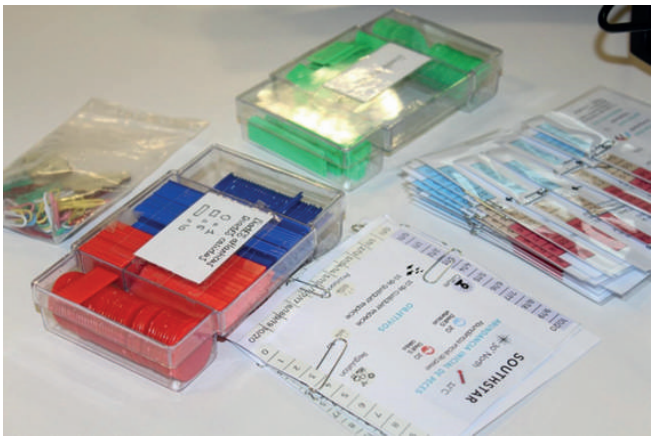

Photo 2: Prototype of the DiadESland serious game used for the training sessions

SEVERE DROUGHT IN PORTUGAL: CONSEQUENCES FOR ANADROMOUS FISH POPULATIONS AND THE SOCIO-ECONOMICAL SERVICES THEY PROVIDE

UE-MARE contribution; Esmeralda Pereira, Ana Filipa Belo, Catarina Sofia Mateus and Pedro Raposo de Almeida

To initiate the spawning migration, anadromous species rely on environmental cues such as freshwater flow and thermal regimes. Adequate flow patterns are key to ensure available habitat for reproduction and if disrupted, cues can be masked, the negative effects of possible obstacles to river connectivity are intensified and susceptibility to predation increases. Adult sea lampreys may even postpone reproduction, if flow conditions are not met and consecutive years of drought may have serious impacts (Figure 2).

In the Iberian Peninsula, the increasing frequency of dry years with prolonged droughts may further damage already depleted populations.

The current hydrological year has been considered the second driest since 1931, preceded only by 1999. According to the Portuguese Institute of the Sea and Atmosphere, between October 2021 and February 2022 precipitation levels were only 39% of the precipitation occurring on an average year, leading to a situation where over 60% of the country was in severe drought.

In the Mondego River (Portugal), at the fish pass located in Coimbra Dam (45 km from the river mouth), around 10,000 lamprey successfully negotiate the fish pass each year. However, in 2017, a very dry year, only 295 got through and in 2019 and 2020 the number of spawners was only 717 and 1,328, respectively. Thus, the severe drought observed may have catastrophic consequences on an already depleted population.

The absence of adult sea lamprey was felt in all river basins where professional fisheries dedicated to this species occur, which has made the prices increase considerably from an average of €35 per specimen to over €50, affecting the economy associated with this species.

Nowadays the final customer can expect to pay around €90 per lamprey at the restaurant. Gastronomic festivals dedicated to lamprey were negatively impacted; for instance in Penacova, the Lamprey festival scheduled for the end of February was postponed due to the restaurants difficulty in ensuring the required supply to serve the amount of clients expected.

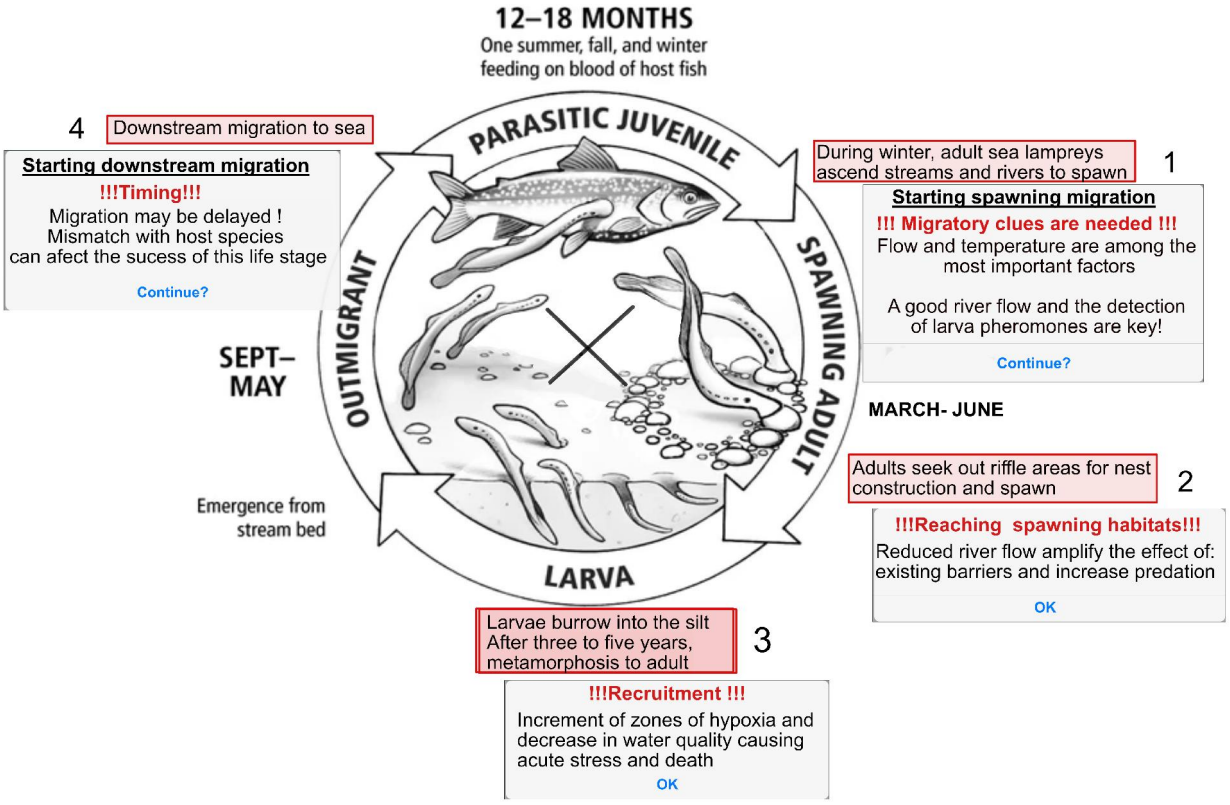

Figure 2: Impacts of abnormally low river flows in sea lamprey life cycle. Adapted from Hansen et al., 2016.

a) b)

Figure 3: Media coverage: a) Supplement of "Jornal de Notícias" (February 26, 2022): special edition about sea lamprey dishes and festivals. b) Festivals scheduled for 2022, in the Mondego River basin.

DIADES MOVIES

Early in 2022, two clips were released and published in DiadES YouTube channel. These clips mixed voices from DiadES scientists and stakeholders, and external stakeholders interviewed specifically.

This clip talks about the different Ecosystem Services provided by diadromous species in the Atlantic area: regulating, provisioning and cultural services.

https://www.youtube.com/watch?v=ImnhWesG-T8&t=10s

In this other clip, our partners talk about success stories in the management of diadromous species and their habitats, derived from European initiatives.

https://www.youtube.com/watch?v=TKSqF4Hum_o

Photo 3: Martin O'Brien, owner of a local café/restaurant on the River Barrow (Ireland) being interviewed about the twaite shad (catch and release) angling fishery

DELIVERABLES AND PUBLICATIONS

Methodologies to assess Ecosystem Services provided by diadromous species

Quantifying the Total Economic Value of Ecosystem Services (ESs) a complex task due to challenges encountered when trying to operationalise a common monetary assessment of the ESs and obtain appropriate data. Therefore, it requires the application of a range of methods from which an explicit monetary assessment could be provided. The methods presented in ***this deliverable*** document are not new; the novel aspect is their application to the diadromous species in the Atlantic Area. The use of statement-based valuation techniques can complement the most traditional market-based valuation, but the quality of the valuation is highly dependent on the methodologies used to obtain the data.

Photo 4: Catch and release fishing of twaite shad, *Alosa fallax*

Moreover, another improvement of our approach is linked to stakeholder involvement. Respondents' statements from surveys are combined with group statements thanks to the engagement of DiadES stakeholders across the whole research. We appreciate your participation!

Case study description and Ecosystem Services data collection

The assessment of Ecosystem Services in DiadES is focussed on 9 case studies: the Ulla catchment, Gipuzkoa rivers, Minho catchment, Mondego catchment, Gironde/Garonne/Dordogne system; Loire catchment, Normand-Breton Bay/Gulf, Tamar, Frome, and Taff rivers, and Waterford Harbour with the Three Sisters Rivers Barrow, Nore and Suir.

This deliverable report provides a broad overview of ESs by considering the key diadromous species relevant for each case study.

The project's stakeholders contributed with a selection that was not based on their use of the ES but more on their knowledge of the biological status of the diadromous species and/or regional administrations.

Dataset on European diadromous species distributions

EuroDiad version 4.0 is a data set that contains distribution and life-history trait information for twenty-eight diadromous species and geomorphological data in selected catchments in Europe, the Middle East, and North Africa from 1750 to present time. EuroDiad was originally created in 2005–2006 and underwent subsequent updates. In 2020 it was updated to v 4.0, with the primary goal of providing information for a new generation of species distribution models, referred to as hybrid models, which incorporate both habitat suitability and population dynamics within their framework.

Other additional objectives of this update were to: (a) incorporate new catchments for which information was provided by additional experts, (b) validate the presence or absence of diadromous species and categorize their population functionality within a catchment, and (c) perform data debugging to prepare the database for broad dissemination. Data for this update were validated by DiadES project partners and local experts, which strengthened the usefulness of EuroDiad, now available for use by the research community.

The paper is available ***here***.

Quantification of land-sea nutrient fluxes supplied by allis shad

Diadromous species act as nutrient vectors between their marine and freshwater habitats. Few valuations of this regulating service exist and none at the scale of species distribution ranges. This large-scale approach seems particularly relevant for species moving and exchanging individuals across borders and territories as these populations may strongly depend upon each other in terms of population viability and provision of Ecosystem Services.

The development of a new nutrient routine within an existing mechanistic species distribution model provided estimates of the 'maximum potential' of the anadromous allis shad (*Alosa alosa*) to provide nitrogen and phosphorous subsidies throughout Western Europe. During their seasonal reproductive migration, shad provided low amounts of nutrient subsidies when compared to North-American anadromous species and annual riverine nutrient loads. However, these subsidies are delivered as pulses concentrated in space and time, suggesting that more work is needed to figure out the significance of these shad-derived nutrients in terms of riverine ecosystem functioning.

The evidence of a substantial flow of strayers (individuals that colonize rivers different from their original birthplace) delivering nutrient subsidies in several rivers confirmed the need for large-scale management of migratory species to ensure a sustainable provision of ecosystem services.

Read the full article ***here.***

Photo 5: Juvenile specimens of allis shad, *Alosa alosa*

NEW COLLABORATORS IN THE CONSORTIUM

A new PhD student within DiadES

Sara Silva is a new PhD student in the UÉvora/MARE team, being involved in trout migration ecology and anglers' surveys works. These tasks will mainly focus on the migratory dynamics of trout in the Mondego River basin. More specifically, they aim to analyze the movements patterns and the migratory behaviour of *S. trutta*, i.e., the differences between anadromous (sea trout) and holobiotic (brown trout) trout ecotypes and the environmental factors related with these movements. Sea trout is very well studied across most of its range, but limited knowledge of its biology and ecology in southern European countries, hampers specific restoration efforts near the southern limit of the species distribution range. Biotelemetry is an important tool to obtain temporal and spatial specific data about the main typology of habitats used and the migratory dynamic of the target-species. Within this task Sara will use a set of complementary techniques, from acoustic, radio and PIT tags.

Since the beginning of the study, the team had already tagged 114 trout specimens (i.e., between 102 mm and 560 mm) with Pit-tags, 18 of which were also tagged with Dual Mode transmitters, that include, simultaneously, radio and acoustic telemetry components. The dual tagging facilitates monitoring species behaviour from the estuary, a deep and brackish environment, to the upstream fresh and shallow waters. Radiotracking sessions have been conducted fortnightly within this task and will take place for at least one more year.

Trout behaviour is also being continuously monitored through the acoustic receiver array installed in the study area, within the COASTNET (https://coastnet.pt/) and ETN – European Tracking Network (https://www.europeantrackingnetwork.org/en) infrastructures.

Apart from telemetry, Sara has been following the fisheries activities directed towards trout throughout the country, including surveys of commercial and recreational fisherman, to assess the real impact of these activities on the species as well as the supporting socioeconomic and cultural components.

Photo 7: Sara Silva doing sampling work

Game designer hired in 2021

Conference organizer hired in 2022

COMING SOON

Final conference of the project "Global and local initiatives: when science is the basis for management measures in diadromous species"
5-8 July 2022, Bordeaux, France
INRAE is organising ***this meeting,*** complemented by the contribution of two projects funded by the Nouvelle-Aquitaine region and the Adour-Garonne Water Agency:

- The Fauna/Shad'EAU project on the conservation of shad populations in the greater southwest, whose scientific results are complementary to those of DiadES;
- The REVE project on the reconstruction of the life history of the European sturgeon population, with a thematic day on the restocking of diadromous migratory fish.

EIFAAC Symposium 2022 "Inland Fisheries and Aquaculture - Advances in Technology, Stock Assessment and Citizen Science in an Era of Climate Change".
20-21 June 2022, Killarney, Ireland
IFI is organising this symposium ***https://www.fisheriesireland.ie/news/events/eifaac-symposium-2022*** which will cover 5 themes:

- Inland fish stock assessment
- Advances in freshwater fish monitoring technologies, with an emphasis on non-destructive methods
- The issues and challenges of climate change and its effects on inland aquatic resources and fisheries
- Citizen science
- Aquaculture: traditional freshwater versus recirculating systems

Beneficiary Partners

Associated Partners