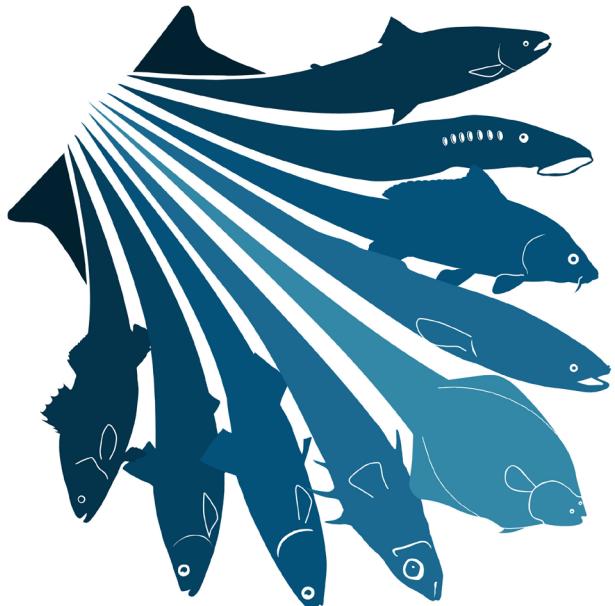


# GalHidria

Revista da Asociación galega de Investigadores da Auga (AGAIA)

Editor: Rufino Vieira-Lanero

## VIII CONGRESO IBÉRICO DE ICTIOLOGÍA



SIBIC  
2020

## VIII CONGRESSO IBÉRICO DE ICTIOLOGIA

**SIGUIENDO EL CAMINO DE LOS PECES**  
(SIBIC X ANIVERSARIO)

**Santiago de Compostela**  
**15-19 junio 2020**

**Libro de Resúmenes - Livro de Resumos**

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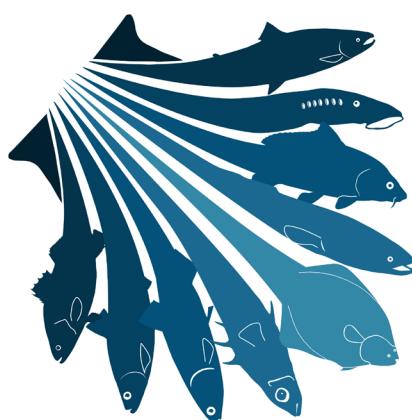
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## **Connecting Fish, Rivers and People: Making a Change from Local to Global**

Pao Fernández Garrido & Herman Wanningen

World Fish Migration Foundation ([pao@fishmigration.org](mailto:pao@fishmigration.org))

In 2014 you could search and easily find how many dams were in USA, how many dams they had removed, how their policy worked and hundreds of river restoration projects they had going on. However, what about Europe? Basically you could only find the large dams' inventories for European countries (only showing the tip of the iceberg of the real situation) and with good luck a few articles of dams that had been removed in France in the 90's. That's it.

Had Europeans built less dams than in USA knowing that some of our current dams had been constructed before Columbus disembarked in America? Were we truly doing so little to restore our rivers? Didn't we have any policy to bring our fish back?

No. Everything was there, in national institutions, in regional agencies, in municipalities. We only needed time to find, connect and share.

The [World Fish Migration Foundation](#) (WFMF) was founded in 2014 to save migratory fish in rivers, from local to global. WFMF brings global attention to the problems and the solutions, provides tools to river practitioners to preserve and to open swimways. Through different projects in the past 6 years, WFMF found hundreds of fish and river restoration projects around the world, connected experts and practitioners with each other, with the public and with the media. Shared knowledge and experiences. Encouraged other countries to take action. Opening citizens eyes and connecting them to fish and rivers.

During this plenary session we will rapidly walk along the evolution and results of some of these projects:

- In 2014 the foundation initiated the first [World Fish Migration Day](#) (WFMD) with a partnership of 6 organizations (e.g. WWF, The Nature Conservancy). WFMD is a bi-annual event which starts in New Zealand and follows the sun around the world, ending in Hawaii. The central message "Connecting fish, rivers and people" is used to connect sites around the world. The last edition in April 2018 hosted 570 local events organized by over 3000 organizations. The WFMD created a growing movement around migratory fish. It helps to reach students, teachers, resource managers, commercial and recreational anglers, as well as those who influence public policies. After 3 editions the global reach is 50-70 million people through (social) media. The fourth edition was planned for May 16, 2020 and it was postponed to October 24<sup>th</sup> of that same year.

- Migratory fish around the world are severely threatened. The main statistic from the 2018 Living Planet Report is the global Living Planet Index which shows a 60% decline of animal populations between 1970 and 2014. In 2020, the Living Planet will publish for the first time an index showing the status only for freshwater migratory species, and we will learn the tendency is even worse. Ongoing river fragmentation is one of the greatest global threat to freshwater biodiversity and ecosystem functioning. Dams, weirs and culverts are blocking these fish while they need to migrate to reproduce, feed and complete their life cycles.

These migratory routes are called swimways. The concept of a “swimway” is essentially an operational concept linked to freshwater fish whose populations need to be managed over their entire migration range. Now, with the cooperation from institutions like IUCN, UN WCMC and Cambridge University the concept of '[Global Swimways](#)' is being developed, where a global overview of migratory fish and swimways (with input from international experts) is being built.

- Recent reports from Europe and the USA conclude that the removal of dams is a very effective ecological restoration measure as rivers recover faster than expected after dam removal. Furthermore, it is becoming increasingly clear that dam removal is often a cost-effective measure. For these reasons, the World Fish Migration Foundation and six partners started the [Dam Removal Europe](#) (DRE) movement in 2016. Unbelievably, DRE found out during the first year that countries like France, Sweden, Spain, Sweden and UK had already removed (all together) over 4,000 river barriers.

DRE's ambition is to make dam removal a viable option for river management and to restore fish populations. After 4 years the development and results of this movement are a success and now, we want to scale this up through channelizing funding and reach out to a bigger audience by starting crowd funding campaigns for dam removals. The ultimate ambition is to use the experiences from the USA and Europe and create a global dam removal movement.

## **Stable isotopes as habitat tracers in fish ecology**

Luis Cardona

Department of Evolutionary Biology, Ecology and Environmental Science. University of Barcelona  
(luis.cardona@ub.edu)

Stable isotope analysis has become a standard method in ecology over the past two decades, mostly for diet studies. However, the stable isotopes of C, N, O and S can also be used as habitat tracers.  $\delta^{13}\text{C}$  values differ in planktonic and benthic primary producers from the same ecosystem and with latitude in marine phytoplankton. This variability propagates to consumers and allows tracking changes in habitat use by fish at different geographic and temporal scales. The  $\delta^{15}\text{N}$  values of marine primary producers also exhibit broad regional variability, primarily because of differences in the rates of N fixation and denitrification. As a rule, fishes from coastal upwelling regions or regions with a huge freshwater runoff are enriched in  $^{15}\text{N}$ . However, the use of  $\delta^{15}\text{N}$  as habitat tracer is often confounded by changes in trophic position. The analysis of stable isotope ratios in trophic and non-trophic amino acids offers a powerful approach to identify the actual reasons for differences in  $\delta^{15}\text{N}$  values between populations. The  $\delta^{18}\text{O}$  of seawater varies regionally because of regional differences in precipitation/freshwater runoff and evaporation. This regional variability is recorded in fish bones and has been used to track movements and delineate fish stocks over broad geographic scales. Finally, consistent differences exist in the  $\delta^{34}\text{S}$  values of terrestrial/freshwater, benthic marine and pelagic marine primary producers. This variability has been used to study estuarine residency and fish movements along salinity gradients. Tissue choice is critical for stable isotope analysis, with blood and liver integrating information over several weeks, muscle over several months and bone archiving information throughout the whole life of the fish. For that reason, otoliths and vertebra centra allow to reconstruct ontogenetic changes in habitat use through the analysis of stable isotopes in sections of different age.

## Taking the lead on the conservation efforts of iberian fish: a challenge to SIBIC

Pedro Morais

CMAR – Centre of Marine Sciences, University of Algarve (Portugal). (pmorais@ualg.pt)

The 21<sup>st</sup> century poses the Iberian ichthyologists with one enormous challenge – protect the endangered and vulnerable Iberian fish in the context of global climate change. Climate change is not only a stressor by itself, but it also increments the impacts of existing stressors, like overfishing, habitat degradation, and biological invasions. Although the expertise of Iberian ichthyologists is diverse and therefore they can deal with the challenges ahead, collaboration is surprisingly residual and funding is a problem for many years to come.

So, will we able to protect the endangered and vulnerable species of the Iberian Peninsula and leave a positive legacy to the Iberians from the 22<sup>nd</sup> century? How can we protect these fish species in the context of global climate change? How can we protect these endangered fish if there are no political commitment and conservation programs focused on fish, thus guaranteeing the long-term effectiveness of current conservation efforts? Finally, why are Spanish and Portuguese ichthyologist not collaborating enough?

I am confident that we can leave a very positive legacy if SIBIC – the Sociedad Ibérica de Ictiología (Iberian Society of Ichthyology) – calls itself the responsibility to lead the conservation efforts of Iberian fish. I will show you the numbers demonstrating the residual cooperation between Spanish and Portuguese ichthyologists and how minimal were the funds that Iberian ichthyologists were able to get from the European Union in recent years. National research funds are insufficient to conduct effective conservation programs and with no guarantee that a one-time effort can evolve to consistent funding. However, I will propose how SIBIC can build bridges between Iberian ichthyologists and be a hub for effective cooperation, and present the successful case-story of the Portuguese Society for the Study of Birds (SPEA) that paved the way to effectively protect multiple endangered species and habitats during the past 20 years.

# ÁREAS TEMÁTICAS



**I Ecología y Biodiversidad**

**I Ecologia e Biodiversidade**



## A review and statistical analysis of the key factors explaining critical swimming speed in Iberian freshwater fish

Carlos Cano-Barbacil<sup>1</sup>, Johannes Radinger<sup>2</sup>, María Argudo<sup>1</sup>, Francesc Rubio-Gracia<sup>1</sup>, Anna Vilagispert<sup>1</sup> & Emili García-Berthou<sup>1</sup>

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<sup>2</sup> Leibniz-Institute of Freshwater Ecology and Inland Fisheries

Swimming performance is a key feature that mediates fitness and survival in aquatic animals. Predator-prey interactions, reproduction, migration and dispersion are processes that depend on swimming capabilities of organisms. The critical swimming speed (Ucrit) test is the most common and straightforward method to assess fish swimming performance. In this work, we analysed the contribution of several predictors (i.e. body length, water temperature, species identity, native status, body shape and form factor) in explaining the variation of Ucrit for inland fishes, using linear models and, for the first time, random forests. We compiled 227 cases for 35 fishes inhabiting the Iberian Peninsula, including 17 alien species widely distributed worldwide. We found that body length is the most important predictor of Ucrit, followed by species identity. By contrast, body shape, the form factor, temperature and native status were less important. The relationship of Ucrit with body length was highly species-specific and could be described by power functions with significantly different exponents. We also found that taxonomic family is not as a good predictor as species identity because of the high diversity of species with different lifestyles and forms within the same family. Similarly, body shape explained much less variation in Ucrit than species identity and native and alien species did not show significant differences. Although there was a positive relationship between Ucrit and temperature, our findings indicate that the latter is not a very important factor affecting swimming abilities of fishes at standard laboratory procedures. This review provides a database and overview for further theoretical and empirical studies. The data and models could contribute to the management of Iberian ichthyofauna, to assess the effects of hydrologic alteration or to categorize fish habitat preferences.

## Ecological causes and consequences of the size-abundance relationships in riverine fish community in the NE Iberian Peninsula

Ignasi Arranz<sup>1,2</sup>, Mireia Bartrons<sup>1</sup>, Lluís Benejam<sup>1</sup> & Sandra Brucet<sup>1,3</sup>

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The regular decrease of abundance with increasing body size has been a successful tool to predict and understand ecosystem processes. Body size is a key trait involved in food-web interactions and bioenergetic processes but also responds to abiotic features such as ecosystem size or climate gradients. Size-based parameters (e.g., slope the rate of decreasing abundance across body size) are derived from the size-abundance relationships and they respond steeply to local habitat and biotic changes, and anthropogenic pressures. Although the variations in the slope have widely used in marine and standing waters, fewer empirical evidences are tested in rivers. Given that ecosystem properties change along the river continuum, and fish play a key role in river food webs, the slope may provide a unique opportunity to assess the ecological processes in riverine fish communities. Here, we predict that local environmental and anthropogenic characteristics can either directly influence the slopes by shaping the fundamental ecosystem properties that drive it or indirectly affect the slope by determining the community composition found across locations which then, in turn, mediates the slopes. As such, we explored the slope of the size-abundance relationships on > 200 riverine fish communities in the NE Iberian Peninsula. Specifically, we modeled size-abundance relationships of each fish community and investigated how the shape of these relationships responds to community composition (i.e., the specificity in species co-occurrence), abiotic factors, and human impacts. Results showed that the community composition was the strongest driver influencing the shape of the size-abundance slopes. Moreover, the slopes were flatter (e.g., greater proportion of large fish) in low-nutrients locations, suggesting that nutrient availability influenced size-dependent processes. Altogether, despite local habitat conditions can determine the geographical distribution of species, the main drivers influencing directly ecosystem processes may derive from the particular combination of species within communities.

## Patrones de movimiento de trucha común (*Salmo trutta* L.) mediante telemetría acústica en el embalse El Portillo (Granada)

Lluís Zamora<sup>1</sup>, Silvia Rubio<sup>2</sup>, Borja Nebot<sup>3</sup> & Jordi Mor<sup>4</sup>

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<sup>4</sup> Water Research Institute (IRSA), National Research Council of Italy (CNR), Verbania, Italia

El embalse El Portillo (Castril, Granada) presenta una de las poblaciones lacustres de trucha común (*Salmo trutta* L.) más cercanas al límite meridional de distribución de la especie en la península ibérica. Con el objetivo de determinar los patrones anuales de movimiento, se realizó un seguimiento mediante telemetría ultrasónica a partir de un sistema automático (VPS, VEMCO) integrado por 24 receptores que cubrían la mitad septentrional del embalse. Se capturaron y marcaron 25 ejemplares (334-455 mm LT) con transmisores ultrasónicos, 13 de ellos equipados con sensor de presión para determinar la profundidad del individuo. Tras 522 días de recogida de datos, se integraron todas las detecciones hasta calcular un total de 115.018 posiciones válidas. Un 64% de los individuos marcados mostraron movimientos en dirección a la cola del embalse, principalmente entre los meses de diciembre y abril, coincidiendo con la época de puesta descrita para esta población. El 28% de las truchas marcadas permanecieron en el embalse hasta el final del estudio sin mostrar desplazamientos en dirección al río, lo que podría indicar que una parte de la población lacustre es sedentaria. También se observó un patrón de movimientos diarios entre la zona litoral y limnética, donde en verano ocupaba profundidades cercanas a los 25 m. En general se observó un claro patrón circadiano en la actividad, siendo mayor al amanecer y anochecer y menor durante el día. La actividad también mostró diferencias estacionales, siendo mayor en primavera y menor en invierno. El uso de la zona litoral fue más intenso en primavera e invierno. El dominio vital medio estimado fue de  $13,7 \pm 9,3$  ha, similar al de otros estudios de poblaciones fluviales, siendo mayor en verano y mostrando mayor fidelidad al hábitat en invierno cuando se redujo el área de actividad.

## Reproductive movements of potamodromous Cyprinids in the Iberian Peninsula

Ana García-Vega<sup>1</sup>, Francisco Javier Bravo-Córdoba<sup>1</sup>, Jorge Ruiz-Legazpi<sup>1</sup>, Juan Francisco Fuentes-Pérez<sup>1</sup>, Jorge Valbuena-Castro<sup>1</sup> & Francisco Javier Sanz-Ronda<sup>1</sup>

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This study aims to describe reproductive migration patterns of two endemic cyprinids with a great ecological importance in the Iberian Peninsula: Iberian barbel and Northern straight-mouth nase. The specific goals were to identify dates with peak migration during spring, as well as variation among years, and to relate them to environmental variables. For this, a fishway located in the Tormes River was monitored from 2012 to 2016 during April to July. Fish were captured by means of a trap in the most upstream pool. The trap was revised with a frequency of two-three times a week in 2012-2013 increasing to one per day the rest of the years. Data analyses were carried out using survival analysis techniques and random forest regressions. Barbel was present in a higher proportion ( $n = 27890$ , 72%) than nase ( $n = 11018$ , 28%), however inter-annual differences in number were observed. Although peak migrations occurred from mid-May to mid-June, significant differences among years were found. In 2012, 2014 and 2016, barbel migration occurred earlier than nase, whereas in 2013 and 2015 the nase migrated earlier than barbel. Movements were strongly related to environmental conditions. Besides photoperiod and water temperature, captures were conditioned by the rain of previous days and river discharge (necessary to pass natural water falls below the fishway) as well as to the water level of a nearby reservoir (that conditioned the passage through a weir downstream of the water falls). Knowledge of migration patterns and cues is fundamental not only to understand fish requirements and constraints, but also to evaluate the potential influence of anthropogenic impacts, the effectiveness of mitigation measures, as well as to develop adaptive management strategies to guarantee fish conservation.

## ¿Son las angulas del Mediterráneo diferentes a las del Atlántico?

Estibaliz Diaz<sup>1</sup>, Carlos Fernández-Delgado<sup>2</sup>, Lluís Zamora<sup>3</sup>, Fernando Jiménez<sup>4</sup> & Derek Evans<sup>5</sup>

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La longitud y la condición de la angula es principalmente el resultado de las características oceanográficas que la rodean y que influyen en la alimentación y el desarrollo durante la fase larvaria y la subsiguiente migración oceánica. Además, se ha demostrado que las larvas que utilizan rutas más cortas producen angulas más pequeñas (Laflamme et al., 2012). Así pues, las larvas de una determinada cohorte que utilizan diferentes rutas de migración, podrían producir angulas de diferente longitud y condición. Por lo tanto, debería haber diferentes tendencias en la longitud o condición de la angula en los distintos lugares y diferentes olas de reclutamiento de angulas dependiendo de la ruta de migración de las larvas leptocéfalas. Para poner a prueba esta hipótesis, se examinaron los datos sobre la longitud y la condición de la angula que abarcan 20 años, de 1997 a 2018, de nueve localidades europeas, que incluían Irlanda del Norte, el Golfo de Vizcaya, un estuario cercano al Estrecho de Gibraltar (el Guadalquivir) y el Mediterráneo. La longitud media de la angula fue mayor en el Golfo de Vizcaya (7,07 cm, SD = 0,46) que en el Mediterráneo (6,39 cm, SD = 0,38) (Guadalquivir y Ter) (prueba de la t, p < 0,0001) y en Irlanda del Norte (6,73cm, SD = 0,35) (prueba de la t, p < 0,0001). La tendencia intra-anual en longitud y condición en el Mediterráneo es diferente a la del Atlántico. Esto sugiere una sola ola de entrada de angula por temporada en Irlanda del Norte y el Golfo de Vizcaya y un proceso de reclutamiento más complejo, incluyendo una ola secundaria de migración en la primavera, en el Guadalquivir y el Mar Mediterráneo.

## Primera evaluación de la biomasa de anguila plateada que abarca tres países

**Maria Mateo<sup>1</sup>, Estibaliz Diaz<sup>1</sup>, Laurent Beaulaton<sup>2</sup>, Labedan Mathilde<sup>2</sup>, Marie Vanacker<sup>3</sup>, Hilaire Drouineau<sup>3</sup>, Carlos Antunes<sup>4</sup>, Elsa Amilhat<sup>5</sup>, Agnes Bardonnet<sup>3</sup>, Maria Joao Correira<sup>6</sup>, Anna Costarrosa<sup>7</sup>, Ramon De Miguel<sup>8</sup>, Isabel Domingos<sup>6</sup>, Carlos Fernández Delgado<sup>8</sup>, Maria Korta<sup>1</sup>, Ana Moura<sup>4</sup>, Teresa Portela<sup>6</sup>, Lluís Zamora<sup>7</sup> & Cédric Briand<sup>9</sup>**

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<sup>7</sup> GRECO

<sup>8</sup> UCO

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En 2007, la Comisión Europea implementó un reglamento por el que todos los Estados miembros deben elaborar planes de gestión para lograr el escape del 40% de las anguilas plateadas. Actualmente, aunque la anguila europea constituye un stock único, se evalúa utilizando diversos métodos que no son comparables. Además, muchos de los modelos utilizados para evaluar el escape requieren parámetros que son muy difíciles de recoger y, por lo tanto, son aplicables en pocos países. Así, los científicos y gestores se enfrentan al reto de encontrar una metodología que pueda aplicarse a lo largo de toda el área de distribución de la anguila europea utilizando datos ampliamente disponibles. Por esa razón, el proyecto SUDOANG, que tiene por objeto proporcionar a los gestores herramientas comunes para ayudar a conservar la anguila en España, Francia y Portugal, ha elegido el modelo Eel Density Analysis (EDA). EDA estima la biomasa de la anguila plateada a diferentes escalas (cuenca, país, internacional) utilizando datos de muestreos rutinarios de pesca eléctrica, como los de la DMA. EDA se basa en un programa de código abierto aplicable a los ríos europeos en los que las densidades de anguila plateada están condicionadas mayoritariamente por procesos naturales (reclutamiento, migración aguas arriba). En primer lugar, se construyó una red fluvial encadenada en los tres países, que incluía los atributos hidrológicos, la ubicación y las características de 10574 obstáculos. En segundo lugar, se proyectaron a la red hidrográfica 46118 datos de operaciones de pesca eléctrica entre 1985 y 2019. Finalmente, se aplicaron los cuatro sub-modelos que constituyen EDA: presencia/ausencia de anguilas, densidad, estructura de tamaño y plateamiento. El modelo proporcionó estimaciones de las poblaciones en cada tramo de río en los tres países y permitió estimar el escape a diferentes escalas espaciales que se presentarán en el simposio.

**Microstructure of European eel (*Anguilla anguilla* L.) otolith and its relation with transoceanic migrations**

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European eel (*Anguilla anguilla*) is a critically endangered species that is of international concern. The sharp decrease of its captures evidences the need to take measures to protect it. One of the possible causes of its decrease is the change of the speed of Gulf Stream that may influence the duration of the eel's journey to Europe. This study tries to bring some light to the transoceanic migration conducted by the European Eel from the Sargasso Sea to the Mar Menor coastal lagoon (western Mediterranean Sea). To achieve this, a study based on the daily growth marks in otoliths was conducted. Otoliths of eels captured at the Mar Menor during a thirteen year period (in 2005, 2012 and in 2017) have been read. For this purpose, otoliths were polished up to the Zero band and images were taken by a microscope at x40 and x100 magnifications. Images were then studied using a new free image analyzing software named OTOLab (produced by the Spanish Institute of Oceanography), previously used in hake species but never for eels otolith reading. The age, in days, of glass eels arriving to their continental phase into the lagoon was established. Statistically differences among the results of the three eels capture groups were analyzed. A mean of  $178.9 \pm 31.764$  days of life was established and a mean daily growth of  $0.98 \mu\text{m/day}$  was observed. No differences among groups were found. These results suggest, unlike to some theories, that the duration of the transoceanic migration between the spawning area and the continental habitat is not being affected, at least for the area and time of study, by changes in oceanic currents and climate change.

## Age and growth of European eel in the Minho River

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The European eel, *Anguilla anguilla*, is a panmitic population widely distributed through the Eastern North Atlantic coasts. It is an economically important species in all its range and the population has been highly decreasing since the 1980's due to several human and environmental pressures. Understanding *Anguilla anguilla* biology and ecology is important in order to implement urgent informed management strategies for its conservation. In the Minho River the European eel has been monitored over the last 30 years, recently, while undergoing age estimation studies of eels from different locations, it was observed a clear divergence between the age structure and growth rate of the downstream main river habitat and the upstream tributaries, which was also reflected in a different sex ratio composition. The phenotypic plasticity and high resiliency of this species is well known and has been thoroughly studied, discussed and ecotypes identified. There are several theories in terms of the factors that lead to habitat choice, different development, strategy for growth and sex determination, and they seem to depend greatly on the specific river basin system. This preliminary work aims to show that there is a higher growth rate in the downstream main river habitat and a higher density of females as opposed to the lower growth rate and higher density of males in the upstream tributaries. As age and growth are key parameters to population dynamics, and otoliths are widely used in fish studies giving important and conservative information on population structure and habitat characteristics, in the future, the authors aim to join further otolith and growth studies, to verify the differentiation, with the abiotic conditions, to explore and unravel the habitat characteristics that could have led to this discrimination in the Minho River ecosystem.

## Fish assemblages in northern Portuguese estuaries: Changes in fish guilds along salinity gradients

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Estuaries play a vital role in the functioning of aquatic systems, by providing many marine, migratory, or estuarine species with basic requirements for their life cycle. Hence, an understanding of the functioning in these ecosystem processes in transitional environments is necessary to enable their protection and the sustainable management required by legislation, such as the European Water Framework Directive (WFD). Fish was considered a key-element and a Multimetric index, the Estuarine Fish Assessment Index (EFAI), was developed and intercalibrated for Portuguese estuaries. After WFD implantation, some actions were implemented, and consequently certain improvements are expected to have been reflected in fish estuarine communities. Therefore, the present study aimed to study fish adaptations to estuarine environments, in terms of fish guilds, by applying a functional approach. Fish was sampled in 7 estuaries along the Portuguese coast (Minho, Ave, Mondego, Douro, Vouga, Cávado and Lis), following a sampling protocol established for the implementation of the WFD (Cabral et al., 2011). Fish species were assigned to ecological guilds reflecting habitat use, according to Franco et al. (2008). A presence of 36 species was found and a total of 2109 individuals. Species richness and percentage of individuals were higher in Douro, Mondego and Vouga estuaries. For all those systems, the number of species have increased since the last sampling in 2010. Water bodies with higher salinities (poli- and mesohaline) presented a higher percentage of mainly resident species, and as the salinity decreased to oligohaline water bodies, the presence of species that use the estuary as nursery increased proportionally. These results state the important relevance of this type of system with saline variability that allows the presence of marine species that use the estuary as a nursery and of the resident species that inhabit them. Finally, we can conclude that there is a notable improvement in the estuarine fish community of northern Portugal during the last decade.

## Connectivity between larval and juvenile fish assemblages: links between estuaries and coastal areas

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The success of early life stages of many marine fishes depends on their ability to reach suitable nursery grounds, which provide essential conditions for their survival and development. In southern Europe, although estuaries are relatively well studied, little is known about the nursery function of their adjacent coastal areas and the dynamics and connectivity between these two interconnected systems. Furthermore, studies rarely integrate both early life stages, larvae and juveniles. This work aims to analyse and compare the importance of an estuary and adjacent coastal zone as nursery areas for marine fish early life stages. Larvae and juveniles were sampled in the Mondego estuary (Portugal) and in its adjacent coastal area from April 2018 to January 2019. The temporal and spatial patterns of the ichthyoplankton communities were described for each system and related to the influence of environmental factors. Then, the recruitment pattern was evaluated by comparison with the composition of juveniles on coastal and estuarine fisheries catches. Results show a seasonal variation of larval density and community structure between and within the systems. In the coastal area, spatial distribution was related to the dominant regional oceanographic features. Seawater temperature was also the most important environmental factor structuring communities. The observed recruitment patterns are species-specific (e.g. *Sardina pilchardus* prefer coastal areas and *Pomatoschistus microps* the estuary), and for some species (*Solea solea*) both areas are important nurseries, at different stages of their life cycle. This study highlights the importance of integrating the larval and juvenile stages to better understand the species life cycle and connectivity between systems, which is essential for an accurate fisheries management and conservation of coastal ecosystems.

**Long-term changes in ichthyoplankton communities in an Iberian coastal ecosystem**

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Estuaries play a key role as a nursery for fish larvae being critical on the first life stages of fish development. Estuarine ecosystems are highly affected by direct human impacts as well as climate change. Climate variably distresses the ichthyoplankton assemblages and thus changes on the larvae community have consequences in the marine pelagic food webs and fish populations biology (namely recruitment). This study aims to investigate the latent influence of environmental variability on interannual abundance changes of ichthyoplankton assemblages in the Mondego estuary (Portugal), on a long term-scale. Consequently, a sampling programme took place through 13 years (2013-2015) along six distinct sampling stations in order to evaluate spatial, seasonal and interannual distributions of fish larvae. The larval fish community was heavily dominated by *Pomatoschistus* spp. and *Pomatoschistus microps* across all seasons and years, while a progressive decrease on captures of *Engraulis encrasicolus* was observed. Wet years and dry years showed similar behaviour according to the ichthyoplanktonic community structure, however, with different species in the assemblages. Great abundances of larvae occurred during summer and spring despite being a wet, dry or regular year. River flow, precipitation and consequently salinity appeared as the main factors influencing not necessarily the abundance and number of species but their distribution in the estuarine area, with a major appearance of marine species inside the estuary during dry years.

**Long-term influence of oceanographic conditions on the early life history of European seabass *Dicentrarchus labrax***

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Climate and oceanographic factors are among the most important drivers regulating marine fish population dynamics and connectivity, playing a key role in their early-life history. This work aimed to determine the influence of environmental changes on the interannual variability in hatch dates and early-life growth patterns of the European seabass *Dicentrarchus labrax*, over a seven-year period (2011-2017) in the Mondego estuary, in the Portuguese Atlantic coast. Seabass hatch dates and early-growth trends were both obtained via otolith microstructural analysis. Hatching was estimated to occur mostly between February and April, with two exceptions: in 2012, hatching started 1 month earlier than expected, and in 2016 the hatching period was exceptionally long, lasting until May. Using Generalized additive models (GAM) we verified that sea surface temperature (SST) and the North Atlantic Oscillation index (NAO) were the main drivers behind the inter-annual variability in seabass hatch dates. The effect of Chlorophyll-a was negligible. Growth correlation analysis revealed the existence of important growth periods for seabass, with the potential to affect future growth. With seawater temperature among the main drivers for seabass recruitment and growth, its life cycle may suffer important changes due to oceanic warming, resulting in negative consequences for seabass natural marine stocks.

## DNA barcode gap-analysis of mesopelagic fishes in Europe

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Mesopelagic fish live between 200 and 1000 m depths and, according to recent research, could represent 90% of the total marine fish biomass. This large abundance has made them attractive to exploitation, which could be fatal to oceanic ecosystems due to the important role of these organisms in carbon sequestration mediated by their diel vertical migrations. Thus, ecological studies on this still unknown pristine ecosystem are crucial to ensure a sustainable exploitation of this resource, which are hindered by the difficult access to this environment with traditional approaches. Environmental DNA (eDNA, i.e. genetic material released into the environment by macro-organisms) arises as a promising non-invasive way to study this challenging marine ecosystem. Collected by filtering water samples, eDNA can be analysed through metabarcoding, that is the taxonomic assignment of the DNA released by the multiple species present in a sample by comparing short DNA sequences unique to each species, barcodes, to a reference database. Here, we have assessed the viability of using eDNA metabarcoding to study mesopelagic fish diversity by analysing the completeness of publicly available genetic reference databases and the specificity and discriminant power of selected barcodes. By assembling a checklist of the mesopelagic fish species inhabiting European marine waters, we observed i) that the most common genes used for metabarcoding (cytochrome oxidase I, 12S and 16S rRNA, and cytochrome b) are available for 75%, 55%, 42% and 25% of the species, respectively, ii) that barcode coverage shows noticeable differences among mesopelagic fish families, iii) that the most common barcodes may not be specifically designed for fish, resulting in diluted mesopelagic diversity, and iv) that each barcode provides specific discriminative power to distinguish among closely related species. Our results are relevant to guide future efforts on increasing reference databases and to inform interpretations of metabarcoding-based mesopelagic biodiversity assessment studies.

### ***Trigla lucerna* growth in a temperate estuary**

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The yellow gurnard *Trigla lucerna* is a nectobenthic marine fish that uses estuaries as nursery grounds. Although often caught as a non-targeted species, it has economic importance and is appreciated for human consumption.

In this work, the growth of *T. lucerna* was followed during 9 months in the population from Mondego estuary (Portugal). Juveniles (>4.7 cm total length) were found to enter the estuary in spring when temperature and salinity increased. They remained in the area until autumn or early winter, when they migrated seawards. On the other end, older gurnards (2-5 years old) entered sporadically in the estuarine area mainly in autumn and winter. During the estuarine life period, gurnards growth can be described according to the following von Bertalanffy's model equation:  $L_t = 51.40 [1-e^{-0.148(t+0.5007)}]$

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## Evaluación de la densidad y dinámica de las poblaciones de la boga del Duero [*Pseudochondrostoma duriense* (Coelho, 1985)] en el tramo internacional del río Miño

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La boga del Duero, *Pseudochondrostoma duriense* (Coelho, 1985), es una especie endémica del noroeste de la Península Ibérica catalogada como “Vulnerable” por la IUCN (Unión Internacional para la Conservación de la Naturaleza). La información disponible sobre esta especie es muy reducida y poco se sabe de su biología reproductora. En el presente trabajo aportamos datos preliminares sobre la biología y estado de conservación de las poblaciones de *P. duriense* en cinco afluentes de la margen española del río Miño, los ríos: Caselas, Furnia, Pego, Deva y Hospital, abordando la caracterización biométrica y demográfica de las poblaciones y la estructura de edad y la evaluación de la fertilidad en las hembras reproductoras. En general los datos biométricos de los individuos procedentes de los distintos afluentes son semejantes, lo que indica su pertenencia a una población común para todo el tramo internacional del río Miño. El factor de condición de los reproductores en comparación con el observado en los inmaduros indica que las muestras fueron obtenidas en pleno periodo reproductor. Las hembras tienen mayor longitud, peso y factor de condición, y son más longevas que los machos, diferenciándose en ellas cinco clases de edad, considerándose la clase 3+ como el inicio de la maduración sexual.

**Efecto de variables ambientales en el reclutamiento de anguila (*Anguilla anguilla*) en el Río Ter (NE España)**

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En las últimas décadas, la población de la anguila europea (*Anguilla anguilla*) ha disminuido en un 95%. Uno de los indicadores para su seguimiento es la tasa de reclutamiento, estimada a partir de las capturas de angulas en el momento que penetren el río para iniciar su fase sedentaria. Dicho reclutamiento no es constante a lo largo del año y también varía diariamente en función de distintos parámetros ambientales. Estos patrones son poco conocidos en cuencas mediterráneas donde la influencia de las mareas es menor, en comparación con las costas atlánticas. En este estudio, se describen las capturas de angula en la cuenca del río Ter (Girona, NE España) y se analiza su relación con los factores que pueden afectar la migración hacia la costa. En el río Ter existe una pesca artesanal de angulas de forma que se disponen de las series de capturas comerciales desde el año 2010 entre los meses de octubre y marzo de cada temporada. El máximo de capturas se observa entre noviembre y enero. La respuesta a los factores ambientales se ha ajustado a partir de modelos aditivos generalizados (GAM) con distribución de error de Poisson, usando las estaciones de pesca como factor categórico y las variables ambientales como variables explicativas procediendo a su selección basándose en el criterio de información Akaike (AIC). Se observó que el caudal, la temperatura del agua del mar, la luna y la amplitud de la marea afectaban parcialmente las capturas (por este orden). El incremento del caudal tras precipitaciones y un rango de temperatura entre 10-14 °C se asocia con un mayor número de capturas en noches sin luna visible. El efecto de las mareas es más complejo, con una correlación global positiva.

## Feeding strategies of the European eel along the environmental gradient of Río Esva

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The feeding tactics of the European eel, *Anguilla anguilla* (L.), were assessed along the environmental gradient of a Cantabrian river. The feeding patterns in relation to food availability (i.e., benthos assemblages) were examined at four contrasting sites along that environmental gradient. Eels were actively feeding the year round at the four sites but more intensively during the warmer months. Overall eels feed on a wide range of organisms. However, at the scale of site, prey items determined in the eels' stomachs reflected, to a large extent, the benthos composition across seasons suggesting that whilst they behave as an omnivorous fish they actually feed on the most common prey at a local scale.

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## Populations dynamics of three resident fishes of the Mar Menor coastal lagoon (SE Iberian Peninsula): temporal changes in a long-term approach

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The Mar Menor is one of the largest and most biodiverse European coastal lagoons. Despite it, it has suffered environmental changes for decades. Its shallow areas are very important for resident species with conservation interest. The present study aims to analyse temporal changes in the occurrence and abundance, and also to study its habitat relationship, of three target species: *Pomatoschistus marmoratus*, *Aphanius iberus* and *Syngnathus abaster*. The lagoon perimeter had sectorized in areas according to macrohabitat criteria, and several shallow water localities per area was monitored seasonally with a 10-long beach seine during six annual cycles in two period (2002-04 and 2015-19). The temporal changes of species were studied at season level within each year, and at interannual level within each season. A PCA was done to see the habitat relationship in each season, modelling presence and abundance with the scores in GLMs. The shallow areas showed hight abundance and occurrences of the three target species, confirming its importance as critical habitats for these conservation interest species. *S. abaster*, linked to vegetated-bottoms, showed an increase (838 % increase of CPUEs) in the last years, possibly related with the current absence of this habitats in deep water areas, forcing it to search refuge in the still vegetated shallow areas. *P. marmoratus*, mostly dependent on non-vegetated-sand areas, showed a decrease (73% decrease of CPUEs), probably related to a more incidence of anoxia in the unvegetated bottoms. *A. iberus*, linked to vegetated-muddy bottoms, did not show significant changes, probably because its absence in the impacted deep water areas. Long-term monitoring is necessary to understand and confirm species trends. Part of this research was supported by the Environmental Service and Mar Menor Service of the Autonomous Government of Murcia (Spain).

## Olfactory sensitivity of the Lusitanian toadfish (*Halobatrachus didactylus*) to conspecific body fluids

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During the reproductive season (May-July), territorial male (Type I) Lusitanian toadfish produce long advertisement calls (boatwhistles) to attract females, and a variety of pulsed sounds during agonistic territorial defence interactions. Smaller (Type II) males mimic females morphologically and adopt sneaking behaviour. In mature type I males, but not sneakers, accessory testicular glands are well developed, and their secretory fluid runs abundantly from urogenital orifice, suggesting that they could have a role in spawning. The accessory testicular glands of type I males are steroidogenic and undergo seasonal changes in weight and fluid production in parallel to the seasonal profile of gonadosomatic index and main plasma sex steroids. Our hypothesis is that, although this species communicates by sound, this may be used for long distance signalling while chemicals, such as those released by the accessory glands, could operate at shorter distances providing cues of social/reproductive status (i.e., pheromones). Using the electro-olfactogram (EOG), we tested olfactory sensitivity of females to male body fluids – mucus, urine, intestinal fluid, bile fluid, and fluids from the anterior and posterior accessory glands – collected during January (non-reproductive) and May (reproductive). Mucus and urine elicited weak olfactory responses compared to bile, intestinal fluid, and accessory gland fluids. However, only the anterior gland and intestinal fluids from mature males generated significantly larger responses than those from non-reproductive males. Conspecific intestinal and accessory gland fluids contain highly potent odorants, especially during breeding. This suggests that chemical communication is important in toadfish reproduction. The identity of the compounds involved, their biological functions, and the difference in potency of these fluids from males of different social status remains to be elucidated.

## Predicción de la distribución de signátidos en el Parque Nacional de las Islas Atlánticas de Galicia a través de modelos de distribución de especies

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En el litoral español la Familia *Syngnathidae* está constituida por un número limitado de géneros y especies de peces, en las que se incluyen caballitos de mar y peces pipa. El nivel de conocimiento de la biología, ecología y distribución de los signátidos en nuestro litoral es limitado. El principal objetivo de este trabajo fue generar modelos de distribución de especies (SDMs) que permitan predecir la distribución del pez pipa *Syngnathus acus* en el archipiélago de las Islas Cíes (Parque Nacional de las Islas Atlánticas). Se aplicaron los siguientes SDMs: a) modelos de máxima entropía (MaxEnt), b) modelos lineales generalizados (GLM), c) modelos aditivos generalizados (GAM) y d) modelos de bosques aleatorios (Random Forest). La información biológica utilizada para la generación de los modelos procedió de muestreos del Proyecto Hippoparques (MAPAMA-1541S/2015) realizados en 2016-2018. Los datos procedieron de 192 presencias de *S. acus* registradas mediante inmersiones con equipos de buceo autónomo. Como variables predictoras se incluyeron la profundidad, la exposición al oleaje, el tipo de fondo y la pendiente. Para GLM, GAM y Random Forest se generaron pseudoausencias. Para cada uno de los SDMs se obtuvieron los índices de rendimiento (AUC, Accuracy y TSS), así como la importancia de cada variable. Con cada modelo se predijo la probabilidad de presencia en la zona de estudio. A su vez, a partir de los 4 modelos, se generó un mapa conjunto de predicción en el que se indica que la probabilidad de presencia de *S. acus* es mucho mayor en la cara interna de las islas Cíes, obteniendo altas probabilidades en tres áreas concretas de esta zona. En el caso de disponer en un futuro de suficiente información, estos SDMs se podrían implementar para el estudio de la distribución de otras especies de signátidos como los caballitos de mar.

## Resultados preliminares de la biología marina de las alosas europeas a partir del análisis de las capturas incidentales en las pesquerías de la costa atlántica gallega (NO de la Península Ibérica)

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Las alosas europeas: el sábalo, *Alosa alosa* (Linnaeus, 1758) y la saboga, *Alosa fallax* (Lacépède, 1803), son dos especies anádromas que permanecen la mayor parte de su ciclo vital en el medio marino, donde presentan una distribución costera y migran hacia los ríos para reproducirse.

Debido a la dificultad que entraña la captura en el mar, los datos para esta fase son escasos y fragmentarios y aún se desconocen muchos aspectos de su biología. Esta falta de conocimiento se acentúa en la Península Ibérica donde solamente se conoce la distribución general y la fenología de migración en el medio marino del NO de la Península Ibérica. Además, se carece de datos sobre aspectos biométricos básicos al igual que sobre la distribución específica de las dos especies en su etapa marina de crecimiento. Ante esta situación, las capturas accesorias brindan la posibilidad de obtener una información muy relevante.

La presente comunicación tiene como objeto profundizar en la fase marina en las costas del NO de la Península Ibérica mediante el análisis de la identidad específica y de las características biométricas de los ejemplares capturados de manera incidental en las pesquerías costeras, entre diciembre de 2019 y febrero de 2020. Se analizaron un total 78 ejemplares del género *Alosa* procedentes de las primeras ventas de las lonjas de Fisterra (n=37) y Malpica (n=41), que fueron capturados mediante redes de enmalle. Los ejemplares fueron medidos, pesados y eviscerados para la extracción de branquiespinas y gónadas.

Se discuten aspectos básicos como la identidad específica y la biometría básica (número de branquiespinas, longitud total, peso, sexo, factor de condición e índice gonadosomático) de los ejemplares, revelando aspectos inéditos sobre la biología de las alosas europeas en la costa atlántica gallega.



**II Medio ambiente  
y conservación**

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## Emerging Technologies in Acoustic Telemetry: Real-time and Acoustic Data Storage

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Acoustic telemetry is a well-established tool that has been used around the world for more than three decades to get an understanding of the spatio-temporal movements and associated behaviour of a wide range of aquatic animals. New emerging technologies are being developed continuously that allow for new research applications and designs. Examples for these new technologies are (1) real-time observations of both aquatic animals as well as their aquatic environment and (2) acoustic data storage tags.

Applied real-time systems may consist of various underwater sensors, acoustic telemetry tags on aquatic animals, a surface hub that receives data from the sensors as well as from the tags, and a cloud-centric database. Such systems are now in use at several global installations. Data access is available via a mobile phone or laptop that provide real-time notifications when tagged animals are near receivers or the current state of environmental variables.

Acoustic data storage tags might be used especially for far-ranging animals that might inhabit coastal and pelagic regions at different times of the year. These applications can be used to get a bigger picture of a species behaviour and its spatio-temporal distribution in order to address conservation and management measures since data is also collected while animals are outside of acoustic arrays. Here, we will explore the evolution of the use of acoustic telemetry and how receiving data in real-time and in acoustic data storage applications will help sustain our ocean ecosystems.

## Sperm quality parameters of Iberian toothcarp (*Aphanius iberus*) and Valencia toothcarp (*Valencia hispanica*): new conservation tools from a gamete perspective

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The sensitive state of conservation of several endemic fish species such as Iberian toothcarp (*Aphanius iberus*) and Valencia toothcarp (*Valencia hispanica*) has led governments to consider the implementation of conservation measures to preserve their populations. However, limited knowledge about the reproductive biology of these species makes it necessary to investigate different aspects of their reproductive cycle. In this sense, the main objectives of this work were i) to advance knowledge of the breeding biology of both species, and ii) to develop protocols for the conservation of gametes for the future management and conservation. During the spring of 2019 a temporal series of samplings were carried out in different places in the Comunitat Valenciana. Sperm samples were collected and sperm motion parameters were assessed for the first time in both species. Kinetic patterns were similar showing high motility and velocity values during the first 30 s, and a rapid decrease from that point. At the same time, an in-depth morphometric analysis was carried out using computer-assisted sperm analysis software. Spermatozoa from *A. iberus* and *V. hispanica* showed similar sizes and shapes to other external fertilizers belonging to Cyprinodontiformes, with small spherical heads, uniflagellated and without acrosomes. Furthermore, several pictures were taken with a scanning electron microscope, yielding small structural differences between species. In addition, a new cryopreservation protocol was designed for cryobanking the sperm of these threatened species. Cryopreserved samples showed lower motility than fresh samples but reaching acceptable percentages of motile cells after thawing of around 20 and 25% (*A. iberus* and *V. hispanica*, respectively). This study is the first of its kind to successfully achieve gamete cryopreservation of these two endemic and endangered species from the Iberian Peninsula, providing new and useful tools to complement the management and conservation programs that are being developed for both species.

## Fish morphology and passage through velocity barriers. Experiences with Northern straight-mouth nase (*Pseudochondrostoma duriense* Coelho, 1985) in an open channel flume

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Knowing the relationship between morphological traits and swimming capacity of fish is essential to understand on the one hand, the selective pressure that barriers in rivers and streams can exert on these organisms and, on the other, the swimming capacity of the individuals of this species to successfully surpass these obstacles. Northern straight-mouth nase individuals, an endemic potamodromous fish species from the Northwest of the Iberian Peninsula, were engaged to carry out swimming performance experiments in an open channel flume located in the hydroelectric plant facilities from Vadocondes (Burgos, Spain) on the Duero River. Individuals of this species were released in a resting pool at the end of the flume to permit the pass through it volitionally. Telemetry and video camera were used to know: the relative and total swimming speed, the maximum distance swimming and the fatigue time. Experiments were divided into 2 trials. Each trial was configured to allow fish to swim against three different nominal velocities: 1.5, 2.5 and 3.0 m·s<sup>-1</sup>. A geometric morphometrics analysis was performed based on 10 landmarks: 8 with an unequivocal anatomic significance, and 2 geometrically determined. Landmark configurations were superimposed, aligned, scaled, and rotated to a consensus shape using Thin-Plate Spline analyses. Centroid size, weight, furcal length were also measured and differences between individuals were analysed using proper tests. An orthogonal and empirical morphospace, using a PCA, was developed to analyse the differences in shapes between groups of swimming behaviour (MANOVA and Discriminant Analyses, in a loop of 1,000 random samples, with p-value<0.05 in all cases). Therefore, the obtained results show the existence of morphological differences between swimming behaviours, with potential consequences on fish population due to selection pressures associated to velocity barriers.

## Influence of an endangered cyprinid fish (*Barbus meridionalis*) on benthic invertebrate assemblages and periphyton biomass in a human-impacted Mediterranean stream

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Freshwater ecosystems are affected by multiple anthropogenic stressors, and their effects on aquatic communities is a current interest for ecologists. Moreover, freshwaters are experiencing the loss of fish. This study was conducted in Osor stream (Iberian Peninsula), which is affected by metal pollution and water diversion. Following a hydrological and chemical gradient, we performed an exclosure/enclosure mesocosm experiment using an endangered cyprinid fish, the Mediterranean barbel (*Barbus meridionalis*). The main objective of this study was to assess the responses of periphyton and macroinvertebrates to the presence or absence of fish under different multiple stress conditions. We found that periphytic algal biomass and benthic macroinvertebrates were predominantly controlled by top-down forces through bioturbation and predation, respectively. The reduction of periphyton thickness in fish treatments suggests that this native fish can compensate for the loss of grazing macroinvertebrates in the most polluted sites. On the contrary, periphytic biomass and the most abundant, metal tolerant macroinvertebrates (stoneflies of the family *Leuctridae*) remarkably increased in response to fish extirpation. However, sensitive taxa such as beetles, snails and chironomids did not recover in the most polluted sites, indicating that their populations are affected by multiple stressor effects. In conclusion, results highlight the important functional role of *B. meridionalis* in lotic environments since the presence or absence of fish can result in major changes to the ecosystem's structure, and these changes are modulated by human impacts. Based on this, we foresee that the local extinction of top predators may exacerbate human stressor effects. We recommend that future research is based on effect-based monitoring including different trophic levels for a better risk assessment of pollution.

## Negotiation of small instream obstacles by potamodromous fish: main findings from experimental research

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Though small weirs are far more numerous than large hydraulic structures, much less is known about passability of such small obstacles. In Iberian rivers, small broad-crested (BC) and low-head ramped (LR) weirs are the most frequent types. This study presents the main findings from experimental research conducted on the passability of these small weirs, which were recreated in an indoor flume. Iberian barbel (*Luciobarbus bocagei*), a widespread medium-sized potamodromous fish, was used as target species. Fish passage was assessed for different combinations of waterfall height (H), plunge pool depth (D) and width of crest (W), for BC weirs, while combinations of ramp length (L) and slope (S) were performed for LR ones, and further subjected to placement of substrates to improve passability. All the combinations were tested across a range of discharges (Q). Results showed that for BC weirs (i) fish passage was inhibited by shallow D in association with high H, (ii) increased passage did not occur at higher D in association with lower H, (iii) passage behaviour was highly dependent on combinations of D and H and (iv) the W was preponderant for downstream movements but not for upstream ones. For LR weirs, it was found that (i) successful passage was conditioned by the increase of S and L and that (ii) the number of successful passages increased significantly in response to Q reduction. The placement of natural substrates along LR weirs may help to increase the passability of these structures to fish movements, providing energy dissipation along the obstacle. Moreover, hydrodynamics downstream may have influenced successful passages. These findings can be useful to identify potential migration obstacles and to help design structures more permeable to fish movements.

## River connectivity restoration and its effects on an endangered Atlantic salmon (*Salmo salar* L.) population on the North of Spain: implications for management and conservation

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Since the beginning of the 20th century, Atlantic salmon (*Salmo salar* L.) has suffered a dramatic decline in numbers, becoming extinct in many rivers across its distribution range. River fragmentation is considered one of the most important causes of this decline. Nowadays, temperate rivers of Europe and North America are deeply fragmented by the presence of thousands of dams and weirs, which block the upstream migration of adult salmon from the sea to their spawning grounds and the downstream migration of smolts to the ocean. However, the effect of river fragmentation and connectivity restoration in population trends is not well studied. We developed a new habitat connectivity index (HCIb) that considers cumulative dam passability upstream and downstream, river segment length and river segment quality for salmon spawning and rearing. This new index was applied to the study of river connectivity in the Bidasoa River basin (north of Spain) from 1990 to 2016. The Bidasoa River holds a small Atlantic salmon population in risk of extinction. The Government of Navarra and the Cantabrian Hydrographic Confederation removed 15 dams and built fish ladders on four from 1993 to 2016 to increase the habitat accessible for Atlantic salmon. We analysed the relationship between the increase in river connectivity due to dam removal and the size of the adult salmon population from 1990 to 2016 using time-series analysis and Generalized Linear Models. Our results show that there is an increase in the adult population of Atlantic salmon from 2010 onwards which could be related to connectivity restoration. However, the time-series analysed is too small (27 years) to extract accurate conclusions. More years are needed to correctly analyse the impact of river fragmentation and connectivity restoration in salmon population numbers. These studies would help managers in the planning of salmon conservation strategies.

## Causas del declive del salmón atlántico en los ríos españoles

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En las últimas décadas, el Salmón Atlántico *Salmo salar* ha sufrido un fuerte declive, extinguiéndose en muchos ríos, siendo su disminución particularmente acusada en el sur de Europa. El análisis de loci microsatélites en muestras de escamas históricas (1958-1960) y contemporáneas (2007-2008) ha mostrado una pérdida de la diversidad genética nativa, aumento de la introgresión y descenso abrupto de los tamaños efectivos poblacionales. Evaluamos también las tendencias temporales en la abundancia de los ríos españoles, la variación de los organismos que constituyen su principal fuente de alimentación en el mar y las variables climáticas en las áreas de cría (agua dulce) y alimentación del Salmón (marino) desde 1950 en adelante, para tratar de dilucidar los impulsores de los patrones de declive. La abundancia se redujo abruptamente en 1970-1971, posiblemente vinculada a la sobre pesca generalizada que coincide con los cambios en las redes tróficas marinas e hidrológicos en los ríos, así como el aumento de la prevalencia de algunas enfermedades. En 1986-1987 se produjo un cambio importante en el régimen de las condiciones biofísicas en las zonas de alimentación en el Atlántico Norte, impulsado por la concurrencia de una aceleración abrupta en la tendencia al calentamiento global antropogénico y la fase cálida de la Oscilación Multidecadal Atlántica (AMO). Este cambio de régimen pudo ser la causa inmediata del colapso del Salmón observado en 1988-1989, que siguió disminuyendo en paralelo a las tendencias de aumento de las temperaturas en el océano y los ríos, así como a la disminución de los caudales de los ríos y las condiciones tróficas marinas más pobres. En resumen, el Salmón es una especie resiliente que intenta sobrevivir a las condiciones adversas que el hombre ha impuesto durante décadas. La repoblación con ejemplares aloctonos ha sido perniciosa, y sus efectos se suman a los del cambio climático y la sobre pesca, siendo las principales presiones humanas que afectan a su biología y la integridad del genoma de la especie. Nuestros hallazgos en el sur de Europa podrían extenderse a otras áreas donde la disminución de sus poblaciones está siendo alarmante.

## Estudo dos limites de passagem do barbo ibérico em passagens para peixes de fendas verticais

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A construção de açudes e barragens fragmenta a conectividade longitudinal dos rios, impossibilitando a passagem de peixes e outros organismos aquáticos. As passagens para peixes (PPP) são estruturas hidráulicas projetadas para mitigar os impactos negativos dessas barreiras. Contudo apresentam em muitos casos, baixa eficiência, sendo essencial investir em investigação para readaptar as linhas gerais de projeto das PPP e as adequar a multi-espécies. O presente estudo foca-se no comportamento de um ciprinídeo ibérico, o barbo ibérico (*Luciobarbus bocagei*) em PPP de bacias sucessivas. Os ensaios foram efetuados numa instalação experimental, com inclinação de 15 %. Foram utilizadas duas geometrias: fenda vertical (FV) e fenda vertical com soleira (FVS). Em cada geometria, foram testados, usando diferentes caudais (FV: Q = 110 e 81 l/s; FVS: Q = 99 e 71 l/s) duas profundidades médias de água nas bacias, o que permitiu gerar uma potência dissipada por unidade de volume (Pv) entre 188 e 222 W/m<sup>3</sup>, consideravelmente superior ao valor máximo de referência indicado na literatura (Pvmax ≤ 150 W/m<sup>3</sup> para ciprinídeos). Os ensaios experimentais com peixes (N = 100) foram realizados durante o período de migração e a monitorização individual do comportamento dos peixes foi realizada através de telemetria, utilizando um sistema de marcas PIT (Passive Integrated Transponder). Os resultados mostram que para a motivação, a probabilidade de existir uma tentativa de passagem é o dobro para a FV com Q = 81 l/s (Pv = 222W/m<sup>3</sup>) em comparação com as outras configurações. Na análise de ascensão a probabilidade de sucesso da geometria FV e configuração FVS Q = 71 l/s é, em média, 80% maior do que a probabilidade de sucesso com a configuração FVS\_Q = 99 l/s (Pv = 188 W/m<sup>3</sup>). No geral, estes resultados mostram que, mesmo com Pv elevada, o barbo apresenta uma eficiência de passagem considerável. De facto, na configuração FV Q = 110 l/s de Pv = 222 W/m<sup>3</sup>, o barbo exibiu uma eficiência total de passagem de 68%. Estes resultados fornecem informações adicionais sobre os limites ecohidráulicos de espécies de ciprinídeos que podem ser usadas para estabelecer novas diretrizes de projeto para PPP.

**Mediterranean Chondrichthyans: A review to increase our knowledge for future conservation and management**

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The Mediterranean Sea is a hotspot of extinction risk and uncertainty for chondrichthyans with 53% and 18% of the extant species classified as threatened and data deficient, respectively. Thorough knowledge on population status is required to ensure the proper management of their stocks. Aiming to provide an updated knowledge and to evidence information gaps, we synthesised the insights of 472 peer-reviewed papers published between 2010 and 2020. The increasing trend on the number of publications in recent years denoted a rising interest on chondrichthyans. Although not threatened species are the most studied ( $37 \pm 27$  publications per species), especially *Scyliorhinus canicula*, *Galeus melastomus* and *Raja clavata* (103, 88 and 86 publications, respectively), threatened species are starting to become more relevant on scientific literature ( $23 \pm 12$  publications per species). However, scarce information is still available for some critically endangered species, with no reports of *Pristes pectinata*, *P. pristis* and *Carcharias taurus*. Deeper understanding is also needed for some data deficient species ( $11 \pm 13$  publications per species: ranging from 2 for *Isurus paucus* to 53 for *Squalus blainville*). The works are evenly distributed throughout the Mediterranean, although ISI publications are more frequent than no ISI in the western region (117 and 16, respectively) than in the eastern (80 and 57, respectively). Research on abundance and distribution of chondrichthyans at regional levels dominated over the last decade (36% of total publications), followed by population biological parameters (30%), especially those related to age and growth. Although trade and mislabelling are still poorly studied (1%) and the standardization of methods should be prioritised, our results indicate that research efforts began to focus on gaining understanding about populations status which is essential to ensure the correct assessment and management of chondrichthyans stocks.

## Population dynamics of an endangered fish, the Fartet (*Aphanius iberus*), in the coastal marshes of la Pletera: two decades of monitoring

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The Fartet or Spanish Toothcarp (*Aphanius iberus*) is an endangered endemism of the Mediterranean basins of Iberian Peninsula, being formerly present in coastal lowlands where it occupied both freshwater and brackish waters. Nowadays its presence is almost circumscribed to some saline or hypersaline environments, usually with a direct sea influence. This species is present in la Pletera wetlands, in the Baix Ter floodplain, as a part of its most northern populations in the Empordà area. In the Baix Ter plain its historical presence was probably much greater, but in recent times Fartet occurrence became limited to a single lagoon, Fra Ramon, in la Pletera marshes.

From 2000 to the present several conservation efforts have been done to avoid the local extinction of Fartet in the Area, from two LIFE projects, including LIFE Pletera, to other measures like the creation of the Natural Park of Montgrí, Medes i Baix Ter. At present, the Fartet is present also in other lagoons recently recreated in the area. Almost along all this period fish populations in the Pletera area have been monitored. From 2008 to the present this monitoring has been based on fyke net surveys. Results are presented.

Fartet population is highly unstable, with abrupt and dramatic variation in its density, going from its massive presence, when often is the only fish species present, to its temporal disappearance from some lagoons. Factors explaining these fluctuations are not at all clear, but apparently include the typical interannual variations of limnological conditions of this kind of systems, and also the penetration of Eastern mosquitofish (*Gambusia holbrooki*) in the area.

## Evaluación del estado de conservación del fraile (*Salaria fluviatilis*) en la cuenca del Ebro, en el marco del proyecto SOS Margaritona

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La margaritona (*Margaritifera auricularia*) es un molusco de conservación prioritaria en España. Está catalogada en la categoría “En Peligro Crítico” tanto en España como a nivel internacional. Lamentablemente, su situación ha seguido empeorando. Aún peor, este proceso se ha acelerado en los últimos años. El objetivo general del proyecto SOS Margaritona es la conservación a largo plazo de la margaritona, mediante la identificación de tramos fluviales adecuados para establecer nuevos núcleos de ejemplares en la cuenca del Ebro, y la mejora de los stocks disponibles de su pez hospedador, el fraile (*Salaria fluviatilis*). De hecho, la conservación de la margaritona está necesariamente aparejada a la del fraile. El proyecto SOS Margaritona cuenta con el apoyo de la Fundación Biodiversidad, a través del Ministerio para la Transición Ecológica y el Reto Demográfico.

Uno de los objetivos específicos del proyecto SOS Margaritona, ha sido la evaluación y actualización del conocimiento sobre las poblaciones de fraile en el tramo medio del Ebro. Para ello, se ha diseñado un muestreo específico sobre unas 200 estaciones en la zona de estudio (cuenca del Ebro, excepto Cataluña). En cada una de estas estaciones de muestreo, se han establecido entre una y cinco subestaciones de muestreo de extensión variable, en función de la heterogeneidad del hábitat. Cada subestación tenía un microhábitat y mesohábitat aproximadamente uniforme, representando en conjunto la diversidad de hábitats de la estación. La captura de peces se ha realizado mediante pesca eléctrica. También se ha realizado una nueva modelización de su distribución y probabilidad de aparición en base a los datos obtenidos combinados con datos de estudios precedentes recientes. Se presentan los resultados alcanzados. El fraile solo ha aparecido en un 8,0 % de las estaciones de muestreo. A pesar de que un 41,1 % de los tramos fluviales de la cuenca presentan hábitats potencialmente adecuados para el fraile, solo aparece en un 6,1% de estos tramos con hábitats potenciales.

**Ictiocenosis y efecto barrera en afluentes del tramo internacional del río Miño**

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Las barreras transversales son claves en la fragmentación de los hábitats y en la distribución de las especies acuáticas. La mayoría de los estudios se han centrado en el análisis de los efectos de las grandes presas en la biota; sin embargo, los pequeños y medianos obstáculos, a menudo parcialmente franqueables, son mucho más abundantes y han sido poco estudiados. El objetivo de este trabajo es el de investigar el impacto de los obstáculos de pequeño y mediano tamaño sobre la comunidad de peces en afluentes de la margen española del tramo internacional del río Miño. Para ello se realizaron dos campañas de muestreo de pesca eléctrica entre los meses de mayo y julio de 2018. Los muestreos se realizaron en 9 localidades próximas a 5 obstáculos repartidos entre cuatro afluentes; el Caselas (2 obstáculos), el Furnia, el Deva y el Pego. En cada obstáculo se muestrearon tramos de 100 metros aguas arriba y 100 metros aguas abajo. A pesar de que no se observaron diferencias estadísticamente significativas en la densidad de peces encontrados aguas abajo y aguas arriba, el análisis de los resultados muestra unas tendencias importantes en las comunidades de peces con diferencias tanto en la composición específica como en las densidades de peces en algunos ríos. Por ejemplo, la boga de río [*Pseudochondrostoma duriense* (Coelho, 1985)] ve imposibilitada la migración reproductiva aguas arriba en el río Pego, lo que produce su acumulación aguas abajo del obstáculo. Así, las diferencias observadas en cada uno de los ríos se deben fundamentalmente a la franqueabilidad parcial (franqueable por las especies más reófilas y en épocas de caudales altos) causada por el obstáculo y a los cambios de hábitat causados por éste.

## Use of a multi-metric fish index as a monitoring tool for the shallow waters in the Mar Menor coastal lagoon

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Coastal lagoons are aquatic ecosystems highly threatened by human activity, such as urban development, overfishing or polluting dischargers. The Mar Menor coastal lagoon, located in the Southeast of the iberian peninsula, is one of the most environmentally impacted European transitional water ecosystems. In recent years, the eutrophic levels had been critical, triggering mass fish mortality events and the loss of most seagrass meadows. In order to study its impact on the ecological quality, the fish community of shallow waters was selected as a bioindicator. In 2018 and 2019, seasonal samplings were carried out at 18 sampling sites distributed along the perimeter of the lagoon, following the methodology developed in the reference period (2002-2004). The data collected was integrated into the Estuarine Multi-metric Fish Index (EMFI), adapted for this environment. The results showed a marked seasonal variation in EMFI metrics, obtaining in spring the highest values. Nevertheless, despite the evident deterioration of the lagoon, significant differences were not found among current ecological quality and reference values. Shallow water areas have probably played a key role in buffering the deterioration effects on fish communities, making necessary and prioritary its conservation for the short and long-term lagoon restoration. Part of this research was supported by the Environmental Service and Mar Menor Service of the Autonomous Government of Murcia (Spain).

## Short and long term increased temperature effects on *Halobatrachus didactylus* metabolic rate

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In the last decades the scientific community has focused the studies on aspects of climate change. Given that physiological processes are the link between the environment and the individual-level responses, studies focusing on the effects of environmental drivers on the physiology of marine organisms are sorely needed. In this aspect, the study of fish responses to the stressors related to climate change is of high relevance for sedentary species without the ability to migrate along the temperature gradient. The goal of this study is to quantify and determine the short and long term effects of increased temperature on the stress response of the toadfish *Halobatrachus didactylus* using respirometry. For short term assessment, 32 fish were subjected to acute temperature increases from 12 to 28 °C while in respirometry chambers to measure the changes in metabolic rates. For long term assessment 24 fish were transferred to treatment tanks with two temperatures (12 and 28 °C). Fish were held under the different treatments for 30 days. Baseline and maximum metabolic rates were obtained, and food conversion was estimated for each treatment. For the short term, metabolic rate increased three fold from 12 to 28 °C. Fish from the long term high temperature conditions exhibited a decrease in weight (mean -3.1%) and a higher metabolism (average baseline 24.6 mgO<sub>2</sub> h<sup>-1</sup> kg<sup>-1</sup>, average maximum 36.4 mgO<sub>2</sub> h<sup>-1</sup> kg<sup>-1</sup>). Fish under low temperature gained weight (mean +9.3%) and their metabolism remained low (average 4.5 mgO<sub>2</sub> h<sup>-1</sup> kg<sup>-1</sup>, average maximum 10.6 mg O<sub>2</sub> h<sup>-1</sup> kg<sup>-1</sup>).

**Abnormal body coloration (malpigmentation) in north Atlantic marine fishes**

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Several cases of abnormal coloration in marine fishes captured along the Atlantic European waters are presented. The affected specimens showed the three main coloration anomalies present in nature: Melanism, in *Lepidion lepidion* and *Lepidion guentheri* (*Moridae*); Xanthochroism, in *Lophius budegassa* (*Lophiidae*) and *Raja montagui* (*Rajidae*) and Albinism, in *Merluccius merluccius* (*Merlucciidae*). Abnormal body coloration (malpigmentation) in fishes usually occurs as either a deficiency of pigmentation (albinism or hypomelanosis and xanthism or xanthochroism) or as an excess (melanism or hypermelanism). Malpigmentation in fishes has been extensively studied in the context of aquaculture, but it has been largely overlooked in natural populations. Although the aetiology of these and other pathologies is not known in all cases, and can be multifactorial in nature, taken together their measurement within populations provides a high-level indicator of health status amongst individuals comprising those populations. Monitoring the condition of colour anomalies and changes in its prevalence in natural fish populations can provide valuable information on the status and changes in environmental quality and, therefore, can be useful in assessing the health of the marine ecosystem.



**III Genética, desarrollo,  
parasitismo y ecofisiología**

**III Genética, desenvolvimento,  
parasitismo e ecofisiologia**



## Primeros registros de la colmilleja del Alagón (*Cobitis vettonica*) en Portugal y variabilidad genética de sus poblaciones en la Península Ibérica

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El conocimiento de los peces de agua dulce en la Península Ibérica se ha actualizado en los últimos años mediante estudios de monitoreo y distribución. En estos estudios, las especies con distribuciones reducidas y morfología variable son las más susceptibles de pasar desapercibidas. Sin embargo, son éstas especies las potencialmente idóneas para ser incluidas en las Listas Rojas nacionales. Los peces del género *Cobitis* o colmillejas representan un buen ejemplo en el que se reúnen todas estas características. Son tres las especies ibéricas: *Cobitis calderoni*, *Cobitis paludica* y *Cobitis vettonica*. *Cobitis calderoni* está amenazada en España y Portugal, mientras que *C. paludica* y *C. vettonica* solo en España. La morfología externa de la colmilleja del Alagón *C. vettonica* se parece a la de la colmilleja *C. paludica* aunque la primera presenta barbillas y aletas más cortas junto con una cabeza también más reducida. Las distribuciones de ambas se han actualizado recientemente en España y existen indicios de la presencia de *C. vettonica* en Portugal aunque su distribución permanece desconocida. *Cobitis vettonica* fue descrita en el río Alagón (Tajo) en España y posteriormente se encontraron varias poblaciones en el río Águeda (Duero). En el presente trabajo se hicieron muestreos de pesca eléctrica en los principales ríos en Portugal con especial énfasis en áreas con potencial presencia de especies endémicas. Se utilizaron caracteres moleculares (citocromo b) para valorar la diversidad de las colmillejas en Portugal. Estos datos han servido para la actualización de la distribución de *C. vettonica* en la Península Ibérica y certificar su presencia en tres afluentes del Tajo en Portugal encontrándose algunas poblaciones en simpatría con *C. paludica*. Dada la reducida distribución de *C. vettonica* se debería considerar su inclusión en la Lista Roja de Especies Amenazadas de Portugal.

## Inter-specific introgression and a mixed spawning area shape the genetic connectivity of Atlantic Bluefin tuna

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The Atlantic bluefin tuna (ABFT, *Thunnus thynnus*) is managed considering two demographically independent populations, East and West, separated by the 45°W meridian and assumed to spawn respectively in the Mediterranean Sea and the Gulf of Mexico. However, evidence of regular and frequent trans-Atlantic migrations involving stock-mixing in the North Atlantic and the discovery of a new spawning ground in the Slope Sea (between the Gulf Stream and the northeast U.S. continental shelf) challenges the current two-stock based management strategy. Using thousands of single nucleotide polymorphisms (SNPs) discovered through Restriction Associated DNA sequencing (RAD-seq) data of five hundred larvae, young of the year and spawning adult ABFT samples covering the three spawning grounds and including individuals of other *Thunnus* species, we have studied the population structure and genetic connectivity of Atlantic bluefin tuna integrating information of possible signs of inter-species introgression. We found i) Mediterranean-like individuals in the Gulf of Mexico, ii) that the Slope Sea is an intermediate population admixed from the genetically differentiated Mediterranean and Gulf of Mexico populations, iii) presence of signatures of introgression from albacore tuna in the ABFT nuclear genome, occurring at different intensities between populations, and vi) genomic signatures of natural selection among ABFT samples aggregated in a chromosomal inversion of albacore tuna origin, present at highest proportions in the Mediterranean population. Altogether, these results support strongly asymmetric trans-Atlantic gene-flow from the Mediterranean to the Atlantic spawning grounds. Our findings highlight the need to revisit ABFT management strategies integrating a comprehensive view of population mixing dynamics.

## High genetic differentiation in the endemic and endangered freshwater fish *Achondrostoma salmantinum* Doadrio and Elvira, 2007 from Spain, as revealed by SNP markers

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*Achondrostoma salmantinum* is a small, endangered freshwater fish endemic to Spain. The species is a member of the widely distributed *Leuciscidae* family, but its geographic range is restricted to a few rivers in the southwestern Duero Basin. Its populations are considered to be in regression, having disappeared from some rivers within its historical distribution. Although a captive breeding program has already been implemented for the species, there have not been any population genetic studies on *A. salmantinum*, despite information on genetic variability and variation generally being considered fundamental tools for management and conservation efforts. Therefore, we assessed the genetic diversity of *A. salmantinum* and defined its Operational Conservation Units (OCUs). We sampled throughout the entire known distribution area of *A. salmantinum* and analysed both nuclear and mitochondrial genes and a battery of single nucleotide polymorphisms (SNPs). Contrary to expectations due to its small distribution area, *A. salmantinum* showed strong genetic erosion in addition to a strong population structure that is not associated with the current hydrogeographic configuration of the region but rather with historical geomorphological processes. Likewise, we established four OCUs for the species. Overall, our findings provide insight into the genetic structure of *A. salmantinum* populations, which has revealed both intrinsic and extrinsic factors that threaten the viability of the species.

## Mislabelling, hybridization and connectivity across the Atlantic Ocean in the white anglerfish (*Lophius piscatorius*): implications for management

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White anglerfish (*Lophius piscatorius*) are deep-sea demersal fish of high commercial value that inhabit the North Eastern Atlantic Ocean and Mediterranean Sea. Within the Atlantic, the species is managed as three management units (stocks), although it is unclear whether they are genetically connected. Additionally, the correct management of white anglerfish deeply relies on the accurate distinction between the white and the black anglerfish (*L. budegassa*), which are very similar and mainly distinguished by the colour of their peritoneum. Here, we have performed analyses based on mitochondrial DNA (mtDNA) and nuclear Single Nucleotide Polymorphisms (SNPs) from white anglerfish samples collected across the distribution of the species (the three Atlantic stocks and the Mediterranean Sea) and including also black anglerfish samples. Our population structure analyses based on SNPs show that the white anglerfish samples are classified in three groups, two of them showing low levels of observed heterozygosity and composed exclusively of individuals with all white or all black anglerfish mtDNA, and third one showing higher levels of observed heterozygosity and composed of a mixture of individuals with white or black anglerfish mtDNA. Analyses including black anglerfish samples confirmed that one of the low heterozygosity groups is composed of black anglerfish individuals identified as white anglerfish (mislabelled), and analyses to detect hybridization confirmed that the high heterozygosity mixed-mtDNA group is composed of first generation or back crossed hybrids. Combining these results with catch location, we show that the mislabelled individuals are more abundant in southern locations and that hybrids are almost exclusively found in the area where the distribution of both species overlap. Interestingly, no genetic structure is observed in the non-mislabelled non-hybrids white anglerfish samples. These results have important implications for the assessment of the white anglerfish, which should reconsider the existence of three separate stocks and account for variable proportions of mislabelled and hybrid individuals across areas.

## Design of a sperm extender for different elasmobranch species and first sperm cryopreservation trials

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Sharks and rays are among the most threatened vertebrates on the planet, mainly due to overfishing and habitat destruction. However, techniques to control their reproduction has been scarcely used to protect these animals in *ex situ* conservation programs. The main aim of this study was to develop an extender for elasmobranchs sperm to allow its short-term storage (hours to days), and being the basis of a freezing medium for cryopreservation.

The sperm of three shark species (*Scyliorhinus canicula*, *S. stellaris*, *Galeus melastomus*) and three skate species (*Raja undulata*, *R. asterias*, *R. montagui*) was obtained from by-caughted animals and animals kept in aquaria. Sperm was obtained by abdominal massage or urogenital catheterization and its osmolality and pH were measured. Spermatozoa morphology, sperm motility and membrane integrity were also evaluated prior its dilution in different extenders formulated imitating the seminal plasma composition. Combining the physicochemical information obtained for each species a common sperm extender for elasmobranchs was formulated. The main components of the extender (in mM; 433 Urea, 316.5 NaCl, 160 TMAO, 13.4 KCl, 11 Glucose, 9 CaCl<sub>2</sub>, 3.6 NaHCO<sub>3</sub>, 2.8 Na<sub>2</sub>SO<sub>4</sub>, 1.4 MgSO<sub>4</sub>) were kept in balance with physiological fluids.

Sperm samples stored after dilution with this extender maintained optimal motility and membrane integrity up to 32 days (an average of 21 days) if keep at 4 °C. Bacterial contamination spoiled the samples, but it is unclear if the reason was the release of some bacterial by-product or the consume of essential elements for the spermatozoa survival.

Adding different cryoprotectants (methanol, glycerol, DMSO) to the extender, supplemented with egg yolk, we got by first time the motility activation of shark thawed sperm cells. Further results of this research would allow the sending of elasmobranch sperm samples over long distances ensuring its viability, without the need of transporting alive animals.

**Anatomical study of the reproductive organs of sharks of the family *Scyliorhinidae* to set up the procedures for the extraction of in vivo and post-mortem sperm**

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*Ex situ* conservation programs can be used as an additional tool in the recovery plans of several elasmobranch species. However, techniques to control their reproduction have been scarcely applied to protect these threatened animals. Artificial insemination of females is a technique commonly used in other species, that needs the proper obtention and assessment of the sperm. Three shark species belonging to the family *Scyliorhinidae* (*Scyliorhinus canicula*, *S. stellaris*, *Galeus melastomus*) were used in this study. Animals were obtained from fisheries by-catch or maintained in aquaria. Dead animals were used to study the anatomy of the reproductive organs of each species and set up the invasive procedures required in each case for the extraction of sperm. Sperm was obtained by using different methodologies: 1. In vivo and post-mortem stripping, pressing the abdominal region over the seminal vesicle; 2. In vivo and post-mortem cannulation through the urogenital papillae to the seminal vesicle and seminal sacs, using urogenital and nasogastric catheters (1 to 2 mm diameters); 3. Cleavage and scraped of nidamental glands of dead females. Cannulation of males was the optimal procedure for samples intended to last in time, due the reduction of bacterial contamination. Catheter diameter should be wider than 1.3 mm due the high viscosity of seminal plasma. Abdominal massage was the fastest and least invasive method in fully mature males, while sperm obtained from nidamental glands had the lowest quality. The screw-like morphology of the spermatozoa (length, width, number of gyres of the head), its physicochemical properties (pH, osmolality), motility, and the effectiveness of live/dead staining techniques were analyzed. The presence, shape, and size of sperm cells aggregations in the seminal vesicle was described. Last, up to our knowledge this is the first time that motile sperm with intact membrane is obtained from the nidamental gland of dead females.

**Effects of EOD behaviour on helminth parasitic infections: a preliminary study of *Torpedo* sp.**

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Electric Organ Discharges (EOD) are used by some species of fishes while predating to debilitate, paralyze or kill their prey. Whether or not the EOD used when predating affects parasites in the intermediate host and hampers their capabilities of infection is still an open question. For this, a model species (*Micromesistius poutassou*) was used to compare the effect of electric discharges on *Anisakis* sp., proving that they affect parasites mobility. Further studies need to be done on its effects on parasite capacity of infection. To develop the question, in the present paper the intestinal parasitic community of two species of *Torpedo*, 30 *T. torpedo* and 17 *T. marmorata*, is studied. The specimens were collected in the ports of València and Cullera (Western Mediterranean, Spain) and were captured by trammel fishing nets during March and June 2017, the intestines were analysed to describe their parasitic infracommunities showing low values overall. To contrast this with other studies, two different approaches were conducted: (1) bibliographical search of all previous instances of infracommunity descriptions for batoids (using Web Of Science and Google Scholar), and (2) data given by the Global Cestode Database. It is observed that torpediniform rays have a poor parasite fauna as genus and when compared with other groups of batoids. The causes could be related to a matter of contact with the parasites (influenced by diet or sedentary distribution), compatibility with the host or the effect of EOD.

**Effects of inflammation and/or infection on the neuroendocrine control of fish intestinal motility**

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Food is the largest expense in fish farms. On the other hand, the fish health and wellbeing are determining factors in aquaculture production where nutrition is a vital process for growing animals. In fact, it is important to remember that digestion and nutrition are crucial for animals' physiology. However, digestion is a very complex process in which food is processed to obtain necessary nutrients and central mechanisms of this process require both endocrine and neuronal regulation. In this context, intestinal motility is essential for the absorption of the nutrients (digestive process determining nutrition). An imbalance in the intestinal motility due to an inadequate diet or an infectious process could result in a lower use of the food and inefficiency in obtaining nutrients from food. Very frequently, farmed fish are infected with different pathogenic microorganism and this situation could alter gastrointestinal physiology and, indirectly reduce fish growth. This is why, neuroendocrine control of intestinal motility is altered by infections. In addition, GALT has a key role in intestinal motility control because some immune molecules are motility modulators too. For these reasons, the present work focused on analysing how different inflammatory molecules or infections can alter conventional modulators of fish intestinal motility. In this way, analysing immune-neuroendocrine-motor interactions which could explain intestinal immune response during inflammation and infection.

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**Next Generation Sequencing revealed strong population structure and isolation in the Iberian Toothcarp (*Aphanius iberus*, Valenciennes, 1846)**

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The species *Aphanius iberus* (Valenciennes, 1846) is a secondary freshwater fish endemic from Catalonia to Almeria in the Spanish Mediterranean slope. It is restricted to brackish water of salt marshes and coastal lagoons and its conservation status is very poor, being including in the Endangered category in the IUCN red list. The species also inhabits in the inland Villena lagoon. These habitats are highly impacted by agriculture activity and the construction of channels for irrigation, urban construction and pollution, which have favored habitat fragmentation and the reduction of *A. iberus* populations. Previous mitochondrial and microsatellites studies have suggested in general a low level of genetic structure among populations, as well as low levels of genetic diversity. Nevertheless, some of the populations show a high mitochondrial differentiation, probably as a consequence of historical processes of isolation during Pleistocene. In this study, we carry out a deeper exploration of the nuclear genome by using a battery of Single Nucleotide Polymorphisms (SNPs) in order to analyze the genetic structure and genetic diversity of *A. iberus* populations along its entire distribution range. We also evaluate the level of isolation of populations by analyzing the historical migration patterns among them. We found a highly genetic structure among all the analyzed populations, supported also by low levels of gene flow, although some of the populations showed levels of genetic introgression. In general, genetic diversity values were moderate for most of the populations. The outcomes coming from this study are relevant to establish efficient conservation programs for the species, taking into account its precarious conservation status and low population sizes.

**Molecular and functional characterisation of fads2 gene in grass carp (*Ctenopharyngodon idella*)**

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Long-chain ( $\geq C20$ ) polyunsaturated fatty acids (LC-PUFAs) are essential nutrients involved in critical biological activities with different structural, functional and signalling roles. Indeed, dietary LC-PUFAs levels are especially relevant in human health and have several implications in many diseases processes. Therefore, it is a topic of interest knowing the mechanisms that regulate LC-PUFA biosynthesis in aquaculture species. The LC-PUFA biosynthesis pathway in fishes involves sequential desaturation and elongation steps from C18 PUFA substrates catalysed by fatty acyl desaturase (Fads) and elongation of very long chain fatty acids (Elovl) proteins. In particular, the fatty acyl desaturases 2 (Fads2) is a key enzyme that catalyses the introduction of double bonds into fatty acids. The aim of this work is the molecular and functional characterisation of fads2 gene in the grass carp (*Ctenopharyngodon idella*), an herbivorous freshwater fish with a high market value and reputation in China for its meat quality. Thus, the coding sequence (CDS) of putative Fads2 was isolated from the grass carp and was functionally characterised by heterologous expression in yeast (*Saccharomyces cerevisiae*). The open reading frame (ORF) of the grass carp consisted of 1332 bp that codifies a protein of 444 amino acids. For functional characterisation, transgenic yeast expressing the *C. idella* fads2 desaturase were grown in the presence of  $\Delta 6$  (18:2n-6, 18:3n-3 and 24:5n-3),  $\Delta 8$  (20:2n-6 and 20:3n-3),  $\Delta 5$  (20:4n-3 and 20:3n-6) and  $\Delta 4$  (22:5n-3 and 22:4n-6) substrates. Our results showed that *C. idella* Fads2 has  $\Delta 5/\Delta 6/\Delta 8$  activity, catalysing all the desaturation reactions required for arachidonic acid (20:4n-6) and eicosapentaenoic acid (20:5n-3) biosynthesis from C18 precursors. Furthermore, the *C. idella* Fads2 enzyme also desaturated 24:5n-3 to 24:6n-3, a  $\Delta 6$  desaturation reaction required for the biosynthesis of docosahexaenoic acid (22:6n-3) through the so-called “Sprecher pathway”.

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## Evaluation of osmotic pumps as an alternative method to induce spermiation in European eel males

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In the past three decades the European eel (*Anguilla anguilla*) experienced up to 99% decline in recruitment in some parts of its distribution area. In this regard, breeding in captivity is nowadays considered essential in order to save this species. The aim of this research study was to assess a new osmotic-controlled release delivery system (Osmotic Pumps; Alzet) as an alternative technique to induce spermiation in European eel males. Thirty eel males from a fish farm were transported to the university facilities and randomly divided into 3 groups. Males from Control Group were hormonally treated with weekly intraperitoneal injections of human chorionic gonadotropin (hCG; 1.5 IU/g fish); while newly commercialized osmotic pumps (loaded with hCG ) were implanted in two groups of males (OP-1004 and OP-2006, with a similar dose than control group). Because osmotic pumps can deliver hormones during a limited period, OP-1004 and OP-2006 males were treated as well with weekly injections of hCG from 10th week. The implantation of osmotic pumps was able to induce sexual maturation in some males belonging to OP-1004 and OP-2006 during the first 10th weeks. In this sense, 30% and 10% of males (OP-1004 and OP-2006, respectively) were able to reach the spermiation process and produce sperm samples for a few weeks. Unfortunately, this sperm did not show high quality, reaching maximum values of around 20% motile cells. In comparison, Control Group generated 90% of spermating males from 8th week, and sperm samples from this group showed high quality (>70% of motility) during the peak of the spermiation period (12-15th week). Summing up, although the use of osmotic pumps was able to induce the spermiation in European eel males, the use of this technique does not seem a viable method to be used in large scale for aquaculture purposes.

## Evaluation of osmotic pumps as an alternative method to induce sexual maturation in European eel females

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The European eel (*Anguilla anguilla*) has suffered a dramatic reduction in its natural stocks, thus breeding in captivity is nowadays considered essential to save this species. The aim of this research was to assess a new osmotic-controlled release delivery system (Osmotic Pump-2ML4; Alzet) as an alternative technique to induce sexual maturation in European eel females. Twenty eel females caught in the Albufera Lagoon were transported to the university facilities and randomly divided in two groups. Females from Control Group were treated with weekly intraperitoneal injections of carp pituitary extract (CPE, 20mg/Kg); while an osmotic pump (loaded with similar CPE dose) was implanted in eel females belonging to OP-2ML4 Group. Because osmotic pumps can deliver hormones during a limited period, OP-2ML4 females were treated with weekly CPE injections from 10th week. The implantation of osmotic pumps induced sexual maturation in some females during the first 10 weeks, causing several changes in biometric parameters related to sexual maturation such as eye index and fin colour. In addition, it is important to highlight that 3 females from this experimental group were able to reach the ovulation stage at the 6th-7th weeks. This result represent an unusual fast maturation according to reported in this species, which usually takes more than 15 weeks to reach final maturation. However, the rest of females from OP-2ML4 Group took longer time (19-21 weeks) to reach the ovulation stage than females belonging to Control Group (15-17 weeks). In addition, several females from both groups were successfully induced to spawning with DHP, reaching embryos showing distinguishable head, eyes and somites (>20). Summing up, although the use of osmotic pumps represents a reliable method for inducing the maturation on European eel females, further studies are necessary to understand the high variability in the response of animals submitted to similar treatments.

**Annual study of small spotted dogfish, *Scyliorhinus canicula*, to determine reproductive dynamics and to evaluate the potential use as breeders of by-catch specimens**

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Overfishing is considered the main driver of the worldwide reduction in sharks and rays populations. The aim of this study was to use the by-catch of an elasmobranch species (*Scyliorhinus canicula*) as a resource to study its reproductive dynamics and to obtain viable gametes.

Sharks were obtained from bottom trawler by-catch at the Port of Valencia, Spain. Throughout a year, monthly samplings were conducted, and 52 males and 31 females were processed. Biometric parameters (total length, weight, gonadosomatic and hepatosomatic indexes) for both sexes and clasper length in males and oocytes diameter in females were registered. Sperm was obtained from the seminal vesicle of dissected animals.

Our data suggest that *S. canicula* has a reproductive extended egg laying period, with adult mature females showing well developed oocytes all year round but showing a winter peak. To study the potential use as breeders of by-catch specimens, size at maturity was determined. Females showing developed oocytes and IGS>3 had more than 180 g and 36 cm, which is consistent with other authors. Males with fully calcified claspers, high volume of sperm (>0.5 ml) and IGS>3, showed as minimum 40 cm and 200 g. Small amounts of sperm were found also in sharks considered as non-mature (not calcified claspers).

Sperm samples obtained from adult males showed a good quality (i.e. high proportion of alive and motile spermatozoa, standard cell morphology) and were used to develop other studies. Although by-catch can be a source of samples for reproduction studies, some precautions must be considered: physiological status of body fluids (including seminal plasma) can be affected by capture stress and the time animals remain on board. Reproductive information and samples obtained can be biased by fishing grounds and fishing techniques. Last, fragile structures such ovaries with developed oocytes can be severely damaged during fishing procedures.

## Embryonic development and larval stages of *Achondrostoma occidentale*

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*Achondrostoma occidentale* (Western Ruivaco) is an endangered freshwater fish endemic to Portugal that has been a target species of an *Ex-situ* Conservation program since 2008. Captive breeding for restocking wild populations, ongoing at Aquário Vasco da Gama facilities, provided the opportunity for this first description of the early life stages of *A. occidentale*. Spawning occurred under natural conditions in the early spring, in a 1250 L tank with 27 adult individuals (88-150mm fork-length). Eggs were spherical (~1.8mm Ø), yellowish and sticky to each other and to surfaces, especially vegetation and spawning mops. Hatching occurred after 8 days and the newly hatched larvae had about 7 mm total length and a pyriform yolk sac. The swim bladder division occurred 44 days after hatching, when the larvae were 14 mm total length. On the 69th day after hatching, fins were segmented and had completed fin rays. At day 78, fish were juveniles with ~3cm and completed scales. No evident morphological diagnostic features were identified, comparing with larvae from other captive reared species but more detailed analyses are planned. These results are baseline data for establishing comparisons with embryonic development of wild specimens and future larvae identification guides.

## An experimental study on the effects of breeder diets on newborn seahorses (*Hippocampus guttulatus*)

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Aquaculture represents a valid alternative to wild captured seahorses but ex-situ production still needs to face several biological and technical challenges. Low spawning quality and juvenile survival rates are the most critical factors for optimizing commercial seahorse production. Broodstock nutrition represents a key aspect in breeding success. In this study, three homogeneous groups of adult seahorses were maintained in captivity and fed on the following diets since the onset of the breeding period: Unenriched adult *Artemia* (Diet A), unenriched adult *Artemia* and mysidaceans (Diet AM) and mysidaceans (Diet M). The mixed diet AM (unenriched *Artemia* and mysidaceans) provided the highest overall breeding success and reasonable fatty acid profiles, and better resembled newborn from a wild male, whereas the use of only mysidaceans (Diet M) provided the worse results. Significant differences were observed in newborn characteristics and fatty acid profiles across dietary groups and along the breeding season, especially in n-3 HUFA (DHA). Monospecific diets including *Artemia* or mysidaceans very likely suffered nutritional deficiencies, which were reflected in morphological alterations of the muscle tissue (diet A) and abnormal early mortalities in newborn (diet M). Three progressive stages were identified along the whole breeding period: Initial mixed capital-income period (100 - 120 days since the onset of the breeding period), followed by an inflection period (short transitional stage - income sources), and finally a long period characterized by the use of income sources and the progressive exhaustion of body reserves. Special attention deserve the progressive changes in fatty acid profiles along the breeding season, resulting in a decrease in newborn performance. Considering the time required for a diet to be reflected in newborn, we recommend that *Hippocampus guttulatus* breeders be fed on a high quality diet at least 3three months in advance of the onset of the breeding period.

## Parasitism of native freshwater fish by *Lernaea cyprinacea* in Western Portugal

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Fish sampling in western Portuguese rivers frequently results in the capturing of individuals with wounds and infections caused by the non-native parasitic anchor worm *Lernaea* sp. From February 2018 to October 2019, species acting as hosts for this parasite were identified during field work conducted in 10 river basins. Sixty-five female anchor worms ( $9.95 \pm 2.43$  mm) were removed intact from their fish hosts (belonging to three native species, from five river basins) and preserved in ethanol for subsequent morphological and genetic analyses. We genetically confirmed the identity of the parasite (*Lernaea cyprinacea*), compare its prevalence in different species and its occurrence by age class of the hosts. The average prevalence rate is around 10% and parasite prevalence seems to be independent of age class. This work adds four new species to the already known list of native Iberian fish hosts: *Achondrostoma oligolepis*, *Achondrostoma occidentale*, *Iberochondrostoma lusitanicum* and *Squalius pyrenaicus*. These species occur mainly in temporary Mediterranean-type rivers and are currently threatened by pollution, habitat destruction and fragmentation, invasive species and water scarcity due to climatic changes and high demand for agriculture. Recent work is shedding light on the role of infectious agents in modulating population survival in the endangered native freshwater fish fauna. Parasites, such as *Lernaea* sp., have the potential to disrupt local population's equilibrium and increase their extinction risk. A more detailed study will be needed to assess eventual preferences for certain species/age classes, as well as potentially different susceptibilities of the hosts. Additionally, future studies should include broad genetic sampling of *Lernaea* obtained from different hosts and geographic regions.

## Effects of venlafaxine on zebrafish larvae behaviour - preliminary results

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The presence of psychoactive substances, like chiral venlafaxine (VFX) and its metabolites, in freshwater environments are of great concern as they may affect fish physiology and behaviour. Thus, zebrafish (*Danio rerio*) has been widely used in laboratory ecotoxicological studies and behaviour assays have been performed to assess the potential adverse effects caused by pharmaceutical products and illicit drugs.

One of the aims of this study was to evaluate VFX effect on zebrafish larval behaviour. For that, zebrafish embryos with 2 hours post-fertilization (hpf) were exposed for 96 h to different concentrations of VFX (0.3; 3; 30; 300 and 3000 µg/L), including negative control (E3 medium). At 120 hpf, the behaviour of the larvae was recorded, and some parameters analysed: spontaneous behaviour, social interaction and larvae's ability to respond to a visual stimulus.

Making a quantitative analysis of the spontaneous behaviour of the larvae, it was found that the highest concentration of VFX (3000 µg/L) caused a decrease in speed, distance travelled, active time and absolute turn angle, as well as, an increased distance to the centre of the well, compared to the other concentrations. Regarding social interaction between fish, we observed a decrease in the nearest neighbour distance and in the inter-individual distance, in larvae exposed to the highest concentration of VFX.

The higher concentration of VFX tested (3000 µg/L) affects the normal behaviour of larvae reflecting peaceful fish with less exploratory behaviour, as it was expected. However, this value tested is much higher than the usual environmental concentrations found (0.3-4.0 µg/L). Additionally, enantiomers may present different toxicity effects and further studies will be needed to understand how VFX enantiomers (S and R) may affect zebrafish behaviour.

## Developmental effects of venlafaxine on zebrafish - preliminary results

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Venlafaxine (VFX) is a chiral compound used as antidepressant within serotonin-norepinephrine reuptake inhibitors, used to treat anxiety disorders, depression, etc. The not complete removal of VFX and its metabolites in wastewater treatment plants, contribute to their presence in water bodies. Thus, aquatic organisms can be chronically exposed to this type of compounds, which can cause adverse effects. The transparent embryo of zebrafish (*Danio rerio*) has been widely used to assess pharmaceuticals effects because the stages of embryonic development are very well described and easily observed. One of the goals of this work was to evaluate the VFX effects on embryonic development of zebrafish. For that, zebrafish embryos with 2 hours post-fertilization (hpf) were randomly exposed for 96 h to different concentrations of VFX (0.3; 3; 30; 300 and 3000 µg/L), including a negative control (E3 medium). During exposure, several parameters of embryonic development were evaluated: mortality rate, spontaneous movements, head and tail detachment, heartbeat rate, hatching rate, size of larvae, eye area, yolk area, oedema area, head area, tail curvature and number of malformations. The quantitative analysis of the VFX effects on embryonic development showed that the higher concentration of VFX caused a decrease, spontaneous movements, heartbeat rate, size and in the eye area, and an increase in the oedema area, tail curvature and in the number of malformations. The results displayed that the higher concentration of VFX (3000 µg/L) influences negatively the embryonic development, but we must consider that this concentration is much higher than the usual aquatic environmental concentrations found (0.3-4.0 µg/L). Furthermore, VFX enantiomers may present different toxicity effects and more detailed studies are important to assess the ecotoxicity of R-(–) and S-(+) enantiomers on embryonic development of zebrafish.

## Genotoxicity assessment using comet assay in Mozambique tilapia under the effect of copper and temperature - preliminary data

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Anthropogenic activities release toxics and greenhouse gases, last one contributes to the rise water bodies temperature, both affecting ictiofauna. Hence, genotoxicity can be assess using comet assay to measure DNA single and double-strand breaks. Thus, DNA damage/repair, mutagenicity and carcinogenicity caused by toxicants are important to assess the genotoxic effects in fish. One of the tasks of this study was to assess temperature effect and copper (Cu) DNA damage in Mozambique tilapia (*Oreochromis mossambicus*). So, we randomly distributed 70 fish ( $10.45 \pm 3.7$  cm and  $40.5 \pm 10.12$  g) in 6 aquariums (180 L each) with Cu concentrations of 1.1 mg/L (C1) and 6 aquarium of 3.6 mg/L (C2), for 28 days (C0=negative control). For C0, C1 and C2 we tested two water temperatures, 25°C (T1) and 32°C (T2). The random sampling was performed on days 0, 14 and 28, with the withdrawal of blood from the animal (2 blades). The slides were analysed by fluorescence microscopy and comets classified in four classes: 0 to 4 arbitrary units (AU). The genetic damage indicator (GDI) was applied by multiplying the percentage of nucleoids in each class by the corresponding factor. The qualitative analysis of the effects of Cu and temperature on DNA damage of tilapia, showed that T2 caused less DNA damage compared to T1. This data can be in accordance with the optimum temperature of this species and the higher metabolism in T2 that seems to induce more DNA repair, obvious when comparing with control fish at 14 days. It was found that C2 causes greater damage to DNA, which was expected because C2 is almost the double of C1, and despite been a micronutrient is normal to be more toxic in higher levels. We did not detect interaction between copper and temperature tested in that conditions.

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**Histopathological effects of lead and zinc in the gills of the turbot (*Scophthalmus maximus*) after a chronic exposure to environmental realistic concentrations**António Lima Cardeal<sup>1</sup>, Bruno Nunes<sup>2</sup> & Alberto Teodorico Correia<sup>1</sup><sup>1</sup> Centro Interdisciplinar de Investigação Marinha e Ambiental, Matosinhos, Portugal / Faculdade de Ciências da Saúde da Universidade Fernando Pessoa, Porto, Portugal (atcorreia.ciimar@gmail.com)<sup>2</sup> Centro de Estudos do Ambiente e do Mar, Aveiro, Portugal / Departamento de Biologia da Universidade de Aveiro, Aveiro, Portugal

Pleuronectiformes species, such as *Scophthalmus maximus*, are top predator marine fish that due to their hunting strategy, are prone to uptake considerable amounts of metallic species. This occurs with these species since while being in contact with the sea floor, these animals absorb metallic elements not only from contaminated sediments but also from interstitial water. Consequently, these flatfish are particularly susceptible to aquatic pollution by heavy metals. With the purpose of assessing the effects of metals on a flatfish species, *S. maximus* individuals were chronically exposed to lead and zinc during 28 days, at three concentrations of the above mentioned metallic compounds (Zn: 30, 90 and 270 µg/L; Pb: 300, 900 and 2,700 µg/L), including a negative (uncontaminated water) control group, under controlled laboratory conditions. At the end of the exposures, fish were euthanized and gills architecture was assessed through Haematoxylin-Eosin glass slides under light microscopy. The histological alterations were divided in progressive, regressive, circulatory and inflammatory changes. At the end of each survey, it was evident that both heavy metals produced serious tissue damages, such as hyperproliferation of mucous cell, hypertrophy, hyperplasia, lamellar fusion, curling, haemorrhage and aneurysm. Moreover, a dose-effect relationship was observed. The hereby results showed that both metals could exert toxic effects on the aquatic biota, and that fish from the species *S. maximus* are particularly responsive to the presence of the studied compounds, whose environmental presence may result in deleterious effects on exposed marine biota.

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## **IV Explotación pesquera y acuicultura**

### **IV Pesca e aquicultura**



**Impact of chronic stress on growth performance and immunity of gilthead seabream (*Sparus aurata* L.)**

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Fish stress and welfare are important topics for aquaculture producers, since growth, reproductive performances and disease susceptibility are directly related to fish stress conditions. It has been well reported that aquaculture practices might become potential chronic stressors affecting fish physiology and health status. The aim of this study was to evaluate growth performance and immune status of gilthead seabream throughout an episode of chronic stress. Two groups were established: control group (C) and chronically stressed group (S). Chronically stressed fish were subjected to 1 min air exposure biweekly for 4 weeks. Fish were sampled at t0 (initial sampling), t14 (after 14 days) and t28 (after 28 days). Biometric data and blood and skin mucus samples were obtained to determine stress and humoral immunity parameters. In the t28 sampling, fish were sacrificed and head-kidney (HK) leucocytes were isolated to study the cellular immune response. Fish from S group had negatively affected growth performance in comparison to the C group while no significant effects were observed in stress parameters (cortisol, glucose and lactate levels determined in skin mucus and serum) and systemic immunity (determined in serum and HK leucocytes). Significant decreases were detected in skin mucus of S fish in comparison to C fish in total protein levels and total immunoglobulin (Ig) levels and increases in IgM levels. Furthermore, significantly increased levels of peroxidase and lysozyme activities were observed in skin mucus of S fish. Our results demonstrate that chronic stress impairs growth performance and mostly affects skin mucosal immunity. Furthermore, it corroborates that cortisol, glucose and lactate are not reliable indicators of chronic stress in gilthead seabream.

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**Inflamación aguda provocada 24 horas después de la administración subcutánea de carragenina a doradas (*Sparus aurata* L.)**

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La inflamación es un proceso bien caracterizado en mamíferos, pero no en peces. Diversos métodos y estrategias se han usado para estudiarla. Entre ellos, la carragenina, un mucopolisacárido derivado del alga roja *Chondrus crispus*, ha sido empleada para reproducir modelos inflamatorios en ratas y conejos. En este estudio se inyectaron subcutáneamente 0.05 ml de tampón fosfato salino (como control) o de solución de carragenina (1 mg/ml) en PBS a ejemplares de doradas. Tras 24 horas de haber realizado la inyección, se obtuvieron muestras de piel de la zona inyectada con ayuda de un punzón metálico de los empleados para toma de biopsias. Las muestras fueron mantenidas en TRIzol® hasta la extracción de su RNA, a partir del cual, se sintetizó el DNA complementario y se analizó la expresión de los genes seleccionados mediante PCR a tiempo real. Se analizaron numerosos genes pero los que incrementaron de forma significativa sus niveles de expresión fueron: el marcador celular de granulocitos acidófilos phox22 (NADPH oxidase, subunit Phox40) y de los factores de transcripción relacionados con la vía de transducción de NFκB, relA (v-rel avian reticulendotheliosis viral oncogene homolog A), c-rel (v-rel avian reticulendotheliosis viral oncogene homolog), traf-6 (TNF receptor-associated factor 6) e irak-1 (Interleukin-1 receptor-associated kinase 1). Los resultados obtenidos sugieren que la carragenina podría activar los mecanismos necesarios para restaurar la homeostasis 24 horas después de su administración. Futuros estudios empleando carragenina como modelo inflamatorio podrán ser llevados a cabo con el fin de estudiar este complejo proceso celular, así como su resolución.

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## Skin wound healing in gilthead seabream (*Sparus aurata* L.) fed diets supplemented with arginine

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Dietary administration of arginine on the wound healing process of gilthead seabream was studied. Two replicates of fish ( $n = 8$ ) were fed with either a commercial diet [control diet (CON), no arginine added] and the CON diet supplemented with 1% arginine (ARG1) or with 2% arginine (ARG2) for 30 days. Afterward, half of the fish were sampled while the other half were injured and continued to be fed the same diet for an extra week. Results by image analysis showed that the wound closure rate was significantly improved in fish that were fed the ARG1 diet, compared with those in the CON group. After seven days of wound healing, the aminotransferase and creatine kinase levels in the serum and the protease and peroxidase activities in the skin mucus were down-regulated, while the immunoglobulin M level in the skin mucus was up-regulated in the ARG1 group after wounding and in the CON group before wounding. Compared with the CON diet, the ARG1 diet remarkably depressed the gene expression of mpo, il-8, and tnf- $\alpha$ , and enhanced the gene expression of tgf- $\beta$ 1, igf-1, pcna, krt2, mmp9, fn1 $\alpha$ , and coll $\alpha$  and the antioxidant enzyme cat in the skin tissues after wounding. Furthermore, compared with both the ARG1 and the CON groups, negative effects of the ARG2 diet on wound healing were demonstrated. In conclusion, a 1% arginine supplementation facilitates skin wound healing and prevents a systemic inflammation reaction by alleviating the inflammatory response and enhancing the re-epithelialization and ECM biosynthesis in skin wound sites.

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**Is there anything fishy going on? Conservation status of marine top fished commercial fish species**

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Biodiversity loss is a global problem accelerated by human-induced pressures on the environment. In the marine realm, one of the major threats to species conservation, together with climate change, is overfishing. Harvesting marine species above safe biological limits species resilience and can contribute to extinction risk, but many times regulatory policies even allow overfishing to some extent or do not effectively control it. In this context, having information on the conservation status of target commercial marine fish species becomes crucial for assuring safe standards. We put together fisheries statistics from the FAO, the IUCN Red List, FishBase and Sea Around Us to understand to what extent the top commercial species have been assessed in terms of their conservation status. Levels of assessment of for top fished were higher than those for general commercial or highly commercial species, but almost half of the species have outdated assessments. We found no relation between IUCN Red List traits with FishBase Vulnerability Index. Reconstructed trends were 21.5% higher than those reported by FAO. Species with declining trends according to the IUCN had increased their catches in the recent years, even after the IUCN Red List evaluation. We suggest closer cooperation between countries, FAO and IUCN Red List to ensure that reliable data are available to ensure fisheries sustainability.

**Close Kin Mark Recapture for North-Eastern Atlantic fish stock abundance estimation**

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Stock assessment is the action of collecting and analyzing data about fisheries to generate crucial information for sustainable exploitation of marine resources. One of the most important aspects of stock assessment is abundance estimation, which allows tracking population trends and fishing exploitation levels. Close Kin Mark Recapture (CKMR) is a fishery-independent abundance estimation method that can also provide information on mortality or population. CKMR is based on the principle that the bigger a population is, the smaller the probability will be to find kin relationships between individuals in a random sample of that population. However, the successful application of CKMR depends on species' specific characteristics, such as longevity, fecundity, population structure, and growth among others, and on availability of the number of samples required to find enough kin relationships. In this study, we evaluate the viability of CKMR in various commercially exploited species from the Northern Atlantic: anchovy, sardine, horse mackerel, mackerel, megrim, hake, and white anglerfish. For that aim, we have qualitatively evaluated the biological traits of each species and have calculated the number of samples required for each of them to successfully apply CKMR for abundance estimation. Our analyses show that, although all of these species' biology is compatible with CKMR's requirements, logistics may not be realistically feasible for some of them. These results are relevant for improving North-Eastern Atlantic fish stock assessments and set the basics for future CKMR studies.

## Macaronesian seaweeds wracks. Potential use in diets for grass carp (*Ctenopharyngodon idella*)

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Inclusion of algae in fish feed has been recently described to have several physiological benefits. In order to determine the use of Macaronesian macroalgal wracks in diets for grass carp (*Ctenopharyngodon idella*), two complementary experiments were carried out in a recirculating aquaculture system (RAS). In the first experiment (E1), fish ( $8.6 \pm 1.9$  g) were fed with an extruded diet for tilapia (Skretting) (control group; n=45), or the tilapia diet supplemented with 15% of a 1 mm wind dried-powder of a multispecific macroalgae wrack (33.8% *Asparagopsis taxiformis*, 28.6% *Lobophora* sp., 22.6% *Dictyota* sp., 14.5% *Cymoplia barbata* and 0.5% *Laurencia* sp.) (experimental treatment; n=45) obtained from Gran Canaria island (Spain) coasts. After 133 days, 4 individuals of each treatment were slaughtered, and the remaining individuals used for the second experiment (E2). In E2, the fish received the tilapia diet (control group) or this diet supplemented with 7% of either the multispecific wrack (experimental treatment 1) or a virtually monospecific (95% *Lobophora* sp.) macroalgae wrack (experimental treatment 2), for 99 days. Fish weight, size, hepatosomatic (HSI), viscerosomatic (VSI), and visceral-fat index (VFI) were determined in both experiments. Muscle samples were also collected for their total lipid (TL) contents and fatty acid (FA) profiles. Our results suggest that inclusion of multispecific macroalgal wrack in fish diets for *C. idella* caused a lower and healthier perivisceral and liver fat deposition regardless the percentage of dietary inclusion, and without affecting muscle TL and FA profiles. A 15% dietary inclusion of macroalgae wrack had a negative effect on growth rates whereas a 7% of monospecific wrack did not cause a detrimental effect on growth, which was even improved with the multispecific one. The use of a 7% of multispecific seaweed as a feed additive seems to have a beneficial effect in both growth and visceral fat deposition in *C. idella*.

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### Drástica reducción de las poblaciones de peces en el Río Palancia (Castellón)

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Desde el año 2001 se ha realizado un seguimiento de las poblaciones de peces presentes en el paraje conocido como Las Ventas de Bejís en el río Palancia (Castellón). Los muestreos se realizaron con pesca eléctrica, en un tramo de 120 m de longitud, pesándose y midiéndose todos los ejemplares capturados, fundamentalmente trucha común, trucha arcoíris, barbo mediterráneo, bermejuela y algunos ejemplares de carpa y anguila.

En los años 2001-2006, las poblaciones de las cuatro especies principales fueron abundantes, con unas medias de 92 ejemplares de trucha común, 137 de trucha arcoíris, 57 de barbo y 46 de bermejuela, pero han ido reduciéndose progresivamente, hasta unos valores medios en el periodo 2013-2019 de 24, 18, 5 y 11 ejemplares respectivamente. En el último periodo aparecieron algunos ejemplares ocasionales de anguila, que no se había capturado en los anteriores.

El tramo se gestiona como un “vedado-acotado” de pesca, en el que algunos años se ha permitido la captura de trucha común sin muerte, y la de trucha arcoíris sin limitaciones de cupo ni talla, mientras que en otros se prohíbe cualquier tipo de pesca. La posibilidad de pesca sin cupo ni talla de la trucha arcoíris justificaría la reducción de esta especie, e incluso una posible actividad pesquera furtiva podría explicar el descenso de las poblaciones de trucha común, pero la reducción de los barbos y bermejuelas no tiene una fácil explicación.

## O rio Minho como estudo de caso na gestão da pesca de enguia em Portugal

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A enguia europeia (*Anguilla anguilla*) é uma espécie com importância comercial, explorada em todas as suas fases do ciclo de vida, exceto a do estado larvar, e catalogada pela IUCN como criticamente em perigo. Em 2017, a União Europeia adotou medidas para a recuperação da população determinando aos países membros a elaboração e implementação de planos de gestão ao nível das suas bacias hidrográficas. A enguia de vidro (meixão) capturado no meio natural é ainda a única fonte deste recurso biológico para a aquacultura e repovoamento. Embora proibida a exportação da União Europeia, são várias as evidências de comércio ilegal de meixão para países asiáticos. O alto valor económico do meixão é a principal motivação para a pesca ilegal, na maioria dos rios portugueses. Em Portugal, até ao ano 2000, a pesca de meixão era realizada, na generalidade dos rios, com o recurso a uma rede de mão (rapeta), tendo sido proibida a partir desse ano. A pesca de enguia amarela está regulamentada quer em áreas de influência marítima (lagoas costeiras e estuários) quer em águas interiores. A captura de enguia prateada está proibida a nível nacional. O rio Minho é o único rio em Portugal onde é permitido capturar meixão, existindo para o efeito uma rede única (tela) que está regulamentada desde a década de 70, estando proibida a pesca de enguia amarela. Existem, assim, em Portugal dois modelos de gestão para esta espécie praticamente antagónicos. Há uma ausência generalizada, a nível nacional, do conhecimento científico sobre a espécie que leva à aplicação de modelos de gestão ditos protecionistas, com consequências socioeconómicas negativas e a uma proteção do recurso discutível. Pretende-se avaliar estes dois modelos de gestão no que diz respeito aos seus impactos ao nível do conhecimento científico, económico e social em Portugal.

**Comunidades de pesca local e mercado de primeira venda. A região noroeste portuguesa como caso de estudo**

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A reforma da Política Pesqueira Comum e o Planeamento Espacial Marinho (Estratégia Europeia de Crescimento Azul) têm constituído um desafio para as comunidades de pesca local. Neste contexto, aumentar o valor primário do produto pesqueiro é uma estratégia chave para minimizar os seus possíveis impactos. A Região NORTE Portuguesa tem ainda uma presença vincada de comunidades de pesca local. A fim de conhecer o grau de adaptação destas aos desafios referidos, foi estudado entre outros aspectos a evolução anual de preços em lota das principais espécies comerciais. Para além de descrever a rede logística actual de comercialização de pescado nessa região, foram analisados resultados de iniciativas digitais implementadas para esse fim. Nas lotas tradicionais, a revalorização dos preços do pescado no período 2012-2018 permitiu compensar a respectiva diminuição da produção pesqueira (23% aproximadamente), evitando assim uma queda do valor económico do sector. Em geral, a lota de Matosinhos evidenciou os preços mais elevados de venda, sendo especialmente surpreendente o caso do polvo, cujo valor no ano 2018 foi 56% superior quando comparado ao da lota da Póvoa de Varzim. Em relação aos leilões on-line de pescado, é preciso salientar que hoje são, ainda, pouco utilizados. No caso em estudo, a lota de Matosinhos é o único mercado de primeira venda representado no segmento virtual, sendo a sua presença residual e descontinua. Os resultados obtidos mostram a necessidade de desenvolver mercados de venda descentralizados que permitam corrigir desequilíbrios nos preços de venda. A este respeito, a tecnologia deve desempenhar um papel chave no futuro imediato, diminuindo a dependência de espaços físicos nos quais se concentra, hoje, a procura.

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**Atlantic chub mackerel (*Scomber colias*) fisheries and discards in Portuguese coast**

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Atlantic chub mackerel (CM) (*Scomber colias*) is a middle-size pelagic species inhabiting warm waters. The population abundance in Eastern Atlantic has been increasing and its distribution range expanding northwards. In Portuguese waters, where it is fished mainly by the purse seine and the artisanal multi-gear fleets, landings have increased since the mid-2000's, possibly correlated with the significant decrease of sardine availability, increase in CM abundance, and growing economical-gastronomical interest. However, landings are not regulated and no formal scientific assessment and advice are undertaken, being not guaranteed that the exploitation rate is currently sustainable. In Portugal, CM landings are higher in the 3rd and 4th quarters, and fish aged 1- and 2-years old dominate in the catches. In 2018, 138 purse-seiners landed CM, more than half of the fleet being concentrated in the North, but the landings by contrast, are higher in the Centre and South. Discard estimates at fleet level obtained from onboard sampling data, show that although the main part of the bottom trawl catches of CM are discarded, they represent a very low proportion of the total landed weight. All the other sampled fisheries (deep-water longline, gill and trammel nets, purse seine, beam trawl) also present very low proportions of discards per trip when compared to its total catch. In a preliminary assessment of slipping patterns of CM, the estimated catches from the slipped quantities observed onboard showed to be proportionally small when compared with the landed fraction, especially in recent years. This work confirms the need for a regular and accurate monitoring of the different components of the fishing activity, and for an integrated stock assessment approach, the changes in the patterns observed being likely related to both the species population dynamics, the interaction with other species of the pelagic ecosystem, and to economical/market issues.

**Evaluation of biochemical effects of rapid cooling and common chemical anaesthetics as methods of euthanasia in rainbow trout (*Oncorhynchus mykiss*) and gilthead seabream (*Sparus aurata*)**

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In recent years, the public concern for animal welfare has increased, namely with regard to the use of living animals in scientific research. In very distinct scientific fields of research, at the end of trials, it is necessary to proceed with euthanasia of all involved organisms. This procedure must however cause a death without stress or pain, as human as possible, and to attain this purpose, a large number of drugs are used, namely anaesthetics, in overdosage. However, the objectives of several studies may be compromised by the use of these compounds, whose toxicological activity may result in the significant modification of biochemical parameters that are being assessed. This is the case of ecotoxicological studies, based on the measurement of biochemical markers, whose levels may be changed following the use of anaesthetic agents. Consequently, it becomes difficult to define a method of euthanasia based on the use of chemical anaesthetics, that does not influence the results of scientific determinations. The aim of this study was to compare the effects of rapid cooling (as an adjunctive method of decapitation) and three chemical anaesthetics (tricaine methanesulfonate, clove oil and 2-phenoxyethanol) of common use, as methods of euthanasia in two species of fish, rainbow trout (*Oncorhynchus mykiss*) and gilthead seabream (*Sparus aurata*). The analysed biochemical parameters were biomarkers widely accepted as endpoints in a vast number of ecotoxicological studies, namely carbonic anhydrase (AC), acetylcholinesterases (AChEs), catalase (CAT), cyclooxygenase (COX), glutathione-S-transferases (GSTs) and lactate dehydrogenase (LDH). The obtained results demonstrate that there were changes among treatments at the level of antioxidant enzymes, nervous system and regulation of the acid-base balance in fish, with no changes only in anaerobic metabolism and in the process of prostaglandin synthesis. Based on the here obtained results, we may assume that biomarkers can be strongly influenced by different types of anaesthetics in the euthanasia process.

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### Pienso para dorada con ingredientes 100% ecológicos

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El objetivo del presente estudio, fue estimar el efecto de la alimentación con pienso ecológicos en el crecimiento de dorada utilizando para ello materias primas ecológicas como la harina de ave (ponedoras), harina de trucha, y restos del fileteado de lubina, junto con una mezcla de estas tres. Para ello, se utilizaron juveniles de dorada ecológica, adaptados a las condiciones de la instalación en la Universitat Politècnica de València y se distribuyeron 40 peces por tanque (peso promedio de 60,5 g), es decir 120 peces por tratamiento y un total de 720 doradas.

Se formularon 4 piensos isoproteicos e isolipídicos con diferentes fuentes de proteína ecológica (harina de ave, harina de trucha, restos de lubina y mezcla de las tres materias primas) y dos piensos controles, uno con harina de pescado e ingredientes vegetales ecológicos y otro con todos los ingredientes convencionales, contenido ambos un 30% de harina de pescado.

Tras un periodo de aproximadamente tres meses que duró la prueba, el mejor crecimiento se obtuvo con los dos piensos controles (con un 30% de harina de pescado) sin diferencias significativas entre ambos, posiblemente como consecuencia de un perfil de aminoácidos más equilibrado para las necesidades de la dorada. Entre los piensos ecológicos, no se encontraron diferencias significativas en el peso final de los peces alimentados con la harina de trucha y los restos de lubina, pero sí respecto a los alimentados con los piensos fabricados con harina de ave y la mezcla de los tres ingredientes. Además se observó un rechazo por parte de los peces al pienso que contenía harina de ave y una mayor mortalidad, por lo que parece desaconsejable el uso de esta materia prima en futuras pruebas con alimentación ecológica.

**V Ámbito no ibérico**

**V Ámbito não ibérico**



## Análisis de los requisitos de hábitat de los peces tropicales andinos e implicaciones en la conservación

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La falta de conocimiento sobre la biodiversidad en áreas remotas como los ríos tropicales andinos de montaña es notable y dificulta el desarrollo de planes de conservación eficientes en los ecosistemas acuáticos. Las características del hábitat de los peces tropicales andinos han sido poco analizadas, a pesar de la relevancia de estos requisitos ecológicos en las estrategias de conservación de estas especies. El presente estudio tiene como objetivo examinar la diversidad de peces a lo largo del gradiente altitudinal en los ríos tropicales andinos y su relación con las características del hábitat y los impactos humanos, para detectar los factores abióticos más relevantes relacionados con su conservación. Este estudio se realizó a escala regional, a lo largo de seis cuencas ubicadas en los Andes montanos tropicales (500-2692 m s.n.m.). La población y distribución de peces se estudió a través del gradiente de elevación en relación con las variables abióticas. Nuestro análisis subraya la relevancia de las variables geomorfológicas (para géneros como *Astroblepus* o *Trichomycterus*) en la estructura de la comunidad de peces en los ríos andinos de montaña, mientras que las alteraciones humanas parecen ser menos significativas (afectando significativamente solo a los géneros *Chaetostoma* y *Pimelodella*). Estos hallazgos ayudarían en primer lugar a modelar de una forma más fina la distribución de estas especies, herramienta básica para el desarrollo de las estrategias actuales de gestión y conservación, considerando las amenazas actuales sobre los ríos montanos tropicales.

## Cryopreservation of pufferfish sperm on large scale volumes: effect on kinetic parameters and fertilization & hatching rates

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Cryopreservation of fish gametes has many potential applications both for ecological, scientific and aquaculture purposes. Nevertheless, there is no study for the long-term conservation of pufferfish (*Takifugu niphobles*) sperm, thus the objectives were i) to develop a new cryopreservation protocol for pufferfish sperm and ii) to assess the fertilization capacity of fresh and cryopreserved sperm. Fish were caught in Arai Beach (Japan) and sperm samples showing >80% of motility were selected for the cryopreservation trials. Samples were diluted 1:20 and 1:50 in Seminal-Like-Solution and then cryoprotectant (methanol, 10% v/v) was added to the diluted sperm. Different vials (straws of 0.5 mL and cryotubes of 2mL and 5 mL) were used and sperm motility was tested after thawing process and in the next 7 days. Cryopreserved sperm samples showed excellent motility results when they were frozen in straws, reaching post-thawed motilities of >60% in both dilutions (1:20 and 1:50). Cryotubes also showed good motility results (around 50%) but slightly lower than those obtained in the straws. In relation to short-term storage after thawing process, sperm samples from straws (1:50) were able to keep acceptable motility values (40%) after 7 days of chilled storage. Finally, in vitro fertilization trials were carried using different sperm:egg ratios (1:103, 1:104, 1:105 and 1:106) both in fresh and cryopreserved sperm. High (>90%) fertilization (FR) and hatching (HR) rates were reached using 1:104 and 1:105 ratios (fresh and cryopreserved sperm, respectively). These results mean that cryopreservation process negatively affects the spermatozoa kinetic parameters and then, fertilization and hatching success. In this sense, the sperm:egg ratio necessary to achieve high FR and HR in pufferfish is 10-times higher for cryopreserved than fresh sperm. This study has laid the bases for the establishment of cryopreservation protocol in pufferfish, that will be helpful for further captivity programs and genetic cryobanking.

### Evolution of the immune system in two antarctic notothenioids

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Fish rely significantly on innate immune response which is extremely important for survival in an aquatic environment, potentially rich in bacteria, parasites, fungi and viruses. Antarctic notothenioid fish evolved around 25 million years ago in a very cold and stable environment through adaptive radiation from a single benthic ancestral, likely developing specific responses and host-parasite interactions. Little is known about the functioning and adaptability of their immune system, as climate change scenarios can lead to occurrence of novel pathogens or disruption of microbial balance in the Antarctic Ocean. Experiments with *N. coriiceps* and *N. rossii* were performed in Great Wall Station in King George Island, during the Antarctic summer of 2017 and 2019. The experimental design included groups treated with LPS and Poly:IC, different time-frames and vias of administration, kept at 2°C and 6 °C (n=6/8). Plasma and several tissues involved in the immune, stress and metabolic processes were collected, and functional assays were performed. RNA sequencing and transcriptomic analysis were performed in immune-related tissues to identify the gene networks and key-genes involved and to understand the fish response to pathogens exposures and increased temperature. Also, microbiota studies of skin and gut were done in order to identify their diversity and stability/sensibility to these challenges. Metagenomic approach of intestinal parasites and their host-relation is currently in progress. Comparative in silico analysis was used to characterize TLRs gene family and understand if and how the extreme conditions modulate gene evolution. We identified several specificities of the immune-response at several omics' levels in these Antarctic notothenioid fish and possible correlation to the evolution under constant stable-cold environment.

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**The influence of a new onboard conservation method on the catch composition and discards of the purse seine fishing of *Sardinella brasiliensis* off Southern Brazil**

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A new method of fish conservation in refrigerated brine was implemented in eleven commercial vessels of the Brazilian sardine (*Sardinella brasiliensis*) purse seine fishery, in order to have the best-quality fish to be available to the consumer compared to the traditional ice preserving method. This conservation method shift increased the autonomy of the vessels, drastically changed the catch composition, and had an impact on the non-target species. The effects of this method were evaluated from onboard records of catch composition and discards monitored by scientific observers and from post-landing data. Discards assessment was also conducted in the canning industry, based on the percentage of sardines without quality for the preparation of conserves, on other caught species than sardines, and on the proportion of individuals under the minimum size of capture. Onboard data collected was consistent with a historical series of 13 years of species composition. Vessels with different methods of conservation showed significant differences for onboard records of non-target species. Onboard records showed that the catch volume of most aquatic taxa present in the refrigerated brine vessels catch was smaller compared to the vessels with the traditional conservation on ice method, except for the echinoderms. Moreover, information obtained from the canning industry recorded larger and significant catches of the Brazilian sardine (target species), as well as large amounts of sardine without quality for the preparation of the conserves, other species than the target species and small Brazilian sardine in the refrigerated brine vessels. These findings may be related to a great fishing power of the modern refrigerated vessels that favored by enhanced autonomy, could explore fishing areas with distinct biological features.

**Migration patterns of *Anchoviella lepidentostole* (Engraulidae) in the Ribeira de Iguape River, SW Brazil**

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The lack of information about fish migration in the Ribeira Valley, south of São Paulo, has led to the disorderly exploitation of fishery resources of social and economic value. In view of this scenario, the present study was investigated the habitat use and migration movements by the broadband anchovy, *Anchoviella lepidentostole*, in the Ribeira de Iguape River Basin, an important fishing area of Southeastern Brazil. The movement patterns were inferred from Sr:Ca and Ba:Ca ratios, recorded among core to edge of the sagittal otoliths using a LA-ICP-MS, from individuals sampled in two points at river, Registro (oligohaline environment) and Iguapê (polyhaline environment). The data suggest a high plasticity and environmental adaptation and migratory patterns to different salinity gradients. The hereby results may have direct applications in the management of this halieutic resource, as well as, the preservation of freshwater and marine environments, since the tendency of overexploitation of the species in the region was observed since the 1990s.

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**Movimento de *Mimagoniates microlepis* (Steindachner, 1877) (*Characidae, Stevardiinae*) em um riacho costeiro da Mata Atlântica – BR**

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Informações sobre o comportamento e motivação do movimento de peixes de riachos costeiros da Mata Atlântica são escassas. *Mimagoniates microlepis* é uma espécie de peixe da região neotropical cuja distribuição é restrita a riachos costeiros da Mata Atlântica. É uma espécie da divisão primária com zero tolerância às águas salobras da lagoa de Maricá, onde desemboca o riacho deste estudo, que possui 15 km de extensão. Hipotetizamos que *M. microlepis* migra para as áreas de cabeceira para reproduzir, maximizando assim a chance de seus ovos e larvas pelágicos se manterem no riacho e não serem carreados para a Lagoa. Discutimos aspectos da história de vida de *M. microlepis* com vistas a detectar seus padrões de movimento. Para tal usamos a combinação de 3 metodologias distintas: (i) estudos de marcação-recaptura (MR); (ii) análises da distribuição de jovens e adultos ao longo do eixo longitudinal do riacho (DJA); (iii) estrutura genética das populações de diferentes localidades do eixo longitudinal do riacho. Resultados baseados em MR demonstraram que exemplares de *M. microlepis* se movem, rio acima, até 2 km do ponto de marcação. A distribuição espacial de jovens e adultos (DJA) revelou que adultos da espécie predominam nas áreas mais altas, próximas à cabeceira, enquanto os jovens predominam nas localidades próximas à desembocadura, sugerindo migração passiva, rio abaixo, de ovos e larvas e migração ativa, rio acima, de adultos reprodutivos. Verificamos que a diferenciação genética (avaliada pelo DNA mitocondrial) entre os locais de amostragem ao longo do riacho é reduzida (EG), sugerindo fluxo genético entre as populações. Este conjunto de resultados sugere que a espécie *M. microlepis* migra rio acima para desovar, porém a motivação para tal ainda requer estudos.

**Composition and frequency of occurrence of fish assembly in a mangrove, São Luís island, Maranhão, Brazil**

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This study analyzes aspects of the fish community present in a mangrove on the island of São Luís, Maranhão, Brazil; encompassing species composition, frequency of occurrence and sexual proportion. Sampling was monthly for 16 months. 10824 specimens of fish were collected, representing 63 species belonging to 27 families. The *Sciaenidae* family was the most important with ten species; followed by *Carangidae*, with six species; *Ariidae*, *Haemulidae* and *Gerreidae* with four species. *Genyatremus luteus* was the most frequent species, corresponding to 95% of the samples. Second were *Micropogonias furnieri*, *Stellifer naso*, *Mugil curema* and *Colomesus psittacus*, each present in 88% of the samples. Sex was observed in 38 species, and in 18 species the hypothesis of equality (1:1) was accepted and rejected for 9 species.

## **Relationships between macrophytes abundance, lake size and fish diversity in coastal lakes in southern Brazil**

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The coastal plain of Rio Grande do Sul, southern Brazil, presents a series of shallow lakes with diverse size and morphology. The objective of this study is to determine whether the size of the lakes and macrophytes abundance are an effective factor for structuring fish diversity. In this regard, nine lakes with distinct areas were sampled: three with an area up to 40 hectares, three with area between 40 and 80 hectares, and three with an area of over 80 hectares. Each lake was sampled once on the littoral and pelagic zones. At each point, macrophytes abundance (% coverage - emergent and floating macrophytes and % PVI - submerged macrophytes) was determined, while fish were captured through a set of gill nets with different mesh sizes. Captured specimens were identified, quantified and evaluated for weight and length. A total of 24 fish species belonging to 10 families was obtained, with Characidae presenting the highest species richness. *Cyanocharax alburnus* was the only species that occurred in all lakes. *Cyphocharax voga*, *Astyanax eigenmanniorum*, *Oligosarcus jenynsii* and *O. robustus* were also frequent species, present in most of the sampled lakes. The fish community structure showed the highest species richness in lakes with an area over 40 ha, however the highest fish diversity values were observed both in lakes up to 40 ha and with the lowest of % coverage/PVI of macrophytes; and in lakes above 80 ha and with highest of macrophyte % coverage/PVI. Characteristics such as lakes depth, connectivity and morphometry should also be considered for better understanding of the fish community structure with objective to the conservation and management of these lakes.

## Tracking changes in the growth pattern of a sentinel estuarine fish species based on otolith morphometry

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Otoliths are a powerful tool to understand many aspects of fish life cycle. *Atherinella brasiliensis* (Quoy & Gaimard, 1825) is a tropical-subtropical species of the Western Atlantic Ocean, distributed along the South America. It inhabits estuaries and coastal areas, playing an important role in the food chain and being a sentinel to track impacts in coastal areas. To identify different growth phases of *A. brasiliensis* (N=212, 38 ≤ TL ≤ 141 mm) in a impacted subtropical bay (Araçá Bay, 23°48'47,3"S 45°24'22,1"W), otoliths of individuals sampled for a year were measured in terms of length (OL, mm). A power model was fitted (OL vs TL) and residue analysis revealed trends. Values of b exponent were estimated for each TL class and plotted against OL values to identify stanza changing points (SCP) by derivation. Three growth phases related to two SCP were identified (TL1 = 87.74 mm, OL1 = 2.61 mm, and TL2 = 130.88 mm, OL2 = 3.82 mm), also revealed in the average ratio OL/TL by length classes (after size effect removal). The first growth phase corresponded to juveniles and the second to individuals already mature. SCP1 is the first maturity. The third growth phase presented reduced number of individuals, older fish in final stages of life cycle. Araçá Bay is under intensive pressure due to a project of port expansion and the current results are a baseline to evaluate impacts in the ichthyofauna, reinforcing *A. brasiliensis* as a sentinel species.

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## **Environmental analysis of marine fauna for the implementation of underwater paths at Sepultura beach, Southern Brazil**

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Sepultura beach is well preserved, and its natural beauty favored the development of diverse marine activities. The landscapes and the diversity of marine life created a great potential for marine tourism, with one of the most desired places for diving. Recreational diving activity depends directly not only on its intrinsic beauty but also on the conservation of the environment. In this context, the adequacy of the diving activity was conducted through the implementation of underwater diving trails. The creation of such trails depends mainly on the knowledge of the abundance and diversity of a region and the environmental factors that govern them, in order to choose the best path in terms of fauna to arouse the interest of the diving public and protect the environment. The quantification of marine fauna was conducted through three methodologies (visual census and transects, punctual transect, and photo quadrat and the active search and photographic record) at 14 sample points over one year. The species were identified up to the lowest possible taxonomic level and at their preferred temperatures were obtained. Ecological descriptors of diversity and equitability were built for each point and the environmental temperature was measured by dive computers. The quantitative records of observations were separated into three groups in cluster analysis and their annual frequency, as well as the ecological descriptors and the degree of conservation of the species present, were used to define the best places for implementing the paths. A strong correlation was observed between the species' preferred and the ambient temperature. The type of bottom also played a major role as an aggregating element of fauna, in particular, the corals of the genus *Palythoa*. However, bleaching of these corals was observed which was not seen 17 years ago in this region and seems to be related to the current high environmental temperatures.

**Population structure of the brazilian sardine (*Sardinella brasiliensis*) in the South Atlantic inferred from biological attributes and otolith shape signatures**

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Basic biological information and otolith shape analysis of the Brazilian sardine *Sardinella brasiliensis* were used to evaluate if the fish caught in the two main fishery grounds in S-SE Brazil, Santa Catarina State (SC) and Rio de Janeiro (RJ), were two distinct population-units. Fifty sardines (25/location) were collected by the purse-seine fleets between Feb-Oct/2018. The effects of size on otolith measurements (length, width, area, and perimeter) were corrected for the mean radii. Otolith contour was described by standardized wavelet coefficients. A linear discriminant analysis was applied and the accuracy of re-classification for each location was evaluated through the jack-knifed cross-validation matrix. The association of otolith shape indexes (form-factor, aspect ratio, roundness, rectangularity, ellipticity and circularity) and biological data was assessed by a Principal Component Analysis for Mixed Data (PCAmix). A permutation analysis of variance has found significant differences among the shape indexes between fishing area. Significant differences were found for total length and the interaction between age and length. The reclassification technique achieved an overall rate of 86% for shape indexes, 92% for the otolith contour, and 100% for the methods combined. Numeric variables of PCAmix were best explained by rectangularity, roundness, and form factor opposed to ellipticity, circularity, and aspect ratio. These latter were also associated to fish size, body, gonad and otolith weight. The maturity stages defined as categorical variables with fishing areas showed a clear gradient in both areas. In the comparison of categorical and numerical variables the population-subunits were separated by the depth of the capture and the residuals of the length vs weight relationship. The positive residuals of this relationship may indicate a better somatic condition in RJ which may explain the difference in otolith shape indexes and contour.

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**Upstream as a sanctuary for the French populations of catalan chub *Squalius laietanus* (Teleostei, *Leuciscidae*) threatened by the allochthonous European chub *S. cephalus***

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In the Pyrénées-Orientales department (France), three Mediterranean catchments (Agly, Têt and Tech) are subject to high variations in water levels during Cevenol-type events. In order to fight against the effects of these floods, dams and weirs were built along these rivers with consequences on aquatic fauna, eliminating the ecological continuum. The chub *Squalius* is a potamodromous fish occurring from the salmonids stream to close to the estuaries. Moreover, whereas the European chub *S. cephalus* was thought to be represented by a single species in France, another species, endemic to Catalonia, was described: the Catalan chub *S. laietanus*. However, *S. cephalus* was also introduced in the catchments of this area with possibly threats of hybridization. Samples from eight populations of *Squalius* spp coming from these rivers were genetically identified using a DNA Barcoding approach with a mitochondrial (COI) and a nuclear (RAG1) markers. Our results confirm the presence of both species in the three drainages as well as their hybridization, threatening *S. laietanus* by hybridization as in 70% of Mediterranean endemic species. There is also a downstream-upstream gradient in the presence of *S. cephalus* in the Têt and Tech catchments. *S. laietanus* seems less impacted by *S. cephalus* in headwaters than downstream. One of the explanations would be the numerous weirs between these areas. If the negative impacts of the absence of ecological continuum on the ichthyofauna are known and cannot be denied, these weirs might form in this case a barrier against the presence of *S. cephalus* in headwaters. As a consequence, *S. laietanus* has been evaluated as EN in the last French UICN Red List published in 2019. While the ecological parameters still need to be examined, our study brings additional information for better suited conservation actions regarding the ecological continuum.

## Sperm motility in pufferfish (*Takifugu alboplumbeus*): effect of pH and ions

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Only a few studies are available regarding seminal plasma characteristics, like ionic composition and pH, being important for sperm viability and capacitation. We evaluated the effect of removal of several ions ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Mg}^{2+}$ ) from seminal plasma and the effect of seminal plasma and seawater pH on the sperm activation of the pufferfish (*T. alboplumbeus*). Fish were caught in Arai Beach (Miura, Japan) and only sperm samples showing high motility were used. Samples were diluted 1:50 in the experimental extenders and stored at 4 °C. For ion removal, samples were centrifuged (500 g, 5 min, 4 °C) and resuspended in pufferfish control extender (Krasznai et al. 2003), K-free, Na-free or K/Na-free extenders. Sperm was evaluated after 2 hours of incubation, registering the percentage of motile cells and some kinetic parameters (p-MOT, VAP, VCL, VSL) after activation with seawater. None of the media reduced the sperm motility in comparison to controls, although K-free extender induced a higher percentage of hyperactive spermatozoa, and after 3 days of storage, VCL was reduced in Na-free and Na/K-free extenders. Extender pH was adjusted to several pHs, showing a strong effect on sperm motility. Samples diluted at pH 6.5 showed a high reduction of motility in comparison with higher pHs (7.5, 8.5 and 9.5). The inhibitory effect of low pH was reversible. Regarding the pH of seawater (used as activation medium) there were no significant differences between control (pH 8.2) and pH 6.5, indicating that fugu sperm can swim in acidic environments. Finally, nigericin (that equals intracellular pH with extracellular pH) was added, and the highest sperm motility was found at pH 7.0, although the highest percentage of progressive motility was caused by pH 6.8. That indicated that the optimal intracellular pH of pufferfish for sperm motility is 6.8-7.0.

## Improvement of pufferfish (*Takifugu alboplumbeus*) sperm extenders

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Morisawa (1985) described the ionic composition of the pufferfish sperm, including Mg 0.9 mM. Krasznai et al. (2003) designed an extender called SLS used from then with this species, but including no Mg at all. Pérez et al. (2019) found that the pH of the pufferfish sperm is 7.5 (as SLS pH), but the seminal plasma pH is 8; and our experiments suggested 8.5 as a good pH for the pufferfish extenders. We tried to optimize these diluents to get a longer preservation under refrigeration. Three experiments assessed the addition of several concentrations of Mg and NaHCO<sub>3</sub>, as well as different pHs. Fish were caught in Arai Beach (Miura, Japan). Sperm samples showing >80% of motile cells (MOT) after activation with seawater were selected. Samples were diluted 1:50 in the tested extenders and stored at 4 °C. Motility was tested after 24, 48 and 72 h, 7, 10, 14 and 21 days, registering MOT and some kinetic parameters (p-MOT, VAP, VCL, VSL). Exp. 1. Sperm samples (12) were preserved in SLS, SLS + 1 mM MgCl<sub>2</sub> (imitating pufferfish seminal plasma), or SLS + 20 mM NaHCO<sub>3</sub>. SLS and SLS + MgCl<sub>2</sub> showed similar MOT and kinetic parameters after 10 days, while SLS + NaHCO<sub>3</sub> already showed a MOT reduction. SLS caused the best results (>80% MOT) after 2 weeks. Exp. 2. Samples (7) were preserved in SLS or in SLS + 1 or 2 mM MgCl<sub>2</sub> with pH 7.5. No important differences were obtained, and all the extenders preserved MOT>70% and high kinetic parameters after 3 weeks. Exp. 3. Samples (7) were preserved in SLS or in SLS + 1 or 2 mM MgCl<sub>2</sub>. pH was adjusted at 7.5, 8 or 8.5 (9 combinations). Only SLS + 2 mM MgCl<sub>2</sub> with pH 7.5 preserved MOT>70% after 14 days. Sperm kinetic parameters showed similar profiles. This extender is recommended for pufferfish sperm.

## Sublethal effects of propiconazole on the metabolism of lambari *Deuterodon iguape*

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Propiconazole is one of the most widely used pesticides in banana culture in Brazil. In the aquatic environment, it can interfere with the activity of the neuroendocrine stress of fish. Thus, the objective study was to analyze the sublethal effects of propiconazole in the lambari *Deuterodon iguape*, a common fish in Brazil, with potential for aquaculture and used as a bioindicator. Lethal concentration (LC50) and metabolic rates were studied for fish exposed to propiconazole. To determine the LC50 (24 and 48h), 100 fish were submitted into five treatments, with four replicates: 0, 0.1, 0.5, 1.0 and 2.5  $\mu\text{g L}^{-1}$ . Subsequently, for analysis of the metabolic rate and specific excretion of ammonia, individuals were exposed to concentrations of 0.0, 0.01, 0.05 and 0.1  $\mu\text{g L}^{-1}$  of propiconazole for a period of two hours ( $n = 20$ ) in sealed respirometers. The LC50 (24 h) was 0.78  $\mu\text{g L}^{-1}$  (0.55-1.10), for 48 h it was 0.18  $\mu\text{g L}^{-1}$  (0.10-0.26). There was an increase and decrease in the metabolic rate at concentration 0.01 and 0.1  $\mu\text{g L}^{-1}$ , with statistical difference in relation to the control, 0.01 and 0.05  $\mu\text{g L}^{-1}$ . The same trend for the specific excretion of ammonia also initially increased to a concentration of 0.01  $\mu\text{g L}^{-1}$  and then decreased as the concentration of propiconazole increased. The decrease in means of specific ammonia excretion at a concentration of 0.1  $\mu\text{g L}^{-1}$  showed a reduction in ammonia excretion in the order of 46.34% in relation to the control. It was found that the averages of specific ammonia excretion in all concentrations were significantly different compared to the control. It is concluded that exposure to propiconazole increases the metabolic rate of *D. iguape*, up to 0.05  $\mu\text{g L}^{-1}$ , decreasing at the highest concentration tested (0.1  $\mu\text{g L}^{-1}$ ). It is concluded that exposure to propiconazole increased the metabolic rate of *D. iguape*, up to 0.05  $\mu\text{g L}^{-1}$ , and decreased when the concentration was doubled (0.1  $\mu\text{g L}^{-1}$ ), causing serious problems in the metabolism of the studied organism.

## The stress axis and response to acute stressors in *Notothenia rossii* acclimated at different temperatures

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Antarctic fish evolved in a stenothermal environment, subject to very small fluctuations in temperature throughout their life (-1°C - 2°C). Their ability to respond to increased temperature is uncertain. We aimed at evaluating the mechanism and capabilities of the HPI axis in Antarctic fish in three sets of experiments. Four groups were placed at 2°C. Upon a standard stress test (SST: chasing+netting +1min air exposure) fish were returned to tank and sampled after 1,4,24 h. Six groups were acclimated to 2, 5, 8 °C for 10-days. At this point the control group of each temperature was sacrificed. The other group received SST and sacrificed 90-min after. Plasma and tissue samples were collected for cortisol and stress-related genes and the interrenal used in-vitro to determine sensitivity to ACTH. Eight groups at 2°C were injected with drugs involved in blockage or stimulation of cortisol release/action (saline, cortisol, dexamethasone, metyrapone, spironolactone, mifepristone) and then kept at control or transferred to 6°C and sampled after 36 hours. After SST cortisol peaks between 1-4 hours and reduces to basal between 24-48 hours. Temperature influenced the cortisol response to SST. At higher temperatures cortisol levels in non-stressed group are as high as in fish subjected to SST. Interrenal sensitivity at high temperature showed little response to ACTH, suggesting low sensitivity and/or exhaustion. Manipulation of the HPI-axis showed these fish to respond in a way similar to what has been reported in other fish families in temperate or tropical environments.

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### Lambari fish *Deuterodon iguape* (Eigenmann, 1907) larviculture in salinity waters

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Saline water larviculture can bring benefits to freshwater fish in terms of growth and health aspects. The aims of this study was to verify the survival of *Deuterodon iguape* larvae in different salinities and the changes in the different water parameters related to these salinized water larviculture conditions. *Deuterodon iguape* post-larvae obtained by captive breeding were divided into four treatments with different salinity, where T1: freshwater; T2: salinity 5; T3: salinity 10 and T4: salinity 15. Sixteen aquariums of 50 liters were used. Fish growth indicators and water quality parameters were evaluated. The experiment lasted 42 days. Water quality parameters (dissolved oxygen, oxygen saturation, electrical conductivity and alkalinity) were significantly affected by salinity. Survival was significantly lower in salinized water treatments, which also provided worse results for specific growth rate. *Deuterodon iguape* larviculture with salinized water does not present positive results compared to freshwater. The species presented low tolerance to maintenance in salinized water. Salinization interfered in several parameters of water quality, bringing no advantages for the species.

## Unraveling decadal fluctuations in the Brazilian sardine purse seine fishery off Southern Brazil

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The Brazilian sardine *Sardinella brasiliensis* is the main fishing resource off Brazil. Data from species landings goes back to 1950. A peak was observed in 1973 with 228,000 tons, followed by one collapse in 1990 and another in 2000 after a brief fishery recovery. These fluctuations, alternating decadal periods of high and low abundance/catch can be related to decadal climate changes and recruitment variability. However, since the year 2000 sardine catches steadily increased continuously until 2017, when the third collapse occurred, refuting the decadal hypothesis. These collapses also changed the monospecific nature and the fishing power of the purse seine fleets. The present study analyzed the Brazilian sardine landings between 2000 and 2019 to evaluated the existence a decadal variability possibly masked by the technological modifications from 2008 onwards. At least 97 species were caught jointly with sardines by the purse seine fishery, with emphasis on the Atlantic thread herring *Opisthonema oglinum*, which account for almost 10% of the total. A combination of cluster analysis and generalized additive models found two distinct groups. The first group was represented by massive catches of the Brazilian sardine together with other species, and the second by less expressive catches of the Brazilian sardine, but with greater participation of the Atlantic thread herring and other species. Arranged along a temporal axis, these groups alternated over approximately 10 years. The technological modification to preserve the fish in refrigerated brine, instead of ice, conferred a higher autonomy and greater fishing power to the fleets. When the generalized additive models were applied over the catches until 2008 the bimodal pattern in the deviance residuals disappeared and a new cycle of abundance was identified achieving its minimum in 2017.

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## Unravelling the population structure of *Opisthonema oglinum* (Clupeidae) in the Southwestern Atlantic inferred from otolith shape analysis

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The Atlantic thread herring, *Opisthonema oglinum*, is a small pelagic fish usually found in estuaries and in the continental shelf of the Brazilian coast, presenting higher abundance between Rio de Janeiro and Santa Catarina states. It is exploited by the industrial purse seine fleet that has *Sardinella brasiliensis* as a target. Knowledge about its population structure, movements and habitat connectivity are still limited in spite of its importance as a fishery resource. Fifty fish (25 per location), ranging from 22.7 to 25.4 cm TL, have been collected in the coast of Rio de Janeiro (RJ: 23°04'S and 44°03'W) and Santa Catarina (SC: 26°05'S and 48°18'W) between June and October of 2011 by the purse seine fleets. Sagittal otoliths have been extracted, cleaned of biological tissues. The left otoliths were photographed under a stereomicroscope, normalized about size and rotation to extract Elliptic Fourier Descriptors (EFD) from their contour. The effect of the body size on the EFD was removed. A multivariate analysis of the 37 EFD that better described the otolith shape contour revealed a high re-classification success (92% RJ and 100% SC) following a stepwise linear discrimination function analysis. This data, although preliminary suggest that these two fishery grounds should be regarded as two discrete demographic units for fisheries management purposes.

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**VI Especies exóticas invasoras**

**VI Espécies exóticas invasoras**



## Especies Exóticas Invasoras de sistemas acuáticos epicontinentales de la Península Ibérica: priorización y listas de referencia elaboradas por LIFE INVASAQUA

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INVASAQUA es un proyecto del programa LIFE que pretende reducir la problemática de las especies exóticas invasoras (EEI) de carácter acuático en España y Portugal a través del aumento de información y sensibilización sobre sectores clave en la gestión. En una acción preliminar de dicho proyecto y mediante una metodología participativa que ha involucrado a expertos ibéricos, se ha elaborado un listado de referencia a escala peninsular de las EEI acuáticas presentes y potenciales. En el presente trabajo presentamos un total de 181 taxones de vertebrados, invertebrados y plantas que conforman la lista de EEI presentes o establecidas, junto con un total de 256 taxones potenciales que constituyen una primera lista de alerta a escala peninsular. Este tipo de listados actualizados y parcialmente priorizados son una herramienta esencial para la gestión preventiva de las EEI ibéricas. A su vez, conforman una importante herramienta de transferencia de conocimiento hacia los responsables de gestión y otros sectores clave.

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**Ideas de los estudiantes de secundaria sobre especies exóticas invasoras en ecosistemas acuáticos continentales. Propuesta de un ciclo de aprendizaje**

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Las especies exóticas invasoras constituyen una de las principales amenazas a la biodiversidad, especialmente en ecosistemas aislados o de interés como los ecosistemas acuáticos continentales. La acción humana en este problema ambiental es directa, por lo que hacer partícipe a la sociedad del problema y la búsqueda de soluciones es esencial. Teniendo en cuenta que uno de los principales objetivos de la educación secundaria en España es “capacitar a los estudiantes para que actúen como ciudadanos responsables”, tratar en el aula esta problemática es clave.

Este trabajo constituye una aproximación al conocimiento de las ideas de los estudiantes de secundaria españoles sobre especies exóticas invasoras en ecosistemas acuáticos continentales. Para la consecución de este objetivo y sus derivados se propone un ciclo de aprendizaje con la siguiente secuencia de actividades: 1. Exploración y activación de ideas (Objetivo: Indagar y activar las ideas de los estudiantes); 2. Introducción de ideas (Objetivo: Explicar y concienciar sobre la problemática); 3. Aplicación de ideas (Objetivo: Evaluación del método). En el estudio participaron 201 alumnos de un instituto urbano gallego.

Los principales resultados obtenidos indican un desconocimiento general de la biodiversidad acuática continental, más acusado sobre ciertos grupos de animales. Un elevado porcentaje reconoce que las especies exóticas causan impacto medioambiental, pero muy pocos tienen en cuenta otros impactos derivados y alrededor del 20% soltarían una especie exótica al medio. Además, consideran a las especies exóticas como el factor con menor influencia en la pérdida de biodiversidad. La contaminación de las aguas continentales y la pérdida de biodiversidad son los problemas ambientales menos importantes para los tres niveles. La preferencia hacia los vertebrados detectada en otros estudios parece, según nuestros datos, no extenderse a los peces, ya que, a la hora de ejemplificar, o de elegir especies para las actividades éstas fueron las menos seleccionadas.

## Inter-Population variability in dietary traits of invasive bleak *Alburnus alburnus* (L., 1758) across the Iberian Peninsula

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The bleak *Alburnus alburnus* (L., 1758) is a limnophilic fish native to most of Europe, from the Pyrenees to the Urals. This cyprinid species is a successful invader in the Iberian Peninsula, where it threatens a highly endemic fish fauna. Despite the high ecological risk posed by bleak, no studies exist on variations in their foraging strategies at a large scale for the Mediterranean region of Europe. Thus, the aim of the present study was to compare dietary traits of invasive bleak among the main Iberian rivers and a ‘reference’ native bleak population from France. For this purpose, bleak were thoroughly sampled by using the same variety of catching methods (i.e. electrofishing and netting from boat or wading) during May–June 2012 (i.e. pre-spawning period) from the Iberian Rivers Ebro, Tagus, Guadiana, Segura and Guadalquivir; along with the River Saône (France). Diet composition (i.e. percentages of occurrence and ingested mass) was highly variable among rivers. Specifically, Diptera larvae and zooplankton were very common in the River Saône. Diet was similar in the River Ebro, although insect nymphs were more important. The intake of plant material was higher in the River Tagus. Flying insects were more consumed in the River Guadiana, whereas nektonic insects were important in the River Guadalquivir as percentage of ingested mass. Detritus was a frequent food category for all populations, in terms of occurrence and mass. Dietary parameters (i.e. ingested mass, prey richness, trophic diversity and trophic niche breadth) followed a unimodal response in relation to the latitudinal gradient, with the maximum values for the Tagus and Guadiana populations. Overall results suggest that this wide inter-population variability will contribute to the species’ successful establishment throughout Mediterranean Europe, which poses a serious risk to its highly valuable native fish fauna.

## Unveil the unseen: introductions of two species of minnows *Phoxinus* (Pisces, Cyprinidae) in the Douro basin, Iberian Peninsula

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The number of non-native freshwater fish populations in the Iberian Peninsula has been increasing. Their early detection, followed by the identification of its region of origin, pathways, and vectors of dispersal is crucial for a quick risk assessment and proper anticipation of species invasiveness and impacts. To answer to at least some of these issues, molecular approaches are being increasingly applied.

In this study, individuals of the genus *Phoxinus* were detected in 18 out of 138 stream sites sampled across the Douro Basin in 2017 and 2018. A total of 26 minnows were barcoded using partial cytochrome c oxidase subunit I (COI) and cytochrome b (cytb) genes for species identification and determination of geographical origin. An undescribed *Phoxinus* species in western Douro (Sousa River, Portugal) had haplotypes closely matching those found in the Charente River (southern France), where populations have been previously considered as *Phoxinus phoxinus*. Individuals from watercourses in eastern Douro (Spain) were genetically assigned to *Phoxinus bigerri*, an introduced species previously described for that region.

We discuss if *Phoxinus* sp. introduction is related to the use of minnows as live bait by freshwater anglers and if the pathway of introduction can be explained by human travelling between France and Portugal. We also discuss the potential ecological impacts of both introductions.

## Exploring an ecosystem management approach for the invasive mosquitofish (*Gambusia holbrooki*)

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The spread of exotic species is among the most pernicious consequences of global change. Millions of species are transported annually for being either deliberately or accidentally introduced into areas beyond their native regions. While many introduced species fail to establish self-sustaining populations and spread, some exotic species become invasive, often causing pronounced ecological impacts on recipient regions. Here we explore the potential of an ecosystem approach for the natural control of *Gambusia holbrooki*, which is among the most pernicious and widely distributed fish invaders. We used individual-based linear mixed models to identify the local factors (conspecific density, environment and piscivorous birds) that most influenced life-history variation in male and female *G. holbrooki* from 18 ponds. We found that variation in life history traits of *G. holbrooki* was mostly affected by its density; increasing offspring number at the expense of offspring size at the sites with the highest fish density. Weaker effects on *G. holbrooki* life history were observed for the abundance of piscivorous birds and water-quality conditions, including turbidity and nutrient concentrations. Therefore, we concluded that the effectiveness of local habitat interventions to manage *G. holbrooki* are likely to be limited in stagnant waters and we recommend the use of direct control methods.

## Control poblacional del pez exótico *Salvelinus fontinalis* en el Parque Nacional de Ordesa y Monte Perdido

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El salvelino (*Salvelinus fontinalis*) es un salmónido exótico invasor que en la década de los 70 del siglo pasado fue introducido por la administración -Servicio Nacional de Pesca Fluvial, Caza y Parques Nacionales- en algunos cursos fluviales españoles para fomentar su pesca deportiva. Es la única especie piscícola exótica invasora presente en el Parque Nacional y sólo se conoce además en una localidad, un humedal asociado al cauce del río Arazas (valle de Ordesa) denominado As Fuens. El humedal As Fuens presenta una longitud de cuatrocientos metros, una anchura media de seis metros y una profundidad media en torno a treinta centímetros en el momento del muestreo, a finales del estío. Recibe aportes de varias fuentes y los caudales acaban desembocando en el río Arazas. El salvelino ocupa el hábitat acuático junto con la trucha común (*Salmo trutta*) y en las zonas de manantial hay también presencia de anfibios amenazados como rana pirenaica (*Rana pyrenaica*) y tritón pirenaico (*Calotriton asper*). En 2017 se inició la erradicación del salvelino del humedal mediante pesca eléctrica con pasadas múltiples. Como resultado de los trabajos realizados se han retirado un total de 483 ejemplares del humedal (277 en 2017, 173 en 2018 y 33 en 2019); los resultados obtenidos hacen pensar que en los próximos años se puede conseguir una eliminación completa de esta especie exótica invasora del humedal, mejorando con ello la calidad de los ecosistemas acuáticos.

## Observaciones sobre la respuesta de peces nativos y exóticos en un caso de restauración fluvial

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La eliminación de obstáculos transversales se promueve cada vez más para aumentar la conectividad de la red fluvial y para facilitar la dispersión de los peces. No obstante, es necesario comprender mejor la respuesta de la comunidad de peces a la eliminación de las barreras, especialmente en ríos de bajo orden hidráulico, donde las comunidades de peces autóctonos pueden ser más vulnerables a los efectos de las invasiones de especies exóticas, cuya dispersión involuntaria o no intencionada pudiera verse favorecida por el cambio subsecuente de las características del hábitat.

En este trabajo se valora la respuesta de las poblaciones de peces nativos y exóticos a la permeabilización de un tramo del río Caselas (tramo internacional del río Miño) mediante el estudio de las poblaciones antes y después de la instalación de un paso para peces en un primer obstáculo transversal y del derribo de un azud aguas arriba.

A la vista de los resultados obtenidos, se observa una reducción del efecto concentrador aguas abajo de los obstáculos que se refleja en una menor densidad de todas las especies una vez permeabilizada o retirada la barrera. Excepto la aparición poco significativa de un ejemplar de *Carassius auratus* aguas arriba de los obstáculos después de la permeabilización, especie que no había sido registrada en esa zona con anterioridad, las otras especies alóctonas presentes: *Lepomis gibbosus*, *Gobio lozanoi* y *Cobitis paludica* sufrieron un descenso en su densidad en todas las estaciones después de la intervención, lo que puede asociarse, con mucha probabilidad al cambio hidromorfológico del tramo, que se transformó notablemente y adquirió un mayor reodinamismo, una mayor superficie y una menor profundidad.

## Evaluación de la competencia interespecífica entre especies de peces dulceacuícolas alóctonas y nativas en diferentes situaciones de densidad relativa

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Se evalúa el nivel de competencia interespecífica entre *Salmo trutta* Linnaeus, 1758 y dos especies alóctonas en el tramo internacional del río Miño: *Cobitis paludica* de Buen, 1930 y *Gobio lozanoi* Doadrio & Madeira, 2004 que se encuentran en diferente situación de densidad relativa en tres afluentes: ríos Pego, Caselas y Deva, formulando la hipótesis de que la competencia es proporcional a la densidad relativa entre especies y puede medirse mediante las diferencias en las tasas de crecimiento y supervivencia de la especie nativa. Así, en los tres afluentes se ha comparado la supervivencia de las primeras clases de edad de la trucha común con la densidad poblacional de colmilleja y gobio. Los resultados de dicho análisis indican que la mayor densidad de estas especies alóctonas tiene un efecto positivo sobre la supervivencia de las cohortes 0+ y 1+ de la especie nativa, que se explica porque *Salmo trutta* es una especie euríaga e ictiófaga que encuentra en *Cobitis paludica* y *Gobio lozanoi* una fuente de alimento con alto valor proteíco. Este mayor aporte de proteínas suministrado por las especies no nativas en la dieta de los individuos reproductores de trucha se traduce en huevos con mayor cantidad de vitelo y una elevada tasa de eclosión, que se manifiesta en un aumento relativo del número de individuos juveniles que terminan correctamente el desarrollo como eleuteroembriones y presentan una mayor eficacia biológica derivada de una mejor condición.

## Papel de los niveles de reserva energética del gobio (*Gobio lozanoi* Doadrio & Madeira, 2004) en su capacidad de invasión en tramos fluviales de bajo orden hidráulico

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*Gobio lozanoi* Doadrio & Madeira, 2004 es un ciprínido que ha sido introducido, entre otras, en la cuenca del Miño y cuya área de distribución natural se localiza en las cuencas ibéricas del Ebro y del Bidasoa y en las francesas del Adour y del Nivelle.

En este trabajo buscamos analizar el papel que juegan los niveles de reserva energética (glucógeno, lípidos y proteínas de cada ejemplar, considerados biomarcadores no específicos, debido a que responden ante diferentes tipos de condiciones de desarrollo) en la capacidad de invasión de las especies exóticas en ecosistemas acuáticos epicontinentales lóticos, utilizando como modelo dos poblaciones de *Gobio lozanoi* en dos afluentes del curso bajo del Río Miño.

El río Pego presenta un moderado enriquecimiento orgánico con incremento notable de la producción secundaria frente al estado del río Caselas, con una mejor calidad y una menor producción en términos globales. Los datos obtenidos sobre las reservas energéticas en el material estudiado, diferencian significativamente la población de gobio del río Pego, con valores más altos de lípidos, de la del río Caselas, con mayor cantidad de proteínas.

La situación del río Pego refleja un estado de mayor invasibilidad o, dicho de otro modo, una menor resistencia a la invasión, por el aumento de la oferta de recursos sin merma de las condiciones de habitabilidad. Este estado de alteración de origen antrópico rompe las relaciones de competencia entre las especies residentes y las alóctonas y establece nuevas interacciones y dimensiones de los nichos ecológicos.

El nivel de los lípidos se revela como un buen indicador de las poblaciones de especies exóticas invasoras con recursos tróficos abundantes y en condiciones de ver incrementada su capacidad invasiva.

## Influencia de la alimentación sobre la fecundidad y la capacidad invasora de *Lepomis gibbosus* (Linnaeus, 1758)

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En este trabajo se estudió la influencia de la alimentación en la fecundidad, asignación reproductiva, condición física y otras variables en dos poblaciones de *Lepomis gibbosus*: una de la Laguna de Las Madres (Madrid) y otra de Las Tablas de Daimiel (Ciudad Real). El primero es un ecosistema artificial, pero con una alta variedad y abundancia de presas, principalmente macroinvertebrados. El segundo es un Parque Nacional de gran importancia para la biodiversidad, pero que paradójicamente se encuentra fuertemente alterado y, como consecuencia, tanto la diversidad como la abundancia de macroinvertebrados es muy reducida.

Se determinó la abundancia relativa de los distintos tipos de presa en la dieta de ambas poblaciones, y se midió el índice de repleción, peso, longitud furcal, peso gonadal, fecundidad relativa y absoluta y diámetro medio de los huevos. Se calculó el índice gonadosomático y el factor de condición. Posteriormente, se buscaron correlaciones entre estas variables y diferencias significativas entre los valores de dichas variables en ambas poblaciones.

Los resultados muestran que, a pesar de que la población de Las Madres se alimenta con mayor intensidad y sigue una dieta similar a la observada en otras poblaciones nativas y no nativas, la población de Las Tablas presenta valores más elevados en todas las variables. Dos hipótesis pueden explicar estos resultados: la perca sol podría haber adoptado una estrategia oportunista en Las Tablas en respuesta a la escasez de recursos, asignando una mayor proporción de las reservas energéticas a la reproducción; o bien, la esta población se encuentra en un estado de madurez sexual más avanzado debido a las diferencias en las condiciones ambientales. Bajo cualquiera de las dos hipótesis parece evidente que la habilidad de adaptarse a ambientes tan dispares como los aquí examinados hacen de *L. gibbosus* una especie con alta capacidad invasora.

**VII Proyectos**

**VII Projects**



## LIFE INVASAQUA: un proyecto para la transferencia de conocimiento, formación y sensibilización sobre especies exóticas invasoras acuáticas en España y Portugal

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De forma similar a otros estados europeos, España y Portugal presentan una percepción pública escasa y una comprensión limitada sobre la problemática de las especies exóticas invasoras (EEI) presentes en los ecosistemas acuáticos. Esta falta de conocimiento y sensibilización dificulta notablemente su gestión estratégica. El proyecto LIFE INVASAQUA sobre Gobernanza e Información tiene como principal objetivo aumentar la formación, conocimiento y conciencia del público en general, así como de grupos clave relacionados con el impacto de las EEI sobre los ecosistemas acuáticos estuarinos y dulceacuícolas. Este proyecto recibe la subvención a través del programa LIFE de la Unión Europea (LIFE17 GIE/ES/000515).

## Desarrollo del Proyecto Interreg Migramiño-Minho (2016-2020): Conservación y Mejora de los Peces Migradores y su Hábitat en el Tramo Internacional del Río Miño y afluentes

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Este proyecto tiene como finalidad la protección y conservación del hábitat fluvial de la cuenca del río Miño en el tramo internacional (desde la presa de Friera hasta su desembocadura en el Océano Atlántico en Caminha-A Guarda) a través de actuaciones de mejora del estado de conservación de las especies de peces migradores presentes en este tramo bajo del Miño y sus afluentes. En este proyecto participan 7 instituciones, tres por parte de Galicia (DXPN-Xunta, EHEC-USC, CH Miño-SIL) y cuatro por parte de Portugal (ICNF, CIIMAR, APA e CM Vilanova de Cerveira). Se actúa sobre 6 especies de peces diadromos, 5 anádromas (salmón, *Salmo salar*, lamprea marina, *Petromyzon marinus*, sábalo *Alosa alosa*, saboga *Alosa fallax*, y el reo, *Salmo trutta*) y una catádroma (la anguila europea, *Anguilla anguilla*), en 4 grandes actividades: 1) incremento de la accesibilidad fluvial, 2) mitigación de presiones, 3) refuerzo y mejora de las poblaciones de peces, y 4) evaluación del impacto de las actuaciones.

Hasta el momento se han obtenido los siguientes resultados en cada actividad: 1) Se incrementó la accesibilidad mediante el derribo de 6 obstáculos e instalación de un dispositivo de franqueo innovador en un obstáculo. 2) Se han propuesto unas normas comunes de gestión de pesca fluvial para el Tramo Internacional del Río Miño (TIRM) y afluentes, realizadas entre los socios del proyecto y las Armadas portuguesa y española. -El CIIMAR y la EHEC-USC elaboraron informes sobre las presiones de origen antrópico. -Se restauraron 5 ha de superficie de bosque de ribera para la mejora de la calidad del hábitat fluvial del río Tea. 3) Mediante el Plan de translocación de anguilas a ríos tributarios de ambos lados del TIRM, se ha soltado casi 1.5 toneladas de anguilas en los años 2016, 2017 y 2019. -Se creó un stock reproductor de salmón procedente del río Miño y se han soltado 113 mil juveniles en afluentes de ambos países en 2017, 2018 y 2019 –Se realizó un estudio de las potencialidades para la reproducción en cautividad del sábalo. 4) La EHEC-USC y el CIIMAR realizaron inventarios de peces fluviales e informes sobre el seguimiento de parámetros biológicos en afluentes de las dos márgenes.

El Proyecto Interreg Migramiño-Minho está cofinanciado al 75% por el Programa Interreg V-A POCTEP a través del Fondo Europeo de Desarrollo Regional (FEDER) de la Unión Europea (<http://migraminho.org>).

## Diagnosis de la idoneidad del hábitat fluvial para *Margaritifera auricularia*, en el marco del proyecto SOS Margaritona

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La margaritona (*Margaritifera auricularia*) es un molusco de conservación prioritaria en España. Está catalogada en la categoría “En Peligro Crítico” tanto en España como a nivel internacional. Lamentablemente, su situación ha seguido empeorando. Aún peor, este proceso se ha acelerado en los últimos años. Resulta pues urgente planificar medidas diversas, estratégicamente seleccionadas para evitar su extinción en España.

El objetivo general del proyecto SOS Margaritona, financiado por la Fundación Biodiversidad, es la conservación a largo plazo de la margaritona, mediante la identificación de tramos fluviales adecuados para establecer nuevos núcleos de ejemplares en la cuenca del Ebro, y la mejora de los stocks disponibles de su pez hospedador, el fraile (*Salaria fluviatilis*). El proyecto SOS Margaritona cuenta con el apoyo de la Fundación Biodiversidad, a través del Ministerio para la Transición Ecológica y el Reto Demográfico

El primer de los objetivos específicos del proyecto SOS Margaritona, consiste en la localización de tramos fluviales con características hidromorfológicas y bióticas adecuadas para la eventual acogida de ejemplares de margaritona, sean adultos traslocados o bien juveniles obtenidos en cautividad. Con el fin de dotar de rigor el procedimiento de valoración de tramos fluviales, se propone un índice simplificado para la valoración de la idoneidad del hábitat para margaritona, en base a 20 criterios que incluyen aspectos bióticos, hidromorfológicos, de calidad del agua y estado ecológico. Estos criterios se basan en el conocimiento previo disponible sobre una selección de aquellos aspectos clave relativos a la ecología y la biología de esta náyade, y con especial énfasis a aquellos aspectos críticos o totalmente limitantes, como por ejemplo la presencia de peces hospedadores de sus larvas (gloquidios), o de ciertos hábitats.

Se presenta este índice y los resultados de su aplicación en la cuenca del Ebro.

## Ecological restoration of high mountain lakes in the Pyrenees by fish removal or intensive control: final results of the project LIFE LimnoPirineus

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Nowadays, more than half of Pyrenean high mountain lakes are occupied by fish, as a result of a historical process of introductions dating back to centuries ago, and that has been accelerated during the last 60 years. In the southern slope of these mountains, the main introduced fish are Brown trout (*Salmo trutta*), Brook trout (*Salvelinus fontinalis*), Rainbow trout (*Oncorhynchus mykiss*) and European minnow (*Phoxinus* sp). The specific impacts of the introduction of fish include, among others, the transformation of the ecosystem structure and trophic relationships, and the reduction and extirpation of native species.

The project LIFE LimnoPirineus (LIFE13 NAT/ES/001210), started in 2014 and ended in 2019, included among its main objectives the restoration of eight high mountain lakes with fish (trout or minnow) and the recovery of native species of European interest, either by eradication or intensive control of introduced fish, depending on the size of the lake.

We planned and executed continuous and sustained campaigns to achieve the objectives of either complete removal of fish or at least significative reductions of initial stocks. From 2014 to 2017 we began with operations gradually in all the eight objective lakes, by means of several capture techniques, mainly gill nets for trout and a combination of gill nets, fyke-nets and electrofishing for Minnows.

Right now, we have already achieved the complete fish removal in four lakes. In other three lakes, this objective is also expected to be achieved in 2020, and actually only few individuals persist. In the remaining lake, we have already obtained a substantial reduction of Minnow density (> 85%). We present in detail the results achieved.

## El proyecto INVASAQUA en Navarra: implementación de acciones a nivel local

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El proyecto LIFE INVASAQUA (LIFE17 GIE/ES/000515), financiado por el programa LIFE, tiene como principal objetivo apoyar la comunicación, formación y difusión de información sobre las Especies Exóticas Invasoras (EEI) acuáticas en España y Portugal. Busca aumentar la conciencia del público y de grupos interesados en la problemática de las EEI acuáticas, así como desarrollar herramientas que mejoren la alerta temprana y respuesta rápida en su gestión. Se quiere facilitar el intercambio en el conocimiento de soluciones y prácticas ambientales exitosas mediante la cooperación entre partes interesadas (administración pública, gestores, ongs, científicos, practicantes de deportes y actividades acuáticas, industrias relacionadas y público general). Fruto de ello nace la propuesta de colaboración entre la Sociedad Ibérica de Ictiología (SIBIC), uno de los socios en INVASAQUA, y el Gobierno de Navarra. Esta colaboración pretende desarrollar diferentes acciones en Navarra como: análisis de la percepción y sensibilización social sobre el tema, análisis de las EEI prioritarias e identificación de sus principales vías de entrada; desarrollo de protocolos de actuación ante nuevas EEI para distintos sectores; desarrollo de código de conducta y buenas prácticas específicos; promover el día de la lucha contra las EEI; elaboración de contenidos pedagógicos; realización de actividades divulgativas e informativas y talleres de formación para grupos de interés y público en general; fomentar nuevos proyectos de investigación y estudios de interés para Navarra. La colaboración desde el ámbito local en proyectos internacionales se considera una herramienta imprescindible que facilita la realización y cumplimiento de los objetivos de dichos proyectos. Esta sinergia con las instituciones locales posibilita y facilita el traslado de los objetivos planteados en los mencionados proyectos a un nivel local de una manera más práctica y eficaz, ayudando a su consecución global.

## Conservação e gestão de populações de mexilhão-de-rio (*Margaritifera margaritifera*) e do hospedeiro truta-de-rio (*Salmo trutta*) em rios de Portugal

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<sup>6</sup> CBMA - Centro de Biologia Molecular e Ambiental, Universidade do Minho, Campos de Gualtar, Braga

<sup>7</sup> FRESHWATER LDA. Estrada do Cando 42, Chaves

<sup>8</sup> CITAB-UTAD - Centro de Investigação e Tecnologias Agroambientais e Biológicas. Univ. Trás-os-Montes e Alto Douro. Quinta de Prados, Vila Real

<sup>9</sup> BIOTA Lda - Estudos e Divulgação em Ambiente, Lda. ABC-Apoio de Base à Criatividade. Convento de São Miguel das Gaeiras. Gaeiras

<sup>10</sup> CESAM - Centro de Estudos do Ambiente e do Mar. Universidade de Aveiro. Campus Universitário de Santiago. Aveiro

<sup>11</sup> CIIMAR/CIMAR - Centro Interdisciplinar de Investigação Marinha e Ambiental. Terminal de Cruzeiros do Porto de Leixões, Av. General Norton de Matos s/n, Matosinhos

A conservação e gestão do mexilhão-de-rio *Margaritifera margaritifera* em Portugal, uma espécie Criticamente em Perigo (CR) na Europa, assim como da espécie piscícola hospedeira, a truta-de-rio *Salmo trutta*, depende da existência de informação atualizada acerca da distribuição, estrutura populacional, sucesso reprodutivo e ameaças de ambas as espécies. O presente projeto, financiado pelo POSEUR (Operação POSEUR-03-2215-FC-000096) e Fundo Ambiental, envolve uma equipa multidisciplinar de investigadores cujo objetivo consiste na proteção e recuperação das populações de *M. margaritifera* e de *S. trutta* em Portugal, através da colmatação de lacunas de conhecimento e desenvolvimento de medidas de conservação, entre as quais se destacam ações específicas implementadas 1) *in situ*: (a) determinação da extensão, distribuição detalhada e estado de conservação das espécies-alvo; (b) avaliação da qualidade biológica e ecológica dos rios de aptidão salmonícola; (c) análise da vulnerabilidade às alterações climáticas, controlo de exóticas e outros fatores de regressão; (d) implementação de melhoria de habitats; (e) elaboração de medidas de gestão e ordenamento das massas hídricas; (f) monitorização de repovoamentos de *M. margaritifera* e *S. trutta*; e ainda ações realizadas B) *ex situ*: (g) reprodução em cativeiro de *M. margaritifera*; (h) reprodução em cativeiro de *S. trutta*; (i) caracterização genética das populações selvagens de *S. trutta*, incluindo seleção de vários stocks selvagens para criação em cativeiro, de acordo com a estratégia definida pelo Instituto de Conservação da Natureza e das Florestas.

## **SONICINVADERS – Evaluating the potential of Passive Acoustics to detect invasive fish in freshwaters ecosystems**

Filipe Ribeiro<sup>1</sup>, Diogo Ribeiro<sup>2</sup>, Carlos M. Alexandre<sup>3</sup>, Paulo J. Fonseca<sup>4</sup>, Luisa Sousa<sup>5</sup>, Pinto Bruno<sup>4</sup> & Amorim Clara<sup>2,6</sup>

<sup>1</sup> MARE - Marine and Environmental Sciences Centre, Faculdade de Ciências da Universidade de Lisboa, 1749-016 Lisbon, Portugal (fmvribeiro@gmail.com)

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<sup>4</sup> Department of Animal Biology , Faculty of Science, University of Lisbon, 1700-090 Lisbon, Portugal.; cE3c- Centre for Ecology, Evolution and Environmental Changes, Faculty of Science, University of Lisbon, 1700-090 Lisbon, Portugal

<sup>5</sup> Fluvíario de Mora, Município de Mora, Parque Ecológico do Gameiro, 7490-909 Cabeção - Mora, Portugal

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Non-native species are one of the leading causes of species extinction, being particularly detrimental in freshwater ecosystems. Iberian freshwater habitats are considered a bio-invasion hotspot and are currently invaded at a rate of one new fish in every two years. Early detection of non-native fishes is essential to implement effective management actions. Yet, standard fish sampling often fails to detect such species during the early stages of invasion. The SONICINVADERS project aims to evaluate the potential use of Passive Acoustics to detect non-native fishes that recently invaded the Tagus river, in Portugal. Laboratory experiments are being performed to describe sound repertoire of target species, and field observations are recording aquatic soundscapes aiming to identify putative sounds produced. The usage of passive acoustics in the field is being complemented with standard sampling (electric fishing) and environmental DNA. A final task is directed to the broad public, through the creation of a Fish Sound Exhibit at the largest freshwater public aquarium in Iberian Peninsula - the Fluvíario de Mora.

## The DiadES project: three years to assess and enhance ecosystem services provided by diadromous fishes and lampreys in a climate change context

Estibaliz Diaz<sup>1</sup>, David J. Nachón<sup>2</sup>, Géraldine Lassalle<sup>3</sup>, Patrick Lambert<sup>3</sup>, Pedro Almeida<sup>4</sup>, Carolina Alonso<sup>1</sup>, Carlos Antunes<sup>5</sup>, Matthew Ashley<sup>6</sup>, Tea Bašić<sup>7</sup>, Fernando Cobo<sup>2</sup>, Gordon Copp<sup>7</sup>, Feunteun Éric<sup>8</sup>, Catarina Mateus<sup>4</sup>, Angela Muench<sup>7</sup>, Cristina Marta Pedroso<sup>9</sup>, Arantza Murillas<sup>1</sup>, Ciara O’Leary<sup>10</sup>, Sian Rees<sup>6</sup>, William Roche<sup>10</sup>, Thomas Trancart<sup>8</sup> & Rufino Vieira-Lanero<sup>2</sup>

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<sup>2</sup> USC/EHEC

<sup>3</sup> INRAE

<sup>4</sup> MARE

<sup>5</sup> CIIMAR

<sup>6</sup> University of Plymouth

<sup>7</sup> CEFAS

<sup>8</sup> MNHN, CNRS

<sup>9</sup> MARETEC

<sup>10</sup> IFI Aguirre

Diadromous species are in decline across their Atlantic distribution causing ecological and socioeconomic impacts on local communities. Despite many management measures, the situation remains critical. Diadromous species populations between river basins are not isolated and yet management is mostly organized at the local scale. A shift in their distribution due to climate change would render their management an even more complex problem. Therefore, a transnational approach is needed to enable a common management for the conservation and enhancement of the ecosystem services associated to these species that includes the explicit long-term and large-scale issues related to climate change. The DiadES project (Interreg Atlantic Area) aims to assess and enhance ecosystem services provided by diadromous species in the Atlantic Area whilst considering the possible relocation of these resources under future climate conditions. Three main outputs will be produced to increase the capacity of policy makers and other key stakeholders to make efficient and informed management decisions: – An INTERACTIVE WEB ATLAS will present changes in diadromous species distributions and trends in relevant ecosystem services under climate change, promoting the emerging benefits they provide; – A SERIOUS GAME will bring together targeted groups to (i) share the different knowledge they have on diadromous species conservation and exploitation, (ii) build a joint representation of fish population dynamics across the Atlantic Area and (iii) imagine joint alternative management strategies in the face of climate change. – POLICY GUIDELINES for a large-scale and long-term management of diadromous species will be formalized in a Declaration signed by all key parties involved in diadromous species management.

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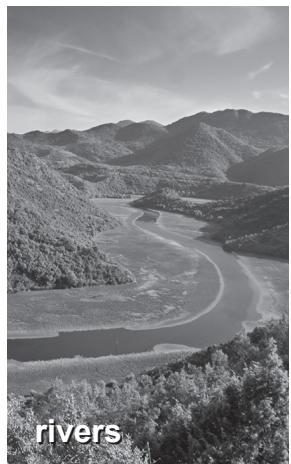




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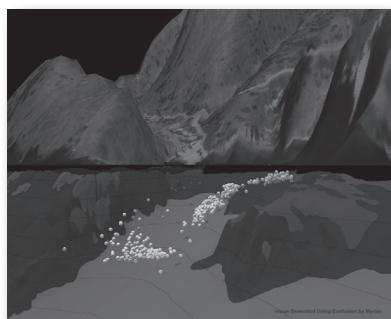
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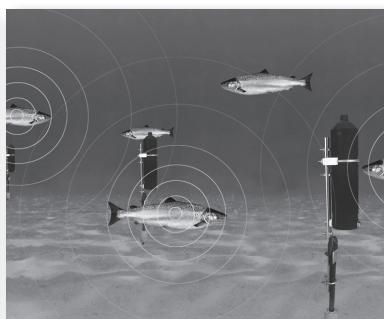
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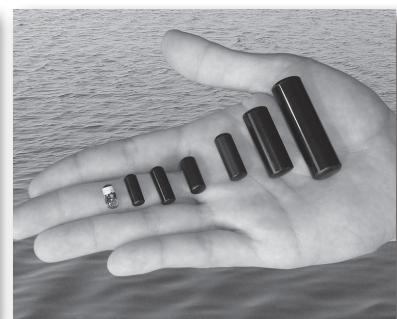
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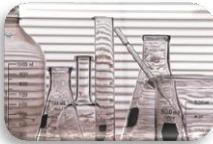
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