Unravelling the distribution, biology and ecology of European shads during a key phase but also a black box: the marine phase.

Various approaches, including otolith microchemistry

Local initiative: Fauna/shad'EAU

DiadES with contributions from Fauna/Shad'EAU session

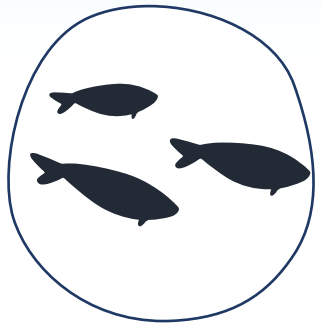
David José Nachón García[1]

[1]Laboratorio de Hidrobioloxía, Universidade de Santiago de Compostela (USC)

LOCAL AND GLOBAL INITIATIVES:

HOW SCIENCE SUPPORTS MANAGEMENT ACTIONS ON DIADROMOUS FISH

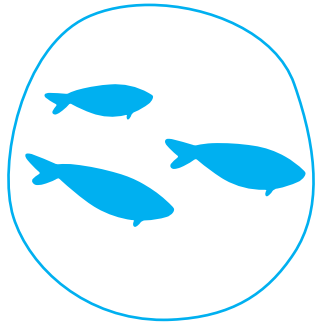
CASE ESTUDIES



LOCAL INITIATIVE

1MARDEALOSAS PROJET (2021)

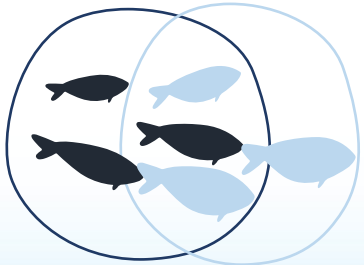
Nachón, D. J, Vieira-Lanero, R. & Cobo, F. and collaborators



FAUNA SHAD´EAU

Dispersal capabilities and connectivity of shad stocks during the 80´s (2017-2019)

Nachón, D. J, Bareille, G. & Daverat, F. and collaborators



LOCAL INITIATIVES + GLOBAL INITIATIVES

1MARDEALOSAS + DIADES PROJET (ongoing)

Nachón, D. J, Vieira-Lanero, R., Cobo, F., *Bareille, G. & Daverat, F. and collaborators*

LOCAL INITIATIVE

1MARDEALOSAS PROJET (2021)

Nachón, D. J, Vieira-Lanero, R. & Cobo, F. and collaborators

Assessment of "bycatch" of *Alosa alosa* and *Alosa fallax* by the Galician coastal fleet: analysis of the problem, awareness raising and proposal of management and protection measures

1MARDEALOSAS

1SEASHADS

To improve the current state of knowledge on the distribution, biology and ecology of the two species of European shads in the coastal environment of the northwest Iberian Peninsula based on the by-catch or incidental catches that occur in the fishery, in order to propose protection, management and conservation measures for these threatened anadromous species

LOCAL INITIATIVE

1MARDEALOSAS PROJET (2021)

Nachón, D. J, Vieira-Lanero, R. & Cobo, F. and collaborators

▪ METHODOLOGY

First sale statistics were **collected and analysed** in the **Galician fish markets** (NW Iberian Peninsula), through the **Galician Fishing Platform, Pescadegalicia**

pescadegalicia.gal

XUNTA DE GALICIA
CONSELLERÍA DO MAR

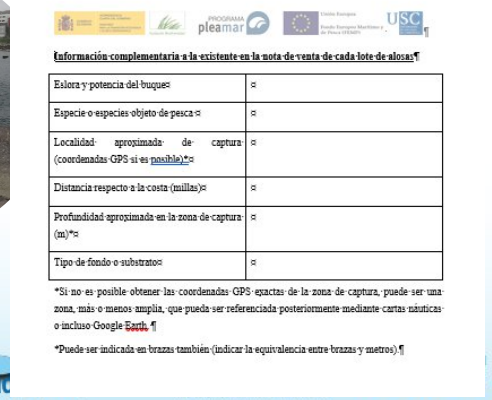
Three of the **main fish markets**

A Coruña,
Malpica,
A Guarda

January to **March 2021**

Complementary information on the **shad by-catches**

catch locations,
depths,
types of vessels,
nets,
target fish species



¶
Información complementaria a la existente en la nota de venta de cada lote de alosas:¶

Eslora y potencia del buque¤	¤
Especie o especies objeto de pesca¤	¤
Localidad aproximada de captura (coordenadas GPS si es posible)*¤	¤
Distancia respecto a la costa (millas)¤	¤
Profundidad aproximada en la zona de captura (m)*¤	¤
Tipo de fondo o substrato¤	¤

*Si no es posible obtener las coordenadas GPS exactas de la zona de captura, puede ser una zona, más o menos amplia, que pueda ser referenciada posteriormente mediante cartas náuticas o incluso Google Earth. ¶

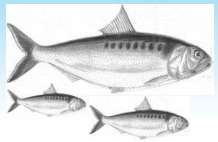
*Puede ser indicada en brazas también (indicar la equivalencia entre brazas y metros).¶

LOCAL INITIATIVE

1MARDEALOSAS PROJET (2021)

Nachón, D. J, Vieira-Lanero, R. & Cobo, F. and collaborators

▪ METHODOLOGY



Purchase of genus ***Alosa*** **individuals**

Basic biometry

Total length (TL, mm)

Total weight (TW; g)

Dissection and tissue collection

Scales
Gill rakers
Liver (LW, g)
Gonads (GW, g)
Stomach (SW, g)

Data processing and analysis

$HSI = 100 \times (LW/TW)$
$GSI = 100 \times (GW/TW)$
$K = 100 \times (TW/TL^3)$

R Studio®

LOCAL INITIATIVE

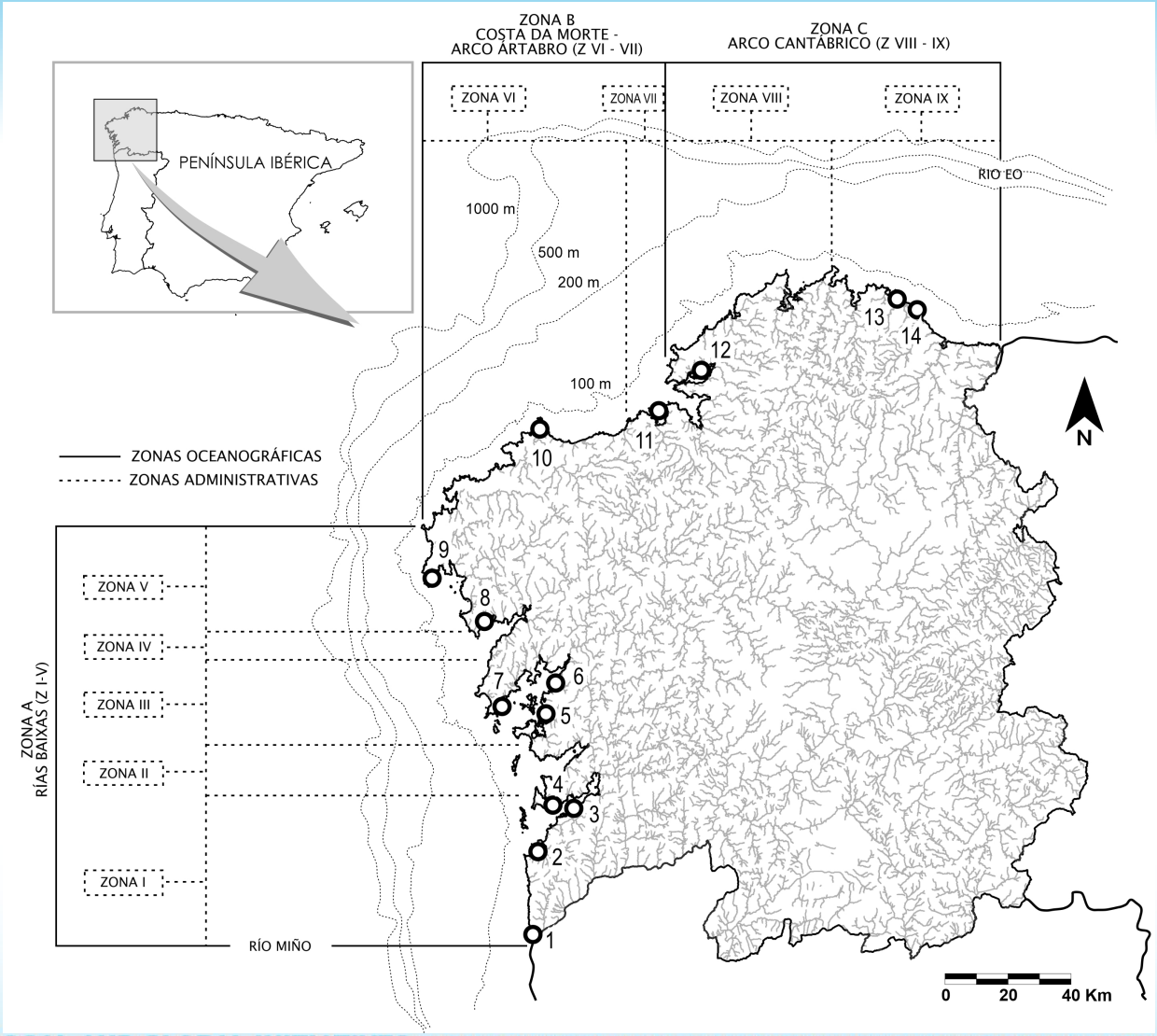
1MARDEALOSAS PROJET (2021)

Nachón, D. J, Vieira-Lanero, R. & Cobo, F. and collaborators

- MAIN RESULTS

pescadegalicia.gal

XUNTA DE GALICIA
CONSELLERÍA DO MAR



Landings in
14 fish markets

Shad catches from
1997 to 2020

LOCAL INITIATIVE

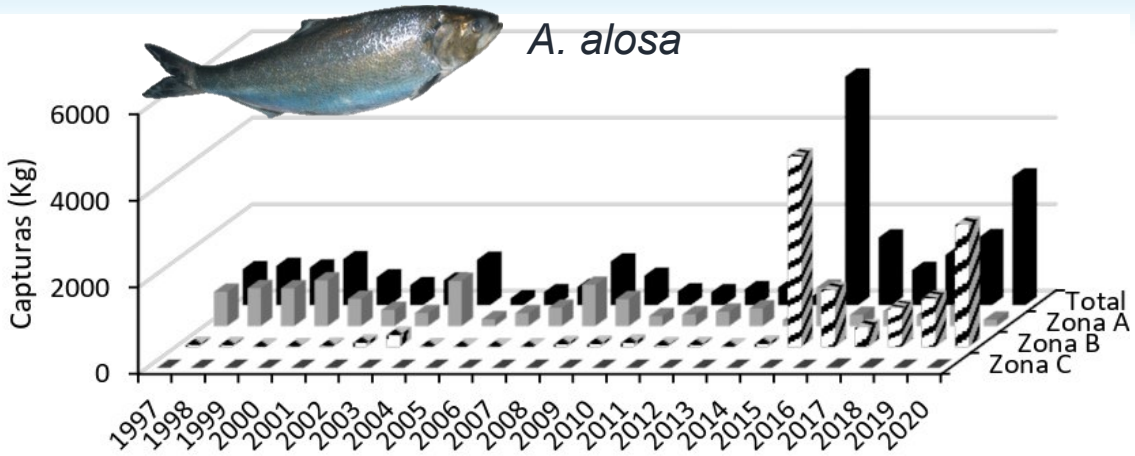
1MARDEALOSAS PROJET (2021)

Nachón, D. J, Vieira-Lanero, R. & Cobo, F. and collaborators

- MAIN RESULTS

pescadegalicia.gal

XUNTA DE GALICIA
CONSELLERÍA DO MAR

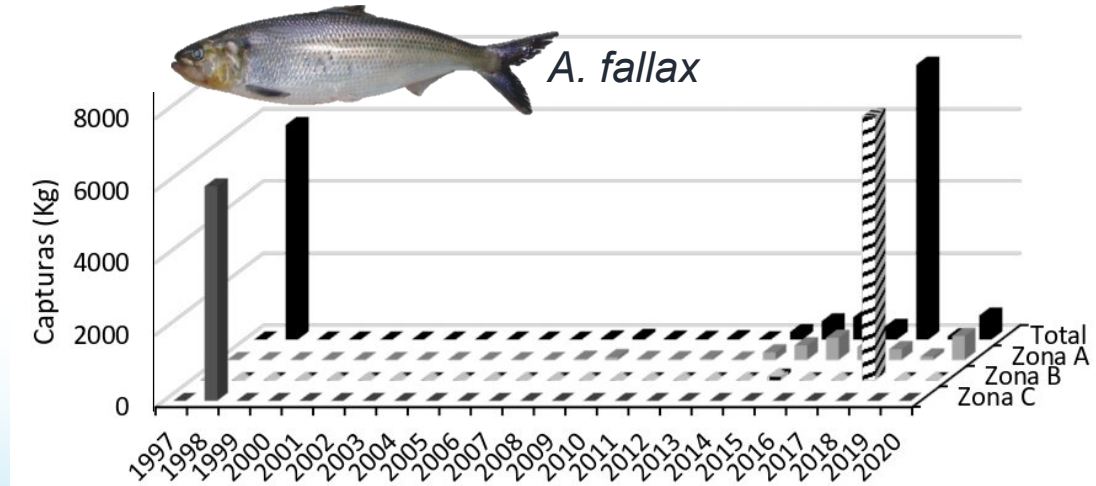


1997-2020: **23956 kilos**

KG

Zone A dominant <2015:
10648 kilos

Zone B dominant >2015:
10977 kilos



1997-2020: **16255 kilos**

KG

There is hardly any continuity in catches.

Exceptional spot captures:

1998: **5950 kilos**
2018: **7320 kilos**

LOCAL INITIATIVE

1MARDEALOSAS PROJET (2021)

Nachón, D. J, Vieira-Lanero, R. & Cobo, F. and collaborators

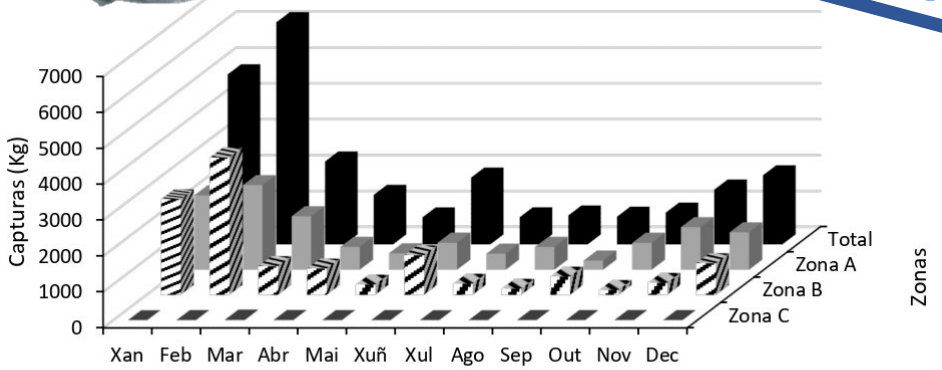
▪ MAIN RESULTS

pescadegalicia.gal

XUNTA DE GALICIA
CONSELLERÍA DO MAR

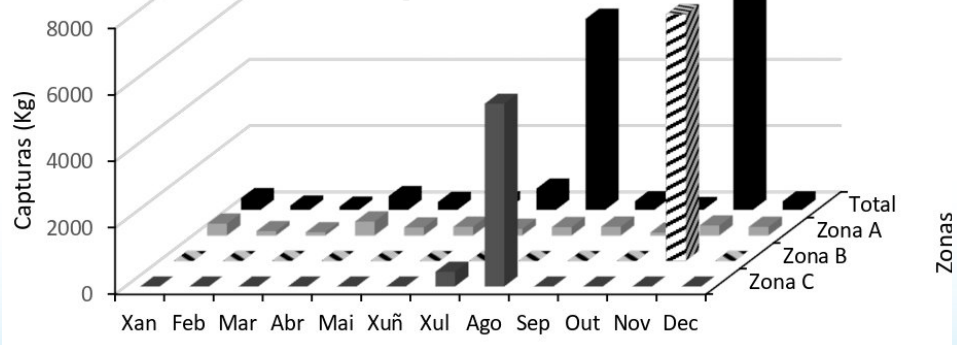
A. alosa

Semelparous



A. fallax

Iteroparus



↗ Biggest catches: **winter and autumn**

↘ Lowest catches: **spring and summer**

Large increase: December and February

Onset of spawning migration at sea

Large catches at particular events → **distort the interpretation**

August and November → **Return of post-spawners**

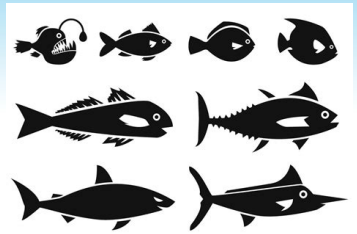
Without these exceptional catches → **Similar trend to *A. alosa***

LOCAL INITIATIVE

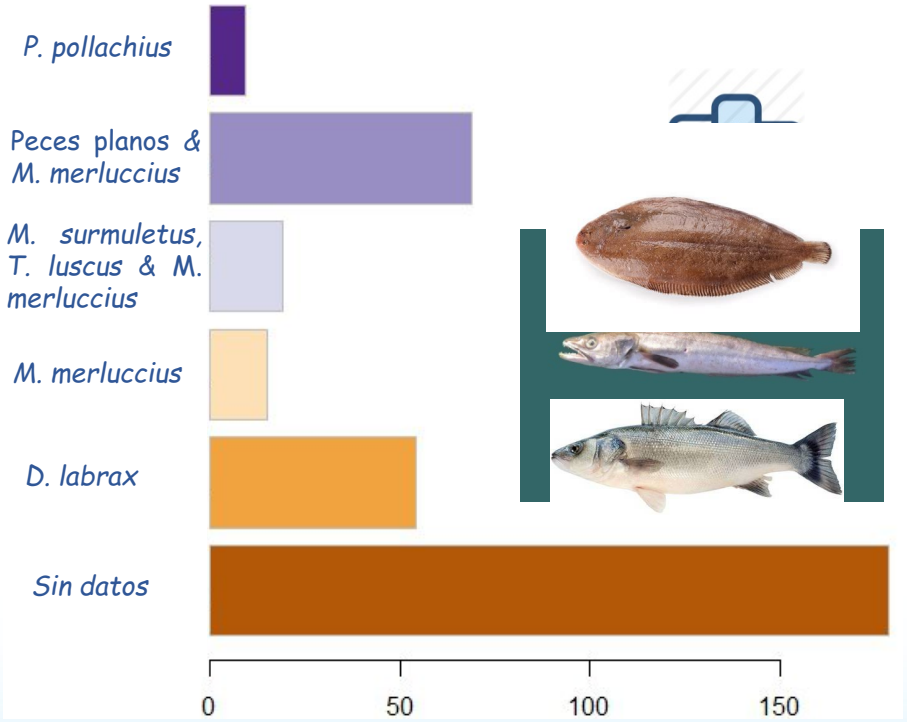
1MARDEALOSAS PROJET (2021)

Nachón, D. J, Vieira-Lanero, R. & Cobo, F. and collaborators

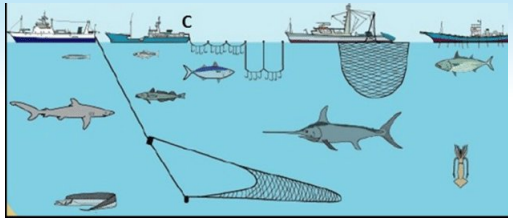
MAIN RESULTS: **TARGET SPECIES & FISHING AREAS**



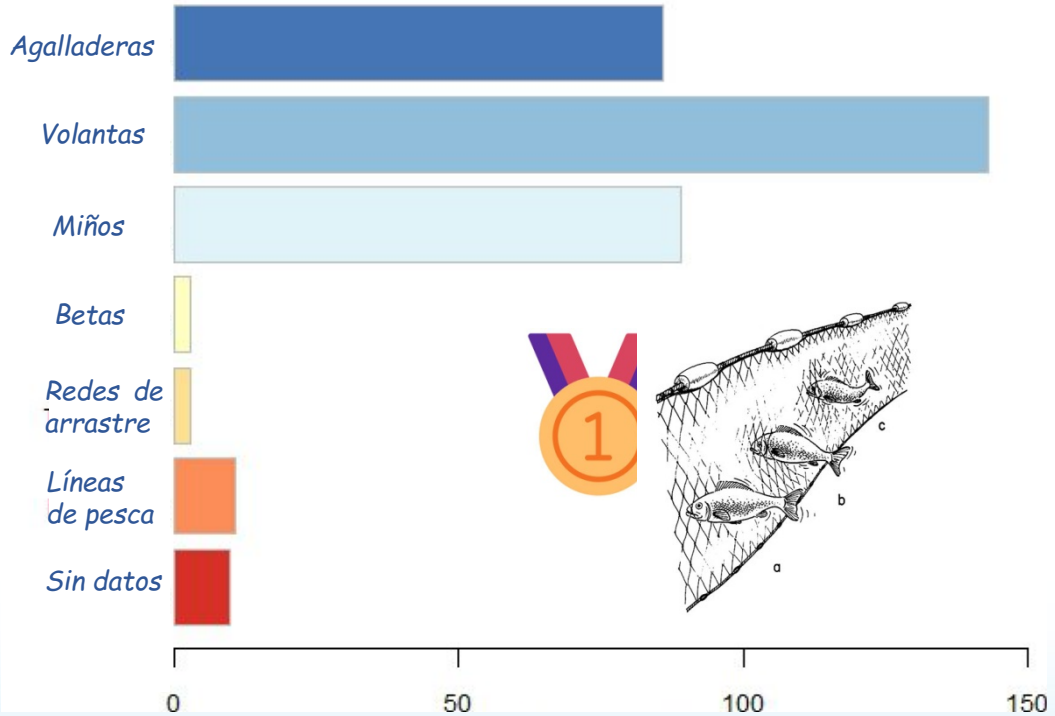
Target species of fishery among which the shads were taken as by-catches



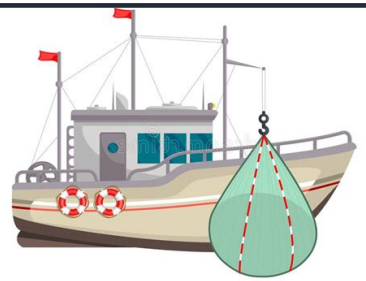
No. of shads caught between each group



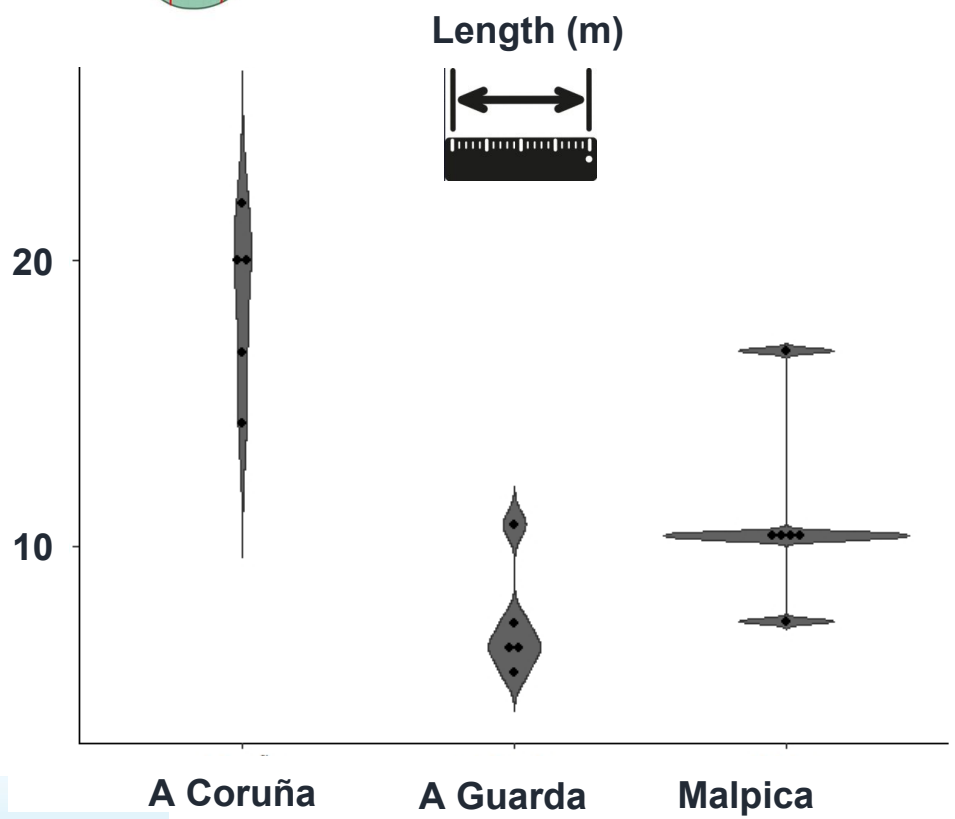
Fishing gears in which the shads were caught as by-catch.

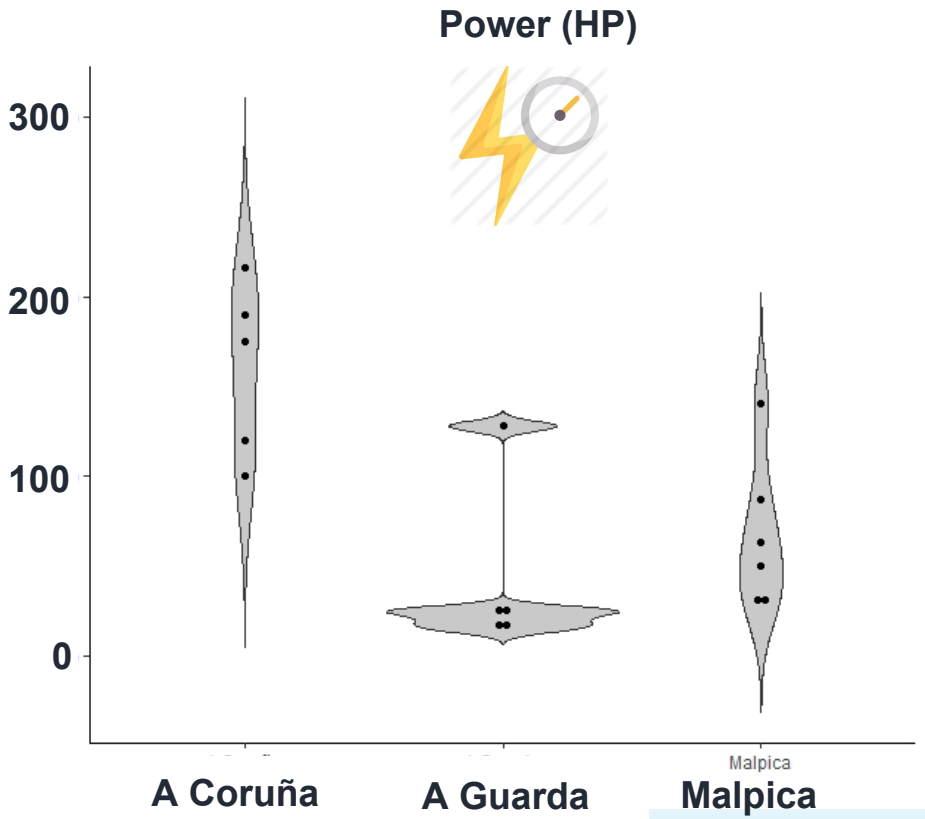


No. of shads caught by each gear



Size and power of the vessels among those that were caught as by-catches

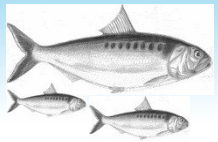




LOCAL INITIATIVE

1MARDEALOSAS PROJET (2021) ▪ MAIN RESULTS: **SPECIFIC IDENTITY I/III**

Nachón, D. J, Vieira-Lanero, R. & Cobo, F. and collaborators



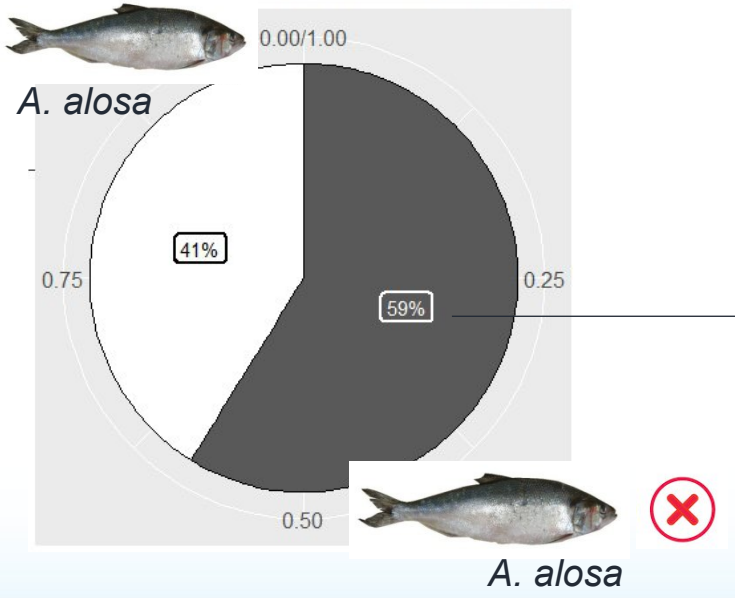
Purchase of genus ***Alosa*** **individuals**

sales notes

All sold individuals

A. alosa

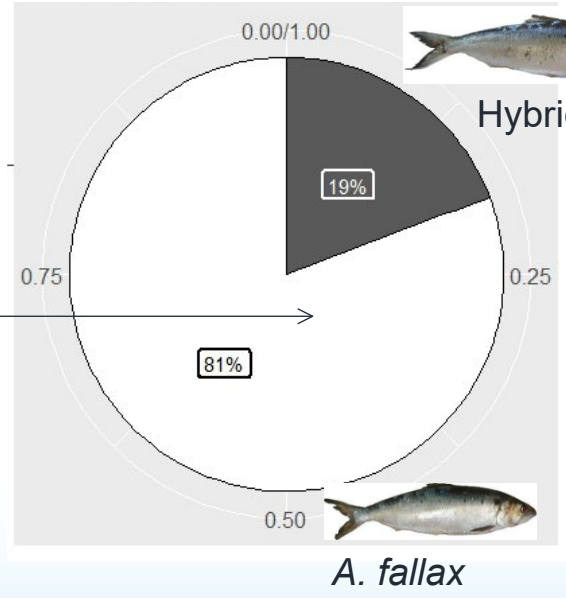
Percentage of correct identifications



A. alosa

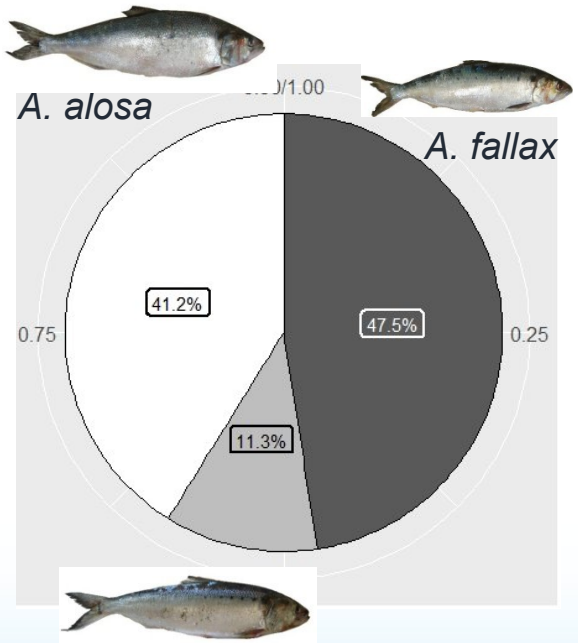
A. alosa

Specific identity of misidentifications



Hybrids

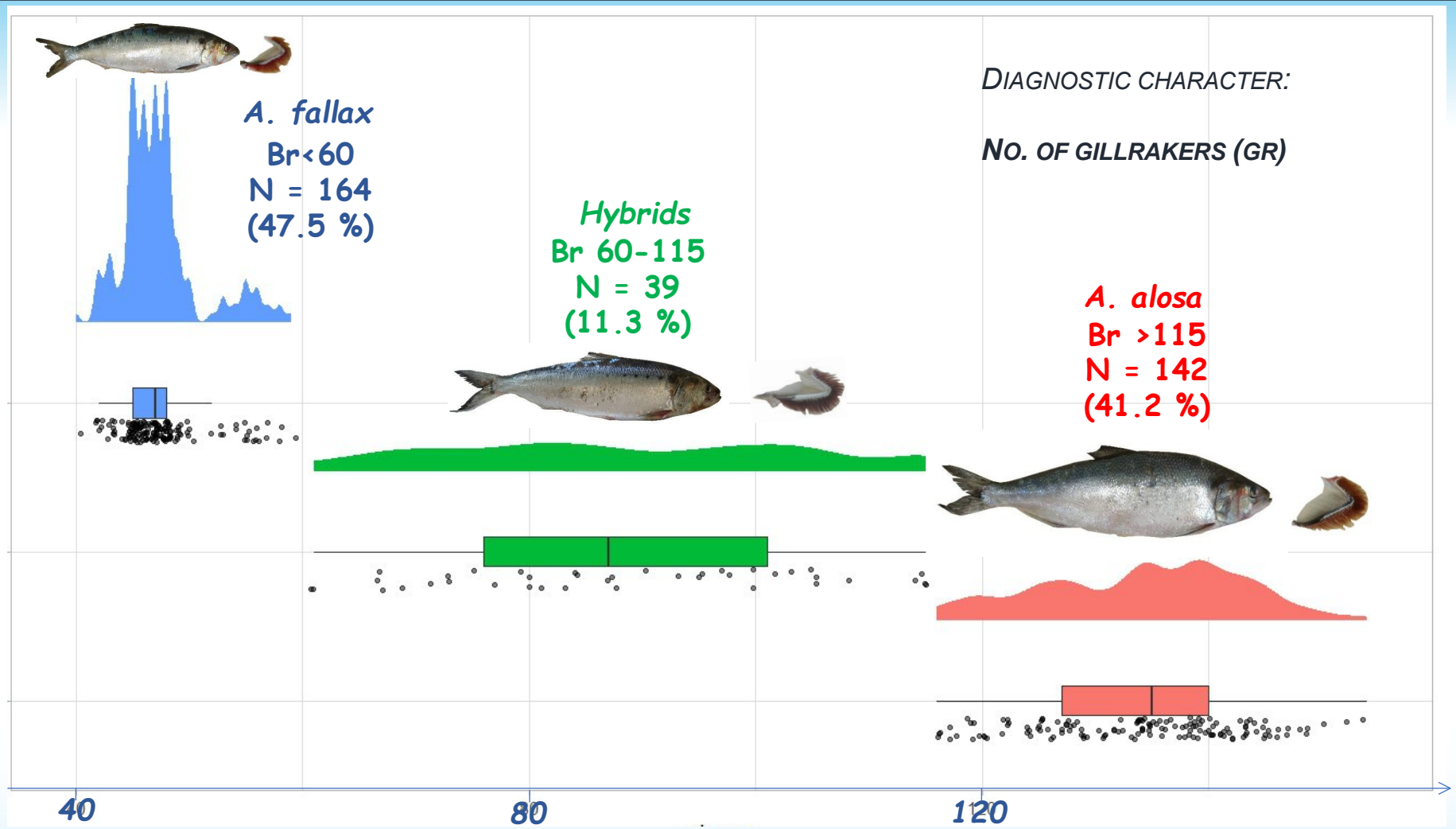
A. fallax

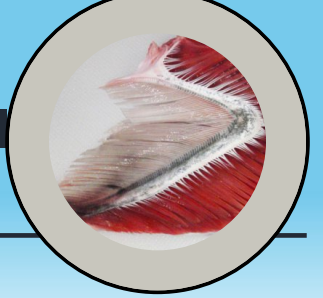


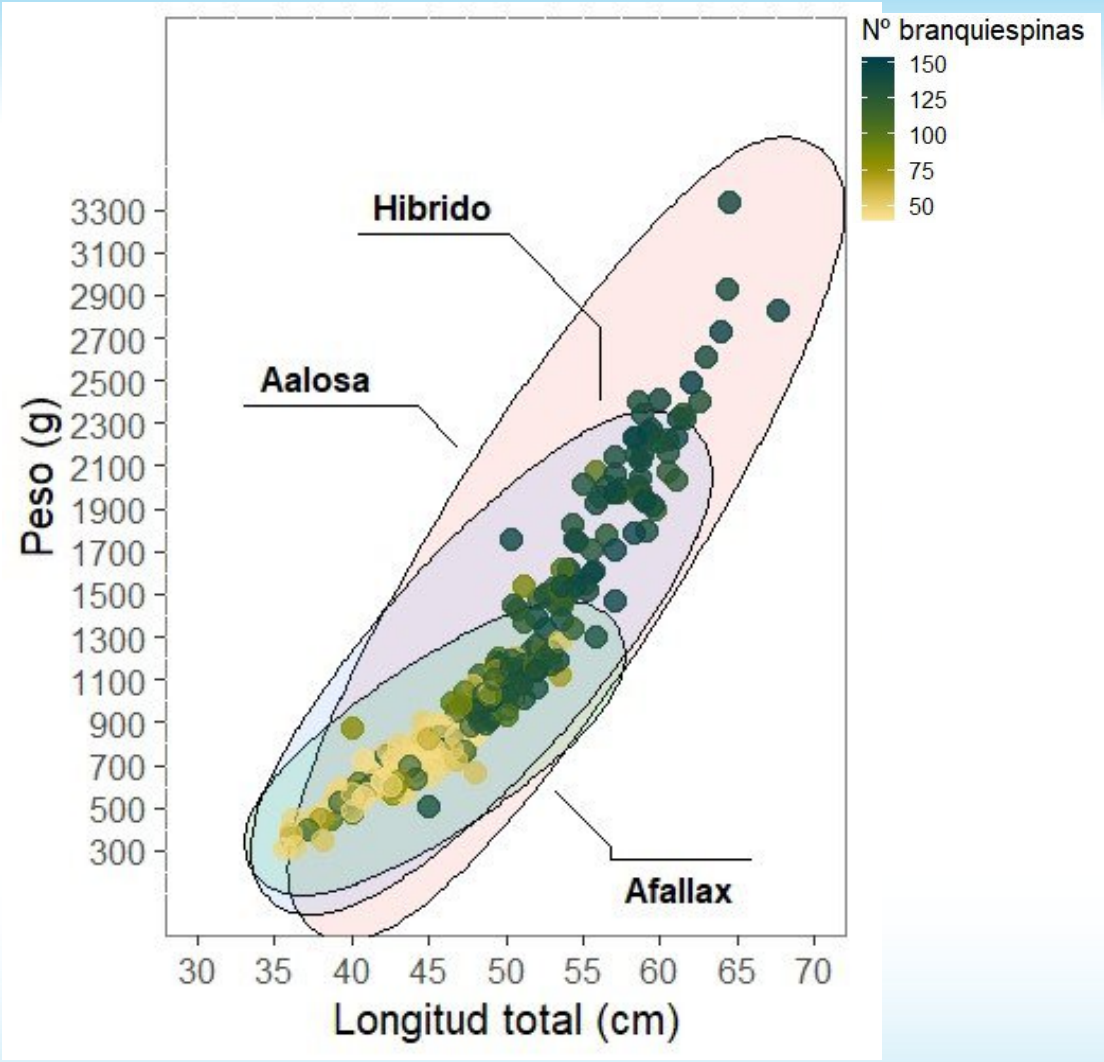
A. alosa

A. fallax

Hybrids


A. fallax
Br<60
N = 164
(47.5 %)
Hybrids
Br 60-115
N = 39
(11.3 %)
A. alosa
Br >115
N = 142
(41.2 %)
DIAGNOSTIC CHARACTER:
NO. OF GILLRAKERS (GR)
40
80
120



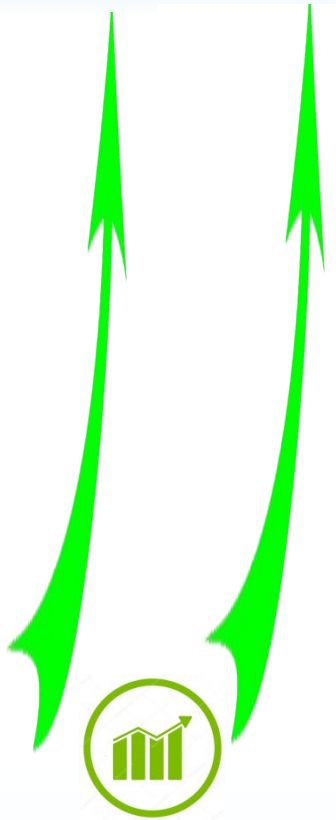


A. alosa

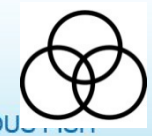
Hybrid

A. fallax

Nº GILLRAKERS



BUT

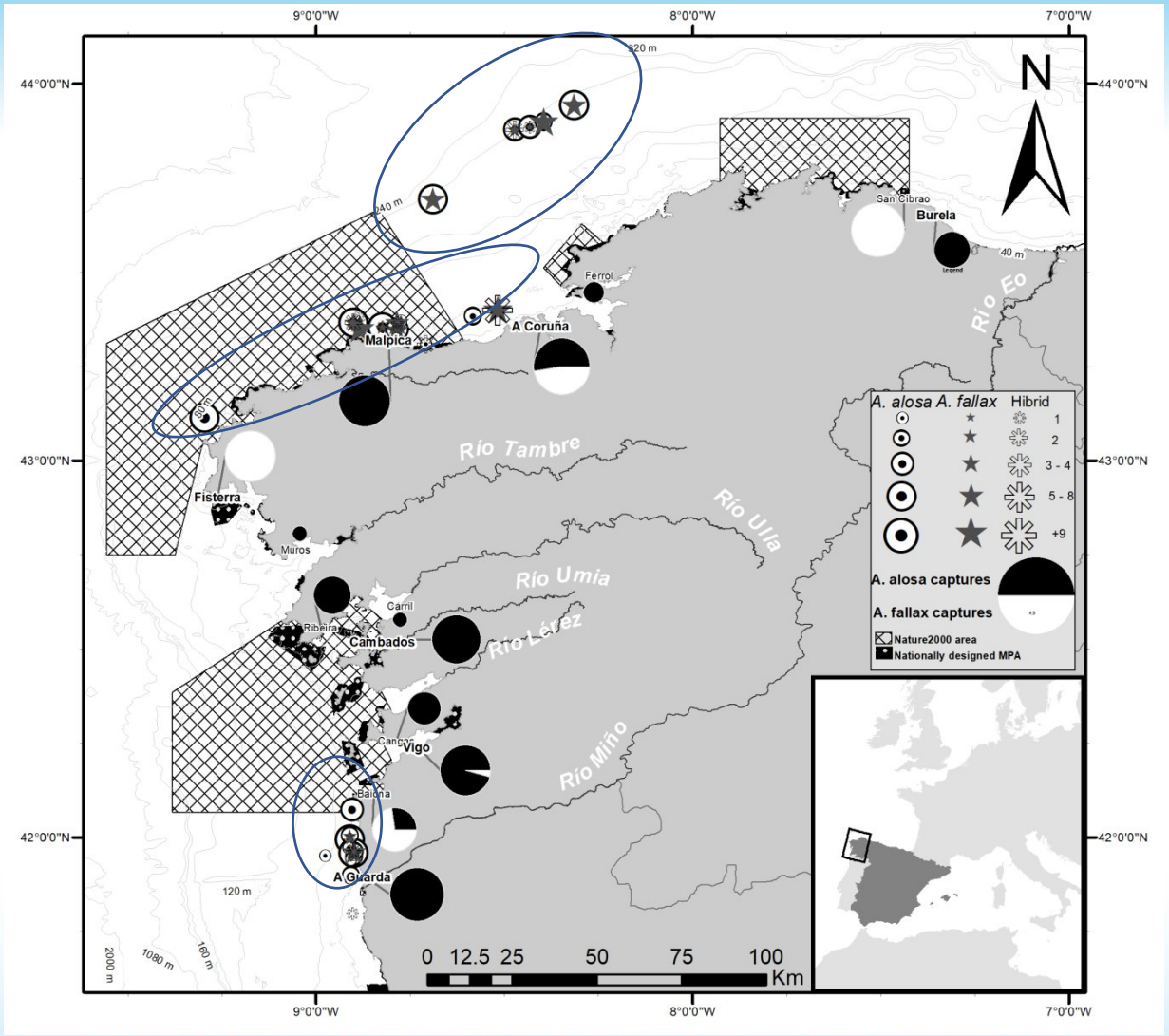


Nº GILLRAKERS

LOCAL INITIATIVE

1MARDEALOSAS PROJET (2021) ▪ MAIN RESULTS: **DISTRIBUTION**

Nachón, D. J, Vieira-Lanero, R. & Cobo, F. and collaborators



A. alosa

Hybrid

A. fallax

Same habitat

Coastal and shallow areas, or more distant and deeper areas

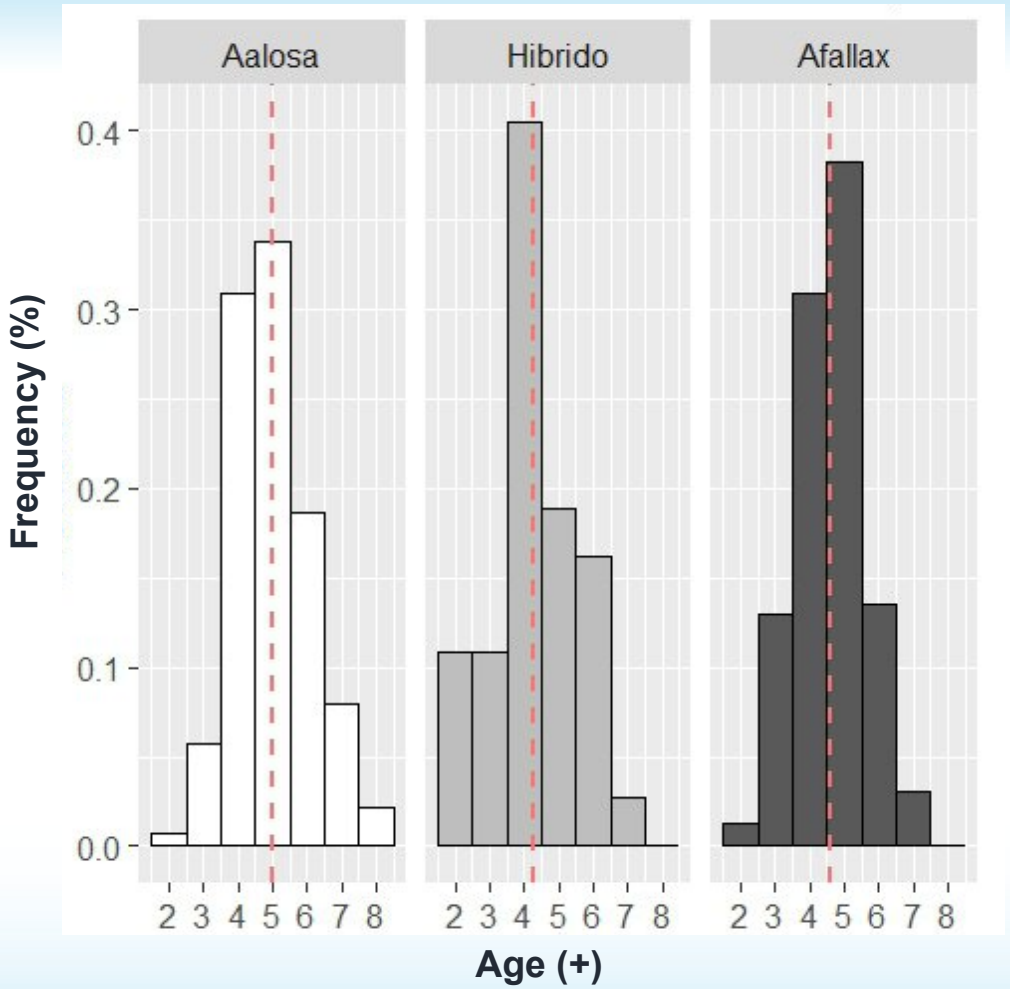
Occupy part of Natura 2000 sites

LOCAL INITIATIVE

1MARDEALOSAS PROJET (2021) ▪ MAIN RESULTS: **AGE CLASS**

Nachón, D. J, Vieira-Lanero, R. & Cobo, F. and collaborators

AGE CLASS DISTRIBUTION BY SPECIES



Mean age

A. alosa 4,96+

Hybrid 4,30+

A. fallax 4,59+

Significant differences

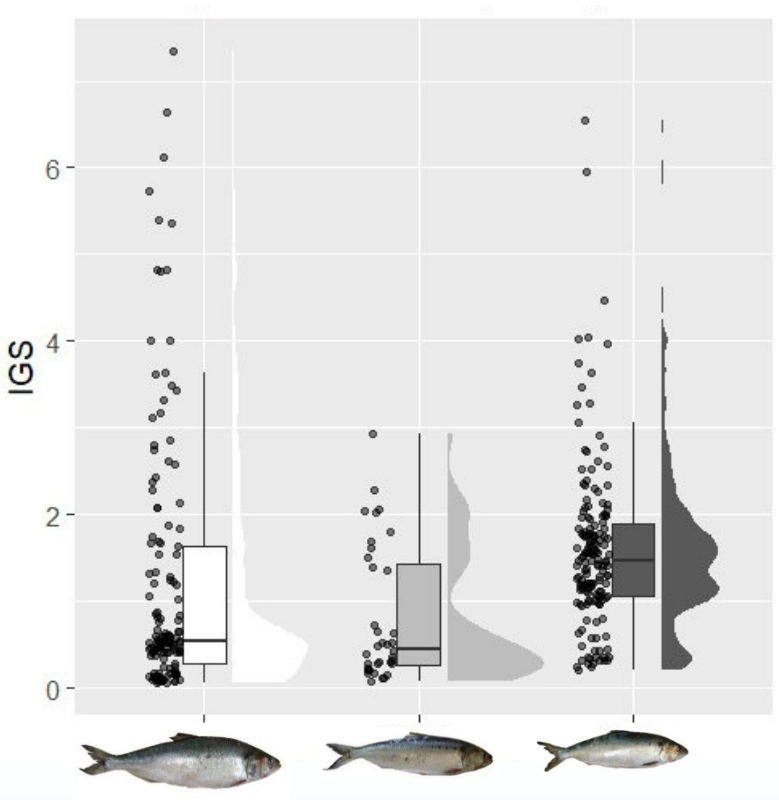
Typical structure of the adult contingent at the age of sexual maturation

LOCAL INITIATIVE

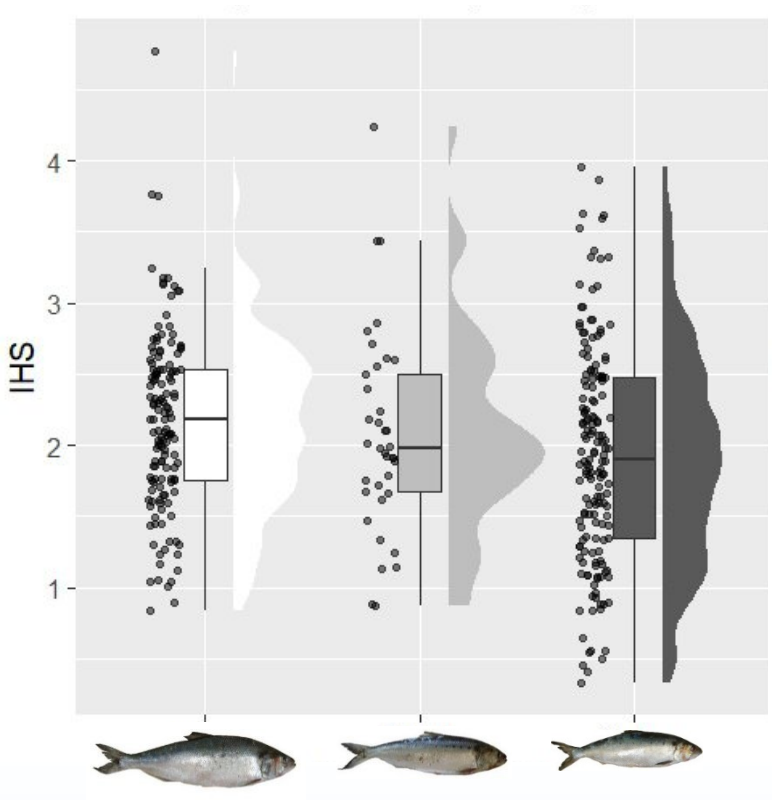
1MARDEALOSAS PROJET (2021) ▪ MAIN RESULTS: **INDEX RESULTS**

Nachón, D. J, Vieira-Lanero, R. & Cobo, F. and collaborators

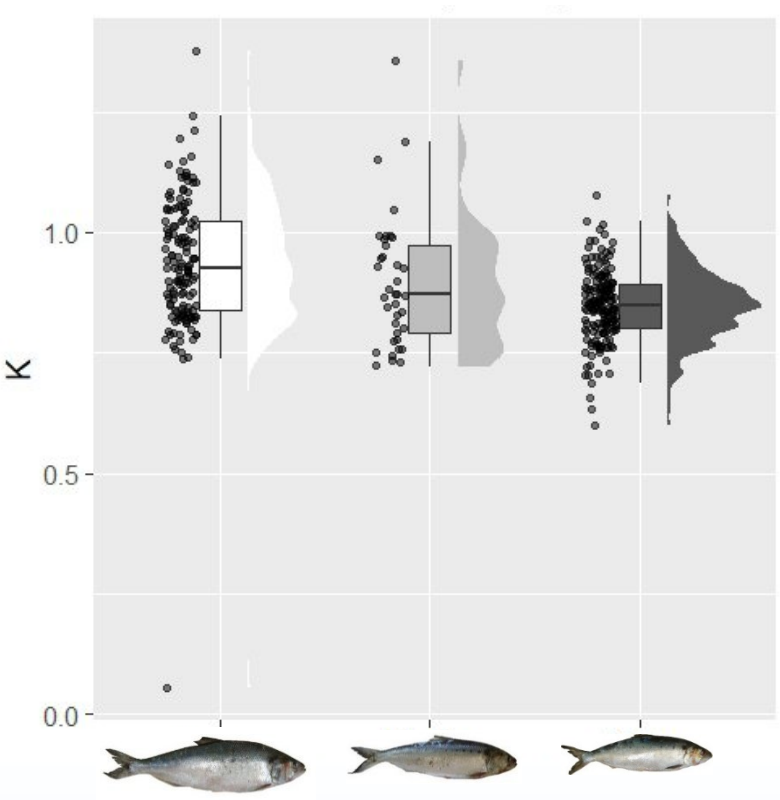
GSI



HSI



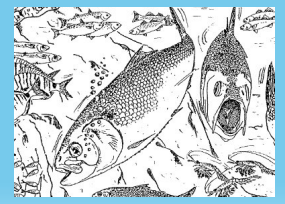
K



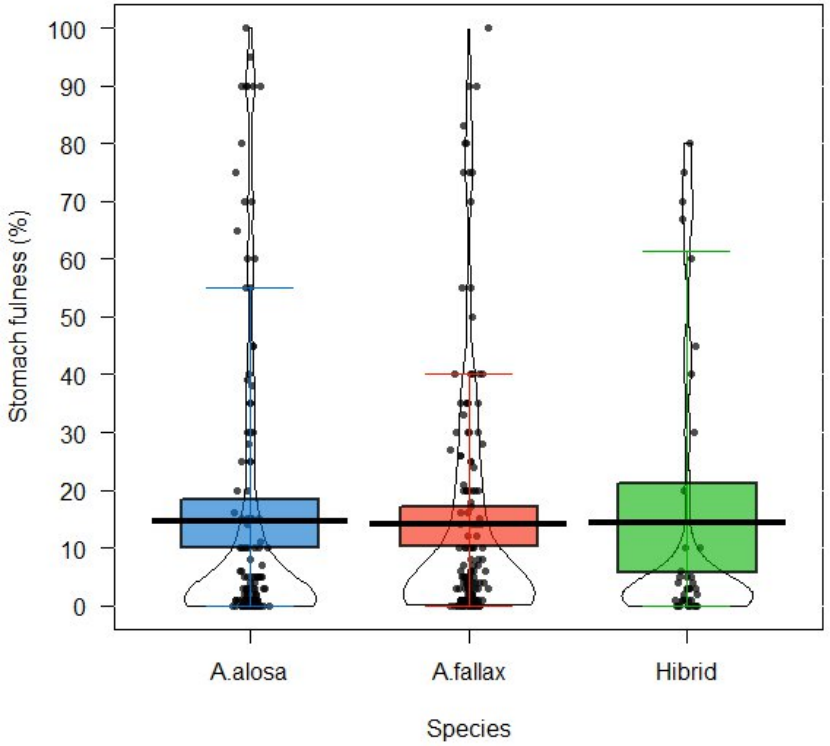
LOCAL INITIATIVE

1MARDEALOSAS PROJET (2021) ▪ MAIN RESULTS: **FEEDING I/II**

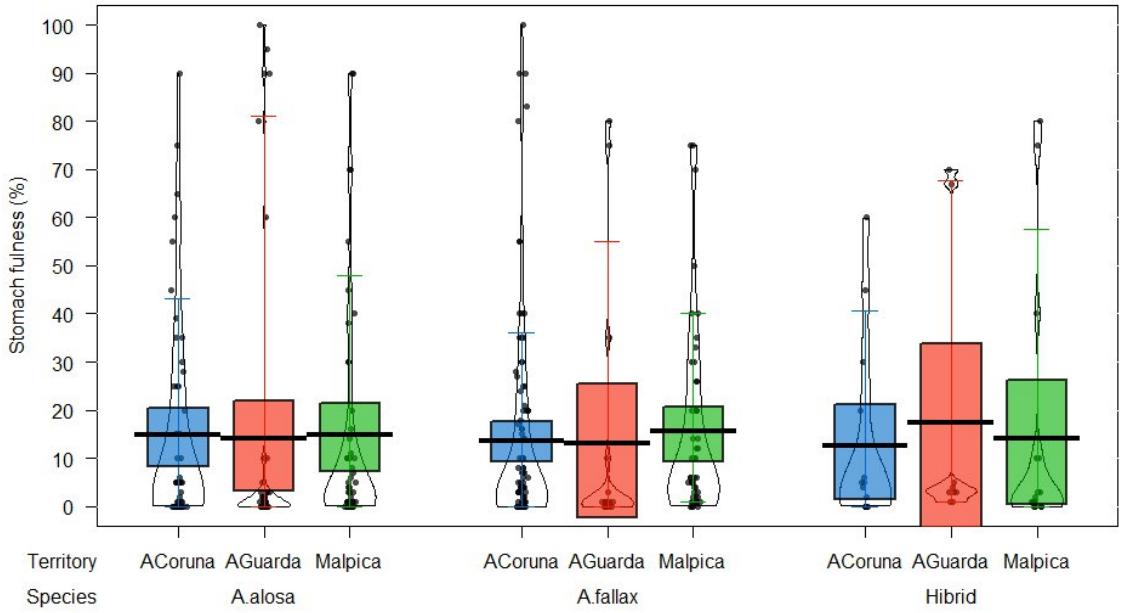
Nachón, D. J, Vieira-Lanero, R. & Cobo, F. and collaborators



Is the feeding intensity different between species?



Is the feeding intensity different among territories within each species?



No significant differences → **Same feeding intensity between**

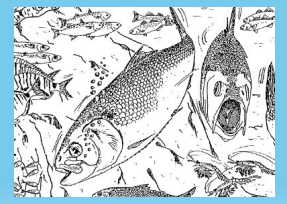
- **Species**
- **Territories**

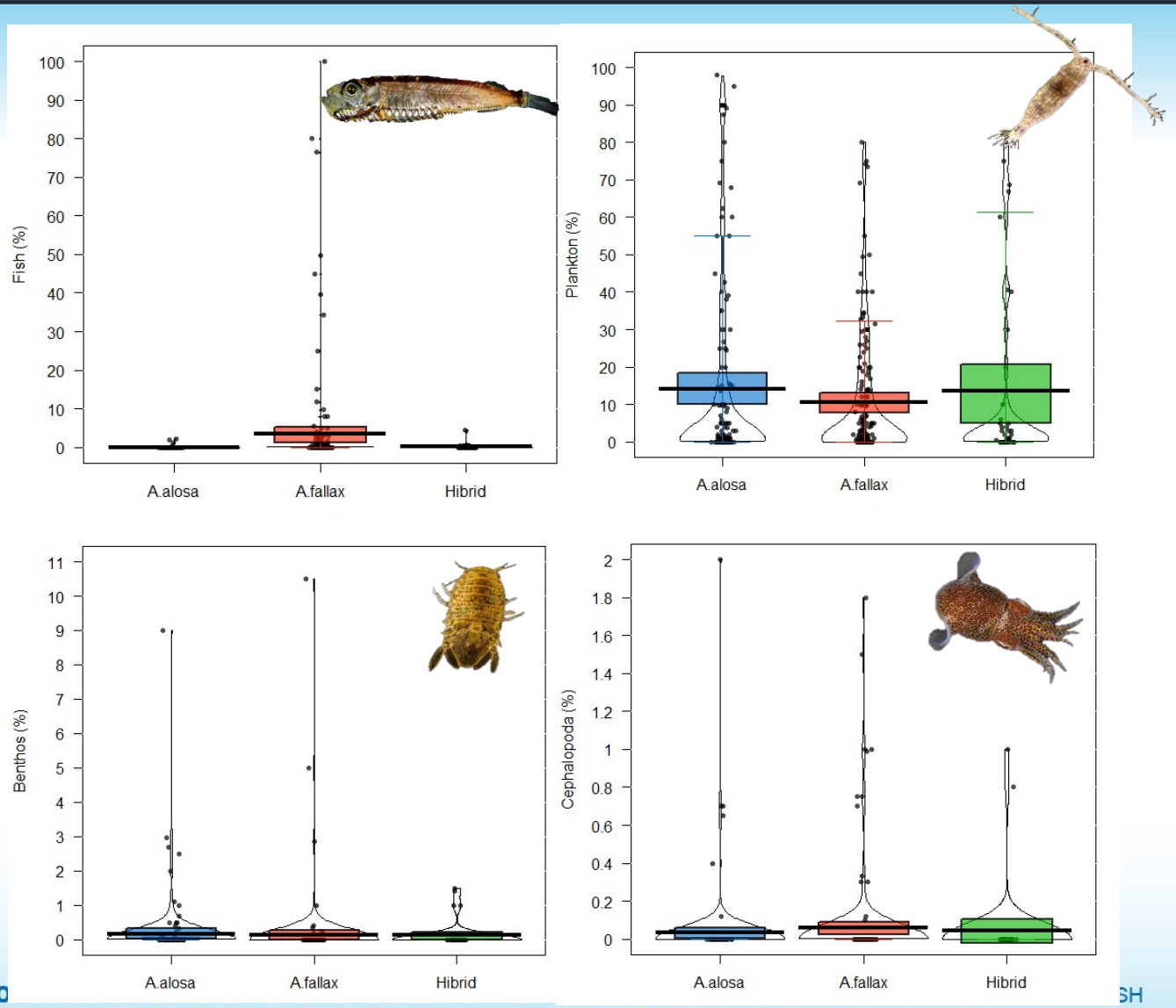
SAME PHASE?

LOCAL INITIATIVE

1MARDEALOSAS PROJET (2021) ▪ MAIN RESULTS: **FEEDING II/II**

Nachón, D. J, Vieira-Lanero, R. & Cobo, F. and collaborators





Foraging behaviour

A. alosa

Híbrido

A. fallax

No significant differences

A. fallax

Significant differences
Most ichthyophagous species

FAUNA SHAD´EAU

Dispersal capabilities and connectivity of shad stocks during the 80´s (2017-2019)

Nachón, D. J, Bareille, G. & Daverat, F. and collaborators

NRC Research Press

ARTICLE

1980s population-specific compositions of two related anadromous shad species during the oceanic phase determined by microchemistry of archived otoliths

David José Nachón, Gilles Bareille, Hilaire Drouineau, Hélène Tabouret, Catherine Taverny, Catherine Boisneau, Sylvain Berail, Christophe Pécheyran, Fanny Claverie, and Françoise Daverat

Abstract: The specific stock composition and dispersion of anadromous fish species aggregations in the marine environment are poorly known, while they can play a major role in the metapopulation dynamics. Otolith microchemistry has proven to be a powerful tool to address natal origins of anadromous fish. We used archived otolith microchemistry to investigate the population-specific composition of subadult European shads (*Alosa alosa* and *Alosa fallax*) in the ocean during the 1980s. The allocation of natal origin was addressed relying on contemporary water and juveniles' signatures within a Bayesian model. A great discrimination of natal origin was obtained at the Biscay Gulf scale. However, the discrimination of 1980s natal origin for the southern rivers with similar geology based on 2013 water and juveniles' baselines was doubtful. Our results showed that the most abundant southern populations were dominant, suggesting that population-specific composition was related to population relative abundance. The dispersion in the marine environment was plastic; alternatively, shads were found large distances away from their natal rivers, while others remained in the vicinity of their natal river plume.

Résumé : La composition spécifique de stocks et la dispersion de regroupements d'espèces de poissons anadromes dans le milieu marin demeurent méconnues, bien qu'elles puissent jouer un important rôle dans la dynamique de métapopulation. La microchimie des otolithes s'avère être un outil puissant pour examiner les origines natales de poissons anadromes. Nous utilisons la microchimie d'otolithes archivés pour examiner la composition propre à la population d'aloses européennes (*Alosa alosa* and *Alosa fallax*) sous-adultes dans l'océan dans les années 1980. L'affection de l'origine natale repose sur des signatures d'eau et de juvéniles contemporaines dans un modèle bayésien. Une excellente discrimination de l'origine natale est obtenue à l'échelle du golfe de Gascogne. Cependant, la discrimination de l'origine natale dans les années 1980 pour les rivières méridionales de géologie semblable basée sur des données de référence de 2013 pour l'eau et les juvéniles est incertaine. Nos résultats montrent que les populations méridionales les plus abondantes étaient dominantes, donnant à penser que la composition propre à la population était reliée à l'abondance relative des populations. La dispersion dans le milieu marin est plastique; des aloses se trouvaient à grande distance de leurs rivières natales, alors que d'autres demeuraient à proximité du panache de leur rivière natale. [Traduit par la Rédaction]

Introduction

Anadromous fish species, such as salmons and shads, share a complex life cycle where reproduction and early life are undertaken in freshwater habitats, whereas growth and maturation are achieved in oceanic habitats. Many anadromous fishes tend to return to spawn to their natal river — a behaviour named homing — with varying degrees of fidelity, albeit few individuals stray to spawn in a different river than their natal one (Walther et al. 2008; Martin et al. 2013, 2015). While a large amount of information is available concerning the use of freshwater habitats, few reports are available on how anadromous fishes use the oceanic environment. When oceanic distribution is defined, often with a poor spatial resolution, little is known about the stock-specific ocean migration or the mixing of the fish originating from different rivers (Walther and Thorrold 2010; Loewen et al. 2015; Johnson et al. 2016).

Over the last decades, it has been generally accepted that the return of anadromous fishes to their natal river is influenced by the combination of geomagnetic and olfactory cues (Lohmann et al. 2008; Bandoh et al. 2011; Putman et al. 2013). Recently, it has been suggested that social interactions and collective behaviour could also play an important role in the return of salmons to the river of origin (Berdahl et al. 2016). That is, there is evidence that collective navigation and group effect could facilitate decision-making to find correct migration pathways from the ocean to the native rivers. This group effect could reduce dispersal, which would most likely occur if one individual moved away from the group. In fact, a recent study has shown that although small-scale Chinook salmon (*Oncorhynchus tshawytscha*) aggregations in the sea are not entirely uniform, they tend to be composed of individuals

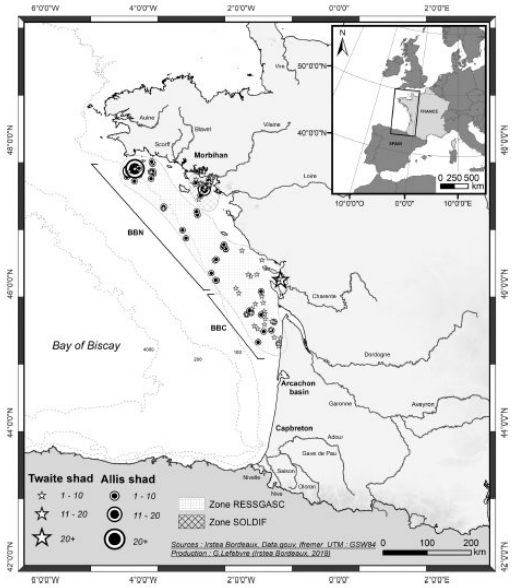
Received 15 November 2018. Accepted 4 June 2019.

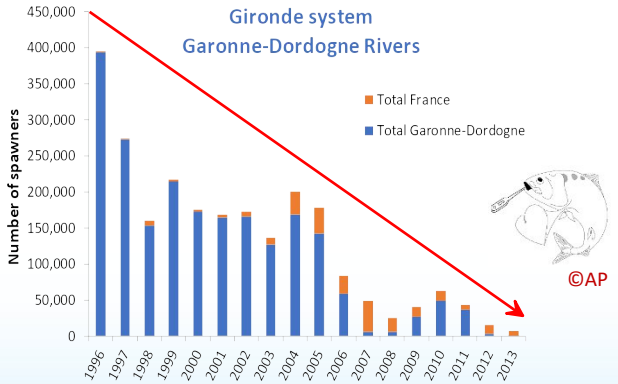
D.J. Nachón,* H. Drouineau, and F. Daverat. IRSTEA EABX, Aquatic Ecosystems and Global Changes Research Unit, 50 avenue de Verdun, Cestas 33612, France.
G. Bareille, H. Tabouret, S. Berail, C. Pécheyran, and F. Claverie. Institut des Sciences Analytiques et de Physicochimie pour l'Environnement et les Matériaux, Centre national de la recherche scientifique, University of Pau and Pays de l'Adour (UPPA), UMR 5254, 64000 Pau, France.
C. Taverny. Fédération Départementale des Associations Agréées de Pêche et de Protection du Milieu Aquatique (FDAAPPMA 33), 10 ZA du Lapin, 33750 Beychac-et-Caillau, France.
C. Boisneau. UMR CNRS CITERES 7324, Université de Tours, 33 Allée F de Lesseps, 37200 Tours, France.

Archived Otoliths

A. alosa and *A. fallax* captured at sea 1986-89 (IRSTEA, now INRAE, otolith collection)

Population connectivity in the Bay of Biscay before the general collapse of shad populations in the 2000s





©AP

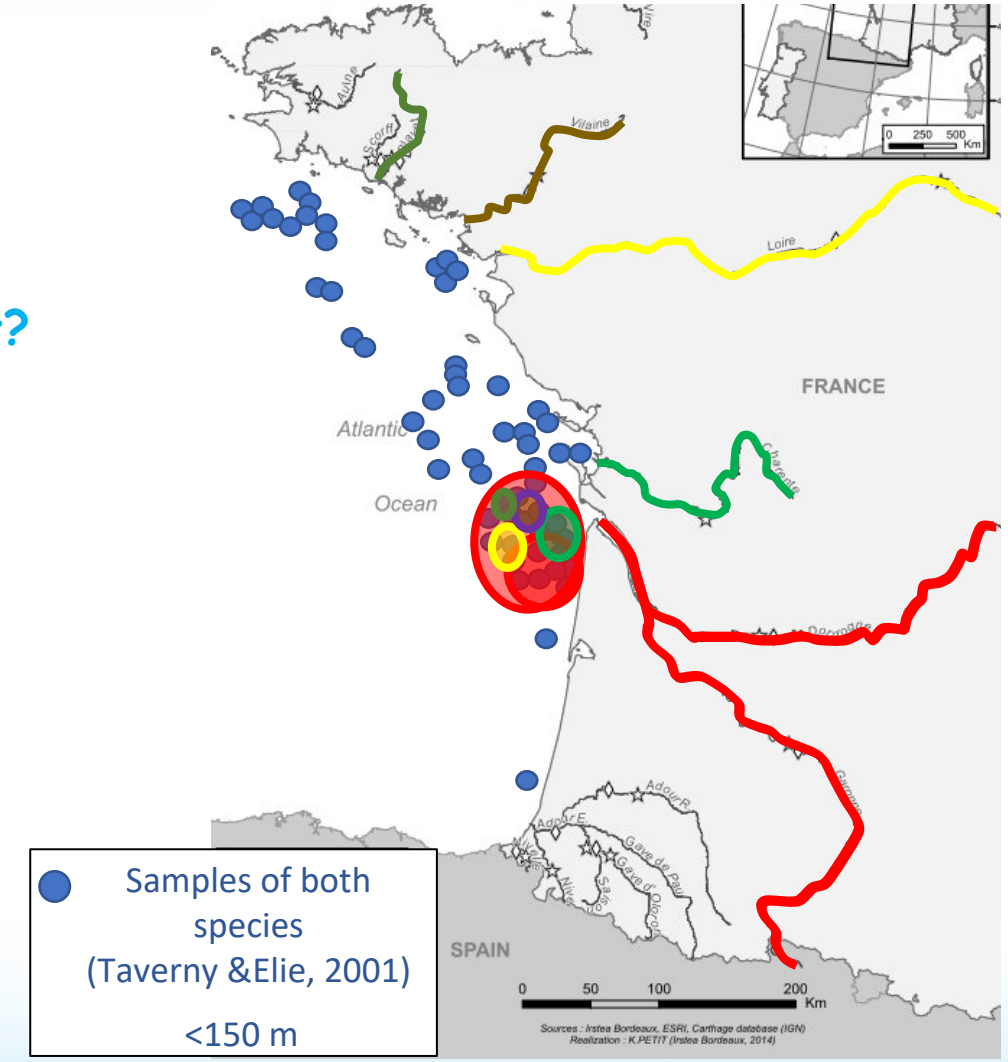
FAUNA SHAD´EAU

Dispersal capabilities and connectivity of shad stocks during the 80´s (2017-2109)

Nachón, D. J, Bareille, G. & Daverat, F. and collaborators

- **HYPOTHESIS**

***mixture of populations or not?**



Samples of both species (Taverny &Elie, 2001)

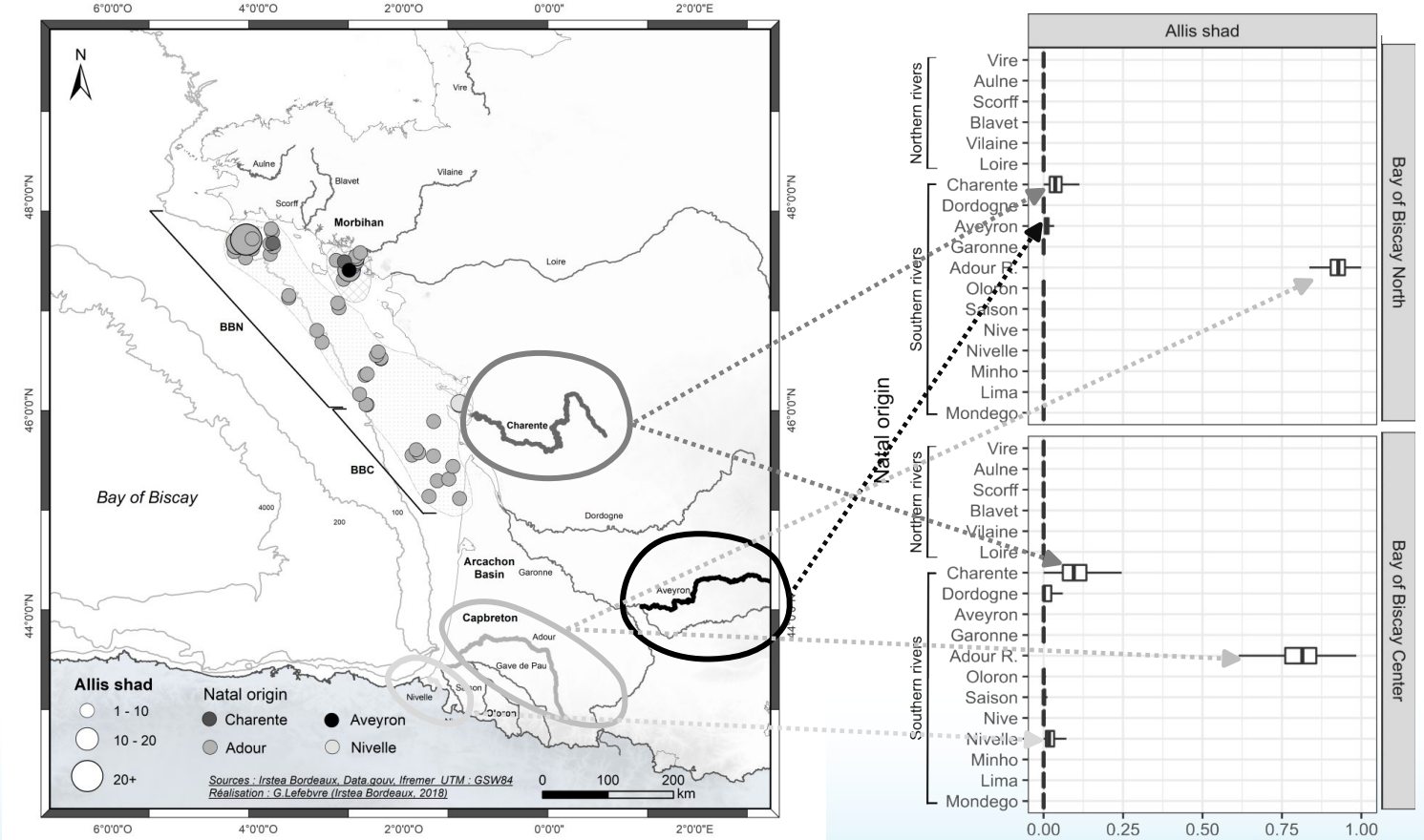
<150 m

FAUNA SHAD´EAU

Dispersal capabilities and connectivity of shad stocks during the 80´s (2017-2019)

Nachón, D. J, Bareille, G. & Daverat, F. and collaborators

- Allocation results: Allis shad, *Alosa alosa*



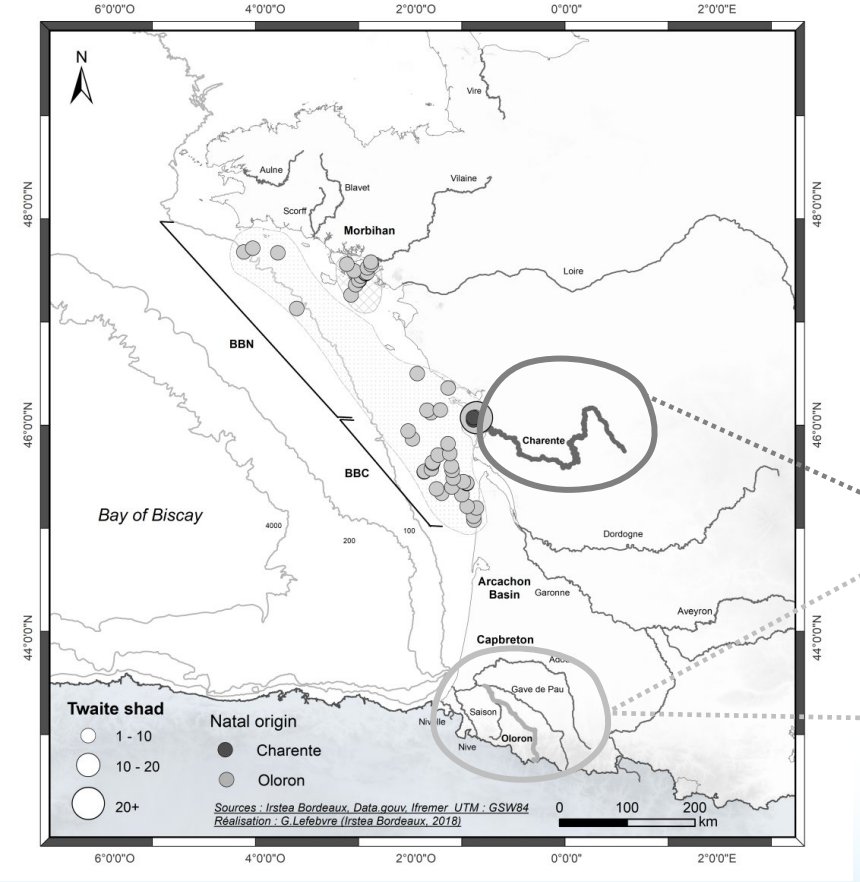
Only 4 source rivers

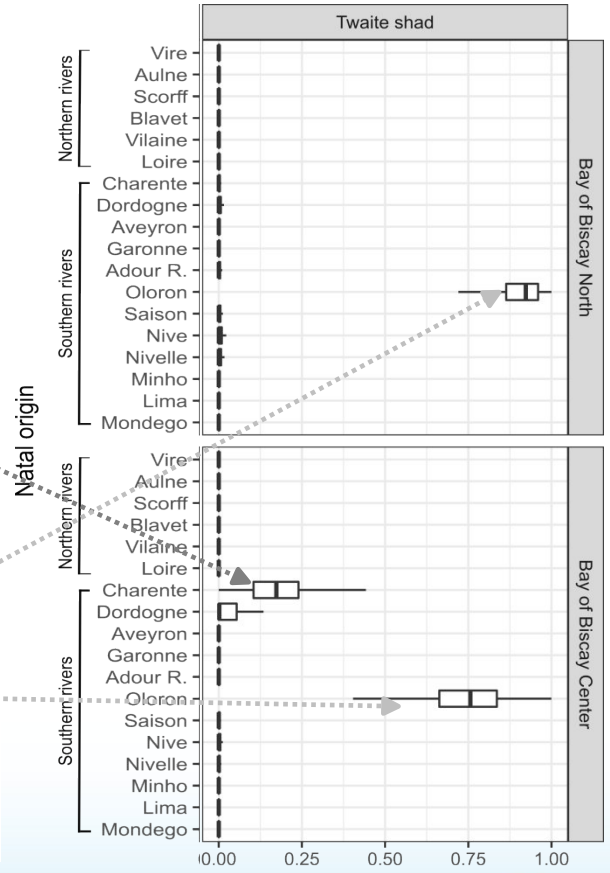
FAUNA SHAD´EAU

Dispersal capabilities and connectivity of shad stocks during the 80´s (2017-2019)

Nachón, D. J, Bareille, G. & Daverat, F. and collaborators

- Allocation results: Twaite shad, *Alosa fallax*

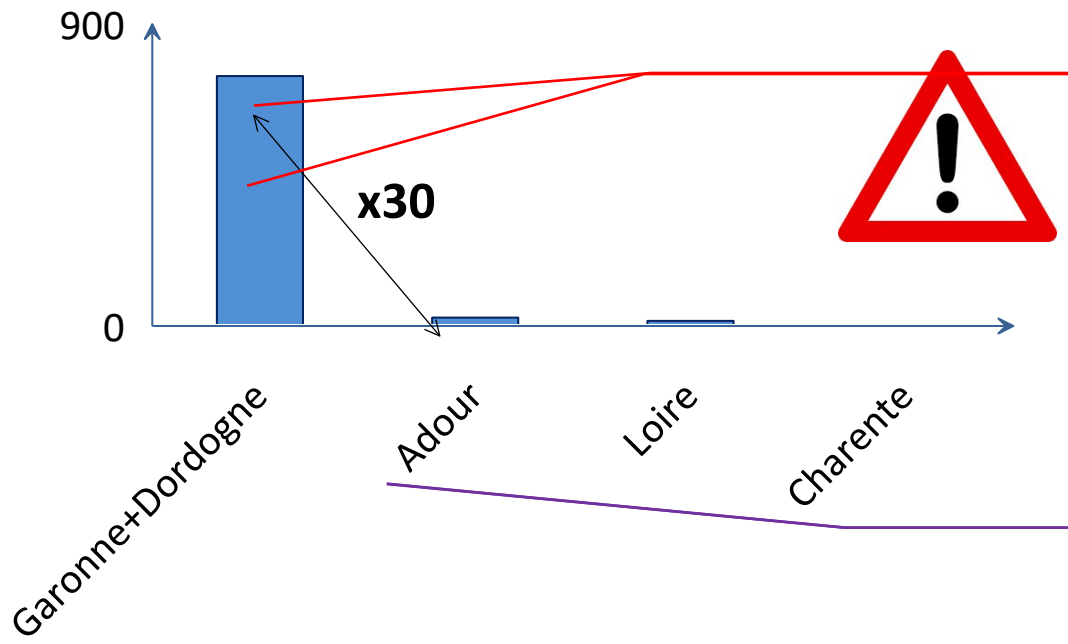


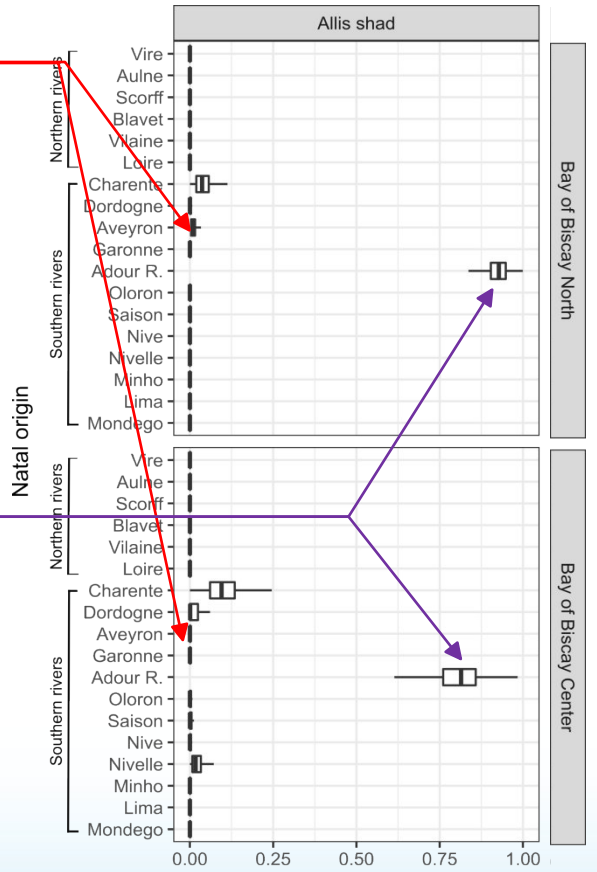


Only 2 source rivers

Allocation results — Abundance index in the 80´s

Abundances index in tonnes (1986-89)





% Natal origin of *A. alosa* caught at sea (1986-89)

This could be due to:

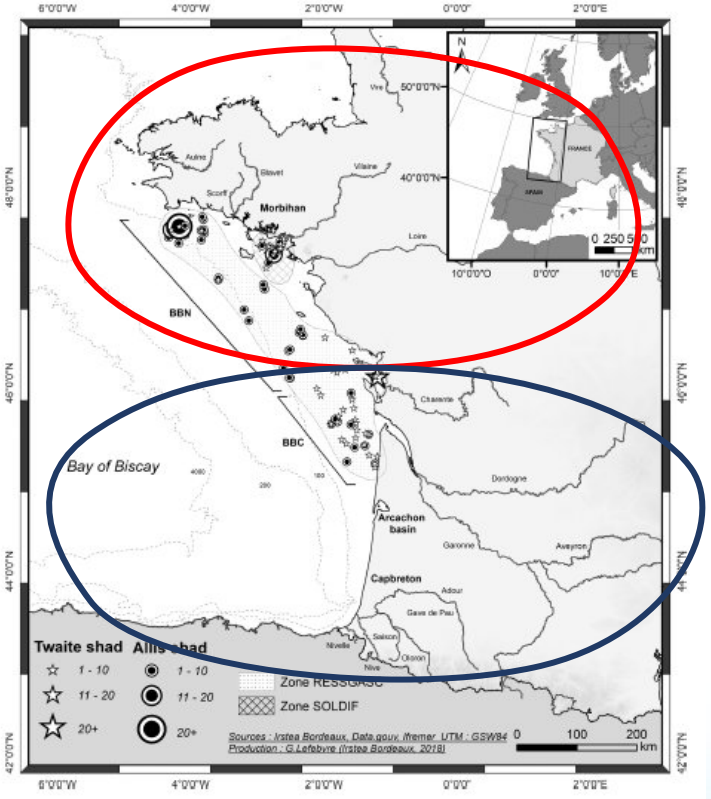
- ❑ Chemical signature between Garonne and Adour is very close.
- ❑ Lack of the spawning grounds signatures in the 80s.
- ❑ Changes in Sr and Ba's concentration in the last 30 years

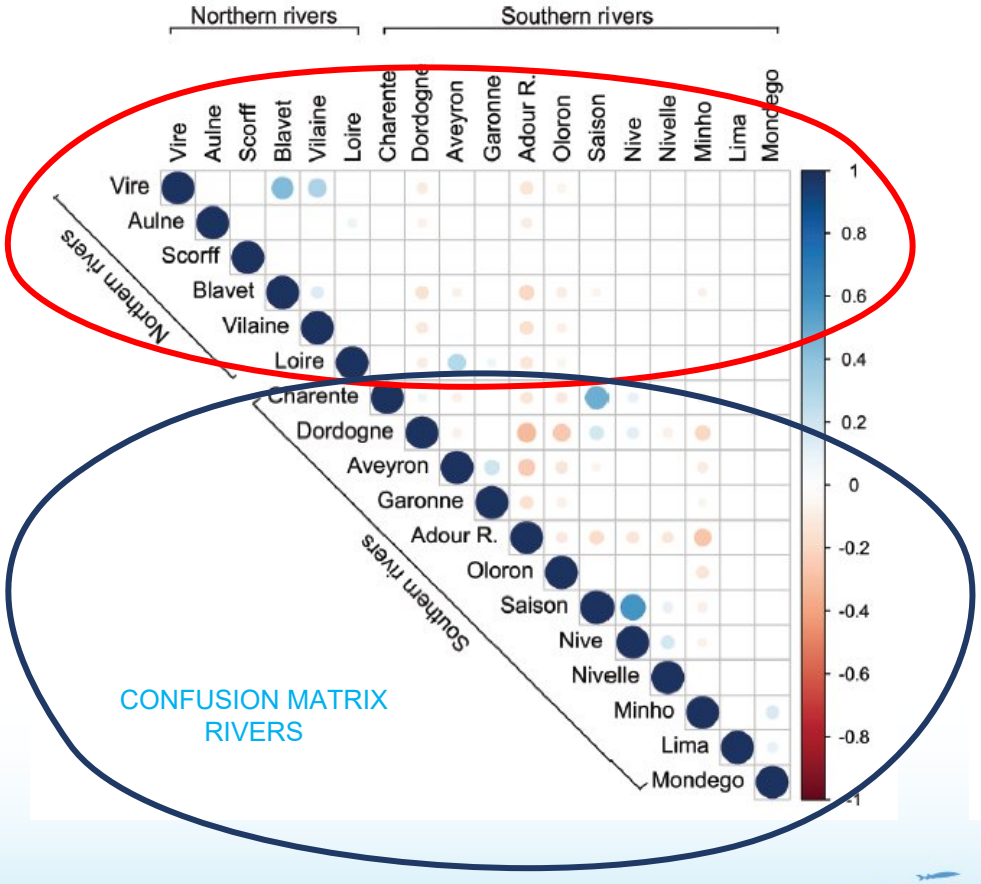
FAUNA SHAD´EAU

Dispersal capabilities and connectivity of shad stocks during the 80´s (2017-2019)

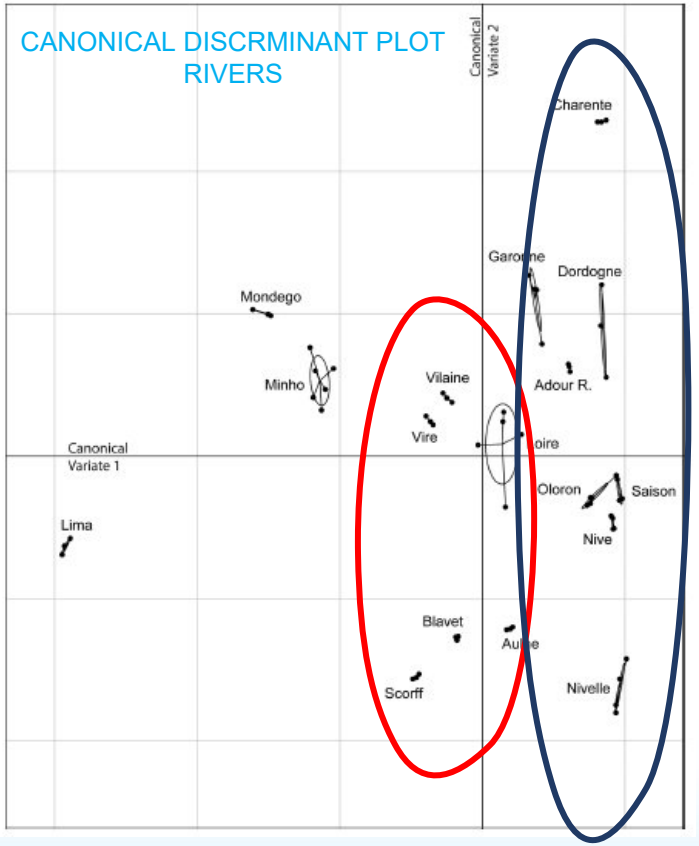
Nachón, D. J, Bareille, G. & Daverat, F. and collaborators

- Contrasted geology and chemistry: northern granitic rivers & southern sedimentary rivers





CONFUSION MATRIX RIVERS



FAUNA SHAD´EAU

Dispersal capabilities and connectivity of shad stocks during the 80´s (2017-2019)

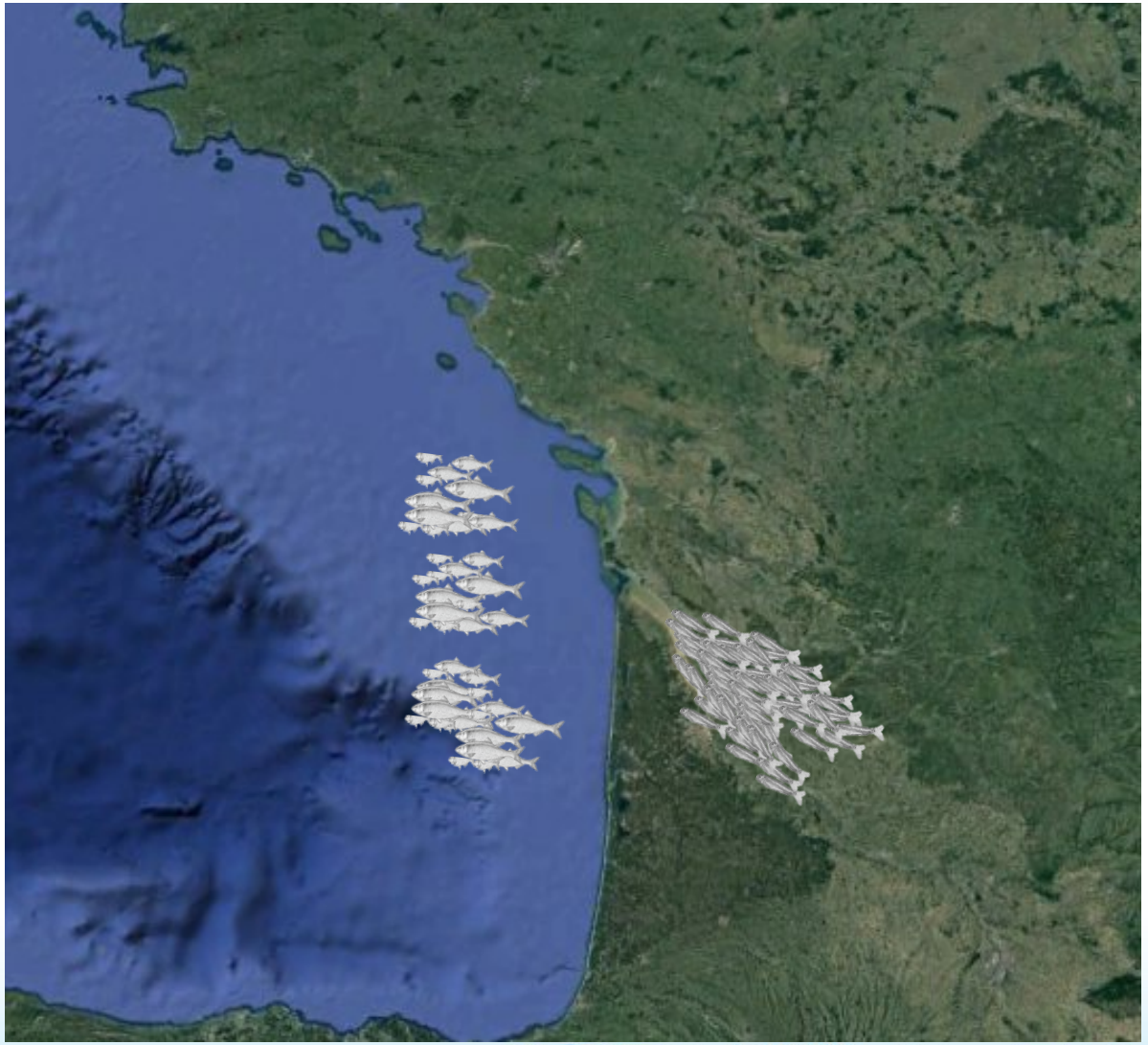
Nachón, D. J, Bareille, G. & Daverat, F. and collaborators

- Great diffusion in the marine environment

two populationspecific dispersal behaviours

dispersive gregarious

resident gregarious



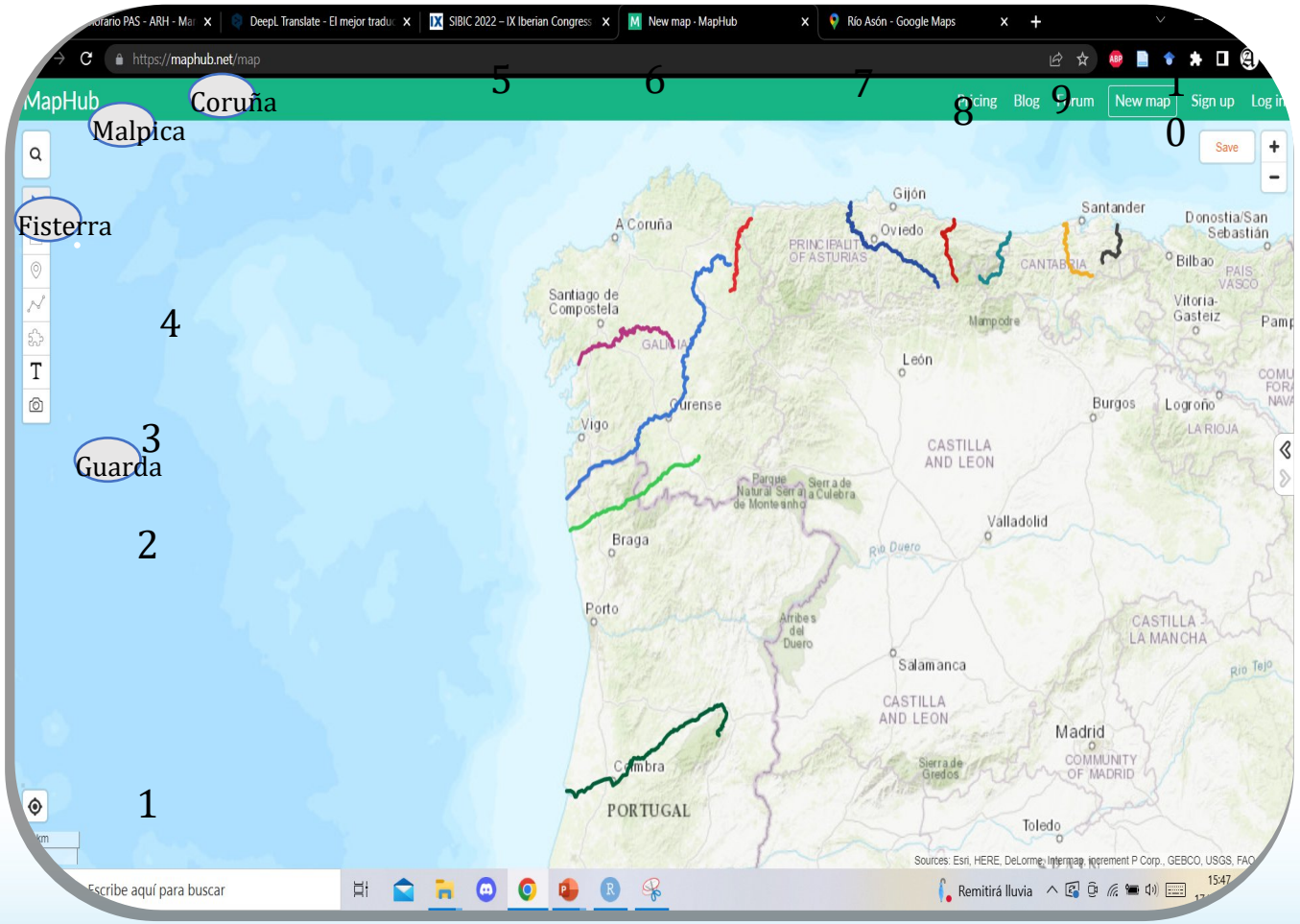
LOCAL INITIATIVES + GLOBAL INITIATIVES

1MARDEALOSAS + DIADES PROJET (ongoing)

Nachón, D. J, Vieira-Lanero, R., Cobo, F., Bareille, G. & Daverat, F. and collaborators

- STUDY AREA:

SEA STOCK CONNECTIVITY?



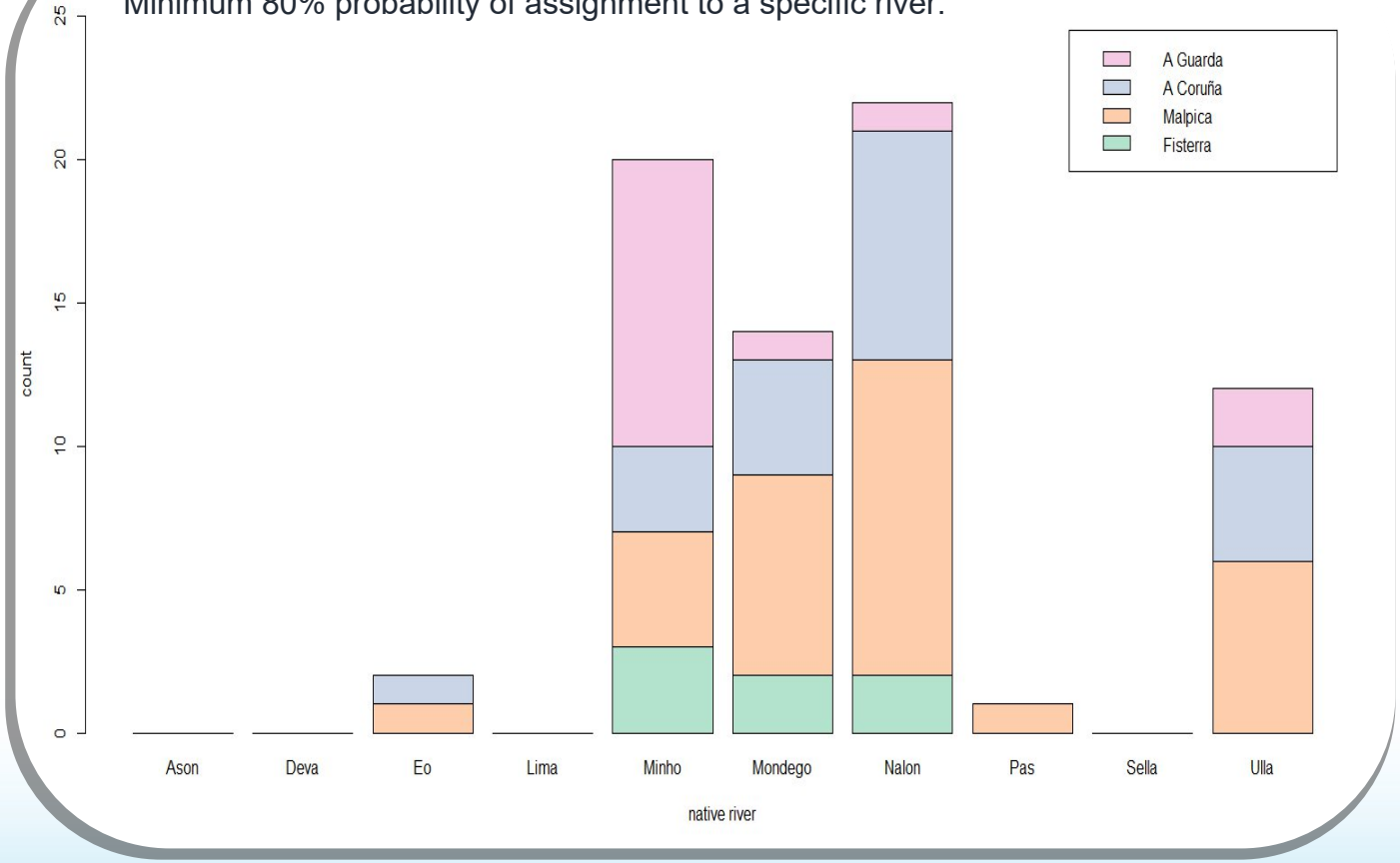
1. Mondego
2. Lima
3. Minho
4. Ulla
5. Eo
6. Nalón
7. Sella
8. Deva
9. Pas
10. Asón

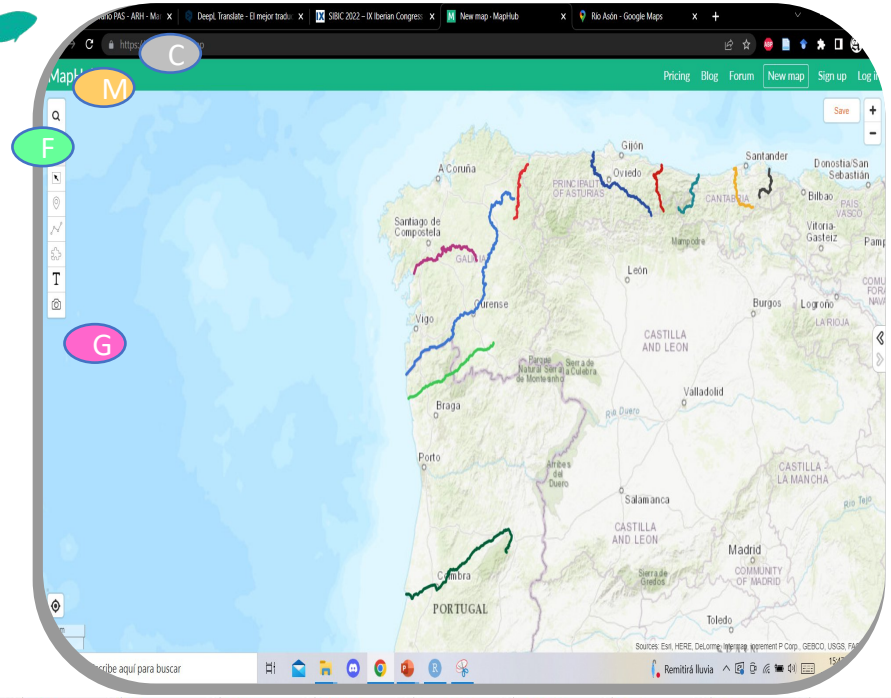
LOCAL INITIATIVES + GLOBAL INITIATIVES
1MARDEALOSAS + DIADES PROJET (ongoing)

Nachón, D. J, Vieira-Lanero, R., Cobo, F., Bareille, G. & Daverat, F. and collaborators

RESULTS:
SPECIFIC RIVER ASSIGMENT

Minimum 80% probability of assignment to a specific river.





	Ason	Deva	Eo	Lima	Minho	Mondego	Nalon	Pas	Sella	Ulla
1	1.444957e-04	3.063067e-03	7.396941e-02	6.342841e-05	3.898292e+01	6.091728e+01	4.754609e-06	1.506105e-06	6.783394e-03	1.582801e-02
2	1.798522e-03	7.288949e-02	8.891956e+00	1.509358e-07	8.440701e+01	3.569275e-03	2.854431e-01	9.844637e-06	5.640959e-02	6.280910e+00
3	6.146004e-06	7.380865e-04	1.010401e-03	1.510469e-09	4.579811e-03	3.329385e-06	9.939181e+01	2.565832e-02	5.168460e-04	5.756745e-01

Thank you very much for your attention!

Do you have any doubts or questions?

NOW?

THEN?
Please do not hesitate to contact me:

Correo: *davidjose.nachon@usc.es*

Teléfono: *+34 696328861*

: *@NachonDavid*