Development of population monitoring methods for the reintroduced Allis shad (*Alosa alosa*) in the Rhine system

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LOCAL AND GLOBAL INITIATIVES:

HOW SCIENCE SUPPORTS MANAGEMENT ACTIONS ON DIADROMOUS FISH

A story of a long-term project

❖ **No record** of *Alosa alosa* in the **Rhine** since the middle of the **20th century**

❖ Since 2008 :

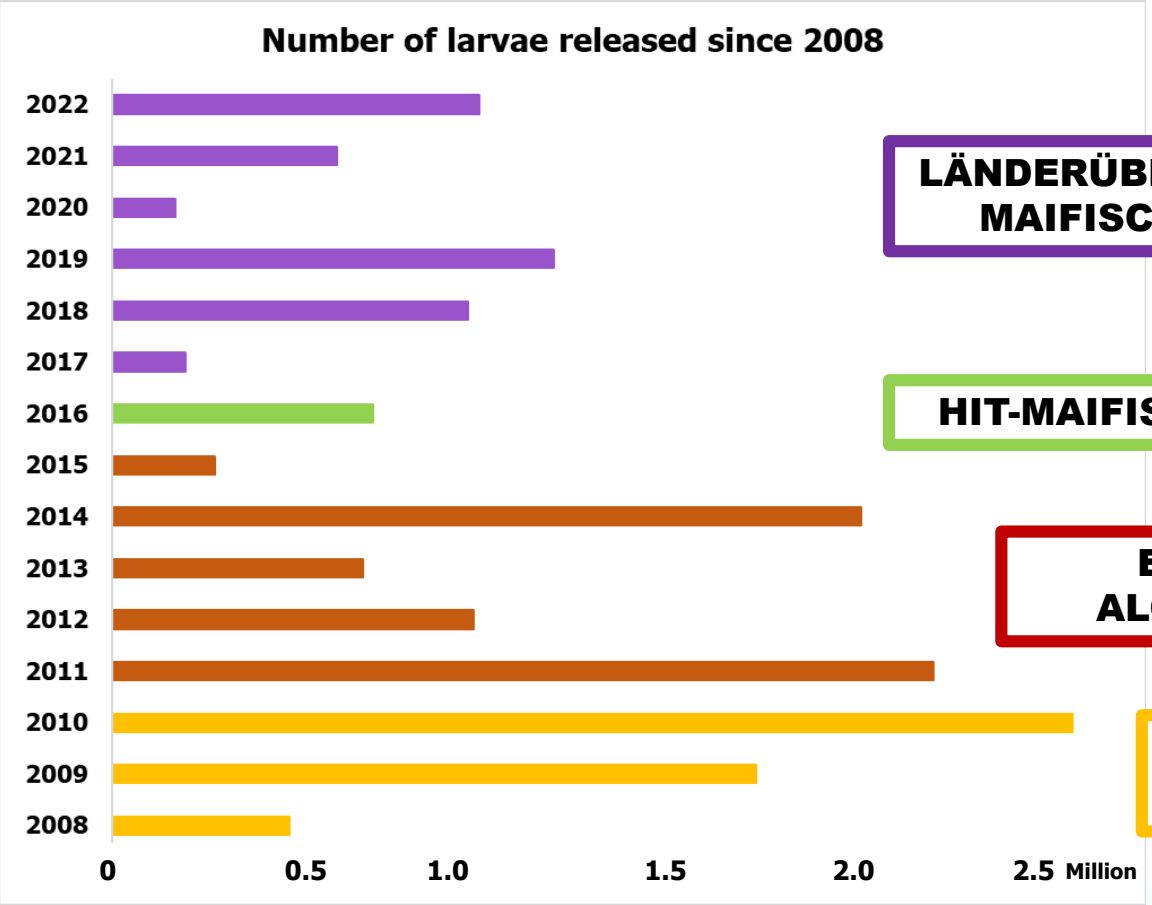
- ✓ Annual reintroduction of larvae
- ✓ Monitoring :
  - **Fish pass and Fisheries : Rhine (**Gambsheim & Iffezheim) **- Mosel** (Coblence) **- Neckar** (Ladenburg) – **Lower Rhine** (stow-net / pro fishermen)
  - **Parental assignment** (genetic analysis - PhD Kathrin Mäck, University of Landau, DE)
  - **Bull-monitoring** (2017-2021)
  - **Otolith microchemistry**

❖ Project 2017-2021 :

- Conservation program
- Scientific research
- Education

Released vs. Returnees

❖ About **16 million larvae released**



LÄNDERÜBERGEIFENDES MAIFISCHPROJEKT

HIT-MAIFISCHPROJEKT

EU LIFE + ALOSA ALOSA

EU LIFE MAIFISCH


16 day old larvae (July 2020)

Released vs. Returnees

❖ More than **800 adults returnees** observed **since 2008**

Video surveillance from the fish pass on the Mosel river - Coblence

Adult caught at the fish pass in Gambsheim (2020)

Objective and methods

- **Increase knowledge** of the life cycle, **identify spawning areas** and **evaluate** the **success of the Allis shad reintroduction program** in the Rhine system
- **Uses of otoliths**
  - ✓ **MICROCHEMISTRY :** Recording of information from the surrounding environment and the natal origin of the reared and caught individuals
    - **Sub-catchment differentiation**
    - **Identification of potential new spawning rivers/locations**
  - ✓ **OXYTETRACYCLINE (OTC) :** help in the identification of reintroduced shad
    - **Natural reproduction vs. Reintroduction**

Method to get reference values

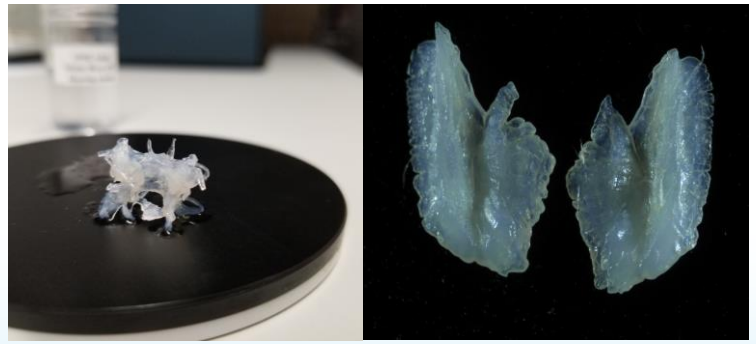
Tank experiment

✓ *Why ?*

- Establish reference values (**Sr/Ca & Ba/Ca & $^{86}Sr/^{87}Sr$**) from fish of known origin

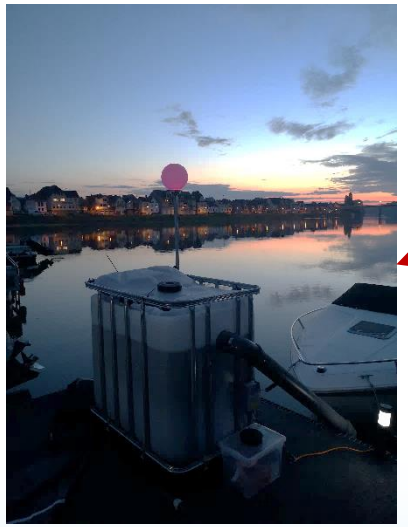
✓ *How ?*

- Sampling of larvae and water (tank + river) **every week for 100 days**
- **Otolith extraction** + polishing + photo
- ICP-MS analyses

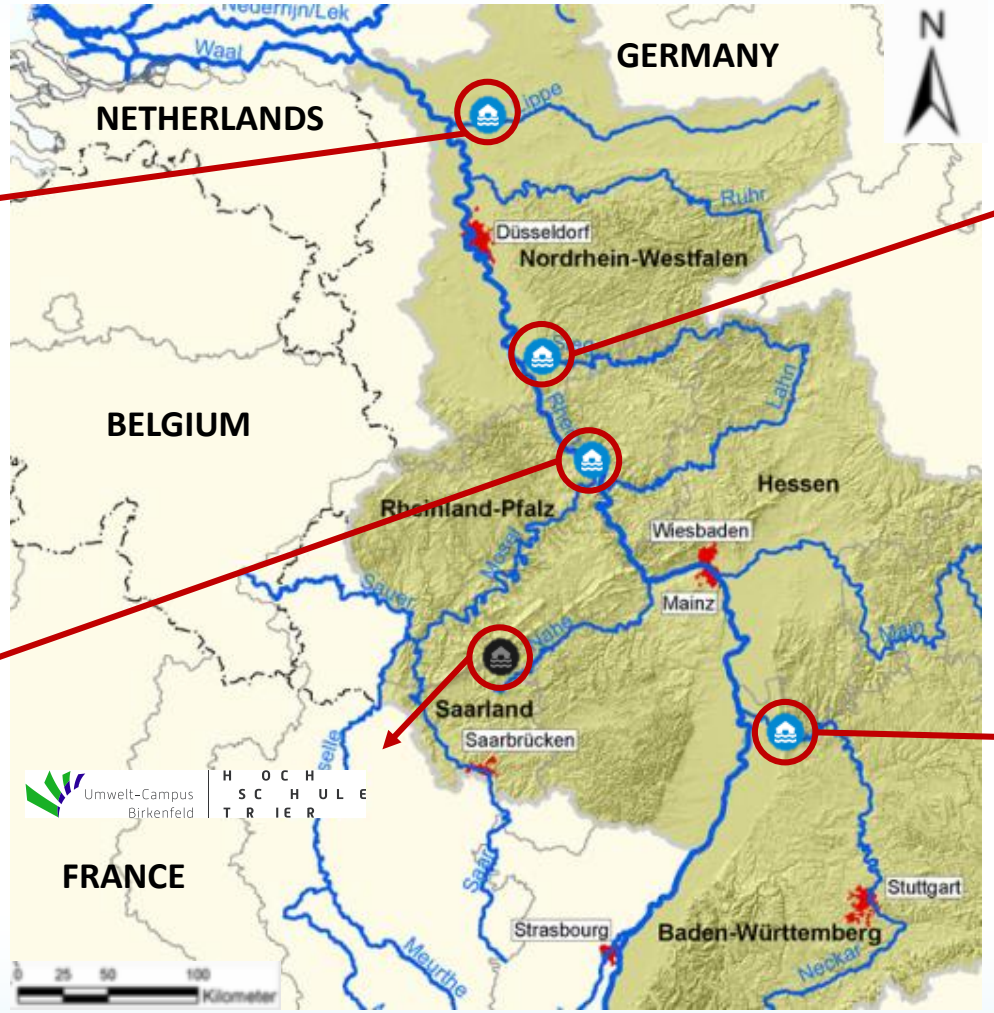


Tank experiments : 4 locations

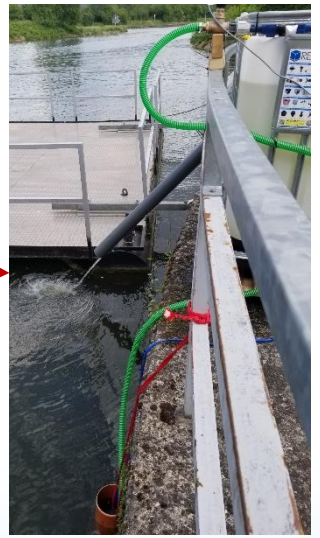
LIPPE - Wesel



RHINE - Vallendar



SIEG - Siegburg

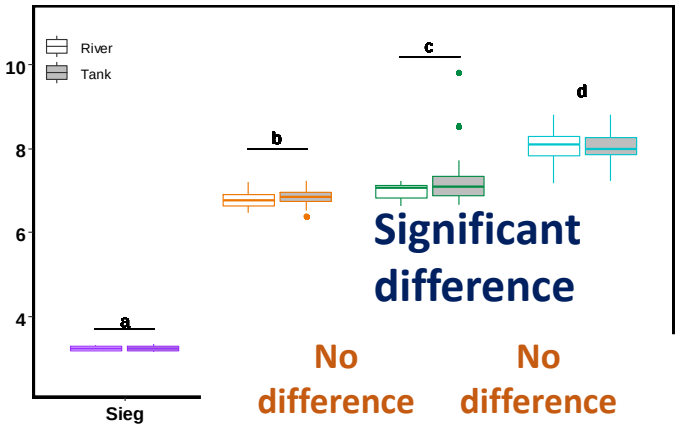


NECKAR - Dossenheim

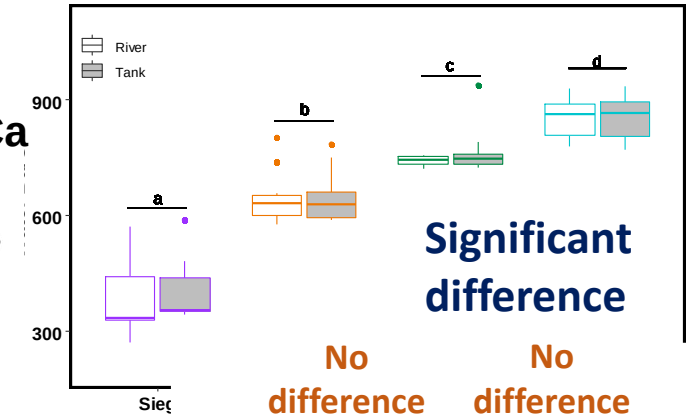
Elemental and isotopic ratios in water and otoliths

Ba/Ca INCONCLUSIVE

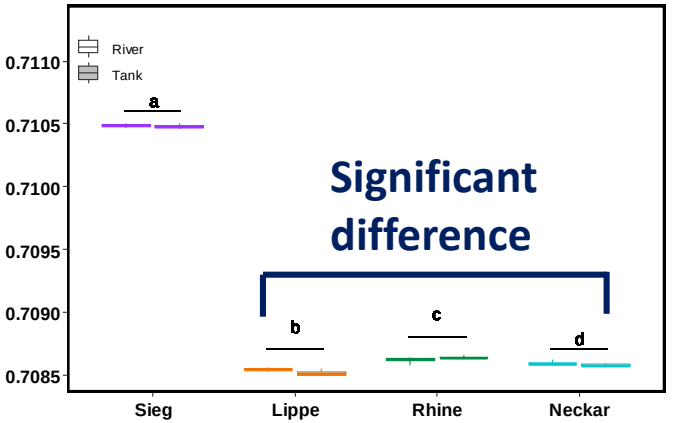
Sr/Ca



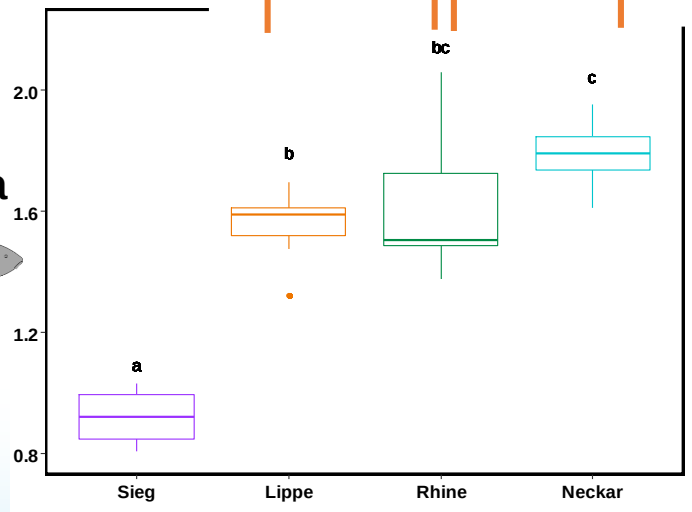
Ba/Ca



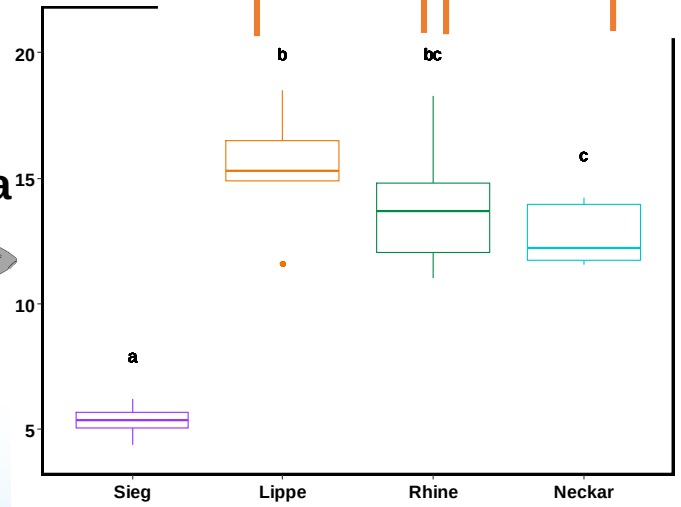
$^{86}Sr/^{87}Sr$



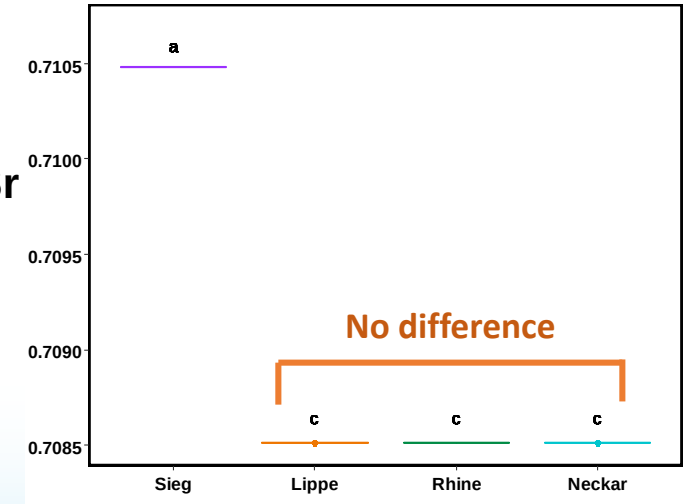
Sr/Ca



Ba/Ca



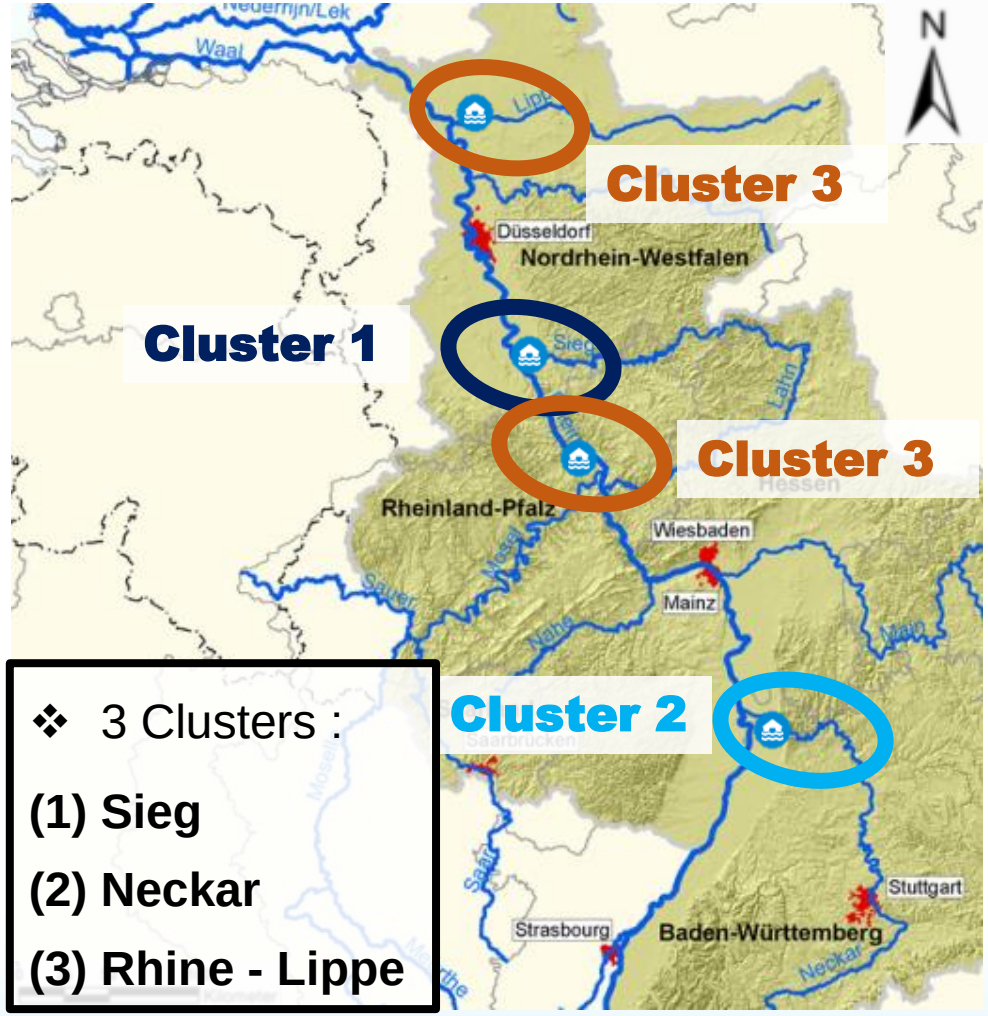
$^{86}Sr/^{87}Sr$



Reattribution model : Random forest

- Variables used : **Sr:Ca** and **$^{86}Sr/^{87}Sr$**
- A total **68 % of fish** tested randomly have been **reattributed correctly**

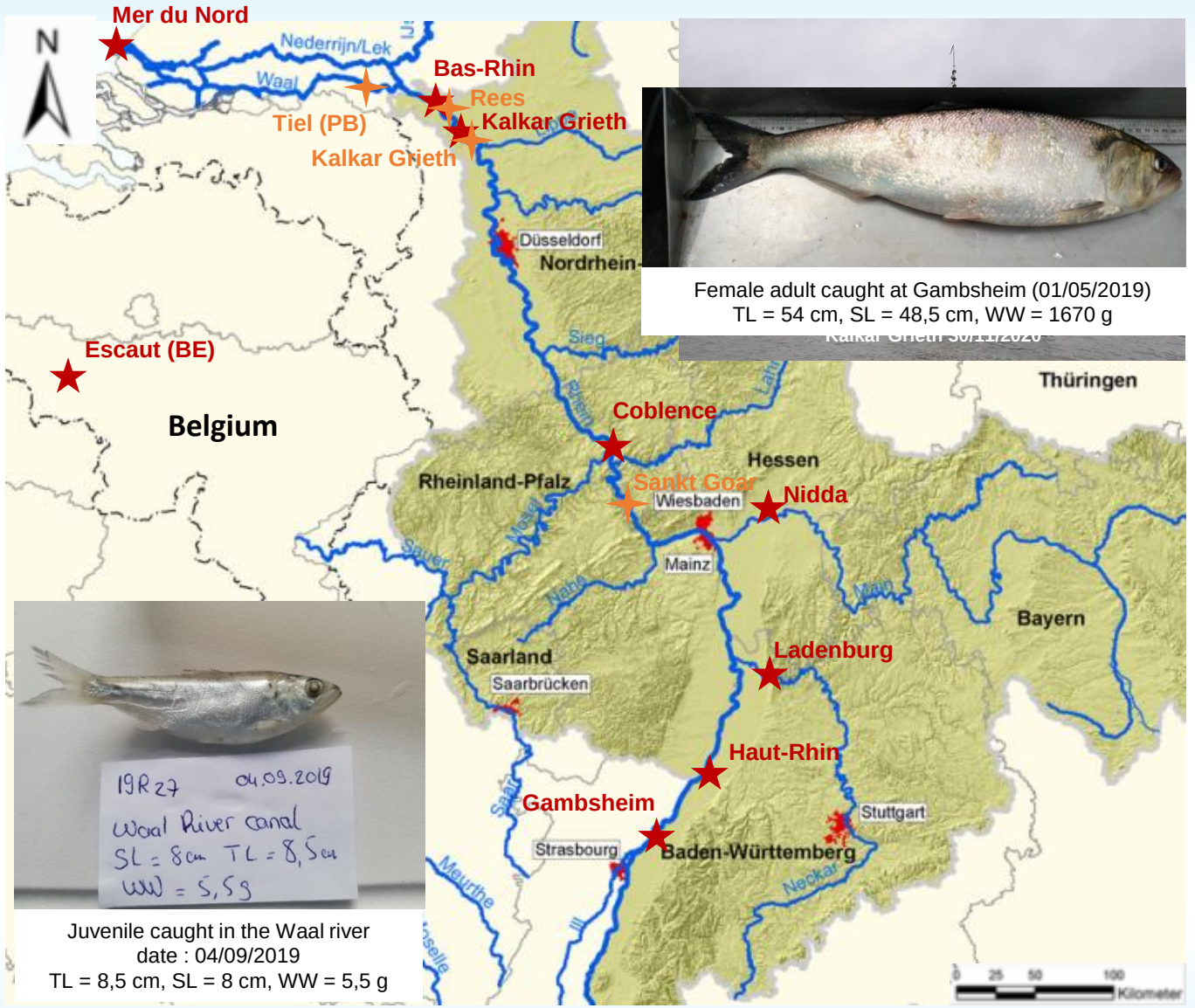
PREDICTED LOCATION	EXPERIMENTED LOCATION: SIEG	LIPPE	RHINE	NECKAR
SIEG	**100.0** %	0	0	0
LIPPE	0	**45.0 %**	17.5 %	20.0 %
RHINE	0	47.0 %	**55.5 %**	5.0 %
NECKAR	0	8.0 %	27.0 %	**75.0 %**



- 3 Clusters :
  - **(1) Sieg**
  - **(2) Neckar**
  - **(3) Rhine - Lippe**

Individual with UNKNOWN origin from 2017 to 2021

Rivière	Localisation	2017		2018		2019		2020		2021	
		A	J	A	J	A	J	A	J	A	J
Rhine	Gambsheim (FR)	-	-	2	-	21	-	2	-	-	
Neckar	Ladenburg	-	-	-	-	3	-	1	-	-	
Nidda	-	-	-	2	-	-	-	-	-	-	-
Rhine	Sankt-Goar	-	1	-	-	-	-	-	-	-	-
Rhine	Coblence	-	-	-	-	1	-	-	-	-	-
Rhine	Haut-Rhin	-	-	-	-	1		1	-	-	-
Rhine	Kalkar-Grieth	-	2	-	-	-	11	-	17	1	-
Rhine	Bas-Rhin	-	-	-	-	1		-	-	-	-
Rhine	Rees	-	-	-	-	-	-	-	6		-
Waal	Tiel (PB)	-	-	-	-	-	4	-	-	-	-
Escaut	Avelgem (BE)	-	-	-	-	-		1	-	-	-
NA	Mer du Nord	-	-	-	-	-		2		-	
		0	3	4	0	27	15	7	23	1	0

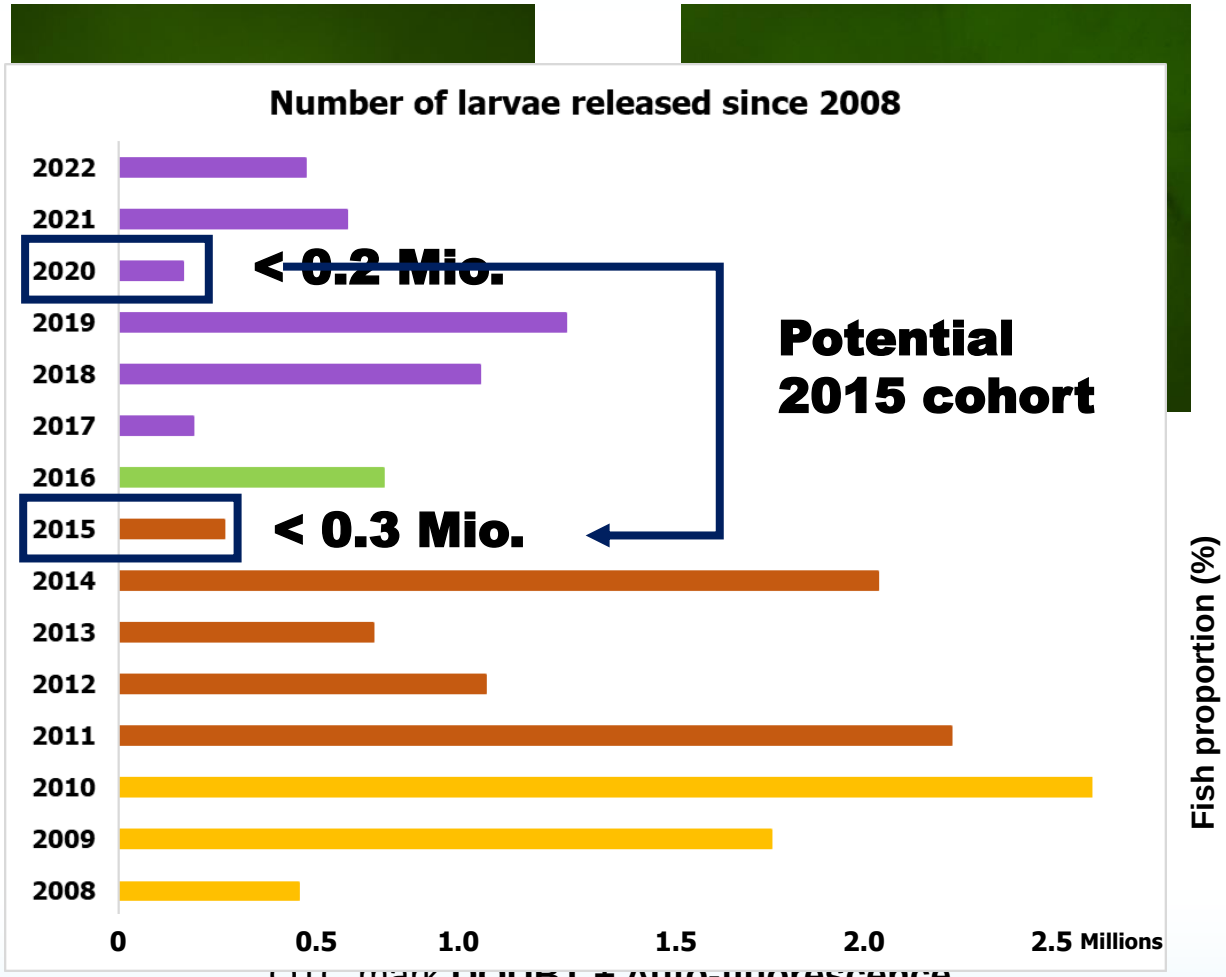


Female adult caught at Gambsheim (01/05/2019)
TL = 54 cm, SL = 48,5 cm, WW = 1670 g

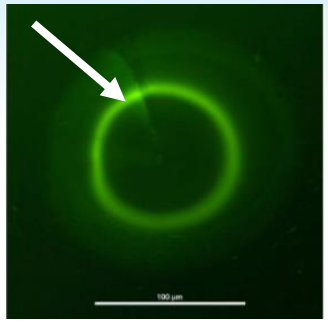
Juvenile caught in the Waal river
date : 04/09/2019
TL = 8,5 cm, SL = 8 cm, WW = 5,5 g

✓ Total of <u>39 adults</u> and <u>41 juveniles</u> recorded between 2017 and 2021

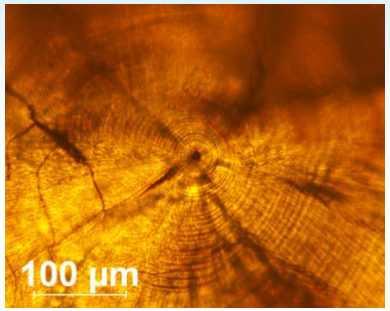
Oxytetracycline (OTC) mark



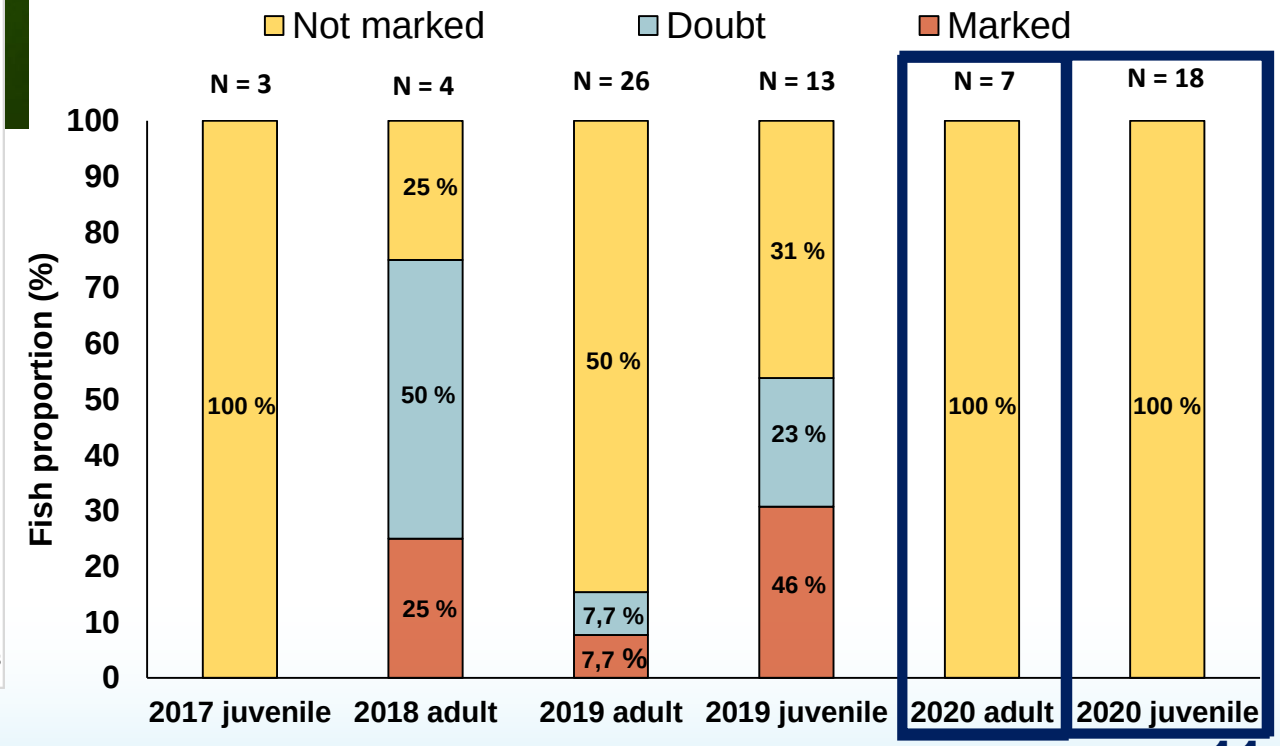
OTC mark **DOUBT + Auto-fluorescence**
Adult (caught on 21/05/19)



OTC mark - Control
Juvenile (2014)



Adult otolith
Caught on 03/06/19

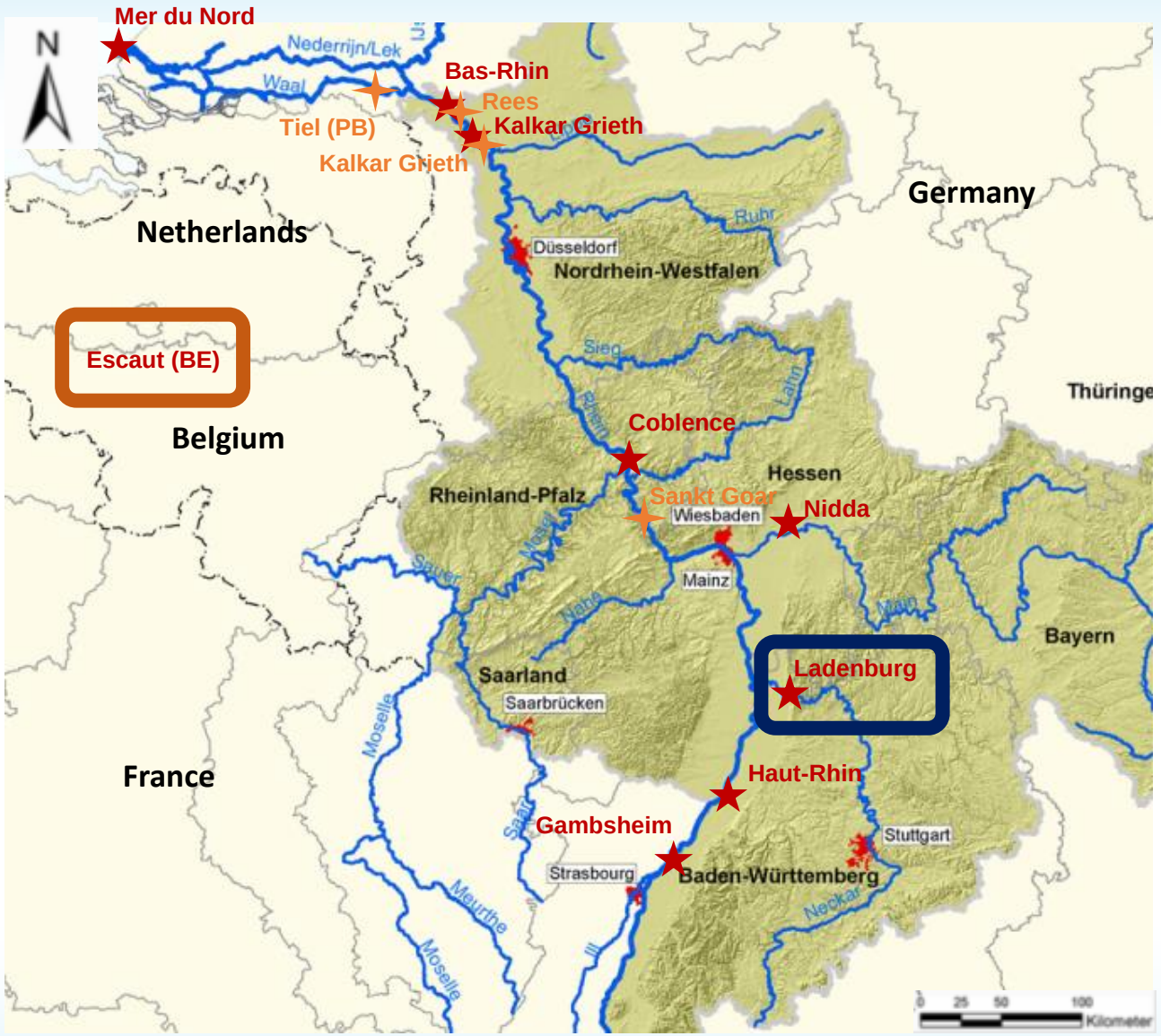


Reattribution of the wild fish from 2017 to 2020

- Variables used : **Sr:Ca** and **$^{86}Sr/^{87}Sr$**
- **59 individuals tested**

% OF REATTRIBUTION	RIVERS			
	RHINE	LIPPE	NECKAR	SIEG
> 75 - 100 %	45.8	6.8	11.9	0.0
< 75 %	35.6	0.0	0.0	0.0
TOTAL	**81.4 %**	**6.8 %**	**11.9 %**	**0.0 %**

- **52.6 % reattributed to the cluster Rhine-Lippe** with more than 75 % of probability
- **11.9 % reattributed to the cluster Neckar**



Since 2008

- **16 Million** larvae released
- **800** returnees observed
  - **77** caught (39 adults + 41 juveniles)
  - **10%** from reintroduction (OTC mark +)
  - **90%** from potential natural reproduction
- 2 markers : **Sr:Ca & $^{86}Sr/^{87}Sr$**
- 3 clusters : **Rhine/Lippe – Neckar – Sieg**
- **52.6 % of fish caught reattributed to the cluster Rhine-Lippe**
- **11.9 % of fish caught reattributed to the cluster Neckar** with one fish returned to the natal river
- **Colonization of other rivers** (e.g. individual caught in Belgium's river)? **Exchange between system ?**
- **Necessity to obtain more references values to improve the reattribution of caught fish in the RHINE system**

PARTNERS AND INSTITUTIONS

Verband Hessischer Fischer e.V. seit 1878

UNIVERSITÄT DUISBURG ESSEN

INSTITUT FÜR UMWELTWISSENSCHAFTEN

cnrs IPREM Institut des sciences analytiques et de physico-chimie pour l'environnement et les matériaux

RHEINISCHER FISCHEREIVERBAND RhFV von 1880 e.V.

LANDESFISCHEREIVERBAND BADEN-WÜRTTEMBERG e.V.

Umwelt-Campus Birkenfeld | HOCHSCHULE TRIER

INRAE

Sportvisserij Nederland

SAUMON · RHIN

Maifisch ★ Grande Alose ★ Elft Project

MIGADO Migrateurs Garonne Dordogne

RHEIN RFG Rheinfischereigenossenschaft in NRW

HIT UMWELT- UND NATURSCHUTZ STIFTUNGS-GMBH

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Umwelt BAFU
Office fédéral de l'environnement OFEV
Ufficio federale dell'ambiente UFAM
Uffizi federal d'ambient UFAM

Bezirksregierung Düsseldorf

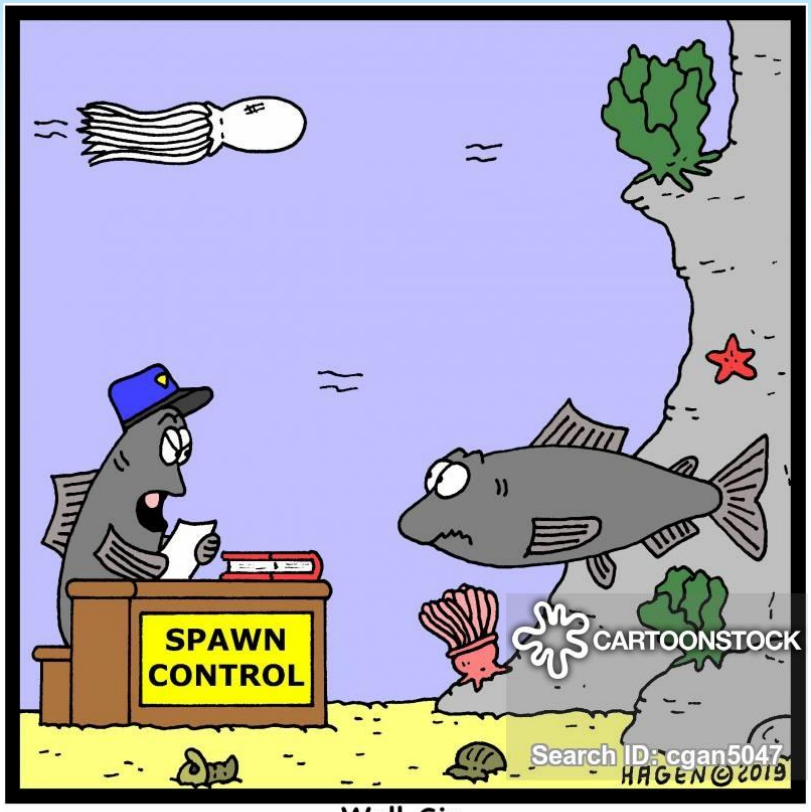
RheinlandPfalz MINISTERIUM FÜR UMWELT, ENERGIE, ERNÄHRUNG UND FORSTEN

HESSEN Hessisches Ministerium für Umwelt, Klimaschutz, Landwirtschaft und Verbraucherschutz

REVE SHAD EAUNA Interreg Atlantic Area Diades

THANK YOU !

SOME QUESTIONS ?



Well Sir,
your birth certificate says you were not born here,

SOCIAL MEDIA

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