



Colloque international de restitution  
Conservation de bivalves d'eau douce et  
restauration des habitats de tête de bassin versant



**natur&emwelt**

zesumme fir d'natur

## Culture of freshwater mussels in Europe. An overview and experiences from Luxembourg

Thielen F., Michels K., Heumann S., Frisch M.,  
Eybe T., Arendt A.



- Why propagation
- Overview of culture in Europe
- Culture of juveniles in Luxembourg
- Release & control of released mussels
- Conclusion & outlook



***Margaritifera margaritifera***

Freshwater pearl mussel  
Moule perlière



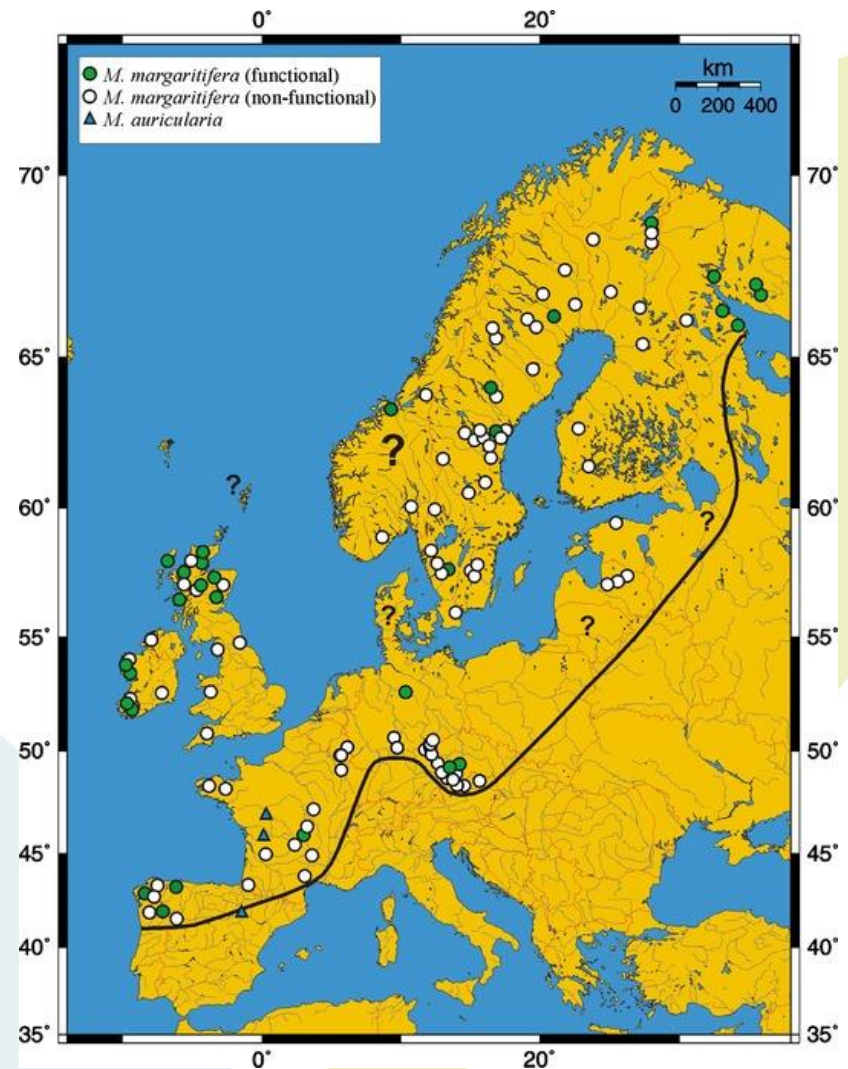
***Unio crassus***

Thick shelled river mussel  
Mulette épaisse

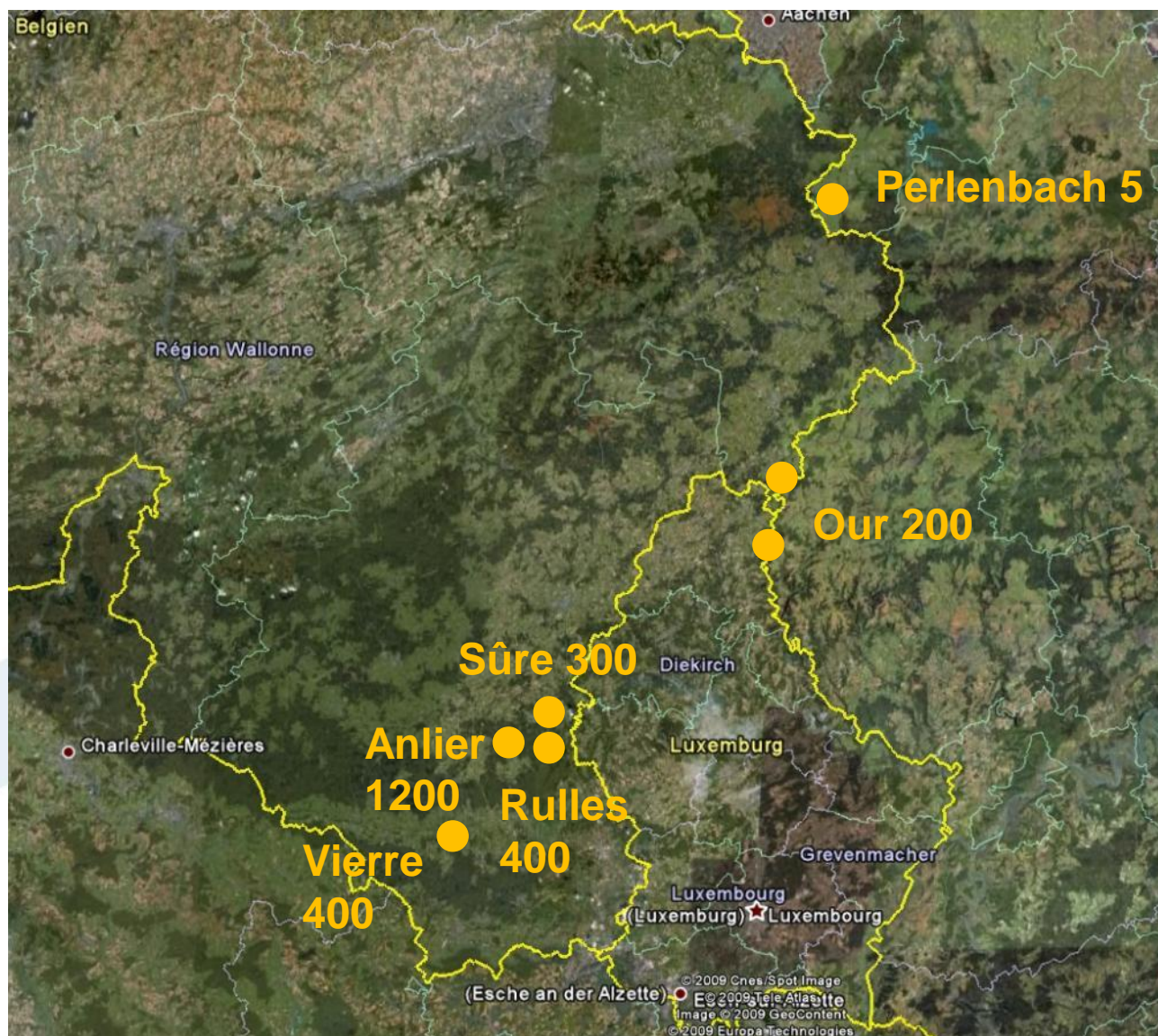
# Why propagate freshwater mussels?

## Example: *Margaritifera margaritifera*

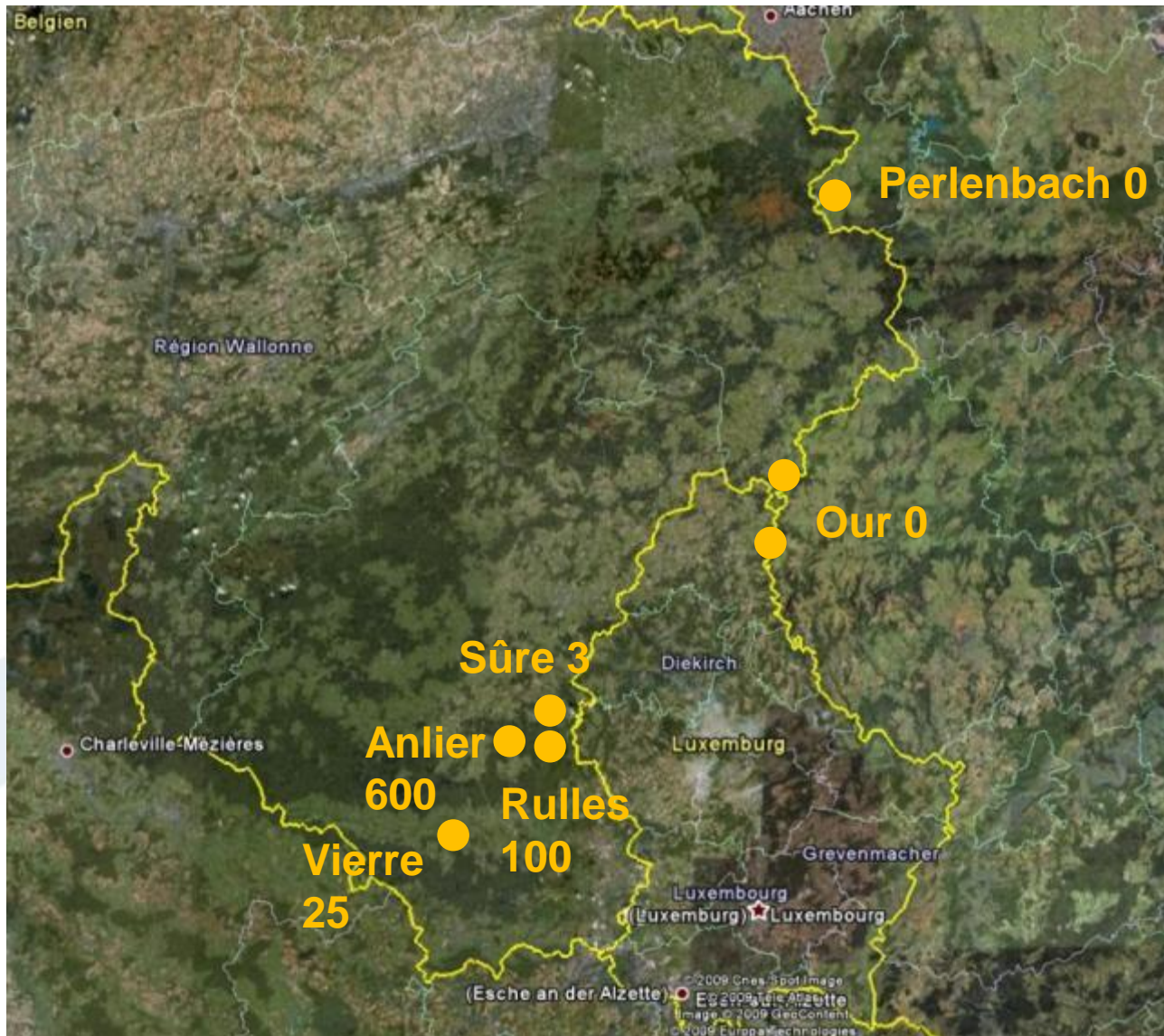
- Massive decline of Freshwater pearl mussel populations during the last decades
- Many populations not functional
- Many local populations extinct or close to extinction



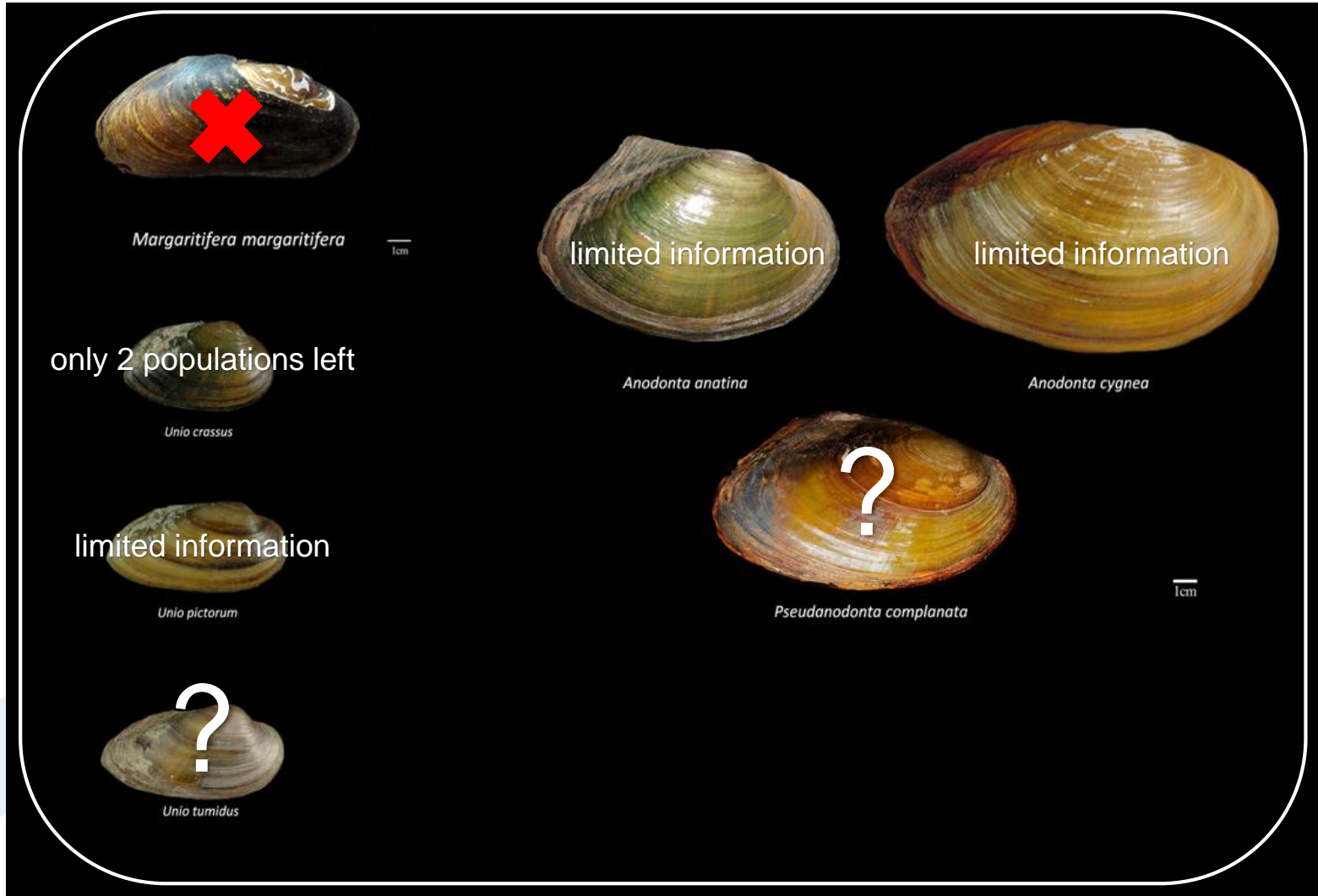
# *Margaritifera margaritifera* Populations in the Ardennes 2010



# *Margaritifera margaritifera* Populations in the Ardennes 2019



# Freshwater mussel species in Luxembourg



Changed from Lima et al., 2017 Biological Reviews 92(1):572-607

# Why do we need to culture freshwater mussels?

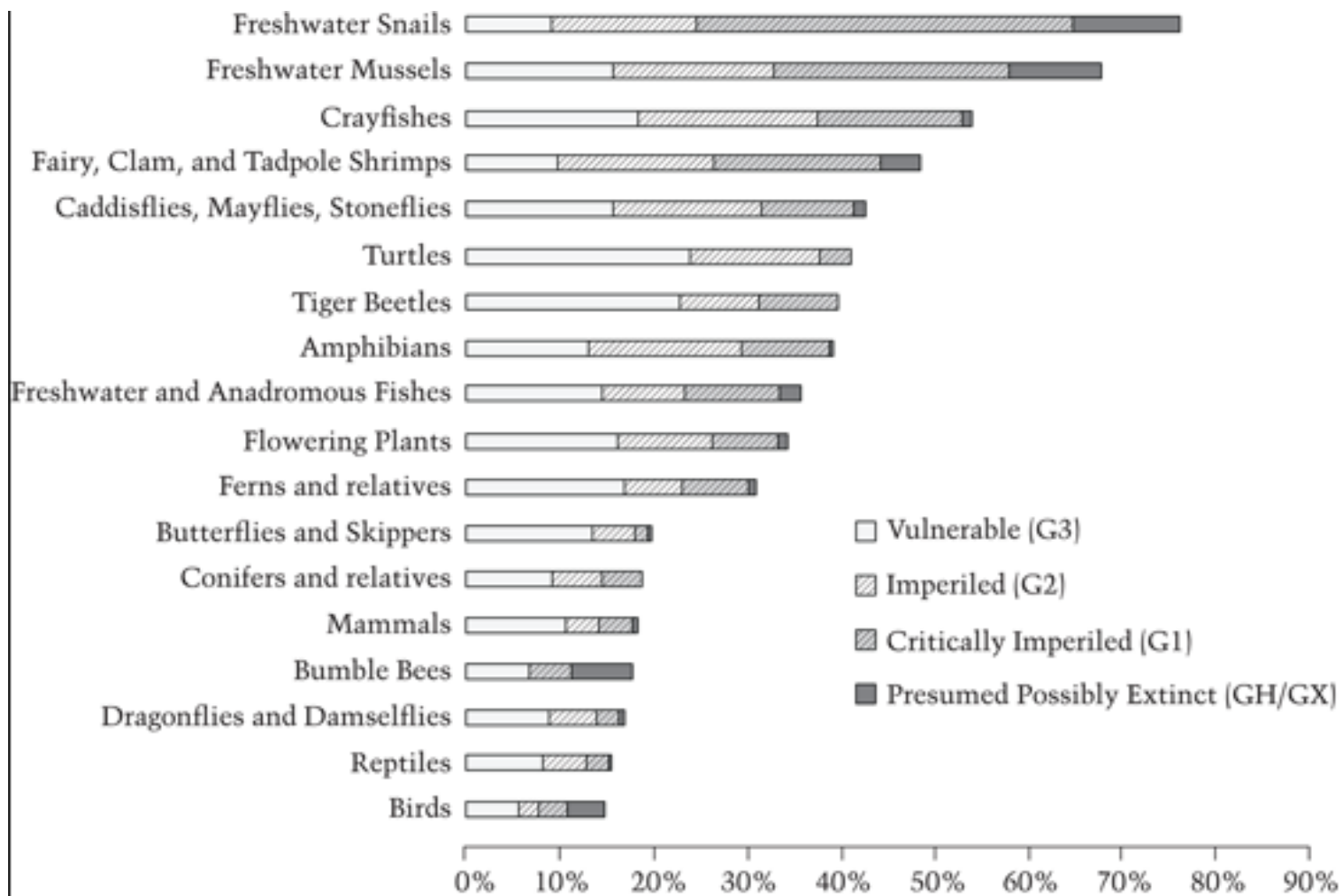
Protected by national- and EU- legislation

- *Margaritifera margaritifera*  
IUCN Red List (Endangered EN)  
Habitat and species directive
- *Unio crassus*  
IUCN Red List (Endangered EN)  
Habitat and species directive

- Umbrella species (keystone- flagship- sp)
- Natural heritage
- Deliver valuable ecosystem-services
- Beauty



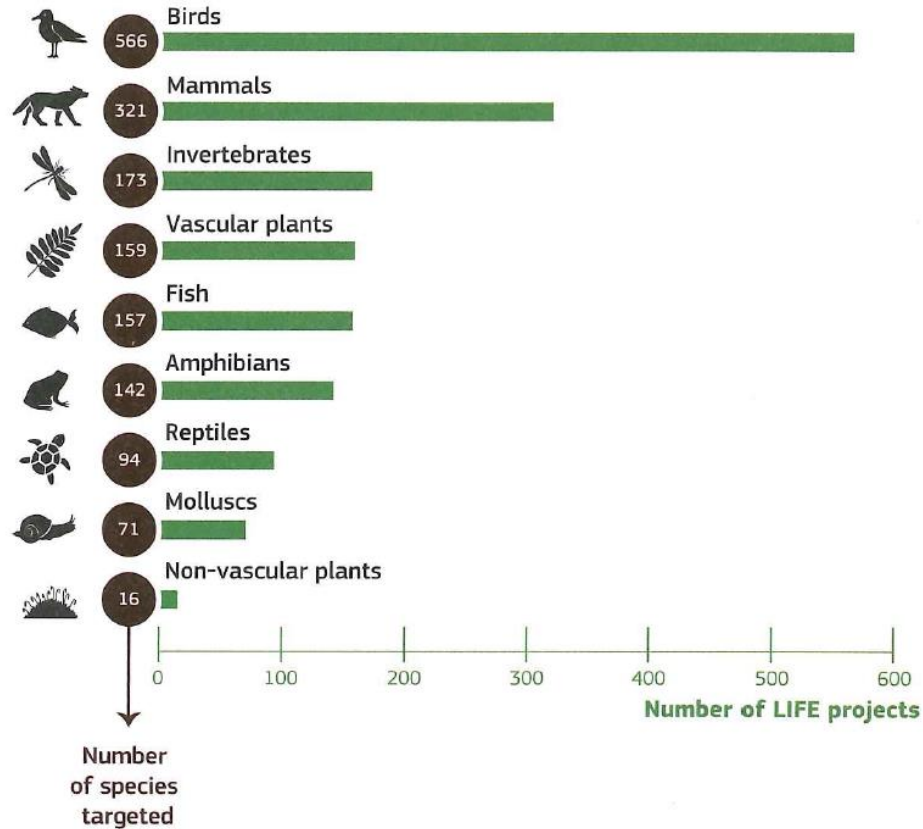
# Why propagate freshwater mussels?



Patterson et al. (2018) Freshwater Mussel Propagation for Restoration, Cambridge University Press

Lopes Lima et al. (2016) Biological Reviews 92, 1 (572-607)





**Top LIFE targeted species (number of projects):**

**Birds**

*Botaurus stellaris* (80)

**Mammals**

*Ursus arctos* (45)

**Invertebrates**

*Leucorrhinia pectoralis* (30)

**Vascular plants**

*Liparis loeselii* (21)

**Fish**

*Cottus gobio* (53)

**Amphibians**

*Triturus cristatus* (45)

**Reptiles**

*Emys orbicularis* (35)

**Molluscs**

*Margaritifera margaritifera* (29)

**Non-vascular plants**

*Drepanocladus vernicosus* (6)

## LIFE projects and species targeted (1992 – 2017)

11 projects: *Margaritifera margaritifera* (1997 – 2013)

3 projects: *Margaritifera auricularia* (2000 / 2014 / 2013)

3 projects: *Unio crassus* (2010 / 2011 / 2015)

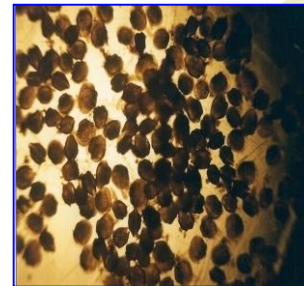
1 project: *Unio elongatulus* (*Unio mancus*, *Unio ravoisieri*) (2012)

# Development of *Margaritifera margaritifera* culture in Europe

- First attempts by Hruska 1980-1990 in the Czech Republic
- Buddensiek 1995 in Germany (Lutter)
- 1999 – 2001 First attempts in Northern Ireland and Scotland
- Michael Lange since 2000 in Germany
- Until now culture programs in 14 European countries



natur&emwelt

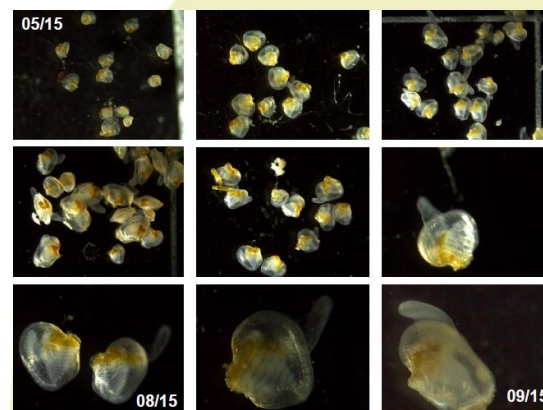
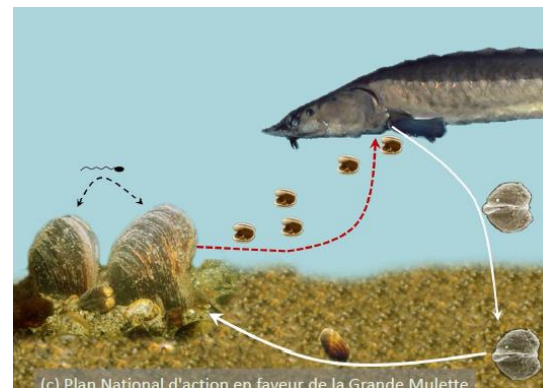


## Development of culture methods for other species in Europe

-2000 – until now: *Margaritifera auricularia*, LIFE projects in Spain and France

-2010 – until now: *Unio crassus*, LIFE projects in Sweden and Luxembourg (Germany)

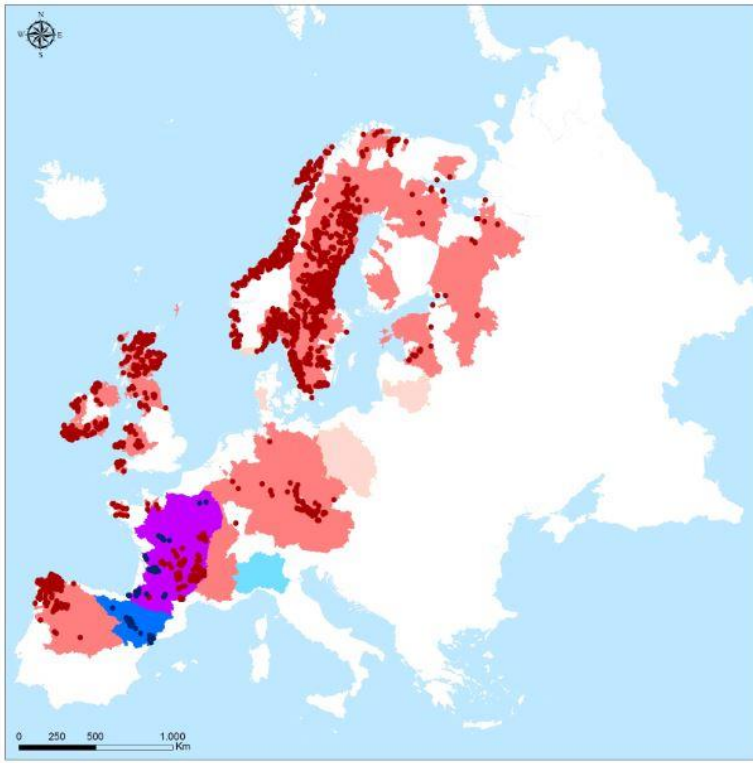
-2012 – until now: *Unio mancus*, *Unio ravoisieri*, LIFE project in Spain



UNIO CRASSUS *for* LIFE

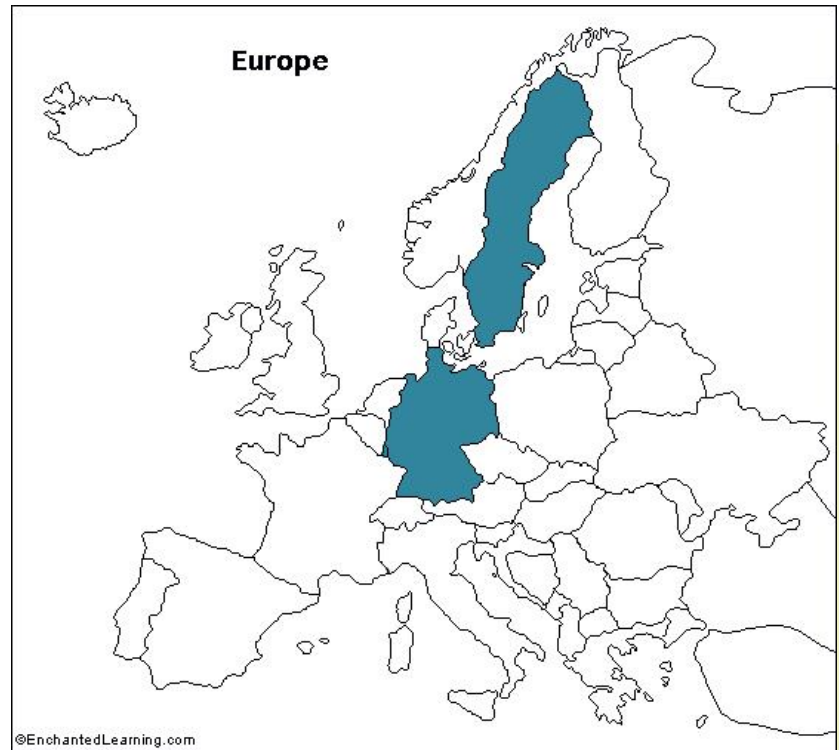
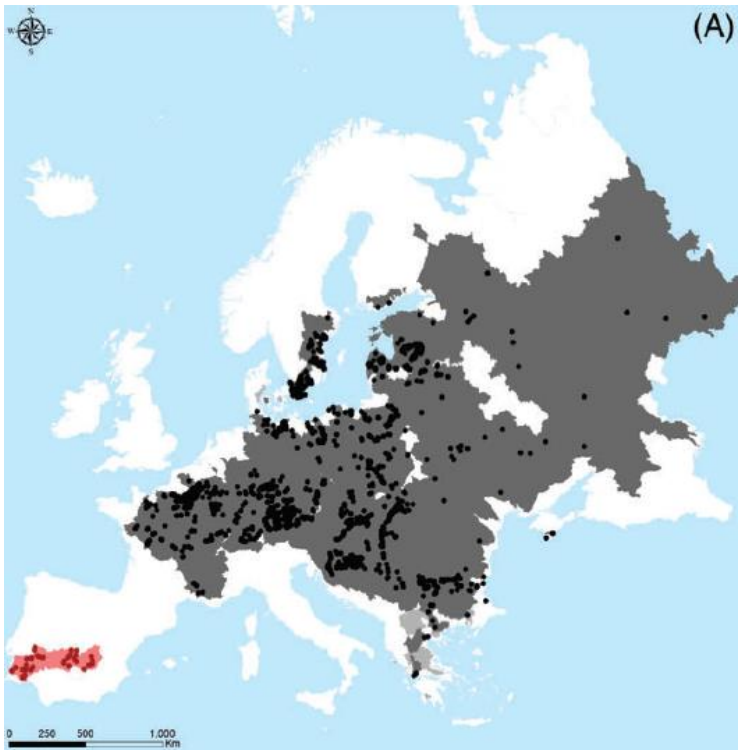


# Distribution and rearing of Margaritiferidae in Europe



Lima et al., 2017 Biological Reviews 92(1):572-607

## Distribution and rearing of *Unio crassus* in Europe

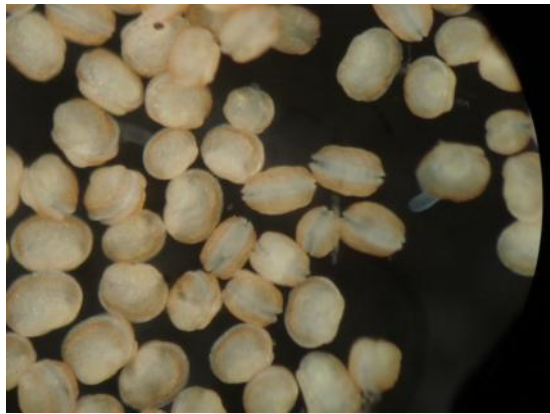


Lima et al., 2017 Biological Reviews 92(1):572-607

# Rearing facility at the mill of Kalborn in Luxembourg



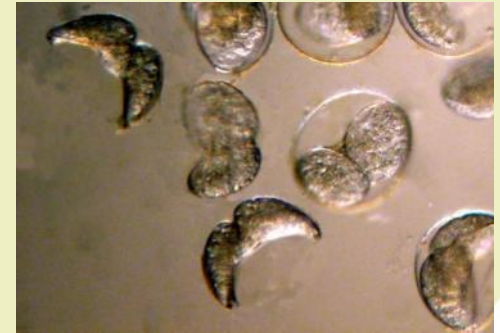
## Life cycle of *Margaritifera margaritifera*



Size: 350-450  $\mu\text{m}$



Size: 12-14 cm  
Age: up to 140 years

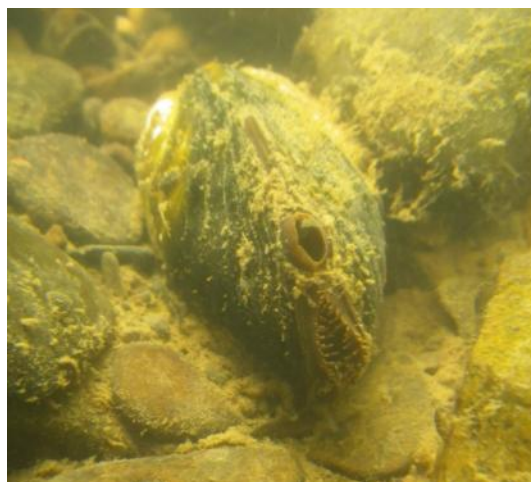


Size: 60-80  $\mu\text{m}$

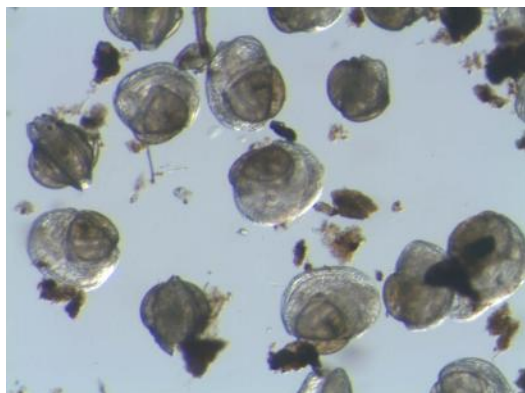


***Salmo trutta fario***  
or *Salmo salar*

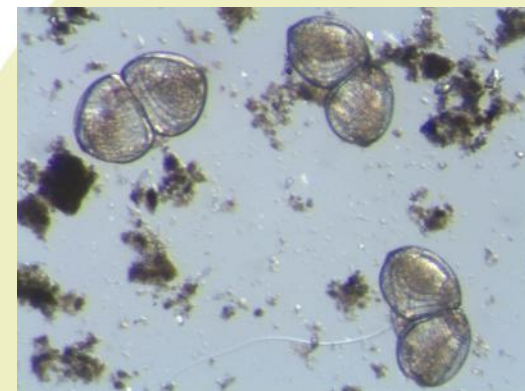
# Life Cycle of *Unio crassus*



Size: 6-7 cm  
Age: 25-30 years



Size: 200  $\mu$ m



Size: 200  $\mu$ m



## ***Phoxinus phoxinus***

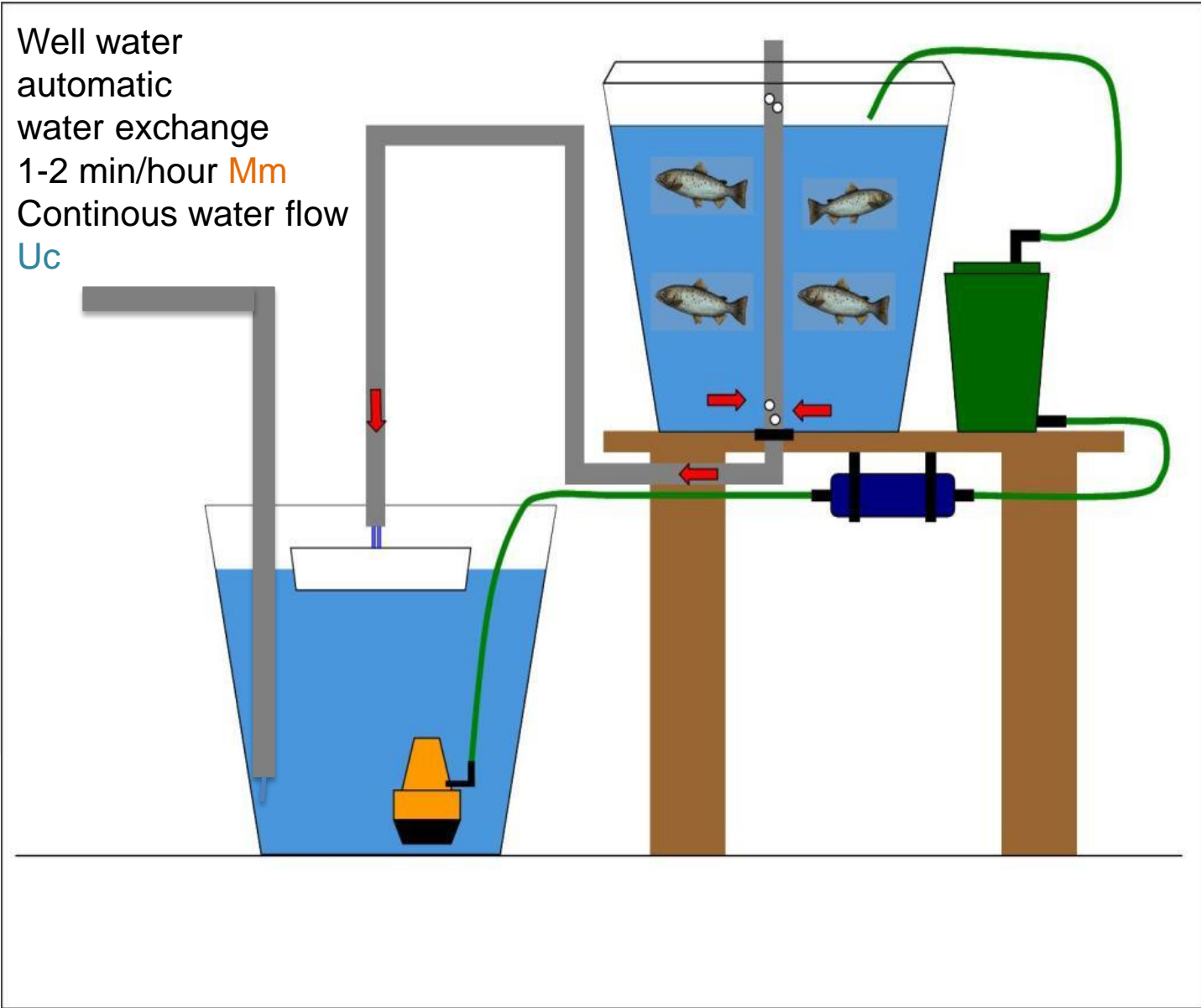
*Cottus gobio*, *Squalius cephalus*, *Salmo trutta fario*  
*Gasterosteus aculeatus*





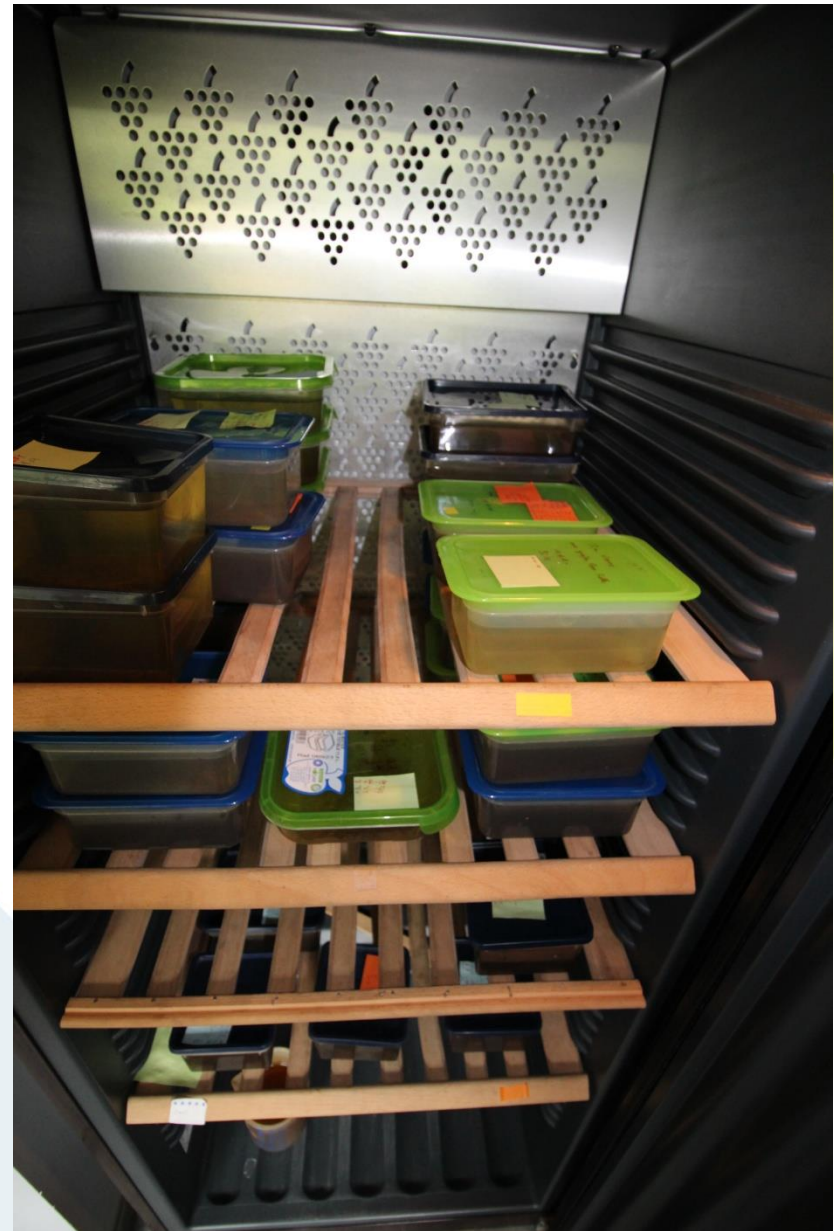
# Mussel collecting installation

Well water  
automatic  
water exchange  
1-2 min/hour  $Mm$   
Continuous water flow  
 $Uc$



## Detritus boxes

- Volume: 500 ml
- Quantity: 500 mussels
- Ø Temp.: 15,6°C
- Sediment: none
- Food: detritus + algea mix (shell fish diet 1800 + Nanno 3600)
- Actions:
  - checked weekly
  - food/water mix replaced weekly
- Ø Effort: 4-8 hrs/week; n=40-80 boxes
- Size and survival:
  - Mm** 0,4 mm – 1 mm (20-30% survival)
  - Uc** 0,2 mm – 1 mm (20-30% survival)



## Sand aquaria

- Volume: 20 l
- Quantity: 150 mussels
- Ø Temp.: 18,2° C
- Sediment: sand
- Food: algea mix (shell fish diet 1800 + Nanno 3600)
- Actions:
  - fed twice daily
  - water changed once weekly
  - checked once in a year
  - sand completely cleaned yearly
- Ø Effort: 4-6 hrs/week; n= 70 Aq
- Size and survival:
  - Mm** 1 mm – 5-10 mm (20%)
  - Uc** 0,2-1 mm – 10-12 mm (25-30%)



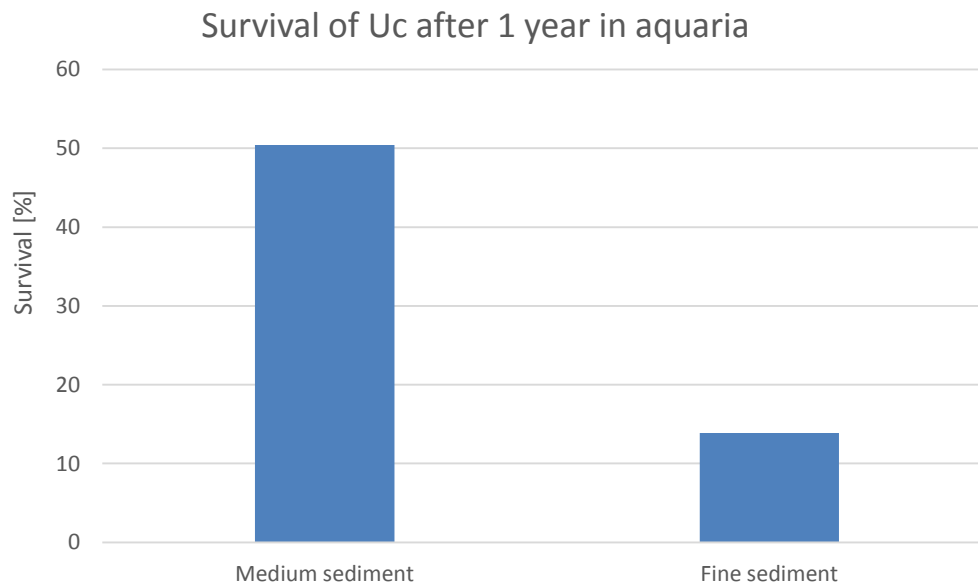
## *U. crassus* from aquaria held in different sized sediment

### Fine sediment (n=6)

- Sand < 1 mm
- Same amount (120 juveniles), same age, same population
- Straight from host fish
- Stayed 1 year in the aquaria
- Survival 14 %

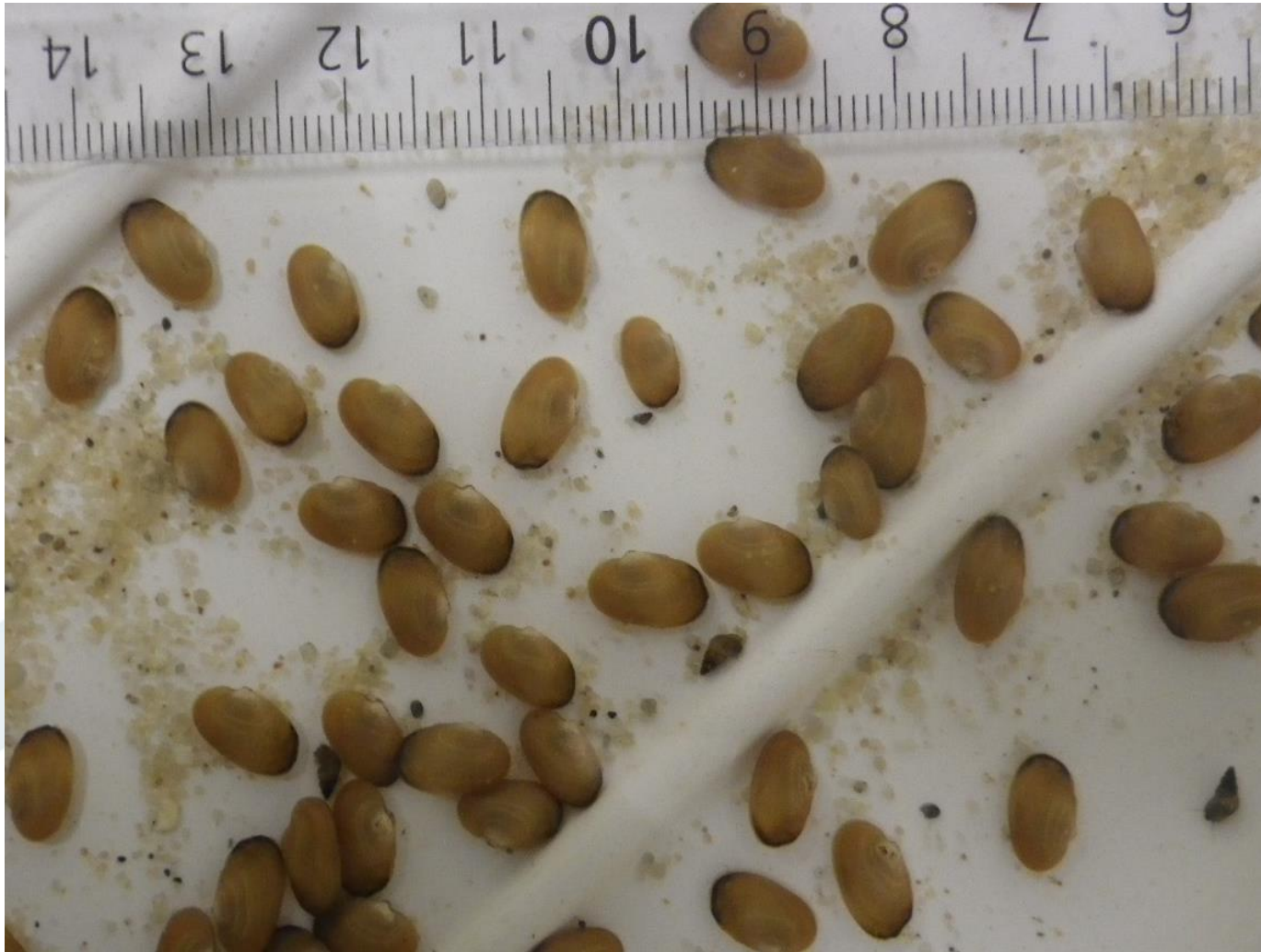
### Medium sediment (n=6)

- Sand of 1-2 mm
- Same amount (120 juveniles), same age, same population
- Straight from host fish
- Stayed 1 year in the aquaria
- Survival 50 %



in line with results from Lavictoire et al., 2016, Hydrobiologia for *M. margaritifera*

## *M. margaritifera* river Anlier

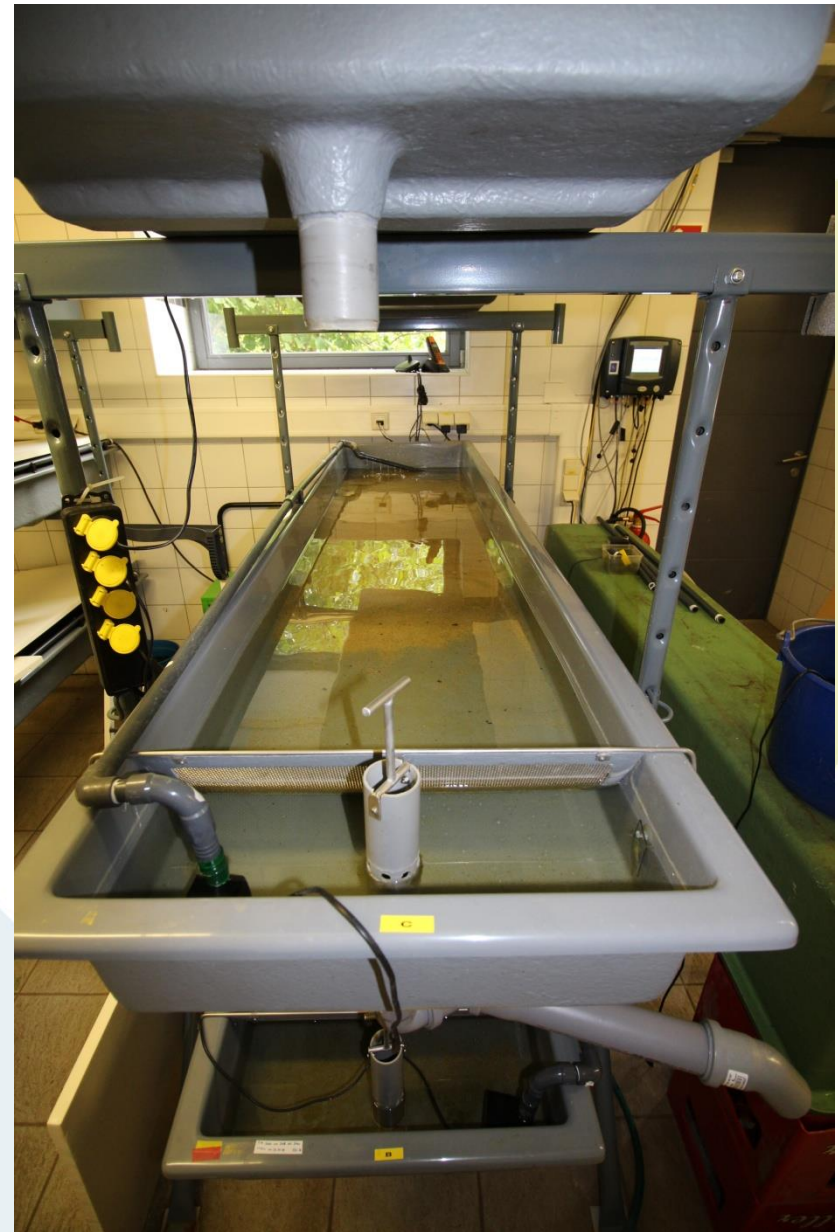


## *U. crassus* river Sauer



## Sand troughs ( water circulating)

- Volume: 140 l
  - Quantity: up to 10.000 mussels
  - Ø Temp.: 18,2° C
  - Sediment: sand 1-2 mm
  - Food: algea mix (shell fish diet 1800 + Nanno 3600)
  - Actions:
    - fed twice daily
    - water changed once weekly
    - checked once in a year
    - sand completely cleaned yearly
  - Ø Effort: 1 hr/week; n=15 troughs
  - Size and survival:
    - a) 0,2 /0,4 mm – 10-12 mm
    - b) 1 mm – 10-12 mm
- Very varying survival for **Mm** & **Uc** (0-30%)



*M. margaritifera* river Vierre in the sand trough





## Sand troughs (river water flow thru)

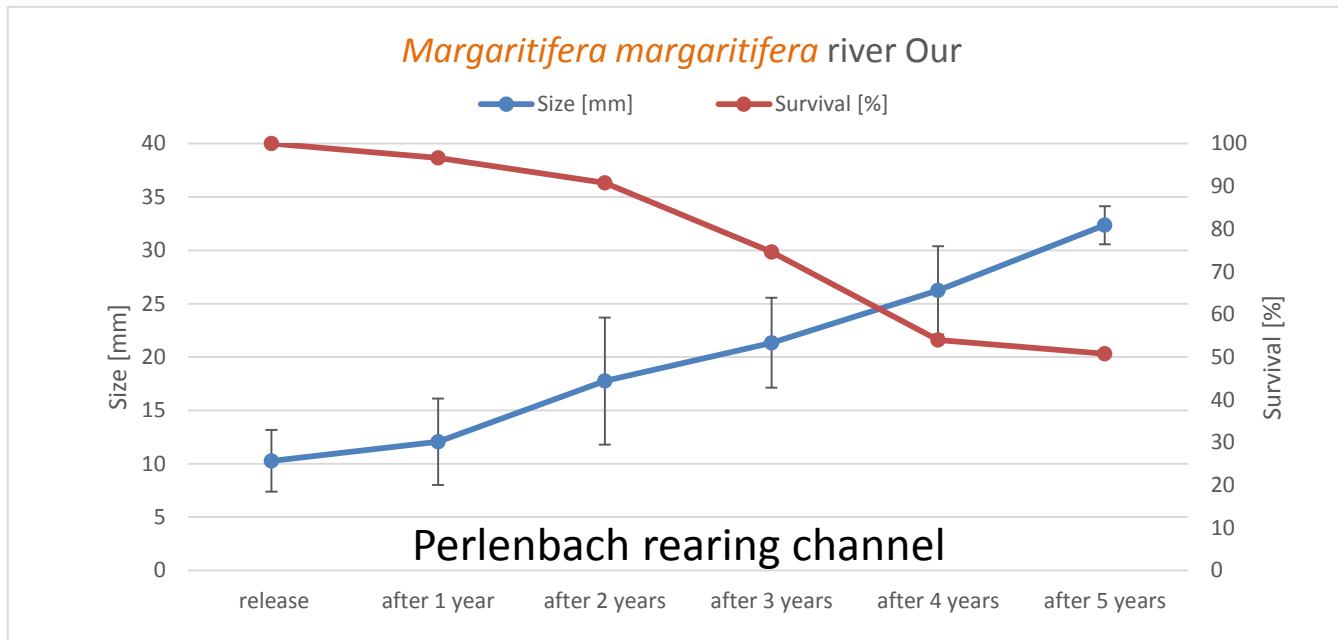
- Volume: 140 l
- Quantity: up to 2000 mussels
- Ø Temp.: natural temperature of river  
12,3° C; min: 1° C , max: 23° C
- Sediment: sand 1-2 mm
- Food: natural food/ algea,  
depending on season
- Actions: - check water flow daily
  - - clean sand 2-3 times / year
- Ø Effort: 10 min/week; n=3 troughs
- Size and survival:
  - Uc 5 mm – 20 mm (85-95%)



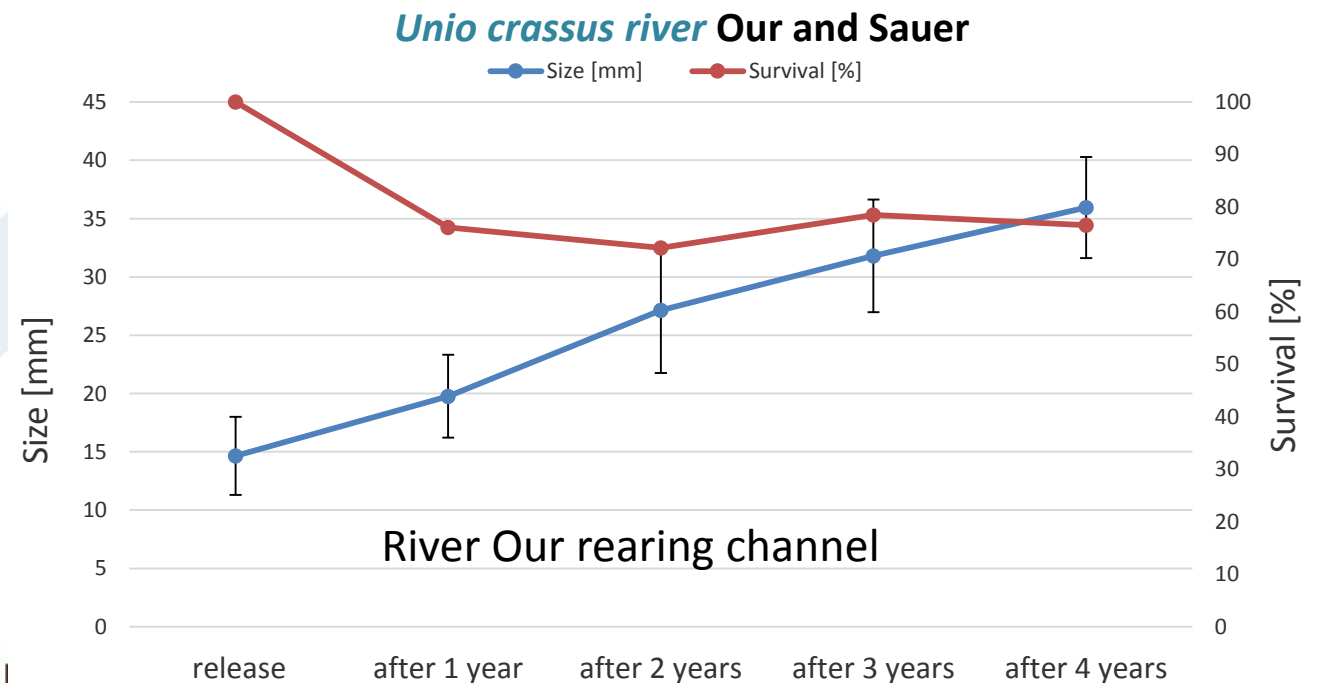
## Outside rearing channel

- Volume: water depth: +/- 30 cm
- Quantity: up to 100- 150 mussels / gravel box
- Ø Temp.: 12,3°C; min: 1°C , max: 23°C
- Sediment: gravel ; 2-10 mm
- Food: natural food/ alga, depending on season
- Actions: - water level in channel checked every second day
  - - screens cleaned once in a month
  - - checked once in a year
- Ø Effort: 0,5 hrs/week; n=10-20 gravel boxes
- Size and survival:
  - **Mm** 10mm – 30mm (20-50%)
  - **Uc** 10 mm – 30 mm (90%)



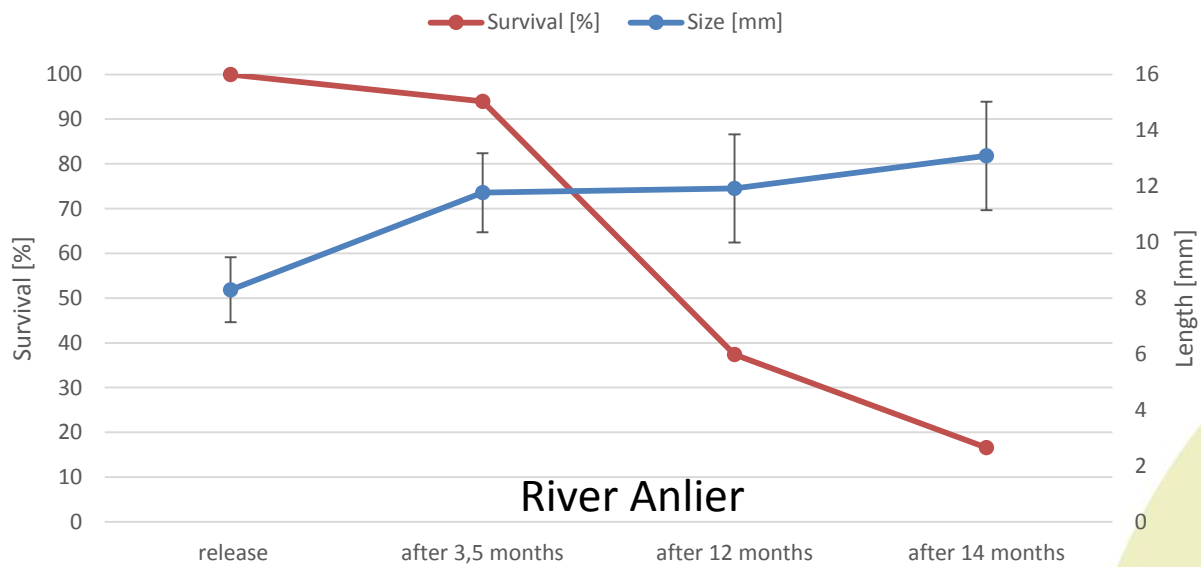


500 animals



1500 animals

*Margaritifera margaritifera* Anlier



64 animals left.

Released in summer 2019



## *U. crassus* from rearing channel



## Release of *Unio crassus* into their home rivers



In **2018** we released

808 animals in the river Our  
1078 animals in the river Sauer

In **2019** we released

738 animals in the river Our  
973 animals in the river Sauer



# Control of released *Unio crassus* in 2019

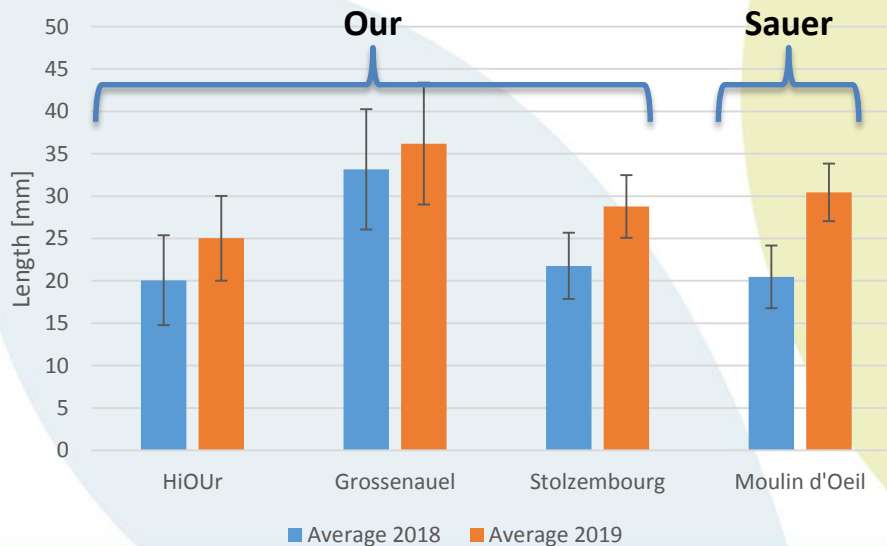
Time search from 25 min at each release point of each site.

Searching and digging the substrate using hands



# Control of released mussels in 2019

Site	Date	Released	Recovered following year [n]	Recovered following year [%]
Hiour 2018	29.06.2018	349	64	18,3
Groussenauel 2018	02.07.2018	219	60	27,4
Stolzembourg 2018	20.07.2018	240	31	12,9
<b>Total river Our 2018</b>		<b>808</b>	<b>155</b>	<b>19,2</b>
Moulin d'Oeil I	30.05.2018	577	0	0
Moulin d'Oeil II	11.07.2018	501	28	5,6
<b>Total river Sauer 2018</b>		<b>1078</b>	<b>28</b>	<b>2,6</b>
<b>Both rivers 2018</b>		<b>1886</b>	<b>183</b>	<b>9,7</b>



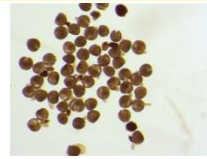


## Conclusion and Outlook

- Better do not feed the fish in the collecting installation
- Rearing in detritus boxes Ok, but time consuming
- The mussels feed on commercial algae food
- Rearing in sand aquaria is good. Use sand of 1-2mm in size
- Survival in sand trough still too low. Optimize food concentration. Keep mussels darker
- First tests with covering the sand throughs to protect juvenile *M.m.* from direct daylight are very promising!
- Growth and survival in outdoor rearing channels is good, especially for *Unio crassus*
- Follow up of the released mussels is necessary. We rediscovered +/- 10% of the released mussels

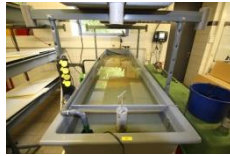
# Strategy

detritus boxes for 2-3 months



drop of

sand aquaria or troughs with medium sized sand for 1 year



outside rearing channel for 1-2 years under naturel conditions

released after 2-3 years  
20-30 mm



## Recommendations or lesson learned

- Start captive breeding before mussels are stressed – or gone
  - Choose a hatchery that suits the mussels (water quality), not politics!
  - Need to plan river restoration in plenty of time - where will you put your juveniles?
  - Passion and patience for mussels are needed!
  - It can be and is a last-minute rescue tool
  - Knowledge sharing is important
- But it can never replace the restoration of stream habitats**

# Acknowledgements

**LIFE Team Luxembourg**

**LIFE FPM + LIFE Unio**

Alexandra Arendt

Mireille Molitor

Sonja Heumann

Patricia Heinen

Karin Michels

Tanja Eybe

Mireille Molitor

Michel Frisch

Thierry Muller

Leo Klein

Lukas Masura

Anna Wanderscheid + other students



[www.unio.lu](http://www.unio.lu)



LE GOUVERNEMENT  
DU GRAND-DUCHÉ DE LUXEMBOURG  
Ministère du Développement durable  
et des Infrastructures  
Département de l'environnement



LE GOUVERNEMENT  
DU GRAND-DUCHÉ DE LUXEMBOURG  
Ministère de l'Agriculture, de la Viticulture  
et du Développement rural



LE GOUVERNEMENT  
DU GRAND-DUCHÉ DE LUXEMBOURG  
Ministère de l'Intérieur  
et à la Grande Région



Chambre d'Agriculture

A stylized graphic of two overlapping leaves. The left leaf is light blue and the right leaf is lime green. They are set against a dark brown background. The text is overlaid on the right leaf.

**zesumme fir d'natur**

**ensemble pour la nature**

**together for nature**

[www.naturemwelt.lu](http://www.naturemwelt.lu)

**Merci**