Rearing freshwater pearl mussels and it's input into species conservation

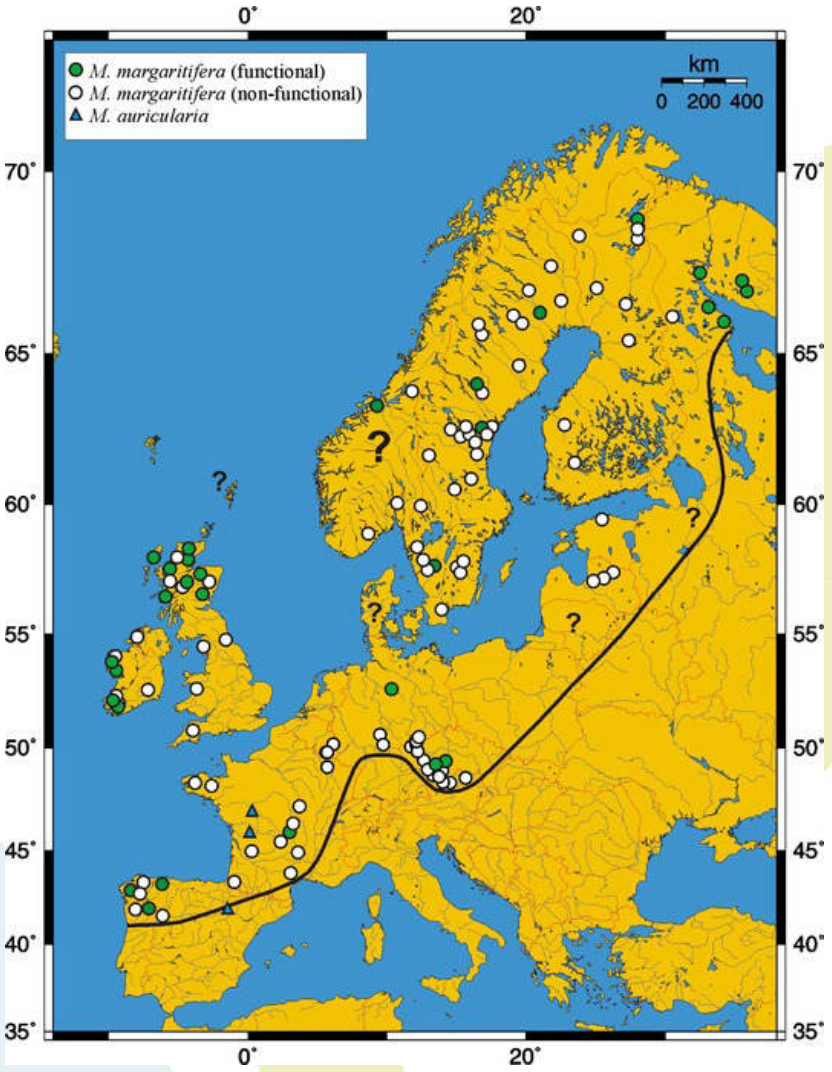
Frankie Thielen

Why should we culture freshwater mussels?

-Massive decline of Freshwater pearl mussel populations during the last decades

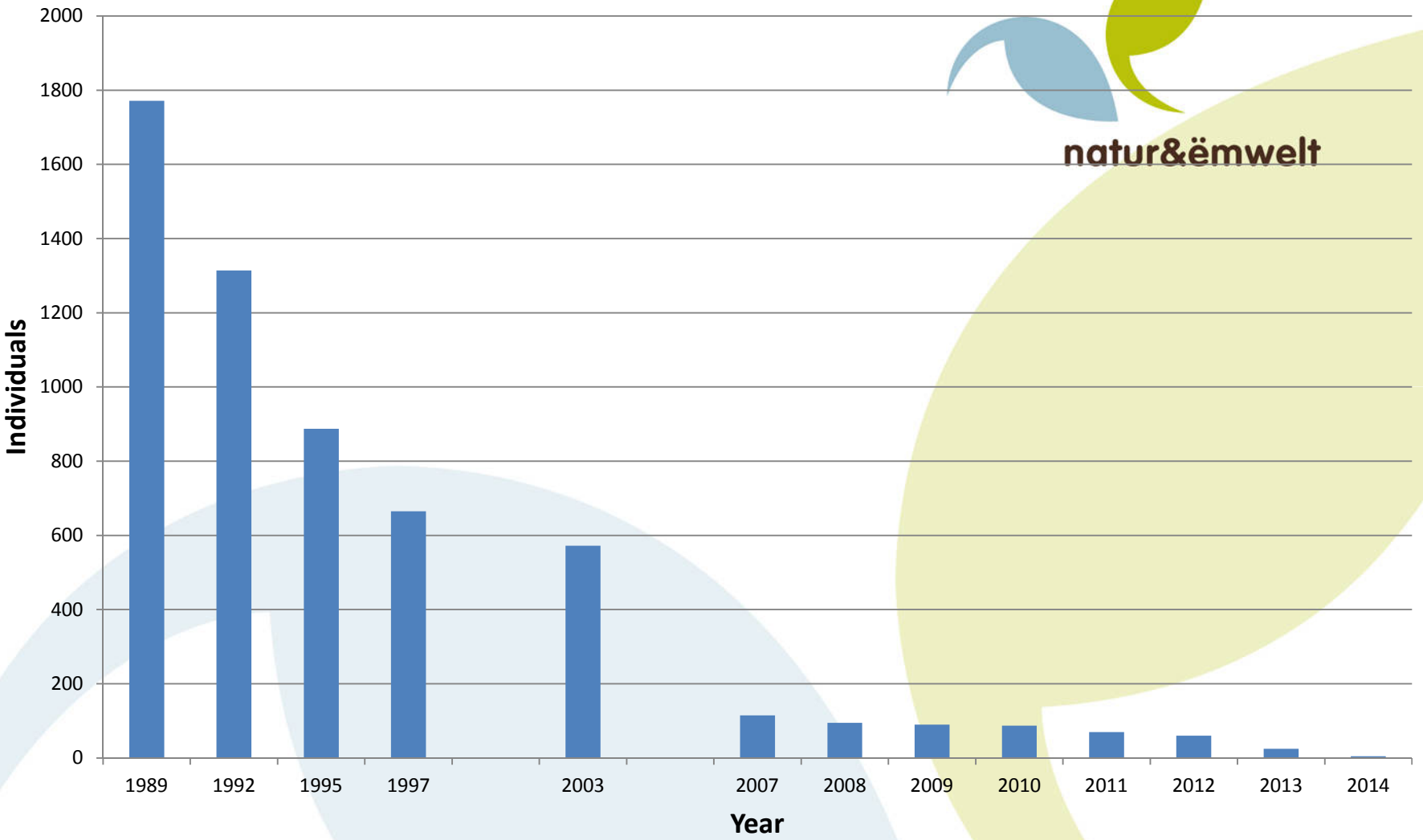
-Many populations not functional

-Many local populations extinct or close to extinction



Geist, Hydrobiologia (2010) 644:69–88

Example: Dramatic decline of the river Our Population



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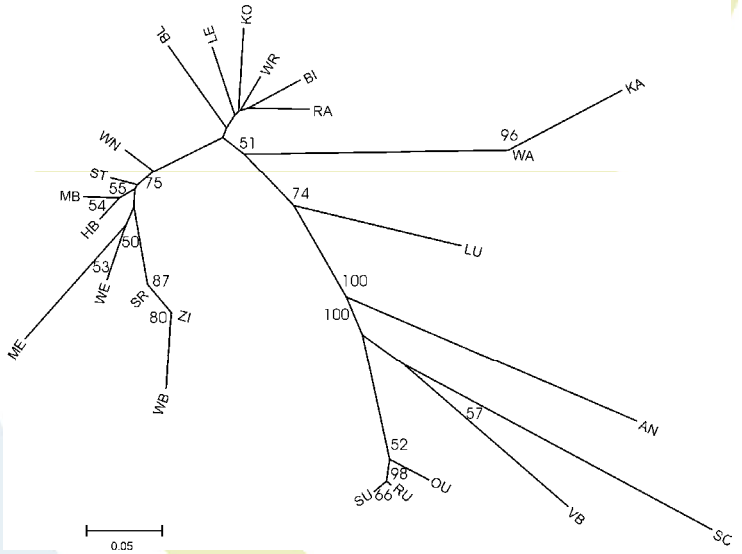
Why do we need to culture freshwater mussels?

-Protected by national- and EU- legislation

-Umbrella species (keystone- flagship- species)

-Natural heritage

-Beauty



Four Strategies to protect Mussel Population (Ziuganov *et al*., 1994).

-Create refuge areas

-Transfer adult Mussel from healthy recruiting rivers to rivers with poor populations

-Release of artificially infested host fish

-Culture of freshwater mussels

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Development of *Margaritifera margaritifera* culture in Europe

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-First attempts by Hruska 1980-1990 in the Czech Republic

-Buddensiek 1995 in Germany (Lutter)

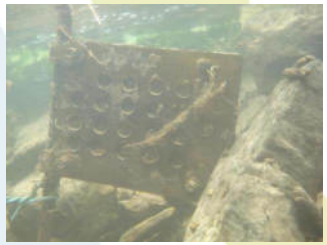
-1999 – 2001 First attempts in Northern Ireland and Scotland

-Michael Lange since 2000 in Germany

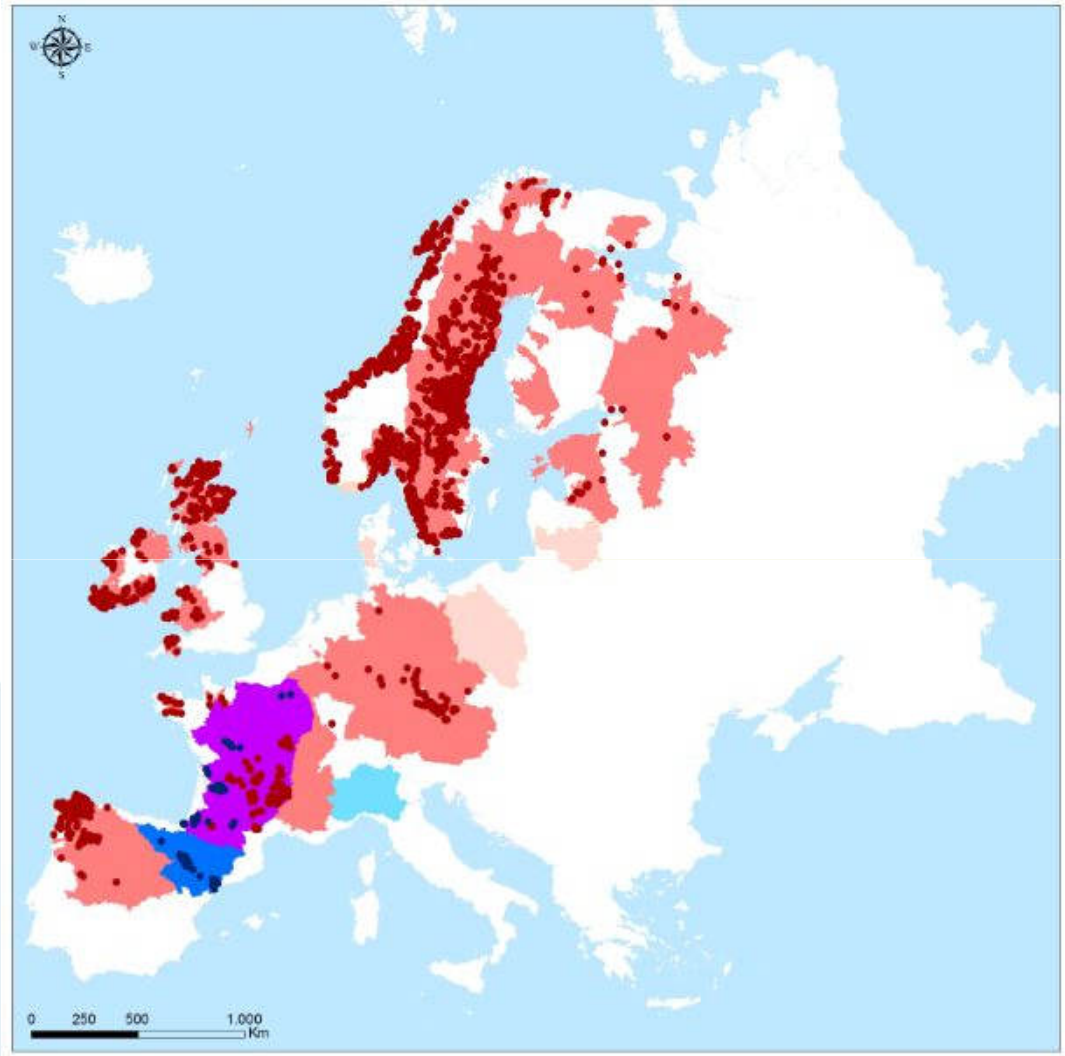
-Until now culture programs in 14 European countries



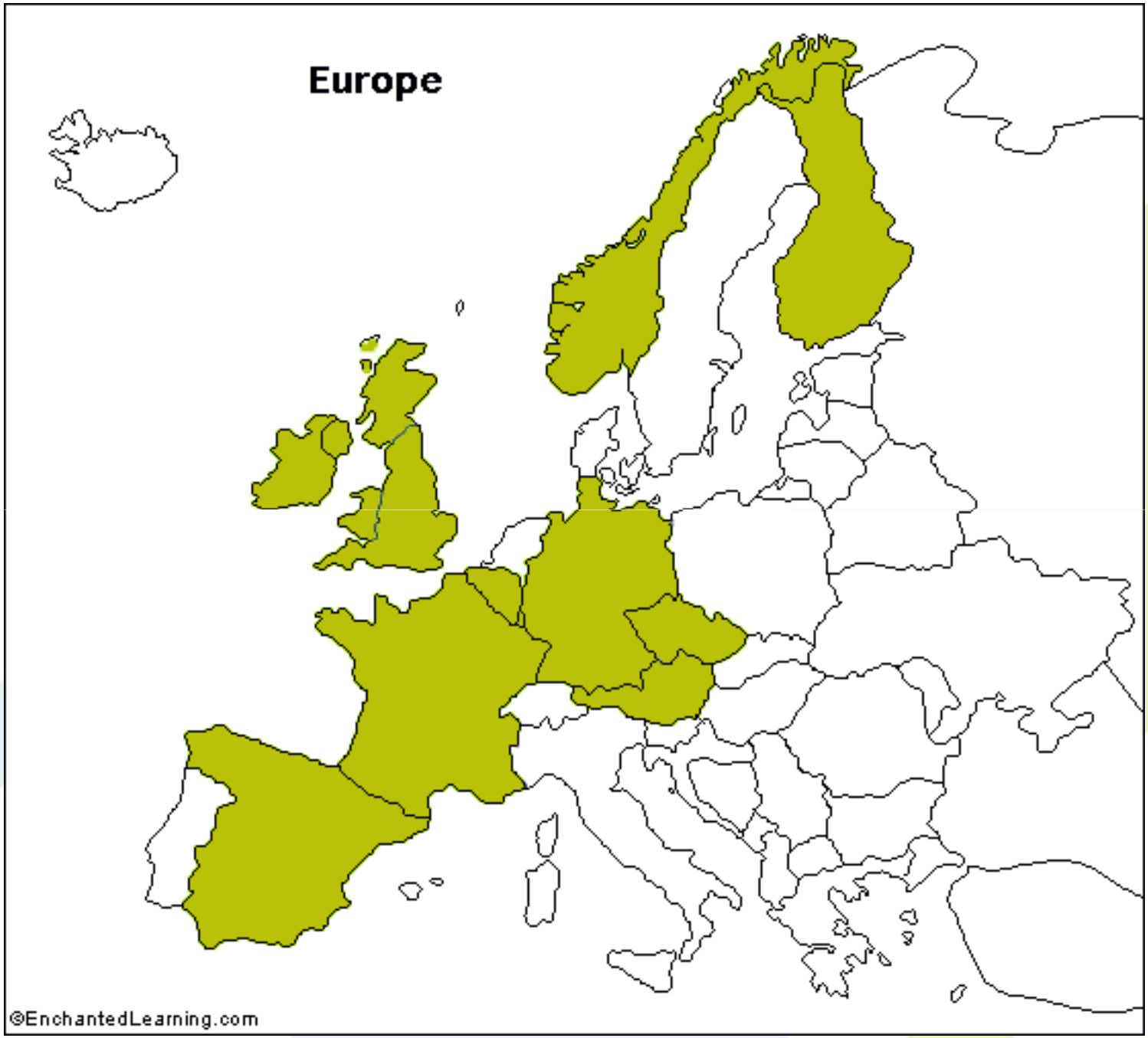




Development of *Margaritifera margaritifera* culture in Europe



Lima et al., The Quarterly Review of Biology, submitted


Europe
©EnchantedLearning.com

Life cycle of *Margaritifera margaritifera*

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

Size: 60-80 µm

Salmo trutta fario or *Salmo salar*

Size: 350-450 µm

Strategies

-Collect glochidia in the home stream / adult mussels stay in home stream

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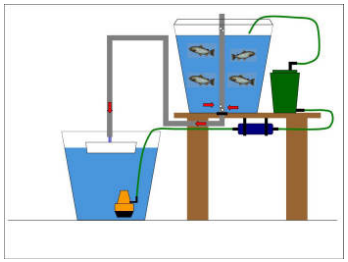
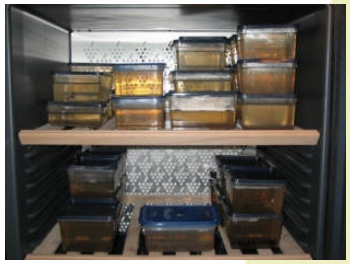
-Create an ark (bring adult mussels to hatchery)

Most common culturing method

- Collect juvenile mussels



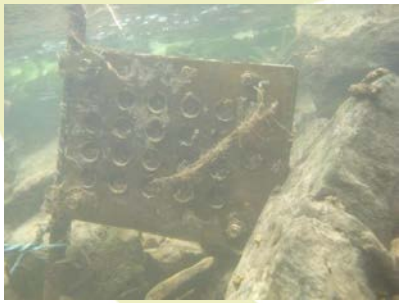
- Keep juveniles in the lab for preculture (detritus boxes) to reach >1mm



- Transfer mussels into cages (Buddensiek cages) and bring back to home river

-Transfer mussels into larger cages

- Release of mussels in home stream



Other rearing methods

- Collect juvenile mussels or natural drop off in culture system

- Transfer juvenile mussels in gravel baskets, gravel raceways or seminatural raceways

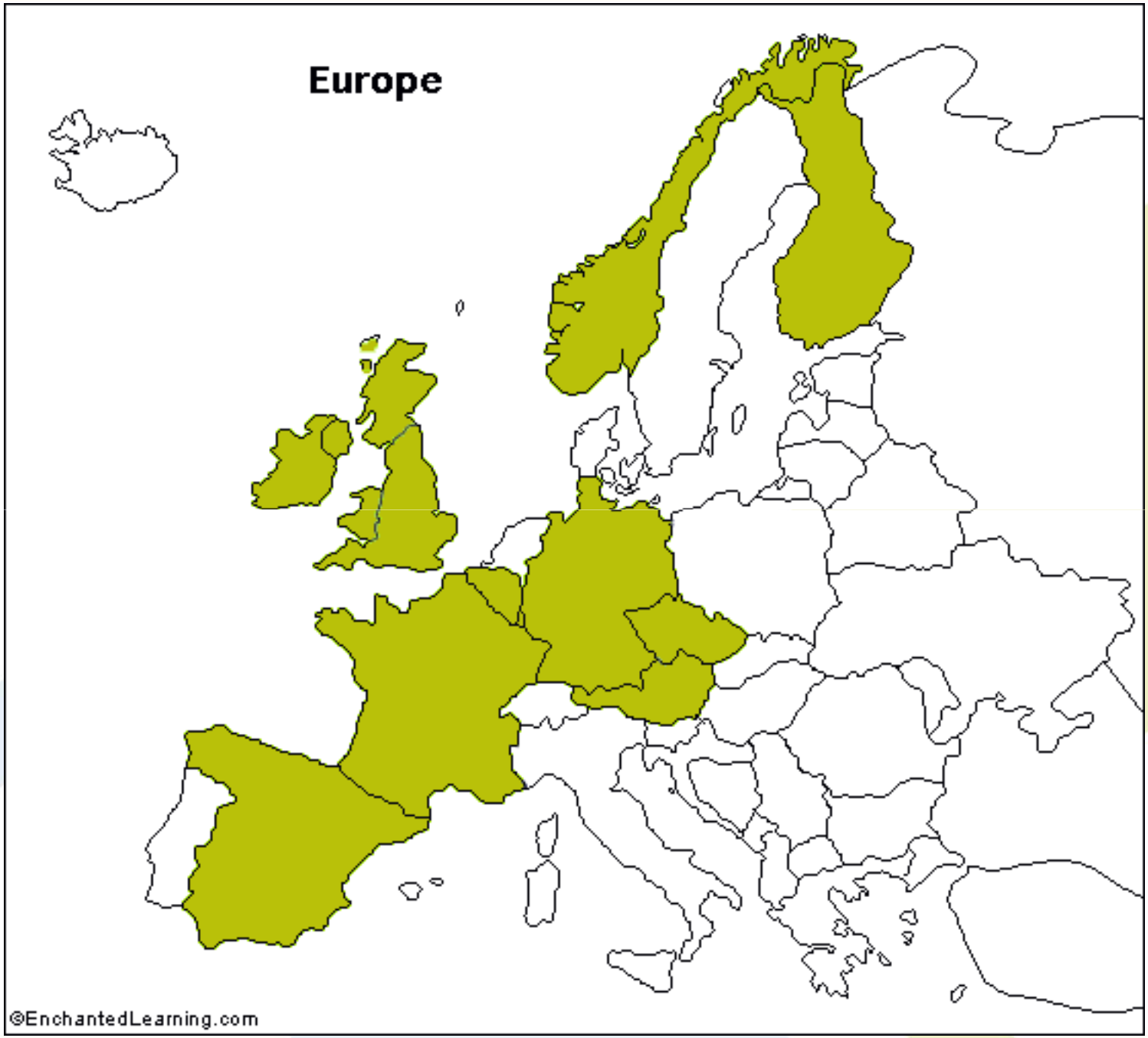
-Release of mussels (juveniles) without preculture in home stream

More rearing methods

-More lab intensive methods are tested and developed

Propagation method

-Host fish infestation and release of infested fish immediately or the following spring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Norway
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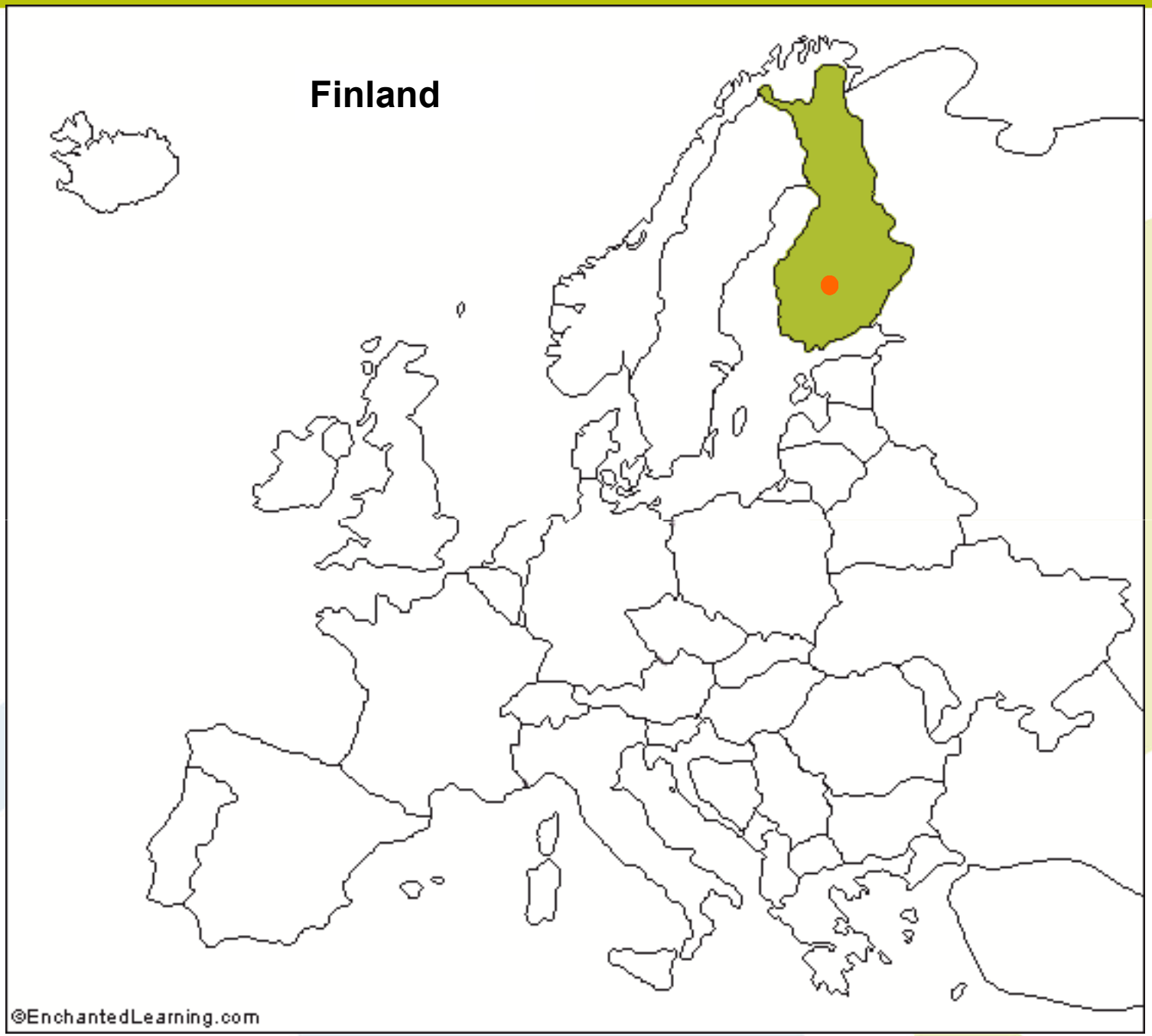
University of Bergen

Since	2011 - ongoing
Host fish	*Salmo trutta fario + Salmo salar*
Water use	Pond water
Populations	19
Strategy	Ark + Home Stream
Method	Detritus boxes + artifical stream
Success	Survival >90% first two years


Finland
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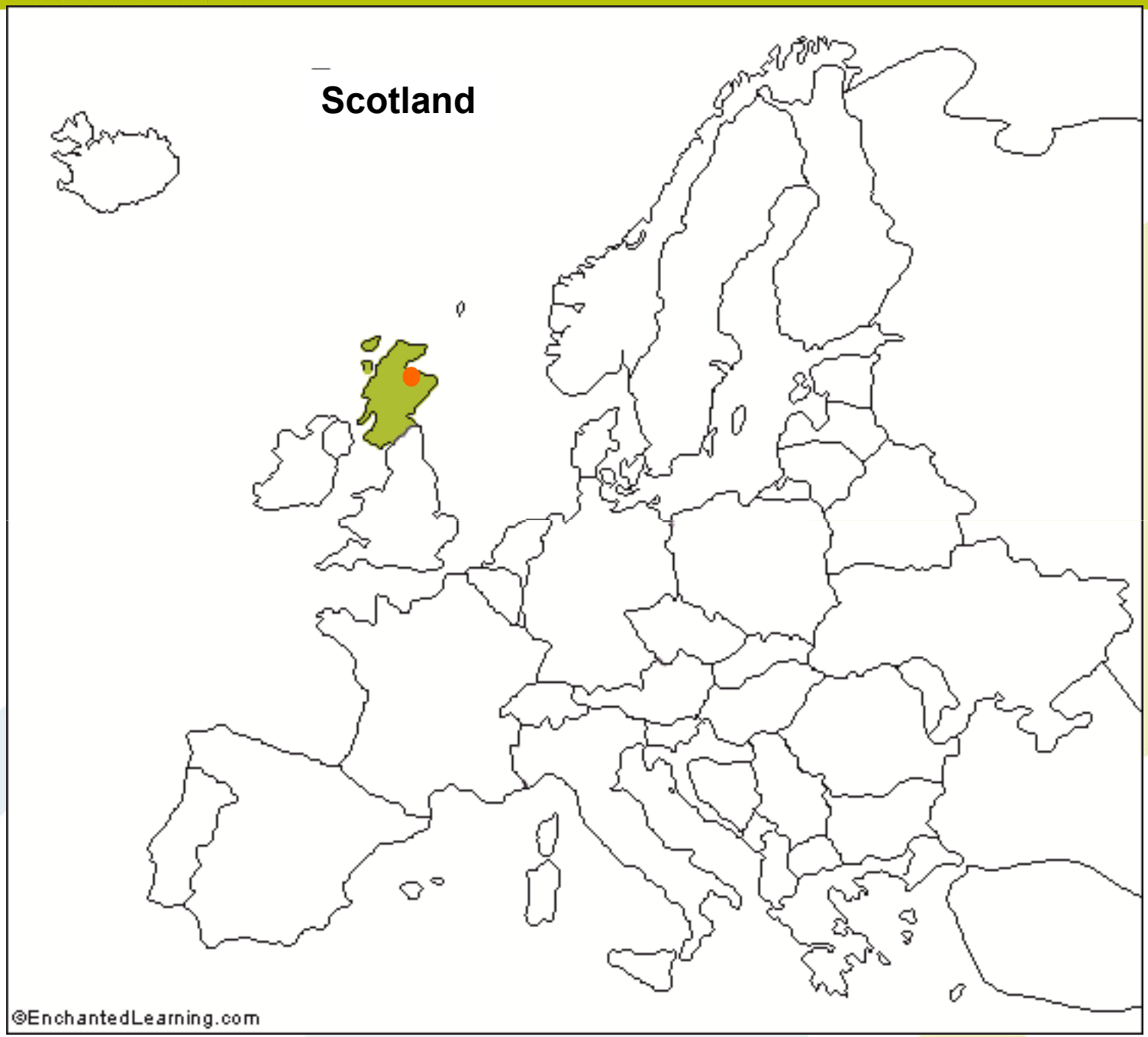
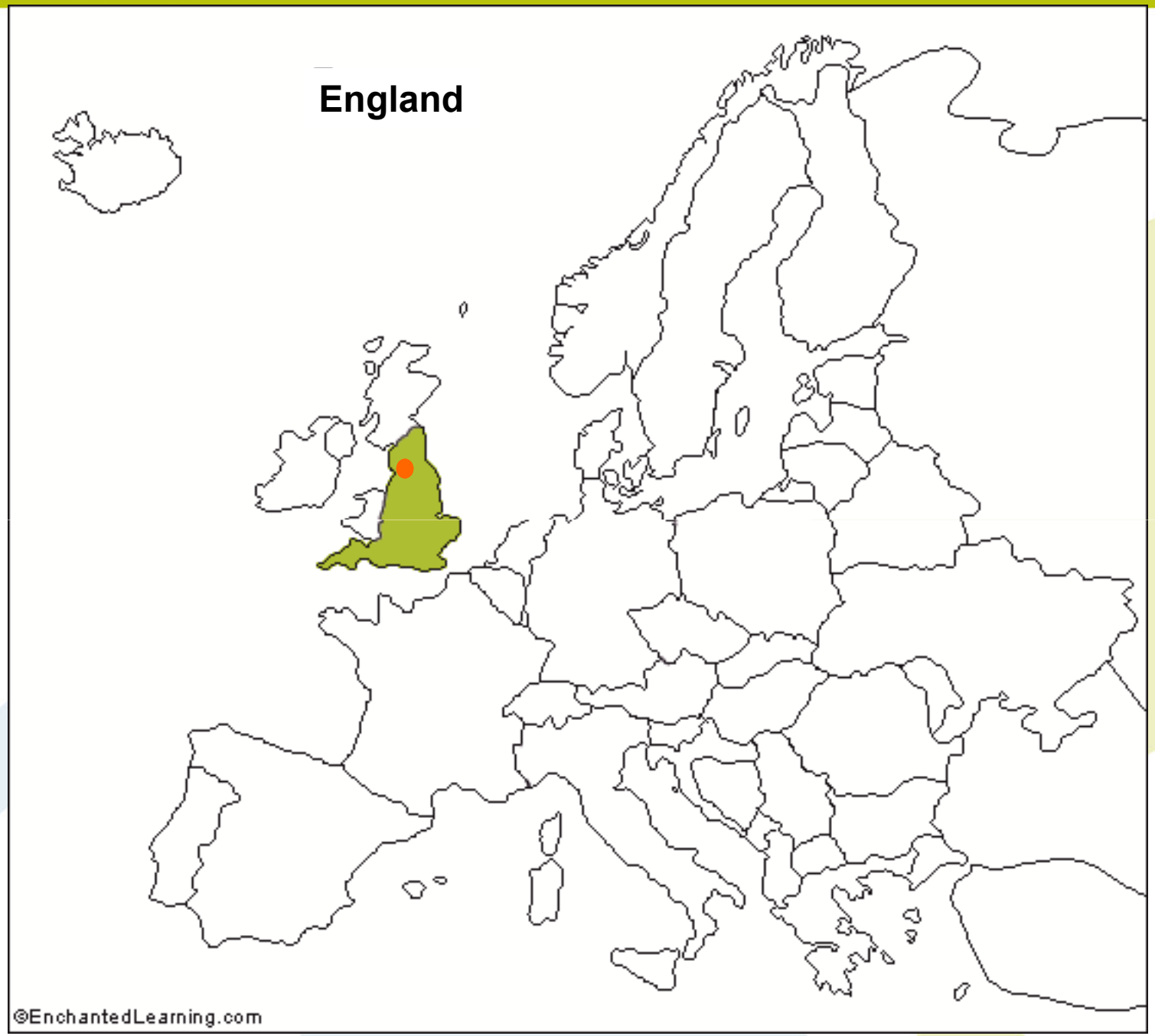
University of Jyväskylä

Years	2005 / 2007 / since 2012 - ongoing
Host fish	*Salmo trutta fario*
Water use	Lake water
Populations	1
Strategy	Home stream
Method	Release of juvenile mussels / invitro culture
Success	River Ala-Haapuanoja, River Iijoki catchment, northern Finland, where 20.000 M. margaritifera juveniles were released in 2007, Estimated total of 24 individuals on the 120 m^2 stocking area, equals 1.2 per mill survival rate during six years.


Scotland
©EnchantedLearning.com

LIFE Project / river Moidart, river Dee

Year	2001
Host fish	*Salmo salar*
Water use	River water
Populations	2
Strategy	Home stream
Method	Gravel cages
Success	Survival 1-11% only < 100 mussels


England
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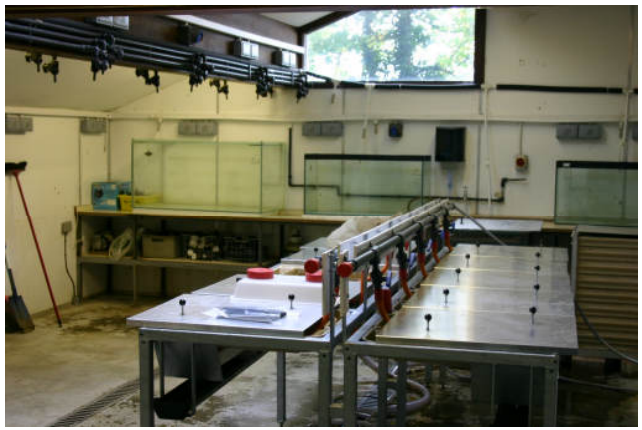
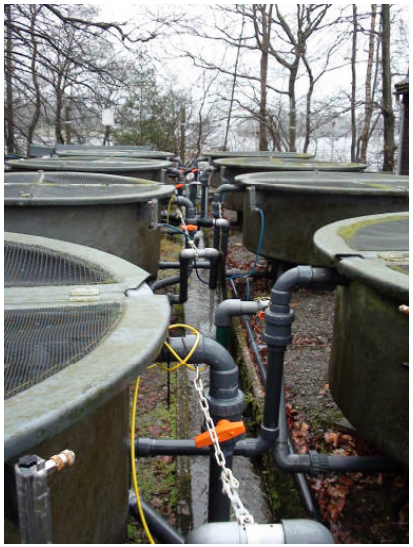
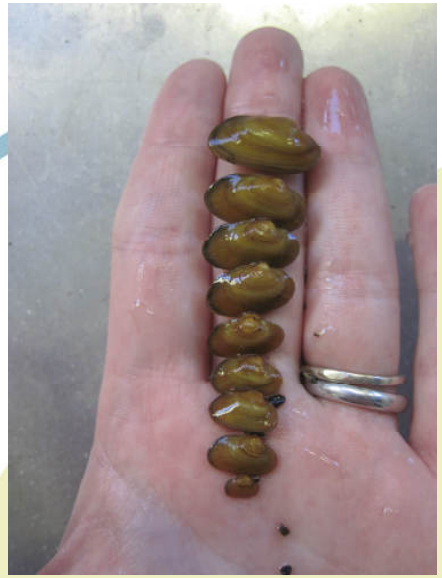
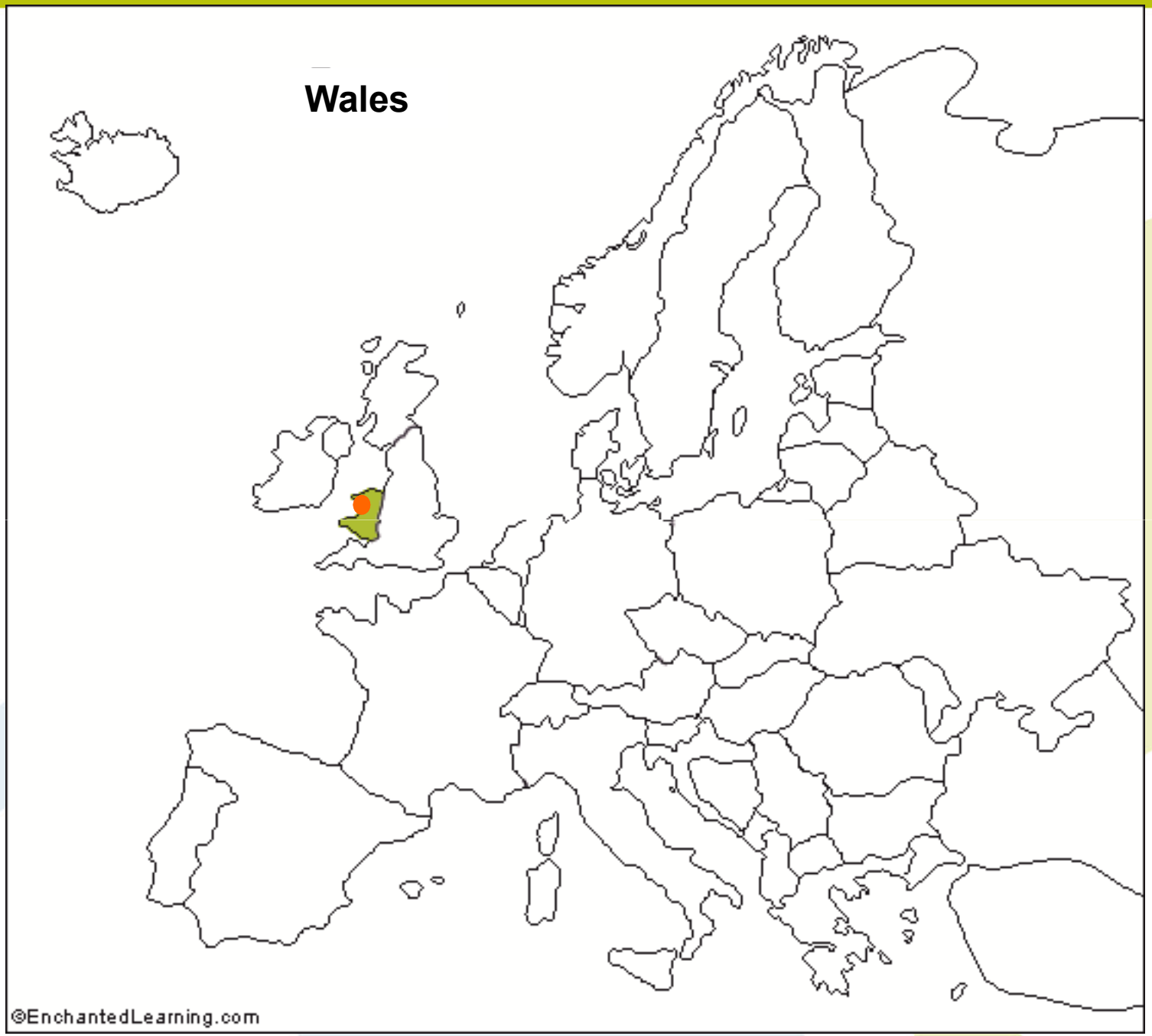
FPM Ark project Windermere, Freshwater Biological Association





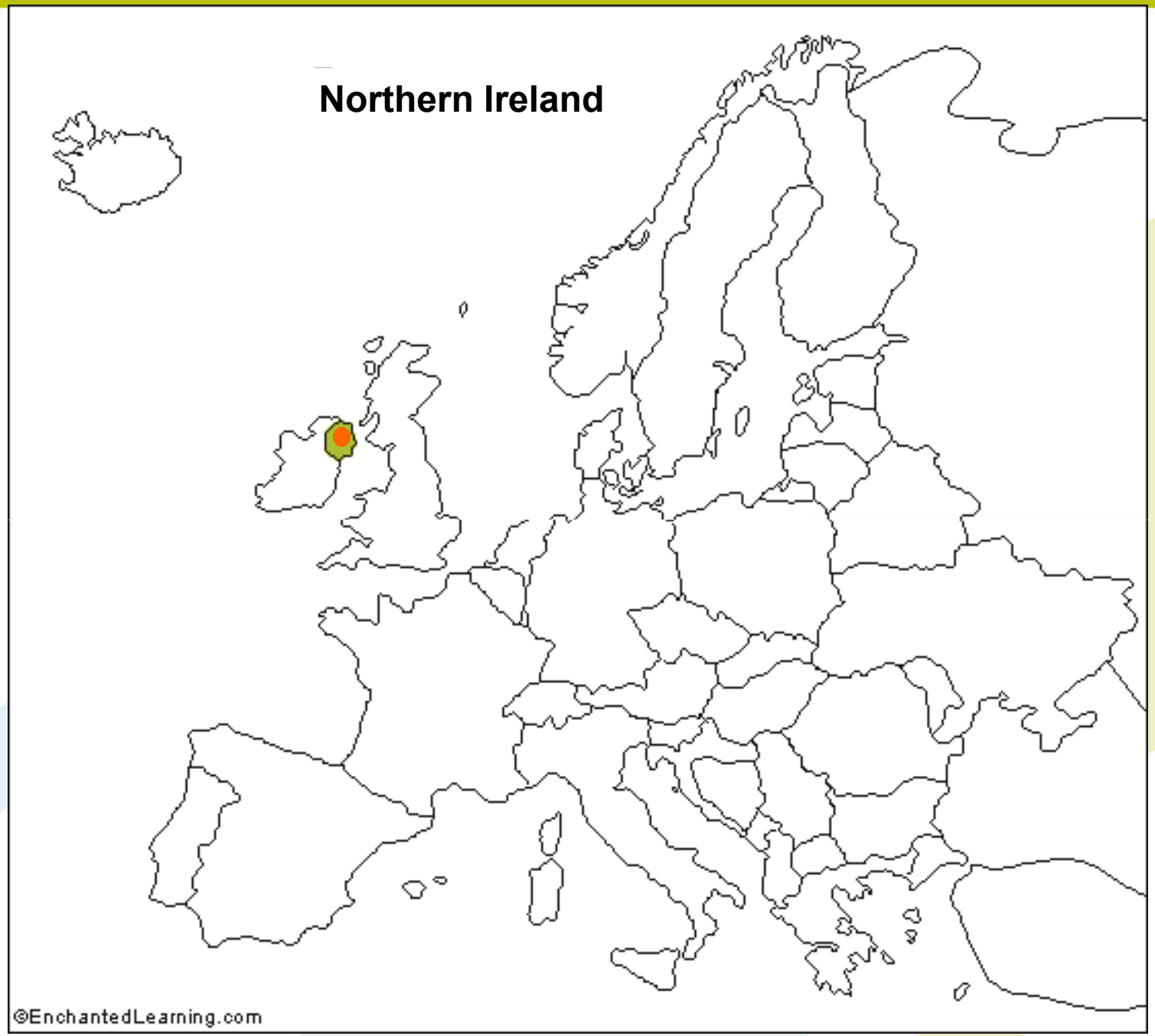


Since	2007 - ongoing
Host fish	*Salmo trutta fario + Salmo salar + Salvelinus alpinus*
Water use	Lake water
Populations	9 in 2012 / 7 in 2014 – 2 returned to river
Strategy	Ark
Method	Gravel trays
Success	136 mussels > 6 years / 60 mussels > 5years 518 mussels > 2 years / >10000 mussels > 1-0 years


Wales
©EnchantedLearning.com

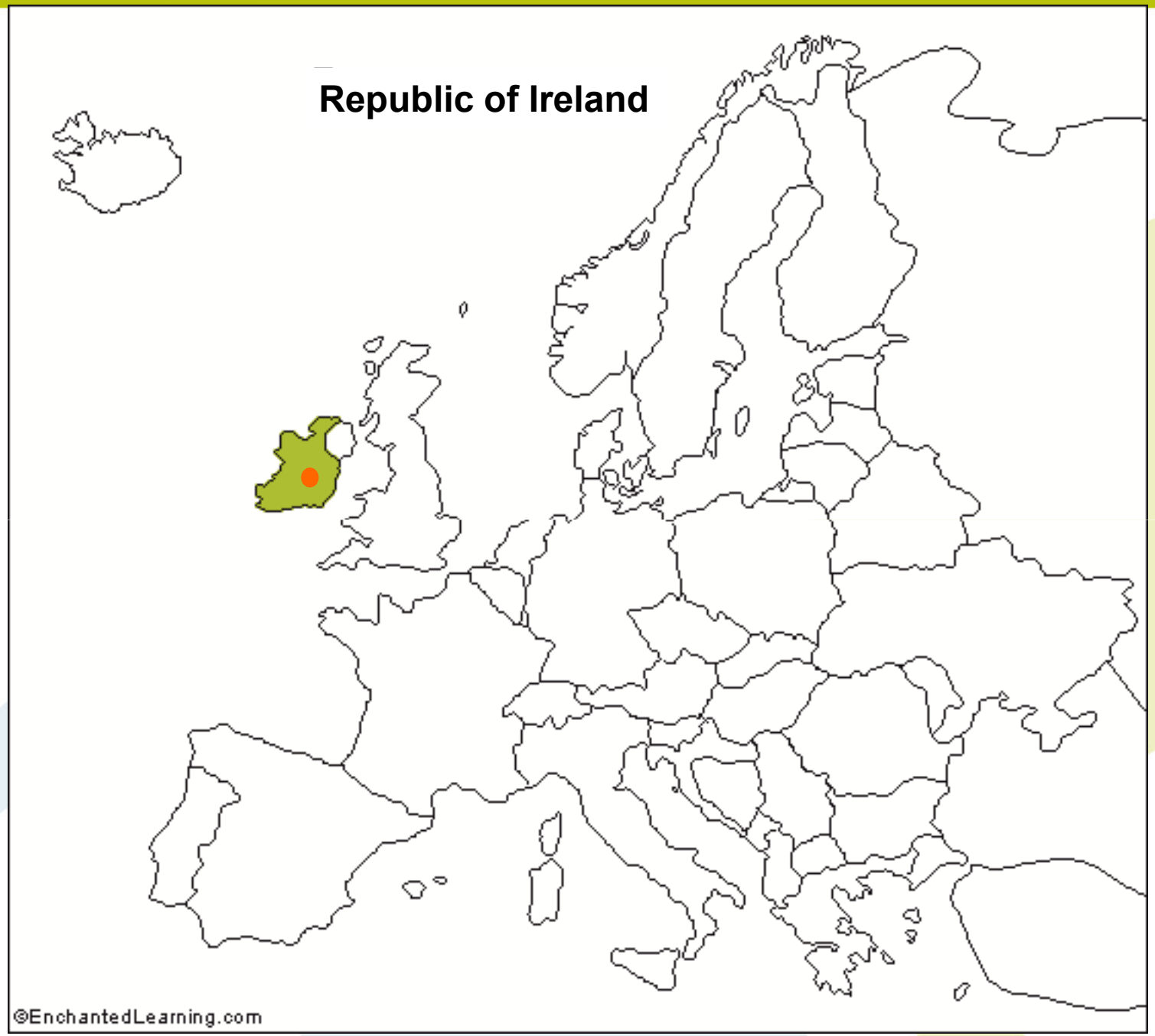
Environment agency Wales, Mawddach Hatchery

Since	2004
Host fish	*Salmo trutta trutta + Salmo salar*
Water use	River water
Populations	7
Strategy	Ark
Method	Gravel trays
Success	<100 mussels different ages / still high juvenile mortality


Northern Ireland
©EnchantedLearning.com

Ballinderry Fish Hatchery Ltd, Orritor Road, Cookstown

Since	1999 ongoing
Host fish	*Salmo trutta fario*
Water use	River water
Populations	1
Strategy	Ark
Method	Seminatural raceway, release of infested fish
Success	100,000 infested fish released, 500 tagged juvenile mussels released, 1,400 juveniles harvested but retained in hatchery tanks. Unknown number of juveniles in vivarium.


Republic of Ireland
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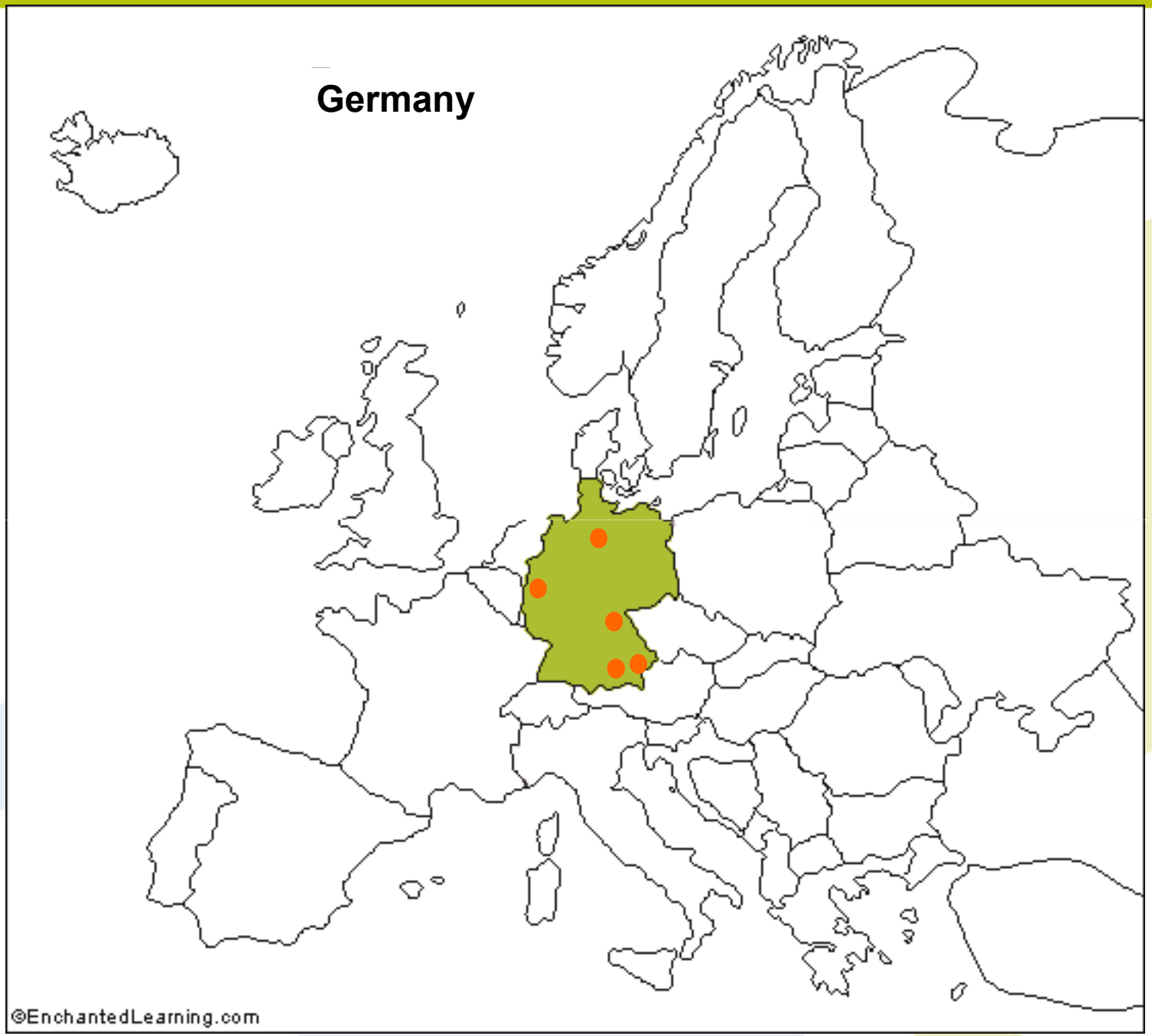
Evelyn Moorkens & Associates on behalf of National parks and Wildlife Service

Since	2006
Host fish	*Salmo trutta fario*
Water use	River water
Populations	1 = ***Margaritifera margaritifera durrovensis*** Nore River
Strategy	Home stream
Method	Semi-natural rearing of juvenile mussels in long and circular tanks with gravel bottoms.
Success	Several 100 small mussels. No mussels released.


Germany
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Vogtland area; Anglerverband Südsachsen "Mulde/Elster" e.V.

Years	2000 - 2012
Host fish	*Salmo trutta fario*
Water use	River water
Populations	3
Strategy	Home stream
Method	Detritus boxes, Buddensiek cages, gravel cages
Success	Numbers of mussels released into the wild: 5.590 (2007... 2012)

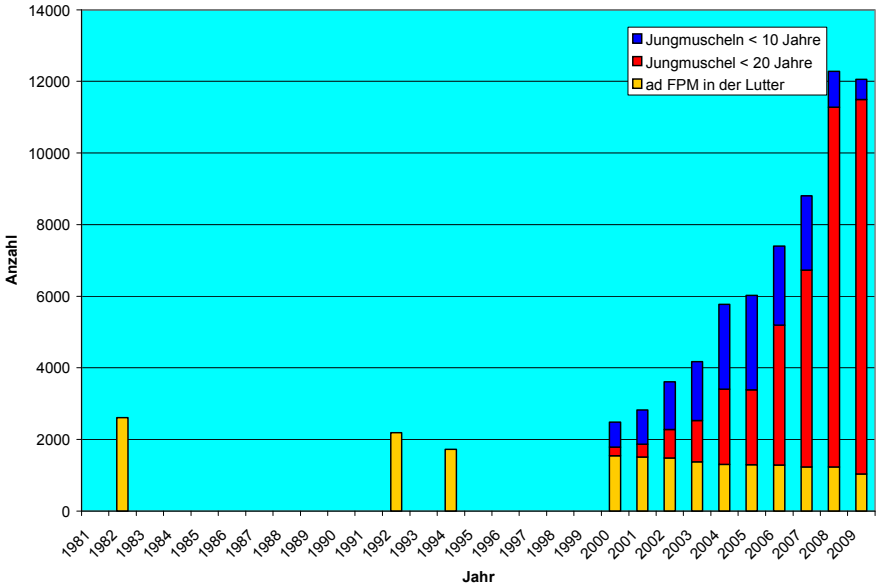
Bavaria/ Landes Pflege Verband (LPV) Passau

Since	2007 ongoing
Host fish	*Salmo trutta fario*
Water use	River water
Populations	2 from bavaria / 1 Our LU / 1 Perlenbach DE
Strategy	Home stream
Method	Detritus boxes, Buddensiek cages, gravel cages release of infested fish
Success	A few hundred several year old mussels/ most released into home rivers

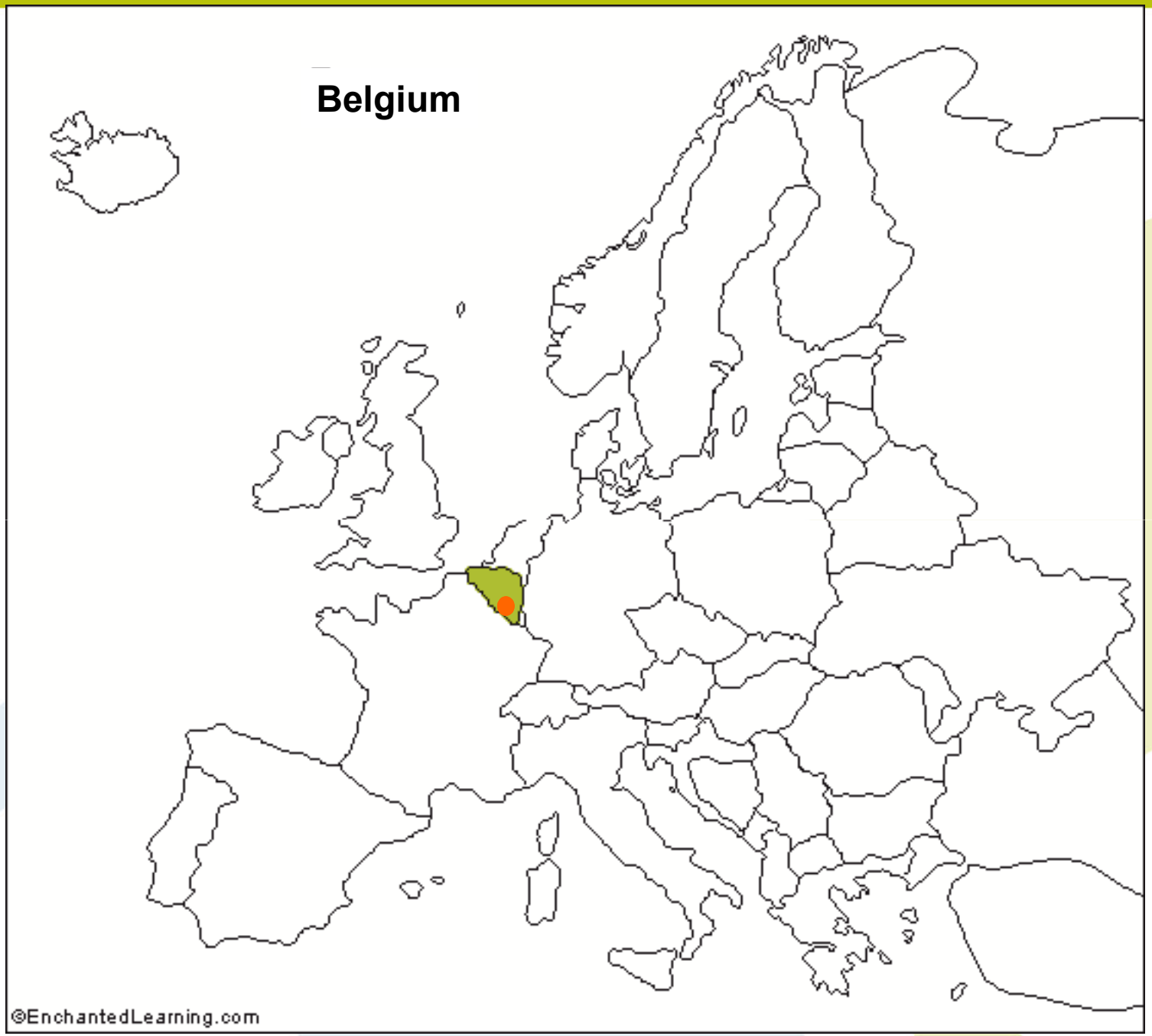
Nordrhein-Westfalen, Biologische Station Städte Region Aachen e.V.

Since	2006 ongoing
Host fish	*Salmo trutta fario*
Water use	River water
Populations	2 Germany / 1 Our LU
Strategy	Home stream
Method	Detritus boxes, Buddensiek cages, gravel cages, release of infested fishes
Success	Thousands in the size of 0,5-1mm/ 300 in the size of 1-2 cm

Lower Saxony, Germany / River Lutter



Years	1973 - 2001
Host fish	*Salmo trutta fario*
Water use	River water
Populations	1
Strategy	Home stream
Method	Infestation and release of infested (autochthonous) fish
Success	Release of 9000 infested autochthonous brown trout Number of juveniles in the river increases since the year 2000


Belgium
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Wallonia / (DEMNA) (DNF), Achouffe Hatchery

Since	2005 - 2012
Host fish	*Salmo trutta fario*
Water use	River water
Populations	3
Strategy	Home stream
Method	Juvenile mussels relesed in seminatural raceway
Success	890.000 juveniles released in two raceways since 2006 No data about survival so far.


Luxembourg
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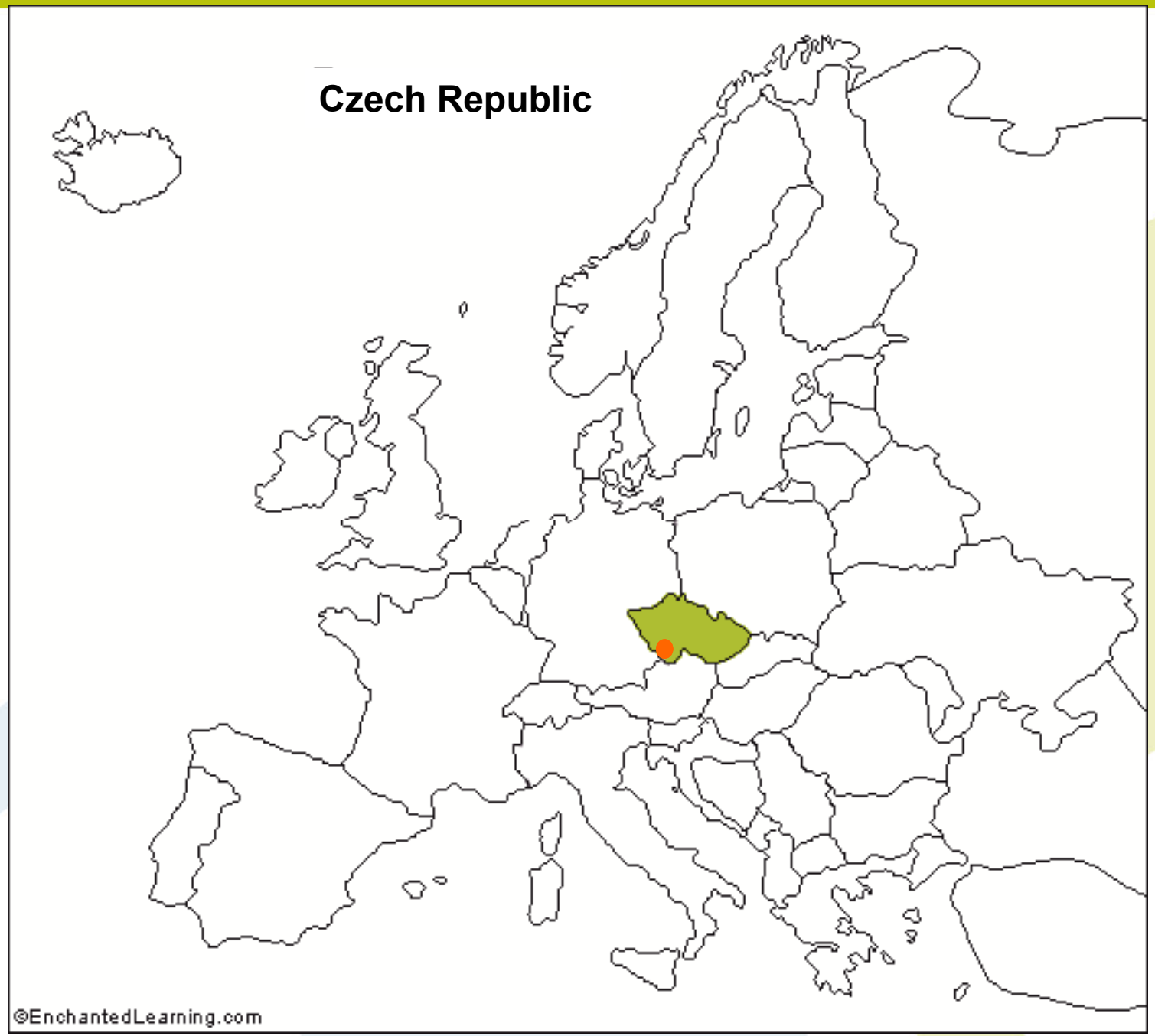
Life Project / Luxembourg government MDDI and MIGR

Since	2008 ongoing
Host fish	*Salmo trutta fario*
Water use	River water
Populations	1
Strategy	Home stream
Method	Detritus boxes, Buddensiek cages, gravel cages, sandaquaria release of infested fishes but also more lab intensive culture
Success	50 mussels > 3cm / 350 mussels 1-2 cm / 500 mussels 0.5-1 cm/ >1000 mussels 0.1-0.5cm / survival in lab good but survival in home stream not good


Czech Republic
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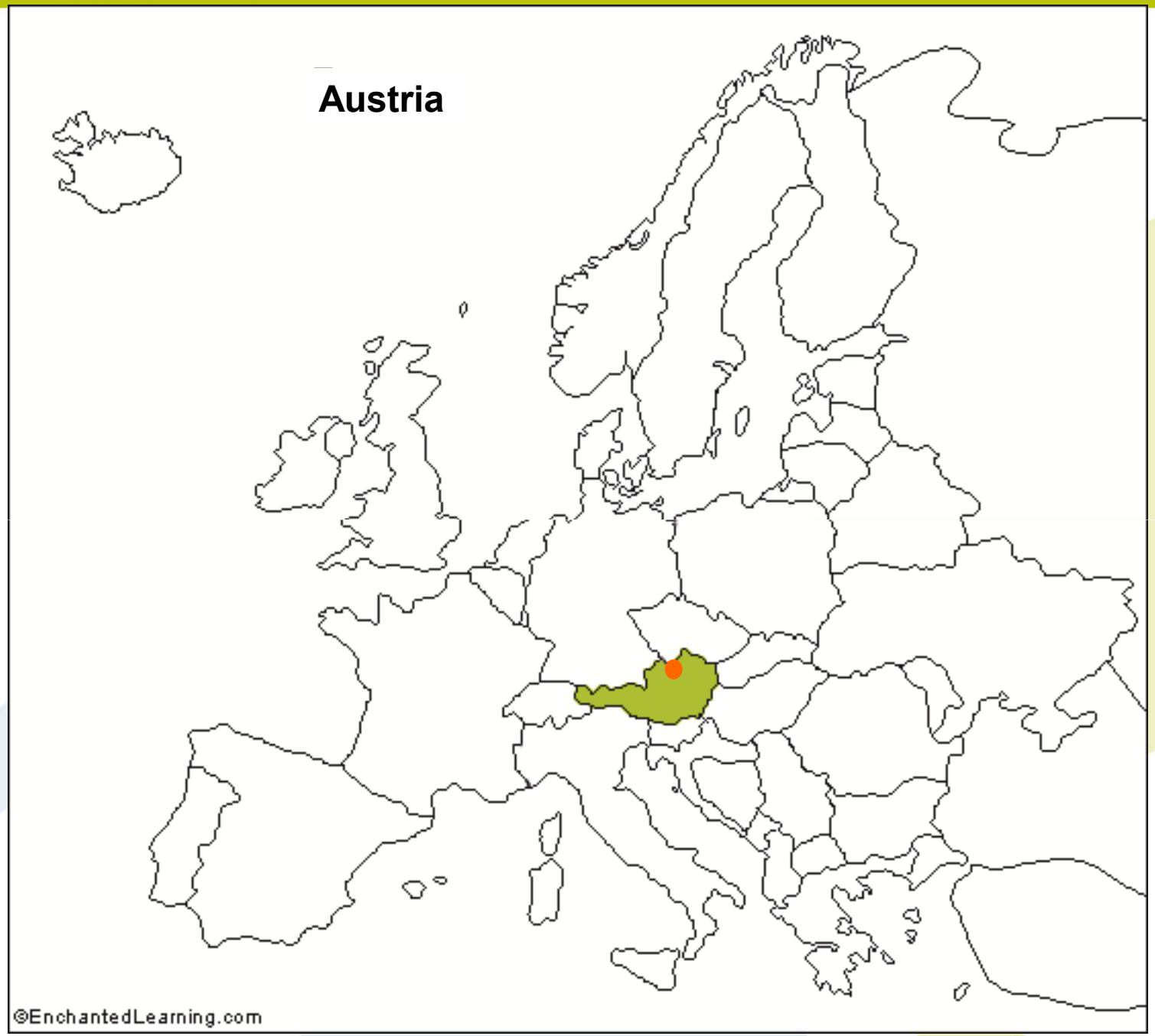
South Bohemia and West Bohemia : Nature Conservation Agency of the Czech

Since	1990 ongoing
Host fish	*Salmo trutta fario*
Water use	Well water and river water
Populations	7
Strategy	Home stream
Method	Detritus boxes, Buddensiek cages, gravel cages,
Success	30000 mussels > 3years released / size 2 -2.5 cm


Austria
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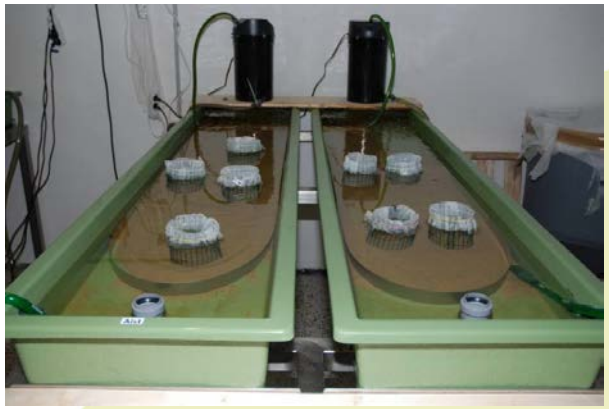
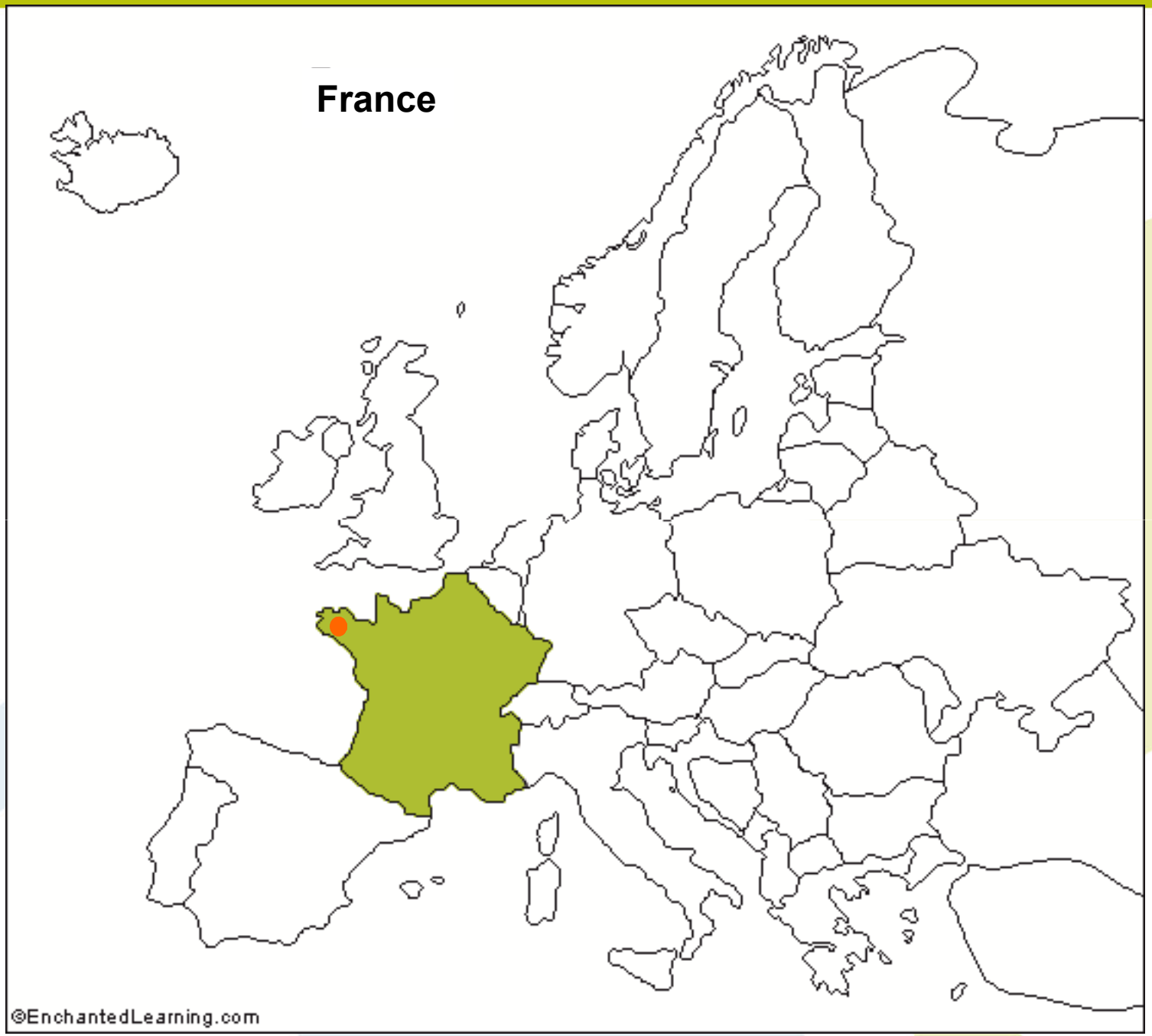
Mühlviertel Consultants in Aquatic Ecology and Engineering, Blattfisch



Since	2010 ongoing
Host fish	*Salmo trutta fario*
Water use	River water
Populations	3
Strategy	Ark
Method	Detritus boxes, Buddensiek cages, gravel cages, silos
Success	3 years old: 141 mussels / 2 years old: 322 mussels / 1 year old: 183 mussels / 0-1 year old: >5000 mussels


France
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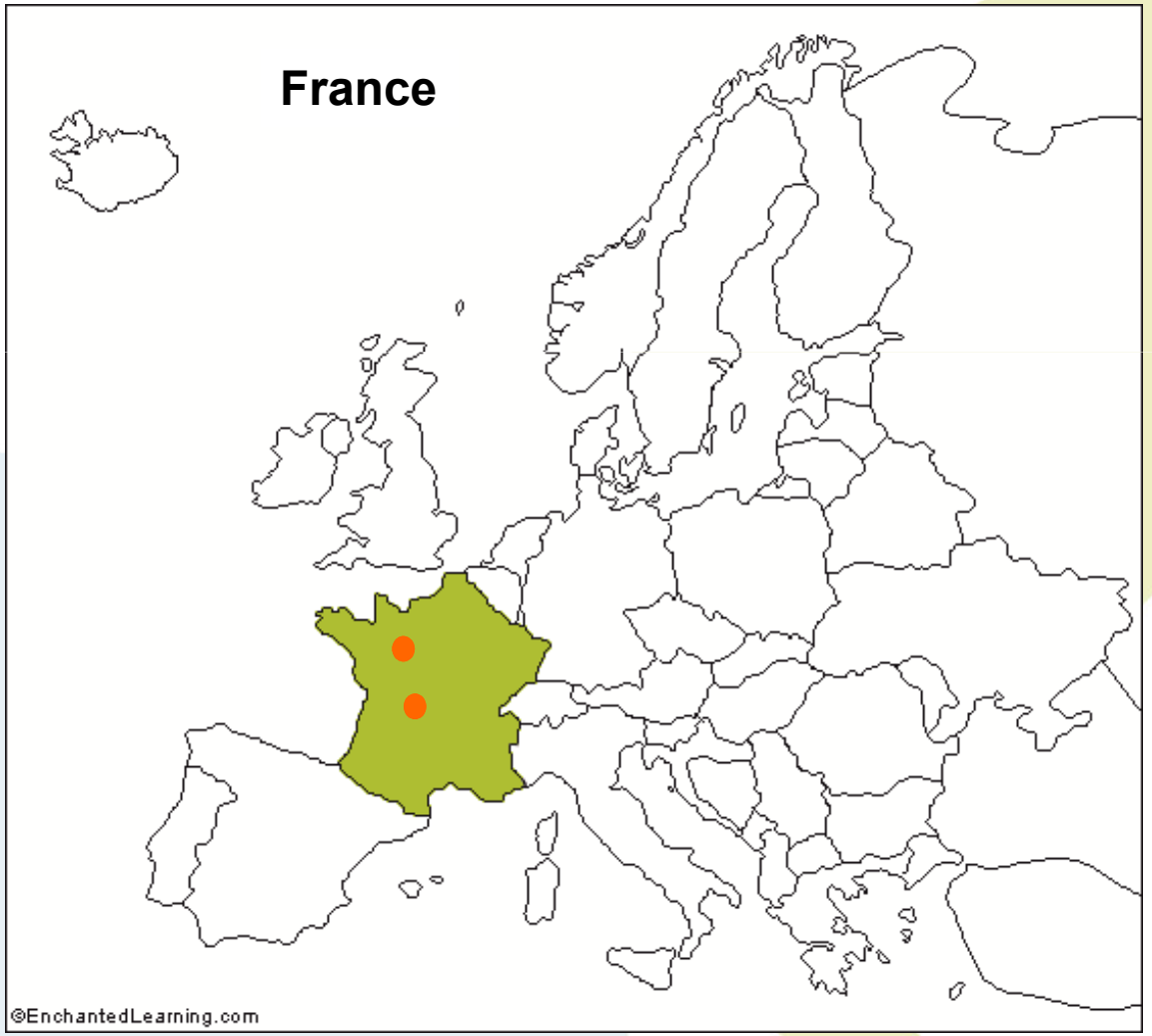
Life Project LIFE+ NAT/FR/000583 in Brittany and Normandy

Since	2010 ongoing
Host fish	*Salmo trutta fario*
Water use	River water
Populations	6
Strategy	Home stream
Method	Detritus boxes, Buddensiek cages, more lab intensive culture
Success	around 20 000 young of 8 months old at the rearing station. Some of them measuring 5 mm.

LIFE + Projet: "Grande Mulette" *Conservation of the Giant Pearl Mussel Margaritifera auricularia in Europe* in Chinon **LIFE13 BIO/FR/001162**

Life+ Project: Marga Haute-Dronne - Life + Nature Preservation of Margaritifera margaritifera and restoration of river continuity of the Upper Dronne River **LIFE13 NAT/FR/000506**




Spain
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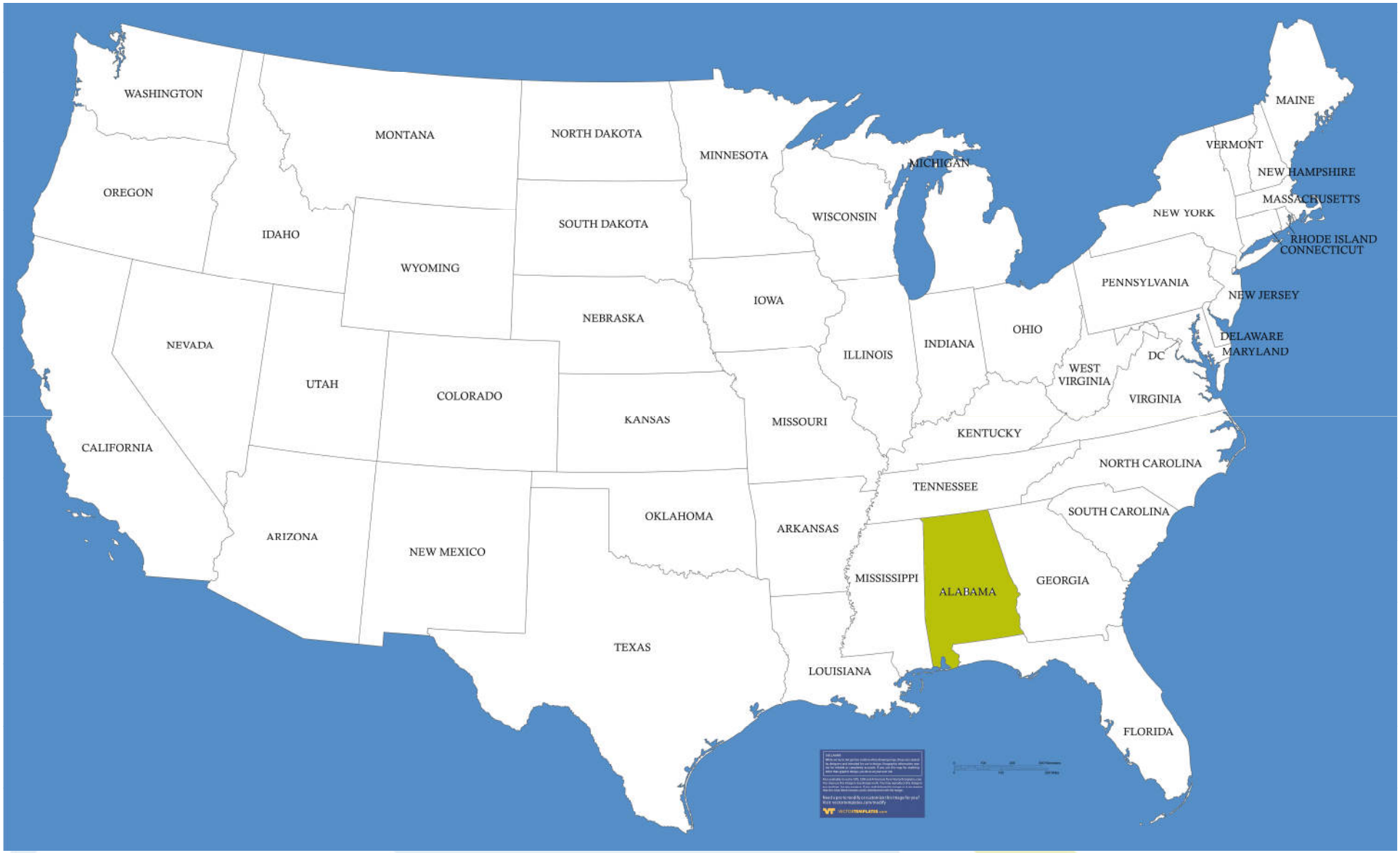
Life project 09/NAT/ES/000514 Galicia (NW of Iberian Peninsula)

Since	2012 ongoing
Host fish	*Salmo trutta fario*
Water use	River water
Populations	2 conservation units / 5 rivers
Strategy	Ark
Method	Detritus boxes, Buddensiek cages, more lab intensive culture Release of infested fish
Success	2 years old: 350 mussels / 0-1 year old: >6000 mussels

LIFE Project 2004-2007 / Government of Aragon/ River Ebro catchment

Since	2003 - 2014
Host fish	*Salaria fluviatilis*
Water use	River water
Populations	3 *Margaritifera auricularia*
Strategy	Ark
Method	Release of infested fish in the river Release of juvenile mussels collected in laboratory Lab intensive culture
Success	250.000 juveniles born in the laboratory released

USA / Alabama


WASHINGTON
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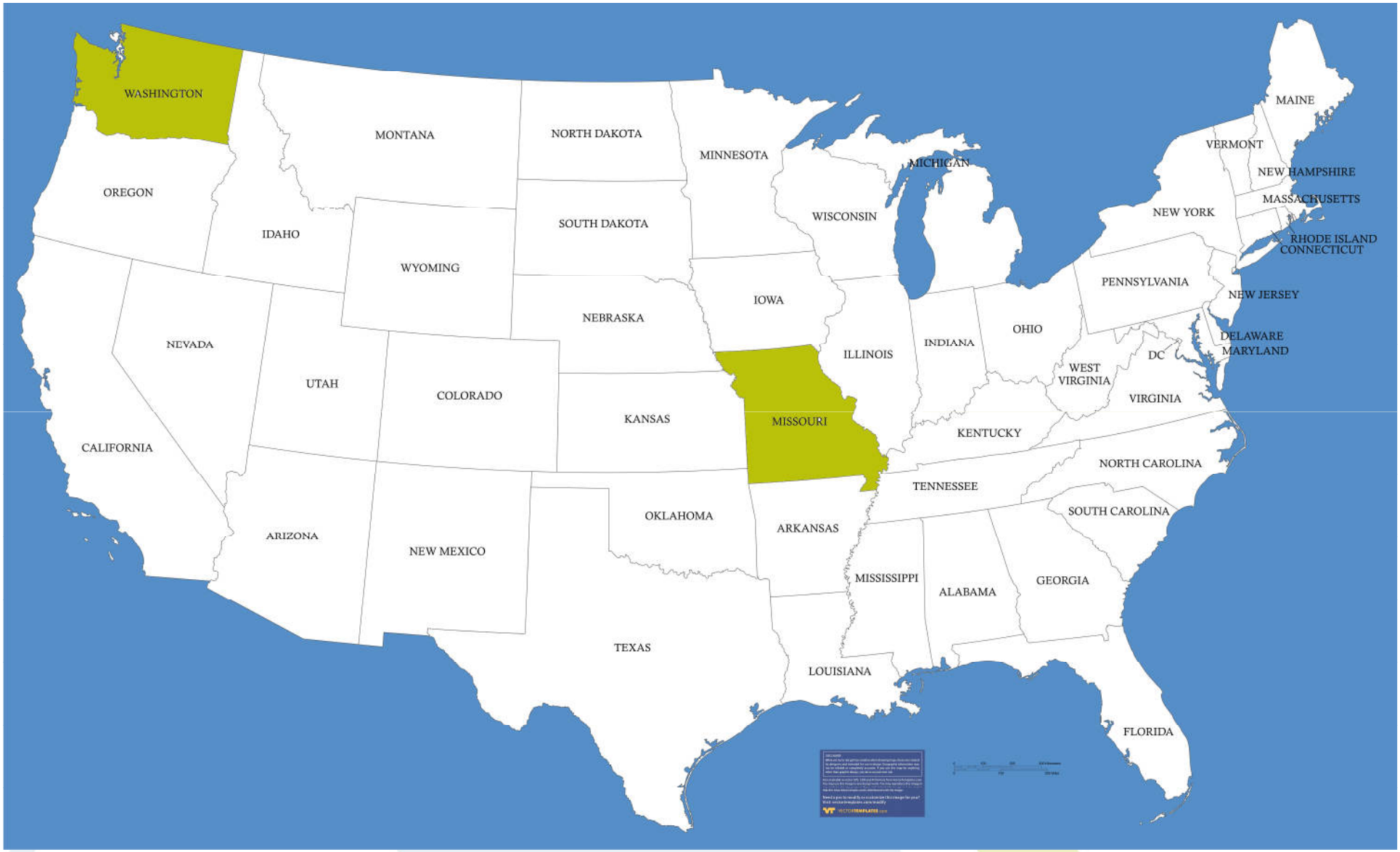
VIRGINIA
WEST VIRGINIA
PENNSYLVANIA
NEW YORK
MAINE
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
RHODE ISLAND
CONNECTICUT
NEW JERSEY
DELAWARE
MARYLAND
DC

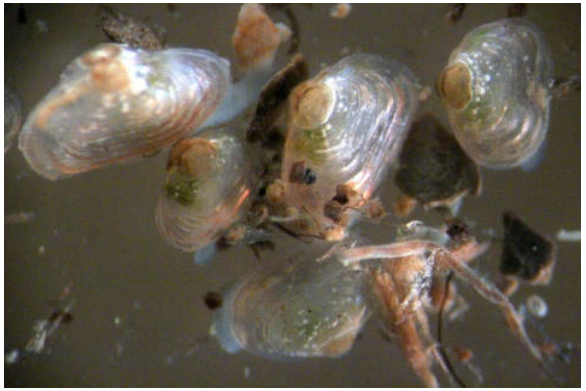
Margaritifera marrianae , Alabama Pearlshell
USA / Alabama Aquatic Biodiversity Center

Since	2013
Host fish	*Esox americanus*
Water use	Well water
Populations	1 *Margaritifera marrianae*
Strategy	Home stream
Method	Detritus boxes
Success	First trials / After 150 days mussels reach 2-4mm

USA / Washington, Missouri

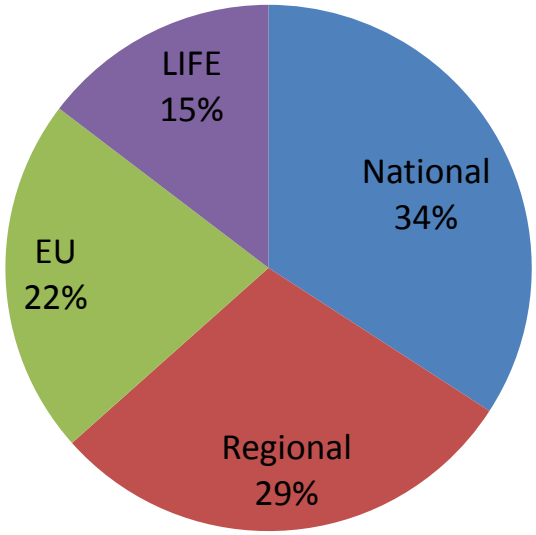


***Margaritifera falcata,* Western Pearlshell,**
Confederated Tribes of the Umatilla Indian Reservation &
Missouri State University, Department of Biology

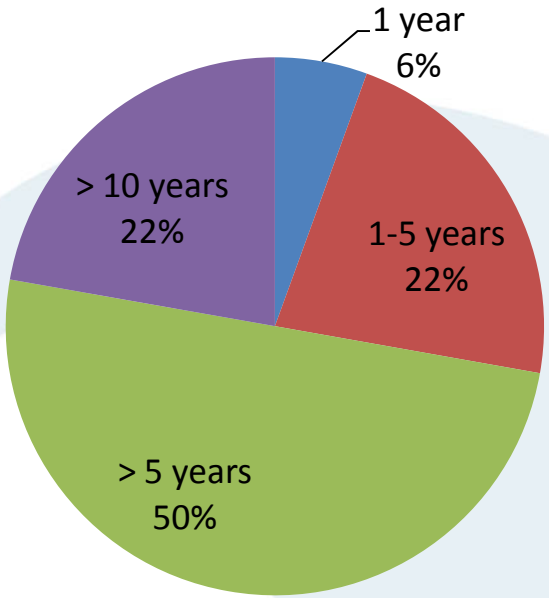


Since	2012
Host fish	Cutthroat trout, Rainbow trout, Chinook salmon
Water use	Well water
Populations	2
Strategy	Home stream
Method	Detritus boxes
Success	No information

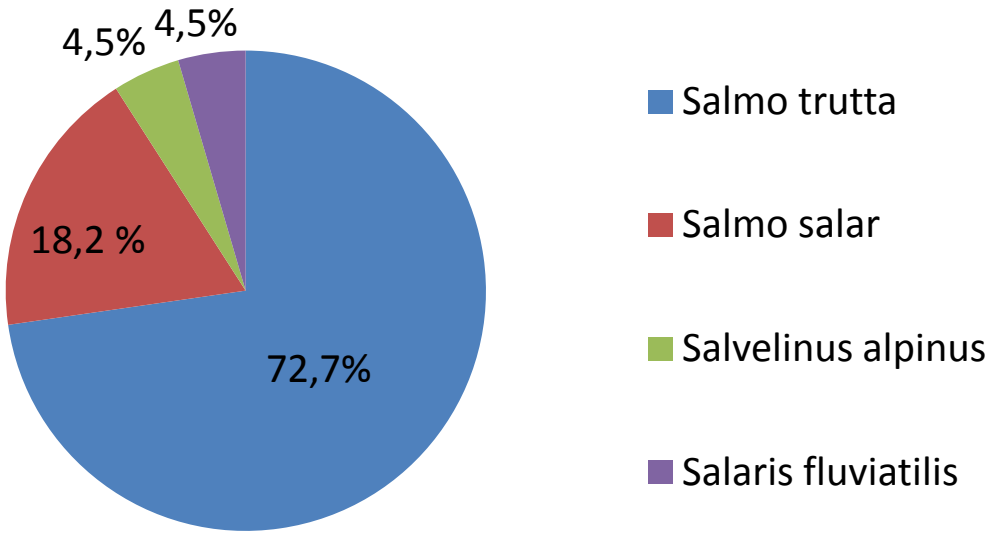
Funding



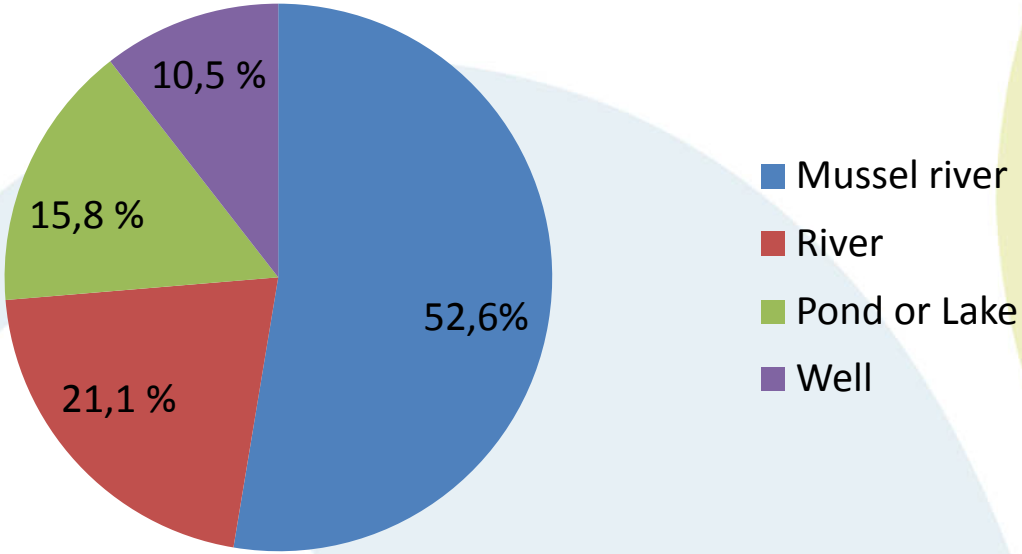
Runtime



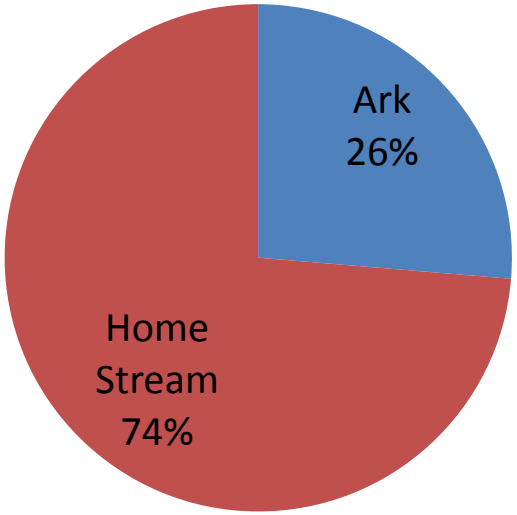
Host fish



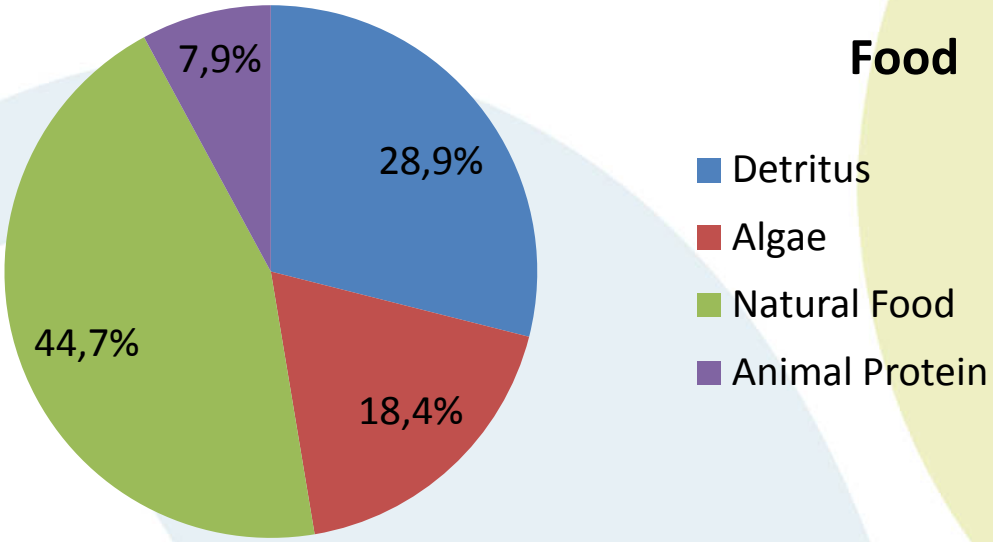
Water used



Strategy



Food



Most mussels successfuly released:

-Northern Ireland (Ballinderry Hatchery)

-Seminatural raceway with natural food

-Saxony Germany (Michael Lange)
-Czech Republic (Hrûska and Ondrej Spisar)

-Detritus boxes followed by Buddensiek- and gravel-cages with natural food

-Lower Saxony Germany (Reinhardt Altmüller)

-Key factor was river restoration

All successful projects had or have a runtime > 10 years

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!

Outlook

More lab intensive methods are tried and used

Additional algae food is tested

Additional rearing stations planed (e.g. France)

Conclusion (Input into species conservation)

Almost all FPM countries in Europe started rearing activities

Successful rearing of *M.m* is possible but successful release projects still rare

It can be and is a last-minute rescue tool

Reared mussels can be used as bioindicators to find suitable release rivers

Following up monitoring should be established for the released mussels

Knowledge sharing is important

But it can never replace the restoration of stream habitats

2nd International Seminar Rearing of unionid mussels

Clervaux, Luxembourg, Tuesday 24th November – Thursday 26th November 2015

1st announcement

Restoration of Unio crassus rivers in the Luxemburgish Ardennes
LIFE11 NAT/LU/857

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
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Gum, B., Lange, M., Geist, J. (2011)

A critical reflection on the success
of rearing and culturing juvenile freshwater
mussels with a focus on the endangered
freshwater pearl mussel (*Margaritifera margaritifera* L.)

Aquatic Conserv: Mar. Freshw. Ecosyst. 21: 743-751

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Thanks