UNIVERSITÉ DE NAMUR

FREEDOM TO RESEARCH

Avec le soutien du Fonds européen pour la Pêche
Investissons dans une pêche durable

Invasion of Western Europe by the Quagga mussel

Dreissena rostriformis bugensis

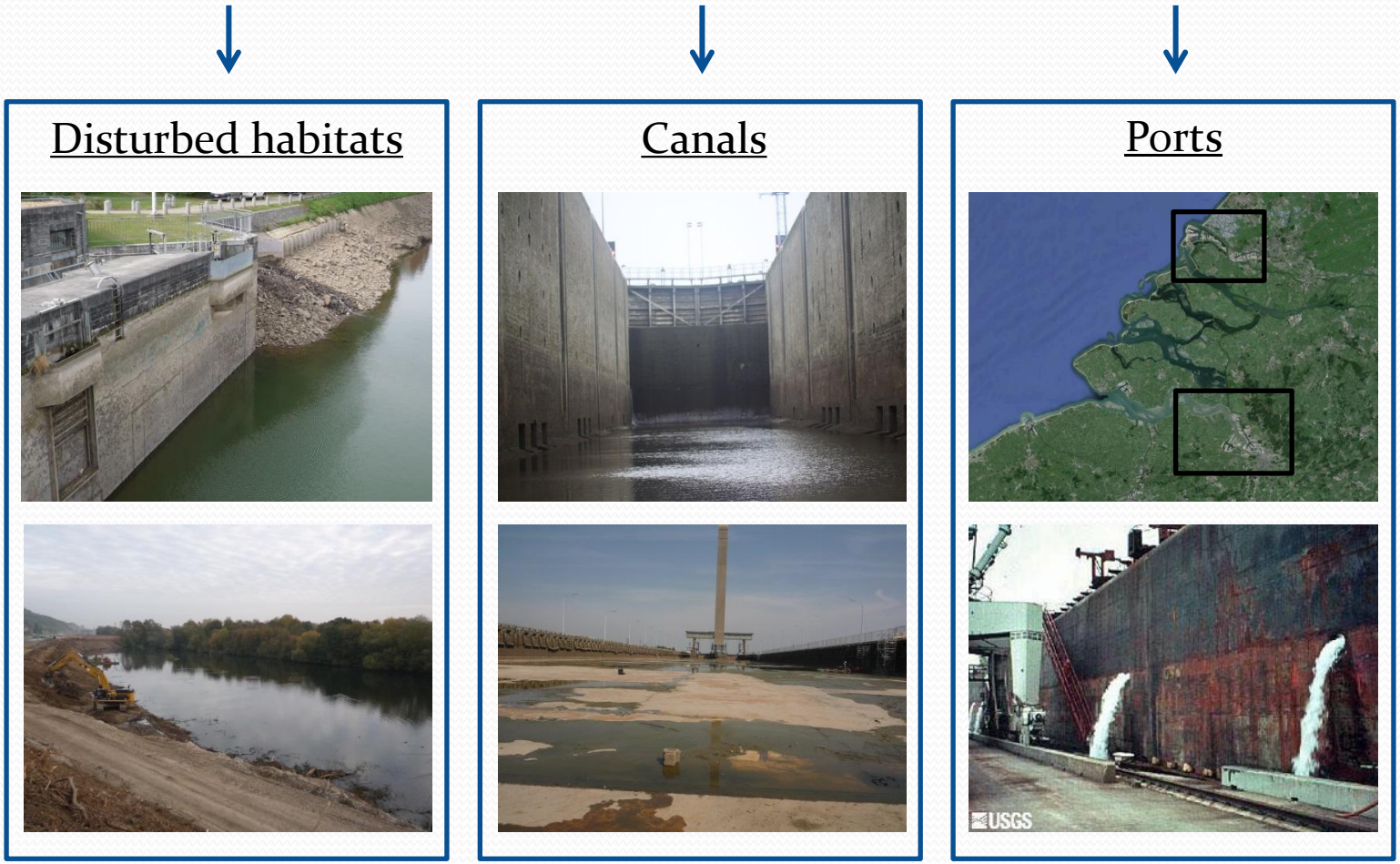
Phylogeography, population genetics and potential risk assessment

University of Namur
Faculty of Sciences
Department of Biology
URBE – LEGE (Pr. K. Van Doninck)

MARESCAUX Jonathan
PhD Student
April 2, 2014

Introduction

Waterways are conducive to biological invasions



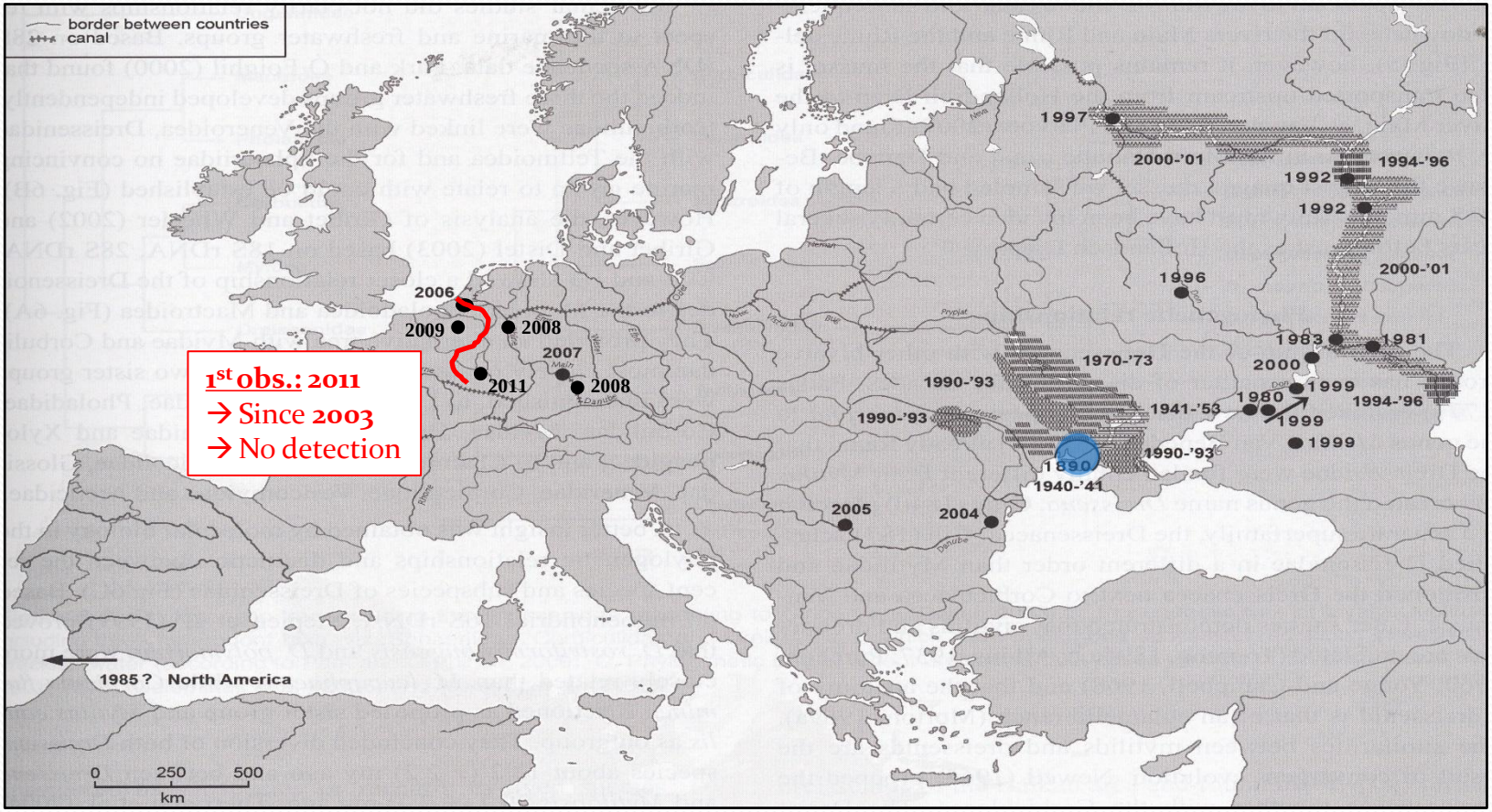
Introduction

- Zebra mussel (*Dreissena polymorpha*)

Modified from Van der Velde et al. (2010)

Introduction

- Quagga mussel (*Dreissena rostriformis bugensis*)

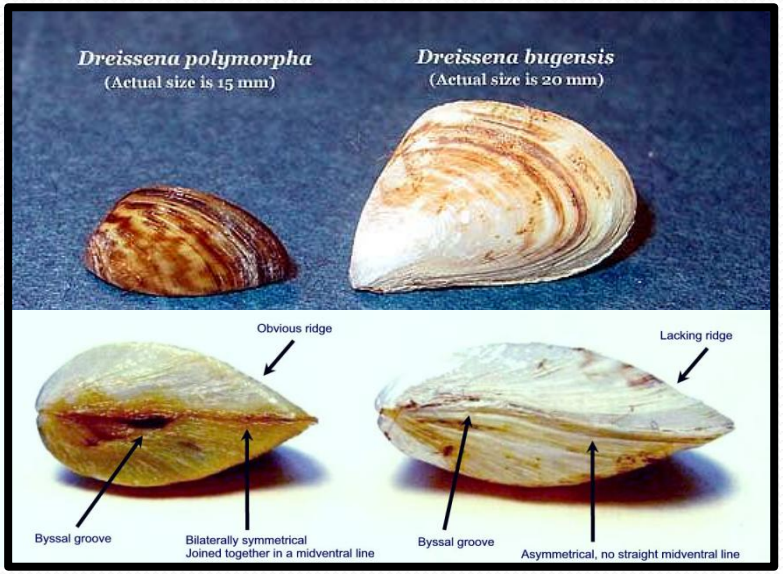


Marescaux et al. (2012a;b)

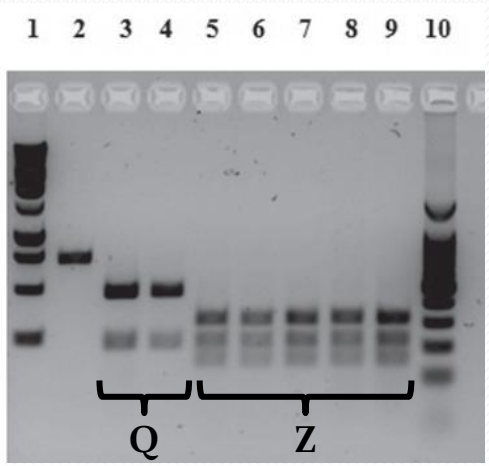
Modified from Van der Velde et al. (2010)

Introduction

- Zebra VS Quagga



US Geological Survey



RFLP on the *COI* gene using endonuclease NlaIII

Marescaux and Van Doninck (2014)

Part I: Colonisation pathways

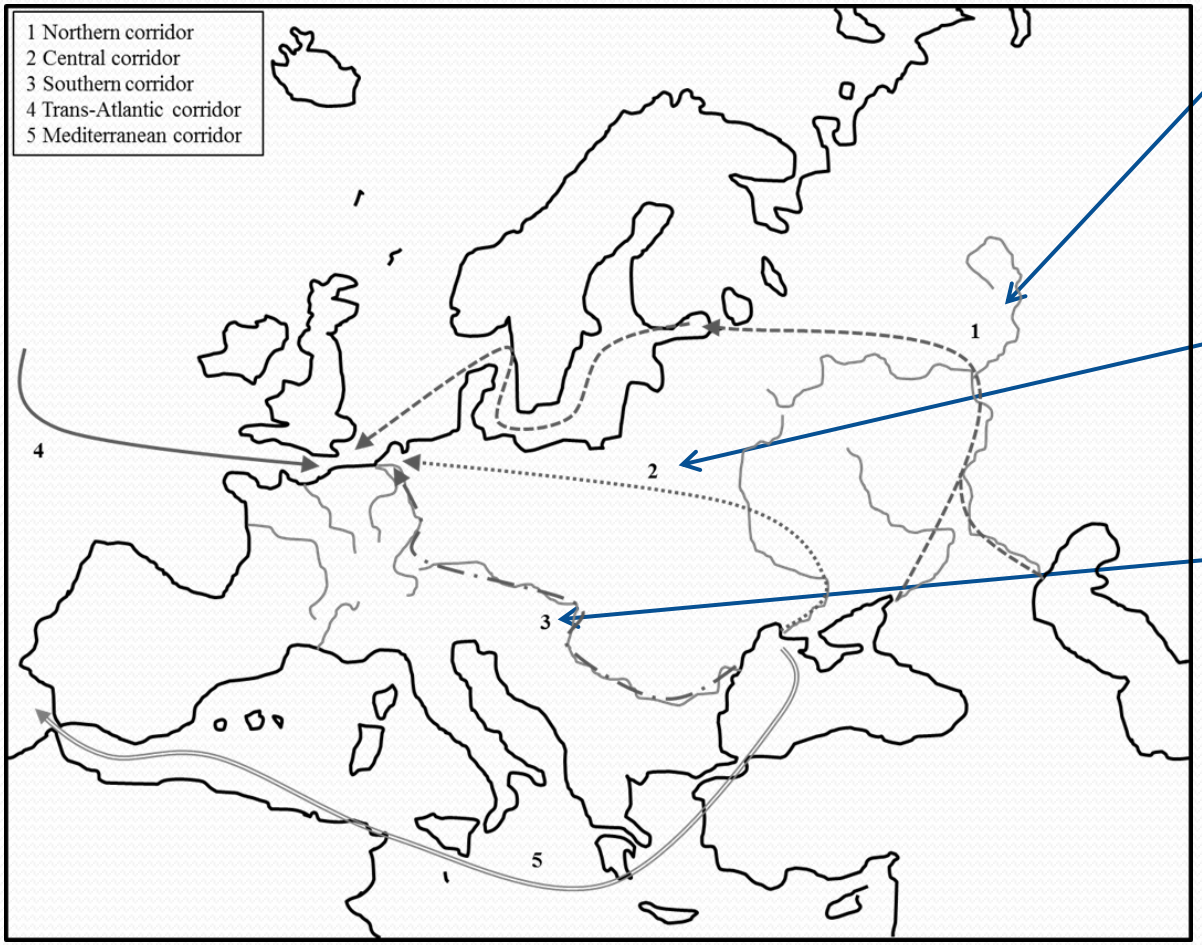
- Hypothesis

What were the colonisation pathways of the Quagga mussel in Western Europe?

Marescaux et al. (in prep)

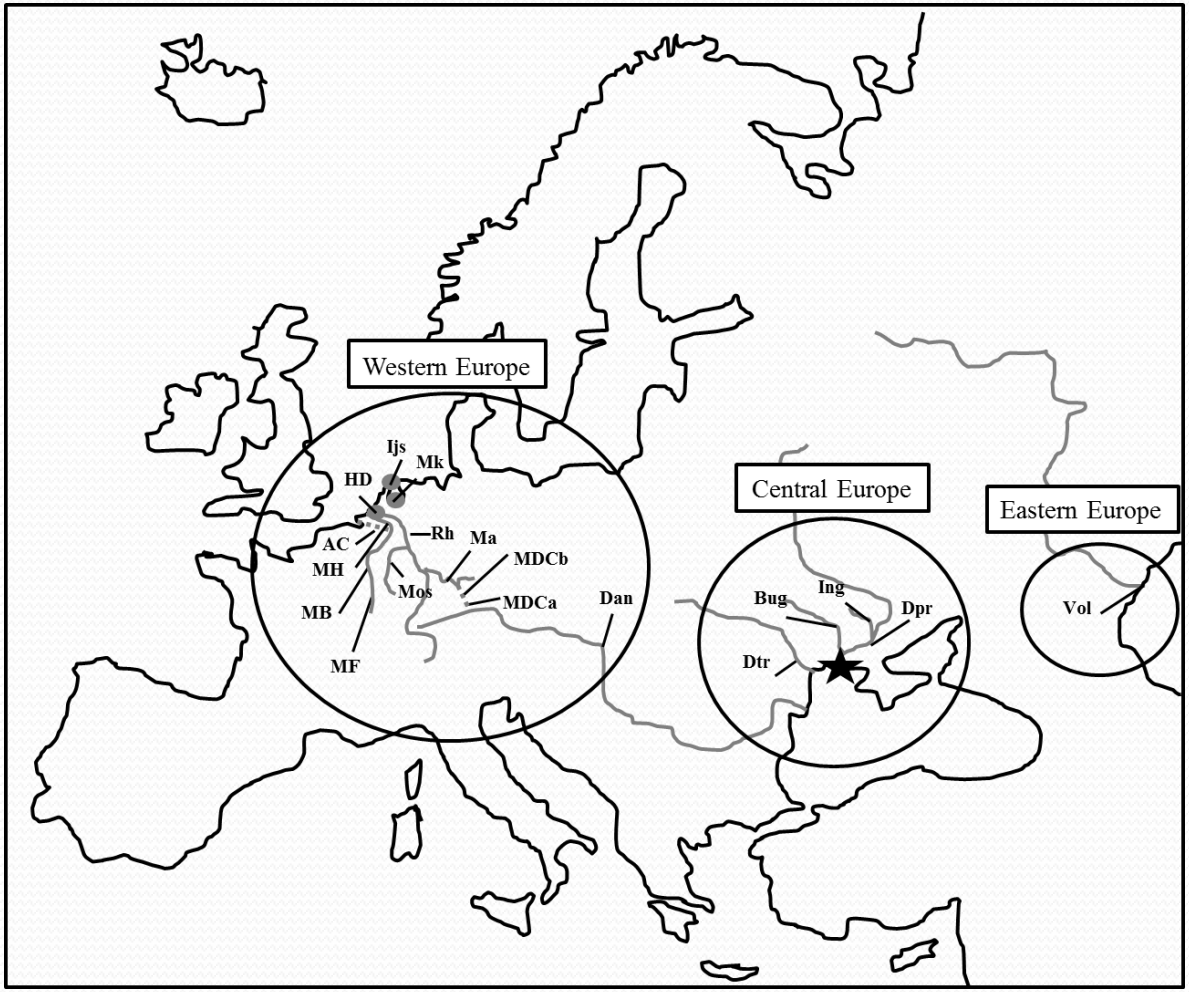
Part I: Colonisation pathways

- Hypothesis



Part I: Colonisation pathways

- Material and Methods

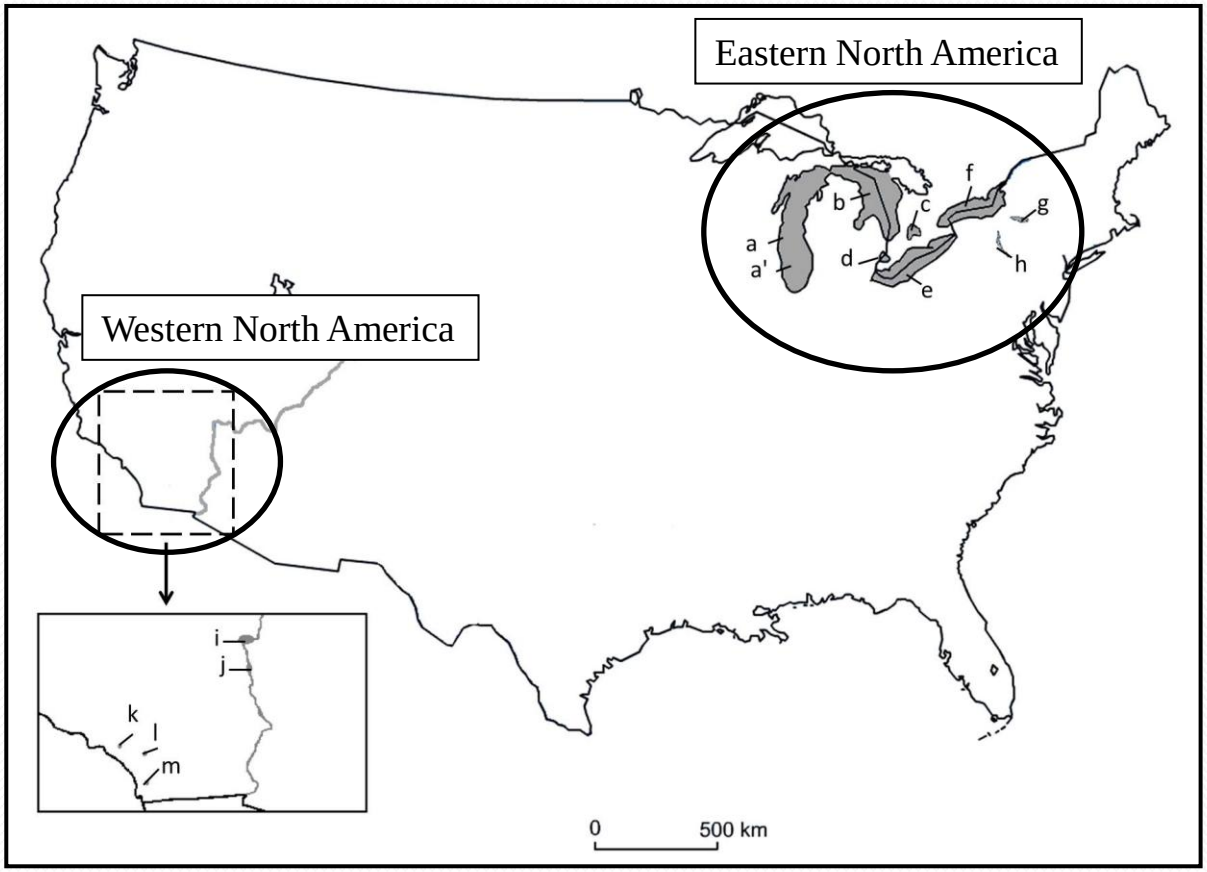


The largest dataset complied to date !

The sampled localities cover the invasion range in both the Old …

Part I: Colonisation pathways

- Material and Methods



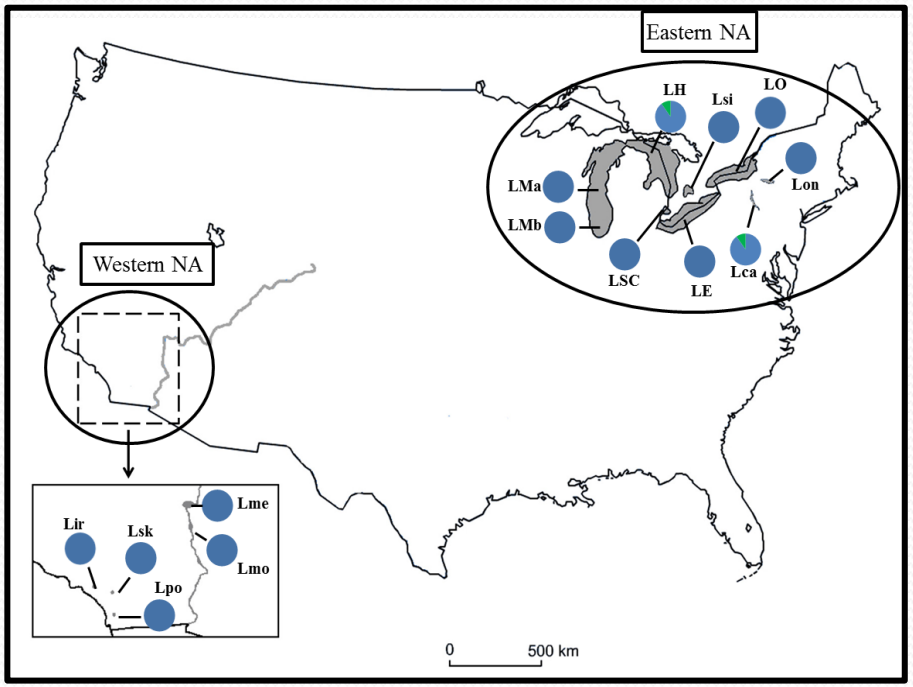
... and New World !

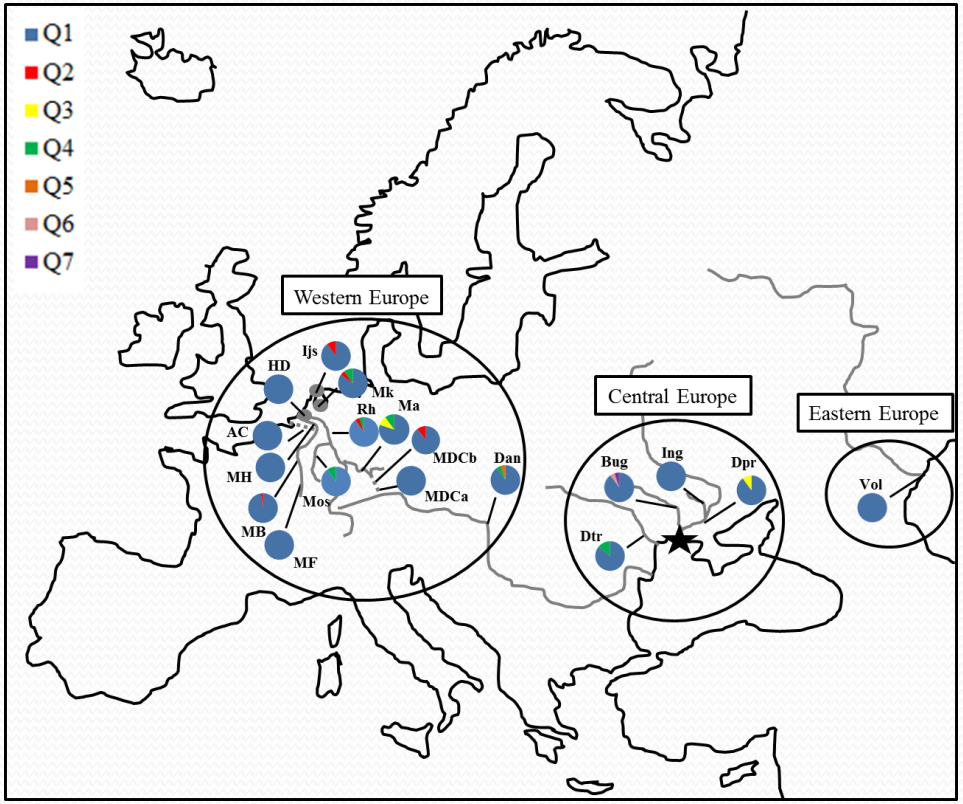
Part I: Colonisation pathways

- <u>Material and Methods</u>
  - Sampling: 32 populations
  - COI mitochondrial gene screened on 573 individuals
  - 10 microsatellite loci tested on 599 individuals
    - Dbug 1, 2, 3, 4 and 5 *(Wilson et al. 1999)*
    - Dbu 74, 75, 92, 93 and 110 *(Feldheim et al. 2011)*

Part II: Colonisation pathways

- Results - *COI* sequencing





D.r. bugensis populations sampled across Europe and North America and haplogroup distribution map of the *COI* mitochondrial gene (Q1 to Q7). The black circles correspond to meta-populations and the black star indicates the native area.

Part I: Colonisation pathways

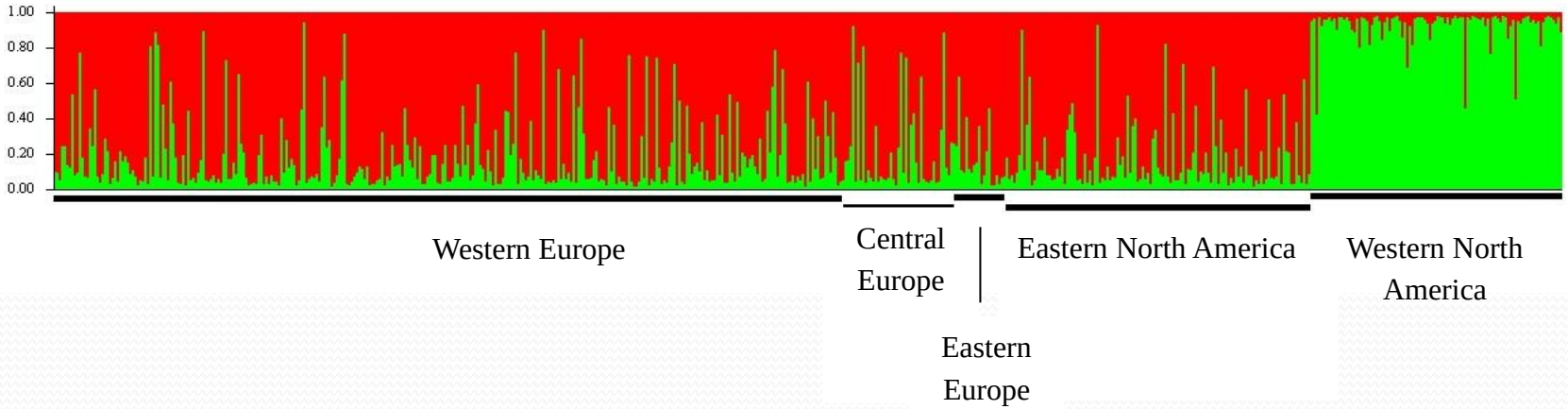
- Results - *Microsatellite analysis*

  - 390 alleles from 10 loci
  - High genetic diversity
  - Low divergence between populations

High genetic dynamism

Part I: Colonisation pathways

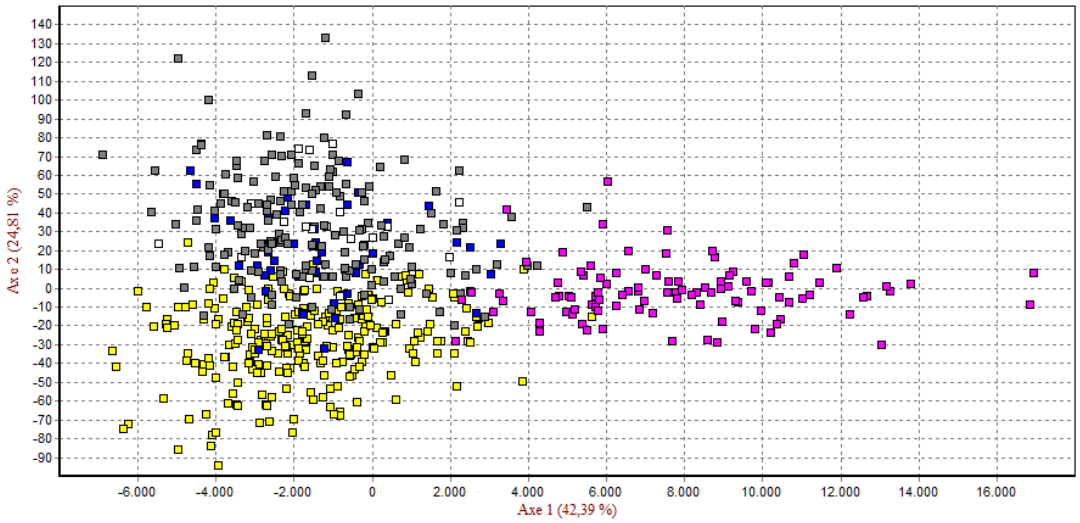
- Results - *Genetic relatedness*

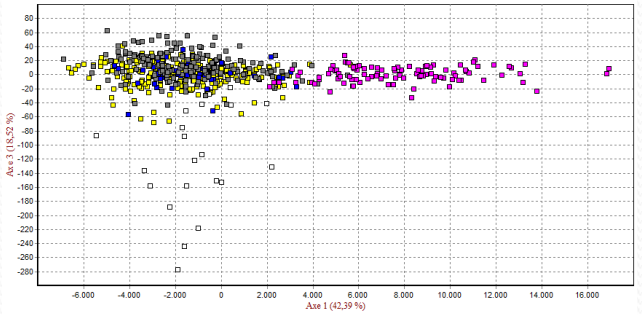


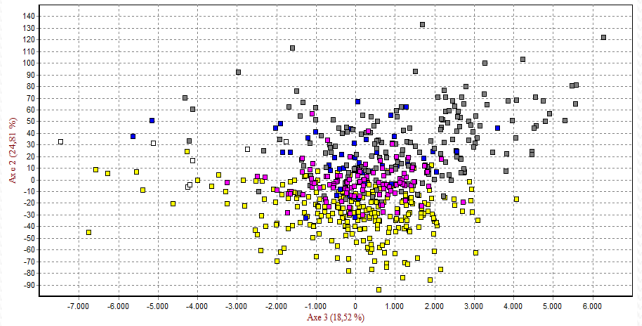
Genetic clusters determined by a Bayesian STRUCTURE analysis on microsatellite data for quagga mussel populations. Each individual is represented by a vertical bar displaying membership coefficient to each genetic population. Analysis discerned 2 genetic clusters (K=2).

Part I: Colonisation pathways

- Results - *Genetic relatedness*



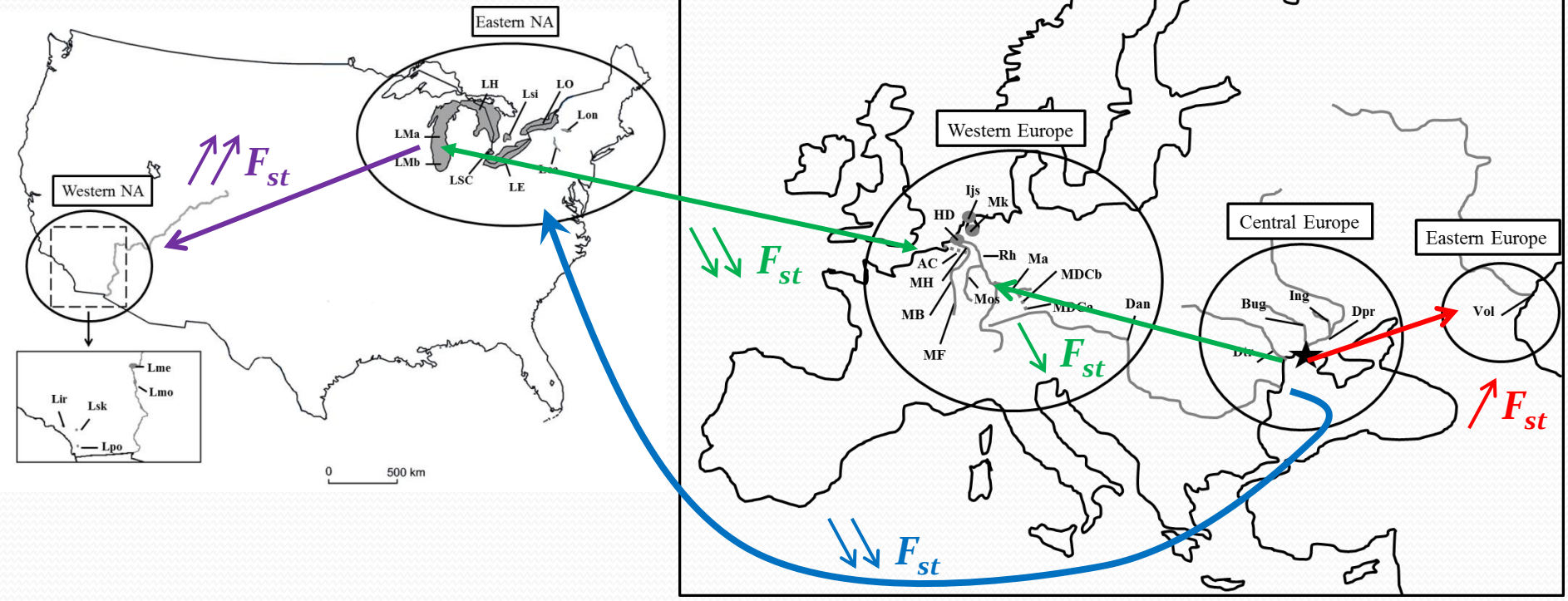




Factorial Correspondence Analysis on microsatellite data of the Quagga mussel.
Western Europe, Central Europe, Eastern Europe, Eastern North America, Western North America

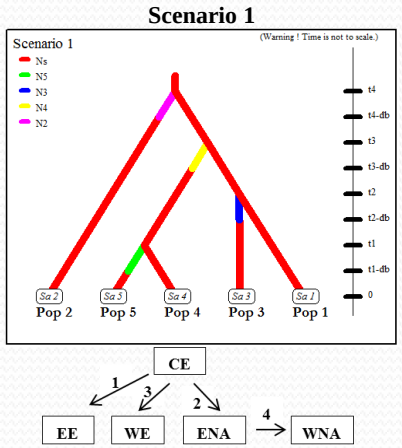
Part I: Colonisation pathways

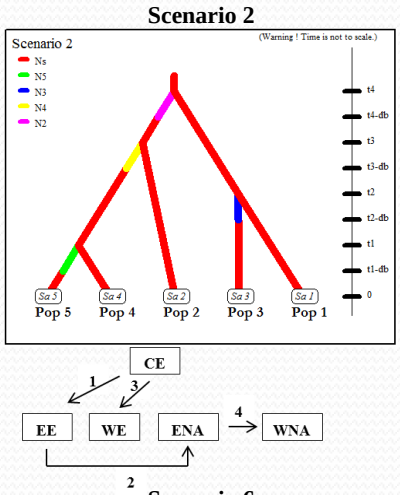
- Results - *Microsatellite analysis*
  - High gene flow

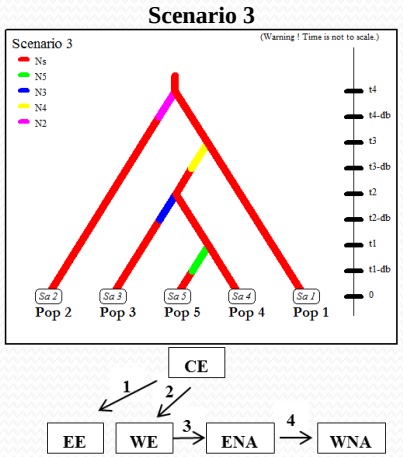


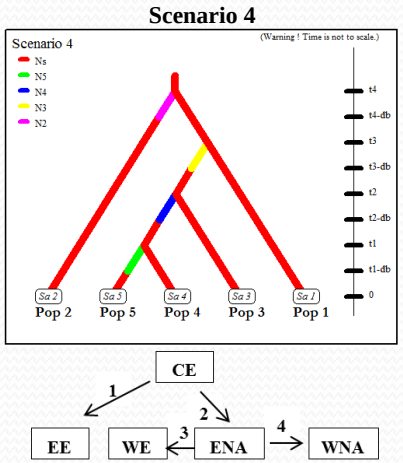
Part I: Colonisation pathways

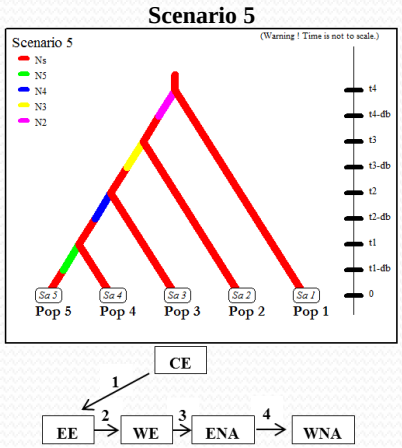
- Results – *Scenario testing (DIY-ABC)*

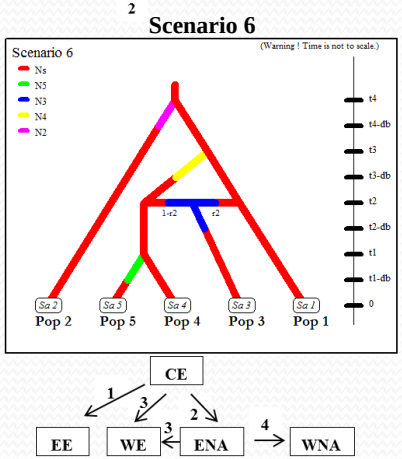


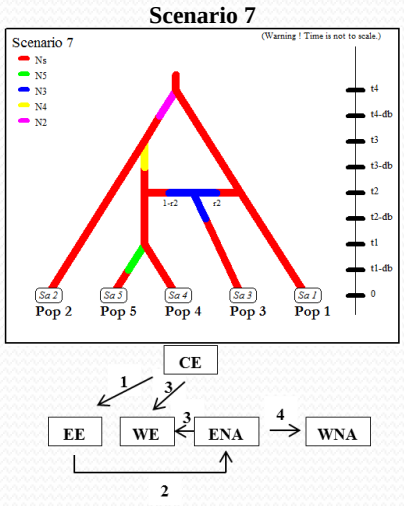








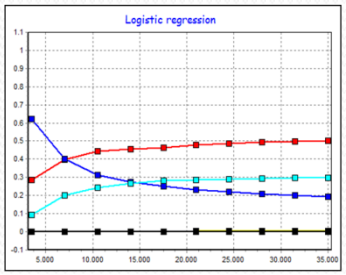


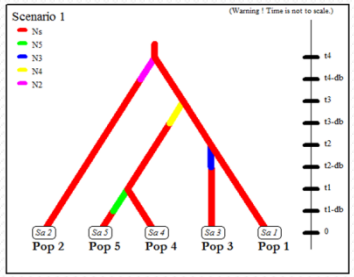


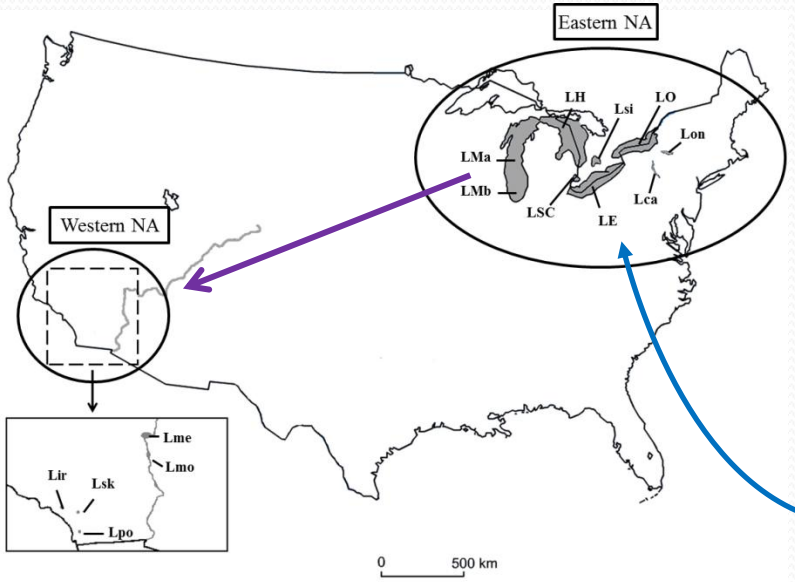
Details of the 7 scenarios tested in the DIYABC software (Pop 1 = CE; Pop 2 = EE; Pop 3 = WE; Pop 4 = ENA; Pop 5 = WNA).

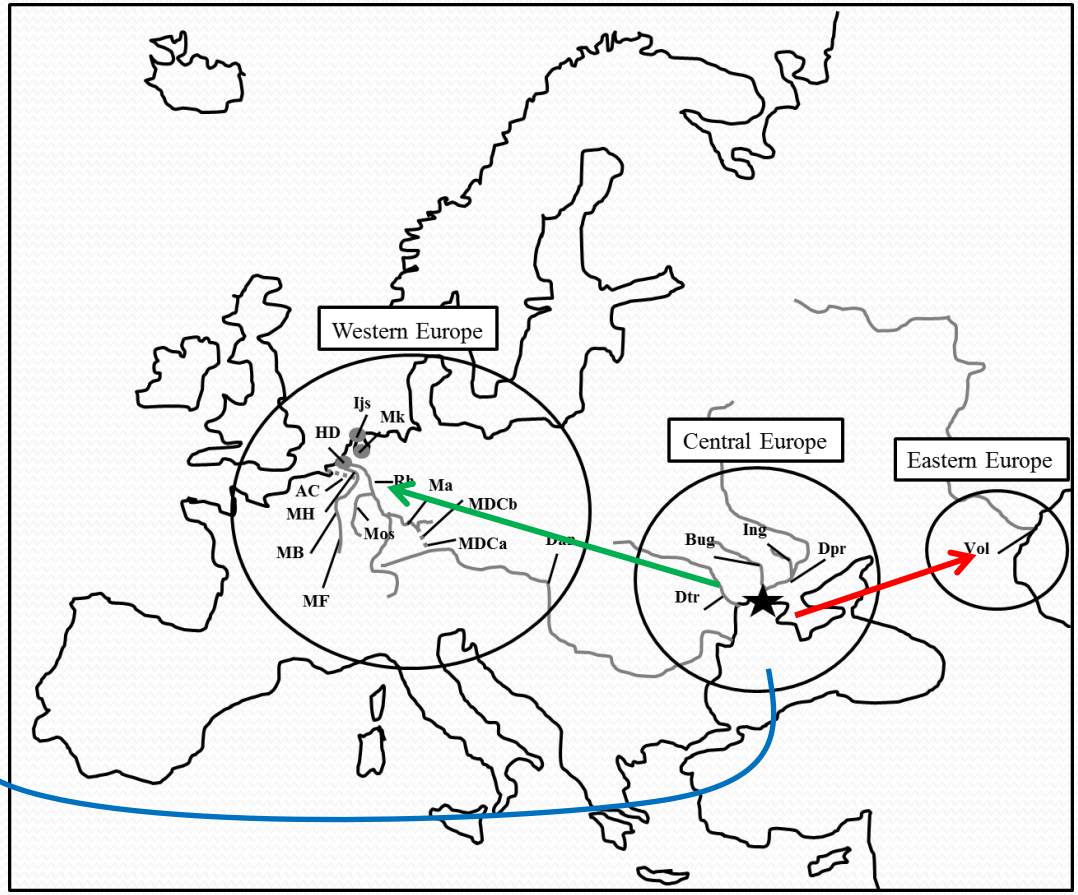
Part I: Colonisation pathways

- Results and conclusion



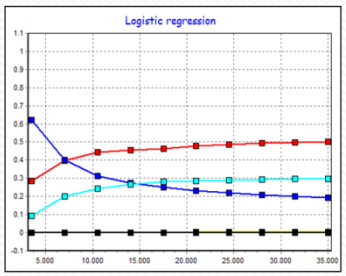


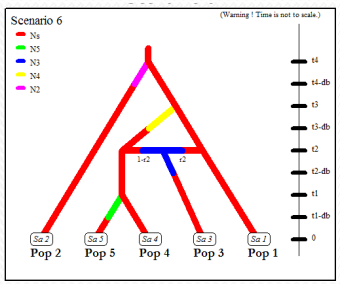




Part I: Colonisation pathways

- Results and conclusion





Part II: Impact assessment

- Hypothesis

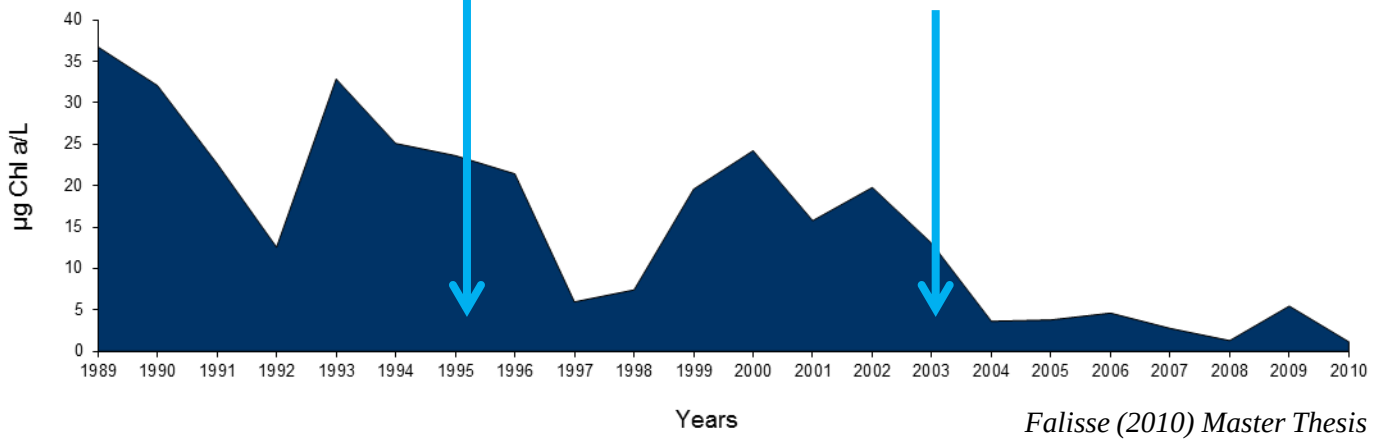
What are the impacts of invasive bivalves on the native fauna of European rivers?

Part II: Impact assessment

- a) Phytoplankton decline in the Meuse River

Introduction of *Corbicula* clams and spread of the Zebra mussel

Introduction of the Quagga mussel

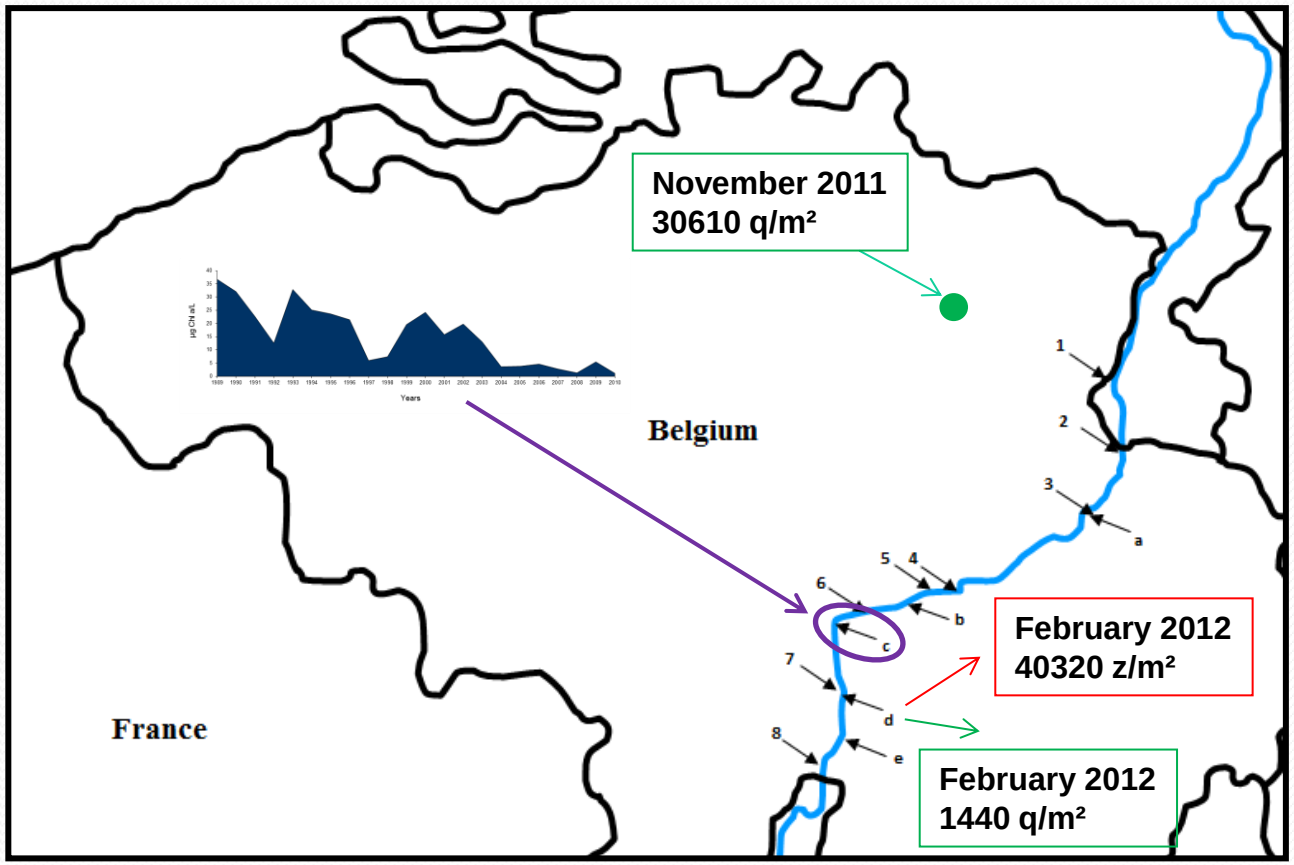


Falisse (2010) Master Thesis

Related to densities and filtration rates

Part II: Impact assessment

- a) Phytoplankton decline in the Meuse River
  - *Measurements of densities*

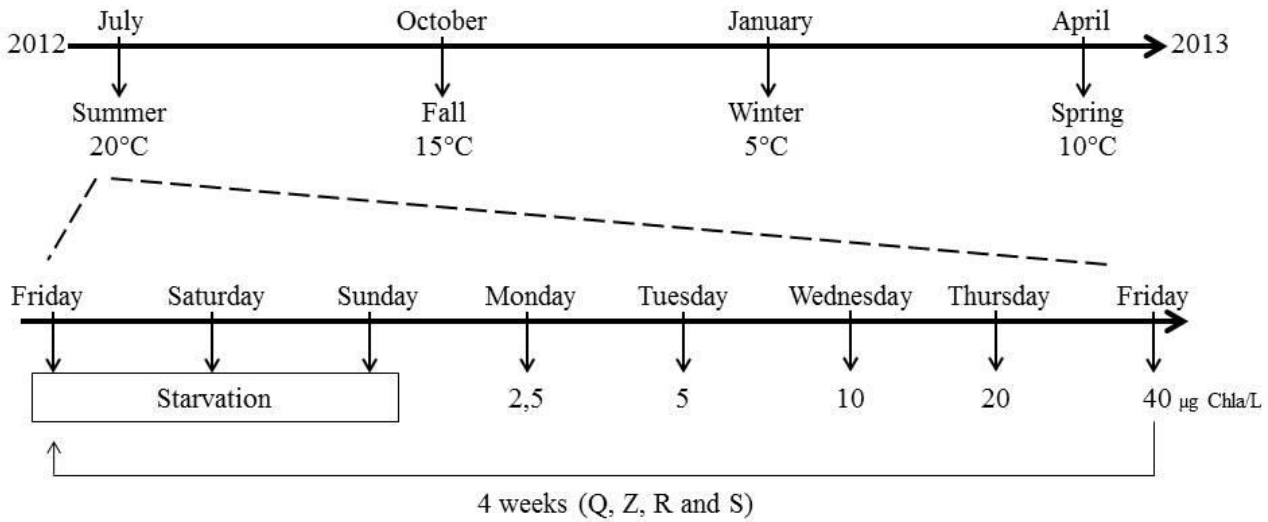


Every 3 months since November 2011

8 sites with natural substratum and 5 fish ladders

Part II: Impact assessment

- a) Phytoplankton decline in the Meuse River
  - *Measurements of filtration rates in laboratory facilities*



Triplicates + control
8 individuals per palourdarium

Part II : Impact assessment

- a) Phytoplankton decline in the Meuse River
  - Preliminary results
  - Mean filtration rate at 5, 15 and 20°C

Mean filtration rate	Z	Q	C
ml/ind.h	80	170	200
l/gC.d	135	50	40

→ Based on observed densities, measured filtration rates and characteristics of the Meuse River, we estimate that 99% of the water column is filtered over 100 km !

Part II : Impact assessment

- b) Native bivalves decline in the Meuse River

Station	$N_{tot\ native\ mussels}$		$N_{inf\ native\ mussels}$	$N_{\textit{Dreissena}}$
Amay	*Unio pictorum*	26	5	1 - 4
	Unio crassus	0	NA	NA
	Pseudanodonta	2	2	5 - 7
	Anodonta	0	NA	NA
Dave	*Unio pictorum*	142	80	1 - 28
	Unio crassus	0	NA	NA
	Pseudanodonta	6	5	1 - 37
	Anodonta	0	NA	NA
Godinne	*Unio pictorum*	101	22	1 - 11
	Unio crassus	0	NA	NA
	Pseudanodonta	1	1	3
	Anodonta	2	0	0
Dinant	*Unio pictorum*	11	4	1 - 4
	Unio crassus	6	5	1 - 6
	Pseudanodonta	0	NA	NA
	Anodonta	0	NA	NA
Anseremme	*Unio pictorum*	24	5	1 - 4
	Unio crassus	3	2	1 - 3
	Pseudanodonta	0	NA	NA
	Anodonta	0	NA	NA
Hastière	*Unio pictorum*	212	60	1 - 11
	Unio crassus	54	44	1 - 31
	Pseudanodonta	3	2	2 - 5
	Anodonta	0	NA	NA
	Total	**593**	**237 (±40%)**	

Conclusion

EUROPEAN
COMMISSION

Brussels, 9.9.2013
SWD(2013) 322 final

COMMISSION STAFF WORKING DOCUMENT

EXECUTIVE SUMMARY OF THE IMPACT ASSESSMENT

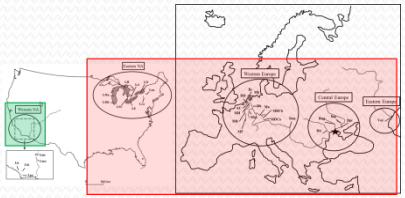
Accompanying the document

Proposal for a regulation of the European Parliament and of the Council

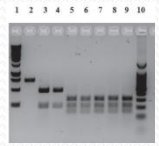
on the prevention and management of the introduction and spread of invasive alien species

{COM(2013) 620 final}
{SWD(2013) 321 final}
{SWD(2013) 323 final}

I. Prevention
→ High gene flow
→ Lack of effective prevention strategies along invasion corridors



II. Early warning and rapid response
→ Remained undetected during at least 10 years
→ Effective detection tools



III. Management
→ Well known impacts
→ *Dreissena carinata* and *Dreissena blanci*

Acknowledgments

- Prof. Karine Van Doninck
  - Supervisor
- A Bij de Vaate, JN Beisel, JP Descy and LM Pigneur
  - Thesis committee
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  - Help in sampling and experiments
- A Bij de Vaate, T Wilke, JN Beisel, L Giamberrini, O Popa, T Nalepa, C Van Overdijk, K Holeck, RF McMahon, A Watters and B Parvis
  - Samples from Europe and North America
- Special thanks to J Lorquet for his valuable technical help

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