A FIRST STEP FOR SUSTAINABLE BREEDING PROGRAMMES IN PIKEPERCH (*Sander lucioperca*) THROUGH THE EVALUATION OF THE GENETIC VARIATION IN DOMESTICATED BROODSTOCKS AND NATURAL POPULATIONS

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Aquaculture Production in Europe

- Since 2000, the aquaculture production in the EU seems to have stagnated at 1.3 million tonnes. Over the same period, it has almost **doubled in Asia and America**, and almost **tripled in Africa**.
- Surprisingly, this lack of growth in the European aquaculture sector contradicts the steadily increasing demand for fish in Europe.
  - lack of growth attributed to a number of factors, such as the shortage of suitable sites, the cumbersome bureaucracy, the competition with other users of marine areas and inland water courses, and the relatively strict environmental protection laws
- Therefore, **65% of Europe's requirement** for fish and seafood today **is met through imports** since domestic capture fisheries do not meet European requirements for fish.

Co-funded by the
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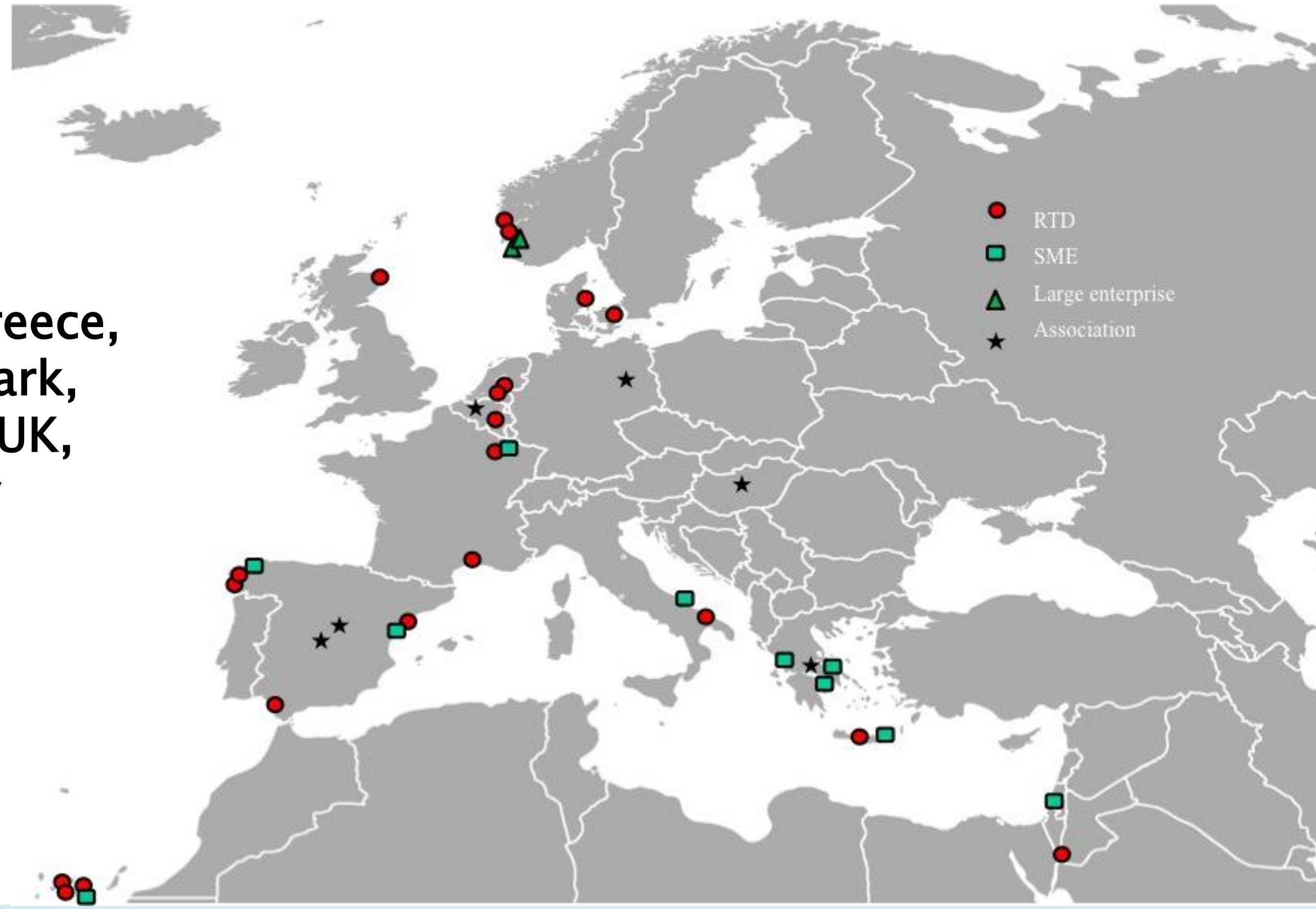
Exploring the biological and socioeconomic potential of new/emerging candidate fish species for the expansion of the European aquaculture industry

- To develop the scientific techniques and methodology, which will ensure the successful rearing and production of six selected species and contribute to the expansion of the industry.
- To determine the drivers for market acceptance of the new food prototypes in order to position the EU aquaculture sector as a leader in aquatic food production

Duration = 5 years (2014-2018) and a Budget = €11,8 million

Partnership of DIVERSIFY



38 partners:

Spain, France, Italy, Greece, Israel, Belgium, Denmark, Netherlands, Norway, UK, Germany and Hungary

20 Research/Universities
9 Small-medium enterprises
3 Large companies
5 Professional associations
1 Non-governmental Organization

- Wide range of climatic and geographic regions within Europe,
- Their biological and economic potential,
- They have a large size/fast growth rate, enabling the production of a variety of value-added aquatic products

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EXPECTED OUTCOMES

1

Scientific knowledge and techniques for culturing new/emerging finfish species that will be safe, sustainable, and attractive to consumers and markets.

2

Wide dissemination of this information to key stakeholders (aquaculture producers, retailers, processors and consumer groups).

3

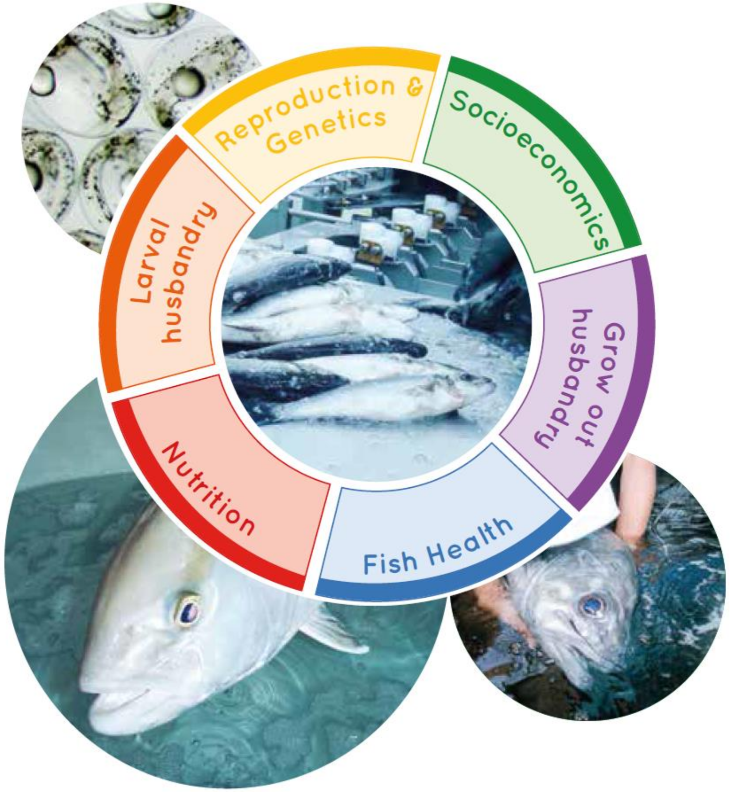
Long-term business plans to ensure the successful market positioning of each species.

4

Increased value of European aquaculture products, which will result in increased economic prospects of the sector.
An efficient, sustainable and market-oriented expansion of the European aquaculture sector.

RESEARCH AREAS

Studies will be carried out in the six selected species across a number of different scientific disciplines:



Atlantic halibut
Hippoglossus hippoglossus
13.2%

Greater amberjack
Seriola dumerili
31.3%

Grey mullet
Mugil cephalus
11.3%

Meagre
Argyrosomus regius
22.9%

Pikeperch
Sander lucioperca
14.2%

Wreckfish
Polyprion americanus
7.1%

Pikeperch (*Sander lucioperca*)
A new species for European aquaculture

- Several measures to support its sustainable development and the use of **Recirculation Aquaculture Systems (RAS)** that are largely isolated from their surroundings.
- These systems have been used to grow rainbow trout, salmon, and eel
- European Percid Fish Culture (EPFC)

EAS THEMATIC GROUP ON EUROPEAN PERCID FISH CULTURE

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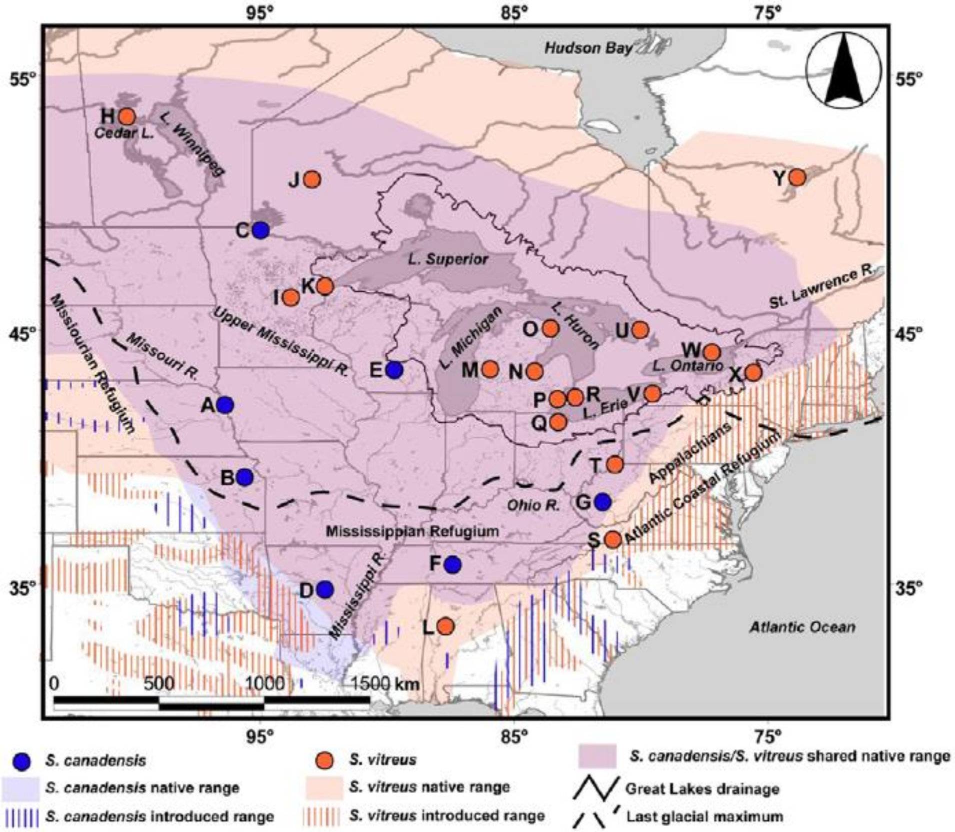
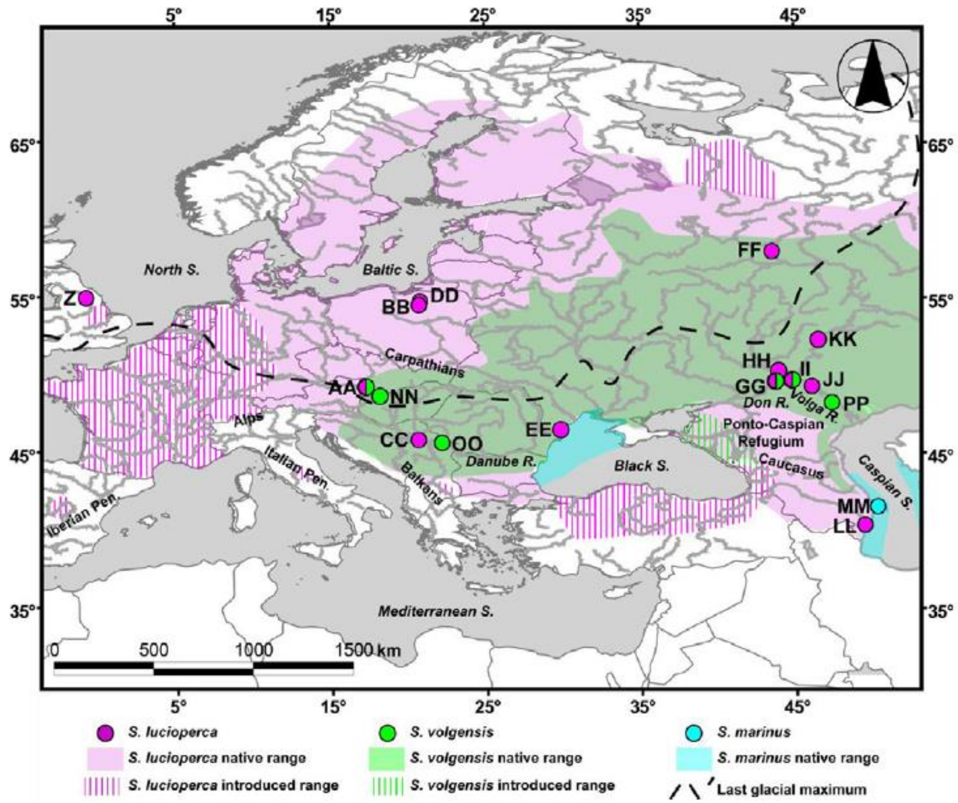
Pikeperch (*Sander lucioperca*).

- A temperate Eurasian freshwater/brackish water fish species,
- Wild populations of pikeperch show signs of decline in many areas of its natural range of distribution,
- Introduced in northern Russia, Italy, Spain, Turkey, the North African countries (from Morocco to Tunisia) and many other regions

The genus *Sander* in the world





Haponski, A.E., and Stepien, C.A. (2013). Phylogenetic and biogeographical relationships of the *Sander pikeperches (Percidae: Perciformes): patterns across North America and Eurasia. Biological Journal of the Linnean Society 110, 156-179.*

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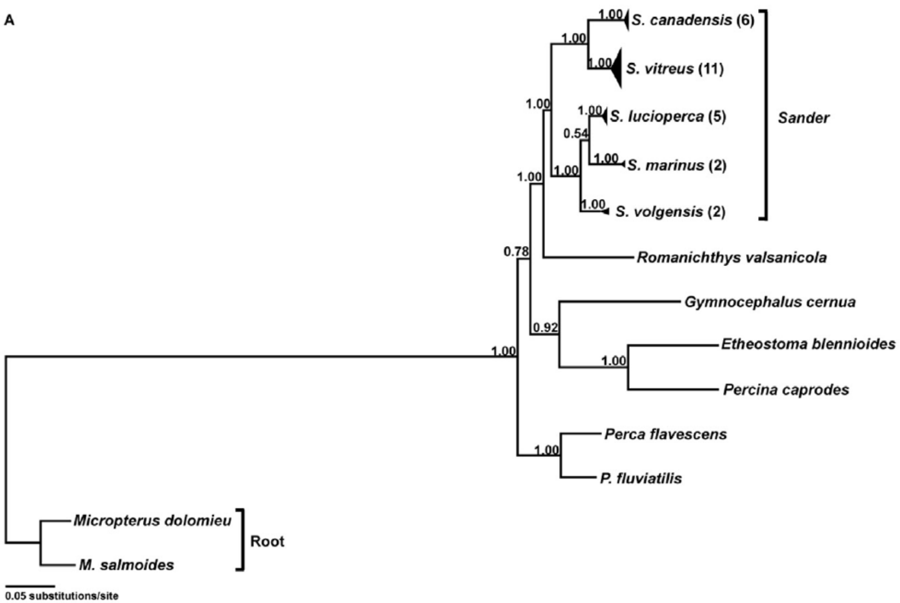
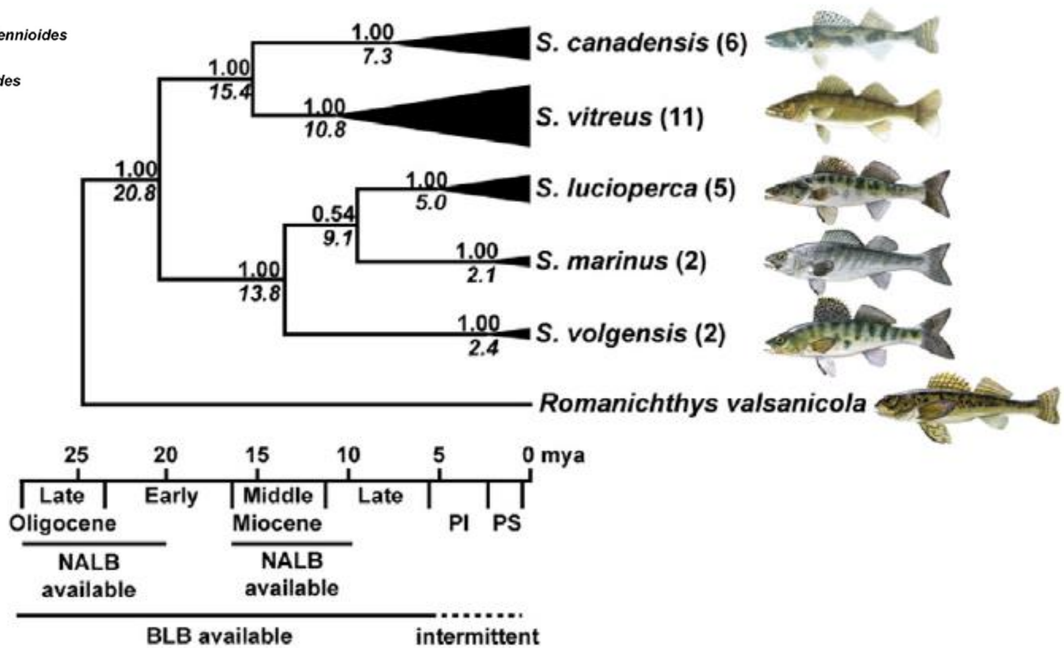
Phylogenetic relationships of the genus *Sander* and members of the family Percidae





Haponski, A.E., and Stepien, C.A. (2013)

Pikeperch aquaculture characteristics

- Pikeperch is considered still **a wild species** for the aquaculture industry,
- In principle, each pikeperch farm uses its own stock, captured either from the wild or supplied by another farmer
- Exhibits **cannibalism** and **territorialism,**
- Spawning **four times a year** in contrast to the wild where **once a year** (April-May) is the norm,
- Constant high temperatures (24-26°C, only feasible in RAS) to ensure relatively high growth rates and allow high densities of **80-100 kg/m^3**.

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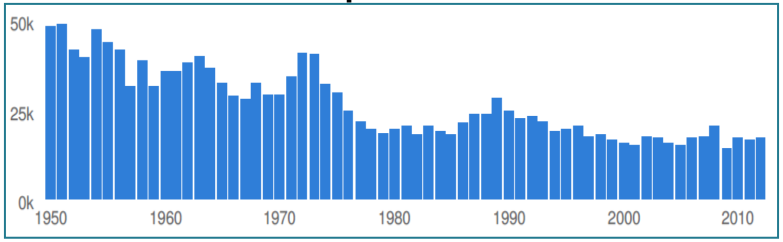
Pikeperch aquaculture characteristics

- Pikeperch flesh quality has a neutral taste
- It normally takes **15-18 months** to reach a market sized fish of **800 g to 1.2 kg**.
- The main market product: **whole round fish & fillets**.
- Pike-perch is still a **niche product**
- Markets are in Europe and North-America.
- The market value is at **8-11 €/kg** at farm gate, whole fish.

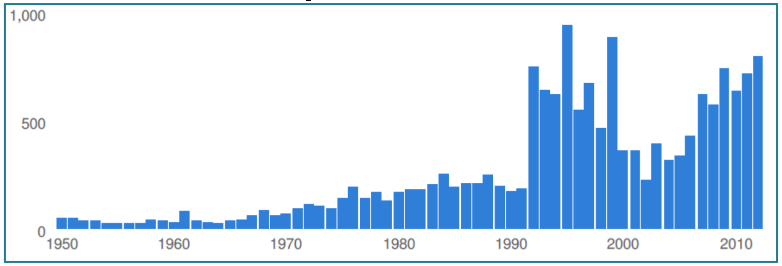
Pikeperch production

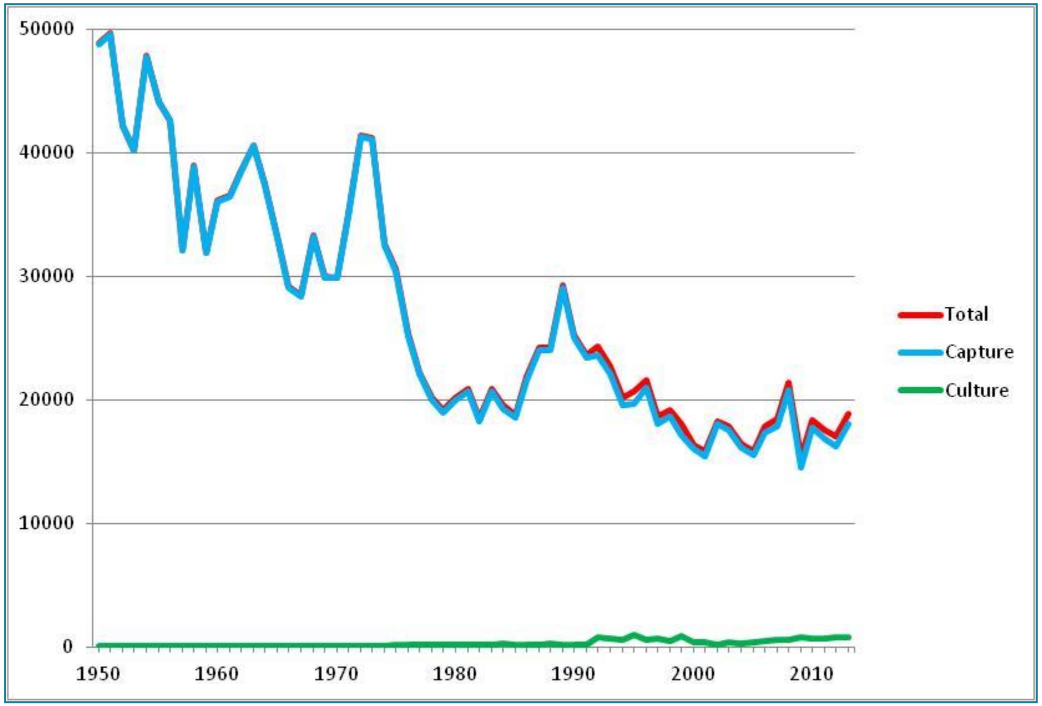
Pikeperch demand has been strengthened by **the strong decline** of wild catches from Russia, Finland and Estonia from 50.000 t in the '50s to less than 20.000 t currently (FAO, 2013).

Capture



Aquaculture





Objectives of the current study

- Assess the genetic variability of captive broodstocks in commercial farms in Europe operating in Recirculating Aquaculture Systems (RAS)
  - Currently, there are no assessments of the genetic diversity of captive pikeperch stocks partly because there are only a few commercial hatcheries (around 10) that produce pikeperch in Europe
- Assess the genetic variability of wild broodstocks in Europe and compare this variability with that of domesticated pikeperch populations to be applied in future breeding programs of the species

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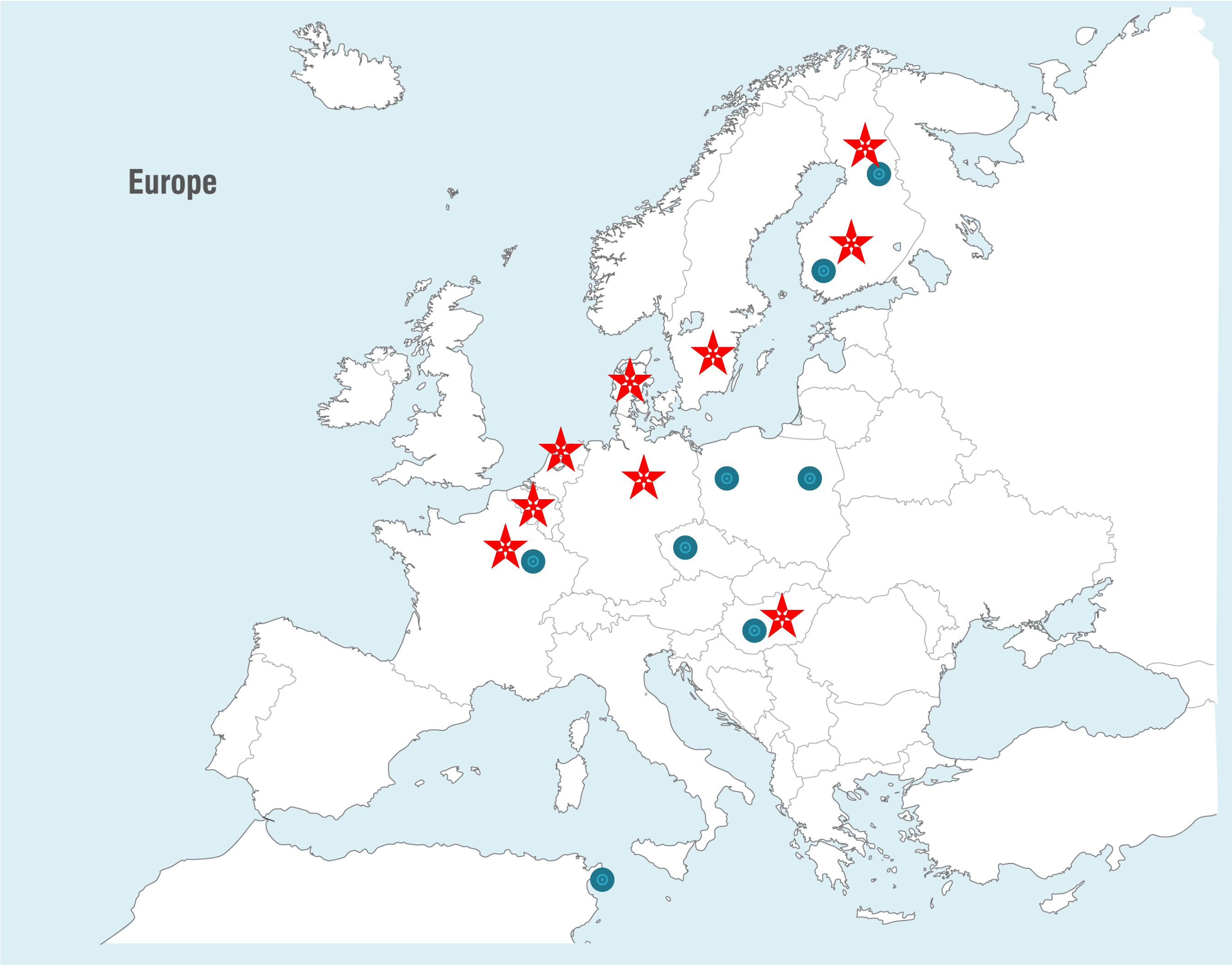
Microsatellite Cross-species amplifications

- Multiplex optimizations for 23 loci reported in:
  - Leclerc et al. (2000) for the yellow perch (*Perca flavescens)*
  - Borer et al. (1999) and Wirth et al. (1999) in walleye *Stizostedion vitreum,* and
  - Dubut et al (2010) in the Rhone streber (*Zingel asper*)
- There are currently two 6-plexes used for genotyping and results shown are based on ten loci

Sampling

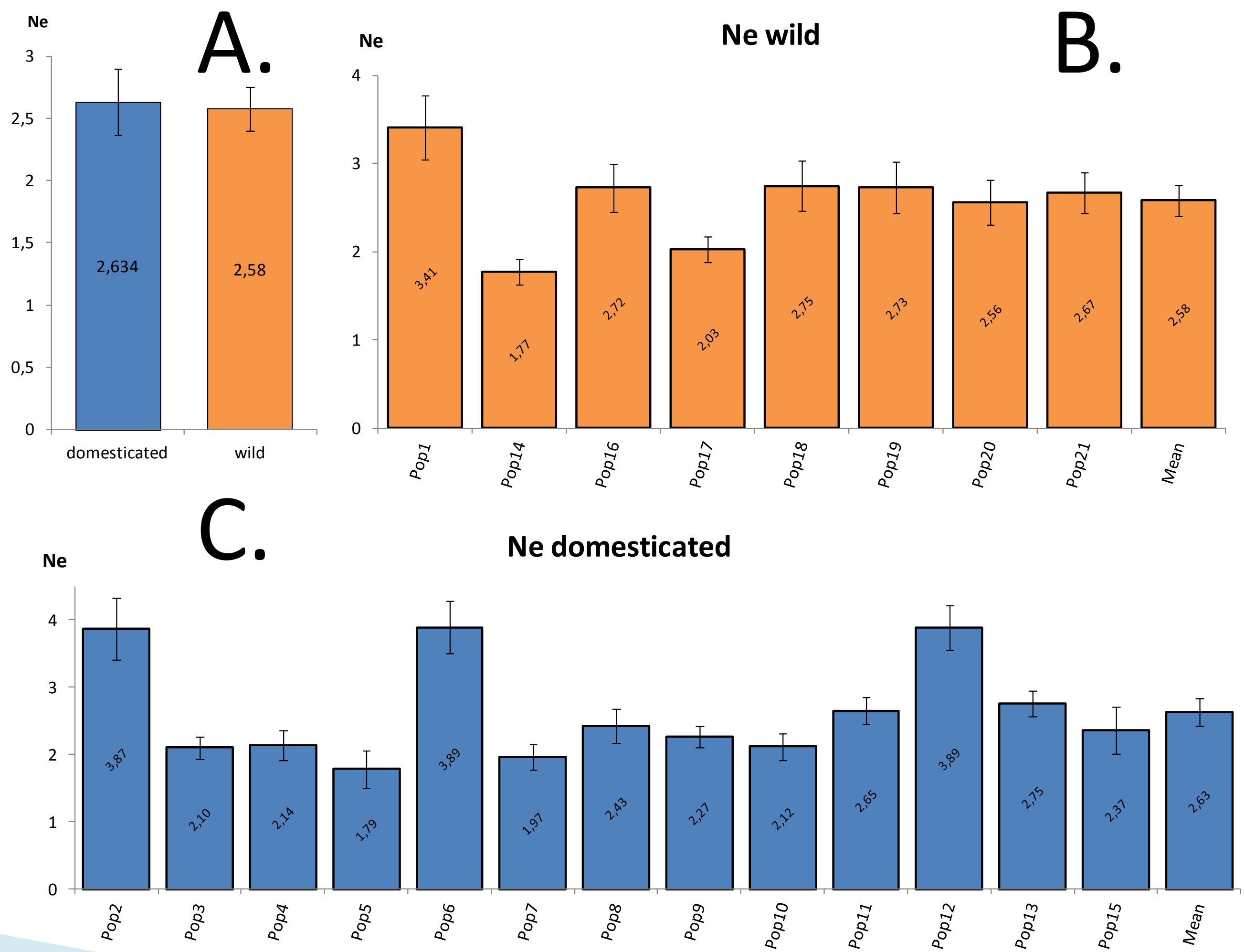
<u>Populations</u>
8 wild &
13 captive



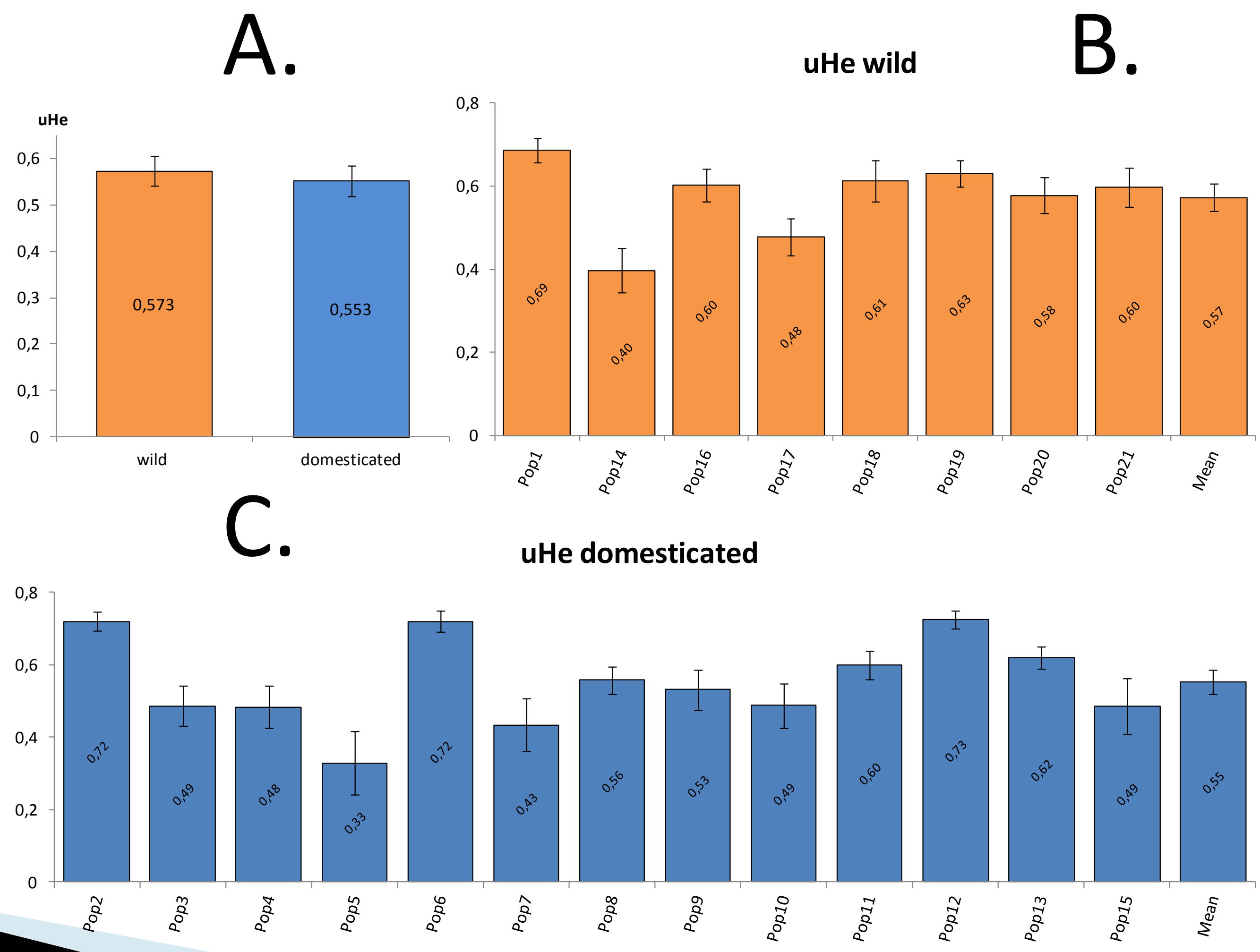
Basic population genetics parameters for all populations analyzed

	Population	Sample Size	Mean Nb of alleles	H_E	H_O	F_{IS}
1	Hungary-1	53	6.2	0.6826	0.7472	-0.08424
2	Hungary-2	49	**7.8**	0.7182	0.6759	0.06962*
3	Denmark-1	54	2.6	0.4675	0.6796	-0.44607
4	Denmark-2	38	3.3	0.4616	0.4882	-0.04401*
5	Denmark-3	14	2.8	0.3408	0.4100	-0.16229
6	Denmark-4	73	**8.2**	0.7194	0.7165	0.01110*
7	Denmark-5	19	3.1	0.4169	0.3985	0.07185*
8	Germany	46	5.7	0.5567	0.5502	0.02343*
9	Finland-1	31	3.7	0.5257	0.5819	-0.09055
10	Finland-2	20	2.8	0.4743	0.6032	-0.24757
11	France-1	63	5.4	0.5940	0.5913	0.01261
12	Belgium-1	100	**7.2**	0.7224	0.8099	-0.11621*
13	Belgium-2	100	4.7	0.6156	0.6465	-0.04510
14	Tunisia	59	3.7	0.4013	0.3585	0.11512*
15	Sweden	30	4.4	0.5250	0.5817	-0.08989
16	France-2	51	4.6	0.5923	0.6706	-0.12237
17	Czech Rep.	70	3.8	0.4692	0.4382	0.07357*
18	Poland-1	14	4.6	0.5763	0.5643	0.05780*
19	Poland-2	11	4.2	0.6149	0.6764	-0.05217*
20	Finland-3	32	4.8	0.5946	0.5995	0.00787*
21	Finland-4	31	4.7	0.6034	0.5340	0.13148*

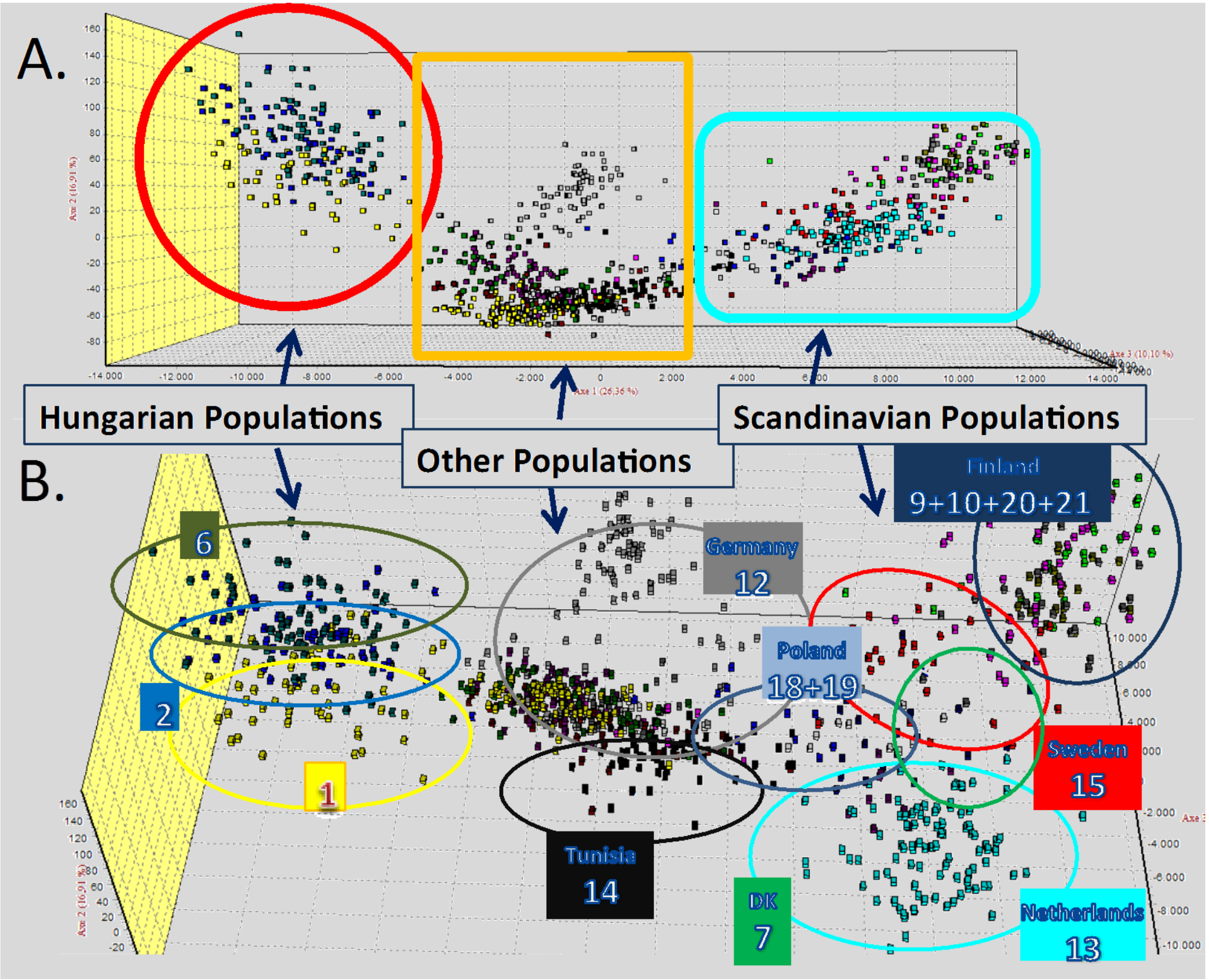
Mean number of alleles for domesticated and wild populations



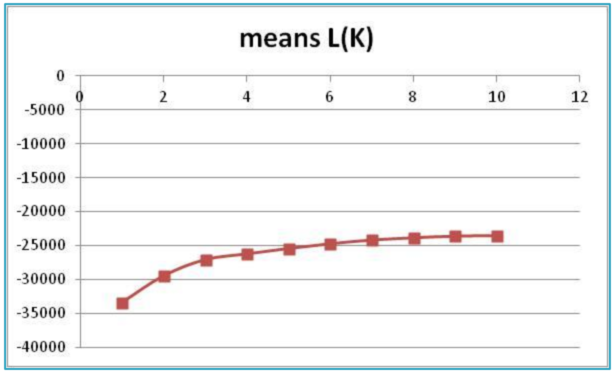
Estimates of Unbiased Expected Heterozygosity (uHe)

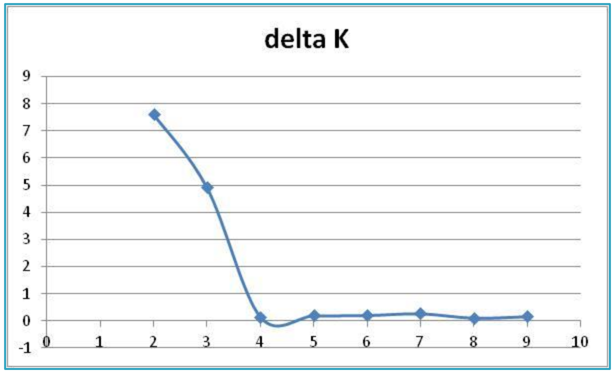


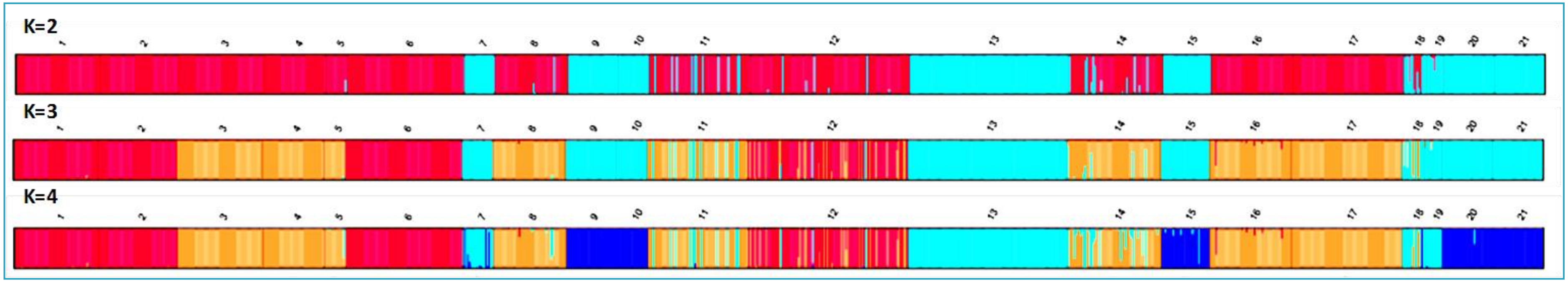
FCA Analysis

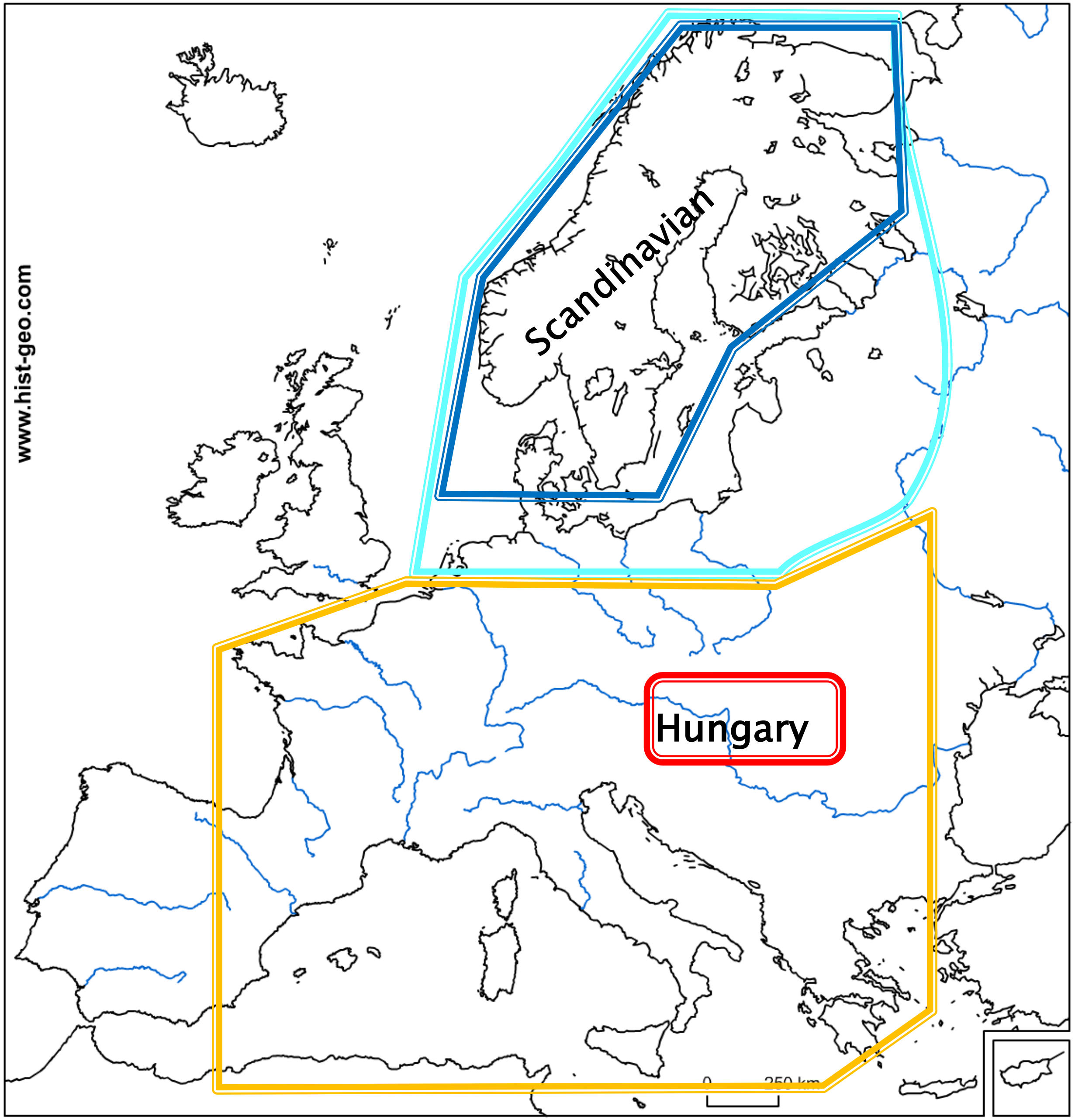


Structure Analysis








www.hist-geo.com
Scandinavian
Hungary

Conclusions

- Evidence that pikeperch populations in Europe are part of at least two genetically differentiated groups.
  - The first is found in northern Europe from Netherlands/Denmark to the West and Poland (at least) to the East to the North of Finland. This is the group probably referred also as “Baltic Sea” stock by Björklund et al. (2007) and Poulet et al. (2009).
  - The second group comprises all remaining populations in Central Europe to as south as Tunisia (and probably Spain, Italy and Northern Greece).

Conclusions

- In the second stock, the Hungarian populations are having a key-position being different from those found geographically near, *e.g.*, from Czech Rep. and Germany.
  - It might be another stock associated with Hungarian lakes, as opposed to all other populations that probably dispersed through the Danube River west-and southwards (see also Kohlmann *et al.*, 2013)
- Most populations analyzed seemed to contain fish of a single origin with very few exceptions

Conclusions

- In general, the mean heterozygosity estimates and the count of the number of alleles per population indicate that domesticated samples do not suffer from inbreeding.
- There are few domesticated populations that either due to their small sample size or their *a priori* known use as ‘selected’ fish, which indicates the notion of some level of inbreeding
- Interestingly, the number of alleles in domesticated samples is slightly higher than that in the wild (2.63 vs 2.58), whereas the unbiased heterozygosity is slightly lower (0.553 vs 0.573)

Conclusions

- Last, we should bear in mind that besides inbreeding that reduces genetic diversity and the effective population size, outbreeding is also a major concern for future breeding programmes.
- Outbreeding is simply the crossing of different stocks, *i.e.*, locally adapted populations/strains with others that are significantly different genetically.
- The scientists involved should decide whether the benefits from crossing different strains outweigh any later detrimental effects on fitness coming from outbreeding depression.

Co-funded by the
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Programme
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Thank you for your attention