EFFAB
European Forum of Farm Animal Breeders

WEBINAR SERIES

**BREEDERS TALK GREEN**

*GENETIC DIVERSITY AND RESPONSIBLE ANIMAL BREEDING*

Thursday 1 July 2021 | 13:30 - 15:00 CET

#BREEDERSTALKGREEN

FABRE TP

# The role of Aquaculture Breeders in Maintaining Genetic Diversity


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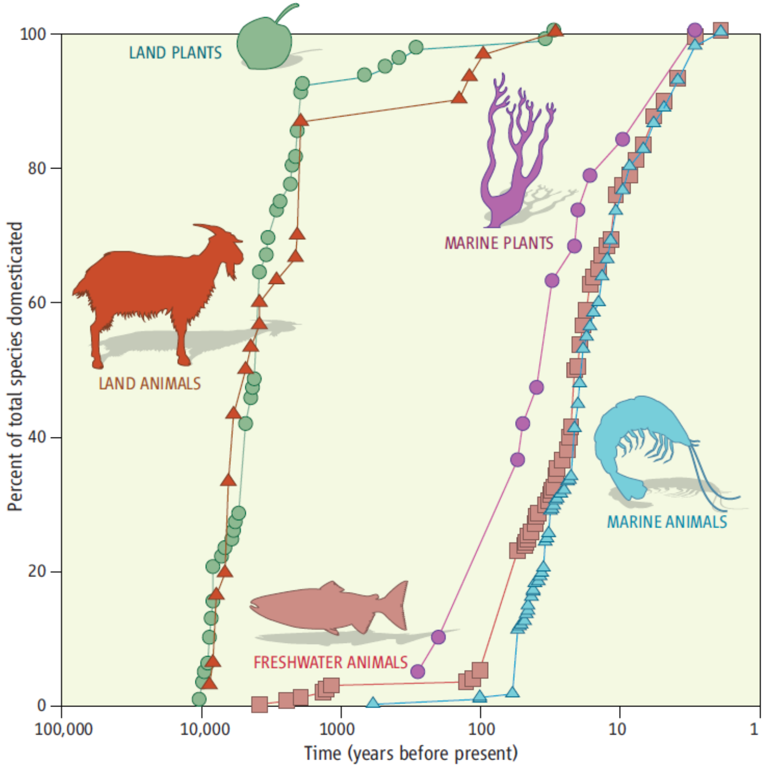
SYSAAF

# **SYSAAF** (French poultry and aquaculture breeding association)


- Non profit organisation (French law on farming)
- 27 geneticists and data scientists (4 PhD students)
- 31 breeding companies (18 aquaculture)
- 30 species (11 fishes, 4 molluscs, 4 shrimps)
- Genetic indexation of 119 genetic lines
- International expertise : Thailand, Mozambique, Mexico, Madagascar


# Aquaculture has just initiated domestication by the creation of genetic resources




Duarte et al., 2007

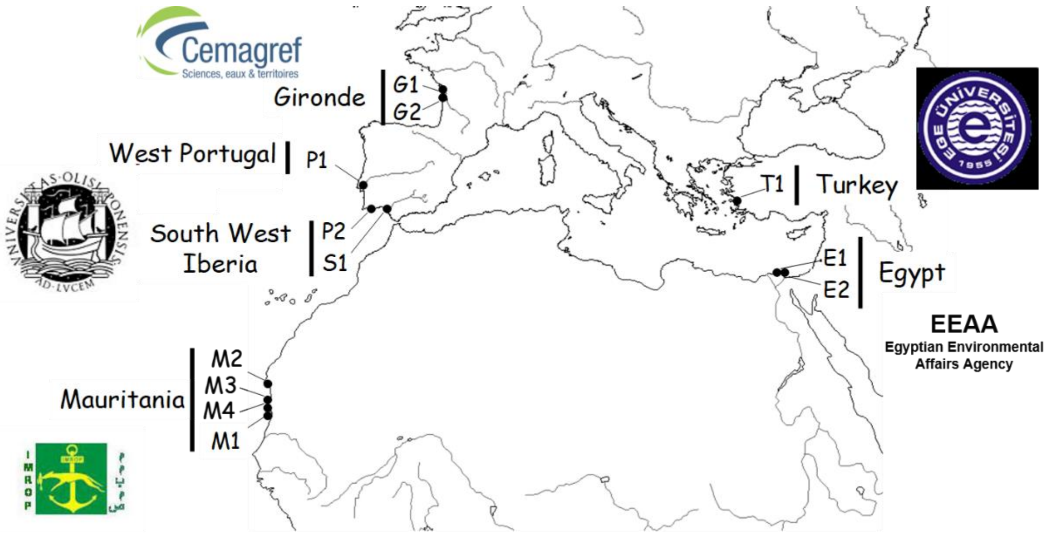

http://www.fao.org/3/ca5256en/CA5256EN.pdf

## Core message is that aquaculture breeders are actively involved in the management of genetic diversity

- In characterising genetic variability of their stocks
- In using genomic tools to trace their pedigrees (family relationship) in using DNA fingerprinting
- In adaptating software to improve pedigree assignment with DNA fingerprinting
- In applying genetic principles to optimise conservation of genetic diversity
- In cryopreserving their genetic resources for long term private and public conservation

# Evaluation of genetic variability for successful domestication

- Domestication of the meagre *Argyrosomus reg*
- Collection of tissues samples for genotyping (m

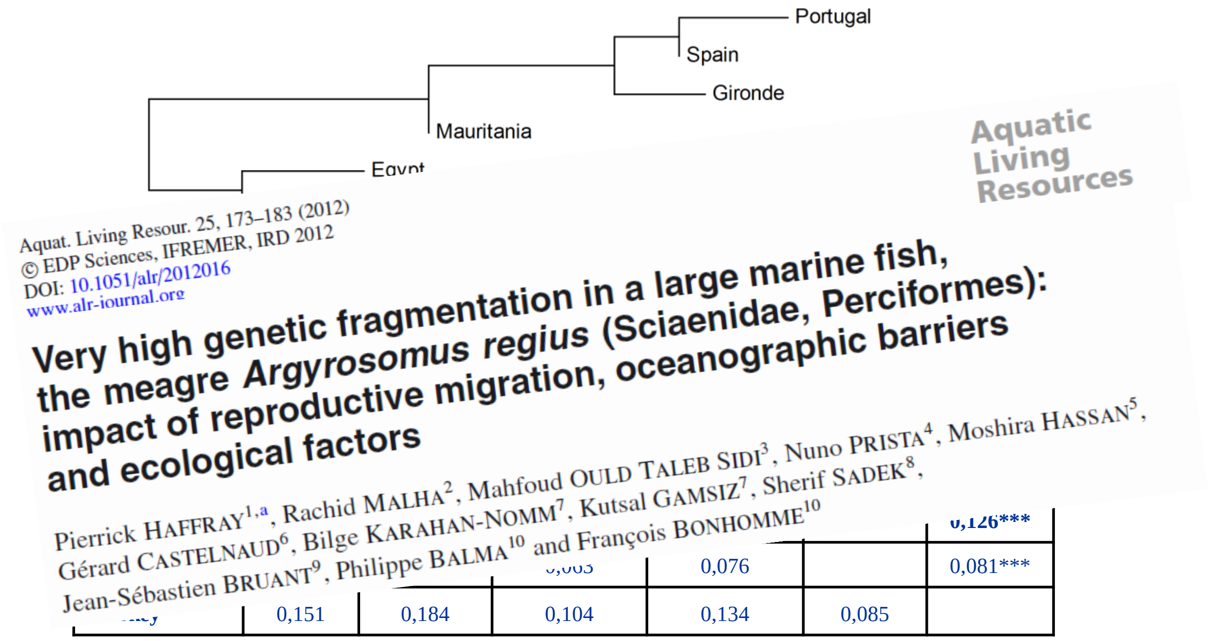




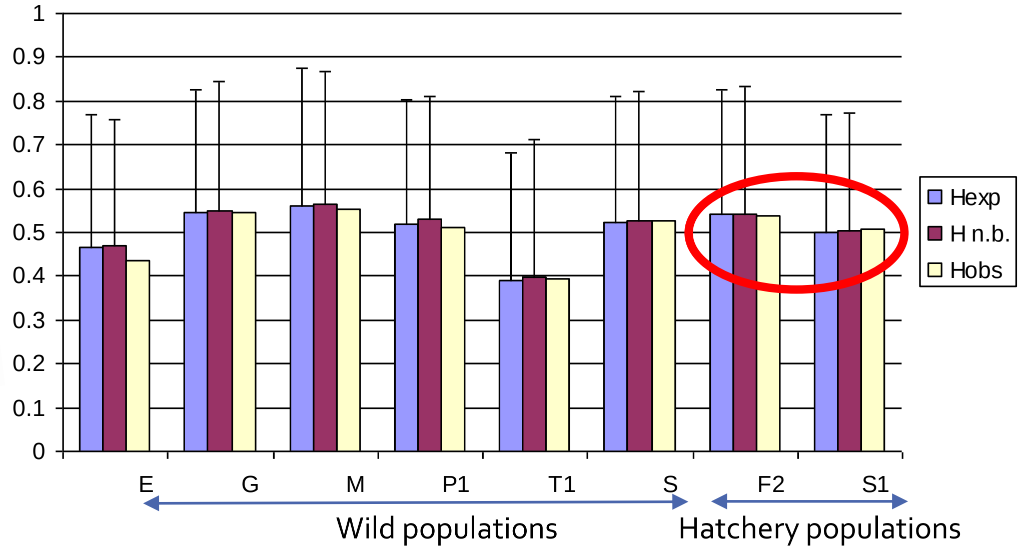
- ABS (Access and Benefit Sharing) agreement with EEAA (Egypt)

# Majors results

- Very important genetic differenciation between wild populations (interspecific ?)




Haffray et al., 2012




Haffray et al., 2013 (EAS, Las Palmas)

- French aquacultural Fo stocks have similar levels of genetic variability than wild populations

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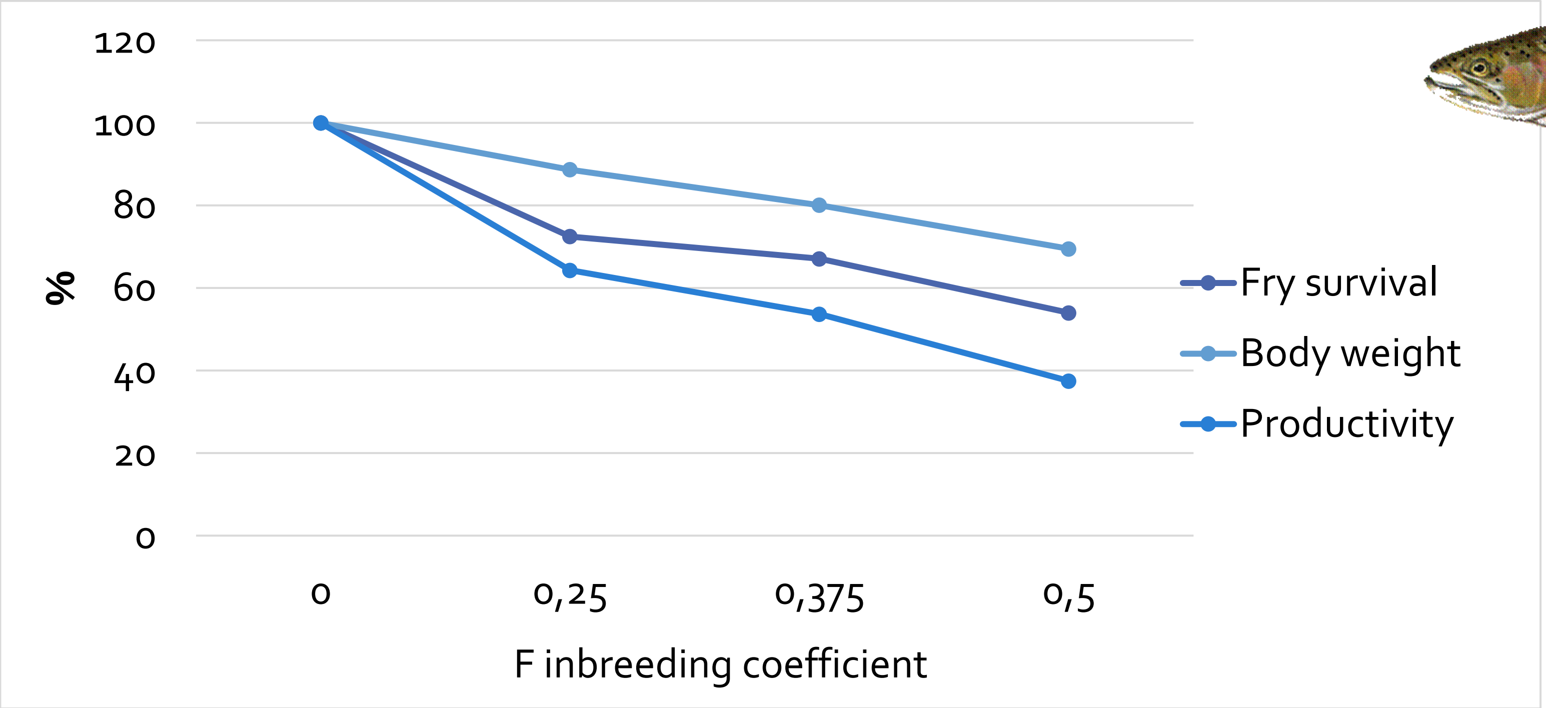
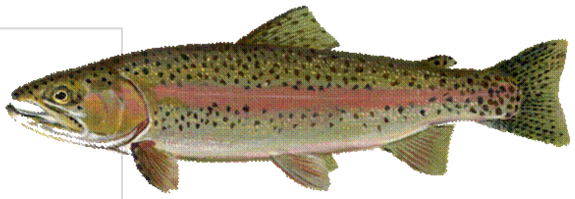
Ferme Marine du Douhet · Les poissons du Soleil · CNRS · SYSAAF · CIPA Comité Interprofessionnel des Produits de l'Aquaculture · FRB Fondation pour la Recherche sur la Biodiversité

# Risks associated with uncontroled inbreeding?

- Evaluation by repeated crosses between brothers and sisters during 3 generations



Gjerde et al., 1983
Rainbow trout
3 successive generation of brother-sister mating

- Additionnal negative effects (malformation, sensibility to diseases, adaptation)
- There is no long term sustainable breeding programs without managing inbreeding

# General principles of a breeding program in aquaculture

**1. Creation of the 200/3200 families / generation**

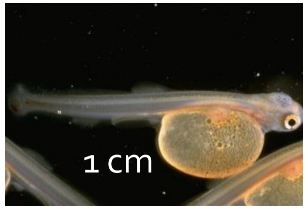
**2. Separate family rearing until individual tagging with electronic transponder and pooling in 1 tank (cage)**

**3. Rearing and phenotyping of candidates and sibs**

disease resistance, processing, flesh quality, reproductive traits…

**4. Genetic and genomic indexation and proposal of best candidates maximising genetic progress and minimizing inbreeding**

# How to get pedigree in aquaculture?

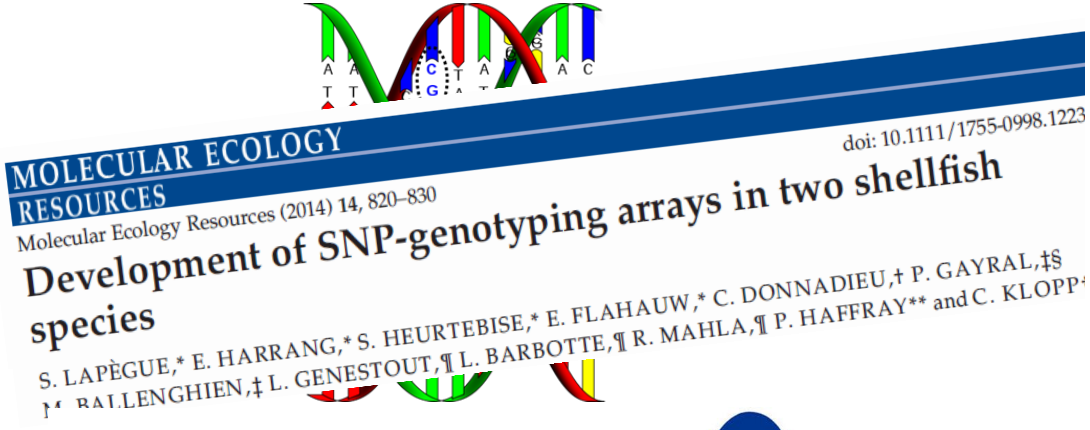



| "Traditional"<br>Initial separated family rearing | "Innovative"<br>Family pooled at hatching |
|---|---|
|  |  |
| • Individual electronic tagging (50 to 1000 / family) before family mixing | • DNA collection, individual tagging<br>• DNA fingerprinting (7-8 € / individual) |
| • Initial investment in facilities, personal<br>• Potential high tank effect | • No specific facilities but genotyping cost<br>• No tank effect = more precise |

French favorite approach as more adapted to SMEs

# Introduction of DNA fingerprinting in shellfish breeding

- Development of a panel to assign pedigree in Pacific oyster *Crassostrea gigas*
- Evaluation of breeding practices in commercial selection programs in 1 year class



MOLECULAR ECOLOGY RESOURCES

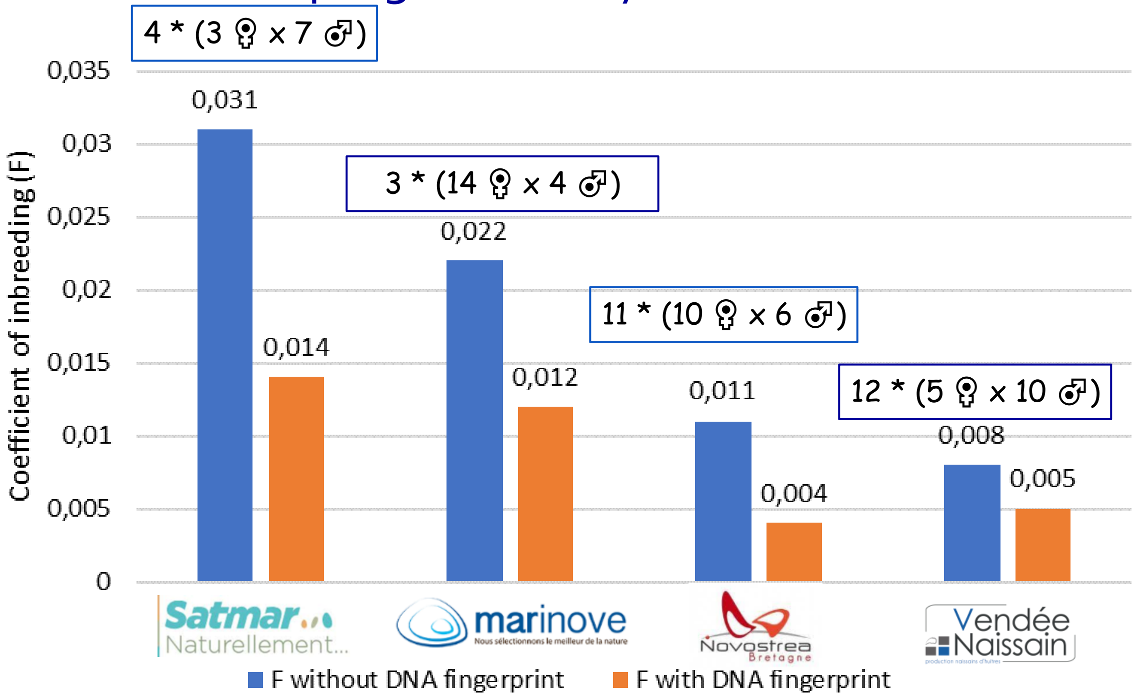
Molecular Ecology Resources (2014) 14, 820–830

doi: 10.1111/1755-0998.1223

**Development of SNP-genotyping arrays in two shellfish species**

S. LAPÈGUE,* E. HARRANG,* S. HEURTEBISE,* E. FLAHAUW,* C. DONNADIEU,† P. GAYRAL,‡§ BALLENGHIEN,‡ L. GENESTOUT,¶ L. BARBOTTE,¶ R. MAHLA,¶ P. HAFFRAY** and C. KLOPP†

Ifremer LABOGENA DNA Experts SYSAAF




- Introduction of DNA fingerprinting is helping to secure domestication in managing inbreeding risk

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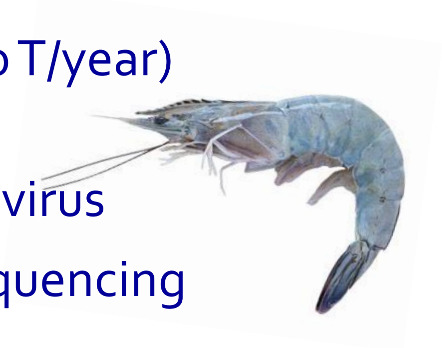
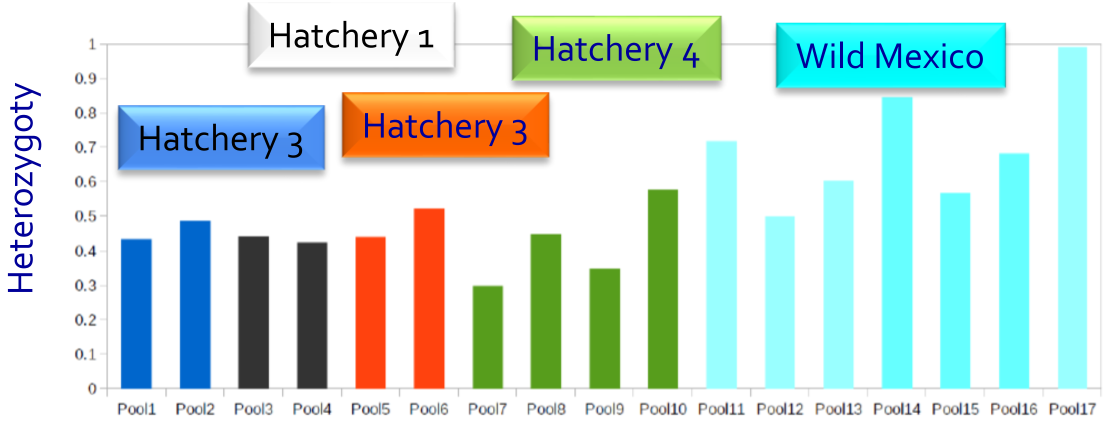
# Introduction of DNA fingerprinting in shrimp breeding

ADECAL TECHNOPOLE NOUVELLE-CALÉDONIE



- The blue shrimp *Litopenaeus stylirostris* was introduced in New Caledonia (1700 T/year) in the 70' with a limited effective of 3-5 founders (Goyard et al., 2003)
- Failure to introduce new genetic resources from sources not resistant to IHHN virus
- Automation of 171 SNP markers from 459 669 locus RAD identified by RAD sequencing




2-5 individuals / pool

| | Raw shrimp | | Cooked shrimp | |
|---|---|---|---|---|
| Trait | Mean (Std) | Heritability (S.E.) | Mean (Std) | Heritability (S.E.) |
| Weight (g) | 14.5 (3.0) | 0.52 (0.11) | 14.0 (3.1) | 0.52 (0.11) |
| Length (mm) | 129.6 (7.9) | 0.46 (0.10) | - | - |
| L* | 48.1 (2.4) | 0.41 (0.10) | 72.1 (1.9) | 0.45 (0.10) |
| a* | 1.2 (0.8) | 0.59 (0.11) | 23.3 (2.7) | 0.53 (0.11) |
| b* | 6.4 (3.4) | 0.51 (0.10) | 19.1 (2.7) | 0.54 (0.11) |
| Tail yield | - | - | 0.59 (0.03) | 0.22 (0.06) |

1200 progenies DNA assigned from 37 ♀ x 31 ♂

Enez et al., 2018 (WCGALP)

- The limited genetic variability(-30-50 % / wild) is not preventing future genetic progress

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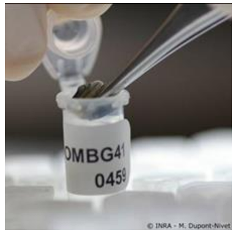
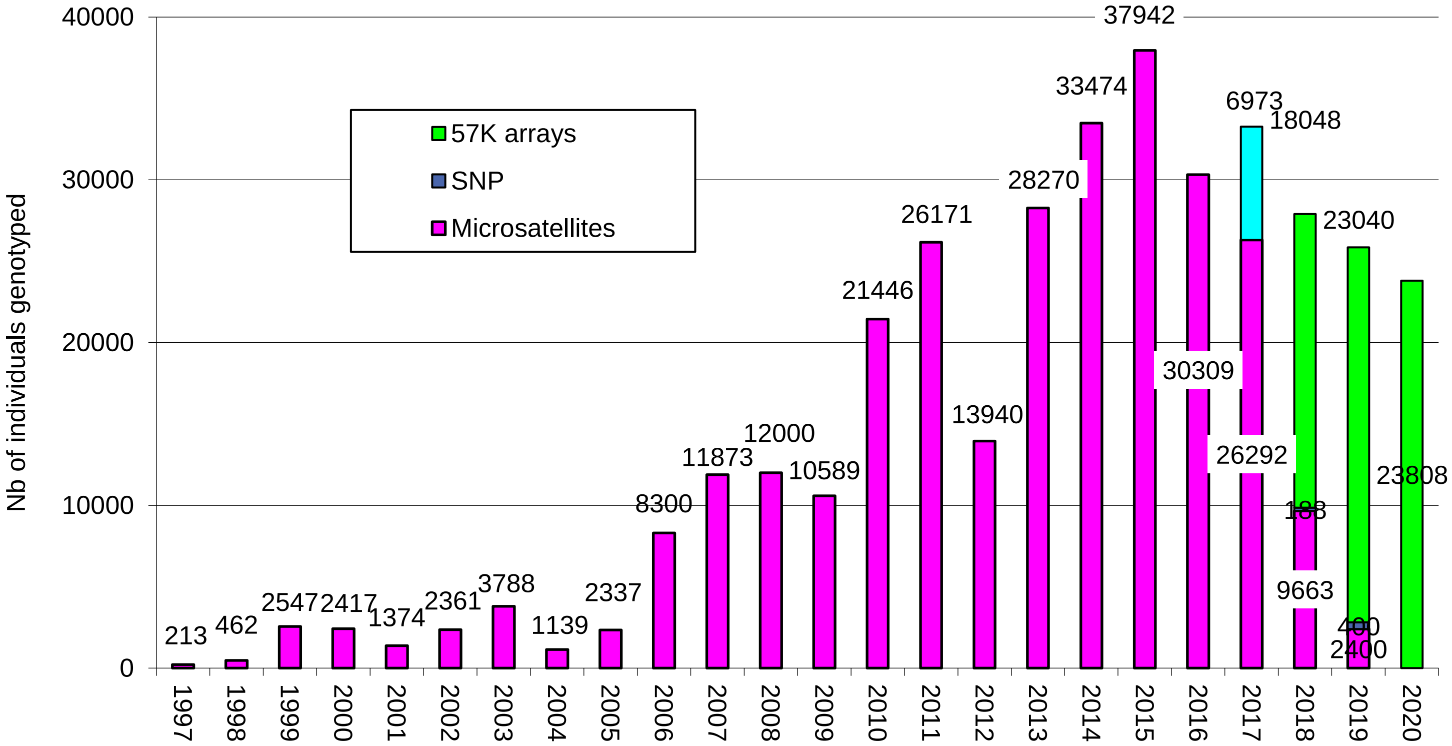
# DNA parentage assignment is now widely applied in SYSAAF to improve breeding programs



SYSAAF

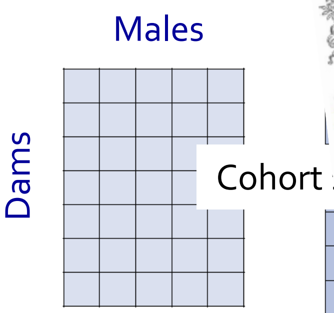


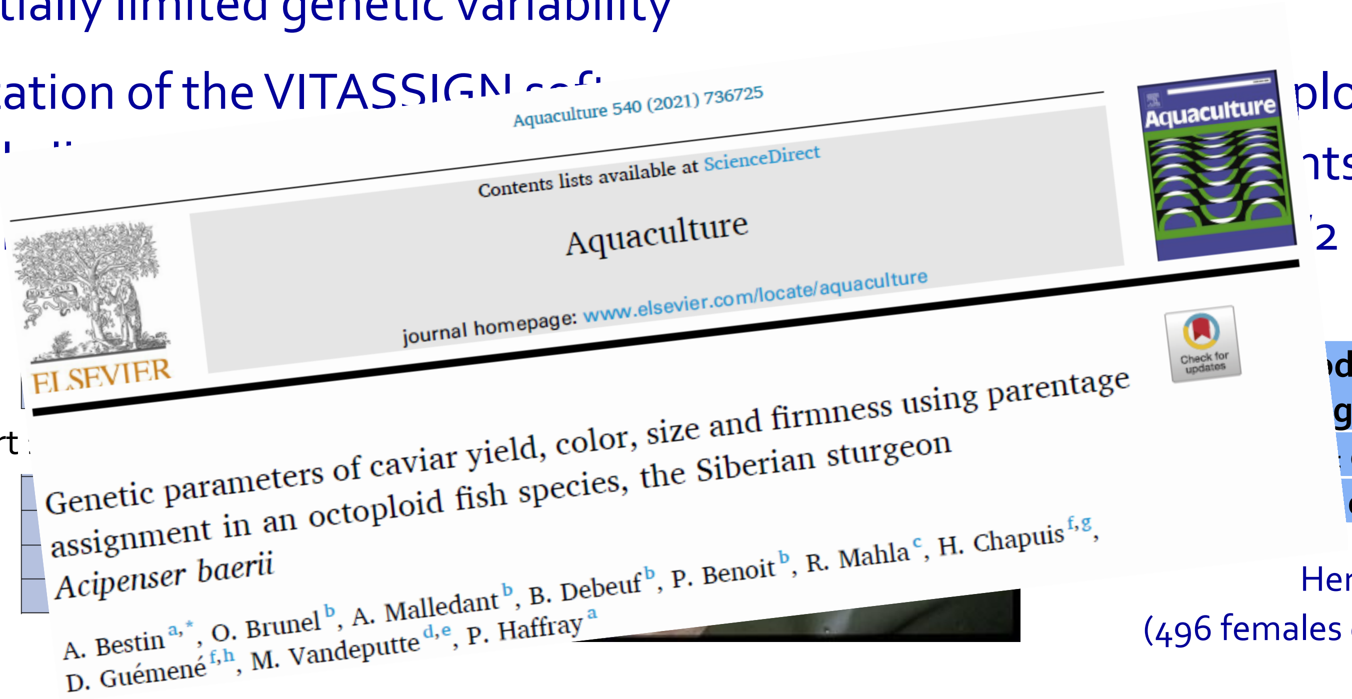

- 8 microsatellite panels for parentage assignement (trout, sea bass, sea bream, turbot, meagre, red drum, salmon, siberian sturgeon)
- 8 SNP panels for parentage assignement (meagre, blue shrimp, tiger shrimp, white shrimp, Pacific oyster, Japanese clam, rainbow trout)
- 5 HD 50 K Thermofisher ans Illumina arrays (trout, sea bass, sea bream, Pacific oyster, white shrimp)
- 1 QTL VNN

- 368 692 fishes, shrimp, or molluscs genotyped since 1997

# Adaptation of software to assign parentage in an octoploid (8N) species, the Siberian sturgeon *Acipenser baeri* for caviar production

- The French caviar production (40 T) is based on two introductions from Russia (1975, 1982) with potentially limited genetic variability
- Adaptation of the VITASSIGN sof… …ploidy level :
  - al… …nts
  - w… …2 alleles for (1) to be true

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ELSEVIER

Genetic parameters of caviar yield, color, size and firmness using parentage assignment in an octoploid fish species, the Siberian sturgeon *Acipenser baerii*

A. Bestin [a,*], O. Brunel [b], A. Malledant [b], B. Debeuf [b], P. Benoit [b], R. Mahla [c], H. Chapuis [f,g], D. Guéméné [f,h], M. Vandeputte [d,e], P. Haffray [a]

| …dy …ght | Oocyte size | Caviar yield | Caviar colour |
|---|---|---|---|
| … 0.07 | 0.37 ± 0.06 | 0.52 ± 0.04 | 0.49 ± 0.08 |
| … 0.06 | 0.36 ± 0.06 | 0.66 ± 0.07 | 0.42 ± 0.06 |

Heritabilities (Bestin et al., 2021)
(496 females genotyped with microsatellite markers)

- It is possible to DNA assign in commercial conditions an 8N animal species to improve stocks and manage inbreeding

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Ministère de l'Agriculture et de l'Alimentation
Union Européenne
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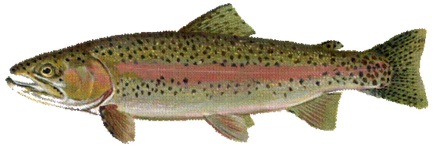
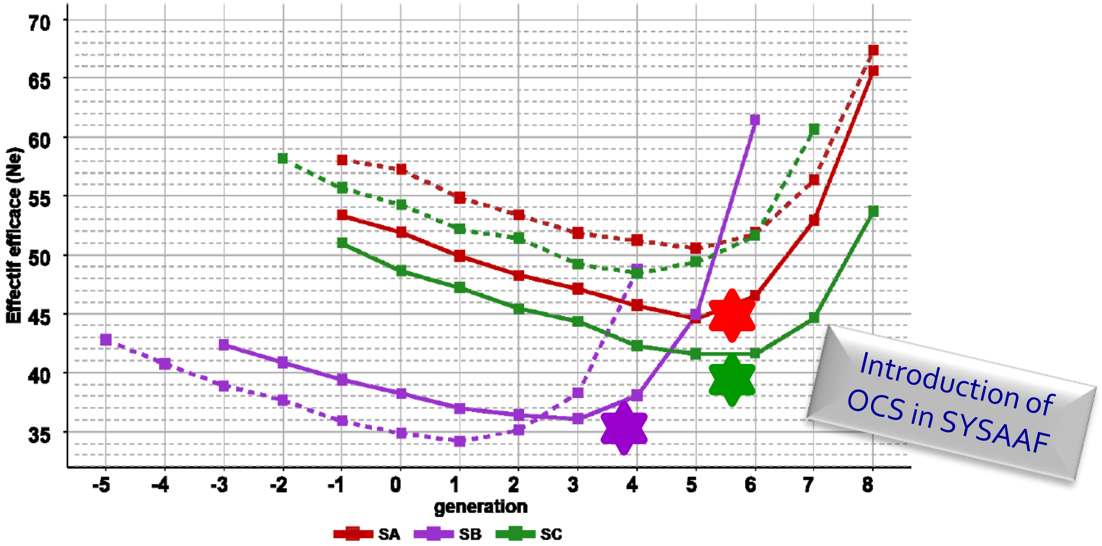
# Optimisation of mating to minimise increase of inbreeding



- **How to choose to mate who with who to create the new generation?**
- Application of the principle of "Optimal contribution selection" (OCS) adapted to poultry and aquaculture (Chapuis et al., 2016) in SYSAAF since 2012 (adaptative simulated annealing - ASA)
- Genotyping of the 2 last generations from 3 breeding programs on 57K SNP array

- Evaluation of the Linkage Disequilibrium of long homozygous conserved DNA fragments (ROH)



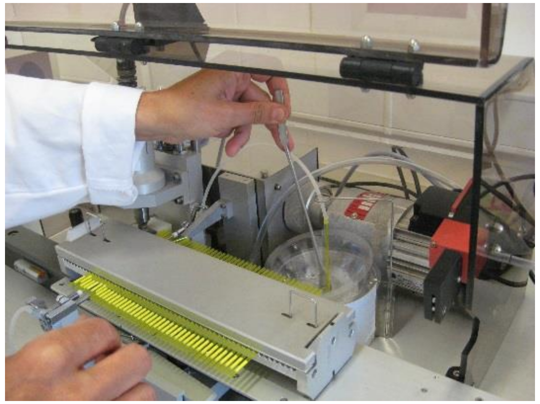

D'Ambrosio et al., (2019) and D'Ambrosio (2020)

The use of adapted OCS-ASA improve the conservation of the genetic variability

# Long term conservation of genetic in using cryopreservation

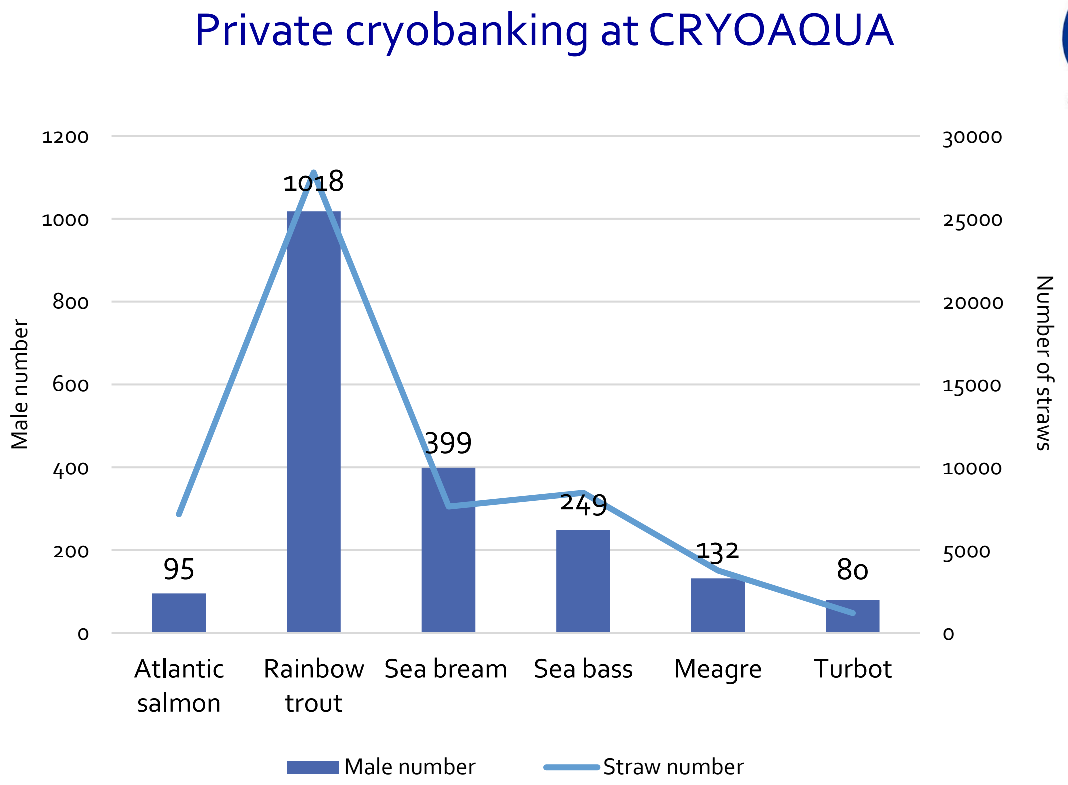
- Initial R&D works to developed extenders and established freezing and conservation procedures (Haffray et al., 2008)

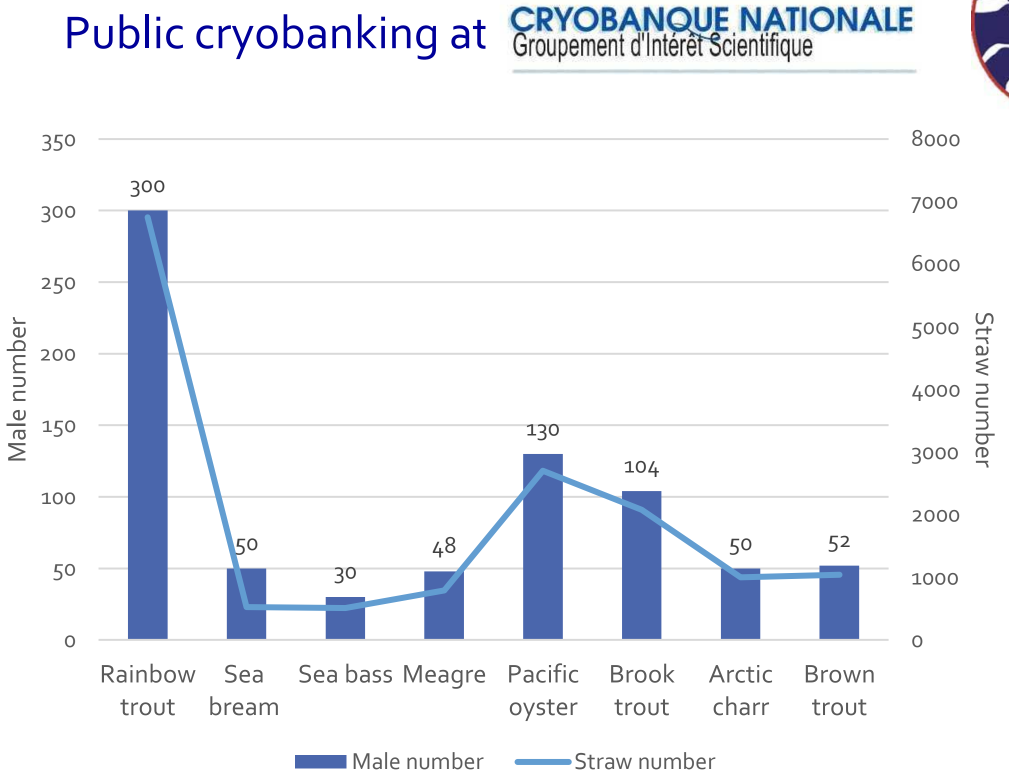
- Partnership to develop a collective cryobank cryoaqua operational since 2012



European sanitary agreement: FR SB 35-1

# Long term conservation of genetic in using cryopreservation




- Sperm cryopreservation is routinely operated to conserve genetic resources in France
- Partnership with Cryobanque Nationale is securing long term conservation of genetic resources






## Thank you for your attention

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