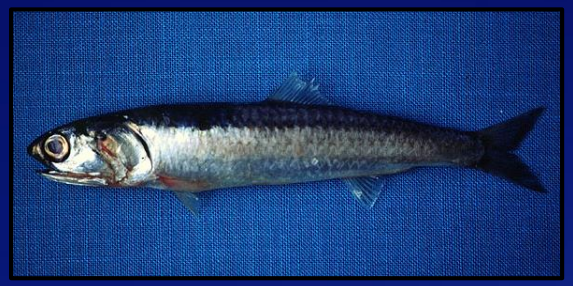


# AQUACULTURE BREEDING AND ETHICS

Fabrice TELETCHEA
fabrice.teletchea@univ-lorraine.fr

UNIVERSITÉ DE LORRAINE



Aquaculture Advisory Council
WORKING GROUP 1 “Finfish” Meeting
Wednesday 05 October 2022 (14:00 - 18:00), Bruxelles

# Introduction

nature ecology & evolution

BRIEF COMMUNICATION

https://doi.org/10.1038/s41559-019-0974-3

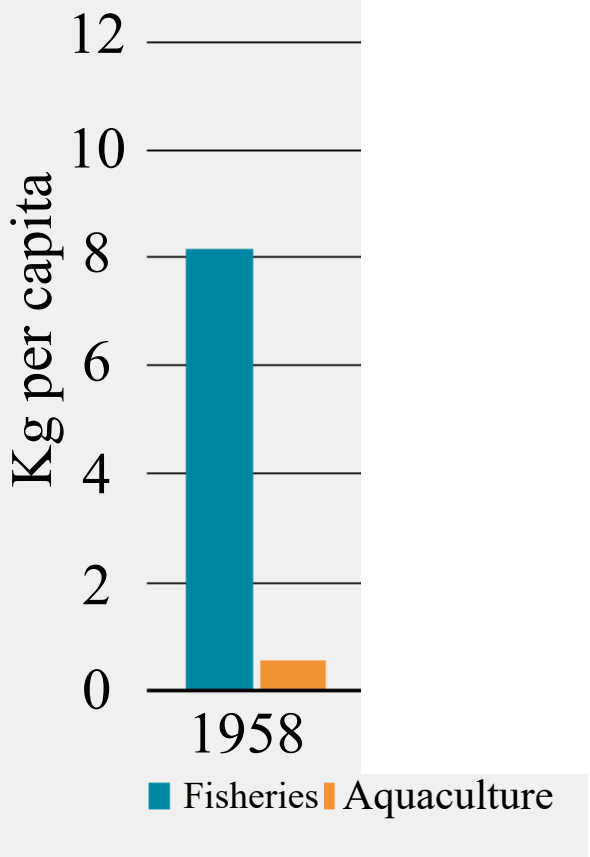
## Common carp aquaculture in Neolithic China dates back 8,000 years

Tsuneo Nakajima[1*], Mark J. Hudson[2], Junzo Uchiyama[3], Keisuke Makibayashi[4] and Juzhong Zhang[5]

Nakajima *et al.* (2019)

# Introduction

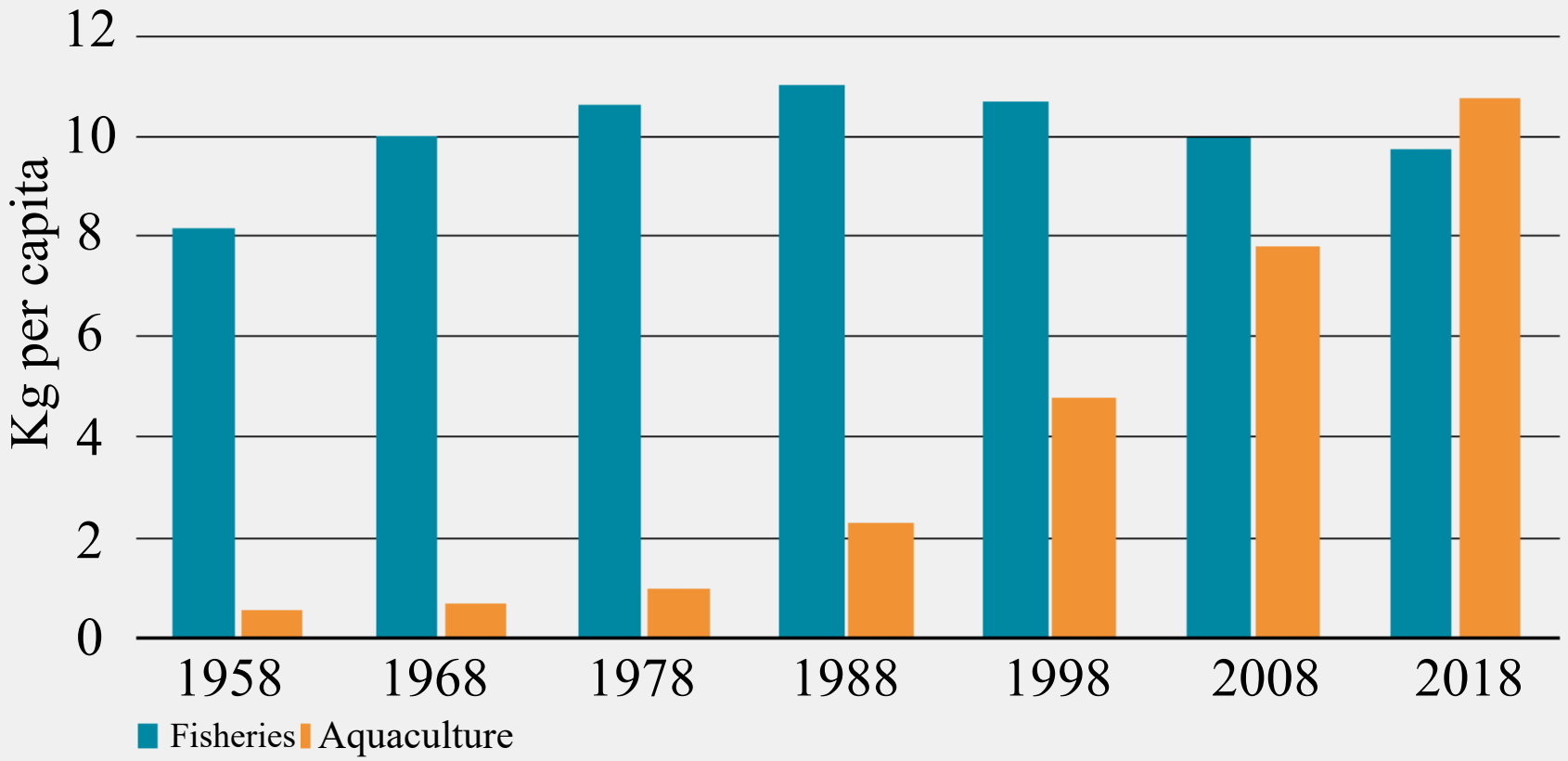
FIGURE 27
RELATIVE CONTRIBUTION OF AQUACULTURE AND CAPTURE FISHERIES TO FISH AVAILABLE FOR HUMAN CONSUMPTION




FAO (2020)

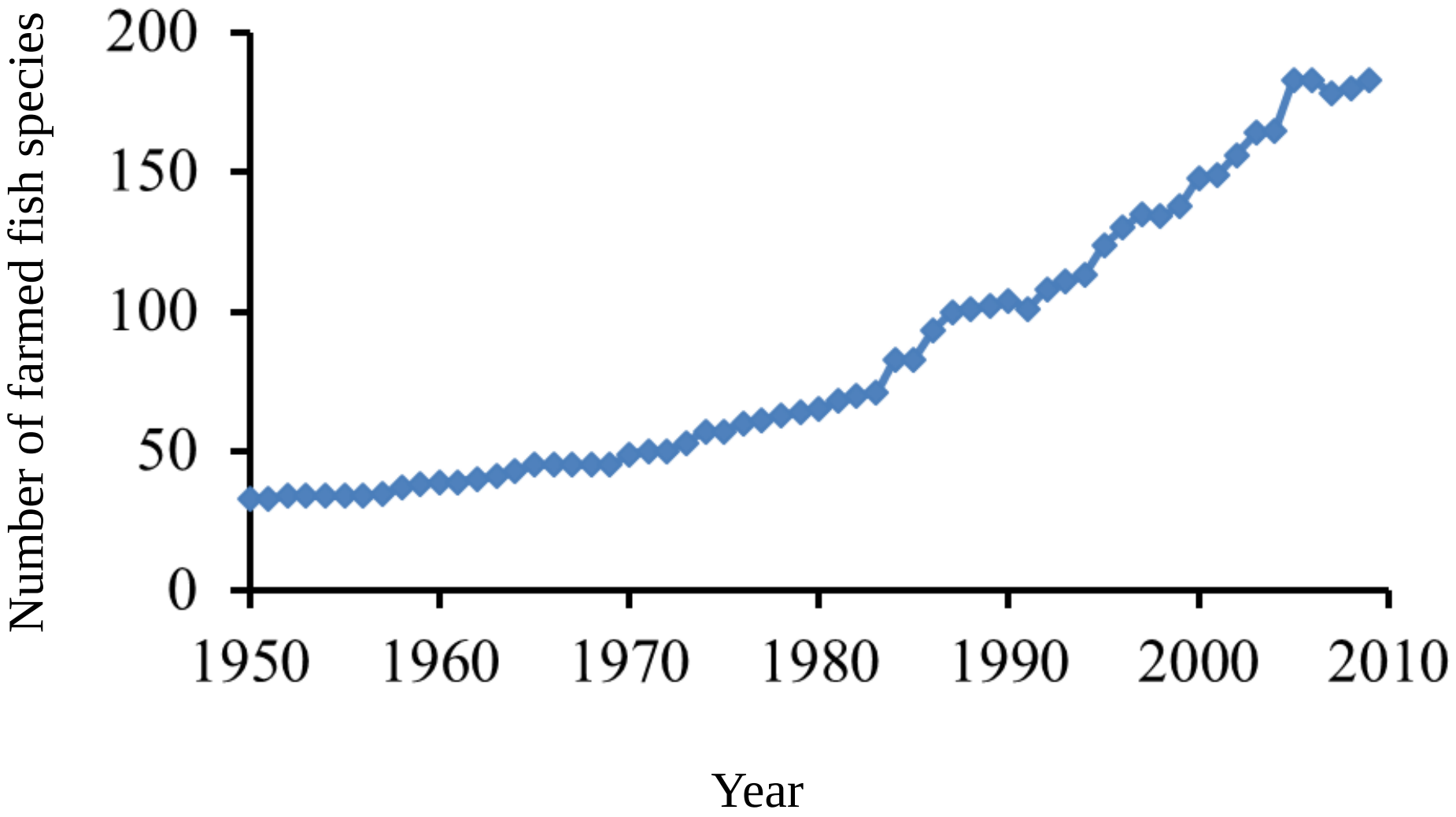
# Introduction

FIGURE 27
RELATIVE CONTRIBUTION OF AQUACULTURE AND CAPTURE FISHERIES TO FISH AVAILABLE FOR HUMAN CONSUMPTION




FAO (2020)

# Introduction




Teletchea (2016)

# Fisheries *vs* Aquaculture ?

**FISHERIES**

**WILD**

**AQUACULTURE**

**DOMESTICATED**

Duarte *et al.* (2007)

# Fisheries *vs* Aquaculture ?

**FISHERIES**

**WILD**

**AQUACULTURE**

| Authors | Number |
|---|---|
| Balon (2004) | 2 |
| Duarte et al. (2007) | 251 |
| Bilio (2008) | 42 |

Teletchea and Fontaine (2014)

# A continuum…

**FISHERIES** **AQUACULTURE**

Strong diversity of production modes
**Continuum FISHERIES => AQUACULTURE**

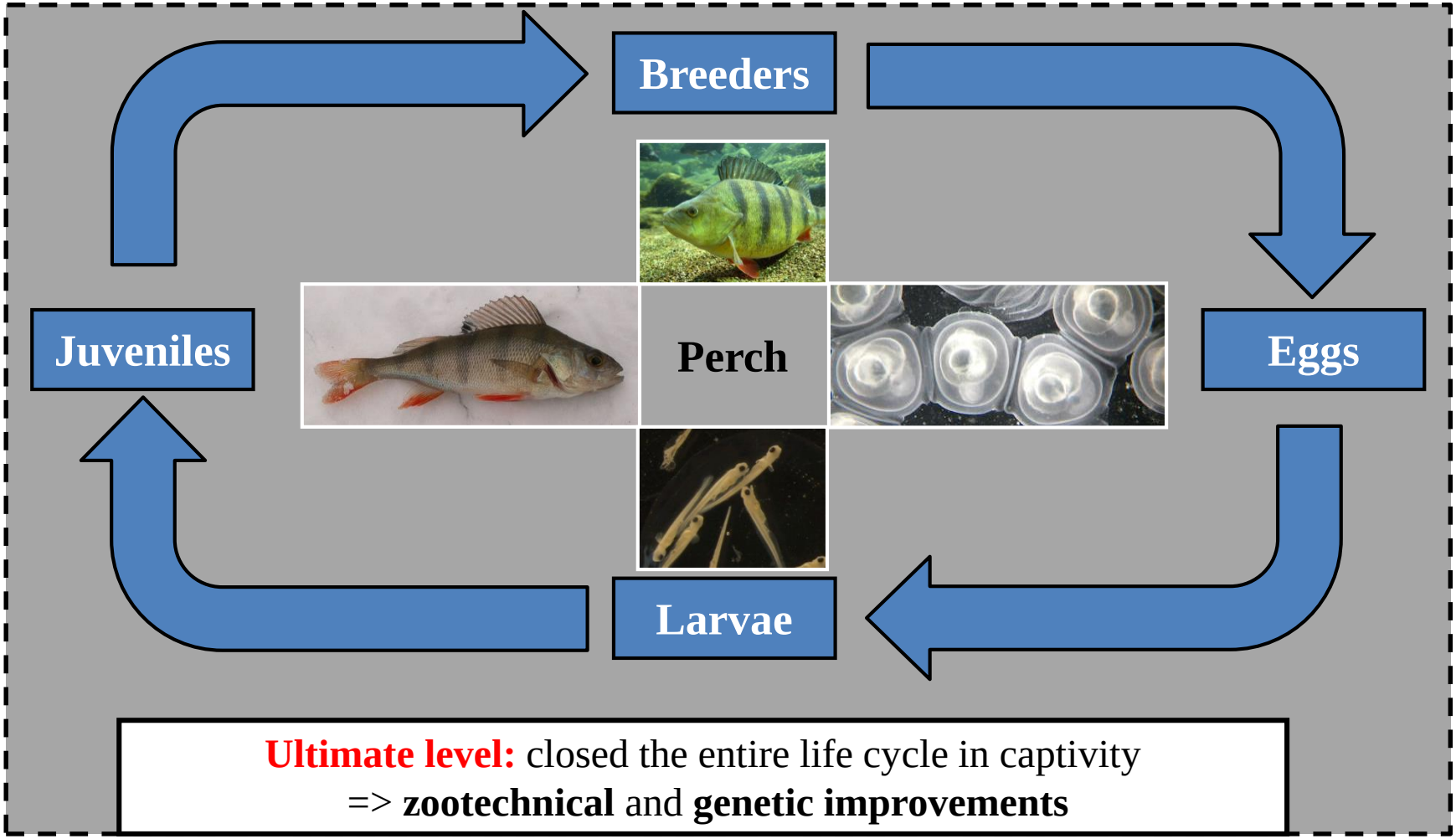
« **Wild** » and « **domesticated** » represent the extremes of a process and not a simple dichtomy

Dobney and Larson (2006); Klinger *et al.* (2013); Teletchea and Fontaine (2014)

# … so different domestication levels

**Not speak about domesticated fish but level of domestication**

1. Independence from wild supplies
2. Control over the entire life cycle




**Ultimate level:** closed the entire life cycle in captivity
=> **zootechnical** and **genetic improvements**

# Five levels of domestication

| Level | Description |
|---|---|
| | |
| | |
| | |
| | |
| | |
| **0** | **Capture fisheries** |

**L0** => Capture of wild fish / No control over the life cycle

# Five levels of domestication

| Level | Description |
|---|---|
| | |
| | |
| | |
| | |
| **1** | **First trials of acclimatization to the culture environment** |
| 0 | Capture fisheries |

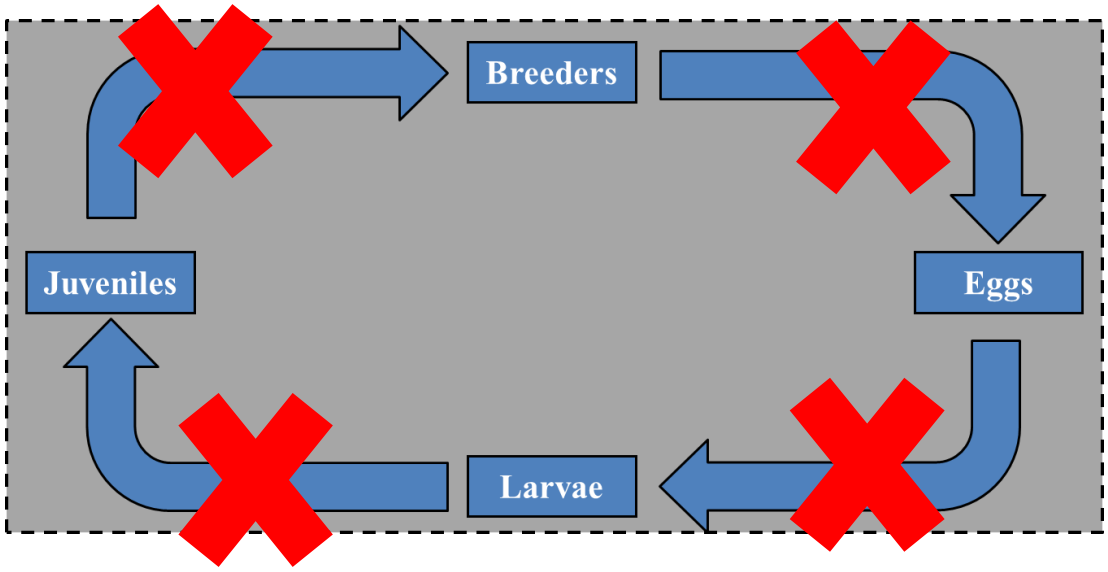
**L1** => Few information in the literature / < 5 continous years of farming in the FAO database

Silver bream (*Blicca bjoerkna*)

# Five levels of domestication

| Level | Description |
|---|---|
| | |
| | |
| | |
| **2** | **Part of the life cycle closed in captivity: several key bottlenecks** |
| 1 | First trials of acclimatization to the culture environment |
| 0 | Capture fisheries |

**L2** => Only part of the life cycle is controlled / « *Capture-based aquaculture* »

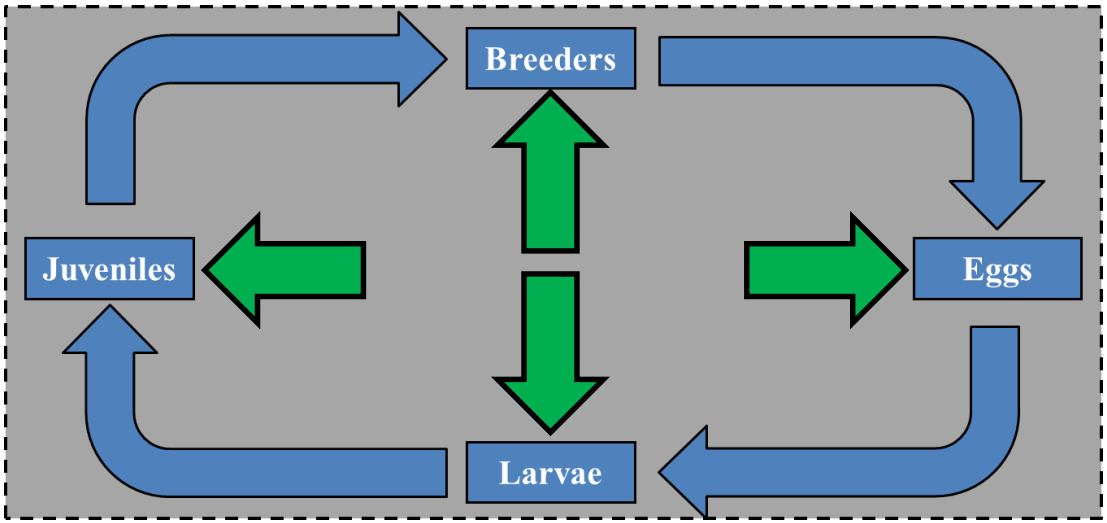



European eel (*Anguilla anguilla*)

# Five levels of domestication

| Level | Description |
|---|---|
| | |
| | |
| **3** | **Entire life cycle closed in captivity with wild inputs** |
| 2 | Part of the life cycle closed in captivity: several key bottlenecks |
| 1 | First trials of acclimatization to the culture environment |
| 0 | Capture fisheries |

**L3** => Maintain the genetic diversity / Conservation biology - aquariology

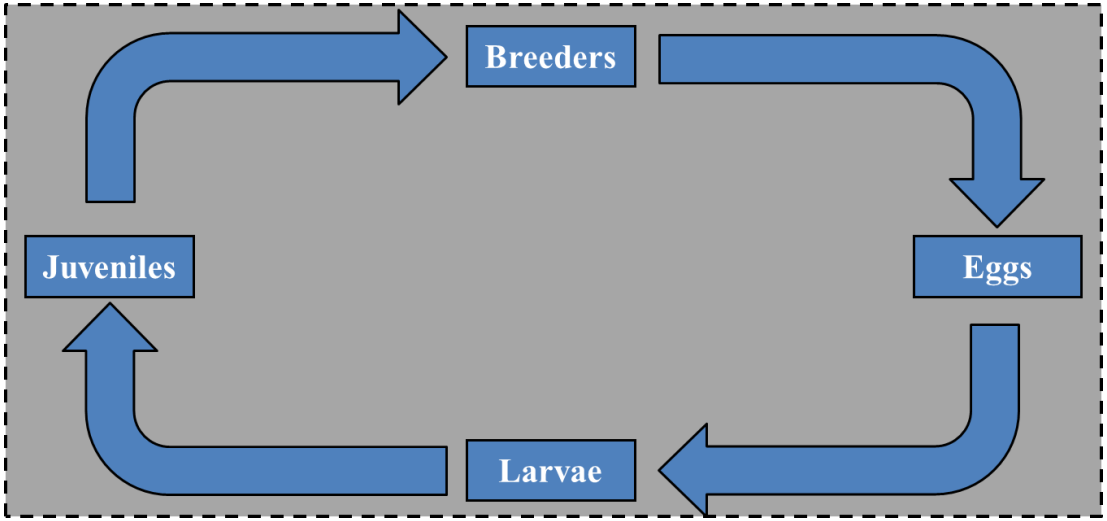



Roach (*Rutilus rutilus*)

# Five levels of domestication

| Level | Description |
|---|---|
| | |
| **4** | **Entire life cycle closed in captivity without wild inputs but no selective breeding program** |
| 3 | Entire life cycle closed in captivity with wild inputs |
| 2 | Part of the life cycle closed in captivity: several key bottlenecks |
| 1 | First trials of acclimatization to the culture environment |
| 0 | Capture fisheries |

**L4** => Changes due to domestication / no active selection




Eurasian perch (*Perca fluviatilis*)

# Five levels of domestication

| Level | Description |
|---|---|
| **5** | **Selective breeding programs focusing on specific goals (growth rate, fillet yield…)** |
| 4 | Entire life cycle closed in captivity without wild inputs but no selective breeding program |
| 3 | Entire life cycle closed in captivity with wild inputs |
| 2 | Part of the life cycle closed in captivity: several key bottlenecks |
| 1 | First trials of acclimatization to the culture environment |
| 0 | Capture fisheries |

**L5** => Active selection focusing on specific goals / Not the entire production at level 5


Common carp (*Cyprinus carpio*)

# Five levels of domestication

In Europe => inland aquaculture

Current production

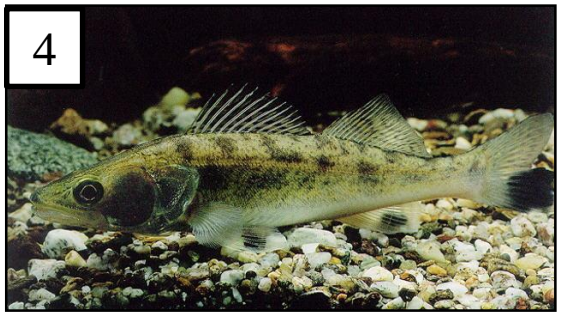
**Common carp**
(*Cyprinus carpio*)


**Rainbow trout**
(*Oncorhynchus mykiss*)

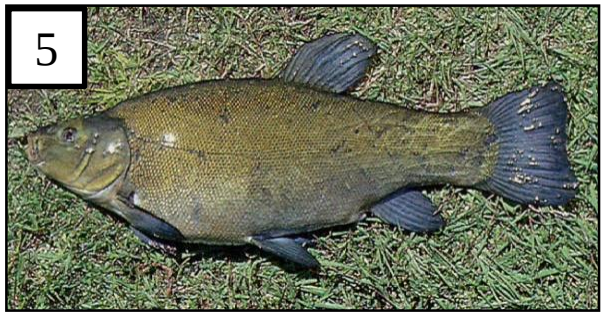

Developing production

**Eurasian perch**
(*Perca fluviatilis*)


**Pikeperch**
(*Sander lucioperca*)




**Tench**
(*Tinca tinca*)




Teletchea and Fontaine (2014)

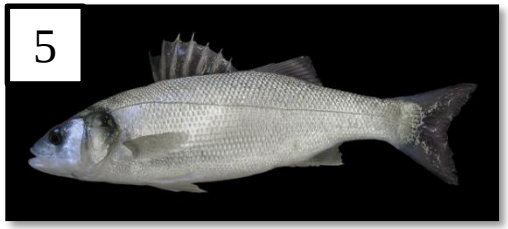
# Five levels of domestication

In Europe => marine aquaculture

Current production

**Atlantic salmon**
(*Salmo salar*)


**Sea bass**
(*Dicentrarchus labrax*)

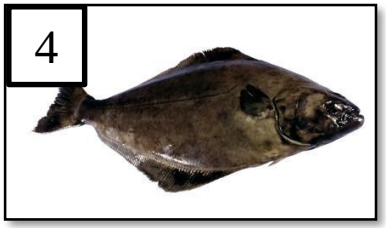



**Gilthead seabream**
(*Sparus aurata*)

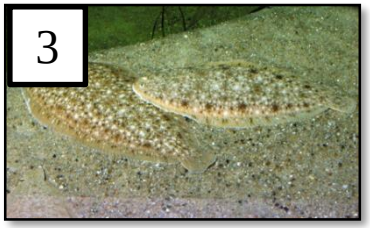

Developing production

**Atlantic cod**
(*Gadus morhua*)


**Atlantic halibut**
(*Hippoglossus hippoglossus*)




**Soles**
(*Solea solea / senegalensis*)



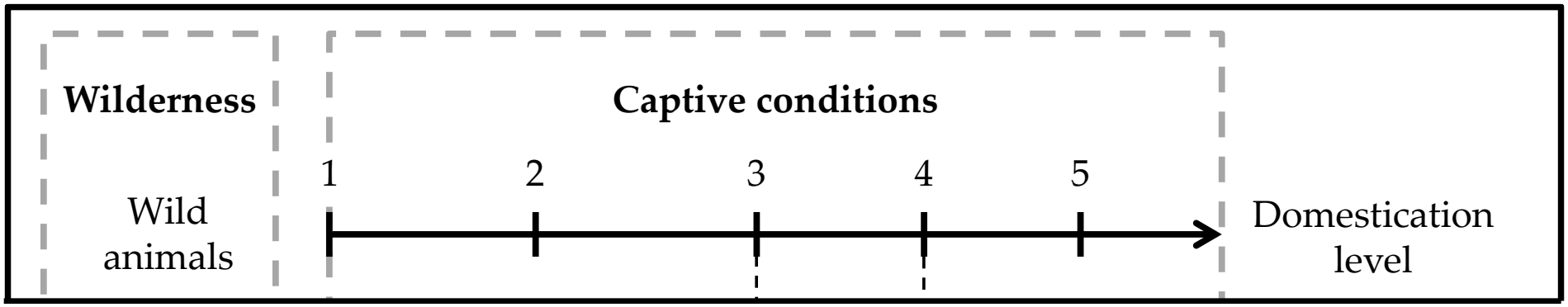

**Meagre**
(*Argyrosomus regius*)


**Sparids**
(*Diplodus puntazzo*)


**Atlantic bluefin tuna**
(*Thunnus thynnus*)


Teletchea and Fontaine (2014)

# Five genetic processes




**Inbreeding and genetic drift (uncontrolled)**

Due to the limited size of the population and produce random changes in gene frequencies

**Natural selection in captivity (partially controlled)**

Selection imposed on captive populations that cannot be ascribed to active selection

**Relaxation of natural selection (partially controlled)**

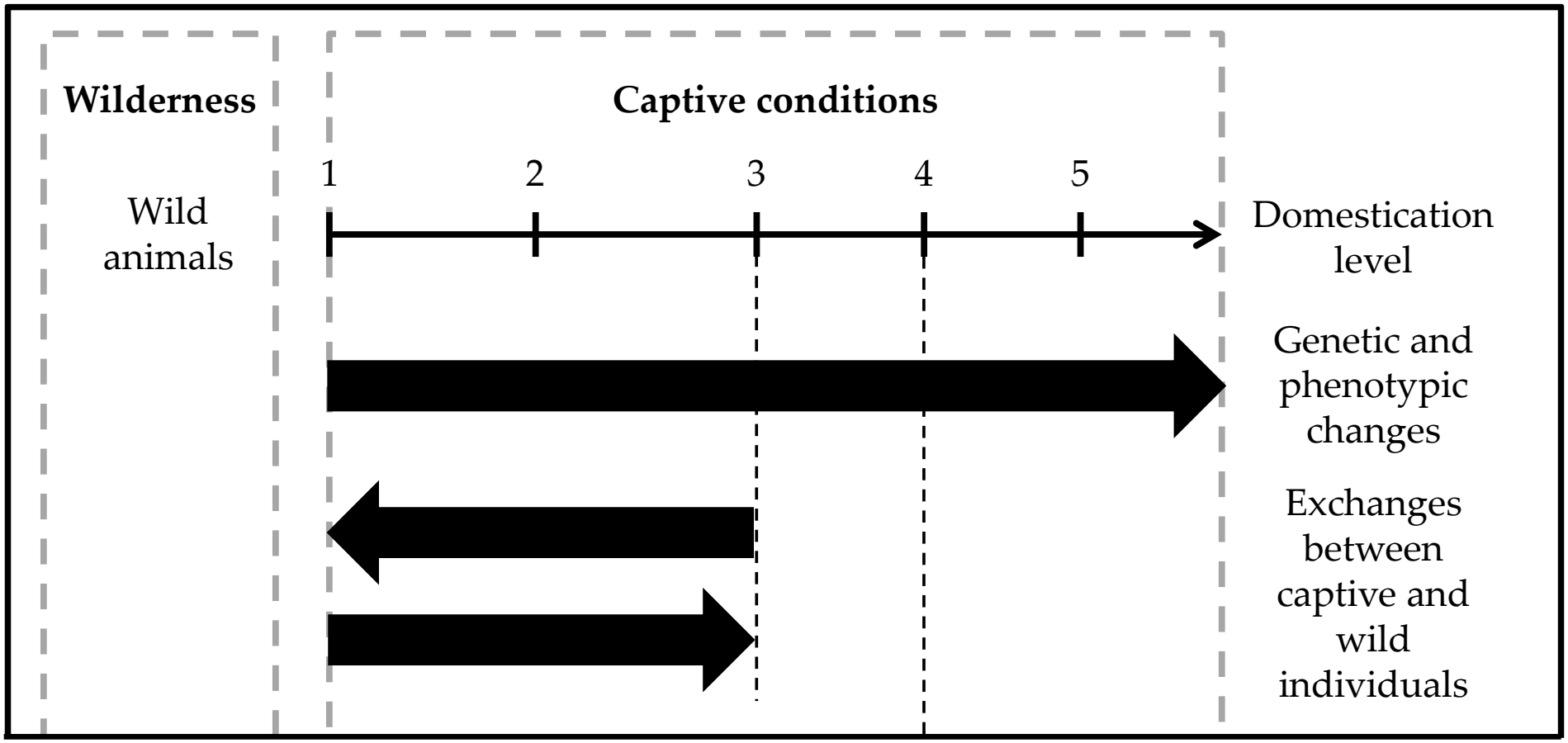
Can be expected to accompany the transition from wild to captive conditions

**Active selection (controlled)**

Changes that are directional

Petersson *et al.* (1996); Price (1999); Mignon-Grasteau *et al.* (2005)

# Five genetic processes




**Number of generations (levels 4 & 5)**

# Which traits were improved?

**Growth rate**

**Feed conversion efficiency**

**Product-quality-related traits**

**Reproduction**

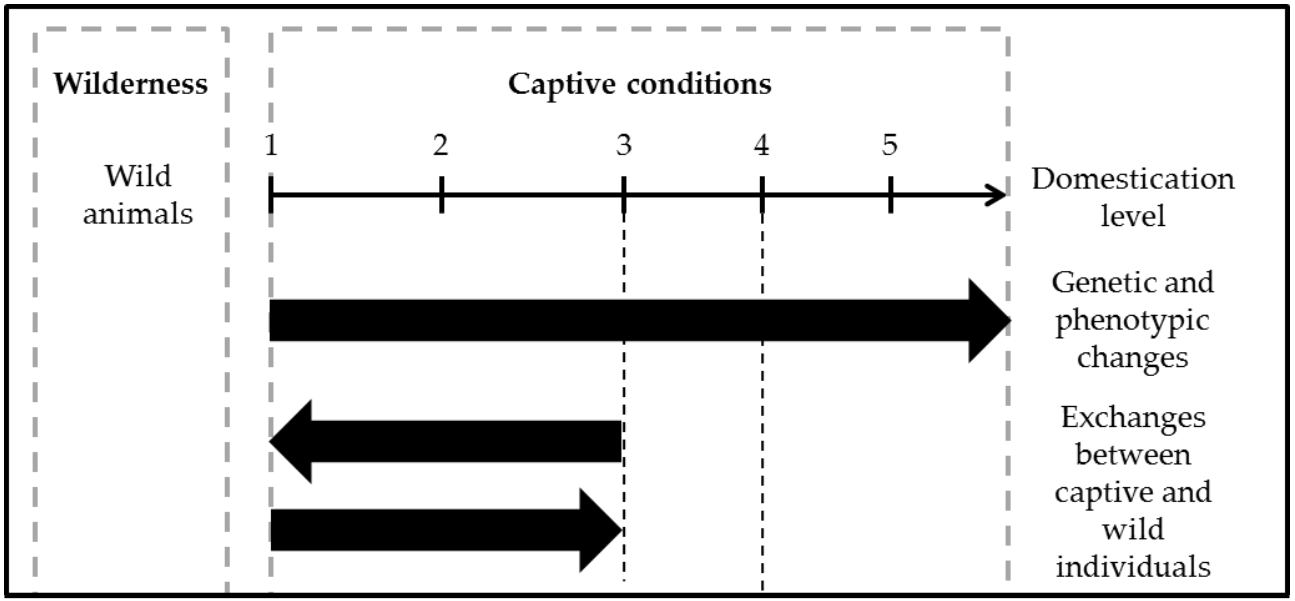
**Resistance to diseases**

**10-15%** of world aquaculture production (*Salmo salar* ~ 100%)

Nguyen (2016); Janssen *et al.* (2017); Gjedrem and Rye (2018)

# Should we slow down fish domestication?

Thousands years => huge genetic variability (*breeds*)

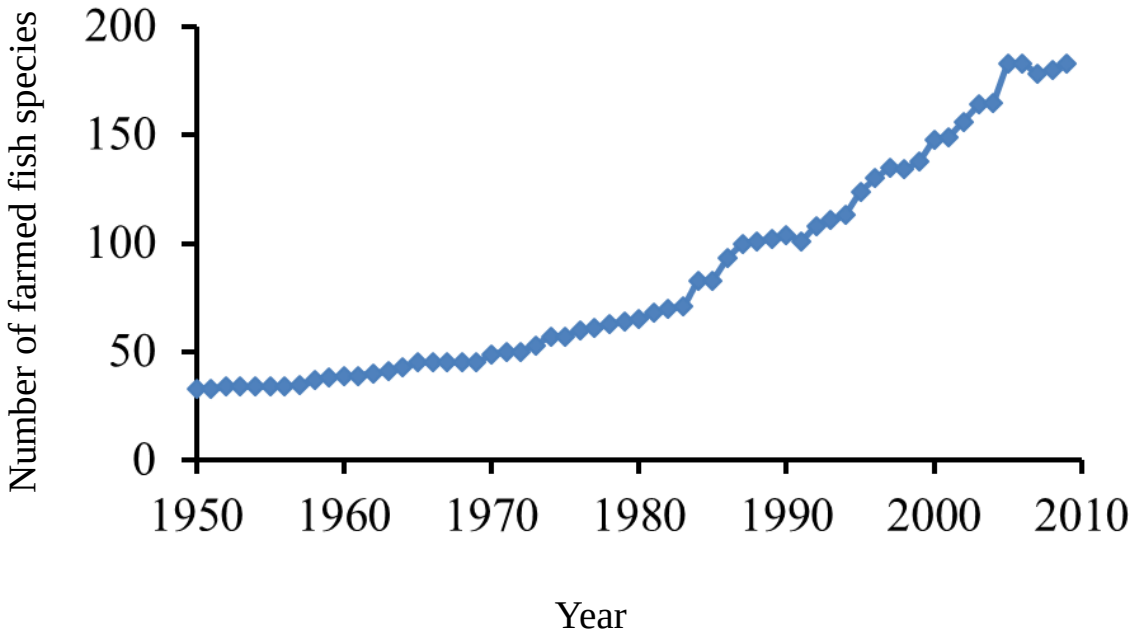



Few decades => from level 1 to 5 (12th generation)

*Climate change, Ocean acidification, Pollution, Ethics*

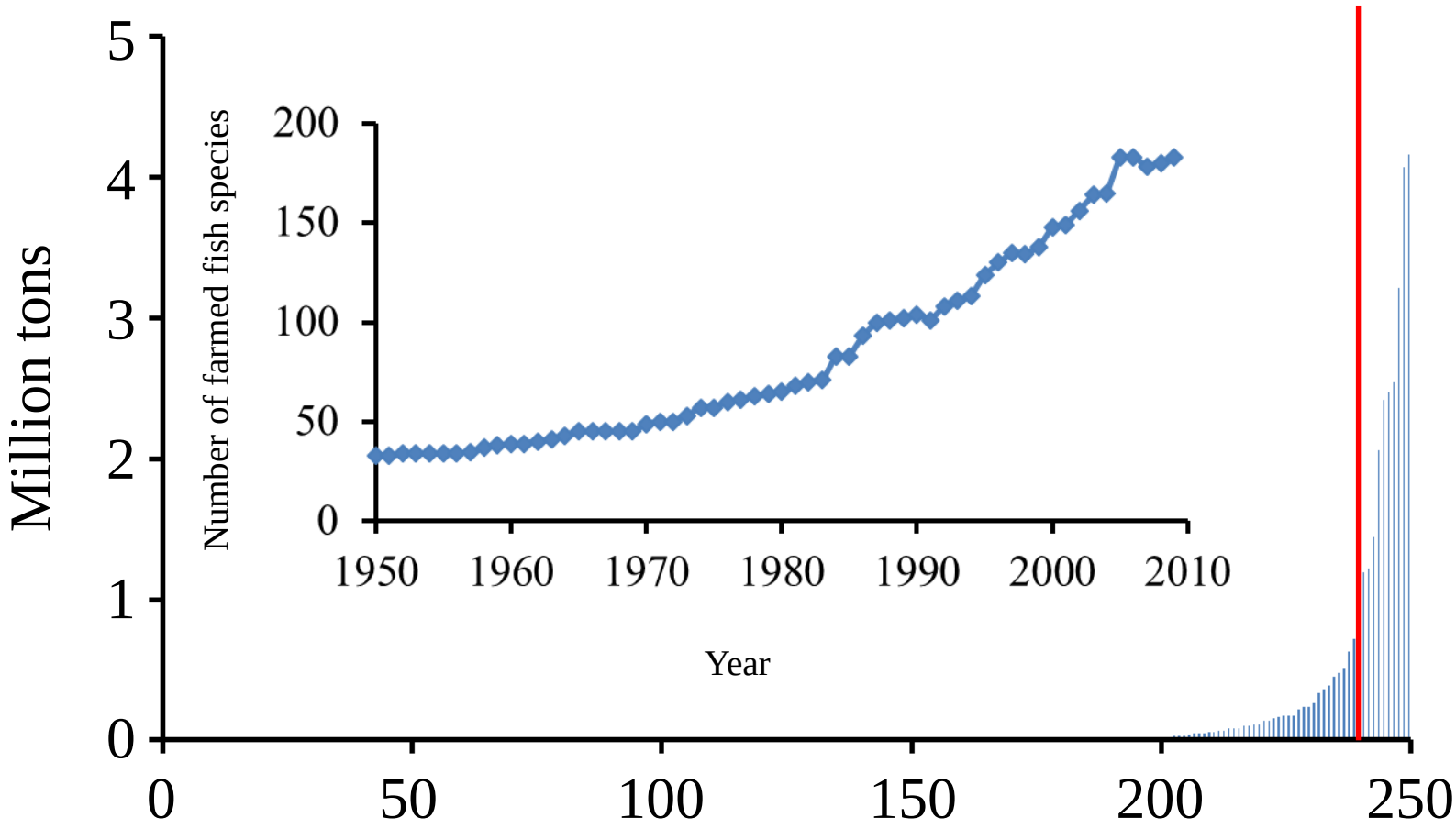
Teletchea (2016)

# Should we focus on a few species?



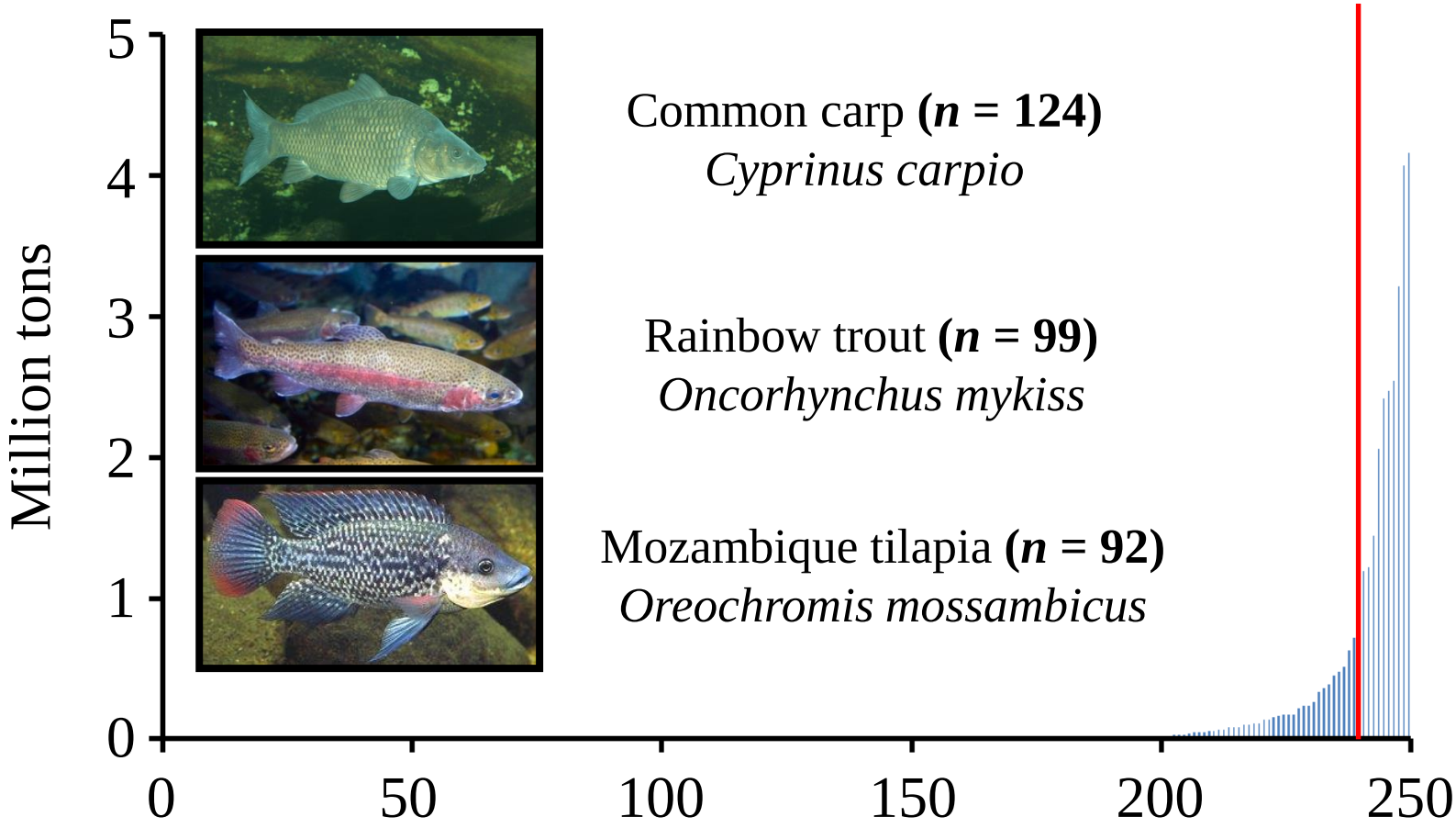

Teletchea (2016)

# Should we focus on a few species?



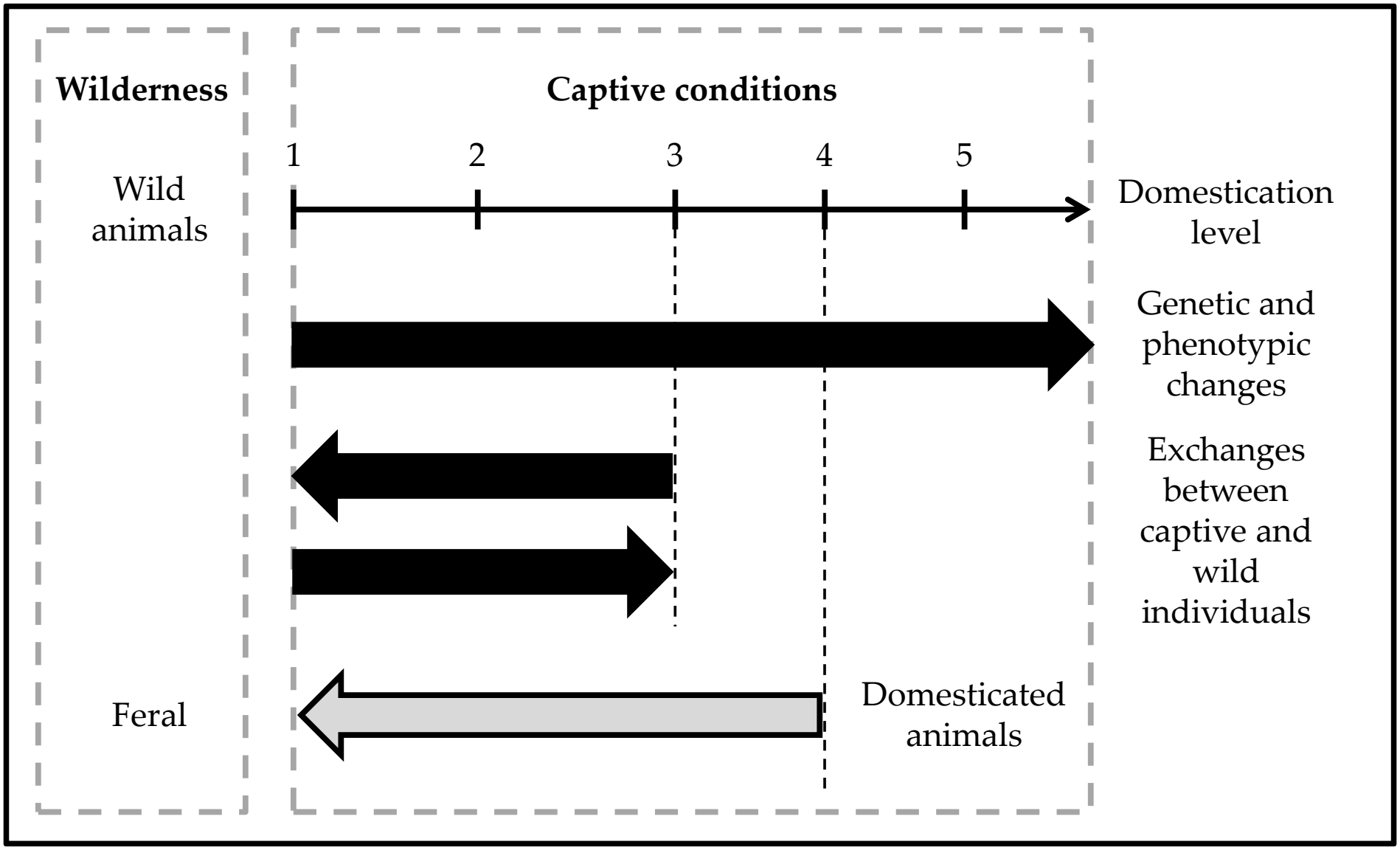

Teletchea (2016)

# Should we focus on a few species?




Teletchea (2019)

# Conclusions



# Conclusions

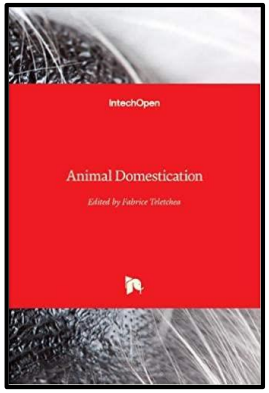
















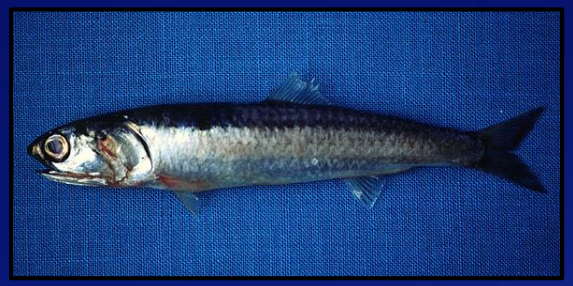
# Conclusions

*Perspectives*

## Fish domestication in aquaculture: 10 unanswered questions

**Fabrice Teletchea**

Unité de Recherche Animal and Fonctionnalités des Produits Animaux, Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement, Université de Lorraine, 54505 Vandœuvre-lès-Nancy, France



# AQUACULTURE BREEDING AND ETHICS

Fabrice TELETCHEA
fabrice.teletchea@univ-lorraine.fr

UNIVERSITÉ DE LORRAINE



Aquaculture Advisory Council
WORKING GROUP 1 “Finfish” Meeting
Wednesday 05 October 2022 (14:00 - 18:00), Bruxelles