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The eel restocking program in France: objectives and method.

Quentin Josset[1], Lou Frotté[6], Anthony Acou[1], Thomas Trancart[1], Fabien Charrier[2], Virgile Mazel[2], Jérémie Souben[3], Laurent Beaulaton[4,5] and Eric Feunteun[1]
(1) Muséum National d'Histoire Naturelle, Dinard Marine Station, UMR BOREA: 38, rue du Port Blanc, 35800 Dinard (2)Fish Pass, 3 Rue des Grands Champs, Z.A. des 3 Prés 35890 LAILLE, (3)Association pour le Repeuplement de l'Anguille, 134 avenue de Malakoff 75116 Paris France, (4)ONEMA pôle Gest'Aqua, 35042 Rennes , France,(5) INRA, U3E, pôle Gest'Aqua, 35042 Rennes, France, (6) Muséum National d'Histoire Naturelle, Concarneau Marine Station: BP 225, 29182 Concarneau Cedex
Contact : acou@mnhn.fr & feunteun@mnhn.fr

Among actions of the French Eel Management Plan (EMP) to restore the severely depleted European eel stock, France has implemented a restocking program.

Restocking consist in the **capture of wild glass eels** in estuaries, and **a transfer to favorable sites**.

Since 2010, **5-10% of the fishing quota** is thus reserved for the restocking operations in France. The French government funds up to 96% of the operations' cost. The release operations are then supported by the stakeholders.

Along the **2011-2013 period, *ca.* 7 tons of glass eels** (≈ 20 million individuals) have been released in aquatic systems of north and western France : 703 kg in 2011 ($\bar{x}$=117 kg.site^{-1}), 3097 kg in 2012 ($\bar{x}$=281,5 kg.site^{-1}) and 2925 kg in 2013 ($\bar{x}$=266 kg.site^{-1}) (ARA France, unpublished). These glass eels are expected to **produce *ca.* 70000-950000 silver eels of 10 years** providing a survival of 30% (Lambert, 2008) the first year and a Z = 0,2-0,4 the following years.

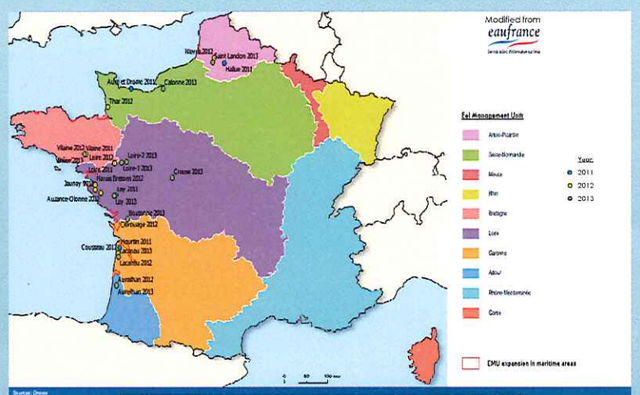


Figure 1: Map of the release sites location and the Eel Management Units

1 Pre-release operations:

- Catch by marine and inland professional fisheries
- Biometric measurements of glass eels: weight, size, pigmentary stage (mainly VIA1 – VIA2; Elie, 1982)
- Assessment of the sanitary status: EVEX, *Anguillicoloides crassus* etc., and of the extent of injuries related to fishing (carmin-indigo test) (Briand *et al.*, 2012)
- Otolith mass marking with Alizarin Red S (ARS) by immersion in a 150 mg.L^{-1} solution for 3h (≈ 30% of the released glass eels) (Caraguel *et al.*, in press)


Photo 1: Glass eel sieve used by professional fishermen

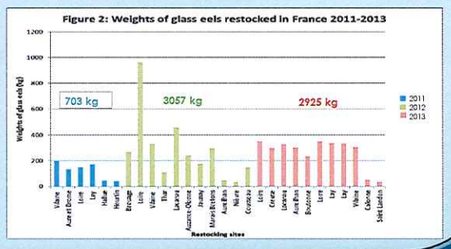

Photo 2: Glass eels marking with ARS


Photo 3: ARS marked otolith

2 Release protocol (Frotté et al. 2012):

- Selection of suitable sites: low eel density, low anthropogenic pressures (chemical loads, turbines, fishery), (Frotté *et al.*, 2012)
- Release from the shore or a boat, in several points, in accordance with the carrying capacity: 2-5kg.ha^{-1} eutrophic or 0,03-0,1kg/ha oligotrophic
- Water physico-chemical measurements


Photo 4: Glass eels release from boat



1 2 3 4 5 **Restocking process**

Year n — Year n+1 — Year n+2 — Year n+3

3 Post-release operation: short-term mortality assessment (15 days)

- Survival monitoring for 15 days
- *in-situ*/labo tests, each with marked/not marked modalities
- 3 replicates of 50 individuals per modality

⇒ Is the mortality rate influenced by marking, handling, & biological factors (condition factor, percentage of catch-induced injuries, etc.)?


Photo 5: *In-situ* – 15 days mortality monitoring


Photo 6: Glass eels used for tests and restocking

4 Post-release operations: a mid-term *in-situ* monitoring (6,12 & 36 months)

- Electrofishing: 25 stations of 20 Point Abundance Sampling (PAS) (30sec) (Lambert & Feunteun 1994)
- Surveys on the release sites, upstream and downstream to analyze movement & dispersion patterns
- Water physico-chemical measurements
- Anatomic measurements and external pathology
- 50 individuals from the expected size-class sampled for otolithometry (epifluorescence microscopy) and internal parasitology


Photo 7: Electrofishing survey

⇒ Growth rate patterns(similarity between naturally recruited & restocked eels)

⇒ Restocking efficiency (proportion and abundance of marked eels)

5 Objectives and prospects:

- Short-term (15 days) :
  - Factors influencing mortality?
    - Biological factors: injury rates, life history traits (*ie* pigmentation stage, size, condition, etc)
    - Technical factors: marking, fishing, housing, transport conditions, glass eels origin etc.
  - Quantification of these effects
  - Recommendations for the restocking protocol
- Mid-term (until 36 months after release):
  - Cohort monitoring: growth and dispersion patterns study marked/unmarked ratio monitoring: survival, dilution (proportion of natural recruits), dispersion ?
- Long-term (until silver eel production: from 4-17 years in France) (Eeliad, unpublished data)
  - **Feature question: Are number and quality of restocked silver eels produced equivalent to natural ones ?**

→ assess yield of silver eels per recruits
→ assess silver eel quality (life history traits, size, age, condition, contamination by metallic & organic pollutants)
→ However, the data on restocked silver eels is scarce.

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