

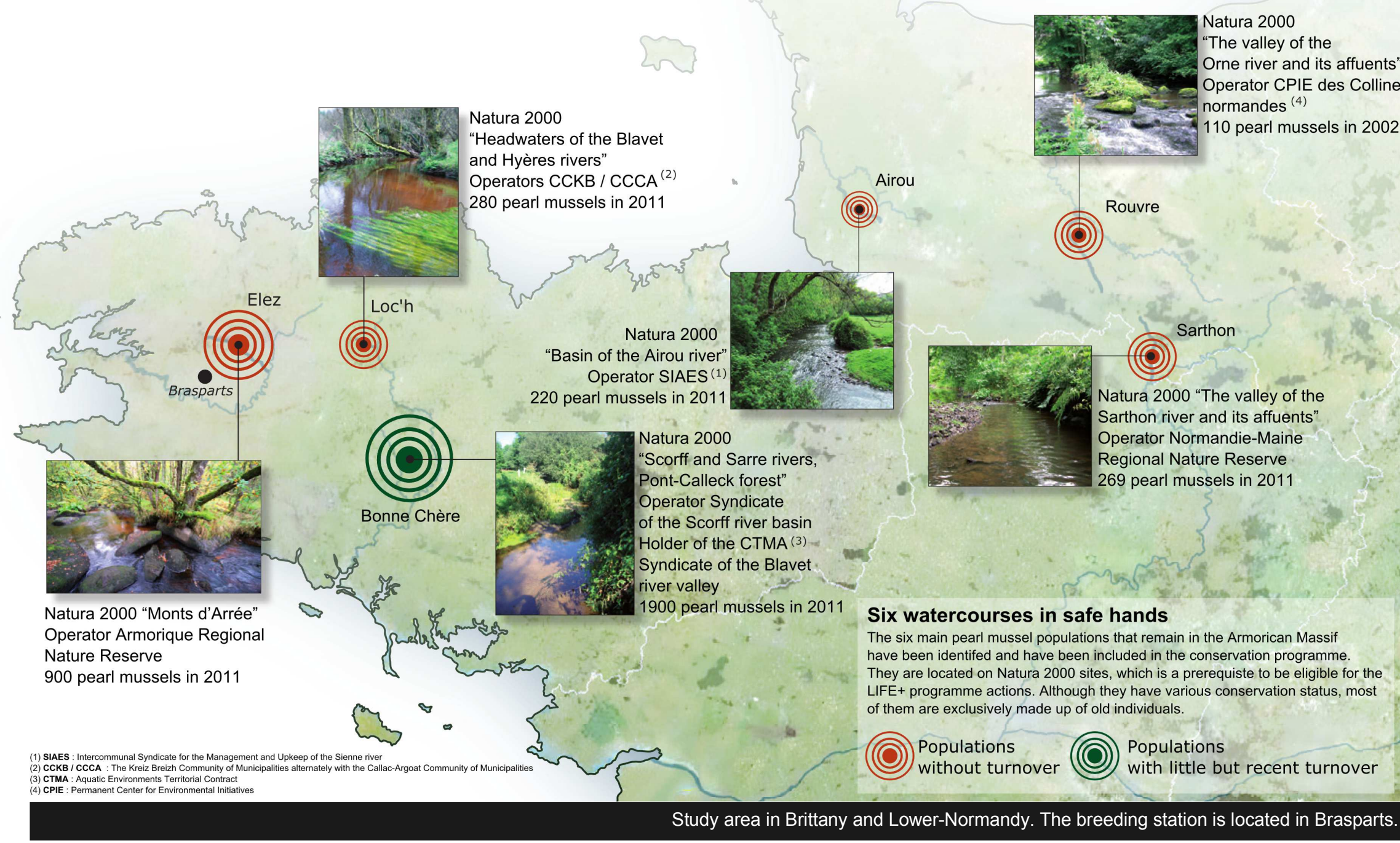
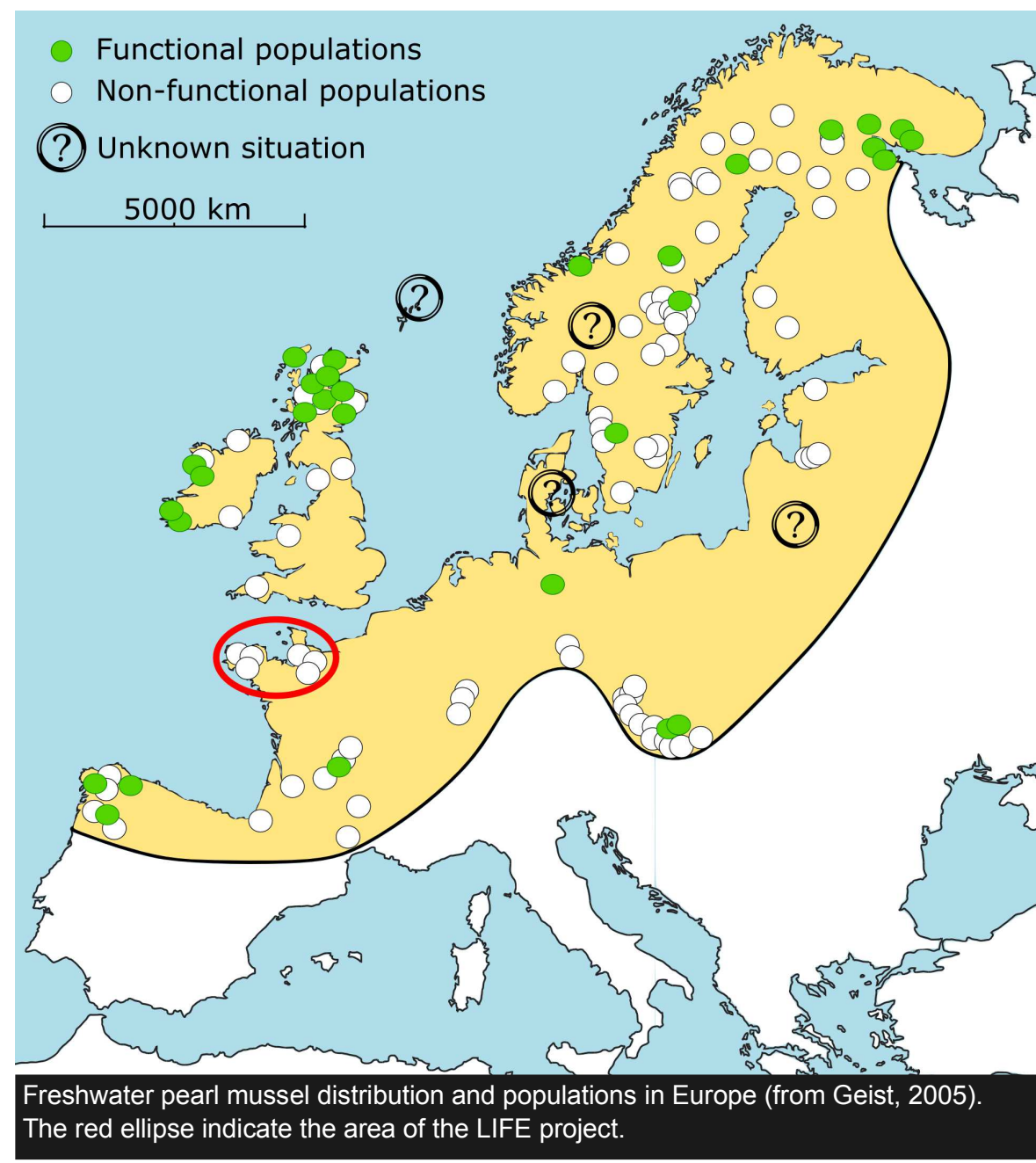
Conservation of *Margaritifera margaritifera* (Linnaeus, 1758) in the Armorican Massif (Brittany and Lower-Normandy, France)

Programme LIFE+ NAT FR 000583 / 1st September 2010 - 31st August 2016



Six rivers located in the north-west of France are known to still shelter the main population of Freshwater pearl mussel (*Margaritifera margaritifera*). All these six populations are still reproducing but are only potentially functional and will, without assistance, disappear in the near future.

Therefore within a LIFE+ Nature project established by the European Commission and government agencies, a rearing station was built in order to save these populations. To achieve this goal, actions are undertaken to unite and educate river stakeholders and environmental restoration managers, to improve our knowledge of the species and finally, to be able to ensure the continuity of the actions performed during the project.



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1. Maintain and support existing populations

1. Harvesting glochidias

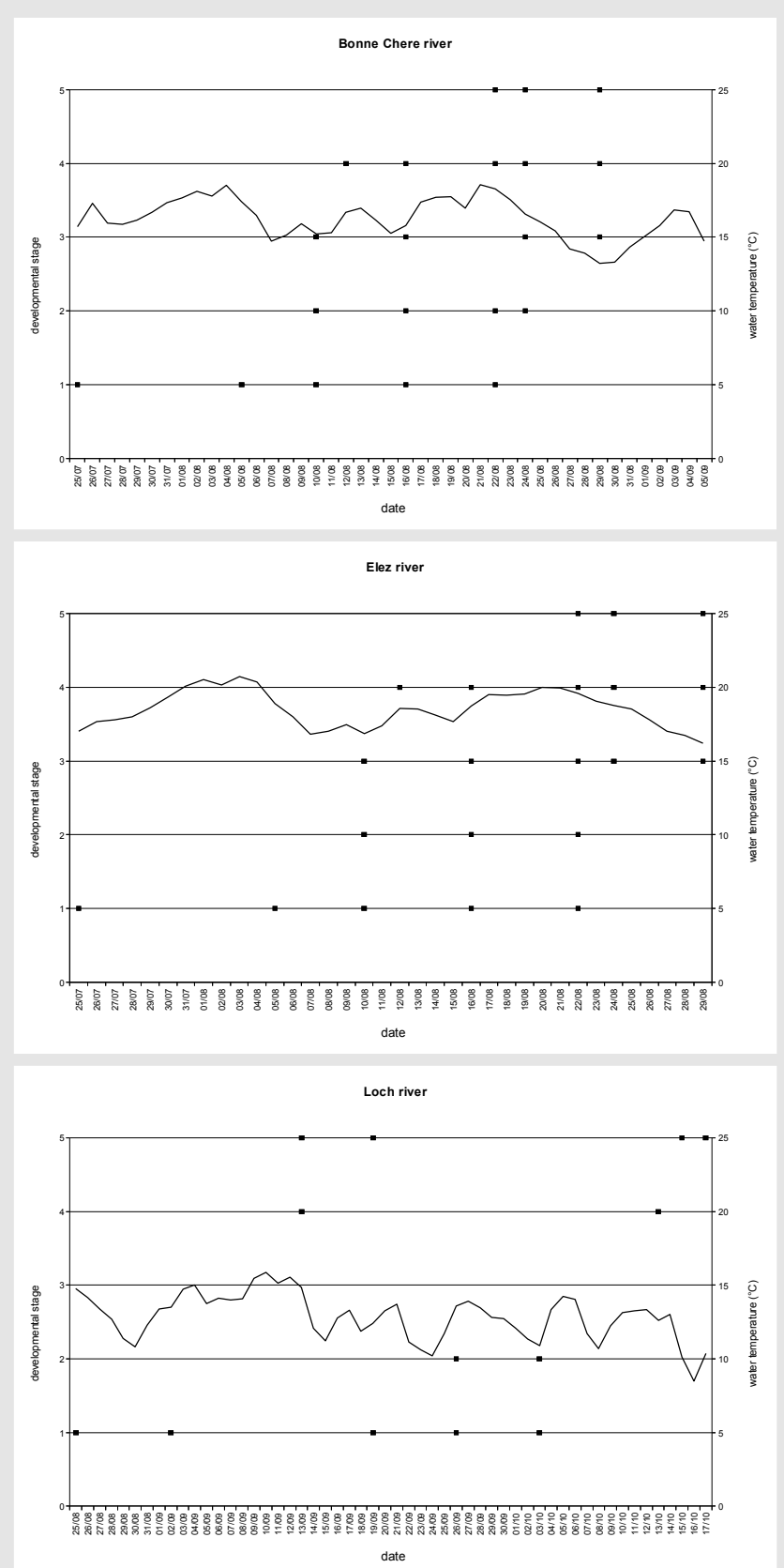


Fig. 1. Developmental course of glochidia of 3 freshwater pearl mussel populations (Bonne Chère, Elez and Loch) in 2011. Dots: occurrence of respective larval stage. Solid line: average water temperature in the respective year (adapted from Scheder et al. 2011).

2. Meeting fish and glochidias

After harvesting glochidias in the field, they were brought to the breeding station for infestation with brown trout (Tabl. 1). The brown trout stock used was reared by the Fédération de pêche du Finistère from wild fish from the Elez river. The major "black point" for freshwater pearl mussel functionality on the Elez river is the lack of fish hosts. In order to support this fish population and support mussel population, infected brown trout were released in autumn 2011 and spring 2012 (Tabl. 2). Initially planned on all rivers of the project, the local brown trout infestation immediately released could be done only on Bonne Chère river in 2011 (Tabl. 3).

River	Nb of mussel	Date of collect	Nb of fish	Hooked glochidia estimation
Bonne Chère	5	22-29/08	2 200	1-2 millions
Elez	8	16-21/09	2 100	2 millions
Loch	2	15/09-17/10	400	80 000

Tabl. 2. Release of reared local brown trout infested at the breeding station (in autumn 2011 and spring 2012)

River	Nb of fish	Hooked glochidia estimation
Elez	700	1 750 000

Tabl. 3. In-situ infestation with local brown trout from 20 to 30 cm immediately released (in 2011)

River	Nb of mussel	Date of collect	Nb of fish	Hooked glochidia estimation
Bonne Chère	2	29/08	31	31 000



3. Excystment

First ex-cysted young mussels were observed the 29/05/12 and during 3 weeks (until 22/06/12). Millions of young mussels were collected and some of them were kept in the breeding station : 3 000 for the Bonne Chère, 10-15 000 for the Elez and 6 000 for the Loch river. The rest of them (millions for the Elez and 2 000 for the Loch) were released directly on adequate river substrates.

Young mussels kept at breeding station were neatly sorted (one by one) by the LIFE team and by 25 volunteers (280 h of voluntary work in 3 weeks).

4. Breeding station

The breeding station was built in 2011-2012 in order to rear the main 6 populations of freshwater pearl mussels of west of France. Water in the station comes from the river Rivoal and 3 different sources and is filtered at 36 µm. The current breeding system is shown on Fig. 2. Substrate was added 3 months after excystment to allow higher survival rates (Thielen F., comm. pers.). Mussels are fed every day (except Sunday), with microalgae at 30 000 cells/mL (Mair et al., 2009). Shellfish diet 1800 and *Nannochloropsis* sp. are currently used. A microalgae culture room will permit the nutrition with fresh microalgae very soon.

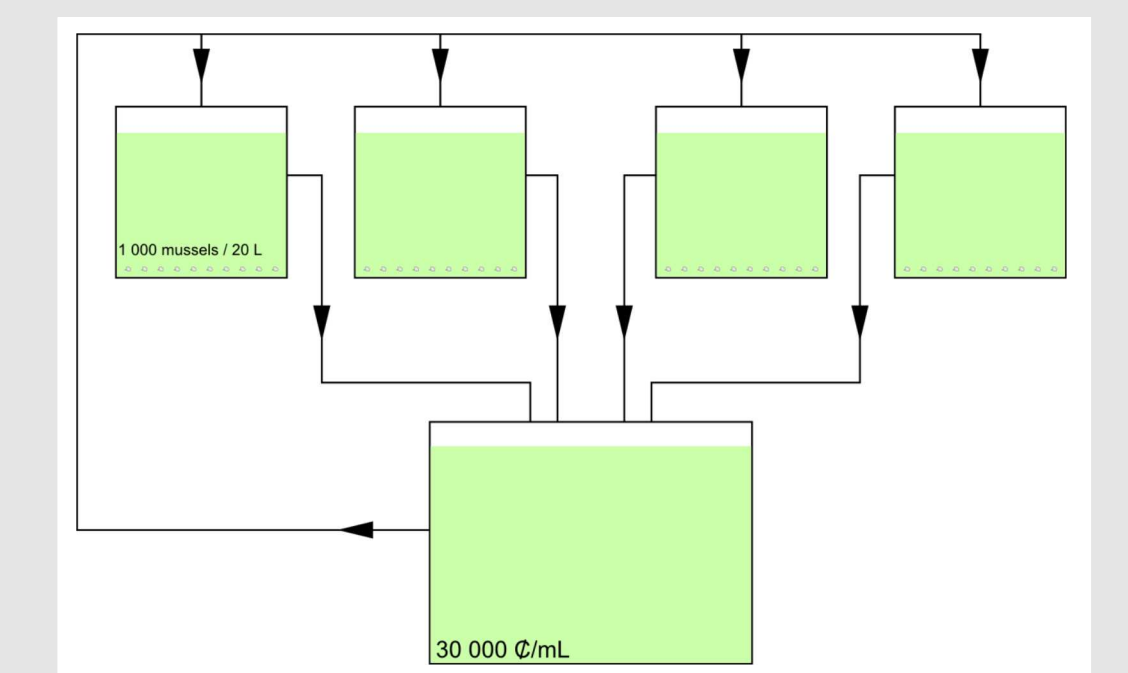
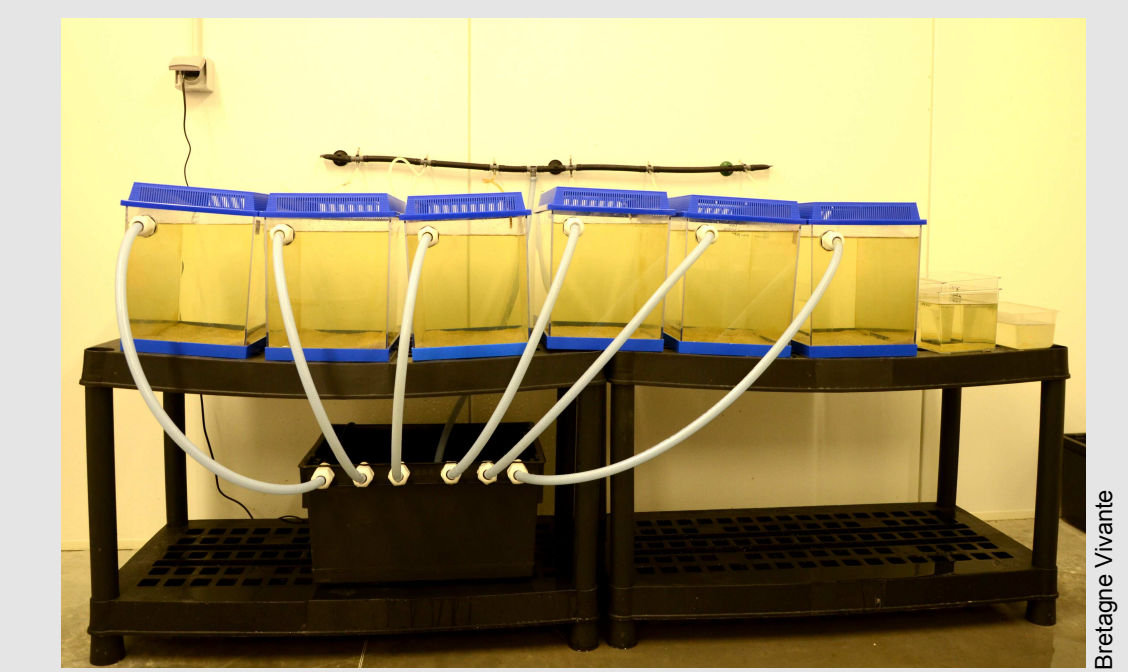
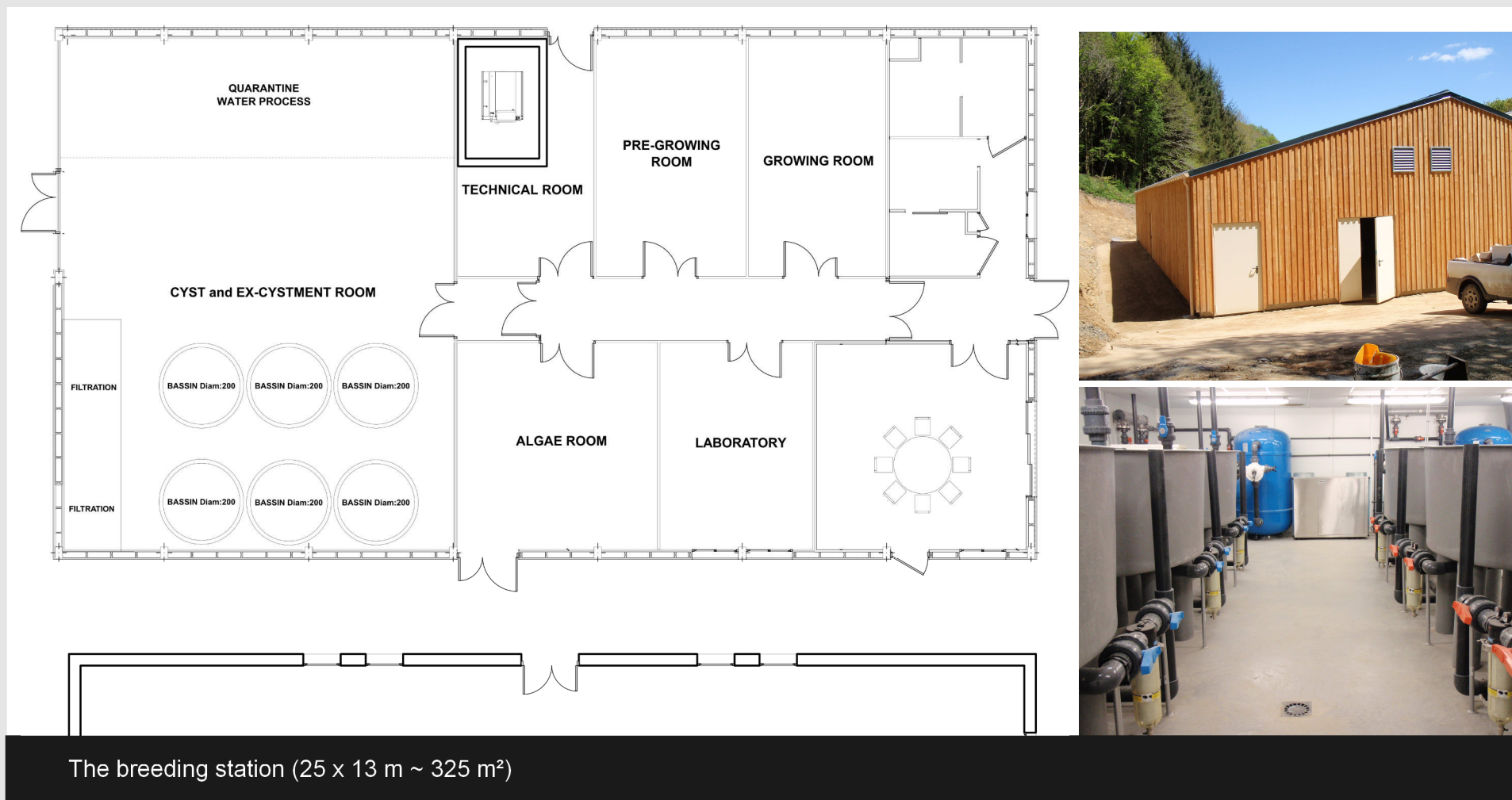


Fig. 2. Actual breeding system : a buffer tank contains 36 µm filtered water with microalgae (30 000 cells by mL). Aquaria contain about 1 000 mussels by 20 L of water. 80 % of water is changed every week and microalgae are added every day. The buffer tank food mussel aquaria is in continue.

Composition of microalgae solutions:

- Shellfish diet 1800
2 milliards cells/mL (5-20 µm)
- Isochrysis* 40%
- Pavlova* 15%
- Tetraselmis* 25%
- Thalassiosira weissflogii* (TW) 20%
- Nannochloropsis* sp.
750 millions cells/mL (1-2 µm)
- Concentration of ~ 30 000 cells/mL (Mair et al., 2009)
- Shellfish diet : 2 drops / 20 L
- Nanno : 175 µL / 20 L

2. Recover a favourable environment for freshwater pearl mussels

Quality of freshwater pearl mussel habitats is improved by encouraging river managers to help with the implementation of measures on short-term (set up fences, riverbank stabilization, control of farms, etc.), but also on medium-term (e.g. land acquisition). Increased public awareness with habitat issues is also very important : river's managers, fishermen and farmers from watershed, as well as general public.

The context of the six rivers is very different (Tabl. a.) and threats for freshwater pearl mussel populations are not the same on each catchment. Then, the means to recover a favourable environment for the mussels are also different (Tabl. b).

River	Catchment size (ha)	Catchment size (ha) in Natura 2000 area	River linear with tributaries (km)	River linear with tributaries (km) in Natura 2000 area
Bonne Chère	1 737.3	18.5	287	2.0
Elez	2 789.6	971.3	29.7	21.2
Loch	1 864.5	99.9	28.9	9.2
Airou	11 530.9	708.2	138.6	64.7
Rouvre	32 435.5	428.9	360.9	12.4
Sarthon	12 033.4	16.5	127.6	127.6

Tabl. b. Restoration actions to recover a favourable habitat for freshwater pearl mussel populations

River	Undertaken actions
Bonne Chère	Restoration contract led by the Syndicate of the Blavet river valley
Elez	Natura 2000 contracts (Armorique National Nature Reserve) ; Fishing Federation of Finistère actions ; Council of Finistère department ; Natura 2000 contracts (CCAC/CCKB) ; Restoration actions led by the Syndicate of Kerné-Uhel ; Fishing Federation of Côte-d'Armor actions
Loch	Natura 2000 contracts (SIAES) ; Natura 2000 contracts (SIAES)
Airou	Restoration contract led by the Syndicate of the Rouvre river ; Syndicate of communes of Athis ; Syndicate of drinking water of the Houme ; Natura 2000 contracts (CPIE des Collines normandes) ; Fishing Federation of Orne actions
Rouvre	Restoration contract led by the Normandie-Maine National Nature Reserve ; Natura 2000 contracts (Normandie-Maine National Nature Reserve)
Sarthon	Restoration contract led by the Normandie-Maine National Nature Reserve ; Natura 2000 contracts (Normandie-Maine National Nature Reserve)



3. Assess and monitor the environment

The physico-chemical quality of the water, quality of the habitat, substrate, the status of host-fish are monitored. All these parameters are contributing 1) to characterise mussel environment and 2) to look for reinforcement area of young reared mussels.

Water parameters

Manual measures are done every month in water near freshwater mussel populations. The multiparameter Hanna HI 9828 (Hanna instrument) records 3 different parameters (among others) : pH (Fig. a.), conductivity and dissolved oxygen. A sensor, HOBO0167, records temperature each hour. Nitrate N-NO3 (Fig. b.) and Orthophosphate P-PO4 samples are analysed by a laboratory. In 2011 and 2015, 20 pesticides molecules are searched by a laboratory (sample after more than 10 mm of rain in 24 h).

Substrate parameters (Geist & Auerwald, 2007)

A multiparameter WTW 3110 with a Pt probe and an Ag/Cl reference probe is used to measure the red-ox potential (Eh) at different depth (0, 5, 10 cm) in order to record the substrate oxygenation (Fig. c.). A pocket penetrometer (0-500 kN/m²) is also used with adapted discs to measure substrate resistance.

Environment

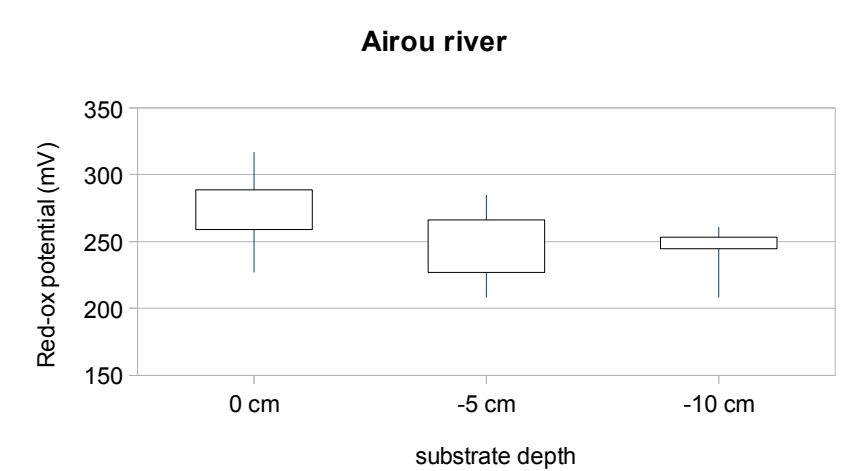
Biological quality is measured twice during the project, in 2011 and 2014, using 2 indicators : the "Normalized Global Biologic Index" (IBGN in French) and the "Biogenic Aptitude Ratio" (Cb2 in French). Both of these indicators use the invertebrate population composition to assess the environment quality.

Host-fish population

Electrofishing is done each 2 years (2011, 2013 and 2015) to monitor host-fish populations (*Salmo trutta fario*) on freshwater mussel populations.



Fig. b. Evolution of Nitrate N-NO3 in mg/L, from January 2011 to July 2012, in the different rivers



5. Experiment

Malo Desrués (intern) has carried on an experiment on young mussel diet (young mussels from the Elez river). Growth and survival were monitoring during 6 weeks since the mussel excystment. 5 bucket systems were made (inspired from Barnhart, 2006) with closed water system changed every day. Each bucket contained 8 mesh boxes of 150 µm (2 *Artemia* sieves fitted together). Each box contained initially 100 young mussels of ~ 400 µm long. Results are presented below.

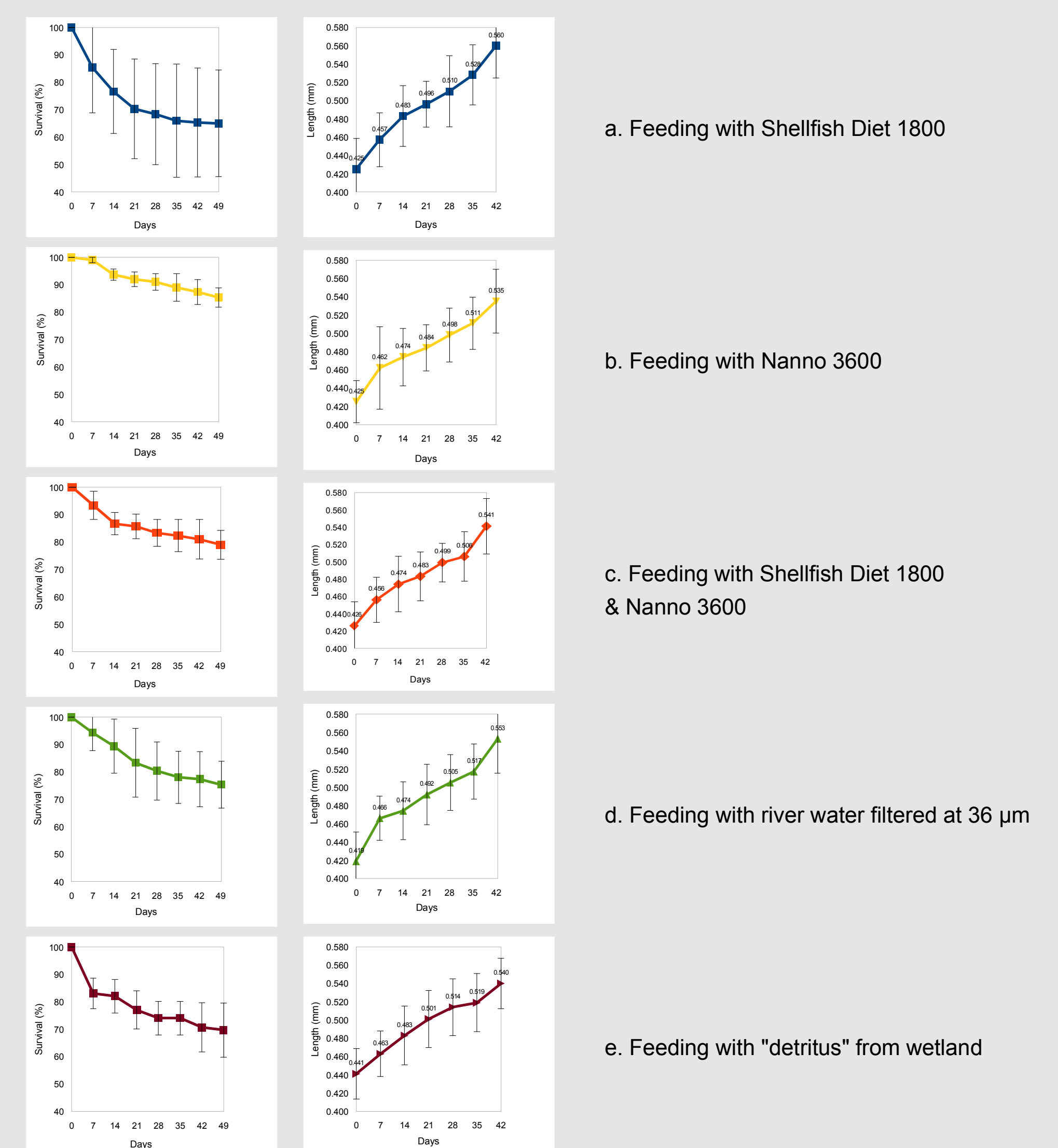


Fig. 3. Survival percentage (left) and growth in µm (right) of 5 different feeding systems (vertical bars shows the standard deviation)

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www.life-moule-perliere.org