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International Conference on Engineering and Ecohydrology for Fish Passage 2015

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Session D6: French R&D Program on «Eel and Dams» Related to EU Regulation 1100/2007

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Presenter Information
Pierre Sagnes, Eric De Oliveira, Philippe Baran, Michel Larinier, Christian Rigaud, and François Travade

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Fish Passage Conference
Groningen, June 22-24, 2015

French R&D program on «eel and dams» related to EU Regulation 1100/2007

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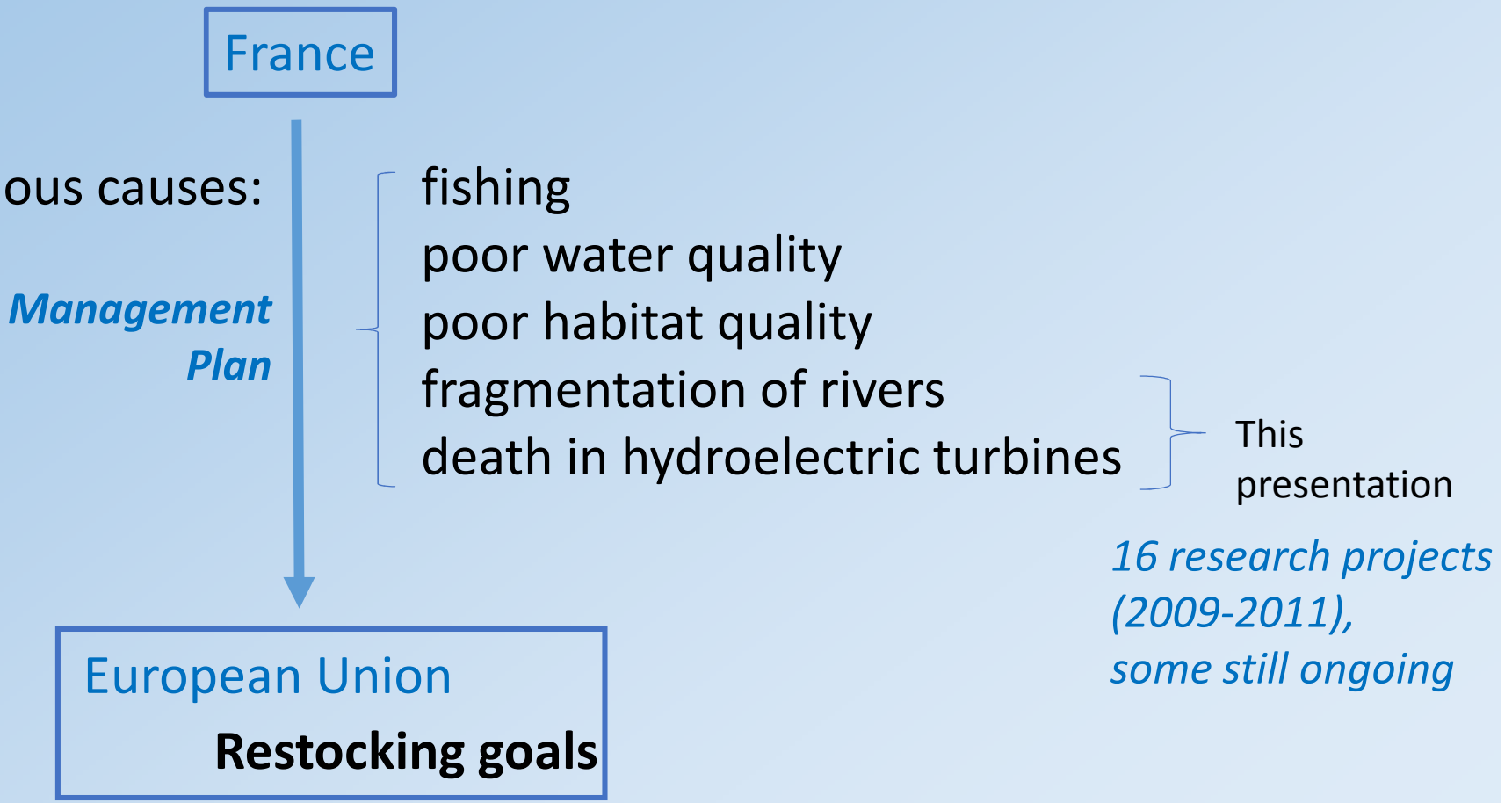
Introduction

Eel: an abundant species in European freshwaters until recently.

Rapid decline since the 1980s.



How to optimize the design and management of installations: 16 research projects (1/5)

See a detailed description of the different projects in:
Baran P. & Basilico L. (2012): Management plan to save the eel: optimizing the design and management of installations. Symposium on the results of the eels & installations R&D programme, 28-29 November 2011, Paris.

Projects for new knowledge

- Development of a sampling protocol to determine eel downstream-migration rhythms (Dordogne river).

- Determining how eels overcome a series of obstacles (Rhine).

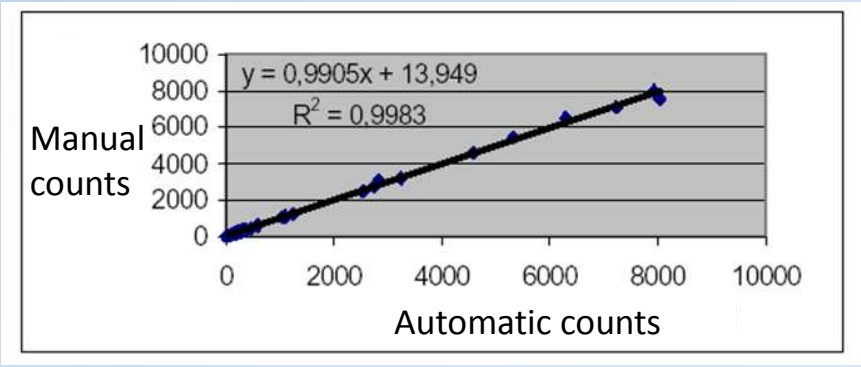
- Study of eel downstream migration and passage of hydroelectric installations (Gave de Pau river).

How to optimize the design and management of installations: 16 research projects (2/5)

Diagnostic tools required for management (1/2)

- Capture-mark-recapture: evaluation of the effectiveness of a specific type of fish pass.

- Development and testing of an automatic resistive counter for elvers.

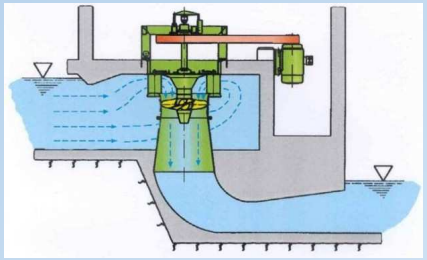


- *In situ* evaluation of eel mortality in large turbines.

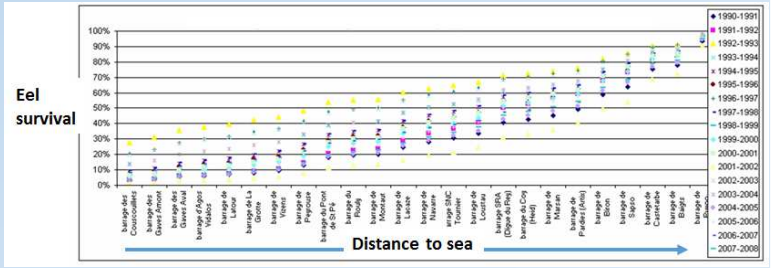
How to optimize the design and management of installations: 16 research projects (3/5)

Diagnostic tools required for management (2/2)

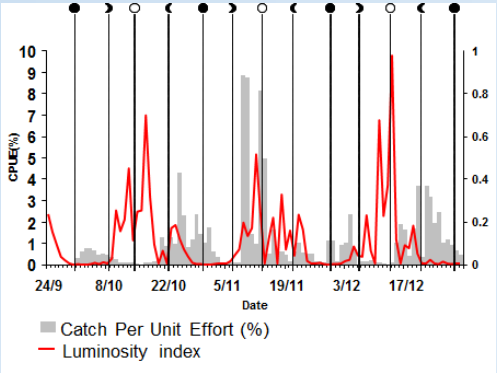
- Models to predict eel mortality during transit through Kaplan turbines.



- Evaluating the cumulative mortality over entire river sections caused by hydroelectric installations during the downstream migration of silver eels.



- Predicting numbers of downstream migrating eels as a function of environmental factors: development of an operational prediction model for turbine management (Loire river).



How to optimize the design and management of installations: 16 research projects (4/5)

Cost-effective technical solutions (1/2)

- Winter management of tide gates for eels with tests on limited admissions.

- Test on a brush pass for eels at a high dam (Golfech on the Garonne river).

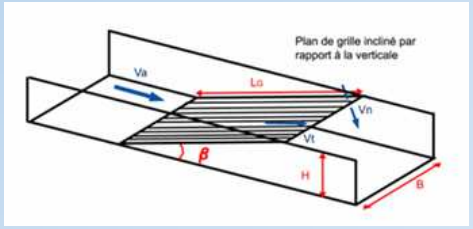
- Test on the MIGROMAT® biomonitor (Shannon river).

How to optimize the design and management of installations: 16 research projects (5/5)

Cost-effective technical solutions (2/2)

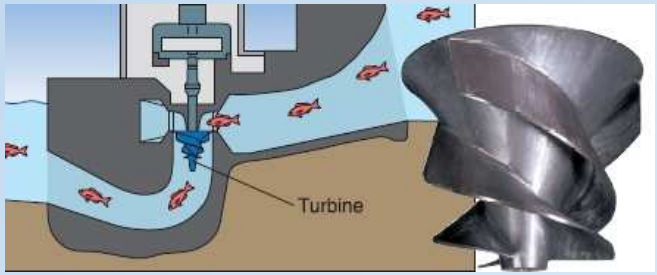
- Test of an infrasonic repulsion device at two hydroelectric plants (Gave de Pau river).

- Determining the necessary conditions for fish-friendly water intakes (head losses with inclined and angled screens, and velocity profiles just upstream).



- Assessment of injuries suffered by eels migrating downstream during passage through VLH turbine (spherical runner housing, Moselle river).

- Contribution to developing the Alden fish-friendly turbine.



Upstream migration (example)

Tests on winter admissions of sea water (Charente estuary): **sites**

Biard tide gate
(downstream view,
underflow admission)

Charras tide gate
(upstream view,
overflow admission)

Upstream migration (example)

Tests on winter admissions of sea water (Charente estuary): **results**

- Glass eels arrive at the tide gates between 2.5h and 1.5h before the high tide.
- Glass eel quantities vary significantly over the migratory season (in part with strength of tides and river flow rates).
- Upstream migration begins before gates' locking (i.e. while river water is still flowing downstream)
  → Glass eels can swim against water velocities of about 20cm/s.
- Number of glass eels transiting the gates was 37% higher for underflow than for overflow water admission.
- Underflow → eels' passage was simultaneous to the arrival of eels.
  Overflow admission → delay (30-60 min) in the passage of glass eels.
- Most passages occur within 2h
  → With an adapted management, it is possible to optimize fish passage while minimizing the entrance of salt and suspended-matter.

Downstream migration (example)

Estimation of mortality for silver eels

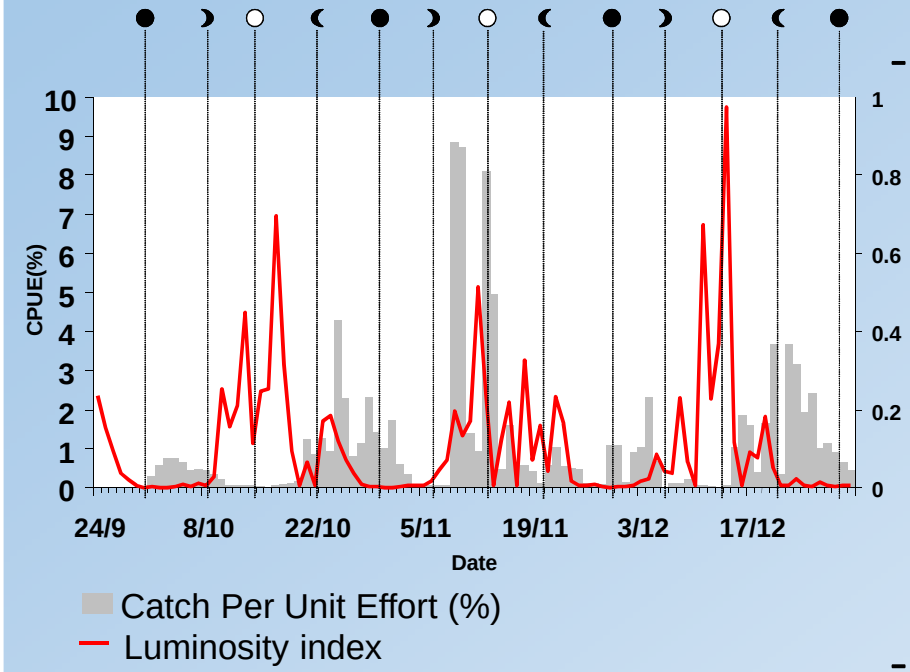
The method is based on the integration of 3 models:

1) A model to estimate daily **numbers of silver eels** arriving at hydroelectric installations;
2) A model to determine **eels' distribution** between the turbine intake and other pathways;
3) A model to estimate the **potential mortality** of eels transiting the turbines.

Downstream migration (example)

Estimation of mortality for silver eels

1) A model to estimate daily numbers of silver eels arriving at hydroelectric installations



- **Local model** (Loire river) = function of:
  - variation in flow rate
  - turbidity
  - night luminosity index
  - atmospheric conditions (pressure, wind, …)
  - week number

- **Global model** = function of:
  - rated flow (Q_{75}, Q_{90}, Q_{95}, $Q_{97.5}$, Q_{99})

Downstream migration (example)

Estimation of mortality for silver eels

2) A model to determine eels' distribution between the turbine intake and other pathways

Model established on the Gave de Pau river.

Eel distribution depends on:

the ratio between the spillway flow and the total river flow;
the configuration of the installation and the turbine flow.

Downstream migration (example)

Estimation of mortality for silver eels

3) A model to estimate the potential mortality of eels transiting the turbines

Bibliographic work and experiments

Ex: Large Kaplan and Bulb turbines

Hi-Z tagging = inflatable balloons

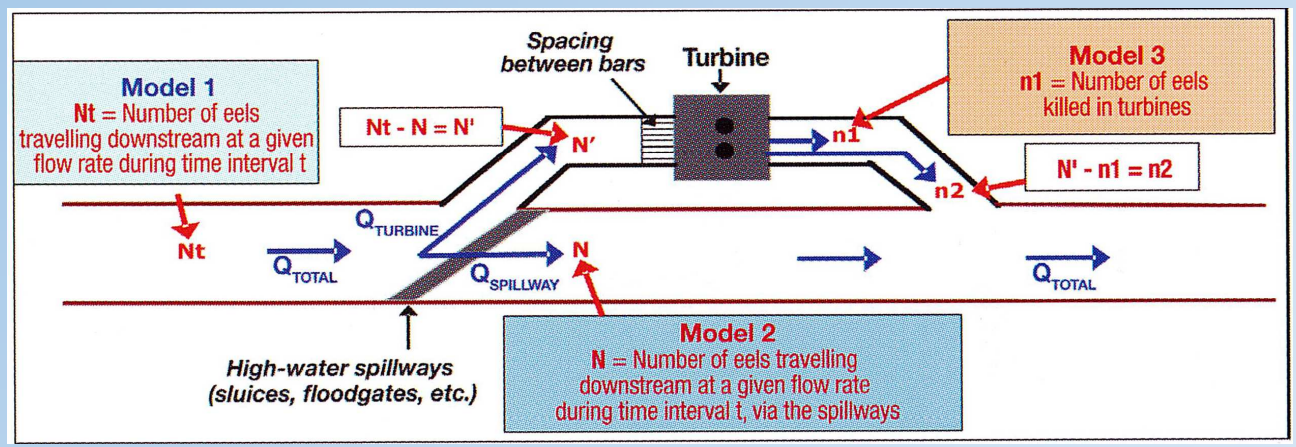
At least 350 fish (60-90 cm) tagged for each test

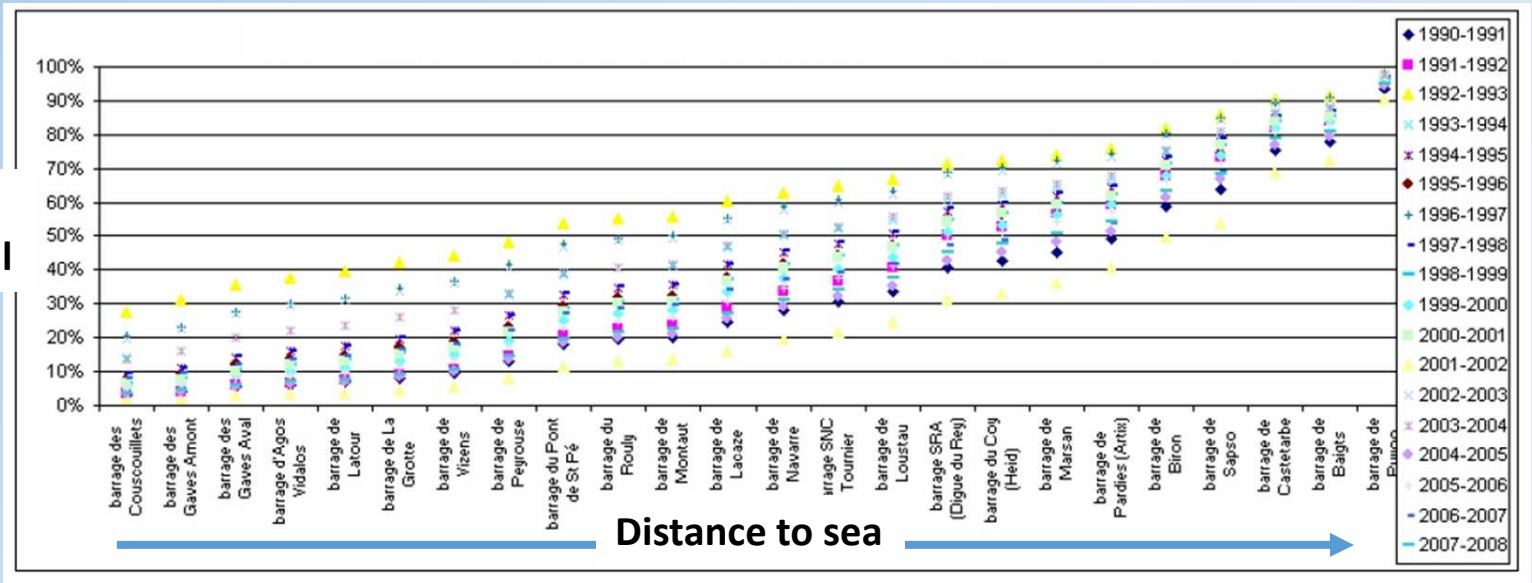
Survival rates (48h) :
78% (Kaplan 5 blades)
92% (Kaplan 4 blades)
92% (Bulb turbine)

Downstream migration (example)

Estimation of mortality for silver eels

General model = cumulative losses for a series of installations, by combining predictive models for single installations



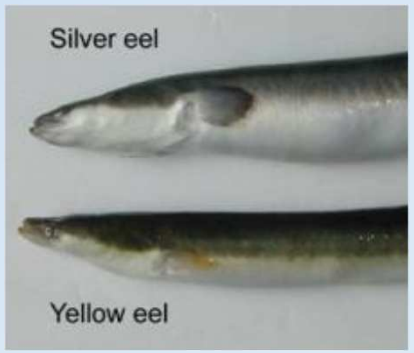


Ongoing and near future experiments (1/2)

- Find a way (sampling method) to quantify each year the number (or biomass) of glass eels entering freshwater systems.

- Follow the upstream migration front, to better determine the influence of hydrology upon the choice of different tributaries by young eels.

- Better understand the 2nd metamorphosis, between yellow and silver eel: use Pit-Tag and several antennas to follow yellow eels during several years.



Ongoing and near future experiments (2/2)

- Determine more accurately the downstream migration processes: find common points between different local models to predict the arrival of eels at power plants, early enough to stop the turbines.

- Collect *in situ* feedbacks for fish-friendly water intakes (cf. presentation of D. Courret).

- Estimate mortality of downstream migrating silver eels in low-head Kaplan and Francis turbines.


THANKS
FOR ALL