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## Session C4: Development of Passive Monitoring Tools of Silver Eel Migration to Trigger Turbine Management for Fish Protection

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# Development of passive monitoring tools of silver eel migration to trigger turbine management for fish protection

Sonny, Damien – Profish (Belgium)

Brunet, Richard – WSP Group (Canada)

Fish Passage conference  
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# Introduction

## Reduction of silver eel mortality at HPP facilities, R&D tracks on the table :

*Catch and transport : an existing solution*

*Fish guidance system : still to come*

*Development of specific bypass*

*Turbine reduction based on :*

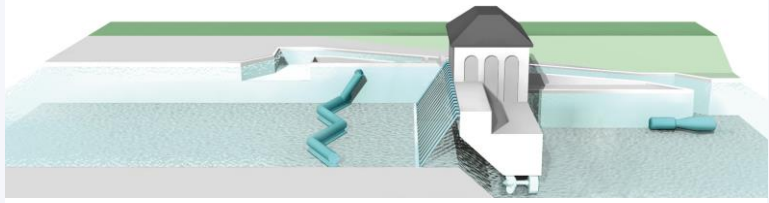
- Prediction by mathematic model of migration*
- Prediction by activity monitoring of silver eels stocked in tanks*
- Monitoring of real migration peaks*



# A new specific bypass has been developed for silver eels

## The zig-zag bypass developed by Klawa GmbH, Germany

Eel bypass



### Far from straightforward - Our solutions and strategies for safe eel migration

The European eel lives in running waters, but spawns in the sea. When migrating downriver, the eel has to pass through many hydropower plants and faces a variety of dangers in the form of screens and turbines. We minimise this risk and offer the eel a system that diverts it unharmed around the plant. The crowning jewel of this system is a zigzag-shaped pipe with several openings that the fish can swim into. From this pipe, the eels swim through a bypass that deposits them safely in the backwater.

The KLAWA eel bypass is now regarded as a recognised protection system in some of Germany's federal states. Field surveys at a plant in north Hesse prove that more than 1,500 eels have already migrated safely using this system. Another benefit is that water consumption is very low at 10-30 l/s. This makes hydropower plant operators more receptive to the system and paves the way for permanent operation.

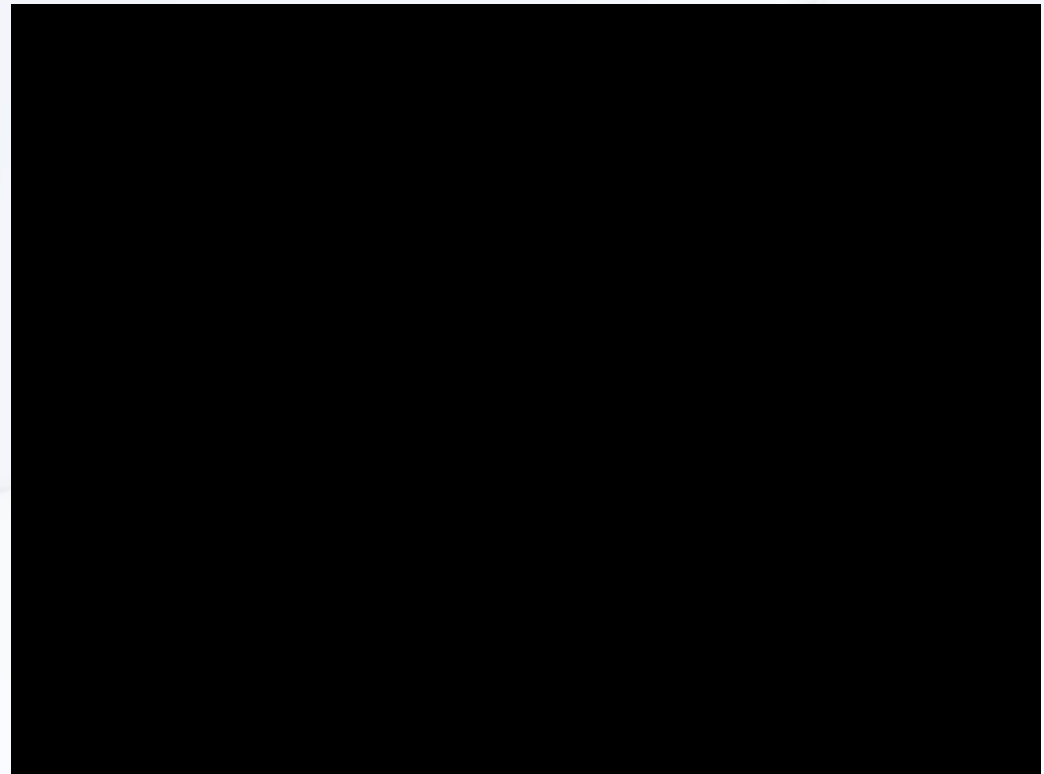
Engineers and biologists at the University of Kassel developed the eel bypass, which has been tested by animals and is protected by patent.





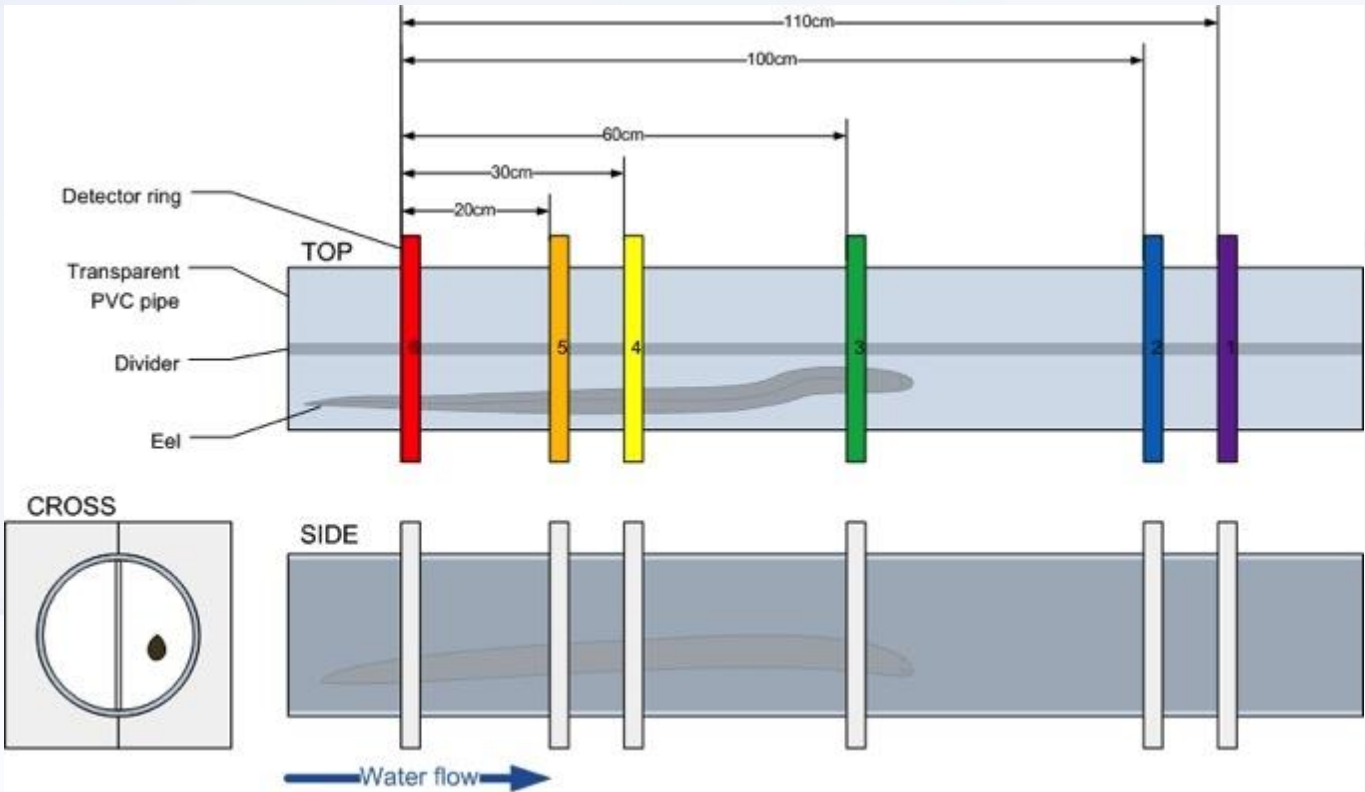
# We proposed to adapt the Ichtyos fish counting system to the zig-zag bypass

**Ichtyos : laser beams counting systems + video + online data set storage**





# Adaptation : infra-red beams to count fish + video confirmation + remote data connections



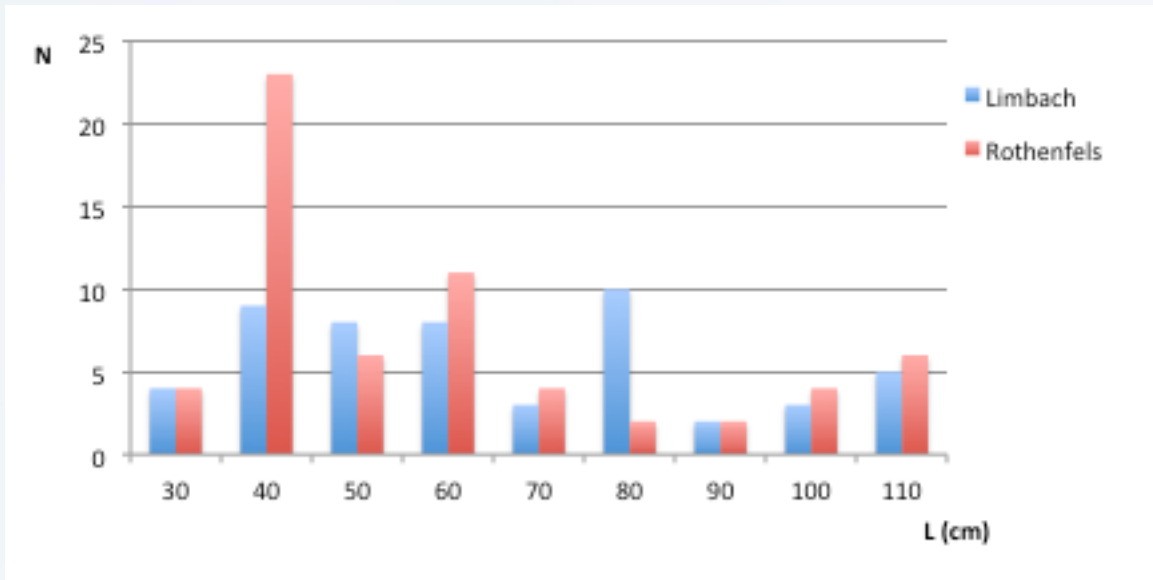
## **Migration 2013-2014**

First set of data that have been required to improve the system and elaborate appropriate algorithm

## **Migration 2014-2015**

Real data set available for eel passage counting and video confirmation

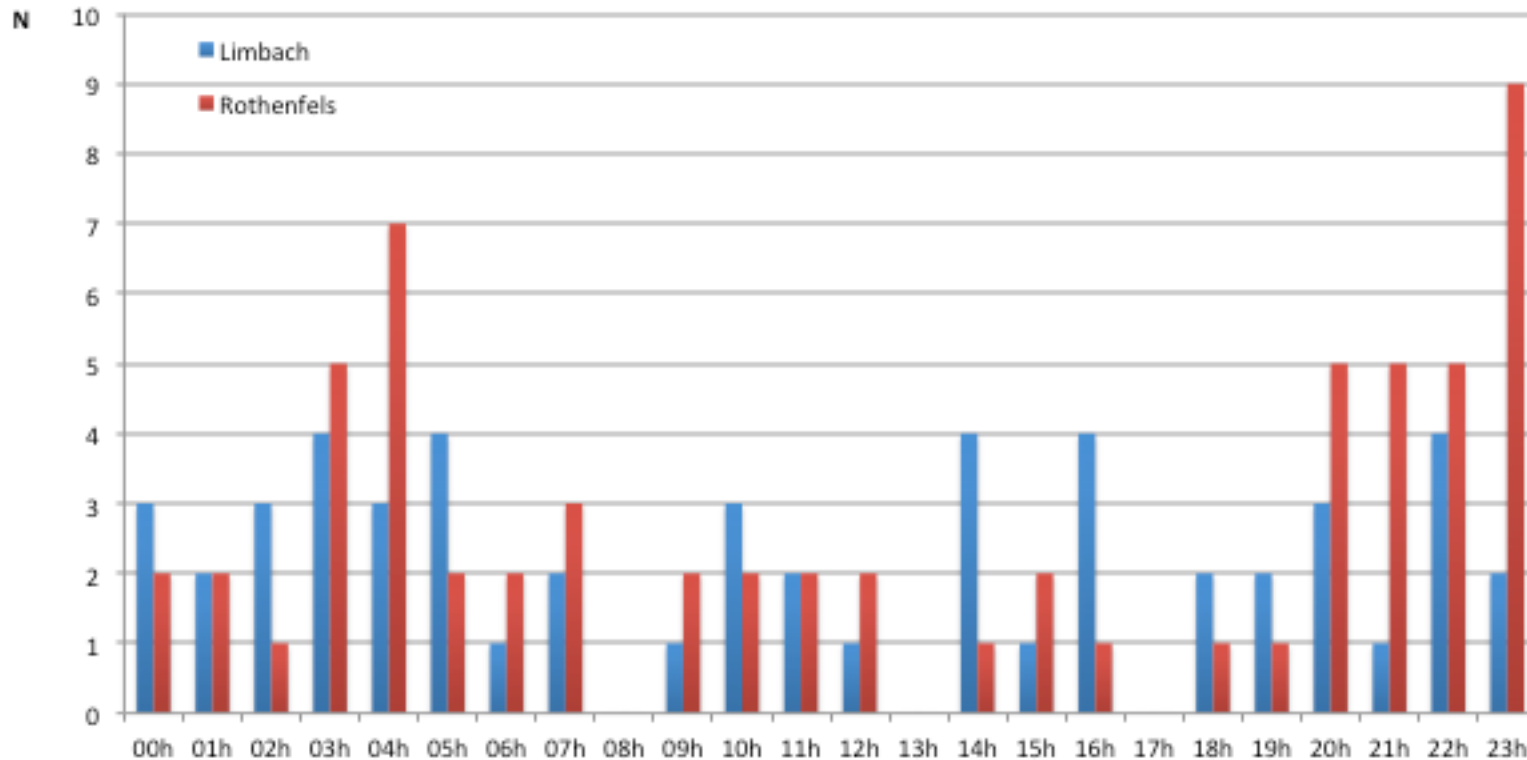
## Results 1 : estimated size of the fish



Error +/- 10 cm, comparison with real data?



## Results 2 : diel repartition of fish passage



65% to 79 % of the eels are passing between 19h and 7h

## Results 3 : data processing

### 3 levels of data :

- Log of detected passage sequence of IR cells
- Algorithm for interpretation of eel based on the cells detection sequence
- Video confirmation

**Our algorithm has been updated progressively over the study taking into account :**

**Step 0 : 1297 counts, 94 positive (real eels), 1203 false positive**

**Daily backwash of the pipe, inducing lot of bubbles and turbidity over several minutes.**

**Step 1 : backwash filters : from 1209 false positive to 306 false positive**

**Duration of the passage : no eels passed in more than 5 sec on the video records**

**Step 2 : duration of passage : from 312 false positive to 90 false positive**

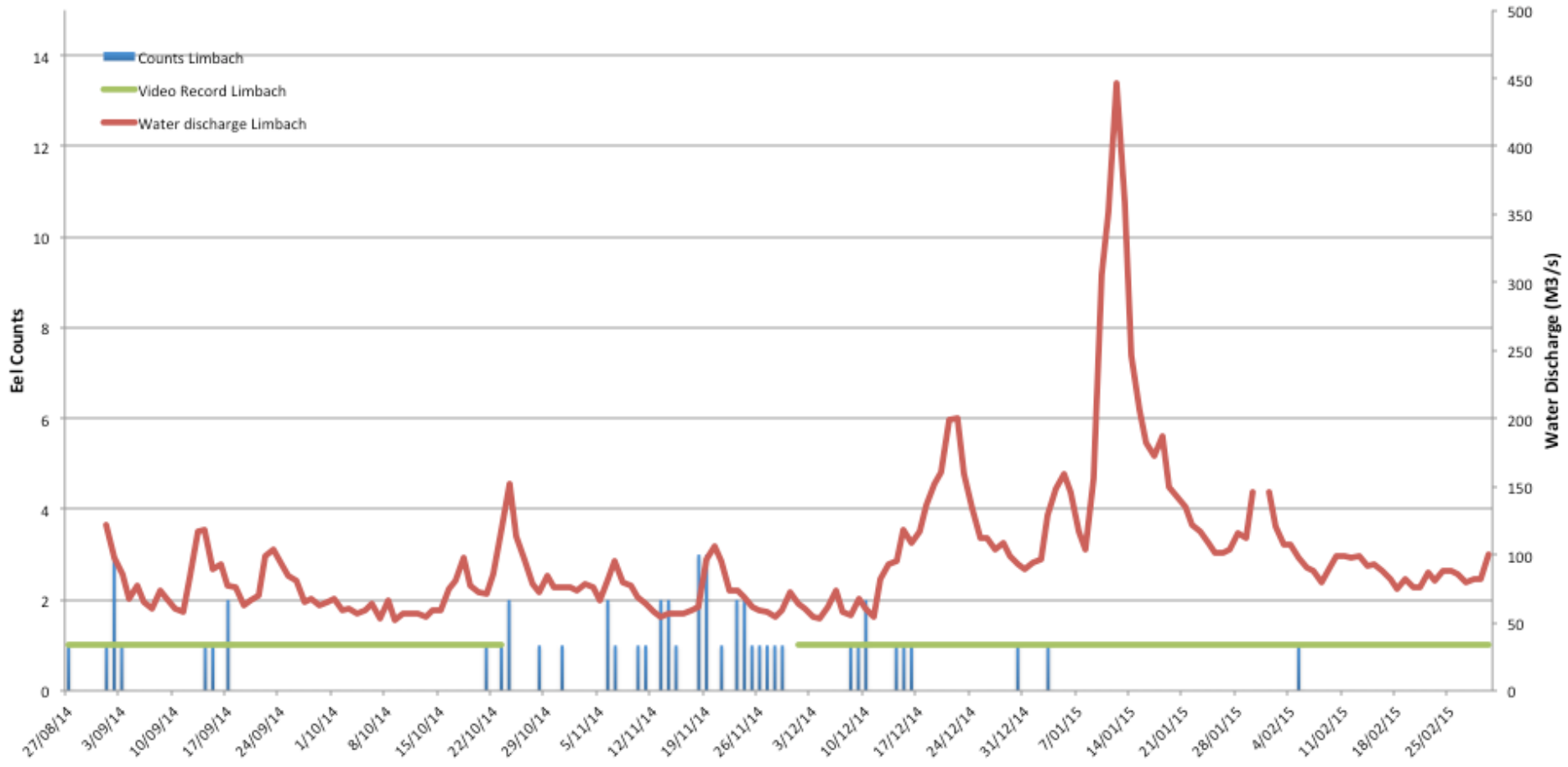
**Conclusion : the system could work as an alarm signal**

**It would have sent 184 events, and by the video connection, an operator would have confirmed 94 events as real eels.**

**This way of operation can be satisfying for the power plant operators.**

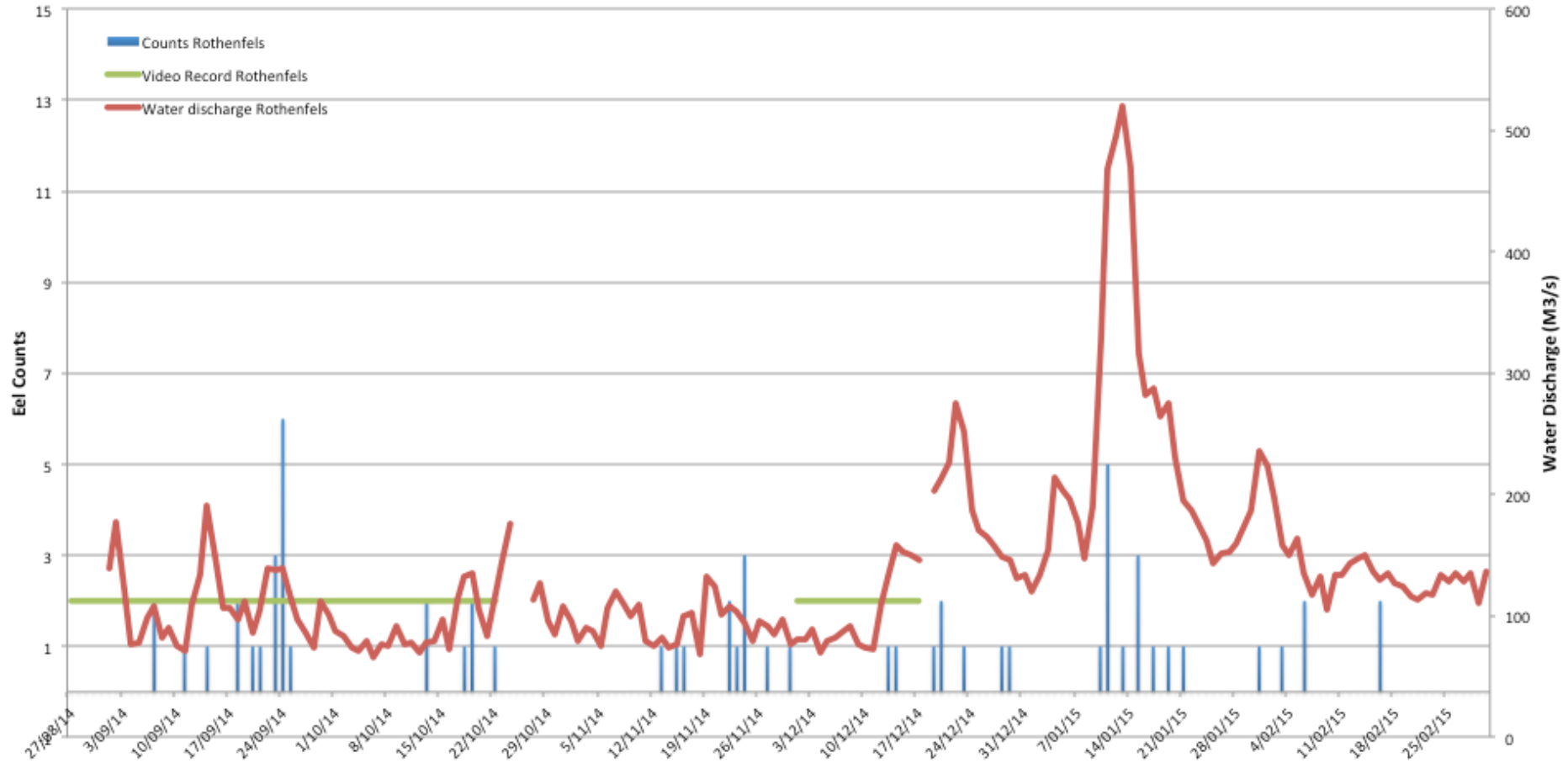
**But : are the counts representative of the real migration?**

## Eel Counts vs Water discharge in Limbach



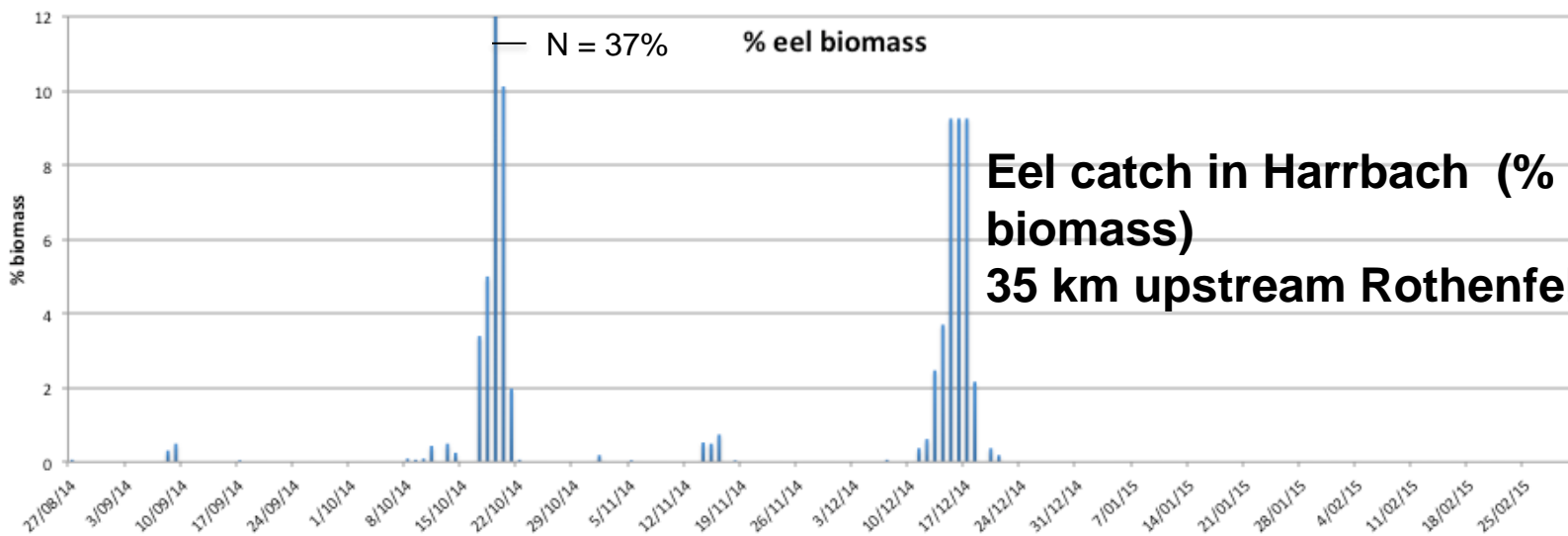
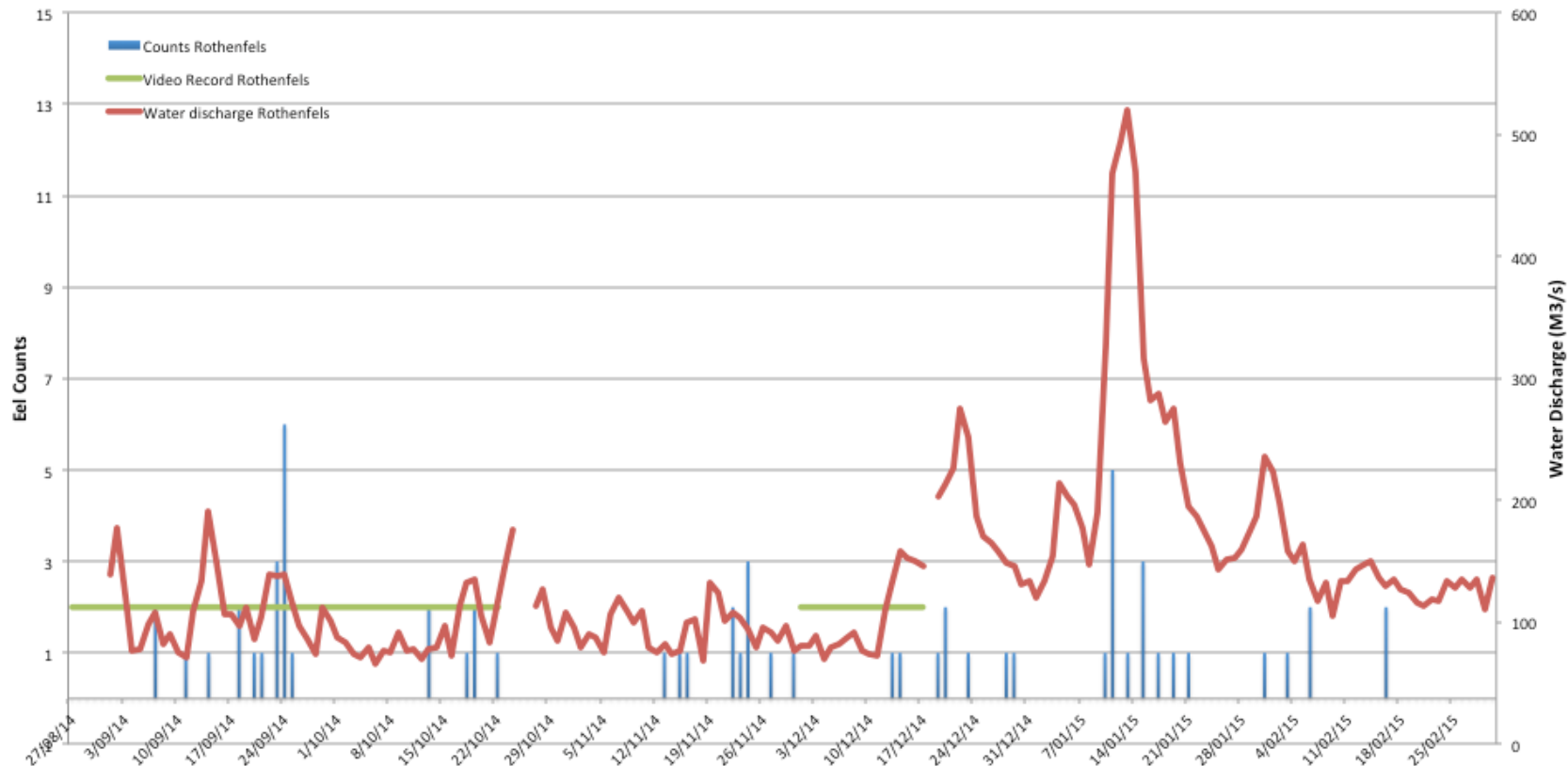
**Mean = 0,28 eels/24h, min = 0, max = 3**

## Eel Counts vs Water discharge in Rothenfels



**Mean = 0,33 eels/24h, min = 0, max =6**

# Eel Counts vs Water discharge in Rothenfels



**Eel catch in Harrbach (% biomass)  
35 km upstream Rothenfels**

**Migration peaks revealed by the counter and by fisherman are a bit different.**

**The differences can be explained by :**

- **The catch are performed at irregular intervals (1 to few days)**
- **The counter information is immediate, the fish catch information has a delay of min 24h.**
- **The catch cover spillways and turbine passage**
- **The efficiency of the bypass is not known**
- **The ratio of discharge turbine vs spillway is not known**

***But the eels counted by the counter are well passing in it!***



## **Perspectives :**

### **1) Validation**

**A new season of monitoring using the new filters and generate automatic alarm.**

**Each alarm will be verified by video**

**But the alarm will not reach yet the turbine operation room, it is a blank test**

### **2) Diversification**

**We are testing the same system to detect salmon smolts migration in large rivers and generates alarm signal for turbine management during the exact migration periods.**

# Adaptation to salmonid smolts counting in river



**Thanks for you attention**

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