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## Session B6: Hydraulic Research on Fish Passage Design at Lock & Weir Sites

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Visser, Klaas Pieter and Viaene, Peter, "Session B6: Hydraulic Research on Fish Passage Design at Lock & Weir Sites" (2015).  
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# Hydraulic Research on Fish Passage Design at Lock Weir Sites



**Fish Passage 2015**  
**June 20-24, 2015, Groningen, The Netherlands**  
**Klaas Pieter Visser & Peter Viaene**



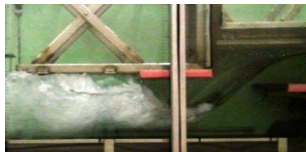
## Flanders Hydraulics Research (FHR)



... is a centre of expertise which carries out scientific research on the effects of hydrodynamics.


### Research domains:

- Coast & Maritime Access
- Nautical Research
- Water Management
- Hydraulic Constructions




[www.watlab.be](http://www.watlab.be)



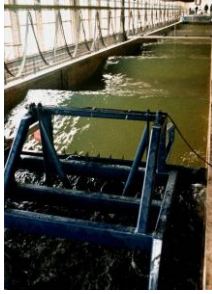


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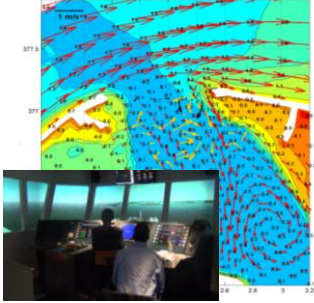
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## Flanders Hydraulics Research (FHR)





Research tools:


- Physical Models
- Numerical Modelling
- Simulators
- Field Measurements
- Sediment Laboratory










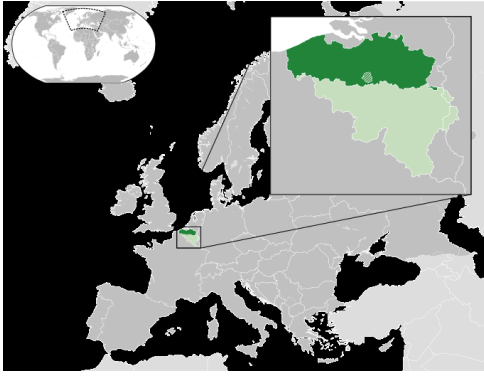


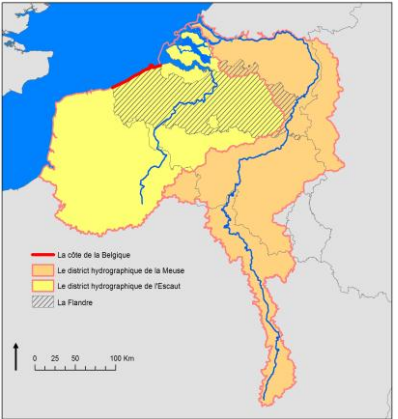
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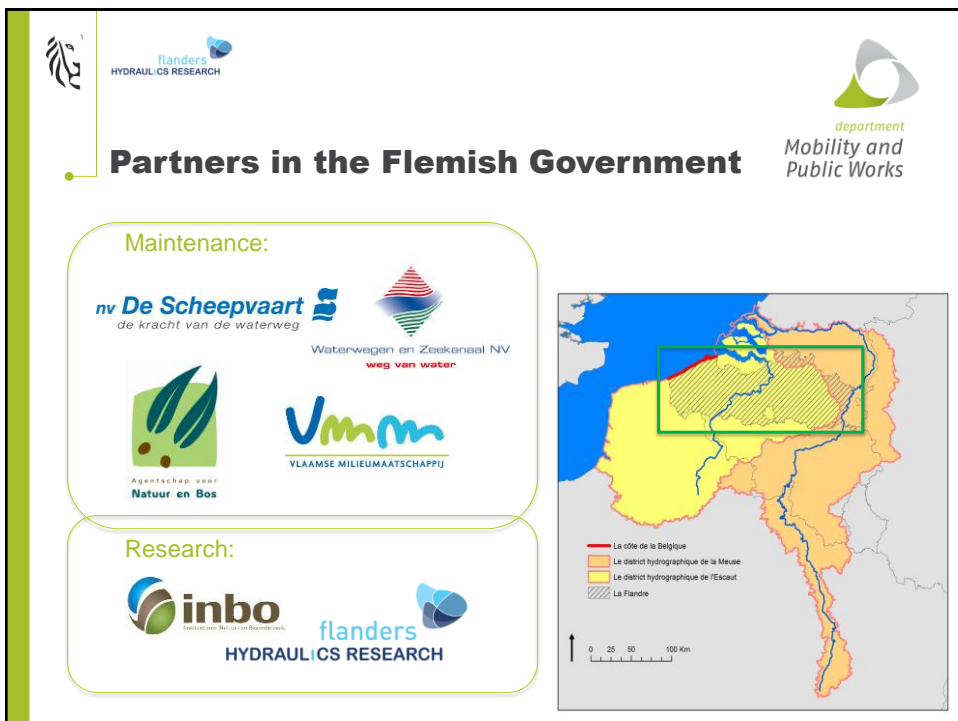
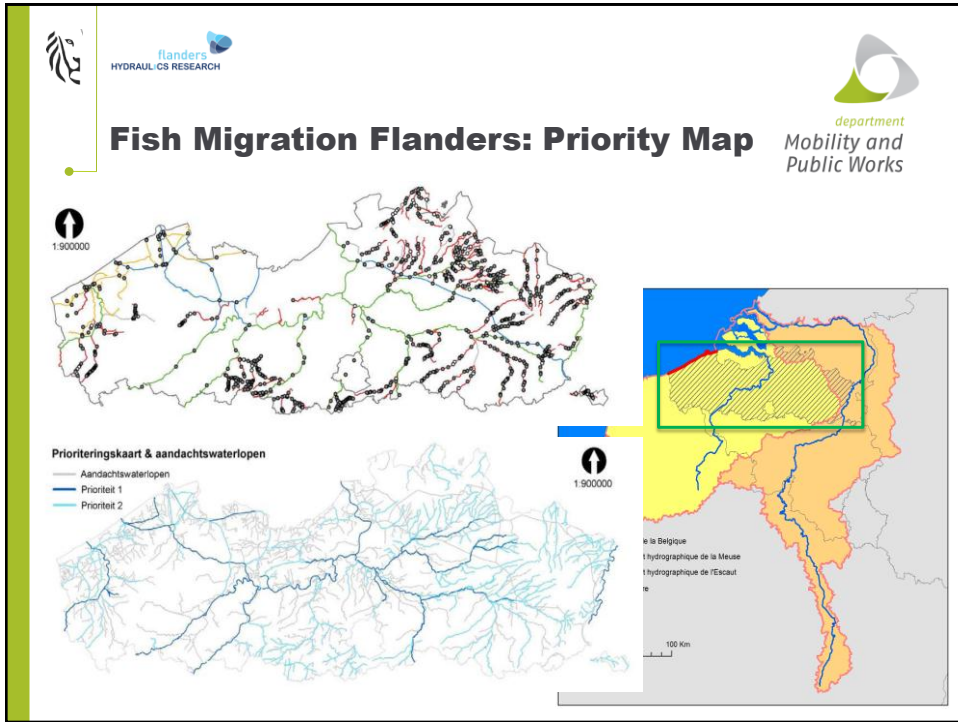
## Fish Migration Flanders







— La côte de la Belgique  
— Le district hydrographique de la Meuse  
— Le district hydrographique de l'Escaut  
 La Flandre

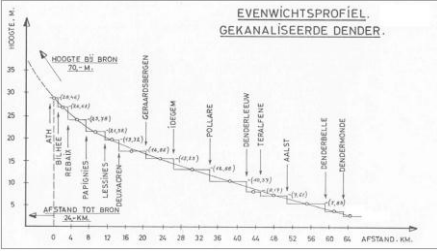
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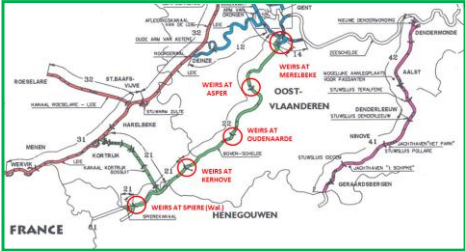


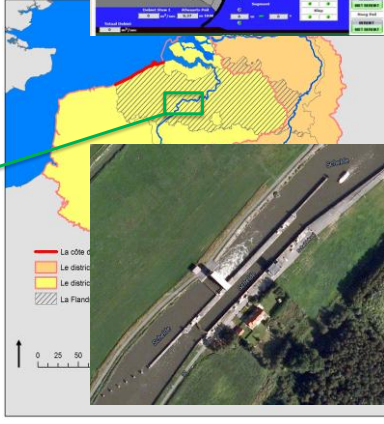



## Disruption of longitudinal habitat connectivity: Lock Weir Sites








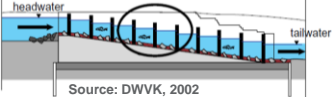




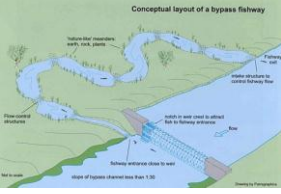



## Weir Lock Sites: Fish Passage Types

- Semi Natural: Bypass
- Technical: Pool Pass:
  - V-shaped Weir
  - Vertical Slot

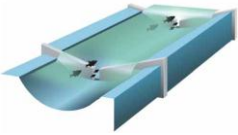


Source: DWVK, 2002






Source: Baeyens et al., 2006



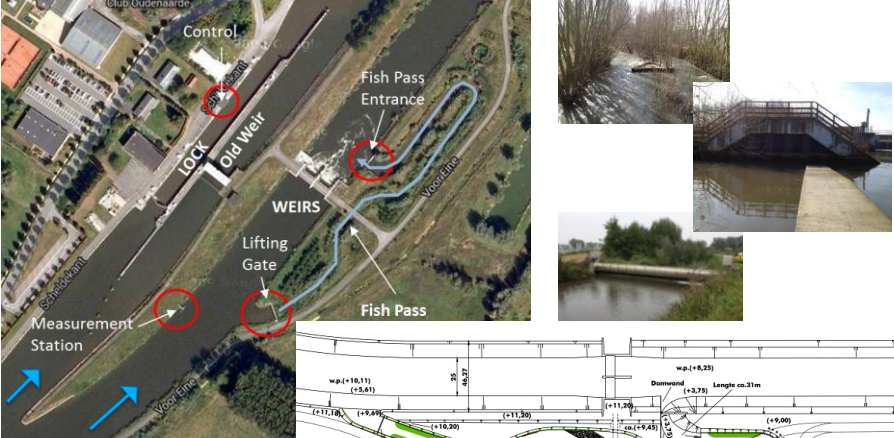
Source: Monden et al., 2005



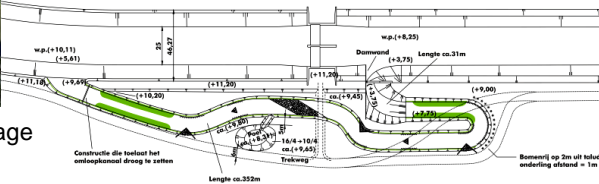
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## Example: bypass channel at Oudenaarde on the Upper-Scheldt



New weirs and fish passage  
constructed in 2004



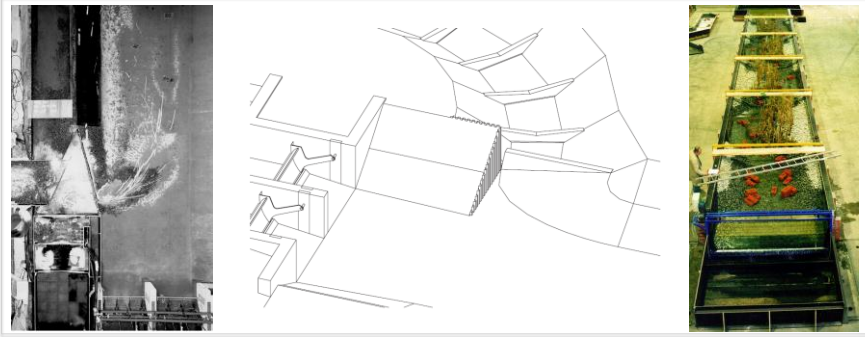
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## Scale Model Research at FHR

Previous research in 1997-98:


- Location entrance and discharge needed for attraction flow
- Higher roughness needed to reduce length of fish passage  
 $n = 0,1 \text{ m}^{1/3}/\text{s}$  (fish pass)  $\rightarrow$  vs.  $n = 0,03 \text{ m}^{1/3}/\text{s}$  (natural stream)



Source: Meersschaet et al., 1998



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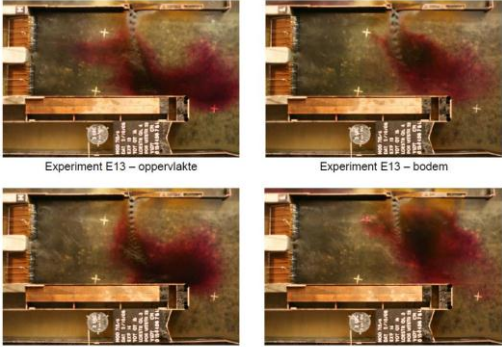
## Scale Model Research at FHR

Further research:

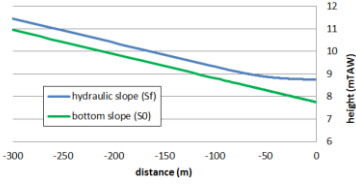
- Location entrance (distance to weir)
- Discharge needed for attraction flow

Hydraulic design:


- Literature study
- Bresse- & Manning formula;
- Roughness:  $n = 0,1 \text{ m}^{1/3}/\text{s}$




Experiment E13 – oppervlakte      Experiment E13 – bodem  
Experiment E14 – oppervlakte      Experiment E14 – bodem

$$\frac{dy}{dx} = \frac{S_f - S_0}{1 - \frac{Q^2 B}{g A^3}} \quad S_f = \frac{n^2 V^2}{R^{4/3}}$$


Source: Viaene et al., 2009





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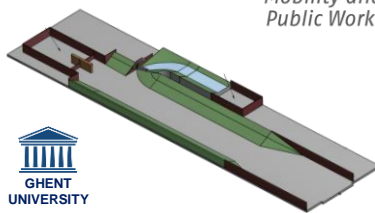
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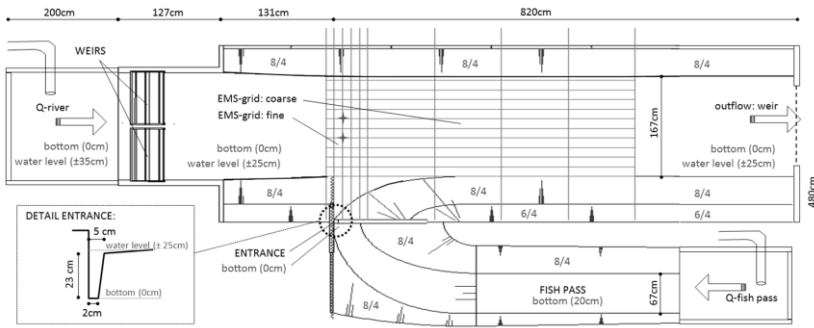
## Scalemodel Research at FHR: Thesis study UGent






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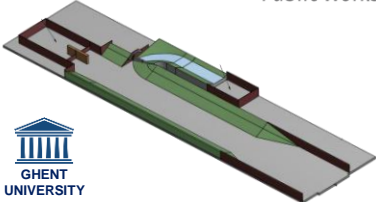






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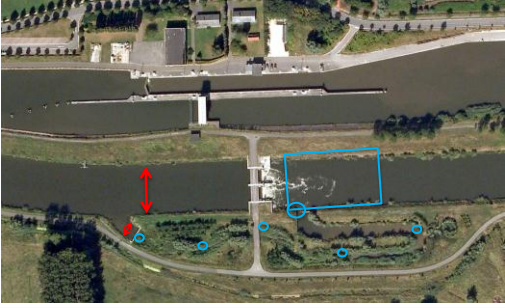
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## Field measurements









- River discharge – ADCP (Rio-grande)
- Fish Pass discharge – ADCP (Streampro)
- Attraction current – Drifters (GPS)
- Velocity profile – Propellor type velocimeter
- Water heigth/ depth – Divers (pressure height)



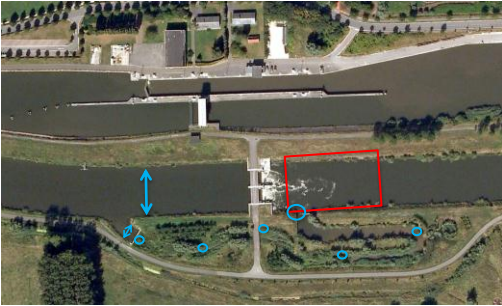




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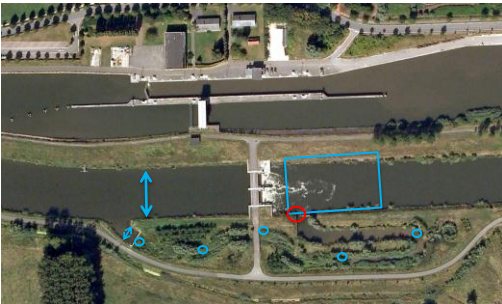




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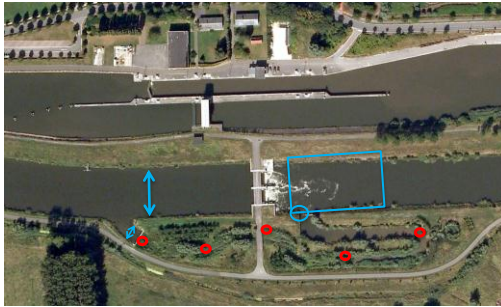


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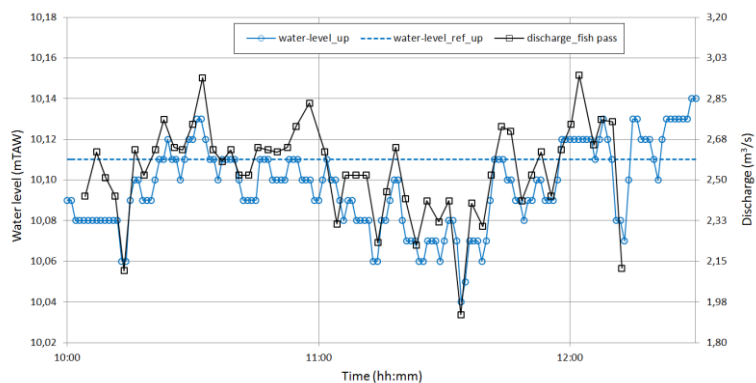
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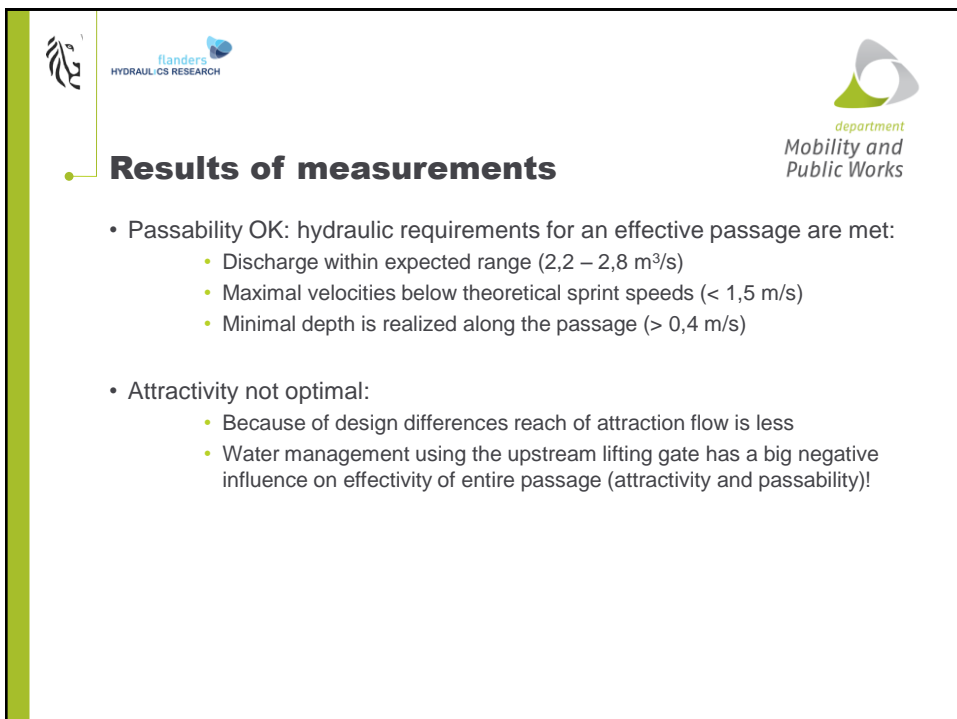
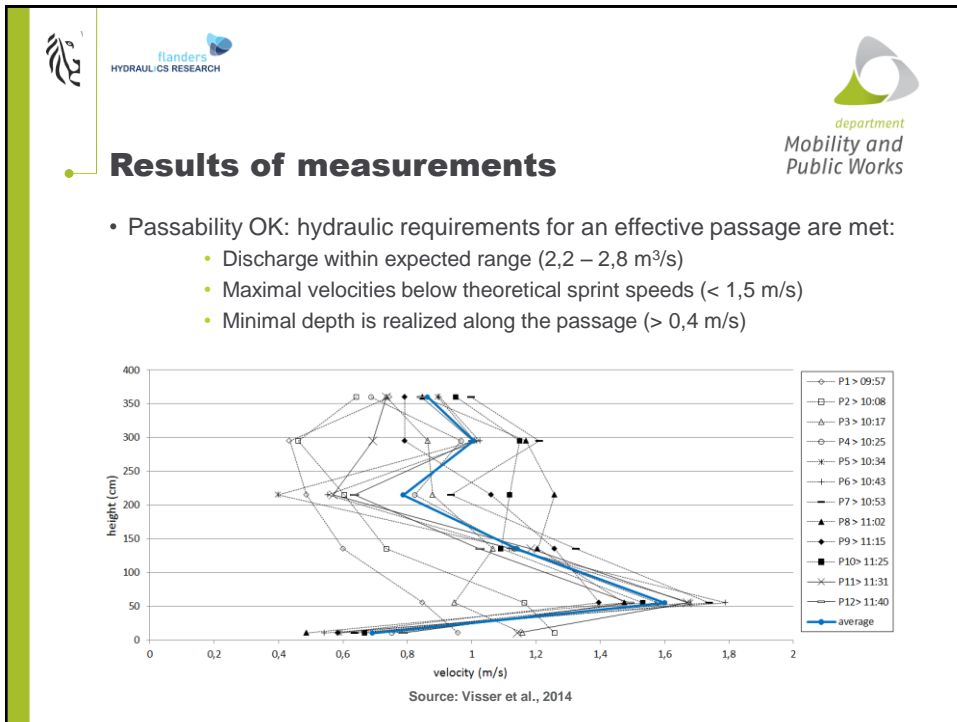
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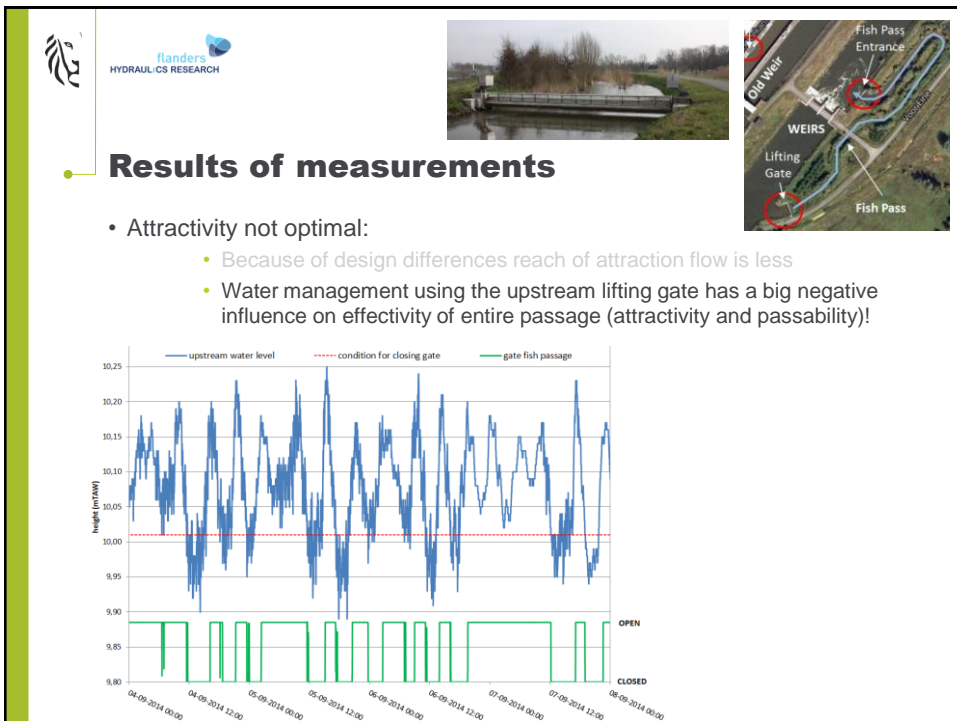
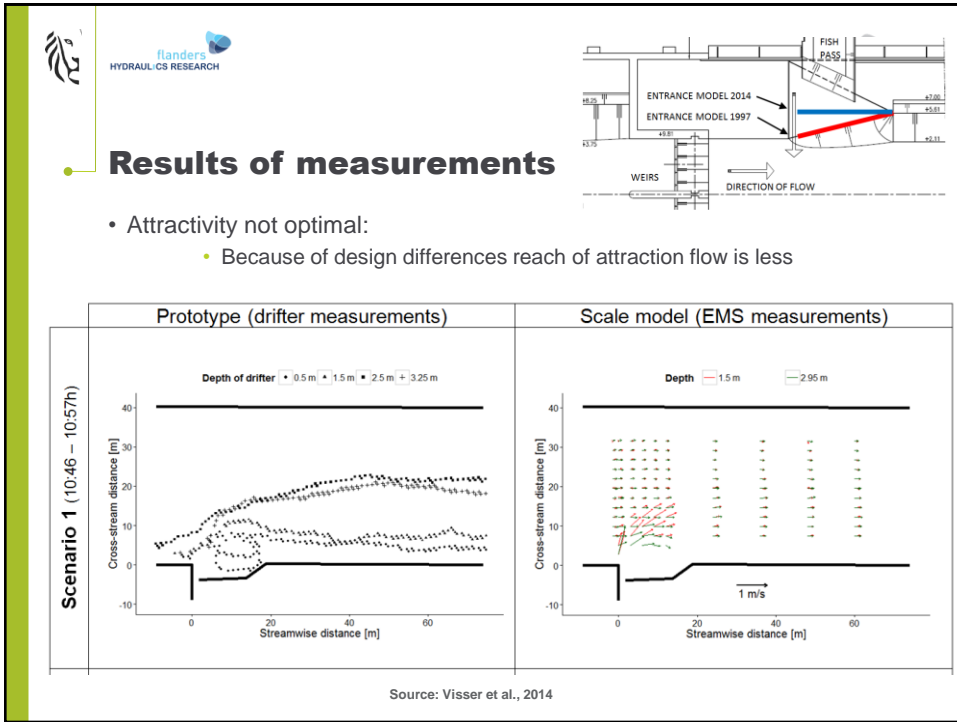
## Results of measurements

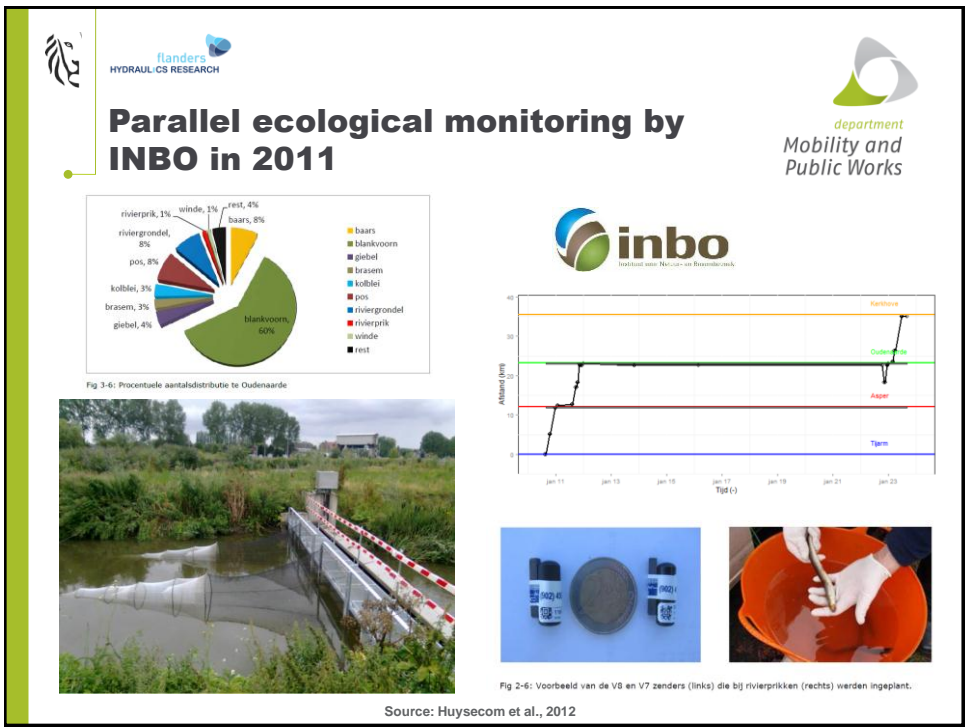
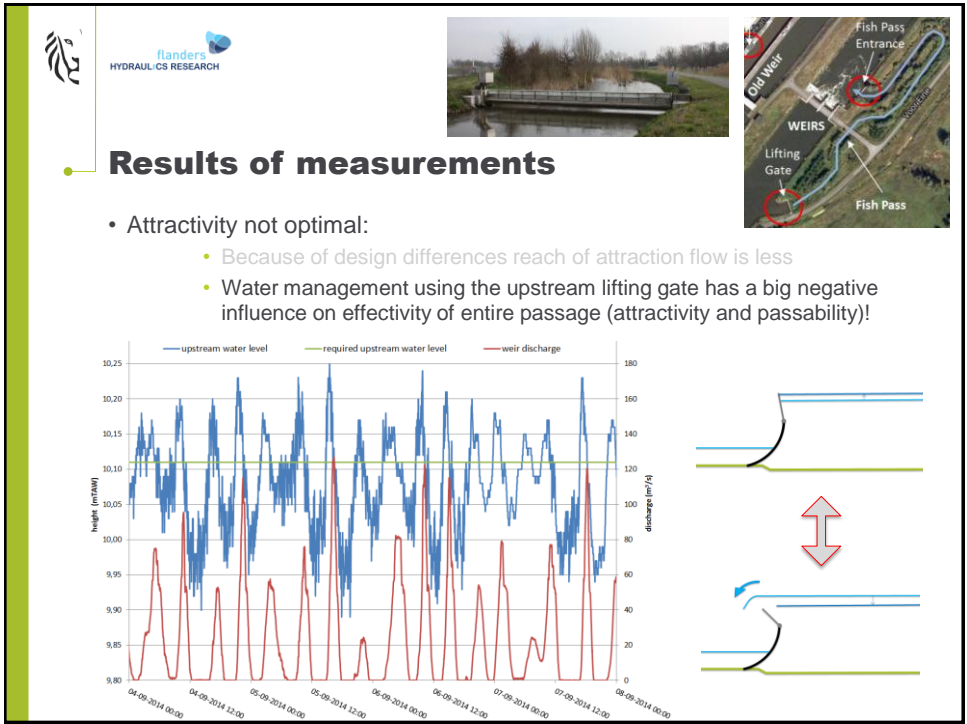
- Passability OK: hydraulic requirements for an effective passage are met:
  - Discharge within expected range (2,2 – 2,8 m<sup>3</sup>/s)
  - Maximal velocities below theoretical sprint speeds (< 1,5 m/s)



Source: Visser et al., 2014









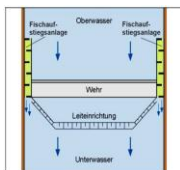
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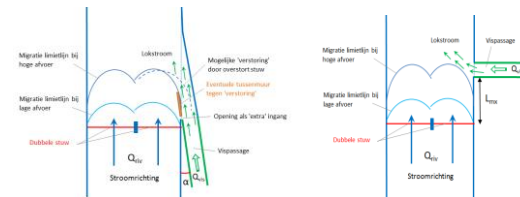
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## Assessment of the effectivity of a semi natural bypass as fish passage

1. Passability OK → hydraulic requirements for key species can be met
2. Watermanagement via automated scripts could have strong negative influence → optimisation script for automatic service is needed
3. Attractivity not OK
  - → Frequently opening and closing of bypass prevents the realisation of a constant attraction flow
  - → Parallel entrance (instead of perpendicular entrance) might improve attractivity: important topic in upcoming scale model research



Source: Adam et al., 2014



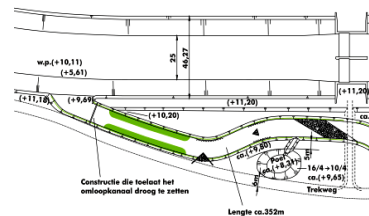
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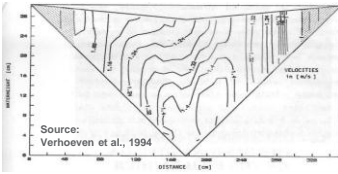
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## Other problems with bypass

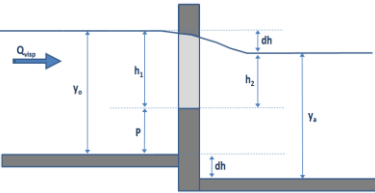
- Strong erosion in fish passage at location Asper
- The added value of a 'short' bypass with regard to secondary goal of creating new habitat area is very low



 **More technical solutions:  
Research on Pool Passes**



- For a few locations designs were made for V-shaped weirs  
→ via literature study
- Vertical Slot is not (yet) applied in the larger waterways in Flanders  
→ because of lack of experience
- Important topic in upcoming scale model research: → compare velocity distribution between V-shaped weirs and Vertical slots at equal drop

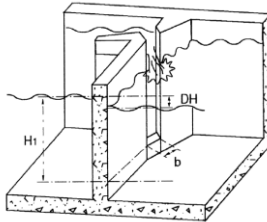


$$E = \frac{\rho * g * Q * dh}{L_v * B * y_a}$$


$$Q_{verij} = \left(\frac{8}{15}\right) C_d \tan\left(\frac{\alpha}{2}\right) \sqrt{2g} (h_1)^{2.5}$$


$$Q_{verdrongen} = Q_{verij} [1 - s^{2.5}]^{0.385} = Q_{verij} \left[1 - \left(\frac{h_2}{h_1}\right)^{2.5}\right]^{0.385}$$

$$Q_{vis} = C_d * b * h_1 * \sqrt{2g * dh}$$



Source: Larinier et al., 2002

 **Summary of Upcoming  
(Scale Model) Research at FHR**



1. Parallel vs perpendicular attraction flow
  - including design of fish pass entrance and augmentation flow
2. Compare velocity distribution between V-shaped weirs and Vertical slots
3. Improvement of automatic scripts for watermanagement at lock weir sites
4. Numerical models? (CFD, SPH,...?)

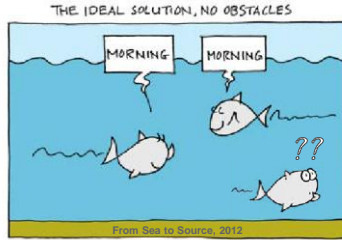


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● **Questions?..**



Thank you for your attention!