Assessment of the attraction current of a fish passage

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29-08-2014

IJREWHS, Spa, Belgium

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

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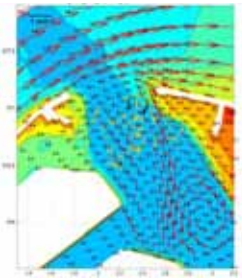
Research pillars

- Physical Models
- Laboratories
- Numerical Modelling
- Field Measurements



Overview

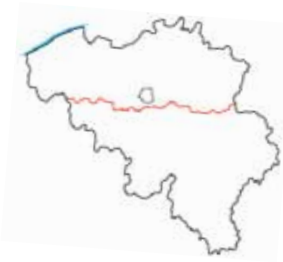
- Introduction
- Research goal(s)
- Methods & materials
- Results
- Conclusion


Assessment of the attraction current of a fish passage: prototype measurements versus scale model tests

Bastiaan Ruys

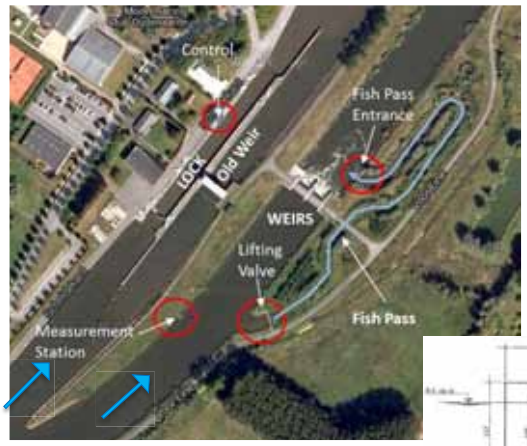
GHENT UNIVERSITY

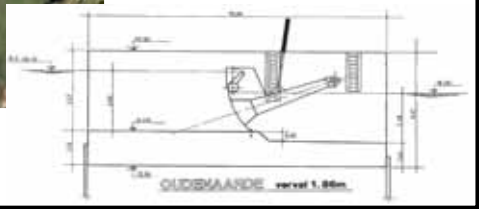
Flanders and the River Bassins of Scheldt & Meuse



Flanders and the River Bassins of Scheldt & Meuse

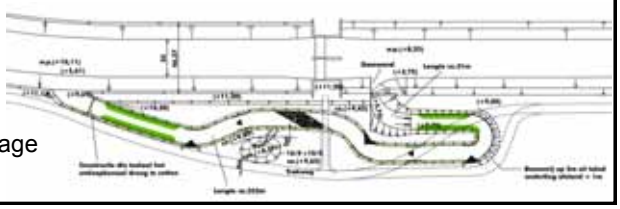
Weir-lock-complex at Oudenaarde





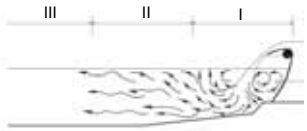
New weirs and fish passage constructed in 2004

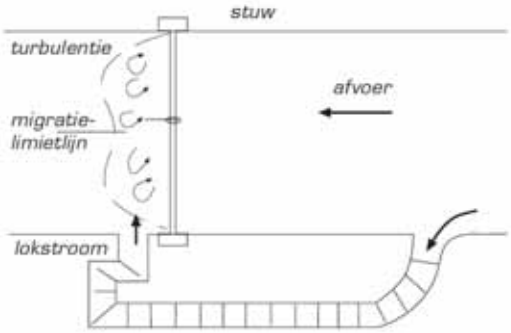
Weir-lock-complex at Oudenaarde



New weirs and fish passage constructed in 2004

Previous scale model research





Previous scale model research

Attractivity

Discharge

Location entrance

Qriv = 20 m3/s
Qfish = 2,5 m3/s
Location = 20 – 30 m

Passability

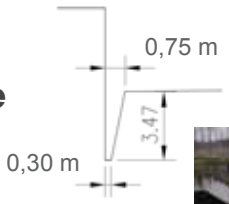
Roughness

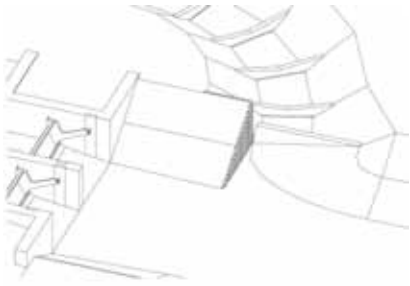
Optimizing length

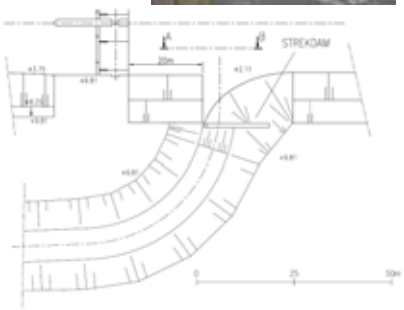
vmax = 1 m/s & hmin = 0,40 m
n = 0,100 s/m$^{1/3}$ → Ltot ≈ 350 m

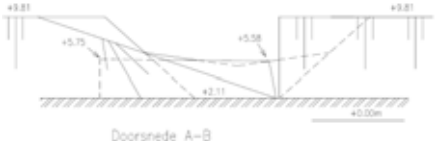
Previous scale model research

Fish pass entrance



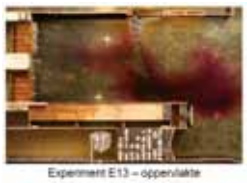




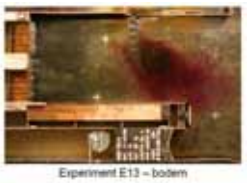


Further (scale model) research

inbo



Experiment E13 – oppervlakte



Experiment E13 – bodem

Experiment E14 – oppervlakte

Experiment E14 – bodem

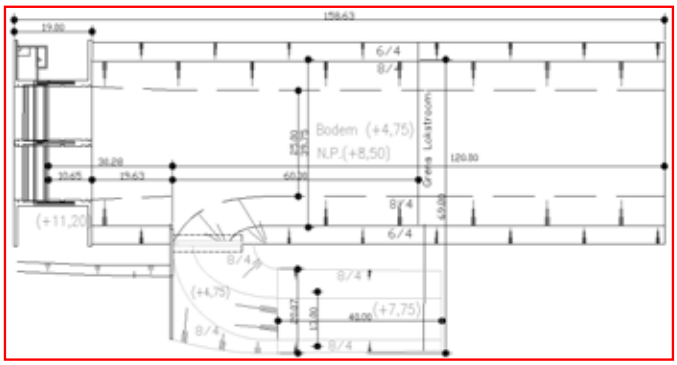
Research goal(s)

- Assesment of the attraction current
- Dual purpose:

1. Flow velocities & Extent are assessed quantitatively
   a) Attraction current
   b) Contraction at entrance
2. Compare results of scale model with data of the field measurements

Methods & materials

- Field measurements and scale model
- Area of interest



Field measurements

- River discharge – ADCP (Rio-grande)
- Fish Pass discharge – ADCP (Streampro)

Field measurements

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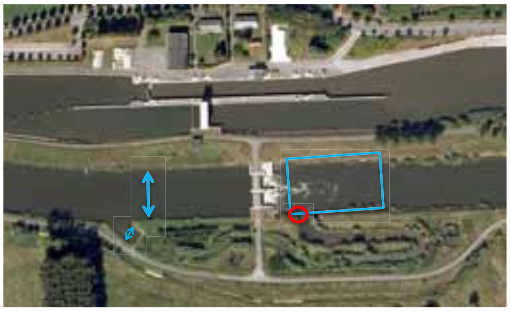
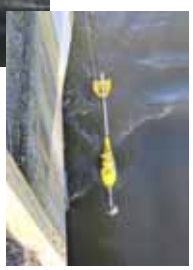
- Attraction current – Drifters (GPS)

Field measurements





- River discharge – ADCP (Rio-grande)
- Fish Pass discharge – ADCP (Streampro)
- Attraction current – Drifters (GPS)
- Velocity profile – Propellor type velocimeter

Physical model

With

$$Re = \frac{\rho \cdot u \cdot R}{\eta}$$

With

$$R = \frac{A}{P}$$

Re:	Reynolds number	[-]
A:	Wetted area	[m²]
P:	Wetted perimeter	[m]
R:	Hydraulic radius	[m]
ρ:	Density of water	[kg/m³]
u:	Averaged water speed	[m/s]
η:	Dynamic viscosity of water	[kg/m/s]

Cross-section 3:

Cross-section 4:

$$u_h = u_b = u_l = 15$$

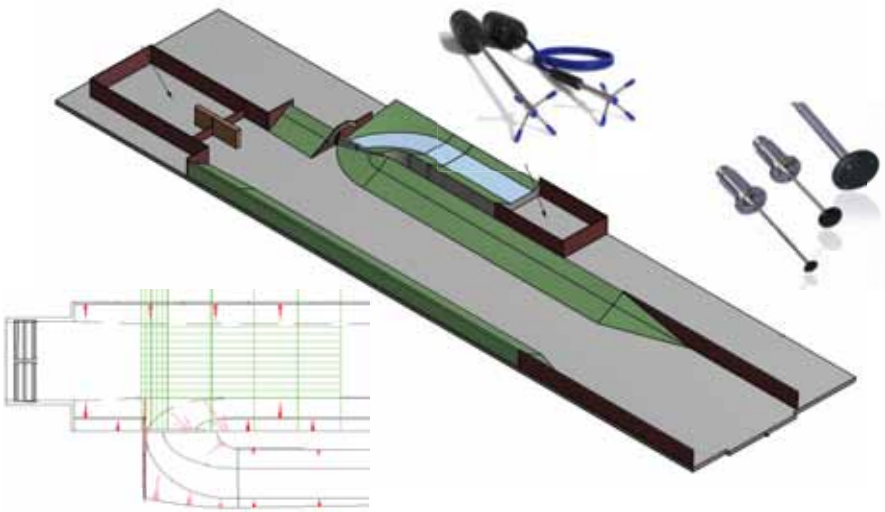
$$u_v = \sqrt{u_h} = \sqrt{15} = 3.87$$

$$u_q = u_l \cdot u_b \cdot u_h = 15 \cdot 15 \cdot 3.87 = 871.40$$

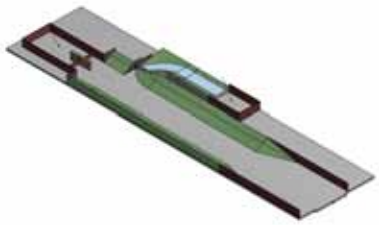
With

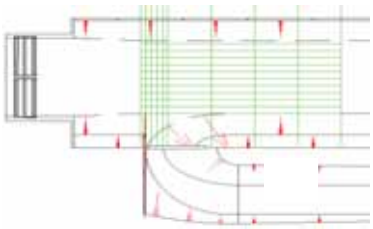
u_b : The width scale
u_h : The height scale
u_l : The length scale
u_v : The velocity scale
u_q : The discharge scale

Physical model: scale 1/15

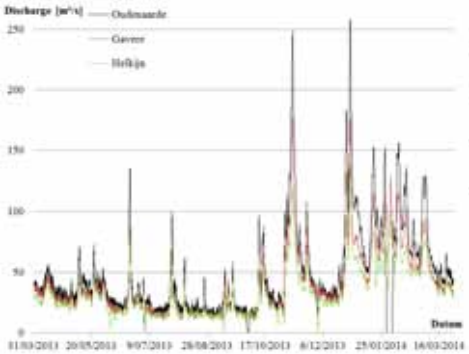


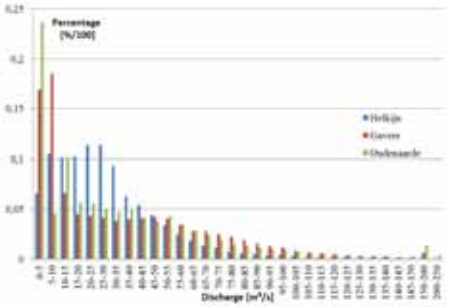
Physical model: scale 1/15





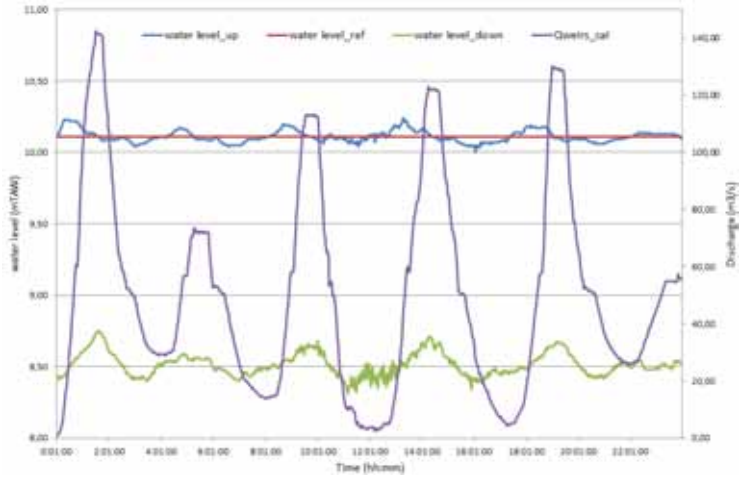
Results discharge





		Helkijn	Oudenaarde	Gavere
Mean discharge	Jan-Jan	29.74	36.51	34.73
	Mar-Oct	24.68	26.9	24.68
Most common class	Jan-Jan	20-25	0-5	5-10
	Mar-Oct	5-10	0-5	5-10

Results discharge & water level



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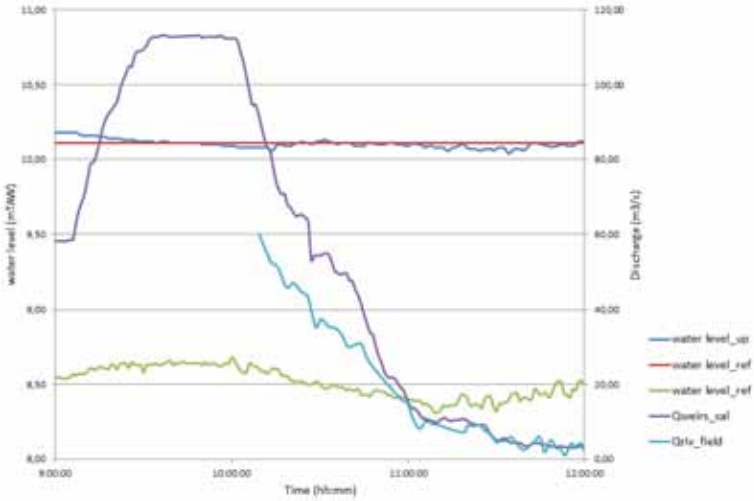
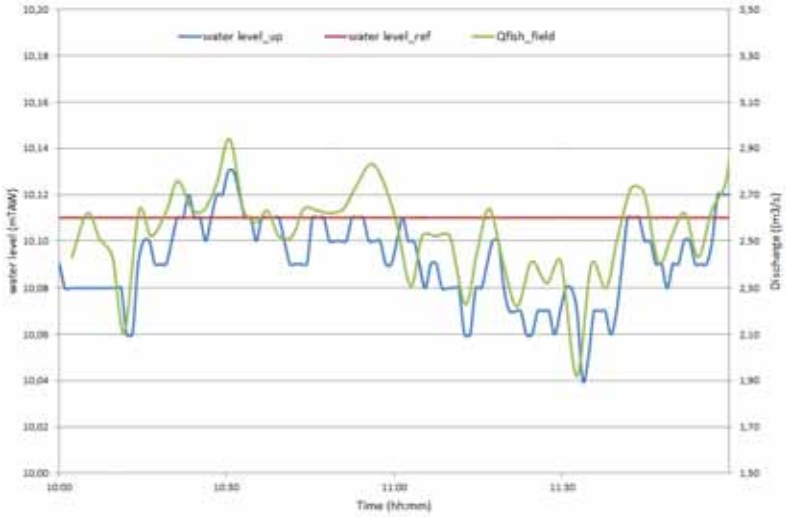
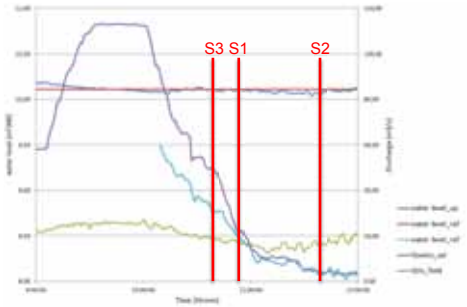


Results discharge & water level

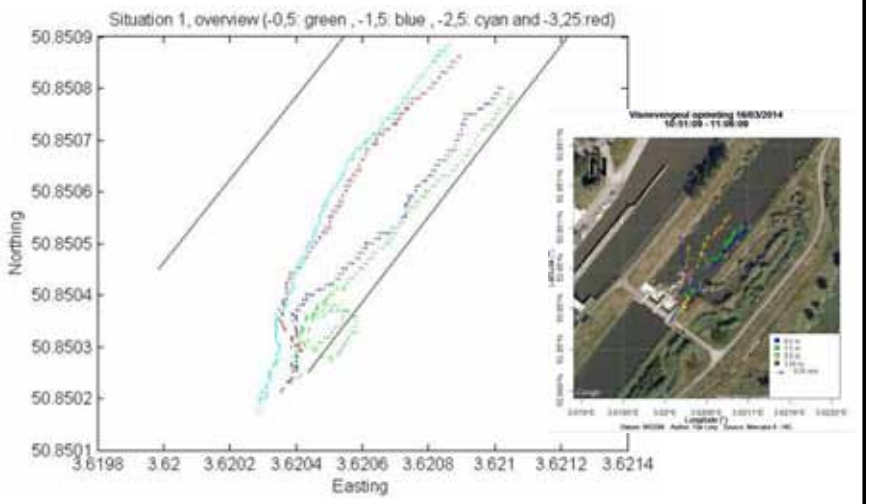


Characteristic situations



	S1 (10:50)				S2 (11:40)				S3 (10:35)			
	prototype		model		prototype		model		prototype		model	
Discharge over weir	20.0	m³/s	22.95	l/s	3.59	m³/s	4.12	l/s	30.96	m³/s	34.43	l/s
Discharge over fish passage	2.5	m³/s	2.87	l/s	2.59	m³/s	2.97	l/s	2.54	m³/s	3.93	l/s
Water depth upstream	5.0	m	0.33	m	5.35	m	0.36	m	5.35	m	0.36	m
Water depth downstream	3.5	m	0.23	m	3.70	m	0.25	m	3.71	m	0.25	m

Results drifters



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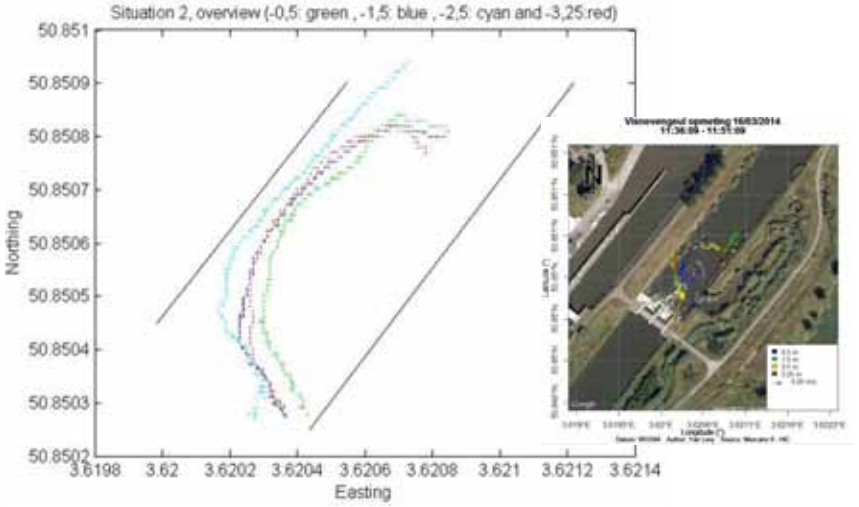
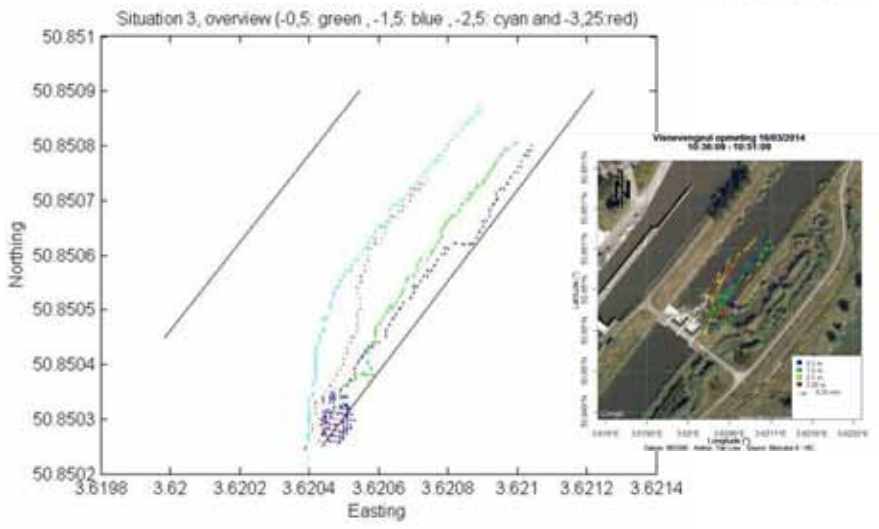
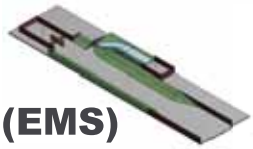
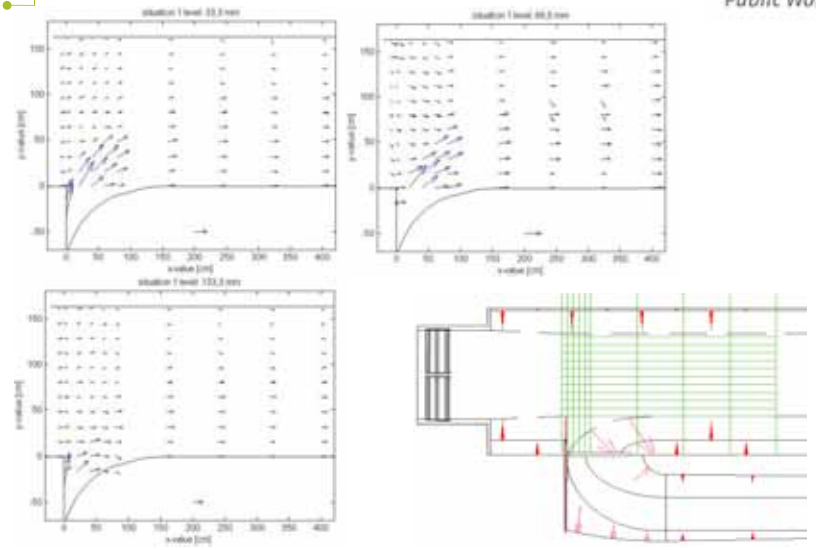


Results drifters



Results Vector plots (EMS)





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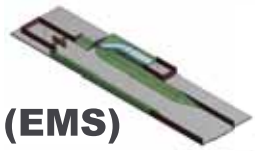
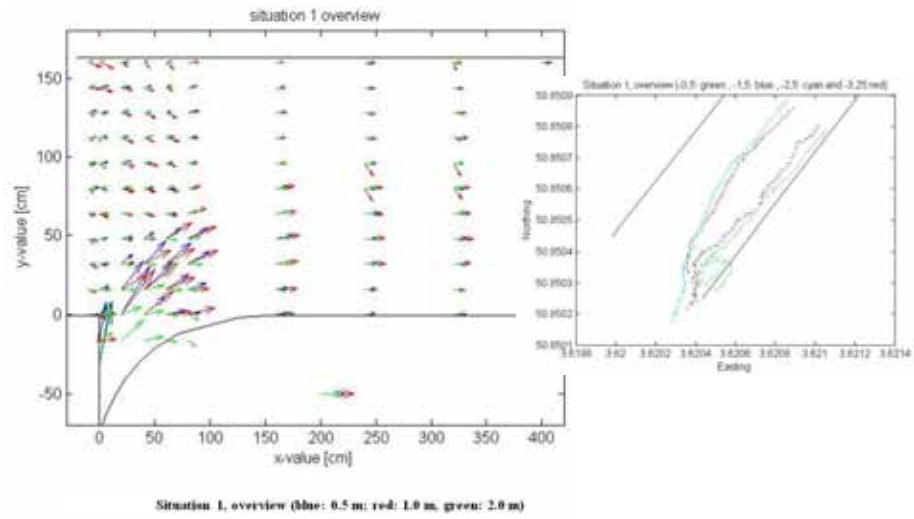
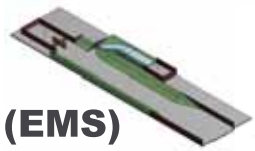
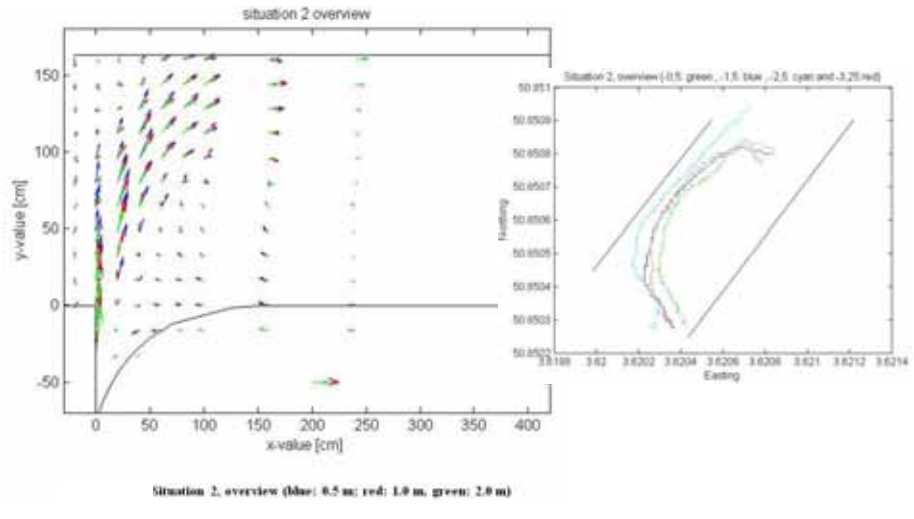




Situation 1, overview (blue: 0.5 m; red: 1.0 m, green: 2.0 m)

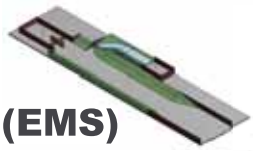
Results Vector plots (EMS)

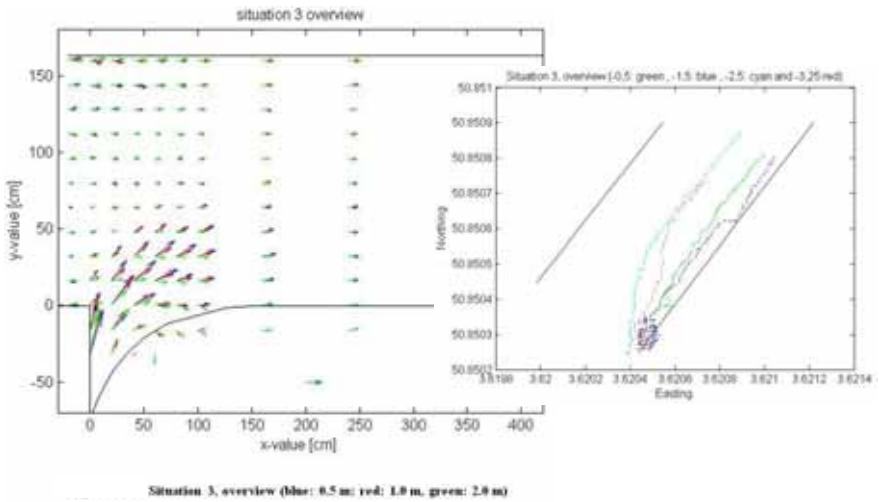




Situation 2, overview (blue: 0.5 m; red: 1.0 m, green: 2.0 m)

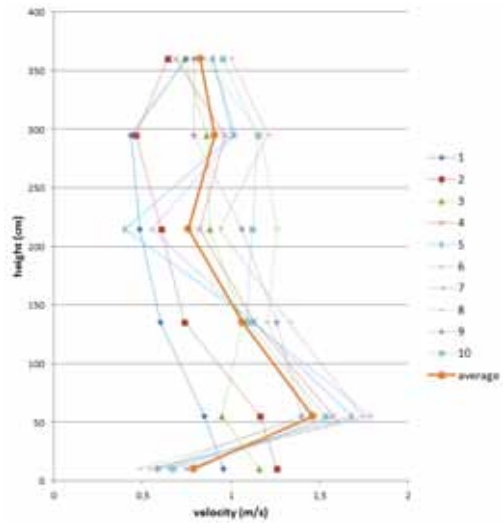
Results Vector plots (EMS)

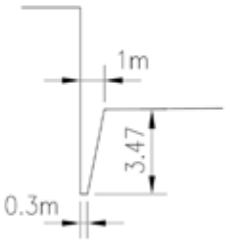




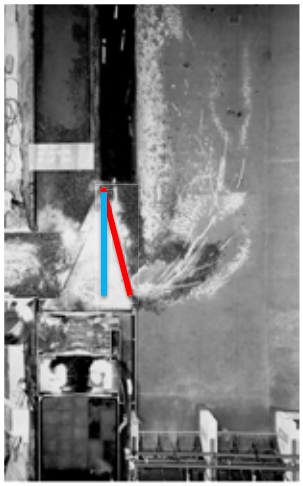
Situation 3, overview (blue: 0.5 m; red: 1.0 m, green: 2.0 m)

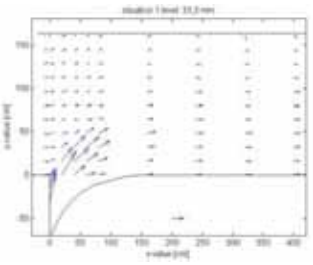
Results Velocity Profile

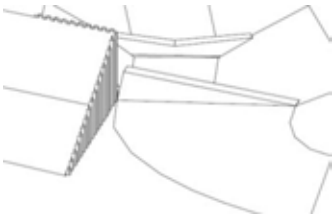




Comparance







Conclusions

- Maximum velocities are slightly higher then original design rules
  - → But: enough alternative locations in vertical profile where velocities are lower than design rules
- The extent of attraction current is less than in previous physical modelstudies due to changes in design of fish pass entrance
- Goal of quantifing the attraction current is met, but further refinements can (/need to) be done, for example:
  - Vertical profile in entrance
  - Refining the grid of the measurements of the attraction current

→ Further research on perpendicular attraction flow needs to be placed within broader research of design rules for fish passages (for example the difference between parallel and perpendicular orientation of the fish pass entrance)

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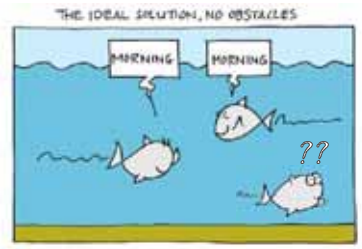
Department Mobility and Public Works

Questions?..



Thank you for your attention!