Jun 21st, 3:30 PM - 3:50 PM

An investigation of the hydrodynamic and fish behavior characteristics of the brush-type fish passage: Iyidere (Turkey) field study

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Fish Passage Status of Dams, Resorvoirs/Regulators, SHP

(Source: State Hydraulic Works of TR (DSI))

Type	Number	Fish passage status	Private or Govermental
Dam	592	No	G
Res/Reg	176	35	G
SHP	413	Most of them	P

Current status of freshwater fish fauna in Turkey

- Fish fauna of Turkish freshwater;
- 368 species, 31 families and 16 orders

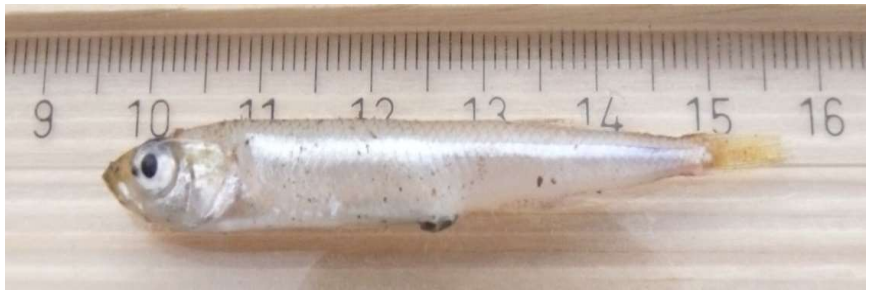
- Dominant species in fish fauna of Turkish freshwater;
- Cypriniformes order with 247 species
- Cyprinidae (188 species), Nemacheliidae (39 species), Salmonidae (21 species), Cobitidae (20 species), Gobiidae (18 species) (Çiçek et al., 2015)

- Endemism; 153 endemic species
- Non-native species: 28 species

Main Problems of Fish Passages in Turkey

- Most of the fish pass structures are pool-weir and they have high velocity (V>2 m/s) in the orifice slots
- Passability of small and weak swimming capacities fish were not taken into account
- Inlet and outlet of the passes were not adequately designed for fish traceability
- Dynamic upstream water levels were ignored in most of SHPs.

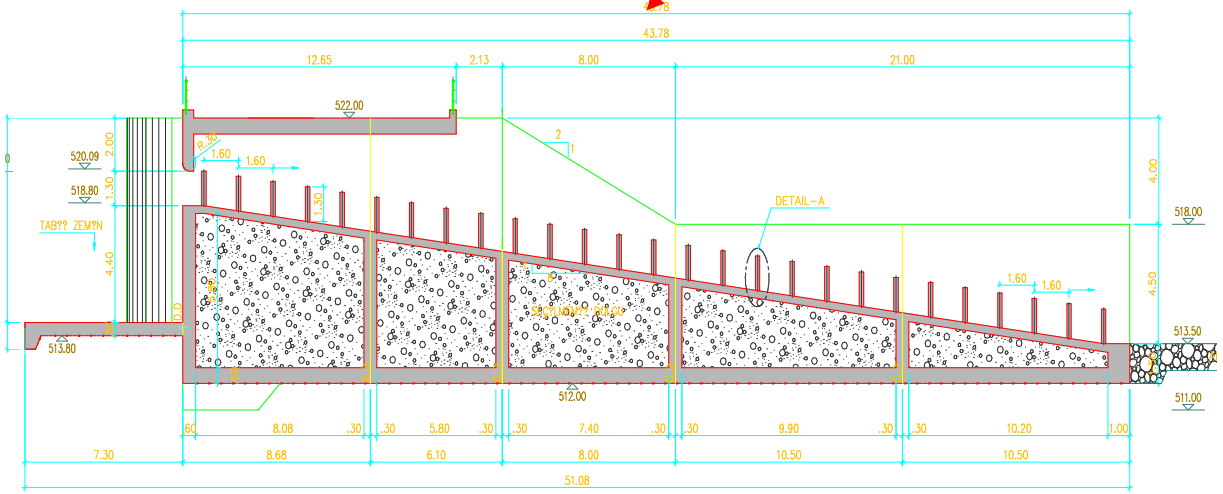
SMALL-BODIED FISH

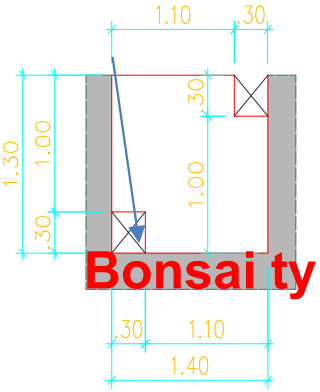


Atherina boyeri

Do not Match

Nemacheilus angorae

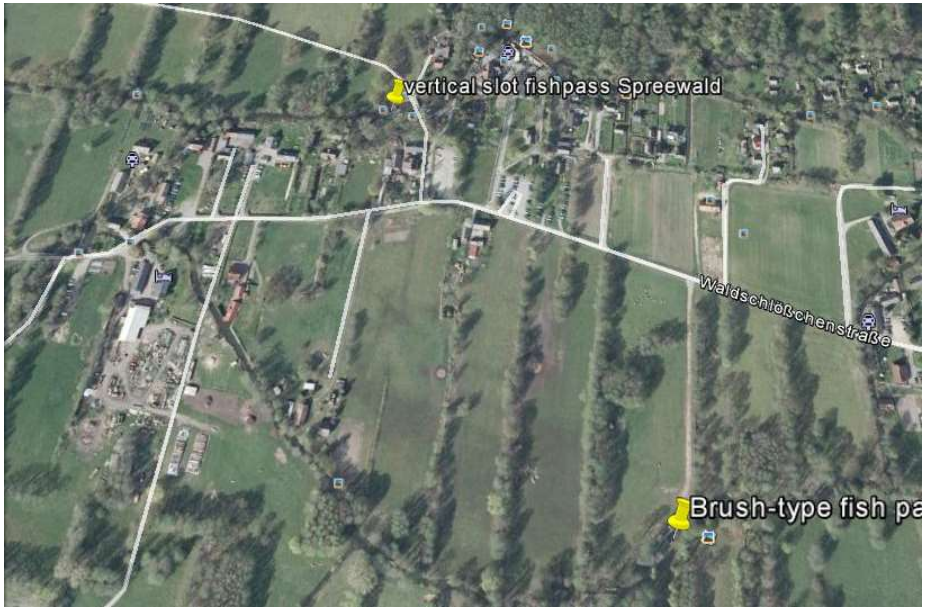




Bonsai type !

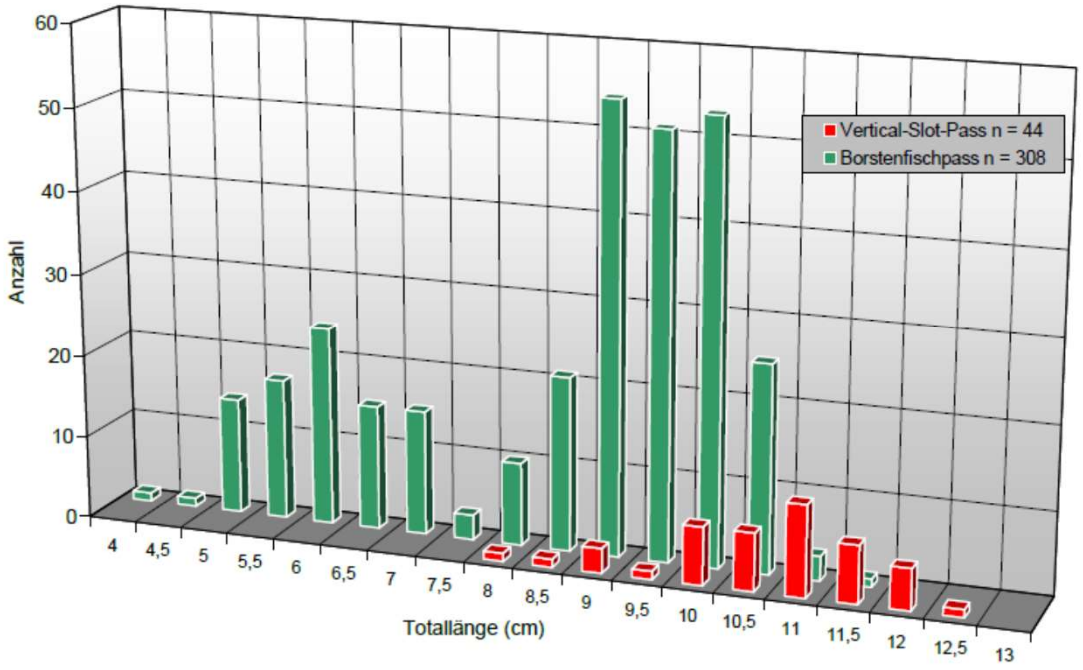
Fish Pass Type: Pool-Weir

Fish Monitoring Studies in Spreewald, Berlin



UNESCO Biosphere Reserve

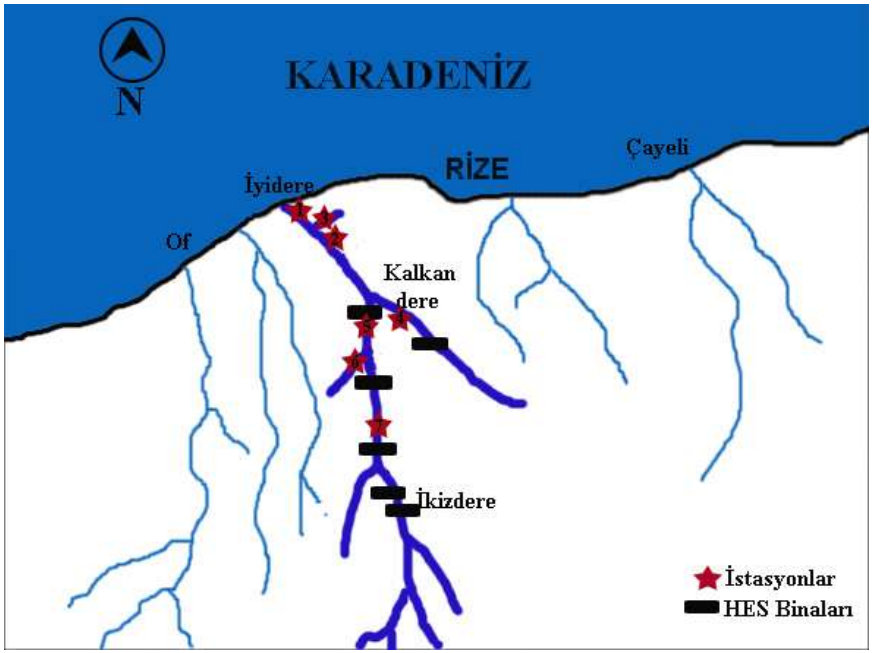
Source: Landesumweltamt Brandenburg, 2007. Erhaltung von Habitaten der Kleinen Flussmuschel (Unio crassus) im Biosphärenreservat Spreewald durch Einrichtung von Borstenanlagen. Studien und Tagungsberichte, Schriftenreihe - ISSN 0948-0838



Comparison of Fish Length Distributions in **Brush (Green)** and Vertical Slot (Red) Passes

PROJECT AREA:İyidere-İkizdere river basin

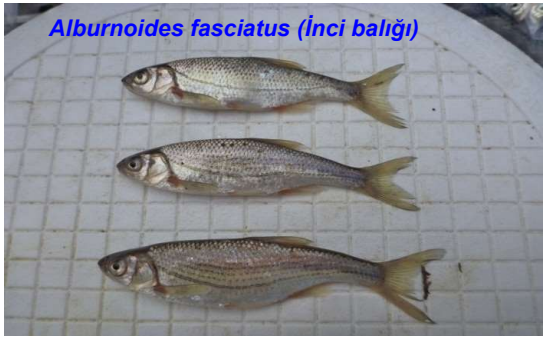
A Research Project on the Eastern Black Sea Region of Turkey



An Investıgatıon of The Hydrodynamic and Fish Behavior Characterıstıcs of The Brush-Type Fısh Passage: İyidere (Rize-Trabzon) Field Study*

*This work is supported by the Scientific and Technical Research Council of Turkey under Scientific and Technological Research Projects Funding Program (1001 TUBITAK) grant with agreement number 315M019

Fish Species of Project Area



Source: Aksu (2014)

Sea trout (*Salmo coruhensis*)

Spirlin (Alburnoides fasciatus)

Brush Fish Pass

The technique of using brush elements as hydraulic-energy absorbers in fish passes had been first applied in 2002. Meanwhile around 50 sites are in operation. During that time, more operating experience and functional results were achieved (Hassinger, 2015).

Brush Fish Pass in Hann-Münden

Source: R. Hassinger www.uni-kassel.de/fb14/vpuw

Advantages of Brush Fish Pass

1) Vibrations of Bristles: Guidance for Fishes and Favorable Hydraulic Conditions

2) Suitable for Small and Weak Swimming Capacity Fish

3) Social Benefit: Passage of Canoes

Shared Value

Source: Landesumweltamt Brandenburg, 2007

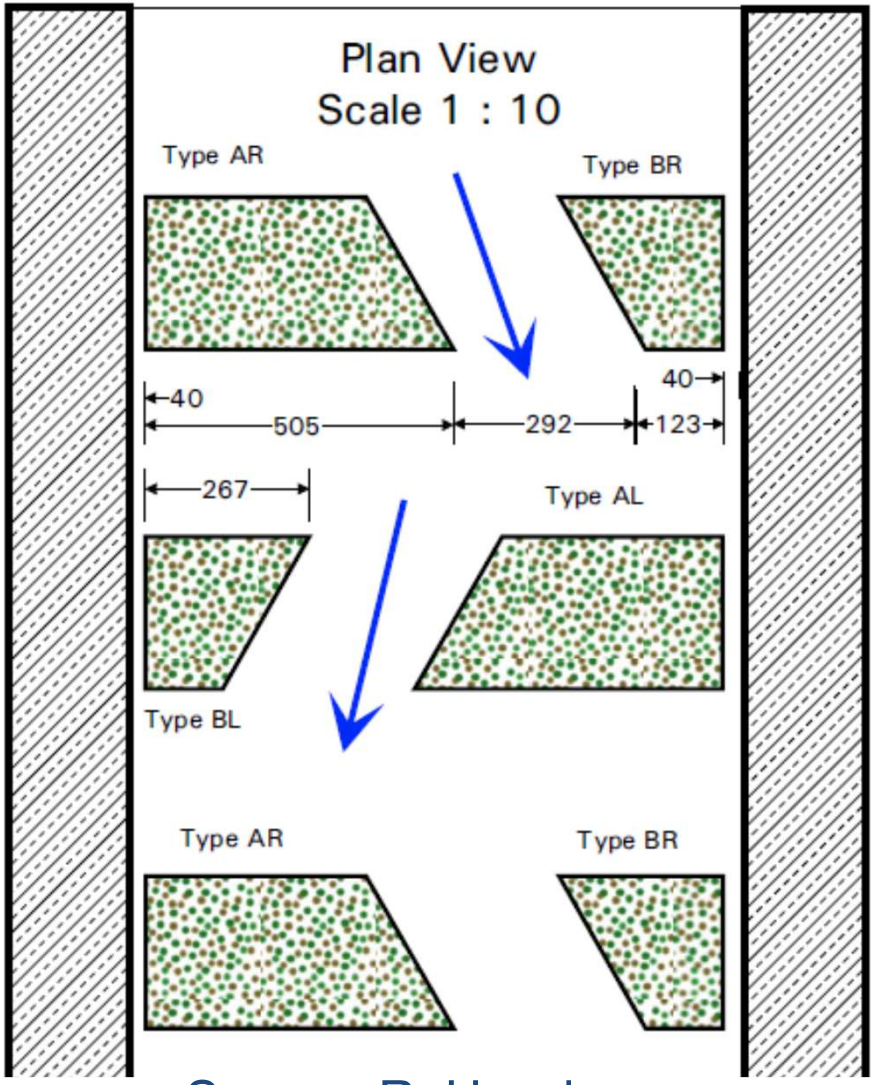
Construction of Brush Fish Pass

Fish Pass Structure Connection to River

Fish Pass Entrance

Iyidere Project

The proposed project aims to investigate the relationship between the hydrodynamics and fish behavior (fish entrance, migration corridors and resting areas) characteristics of brush fish passage



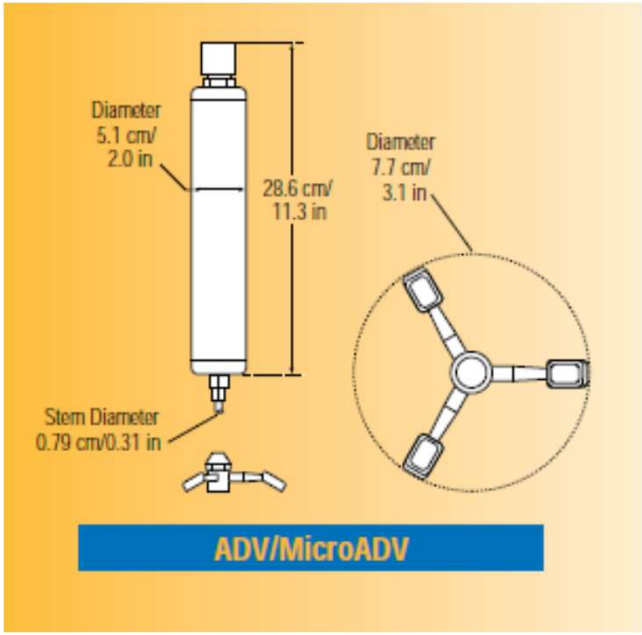
Source: R. Hassinger

Sampling Methods:

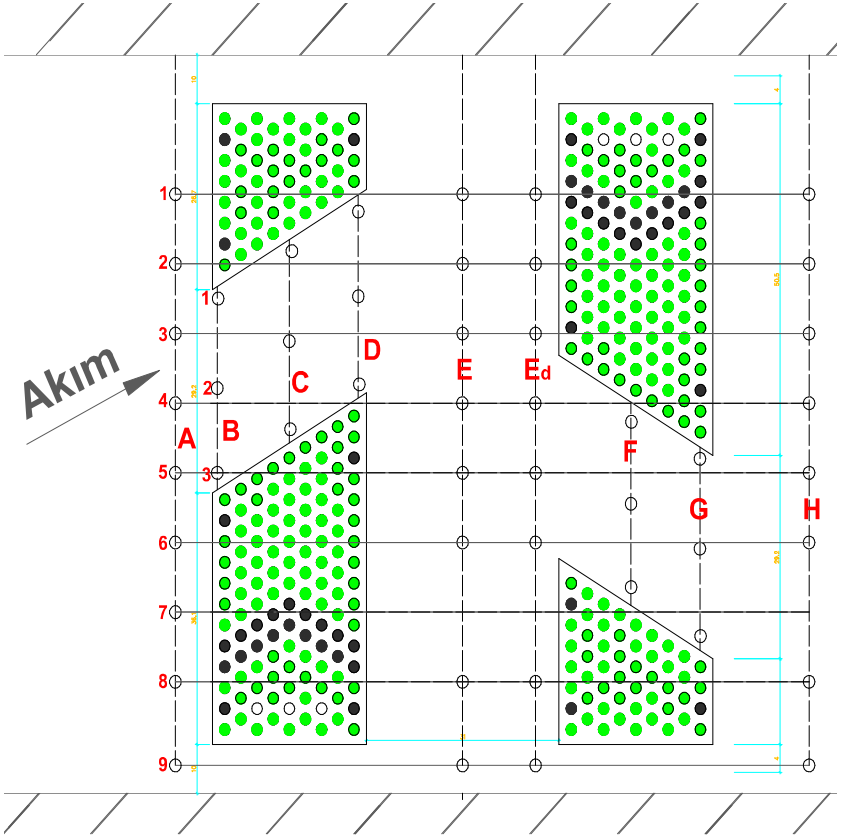
3D Acoustic Velocity

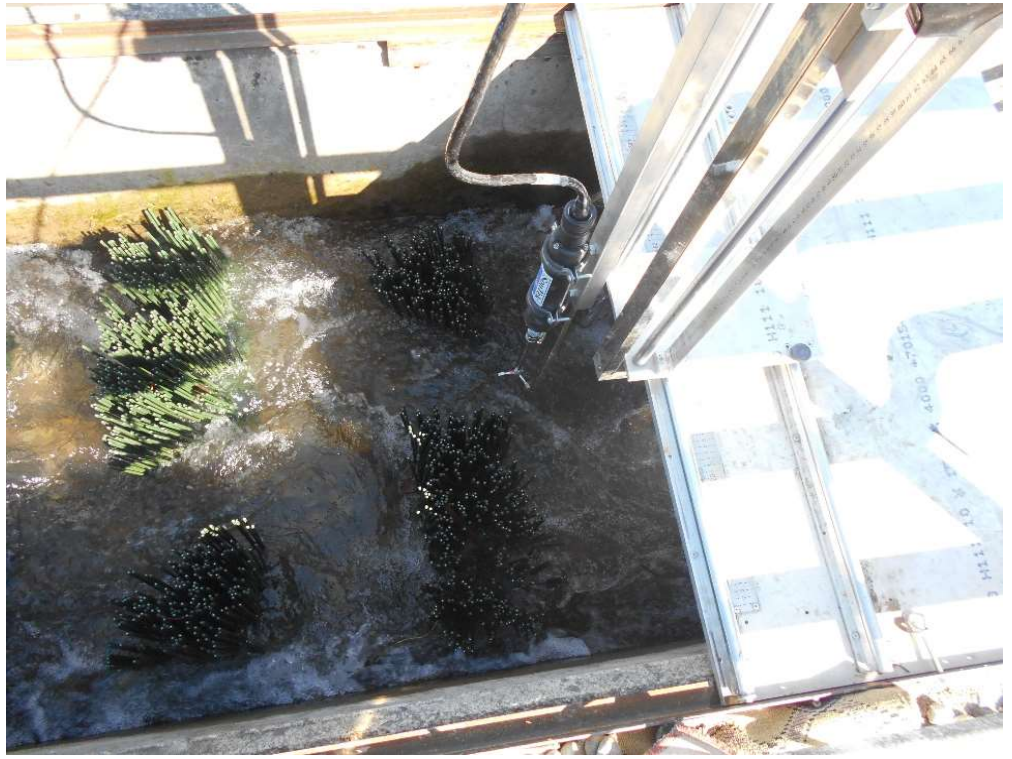
Velocity and Turbulence

Biotelemetry

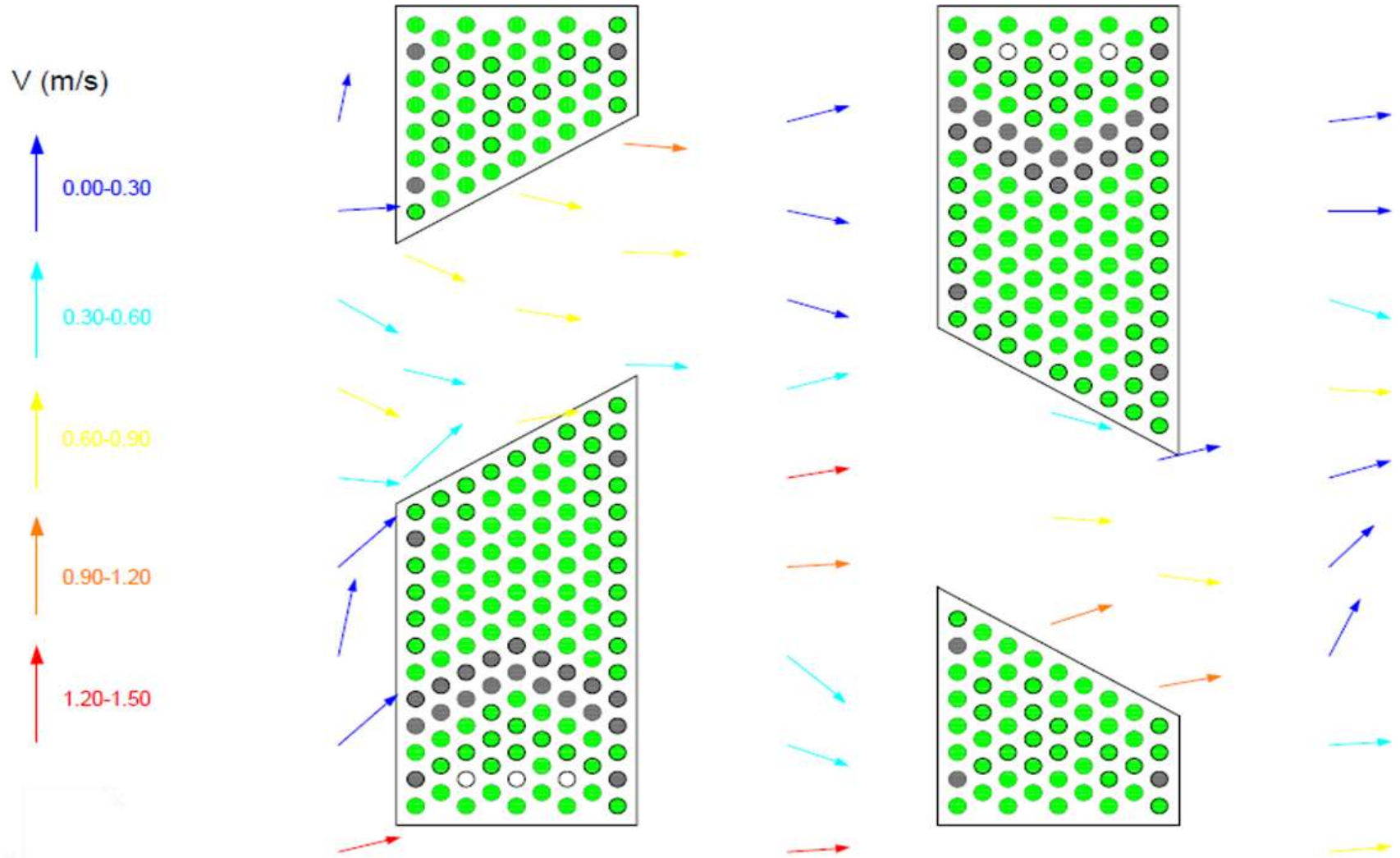


Measurement Grid for ADV



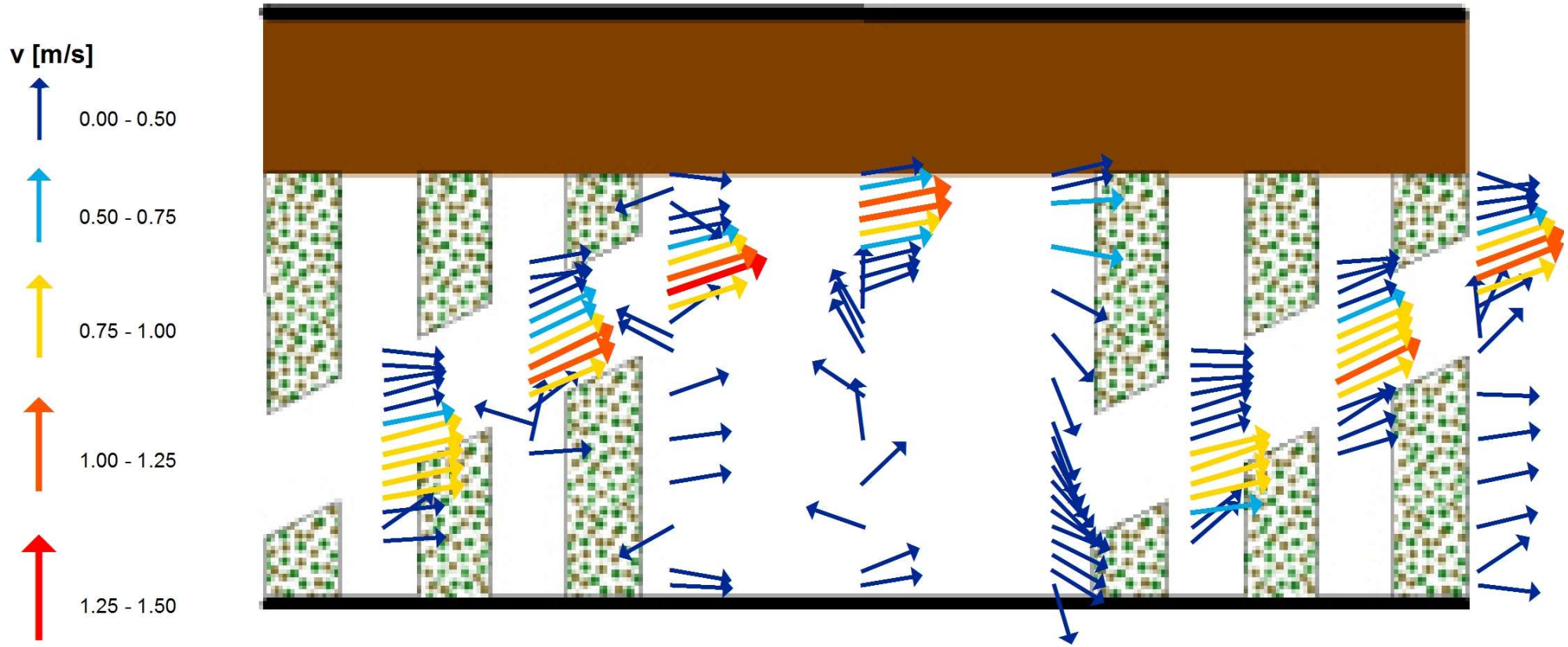


Velocity Field Around Brush Blocks (Field Study)



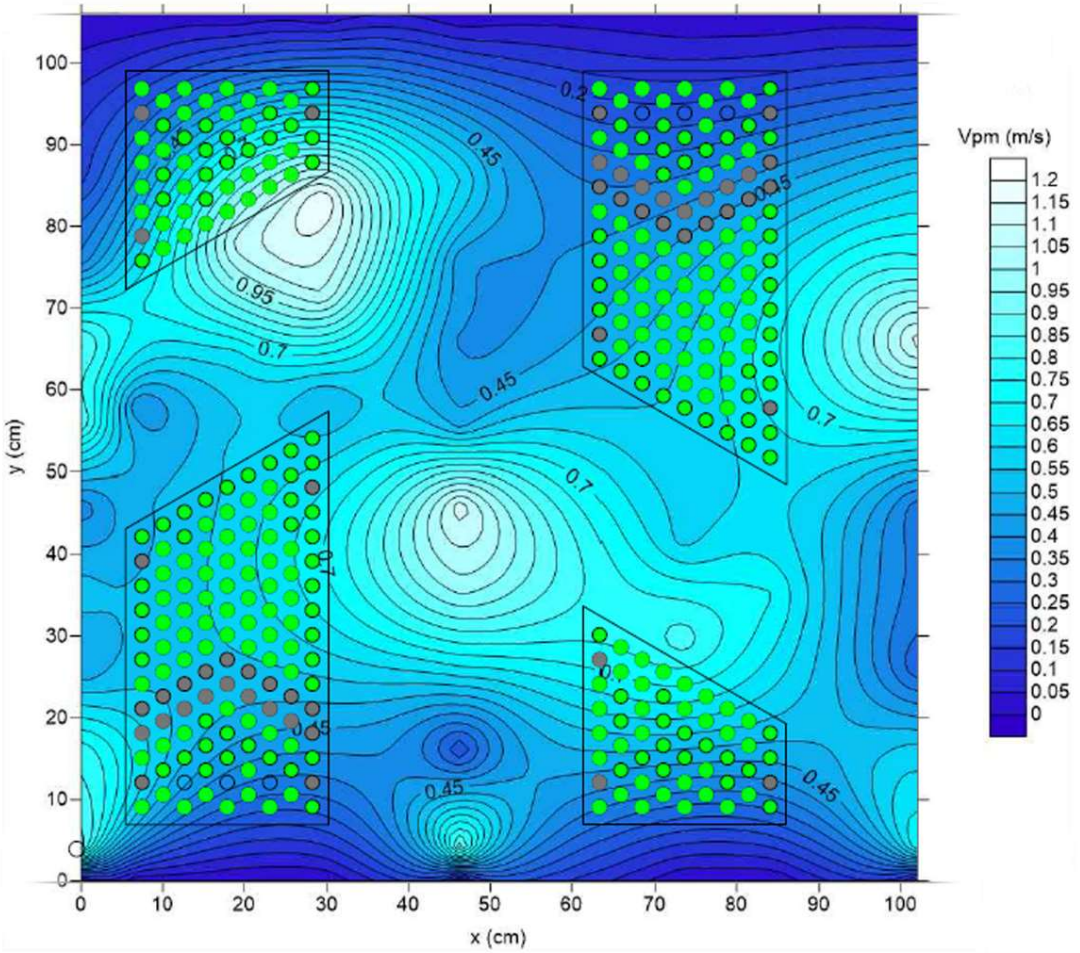
Maximum velocity is reduced about 30% with respect to pool-orifice type

Velocity Field Around Brush Blocks (Kassel University, Hydraulics Laboratory)



Source: Rahn, S., 2011. Hydraulische Untersuchung der Strömungsverhältnisse in Borstenfischpässen mit Dreifachriegeln. Master Thesis in Faculty of Civil and Environmental Engineering, University of Kassel (in German).

Power Velocity Distribution

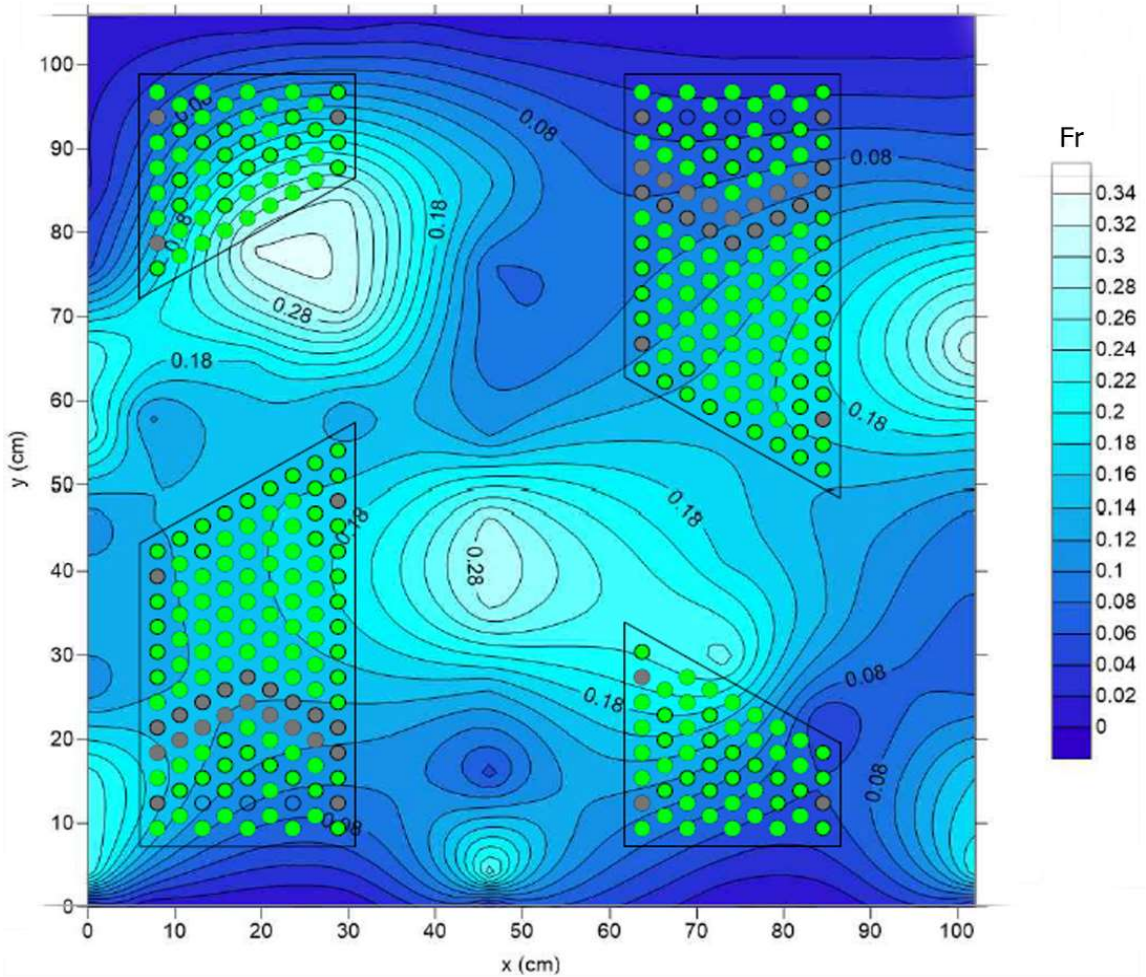


$$V = \sqrt{u^2 + v^2 + w^2}$$

$$V_{pm} = \sqrt[3]{\frac{\sum |V_i^3|}{n}}$$

Froude Number Distribution

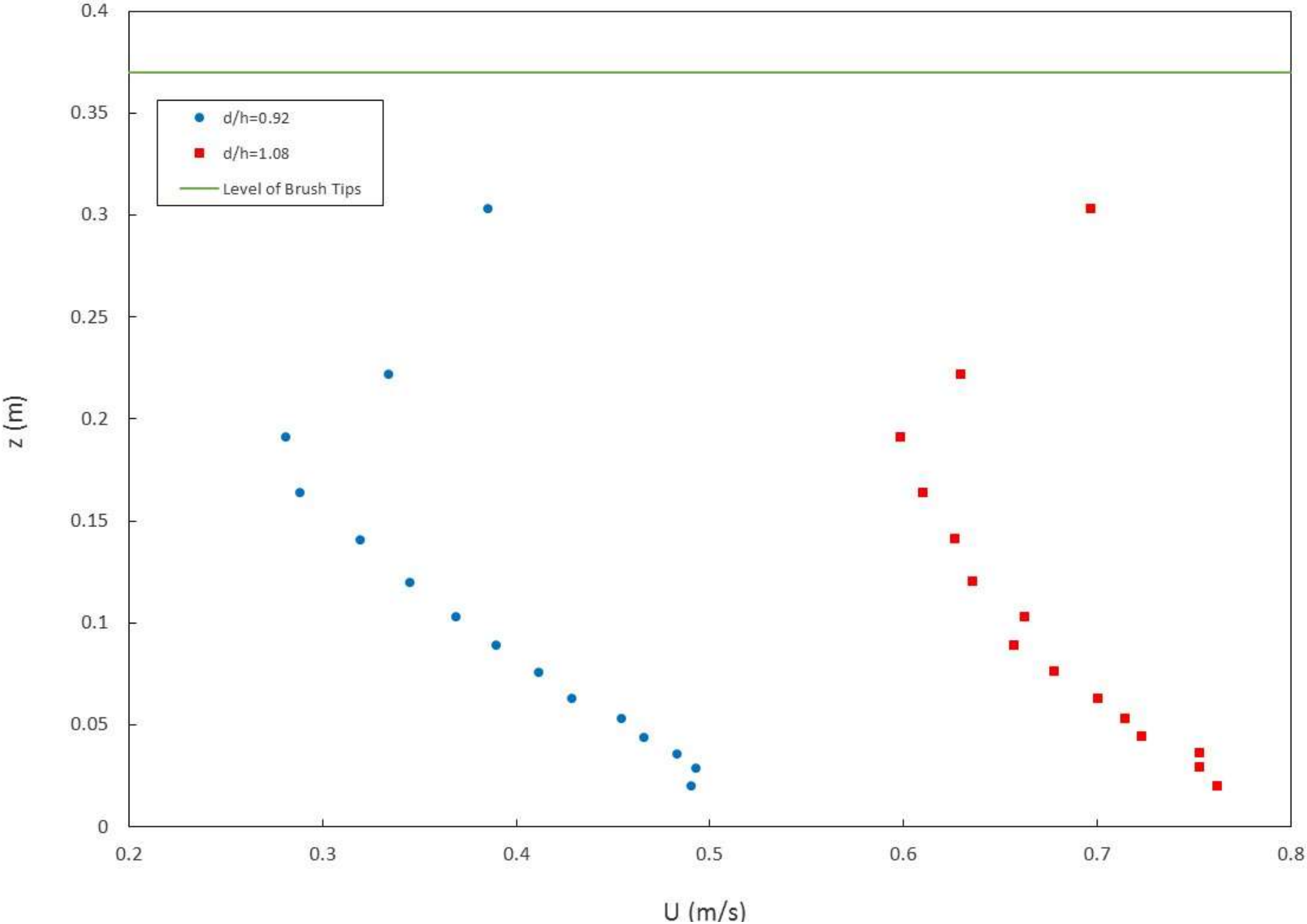
There is no transition zone



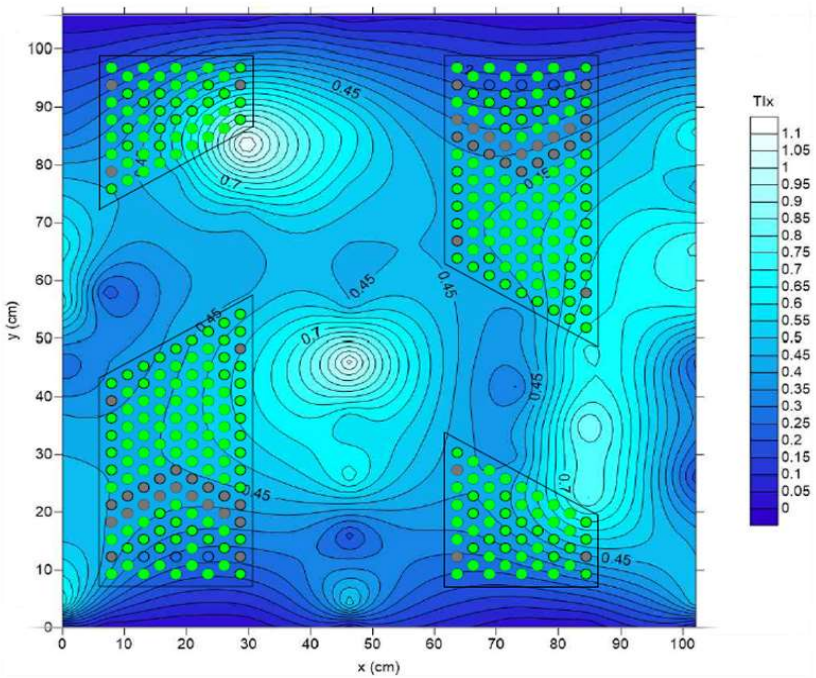
$$Fr = \frac{U}{\sqrt{dg}}$$

Velocity Profiles

(In Front of Brush Blocks)

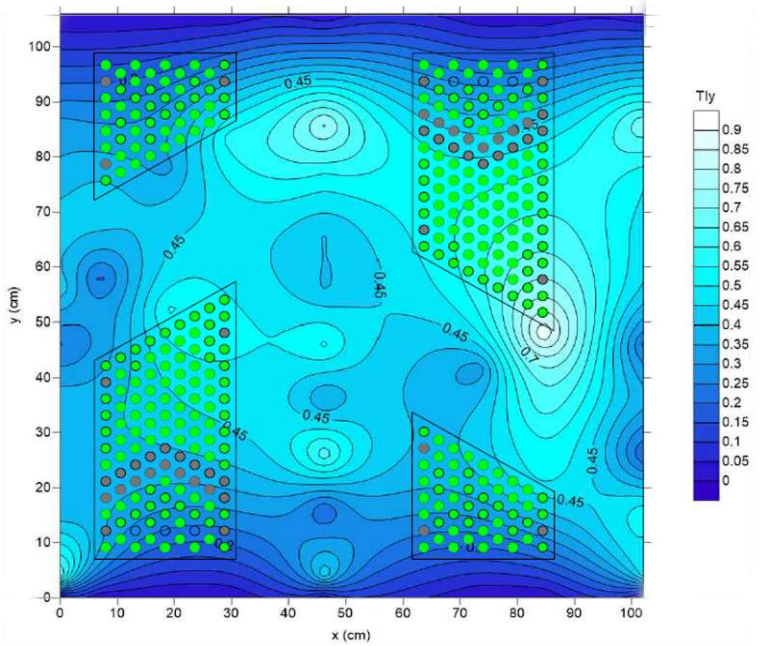


Turbulence Intensities

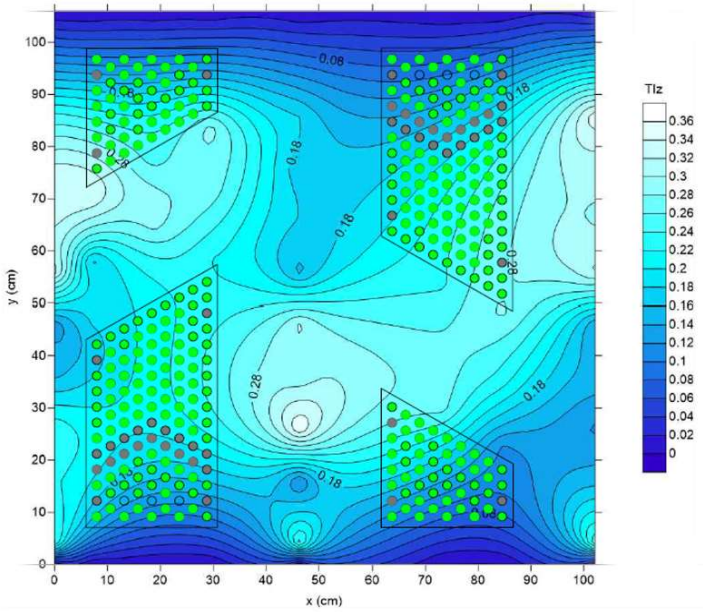


Streamwise

$$TI_x = \frac{\sqrt{\overline{u'^2}}}{U}$$

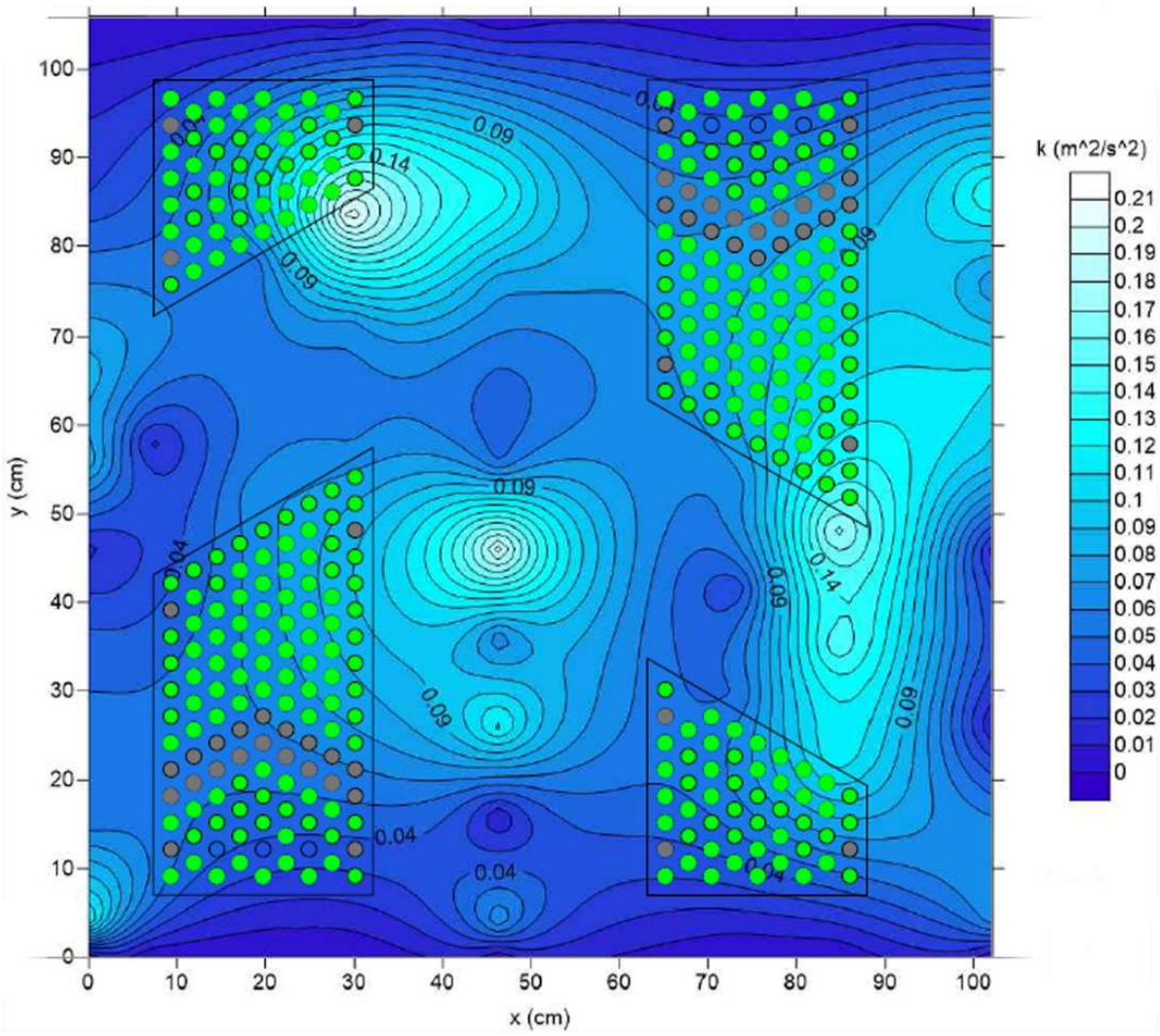


Lateral



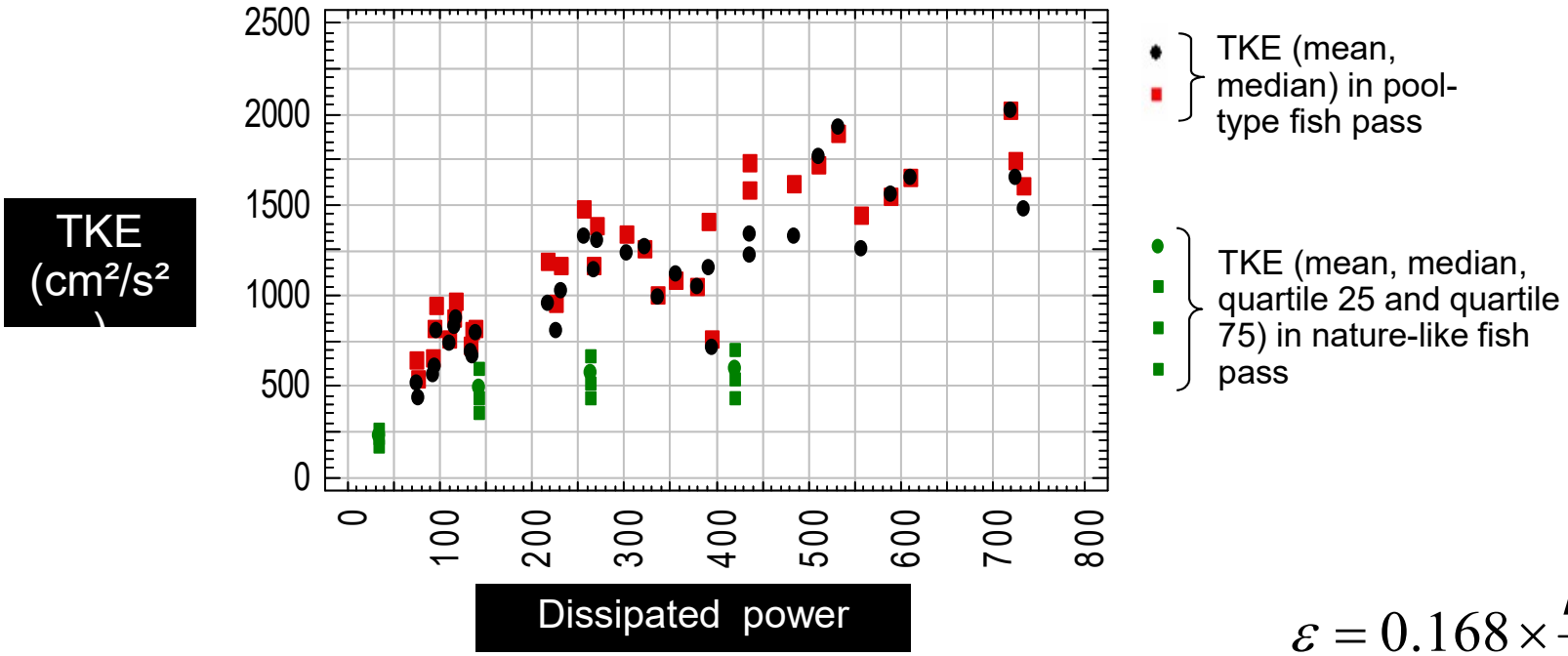
Vertical

Turbulence Kinetic Energy Distribution in Horizontal Plane



$$k = \frac{1}{2}\left(\overline{u'^2} + \overline{v'^2} + \overline{w'^2}\right)$$

Energy Dissipation and Turbulent Kinetic Energy

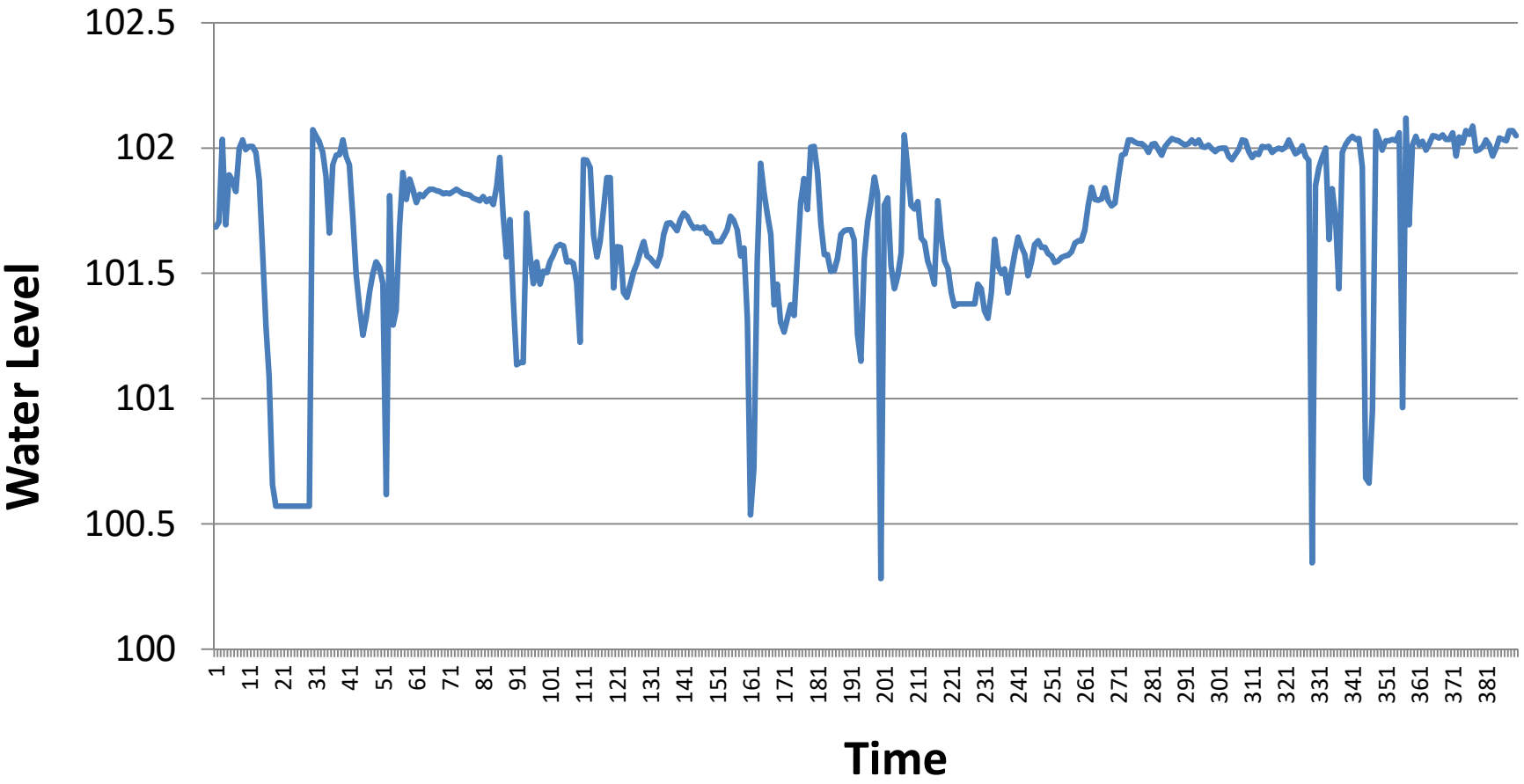


$$\varepsilon = 0.168 \times \frac{k^{3/2}}{L}$$

Source: Larinier (2007)

TKE seems to be lower (for a same dissipated power) in brush fish than in pool-type fish passes.

Fish Pass Intake Water Level Dynamics (May, 2016)



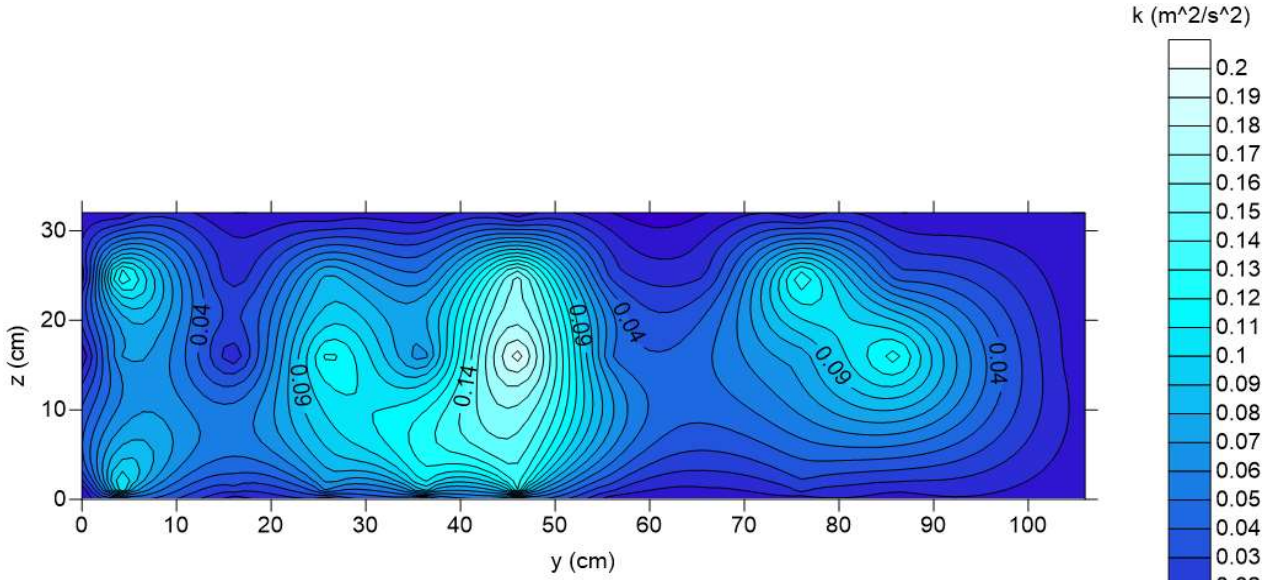
Fishpass Water Intake Operation Range: H=101.20 – 102.05 m

Unsubmerged and Sumberged Flow Conditions

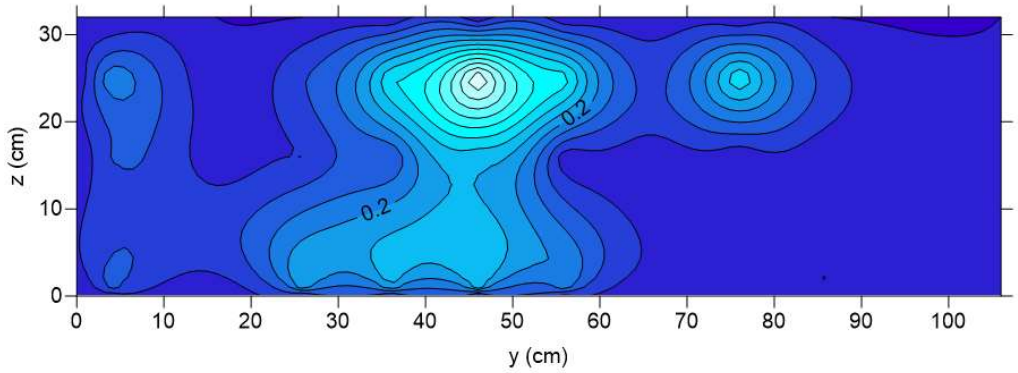
UnSubmerged
H=102 m

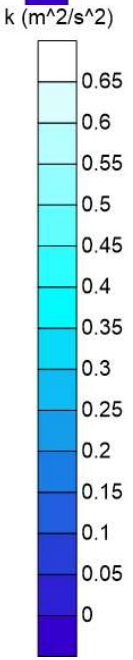
Submerged
H=102.05 m

Turbulence Kinetic Energy Distribution in Vertical Plane



UnSubmerged
H=102 m





Submerged
H=102.05 m

Vibration of Bristles

$$St_b = \frac{U \times D}{f_b}$$

Tagged Fish

Ponticola rizeensis

Salmo coruhensis

Alburnoides fasciatus

(Squalius sp.)

Fish Species Travel Times in Fish Passage

Squalius sp. (L=17.6 cm): t=23 minutes

Squalius sp. (L=14.2 cm): t= 55 minutes

Ponticola rizeensis(L=19.5 cm): t=2 hour 39 minutes

Alburnoides fasciatus (L=9 cm): we did not able to detect travel time due to some technical problems

Summary

A wide spectrum of different flow characteristics is provided.

TKE seems to be lower (for a same dissipated power) in brush fish than in pool-type fish passes.

There are several migration corridors with different hydraulic conditions and they continue through the complete fish pass.

The cleverness of the fish is used to seek the convenient corridors and to avoid zones not suitable for their migration preferences.

Thank you for your kind interest

Dr. Serhat Kucukali

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