Effect of ship induced waves on drift density of fish larvae in a large River.

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Content

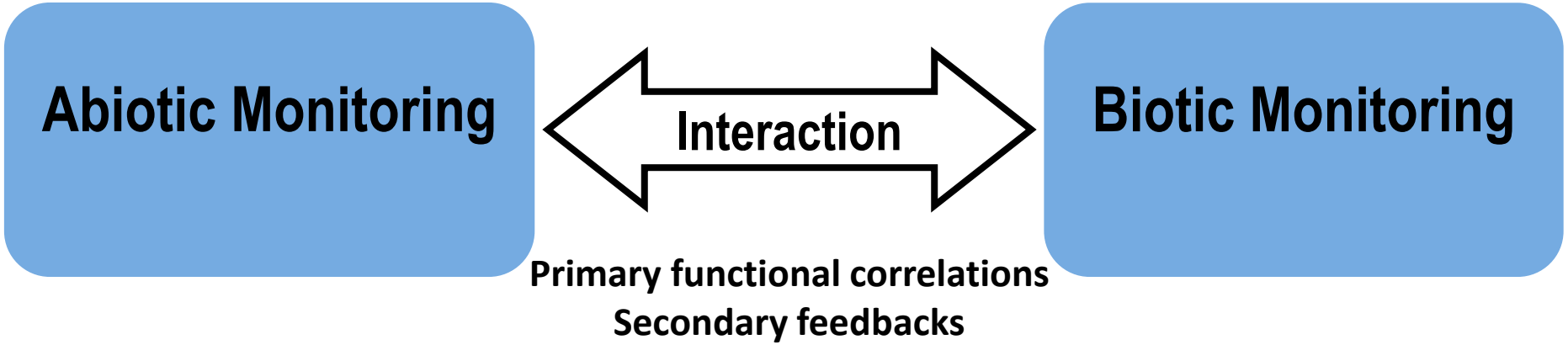
- The River Danube and the “Integrated River Engineering Project”
- Ship-Induced Waves – Early stages of fish as indicators
- Shores are different: shore specific hydraulic conditions
- Fish are different: taxonomic, onogenetic and site- specific effects/responses
- Outlook

River Danube east of Vienna: free - flowing; National Park Donau-Auen

Ecological deficits of the Danube east of Vienna

- Structural deficits in the main stem leading to low habitat quality
- Reduced geomorphologic dynamics
- Degradation & incision of the river bed
- Unbalanced sediment budget
- Increasing isolation of the flood plain

The “Integrated River Engineering Project”

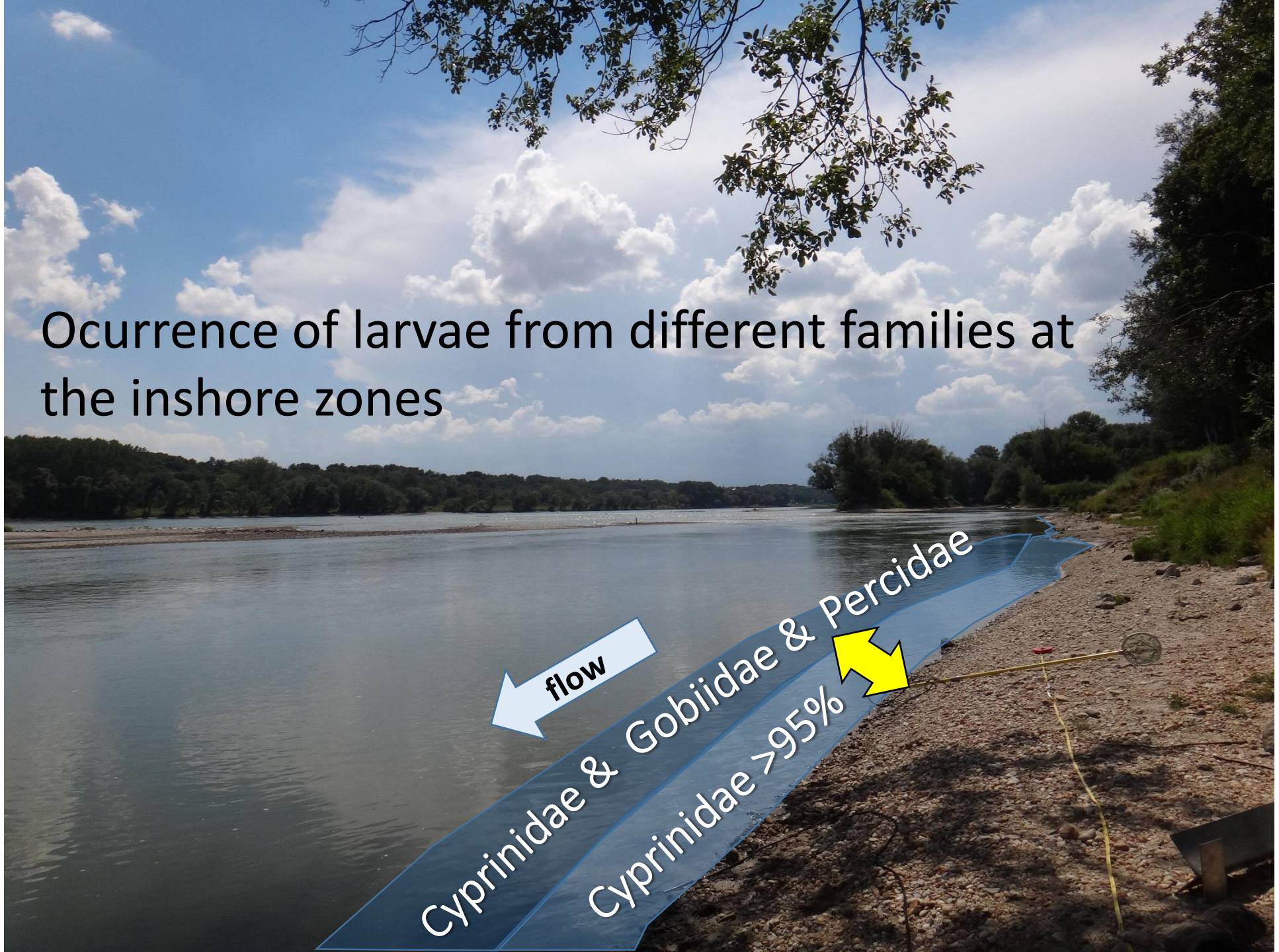


A1 Hydrology and Hydraulics
A2 Hydrology and Hydraulics of Groundwater
A3 Sediment Budget and Transport
A4 Changes in Morphology
A5 Navigation

B1 Ecological Functions and Processes
B2 Landscape- Dynamics & - Structure
B3 Habitat Diversity
B4 Biodiversity and Bioindication

The “Integrated River Engineering Project”– Main Aims

- A stop of the ongoing degradation and incision of the river bed
- Improvement of the ecological quality of riverine and riparian habitats
- Improvement of navigation


Ocurrence of larvae from different families at the inshore zones
flow
Cyprinidae & Gobiidae & Percidae
Cyprinidae >95%

Ship – induced waves effect larval nurseries

Video: Paul Humphries

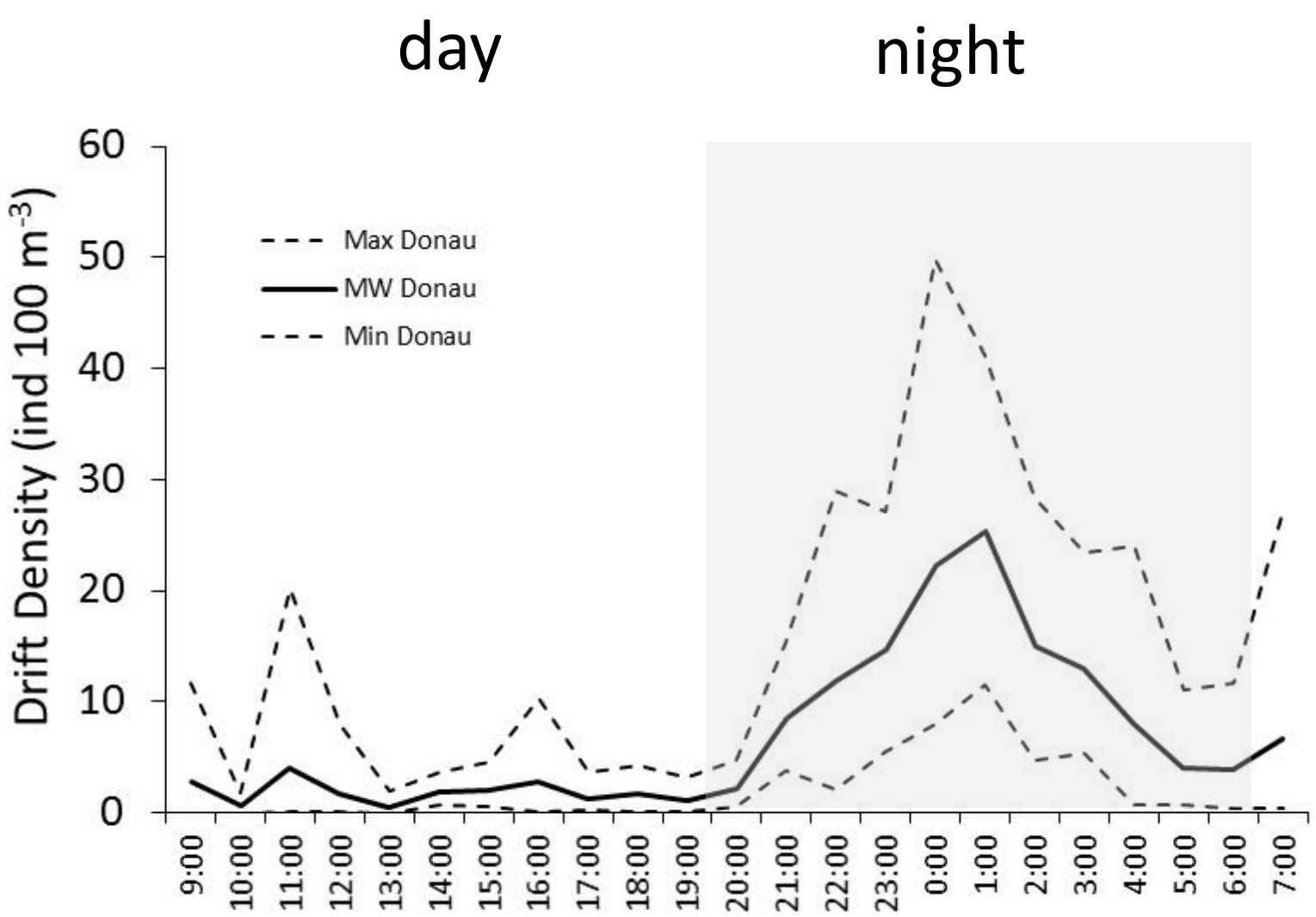
Effects of ship induced waves on fish larvae
(Schludermann, et al. 2013):

wave splash:

- higher current velocities,
- Increased (fine) sediment loads,
- high water turbulences and shear stress
- vessel-induced drawdowns in water level

- Short and long term effects on the riverine biota (Schaefer et al., 1992; Barrett et al., 1992; Adams et al., 1999; Killgore et al., 2001)
- Persistent environmental perturbations caused by shipping, change the structure and composition of the fish assemblage (Wolter & Arlinghaus, 2003; Huckstorf et al., 2010)

Larval drift as an indicator of effects of ship – induced waves



Abel & Keckeis, unpublished

Interdisziplinary approach – sampling design

Liedermann et al., 2013; Schludermann et al., 2013

2 Mesohabitats, before – after rehabilitation measures

Synchronous measurements of:

- Larval drift
- Larval settlers
- flow-velocities (ADV; 3D)
- wave characteristics (Dobbie; height of water column, etc.)
- shift in waters edge, surge, downsurge
- ship traffic (number, type, speed, direction, position etc.)

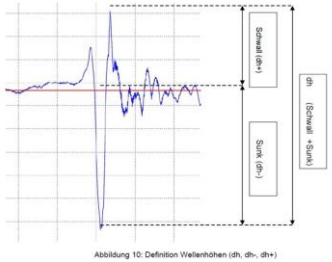


Abbildung 10: Definition Wellenhöhen (dh, dh-, dh+)

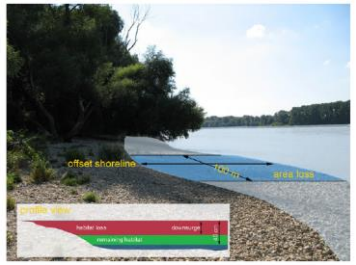
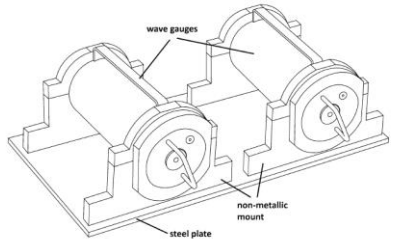


Fig. 3 DOBIE Wave gauges and the massive steel plate used to provide stable device position



Ship passages

Driftnet samples

ADV

Dobie Wave gauge

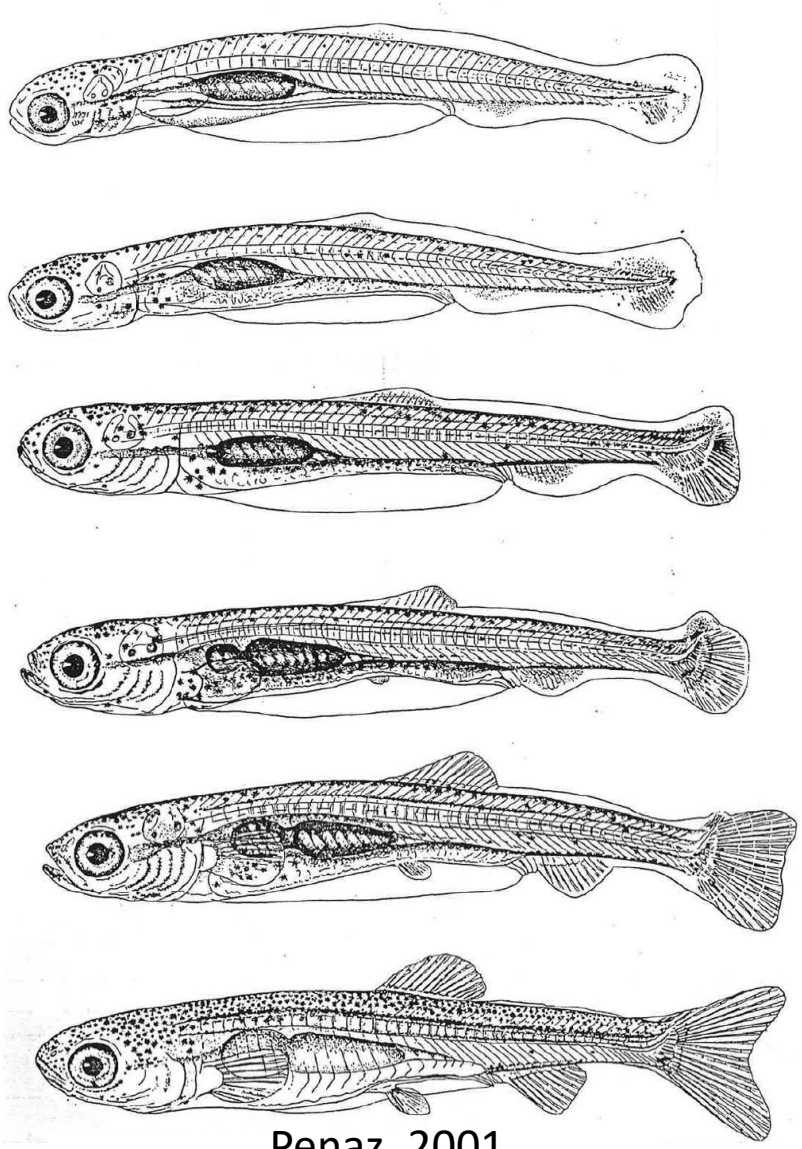
Time of Day

gravel bar

Groyne field

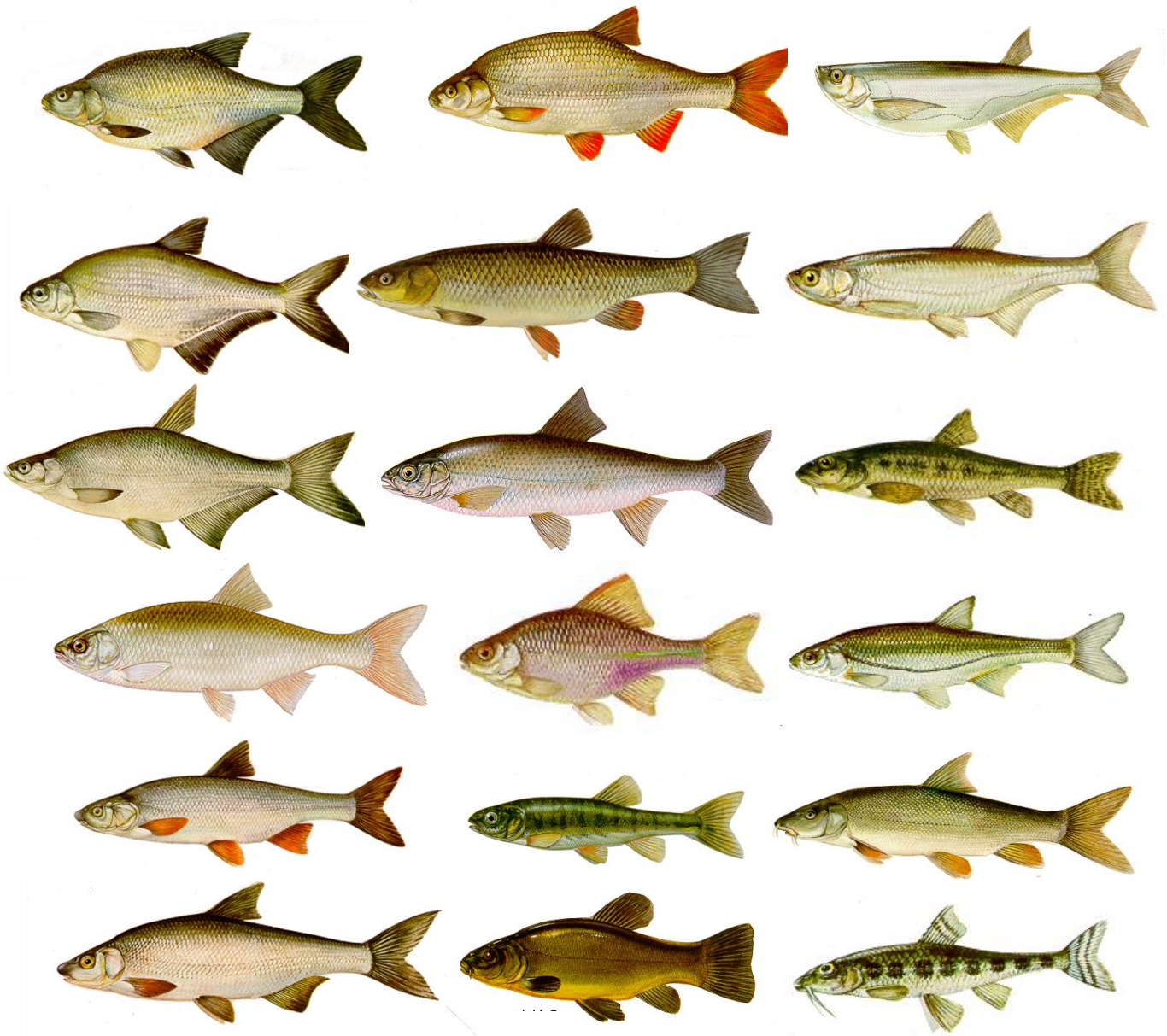
Cyprinid Larvae

4 mm – 12 mm



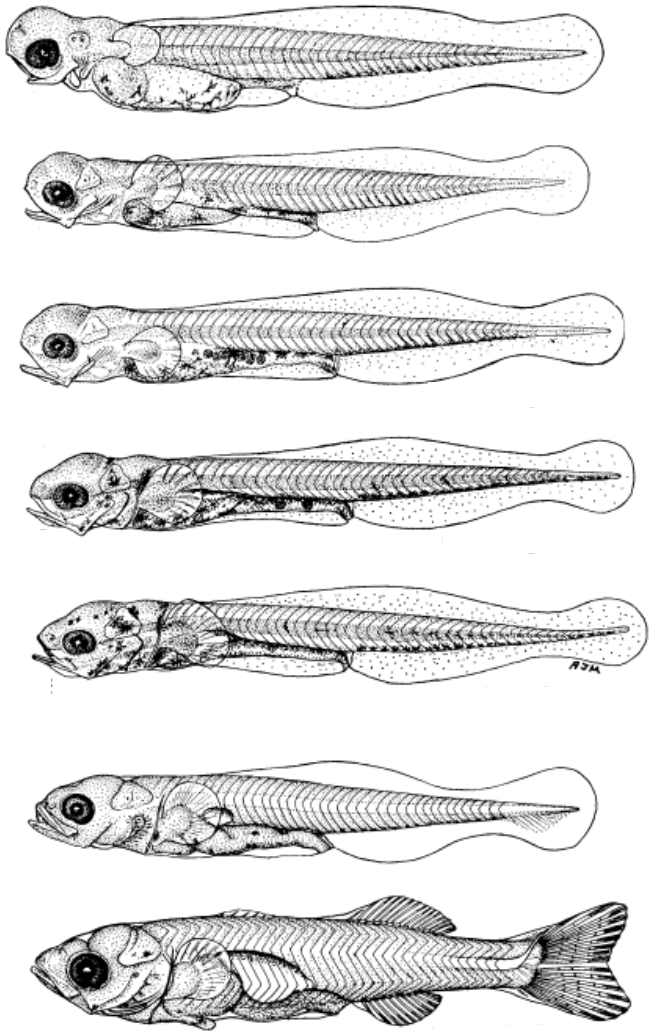
Penaz, 2001

Fam. Cyprinidae > 30 species



Percid Larvae

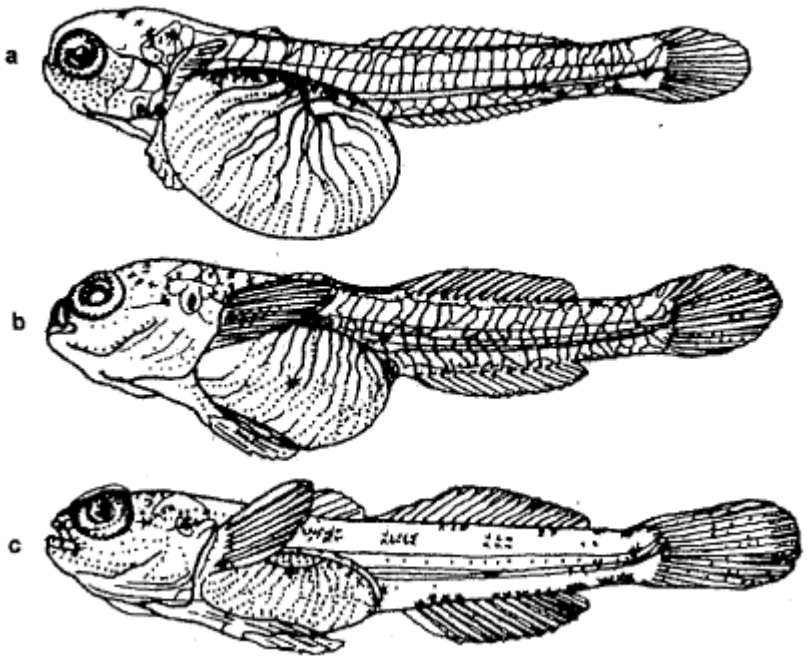
5 mm – 8 mm



Mansueti, 1964

Fam. Percidae 8 species

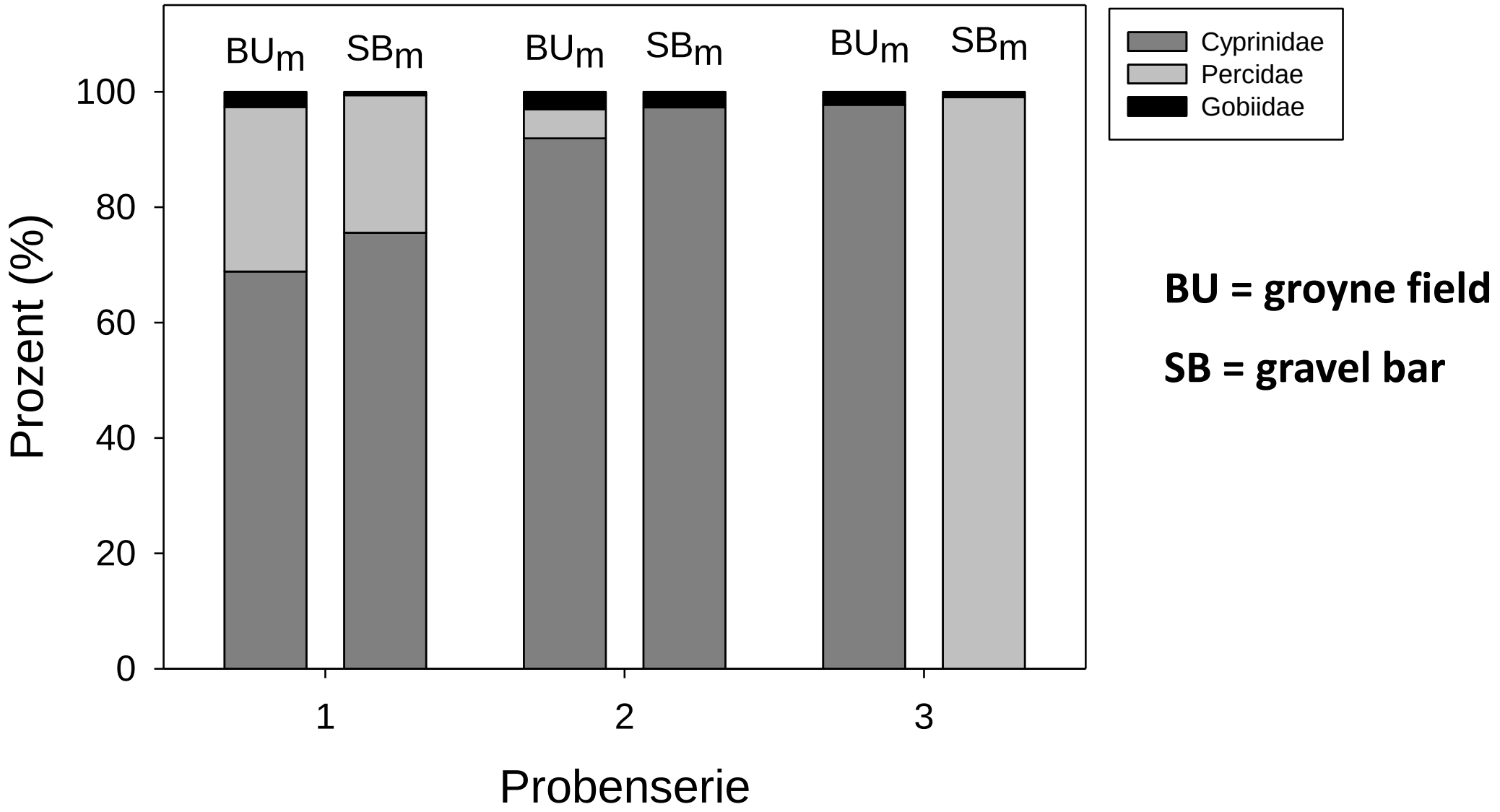
Gobiids
„direct development“
early stages 5 mm – 12 mm



Pavlov, 2002

Gobiidae 4 species
1 native, 3 invasive

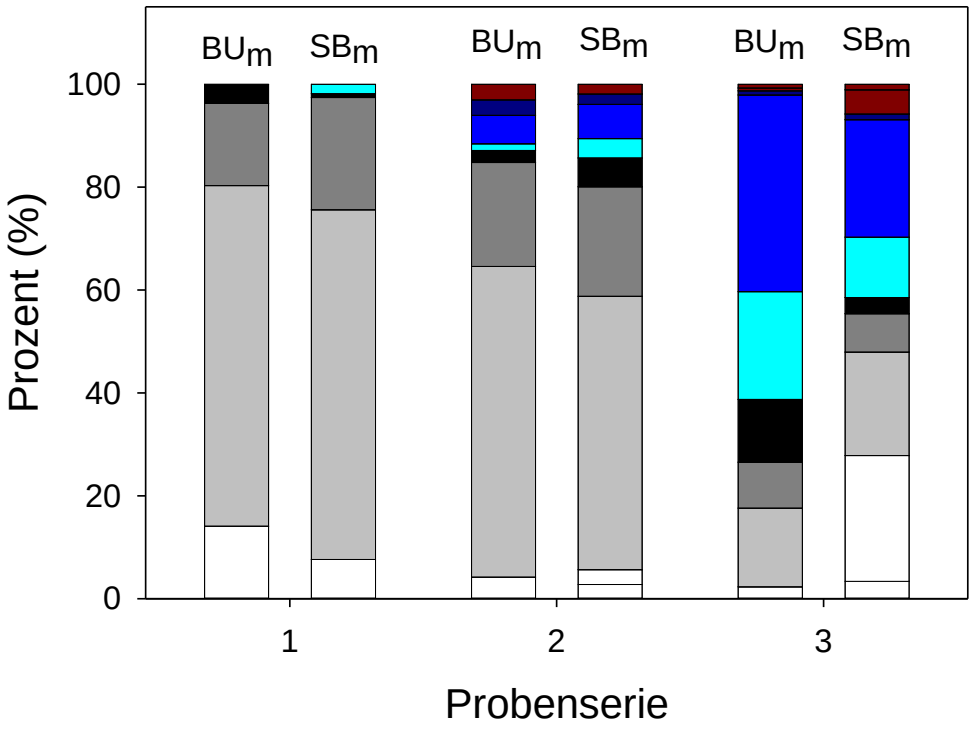
Catch Composition in Drift Nets at different sampling days



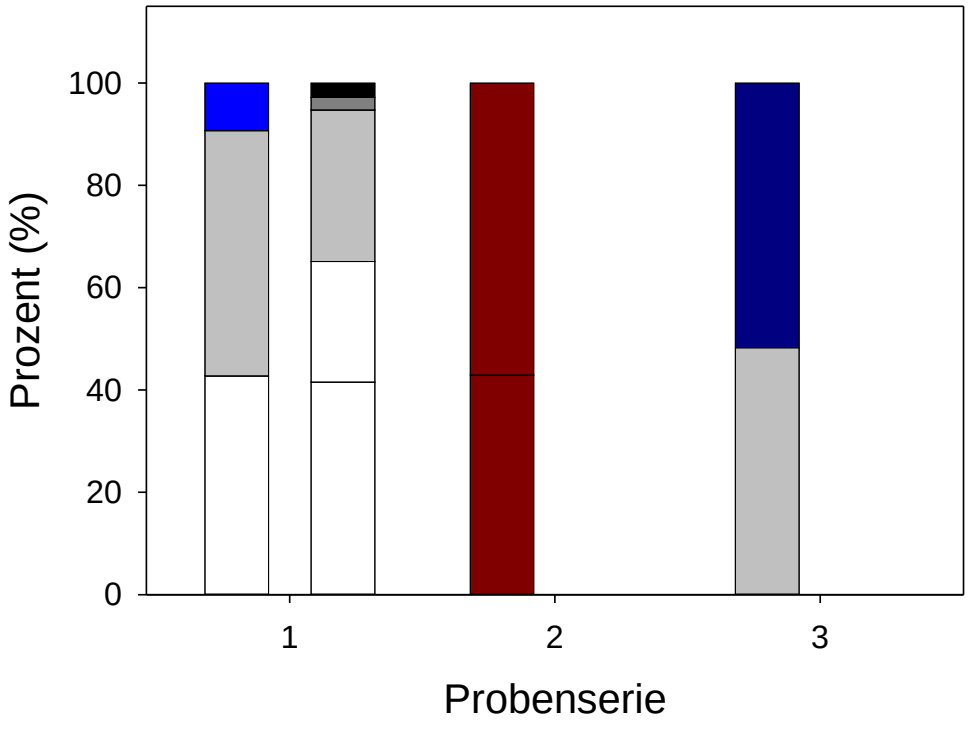
BU = groyne field

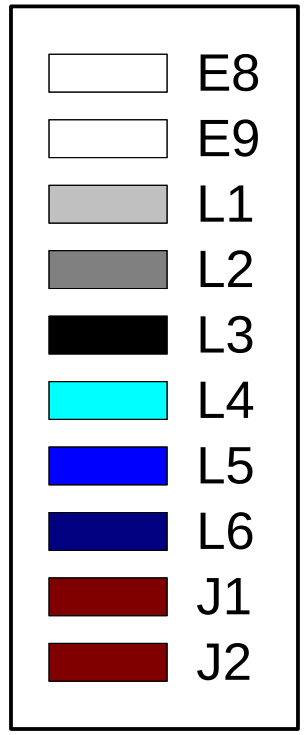
SB = gravel bar

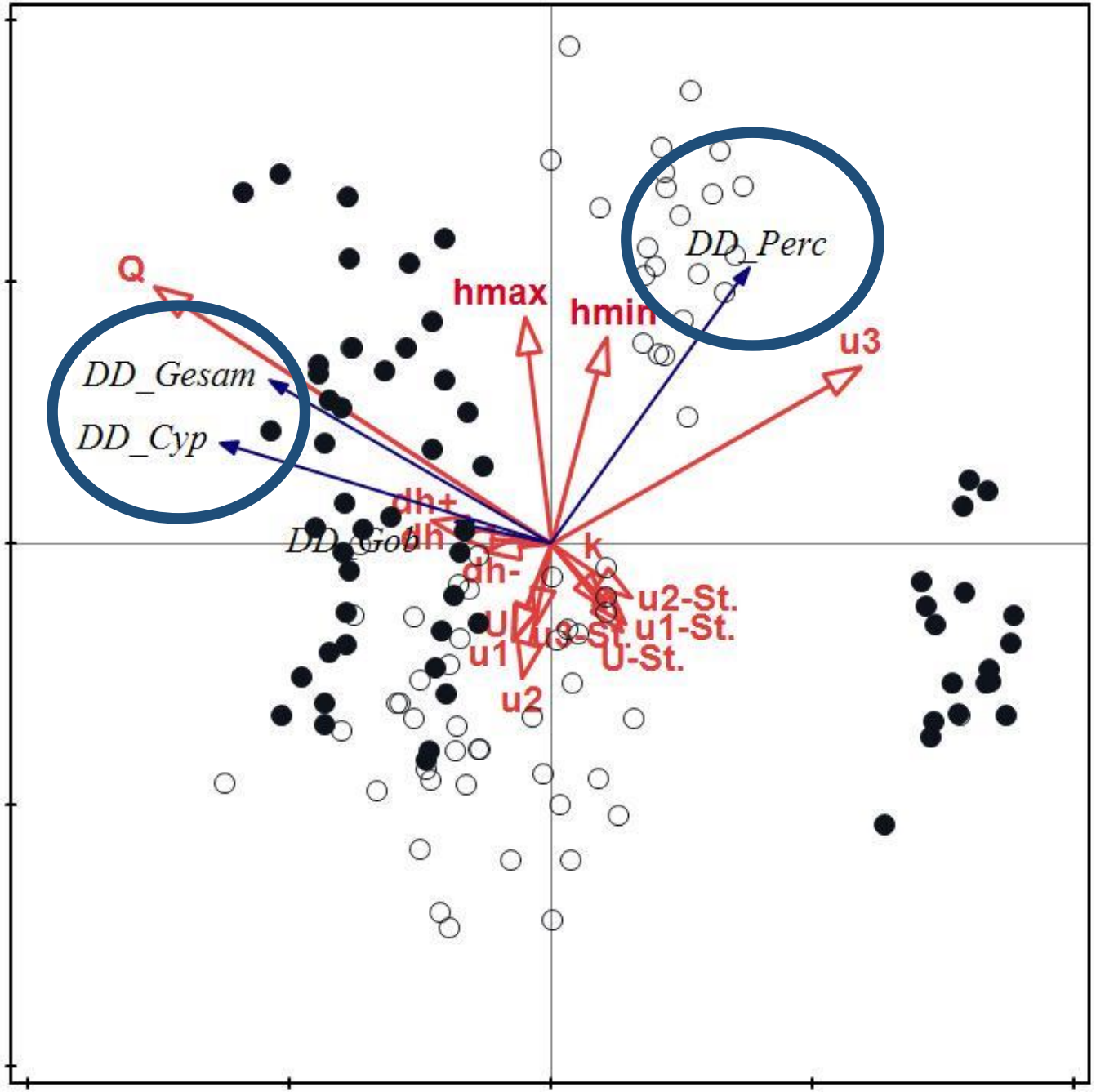
Cyprinidae stages



Percidae stages







Samples

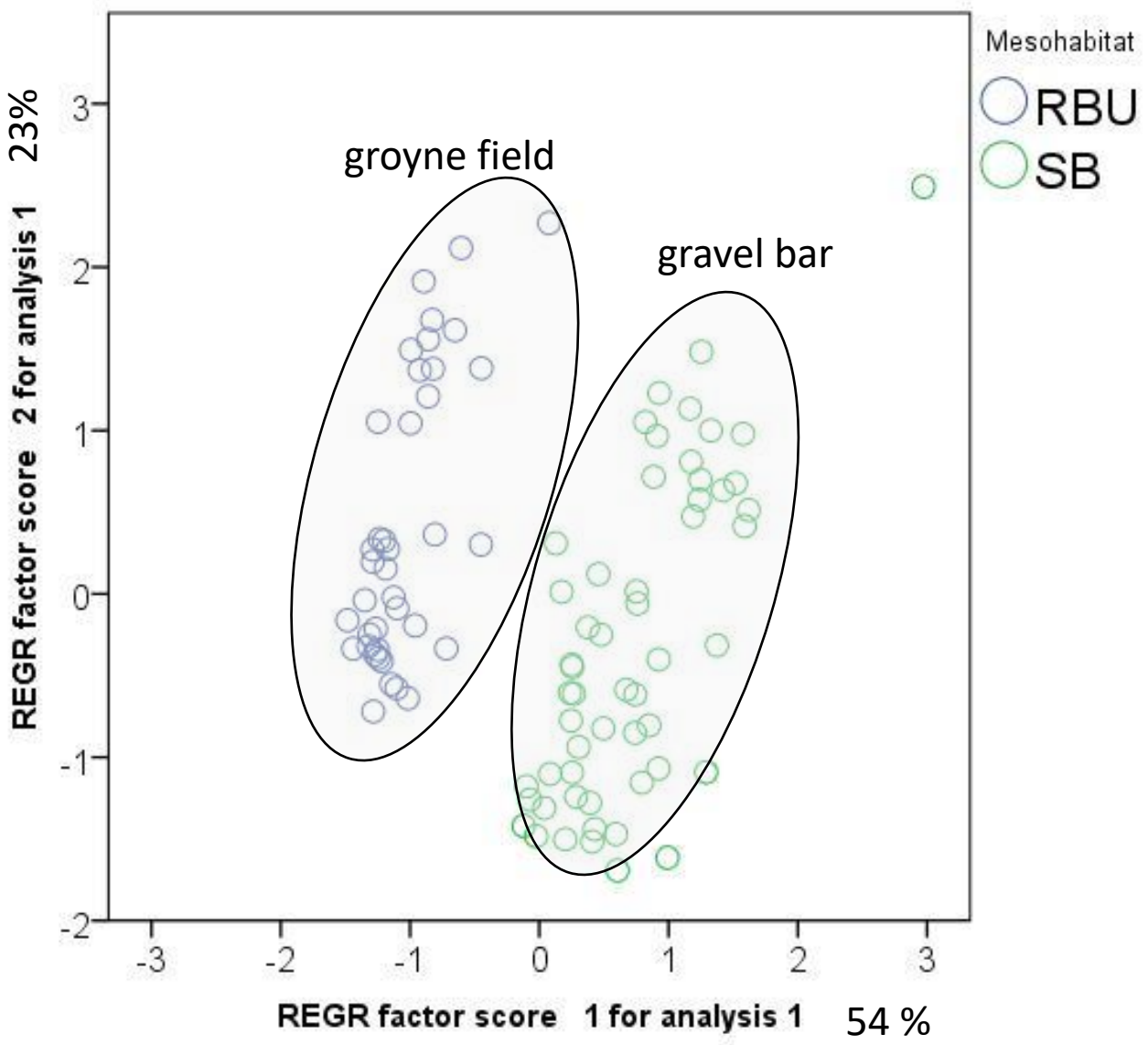
environmental variable

species variable

RDA	Achse 1	Achse 2	Achse 3	Achse 4
Eigenwerte	0,24	0,14	0,01	0,00
erklärte Schwankung (gesamt)	24,25	37,83	38,7	38,83
Pseudo-kanonische Korrelation	0,70	0,60	0,30	0,28
erklärte angepasste Variation (gesamt)	62,45	97,42	99,67	100

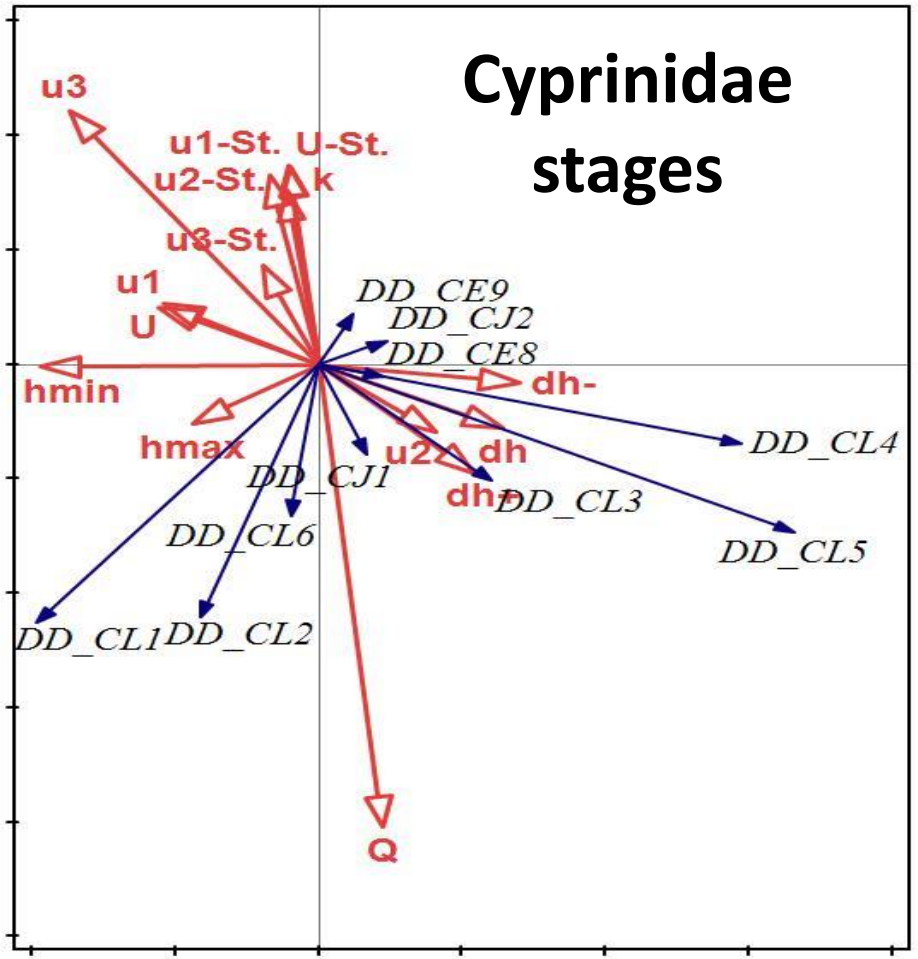
Relation between wave characteristics, flow-velocities and drift densities (family level) at two mesohabitats

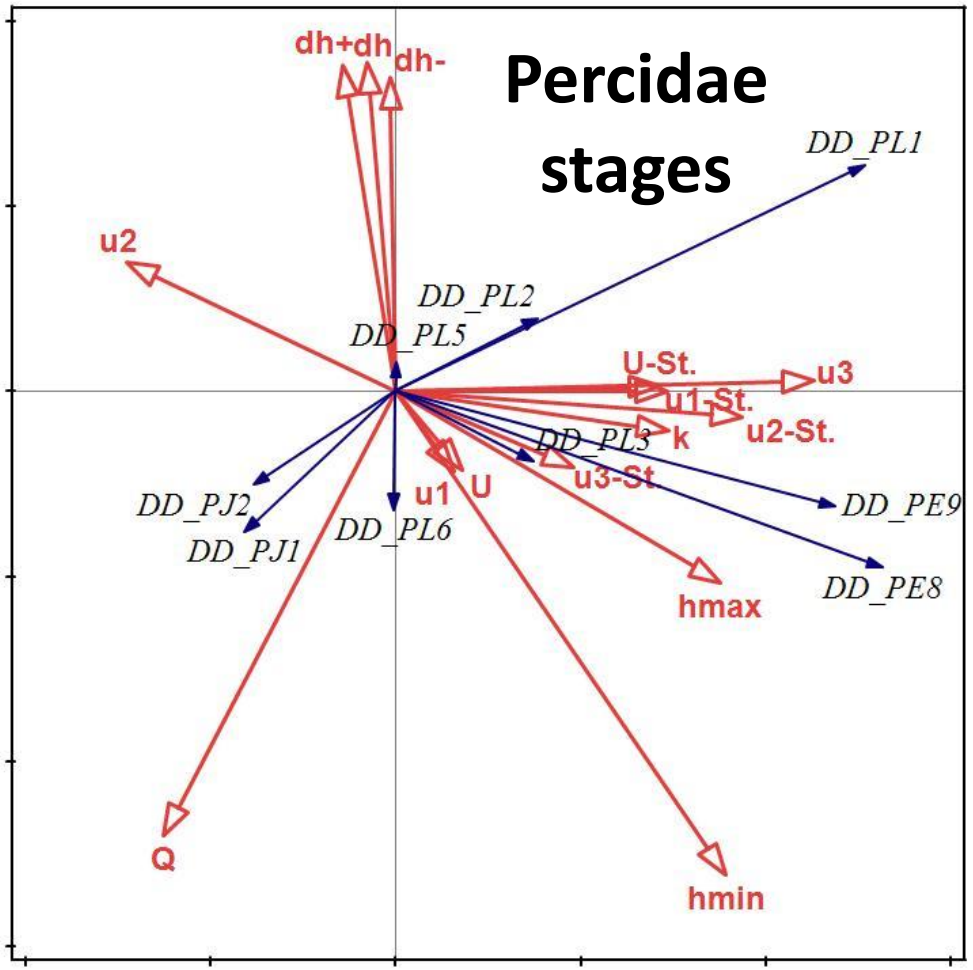
Analyses of wave characteristics at two mesohabitats



	Component		
Variable	1	2	3
hmax	0,73	0,03	0,60
hmin	0,43	-0,76	0,39
dh+	0,32	0,88	0,25
dh-	0,31	0,90	0,20
dh	0,33	0,92	0,23
u1 (m/s)	0,94	-0,07	-0,20
u1 - Stabw (m/s)	0,98	-0,07	-0,08
u2 (m/s)	-0,27	0,32	-0,41
u2 - Stabw (m/s)	0,96	-0,04	-0,18
u3 (m/s)	0,11	-0,37	0,74
u3 - Stabw (m/s)	0,97	-0,05	-0,21
U (m/s)	0,94	-0,07	-0,21
U - Stabw (m/s)	0,98	-0,07	-0,10
k (m^2/s^2)	0,98	-0,08	-0,08

Relation between wave characteristics, flow-velocities and drift densities of developmental stages of two fish families





Conclusions and Outlook

- Ship induced waves significantly increase drift densities of early stages
- Effects are site specific (shore morphology – flow velocity)
- Differences at the family level. Different developmental stages of cyprinids and percids seem to react differently
- Effect of river restoration measures

Future studies should focus on behaviour and consequences (i.e. change in mortality rate, displacement distance, growth, food and feeding, fitness, recruitment and population dynamics)

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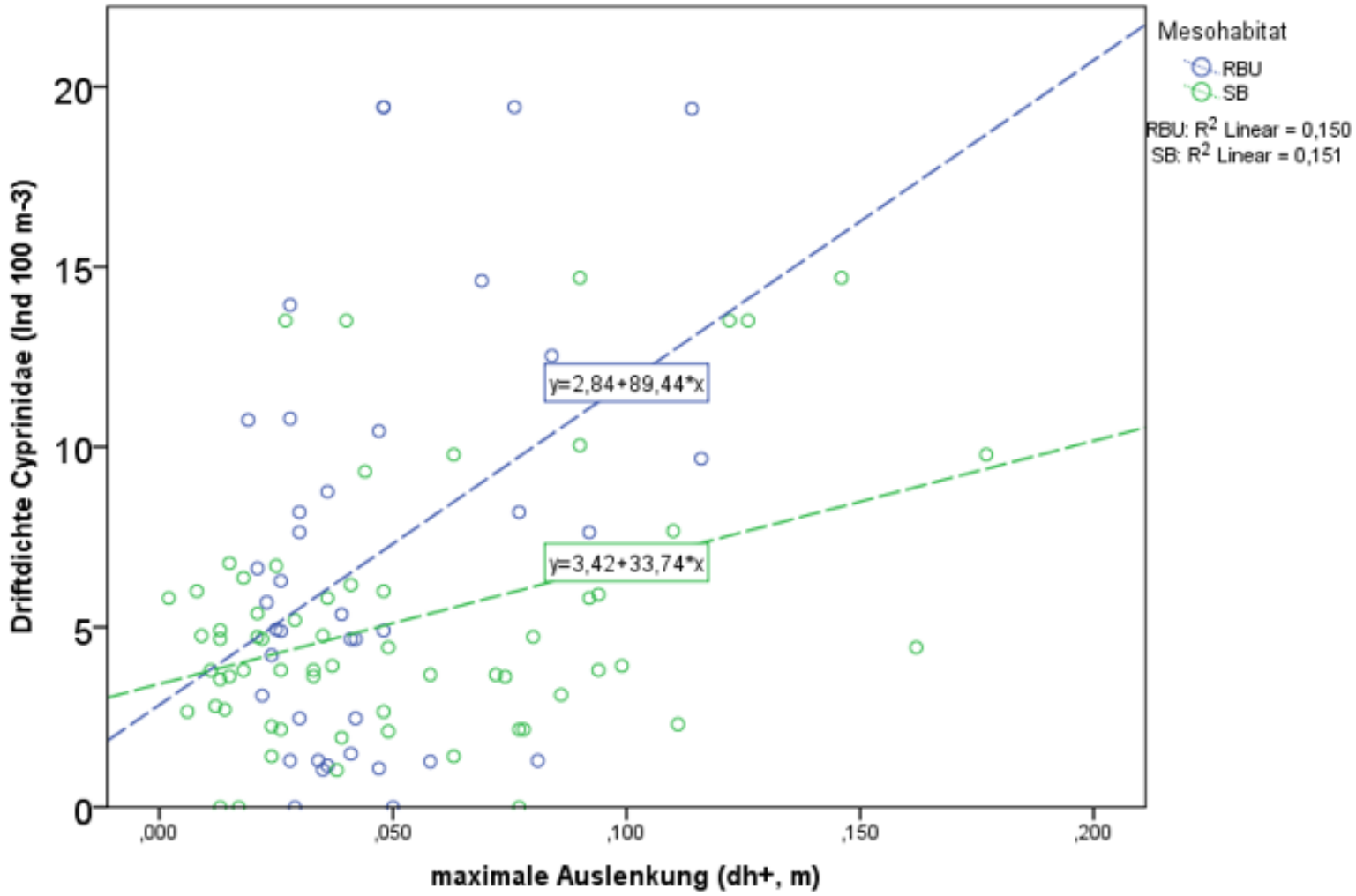
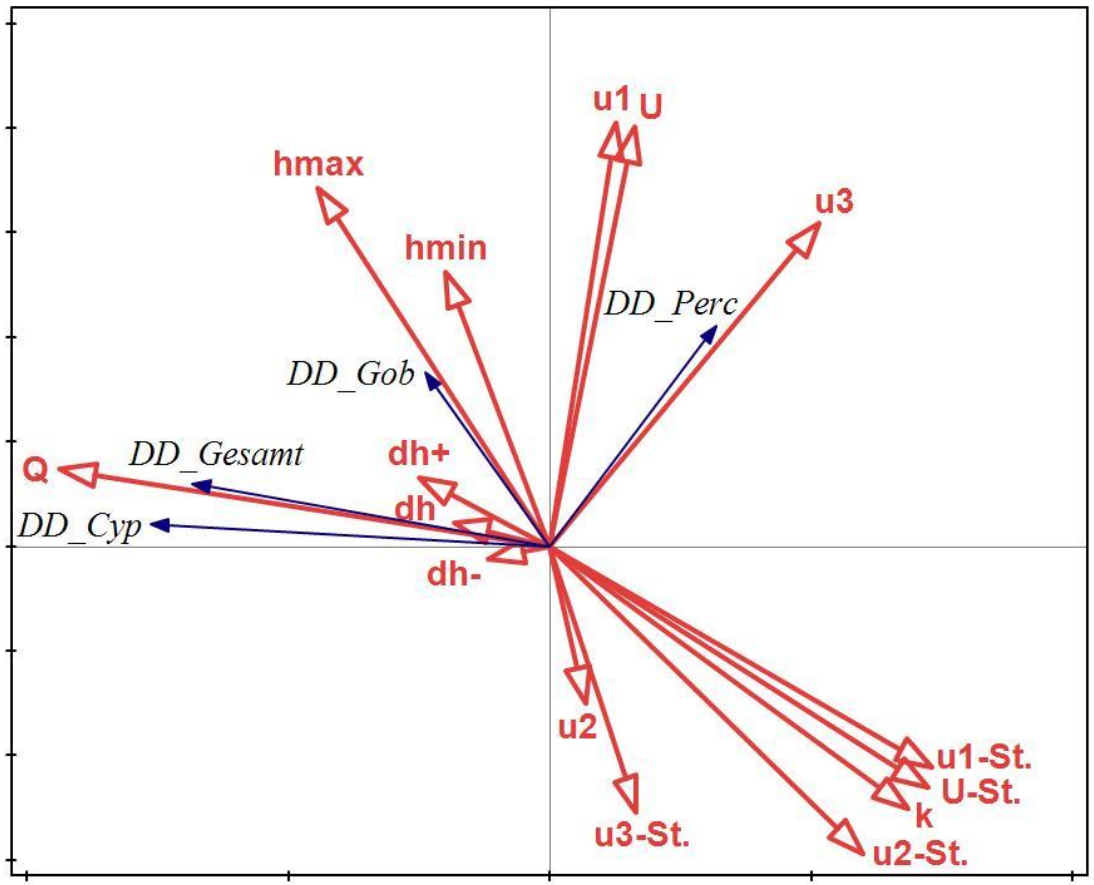
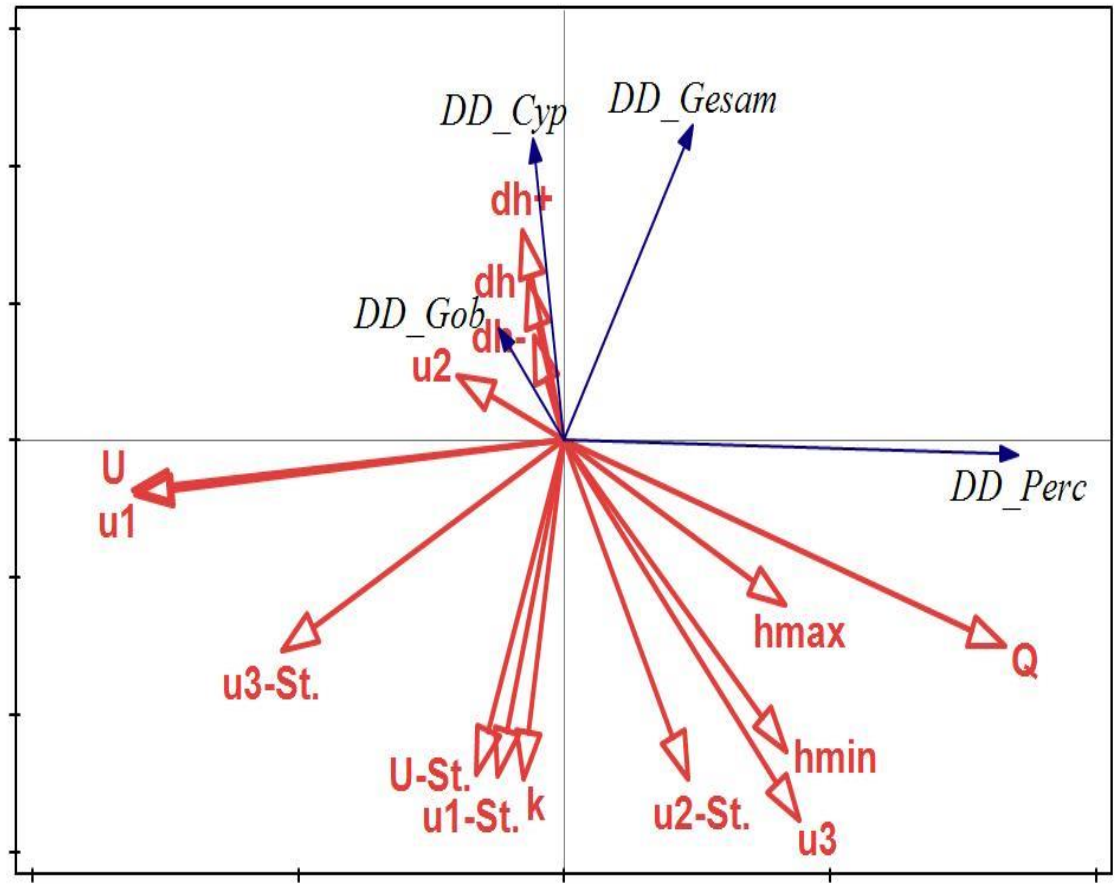
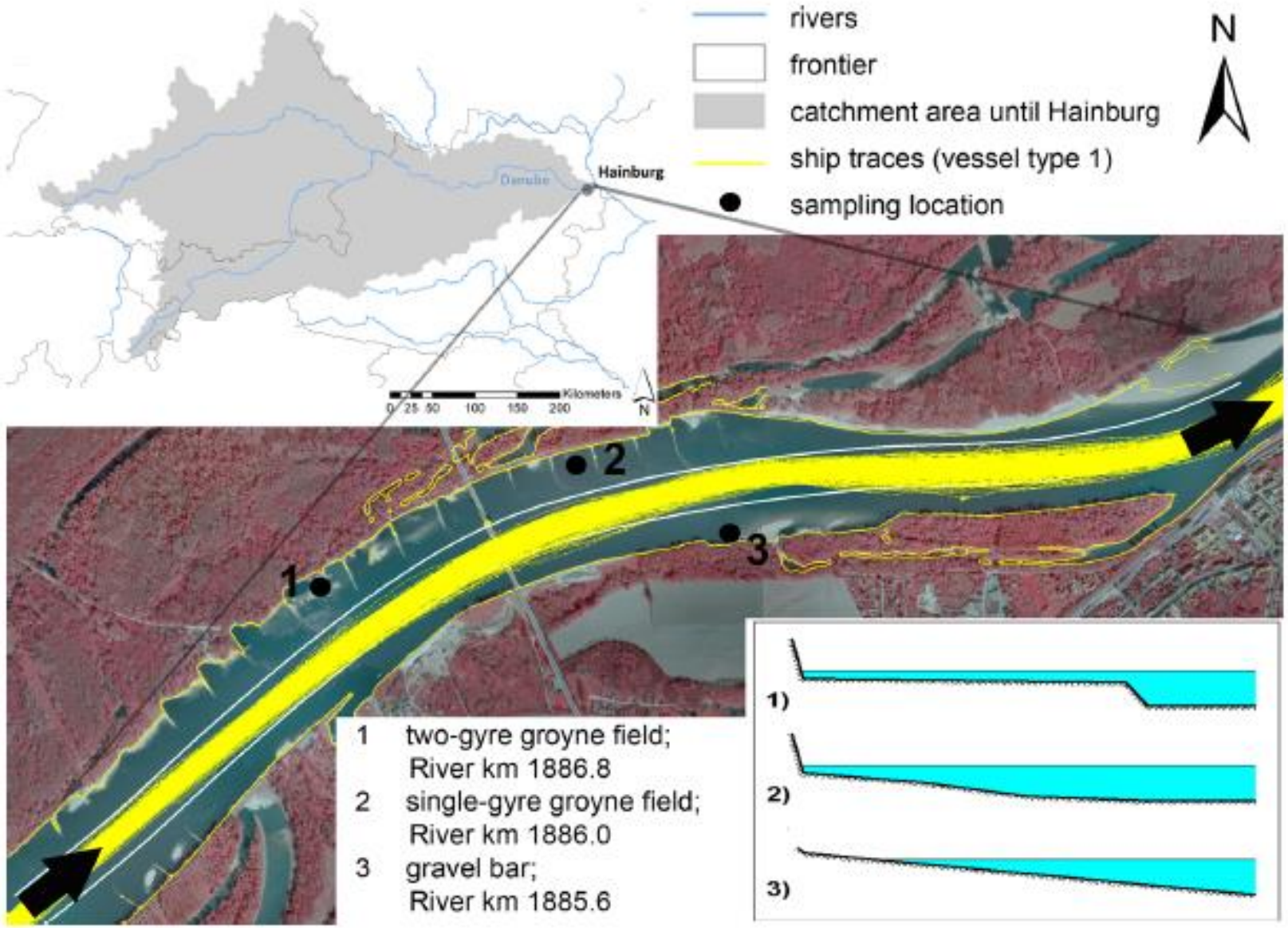
Relationship between wave height and drift densities of larvae of cyprinids at two mesohabitats

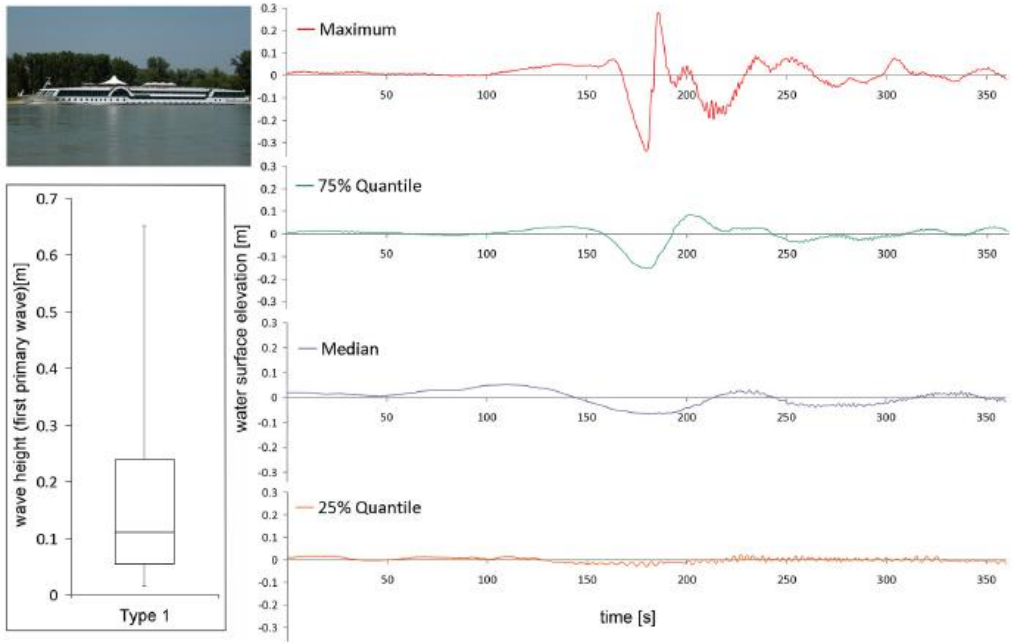


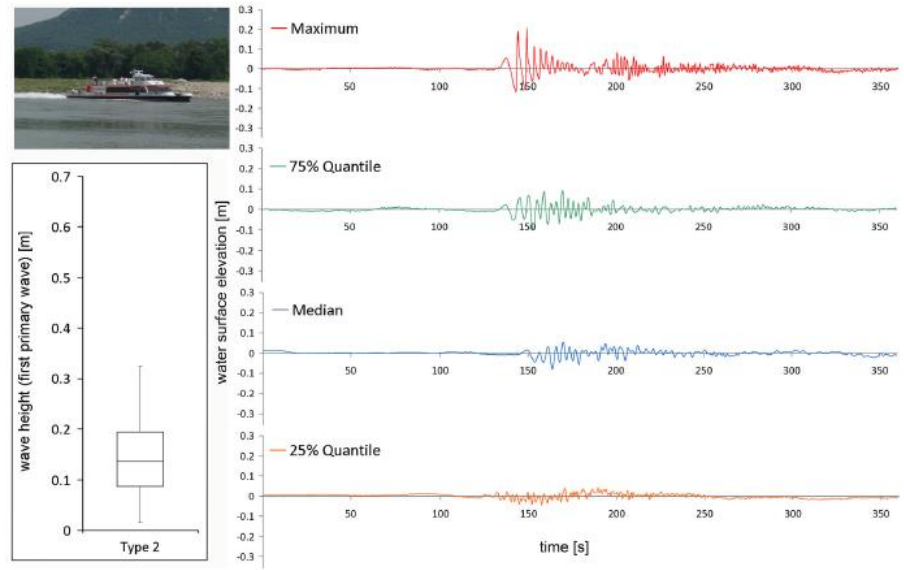

u1
U
hmax
u3
hmin
DD_Perc
DD_Gob
Q
DD_Gesamt
dh+
dh
DD_Cyp
dh-
u2
u1-St.
U-St.
k
u3-St.
u2-St.


DD_Cyp
DD_Gesam
dh+
dh
DD_Gob
dh-
u2
U
u1
DD_Perc
hmax
Q
u3-St.
hmin
U-St.
u1-St.
k
u2-St.
u3



Liedermann et al., 2013





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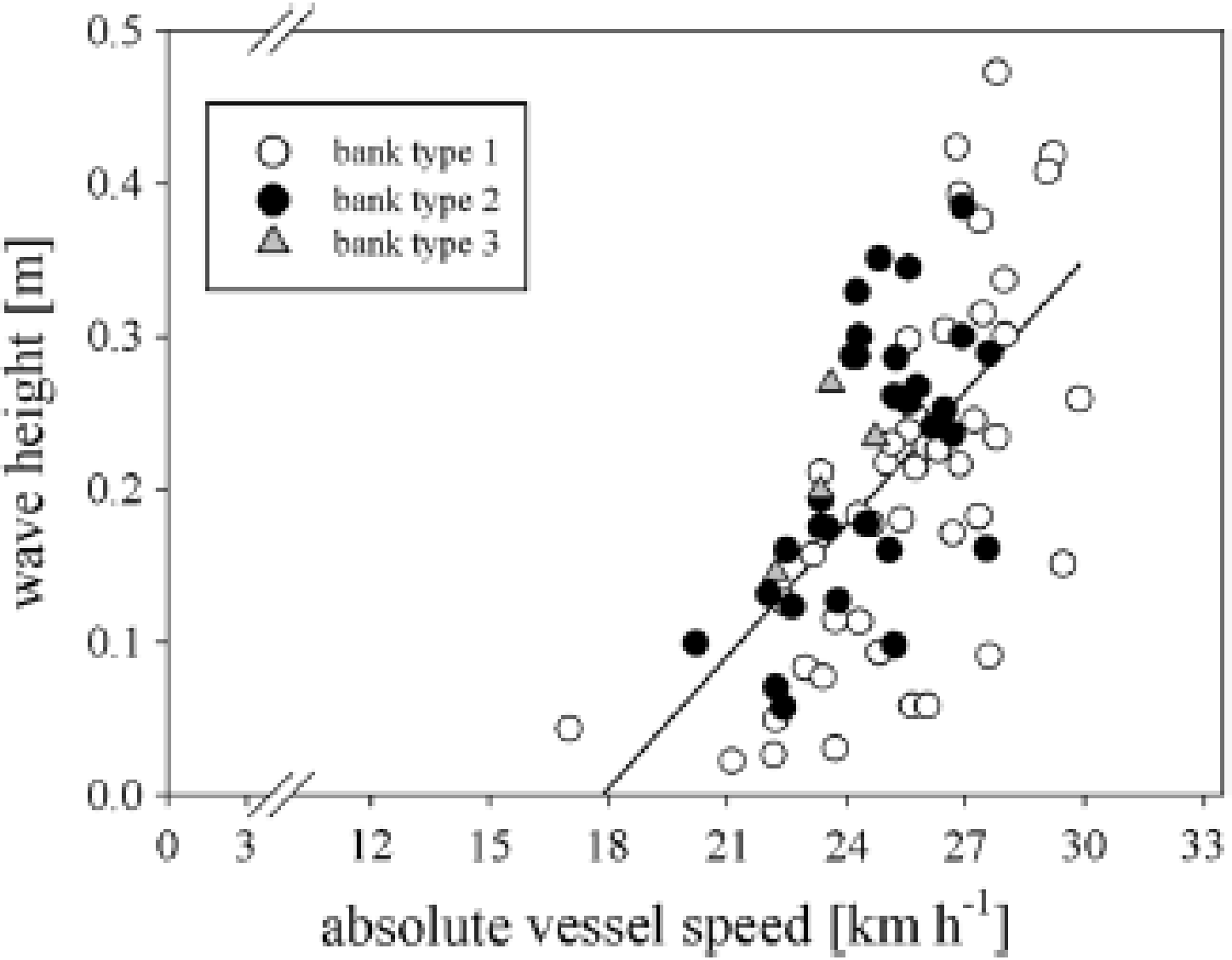
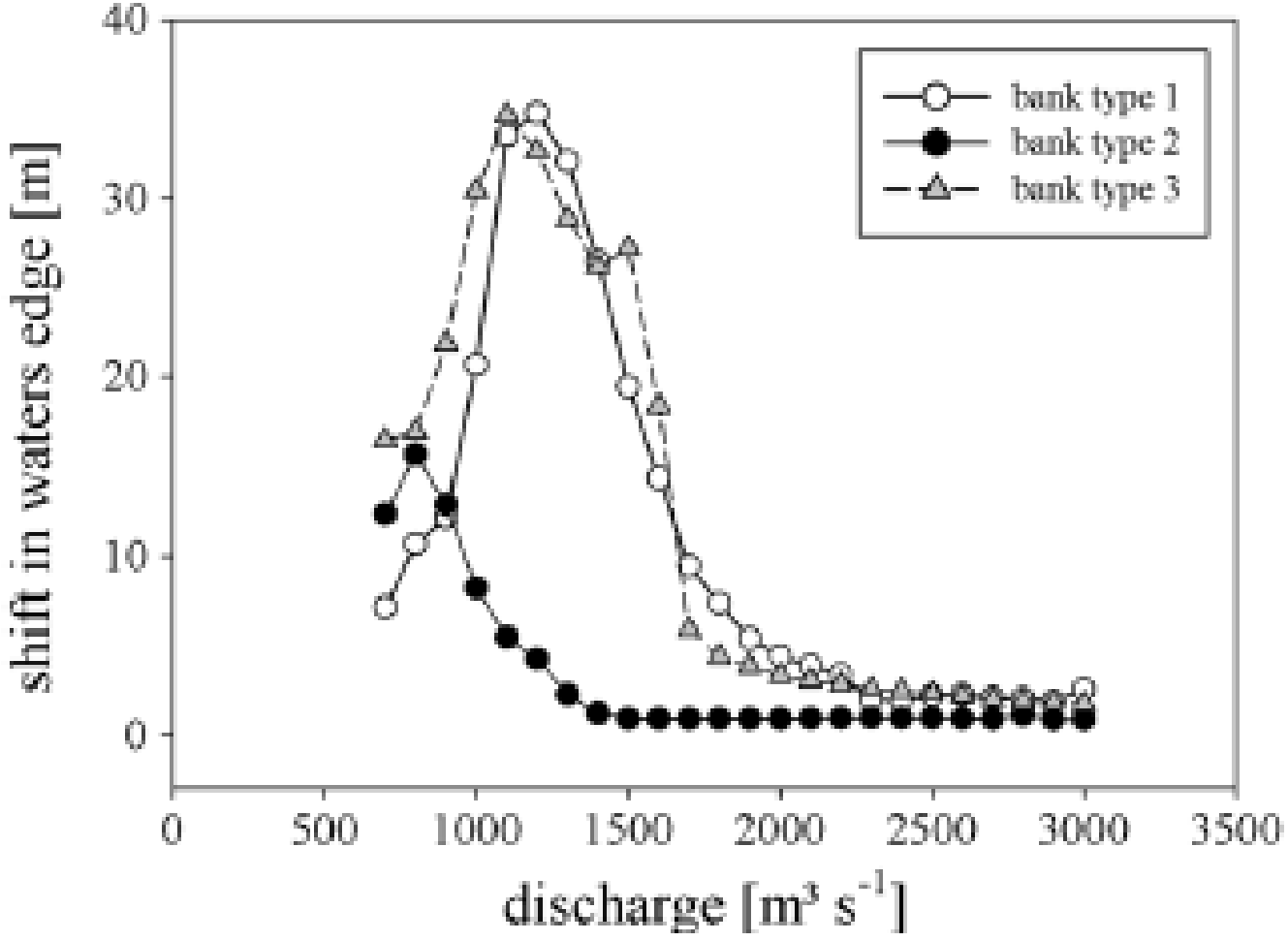


Liedermann et al., 2013



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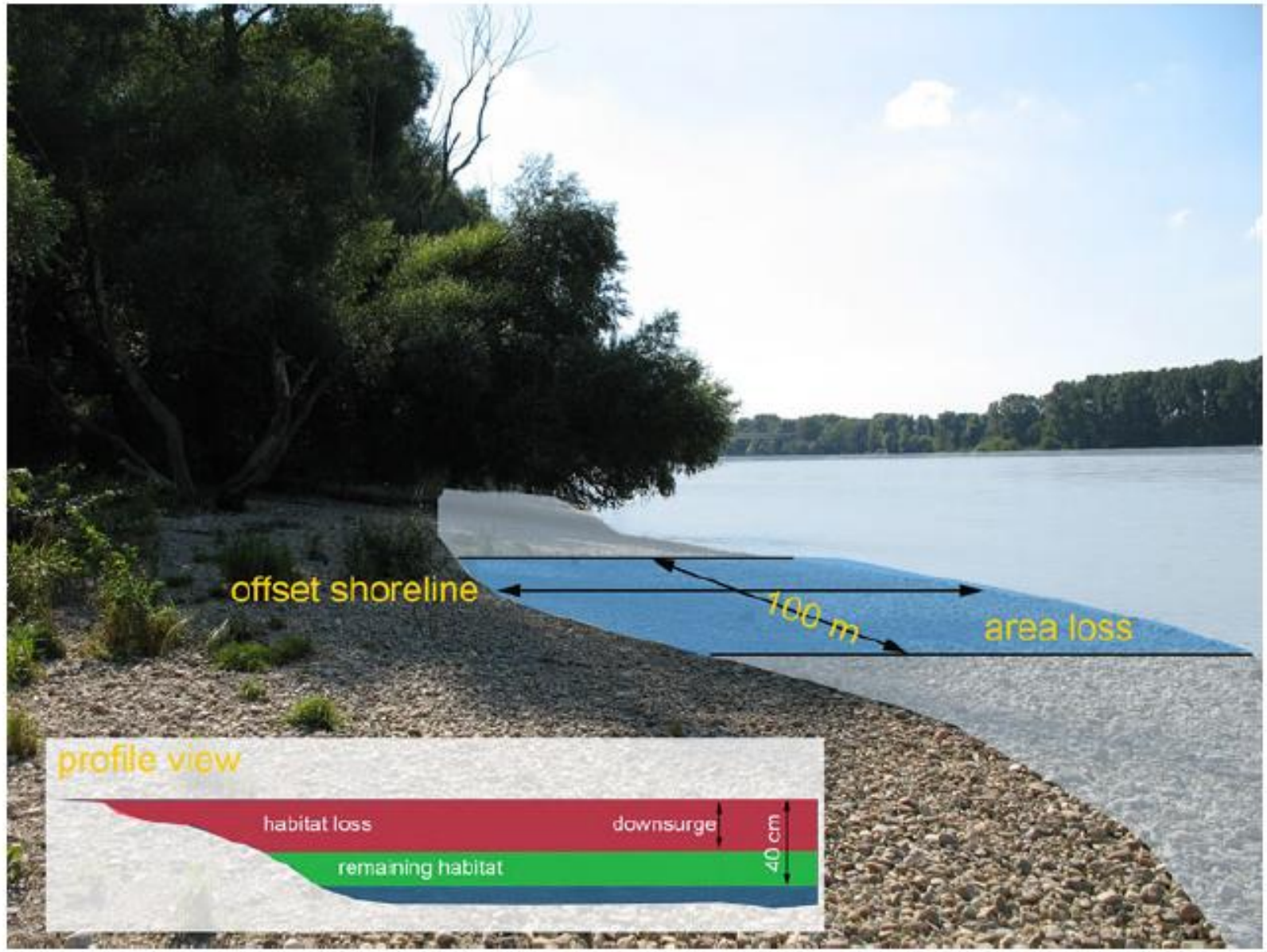

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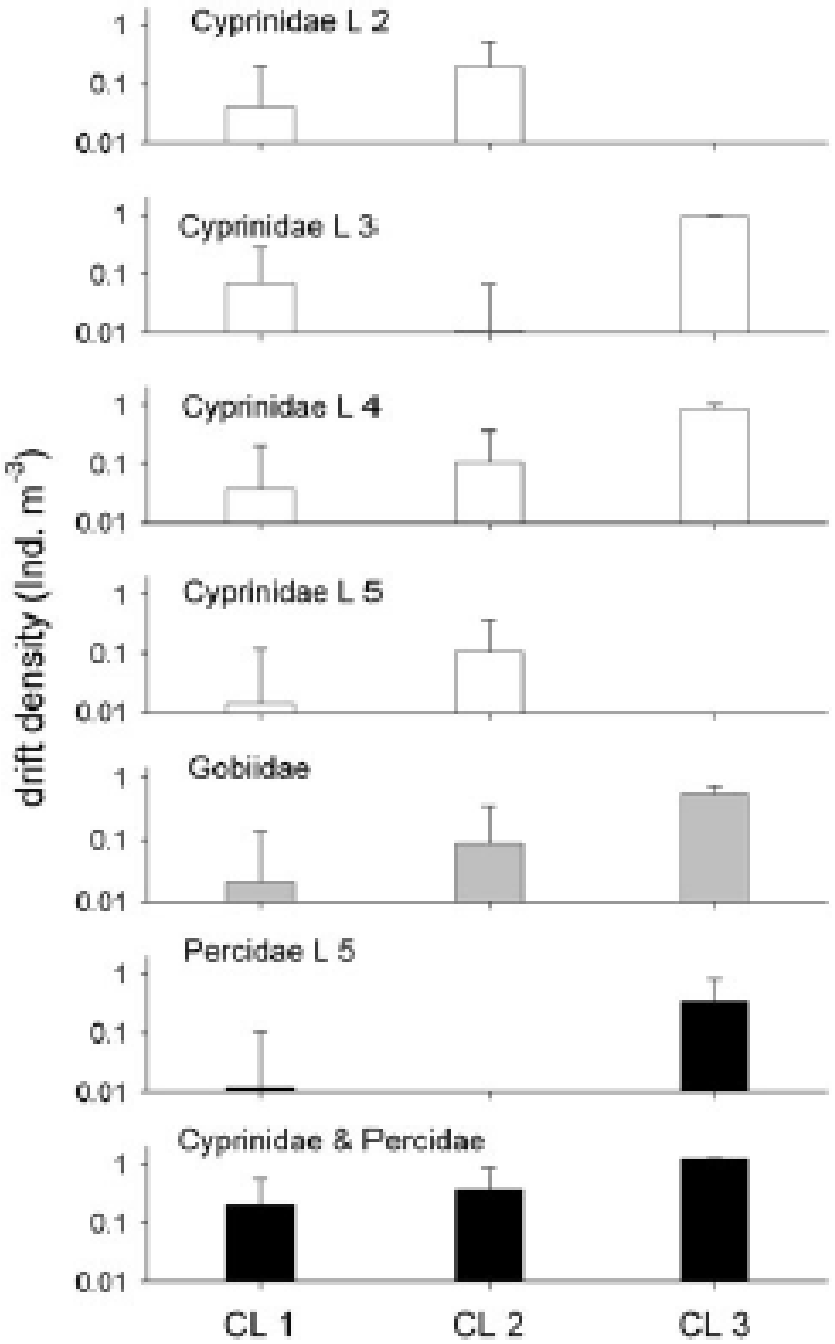
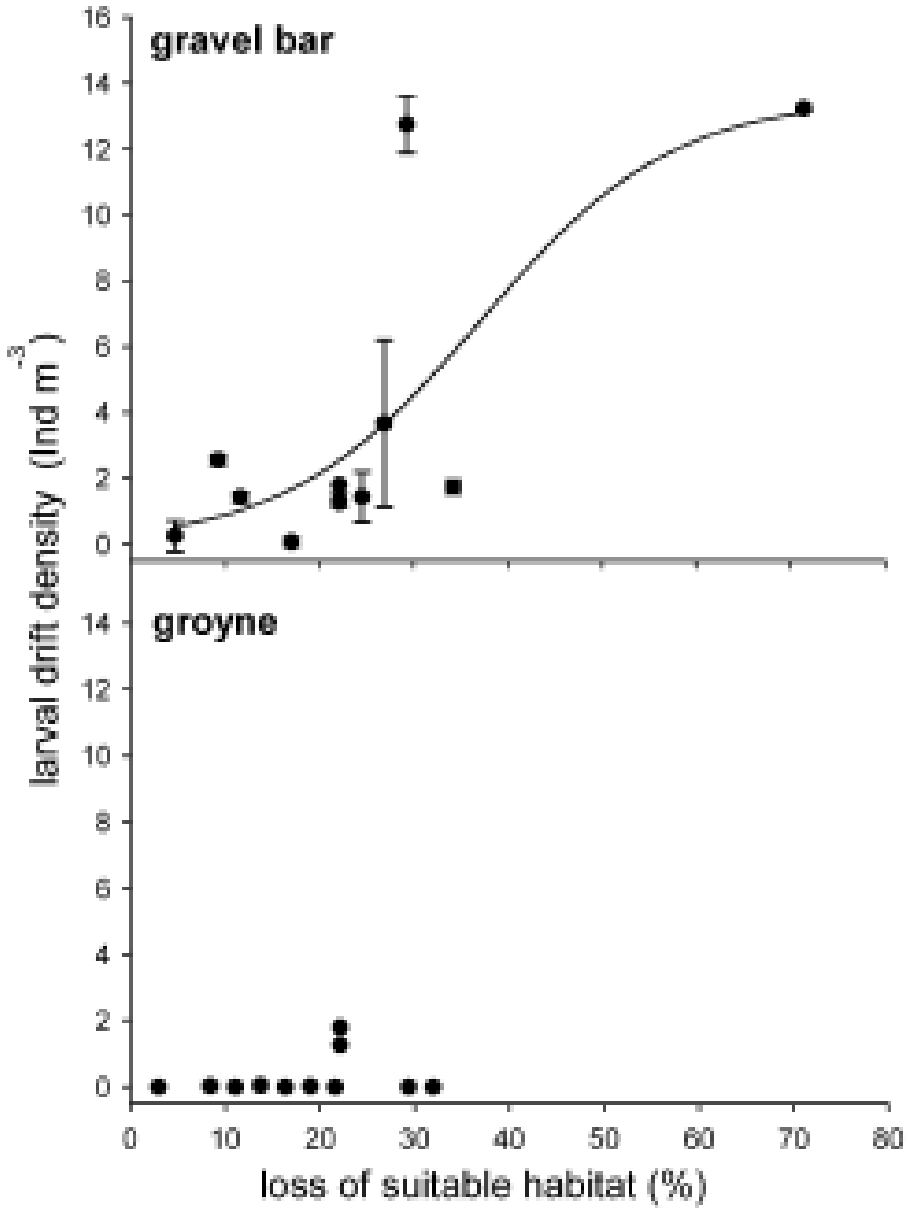


Schludermann et al., 2013



Schludermann et al., 2013