

Effects of aquatic plant patches on flow and sediment characteristics: the case of *Callitriche platycarpa* and *Elodea nuttallii*

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INTRODUCTION

Ecosystem Functions of Submerged Aquatic Plants

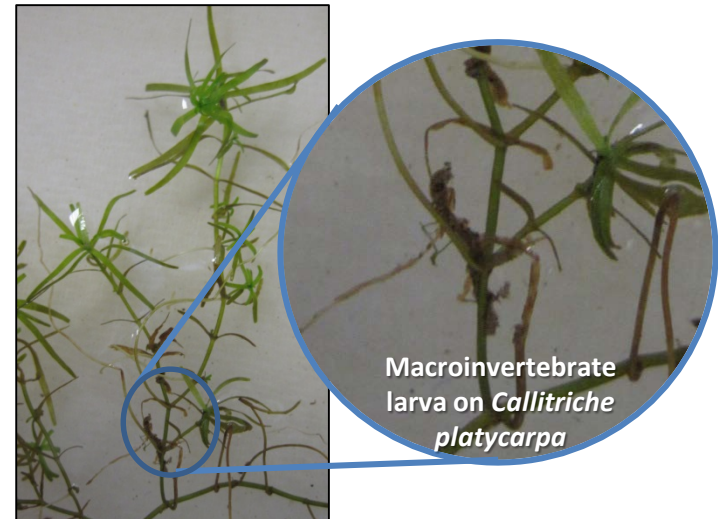
Sediment trapping and bank protection

Water and sediment oxygenation

Sustain of aerobic microbial processes

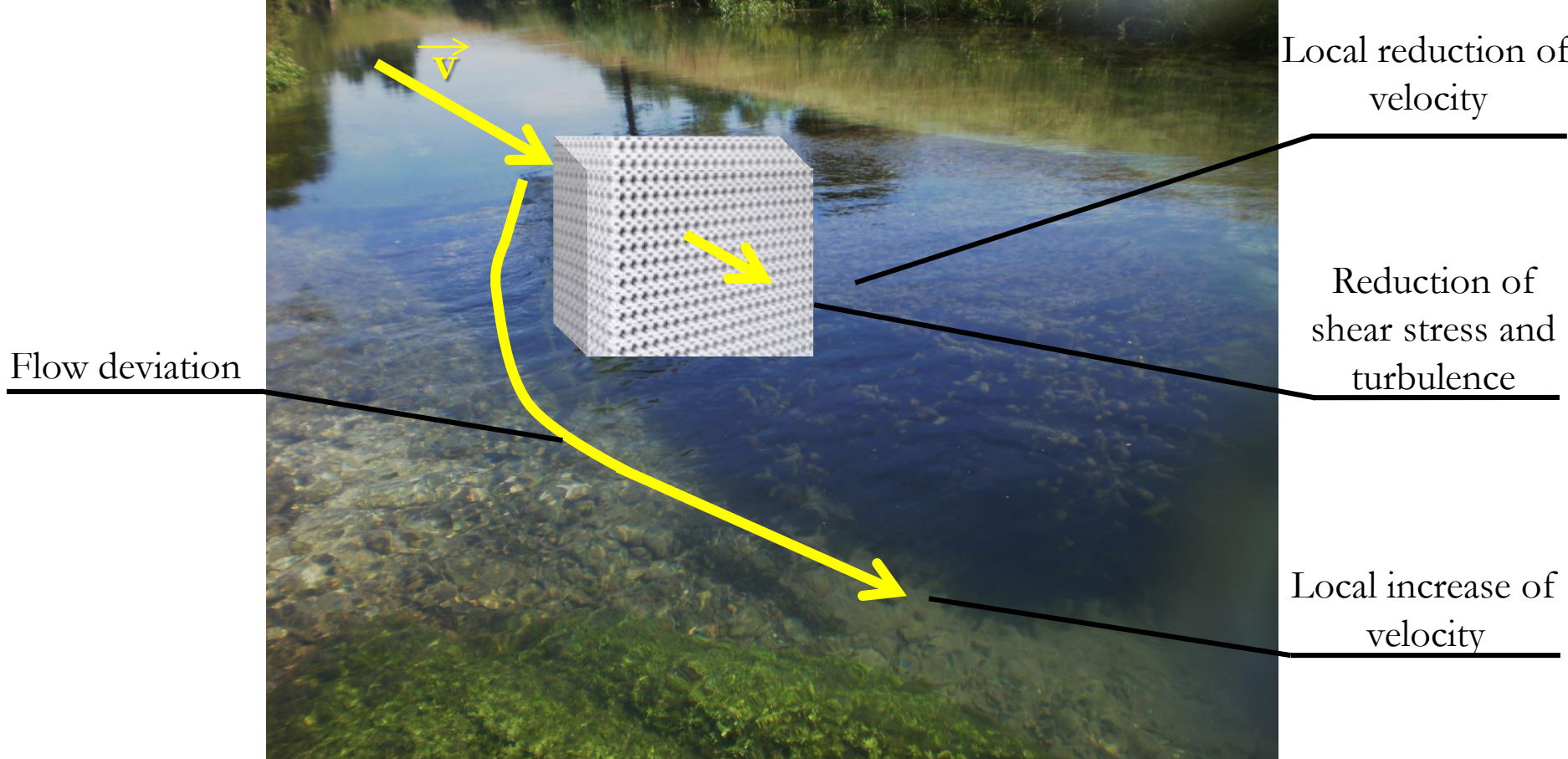
Nutrient dynamics regulation

Source of food and shelter for other organisms



(Sand-Jensen 1982, Kelly et al. 1983, Carpenter and Lodge 1986, Wigand et al. 2000, Rachetti et al. 2010, Marion et al. 2014)

Effect of Submerged Plants on Flow

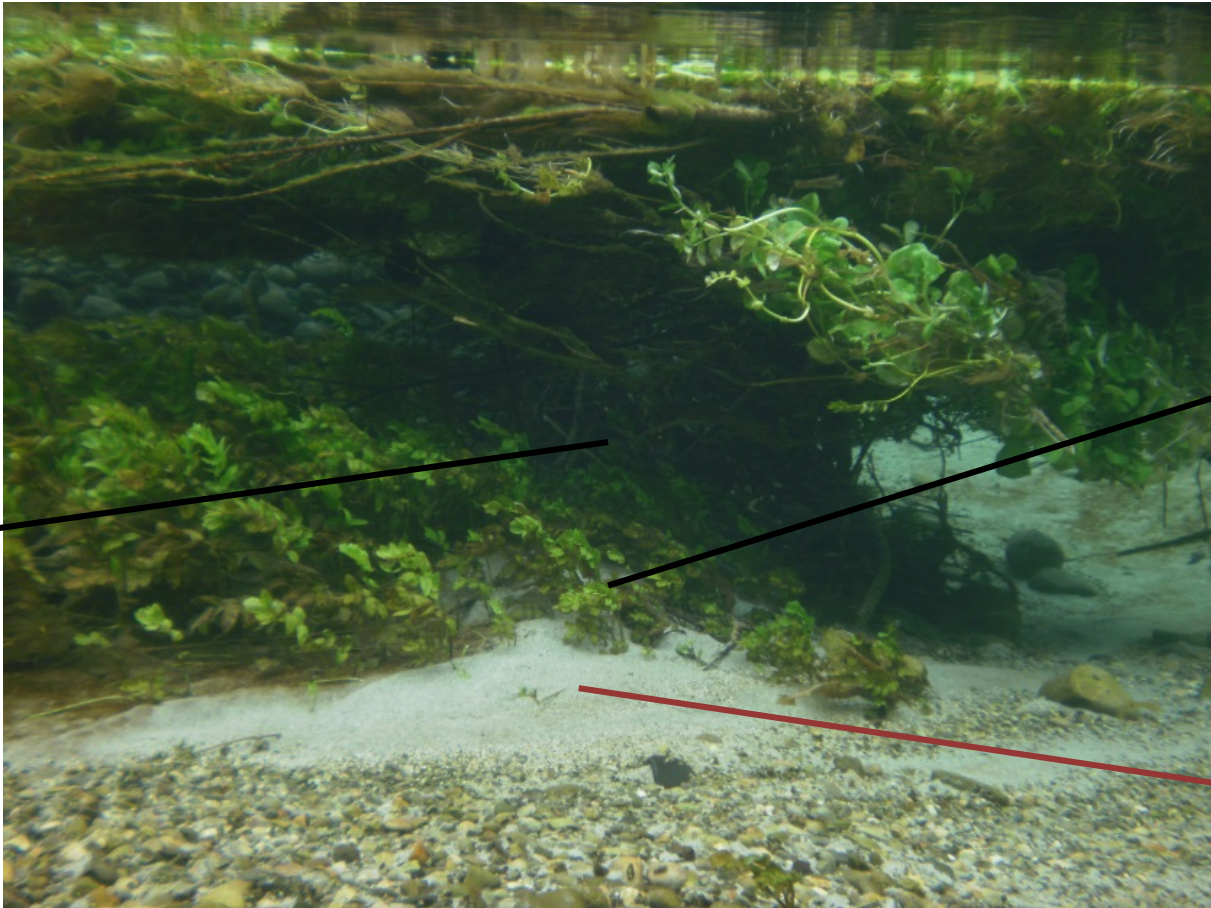


(Sand-Jensen and Mebus 1996, Sand-Jensen and Pedersen 2008, Vandenbruwaene et al. 2011)

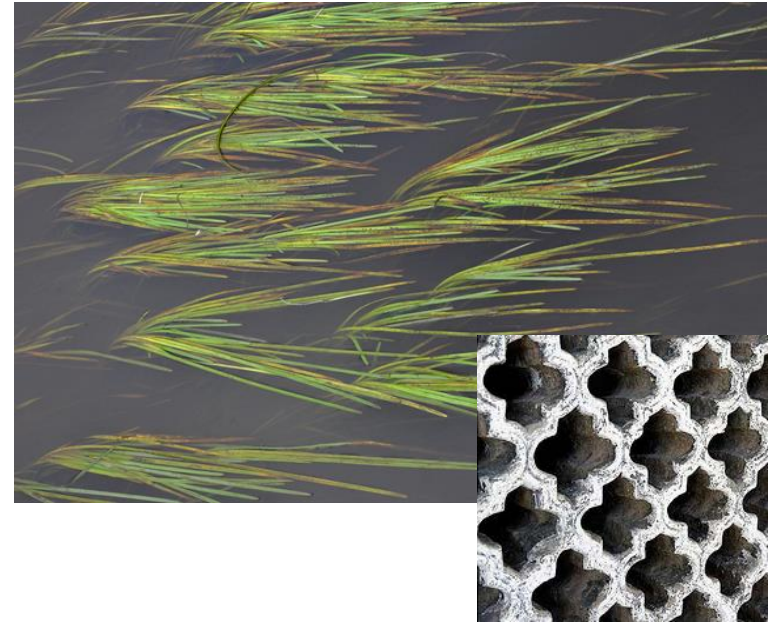
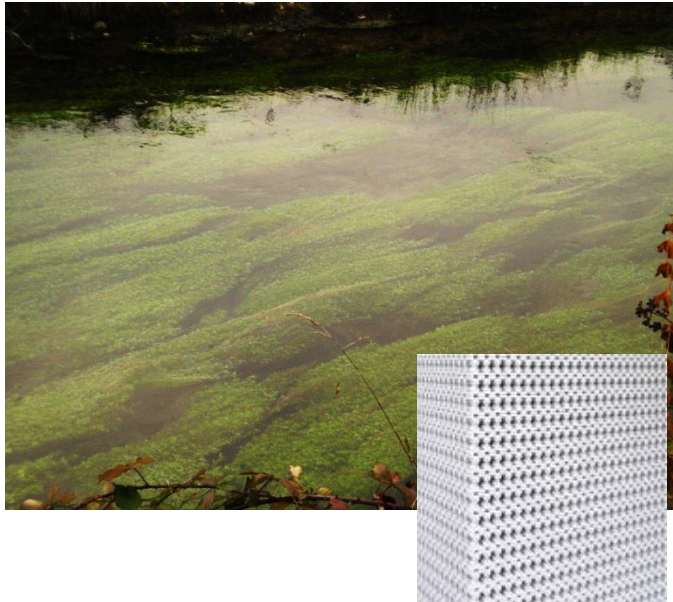
Loss of momentum by velocity reduction

Interception by stems/leaves

Local accumulation
Fine sediment



(Sand-Jensen 1998,Pluntke and Kozerski 2003, Schule et al. 2003, Hendriks et al . 2008,2009)



Patch structure:

- **Density**

Plant characteristics:

- **Flexibility**
- **Morphological Traits (*e.g.* Leaf Area Index)**

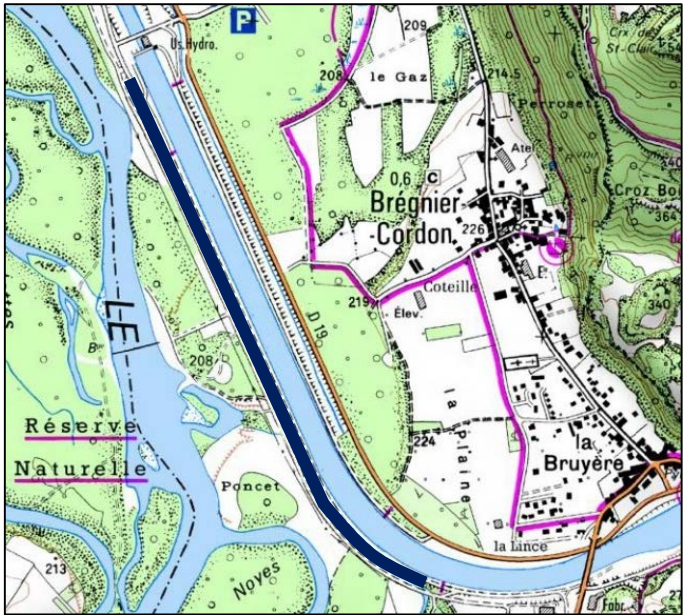
(Petticrew and Kalff 1992, Sand-Jensen and Mebus 1996, Sand-Jensen 1998)

OBJECTIVE

To study the effect of two submerged plant species with **contrasting morphologies** on **different directional components** of flow velocity and **sediment characteristics**.



Study Area

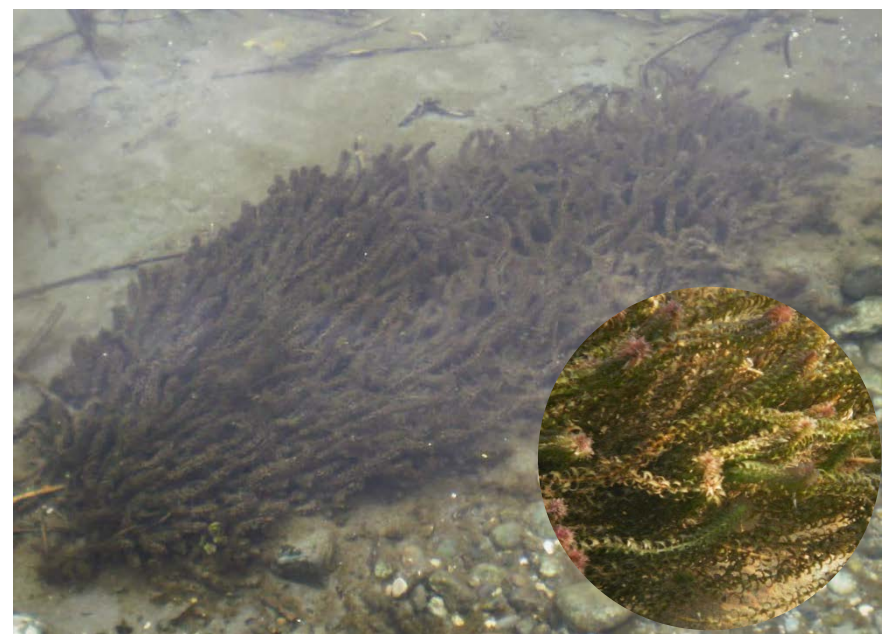


Sofia Licci



Species

Elodea nuttallii

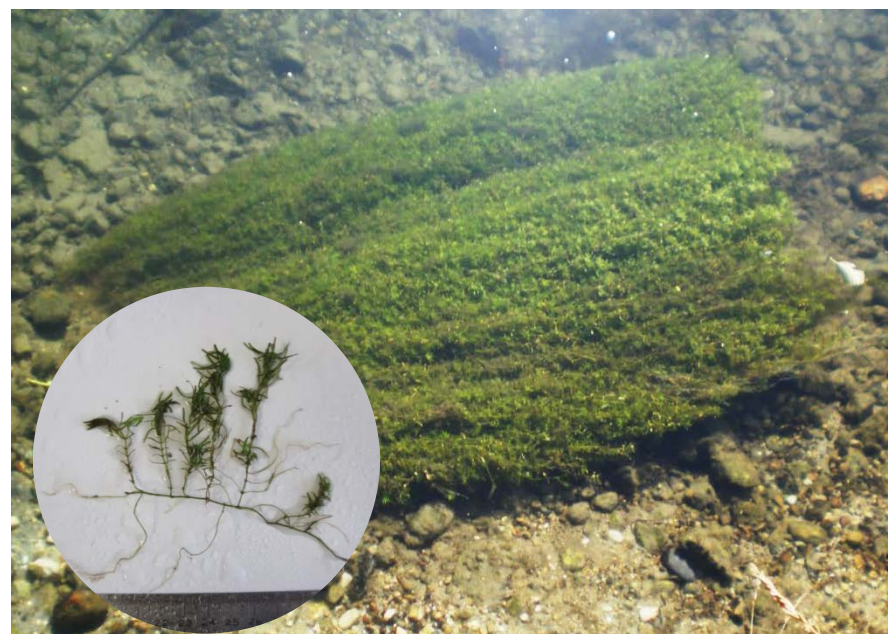


Rigid stems

Short, densely packed leaves evenly distributed along the stem

Dense and compact patches

Callitriche platycarpa

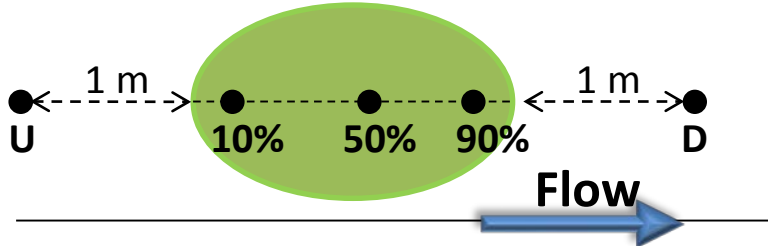


Flexible stems

Leaves are mainly located in the top part of the stems

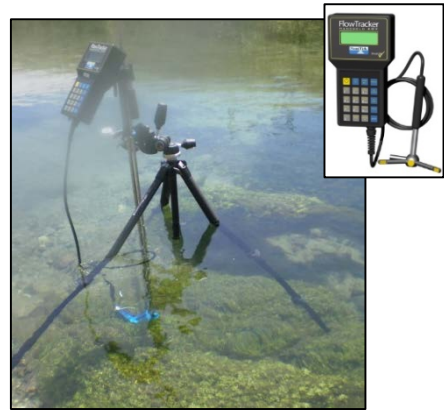
Dense patch with an overhanging canopy

Sampling Design



1 patch
 Length: 1.3 for *E. nuttallii* ; 1.6 m *C. platycarpa*

HYDRODYNAMICS (3D Acoustic Doppler Velocimeter)
 Velocity profiles ($m\ s^{-1}$) : 100 sec at 1 Hz
 Depth intervals of max 12 cm



Relative Turbulence Intensity (SD/ mean velocity)

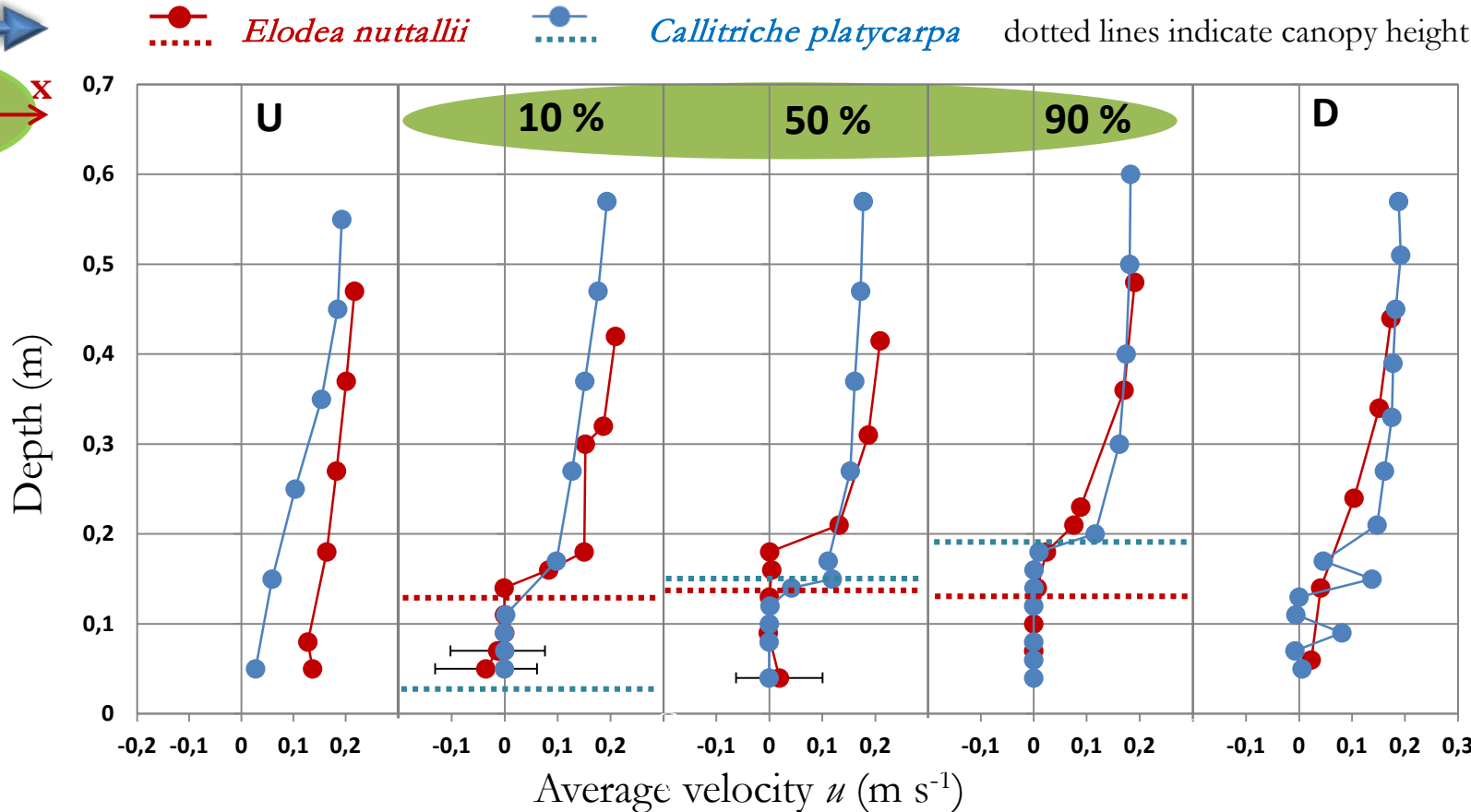
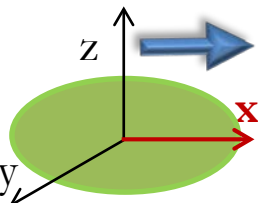
SEDIMENT CHARACTERISTICS (Laser diffractometry on Sediment carrots: 5 cm \varnothing x 10 cm)



Grain size distribution curves (Volumic %)

Percentile value d_{30} (maximum diameter of 30% of particle volume)

Hydrodynamics - Streamwise Velocity Profiles

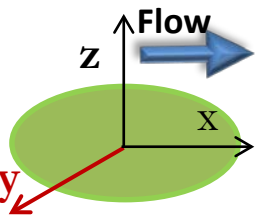


Linear profiles

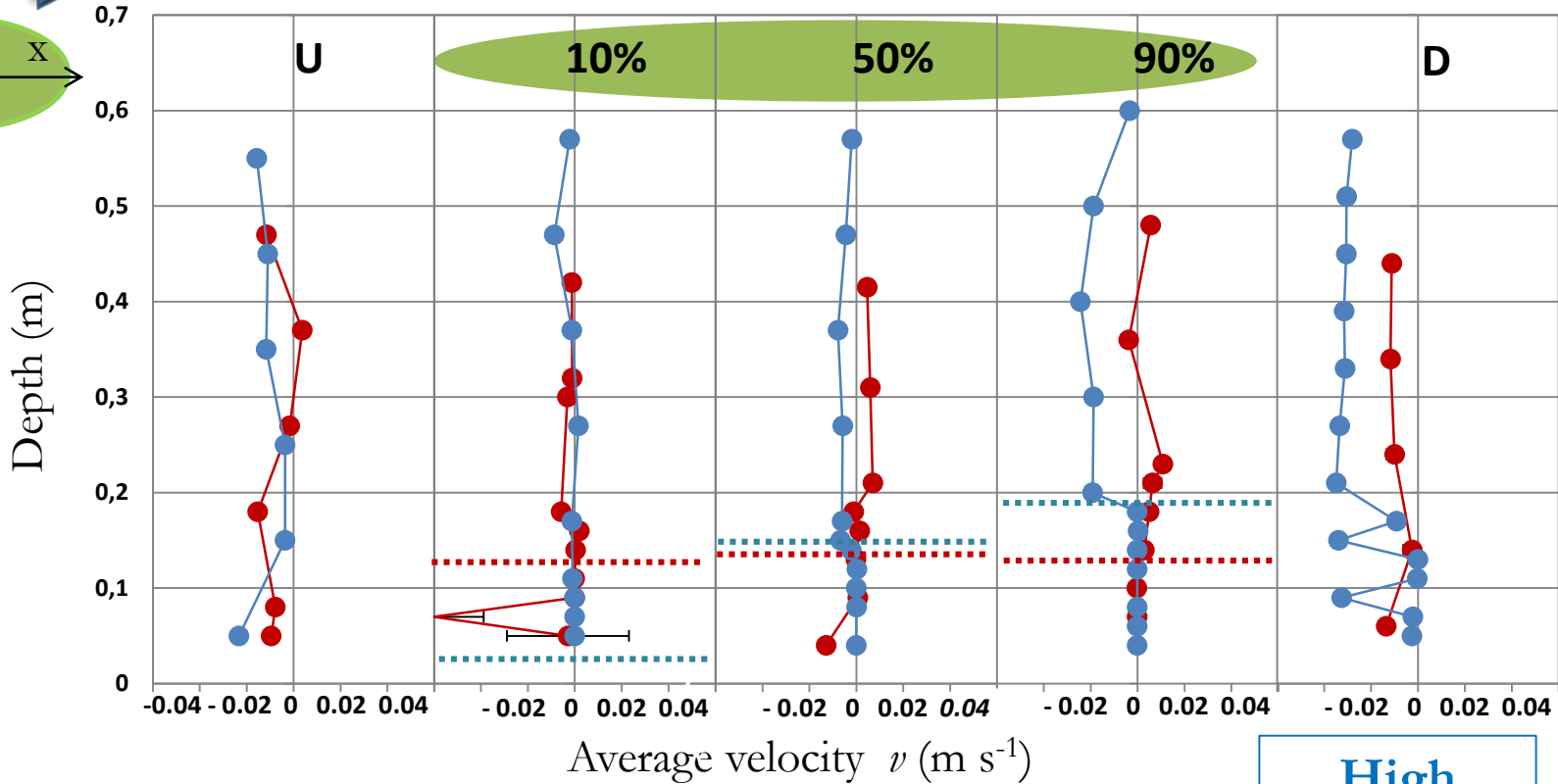
Velocity decreases above canopy height

High variability

Hydrodynamics - Spanwise Velocity Profiles



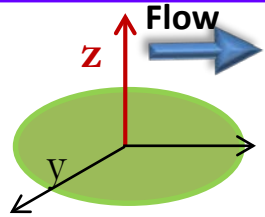
● *Elodea nuttallii* ● *Callitriche platycarpa* dotted lines indicate canopy height



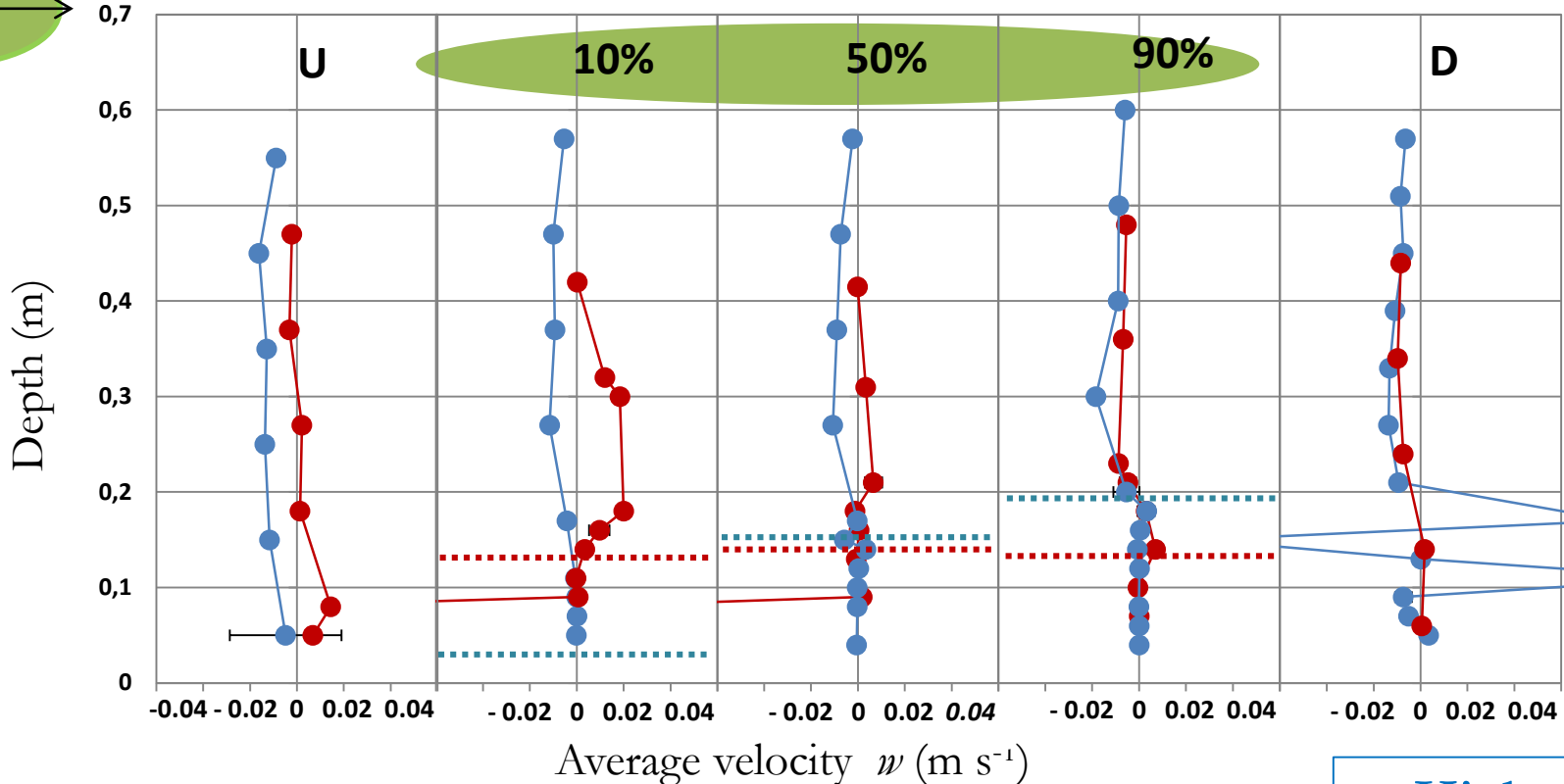
Increase of lateral velocity

High variability, $\approx 90\%$

Hydrodynamics - Vertical Velocity Profiles



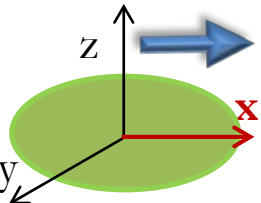
● *Elodea nuttallii* ● *Callitriche platycarpa* dotted lines indicate canopy height



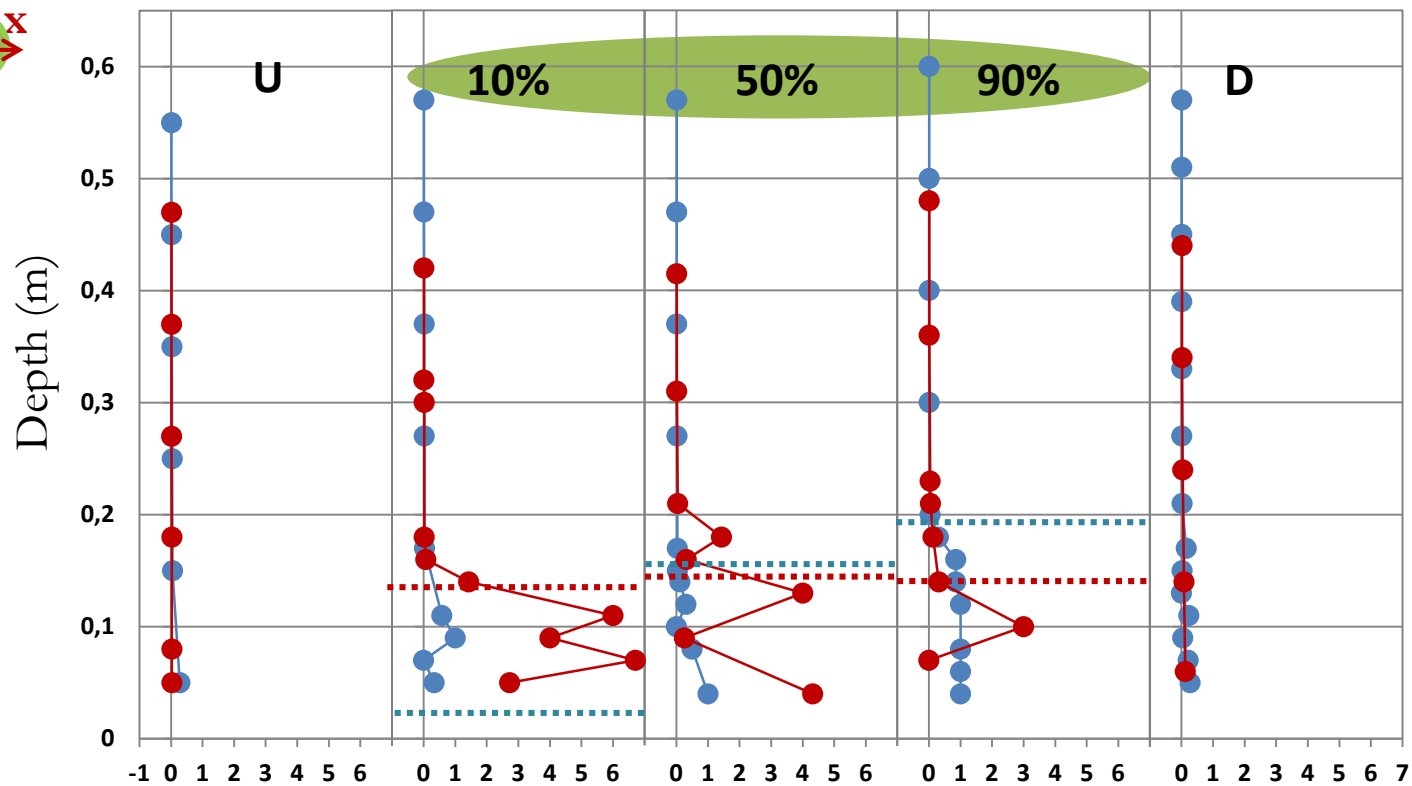
Upwelling

Downwelling

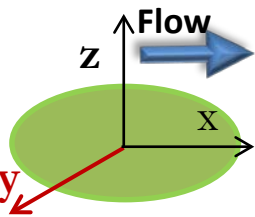
High variability



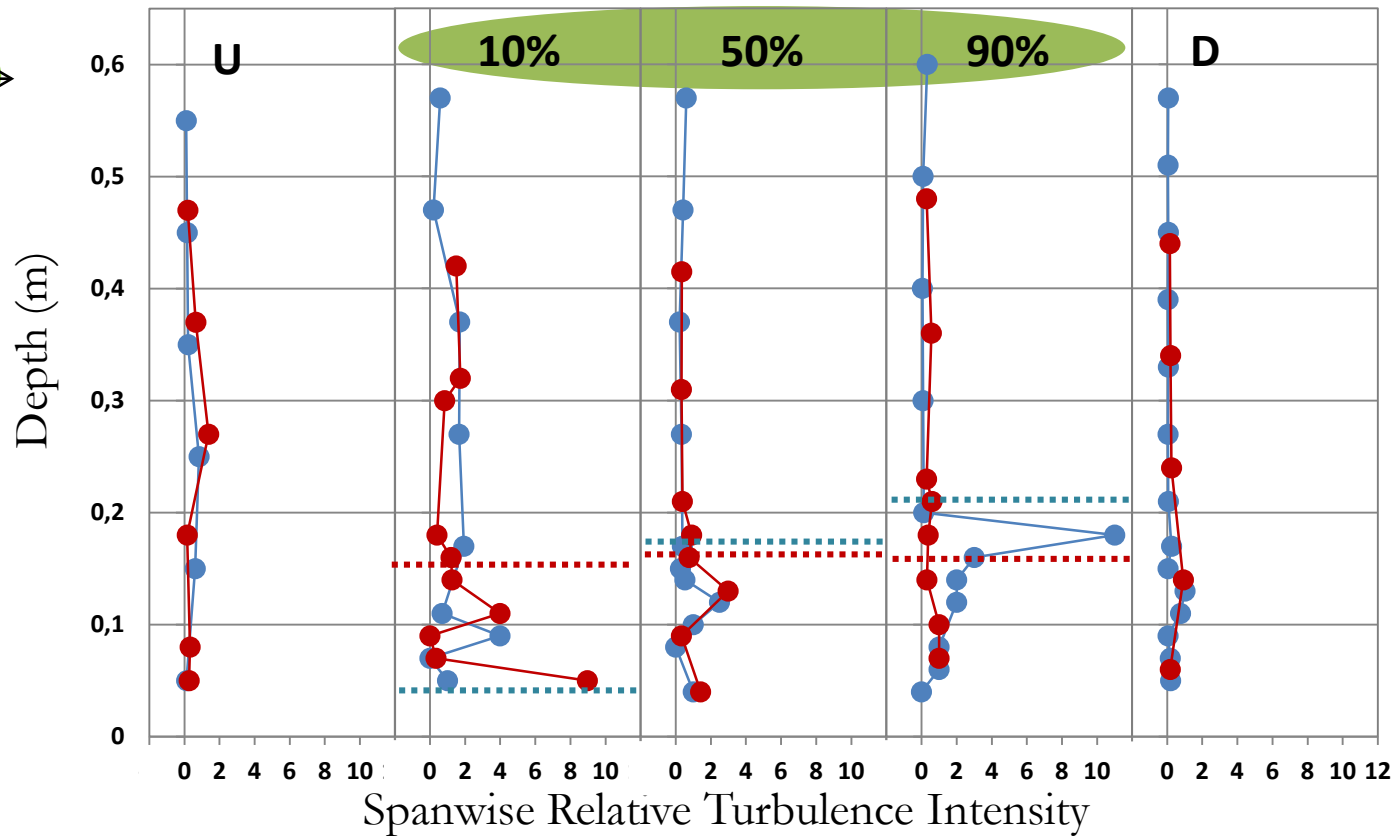
● *Elodea nuttallii* ● *Callitriche platycarpa* dotted lines indicate canopy height



Higher inside the canopy



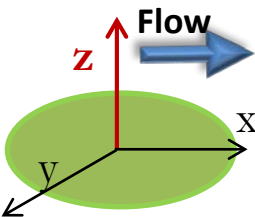
● *Elodea nuttallii* ● *Callitriche platycarpa* dotted lines indicate canopy height



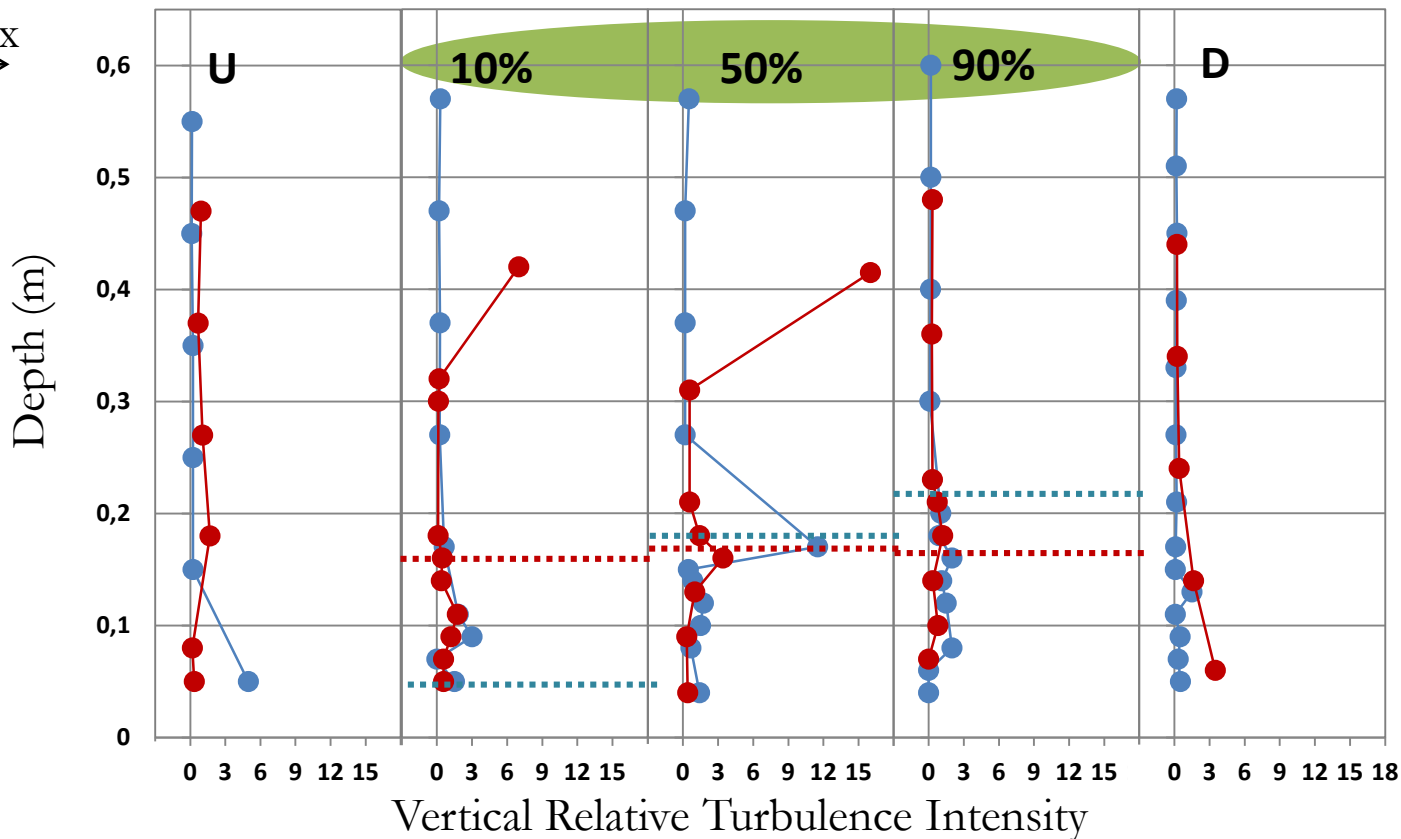
Higher value at 90% position

RESULTS

Hydrodynamics - Vertical Relative Turbulence Intensity



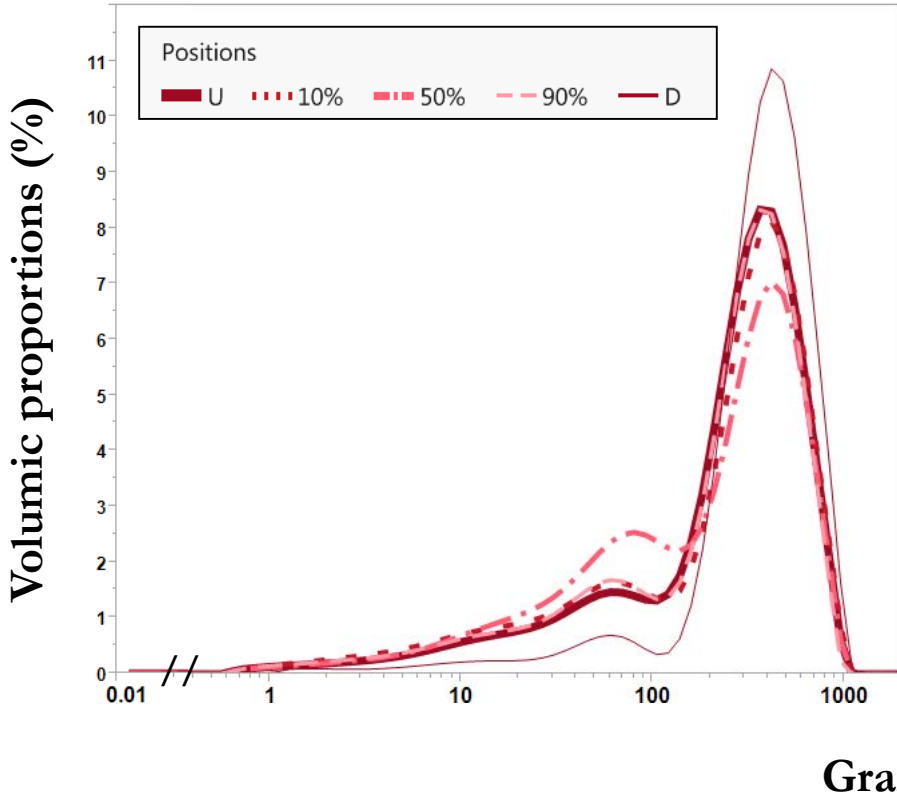
● ⋯ *Elodea nuttallii*
 ● ⋯ *Callitriche platycarpa*
 dotted lines indicate canopy height



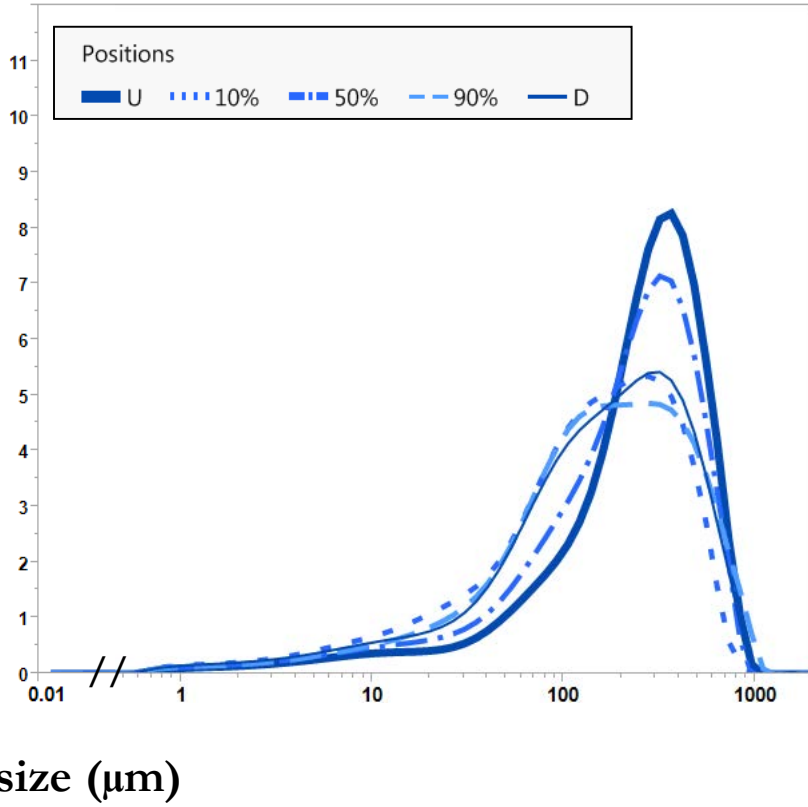
Higher above the canopy

Sediment Characteristics – Grain Size Distribution Curves

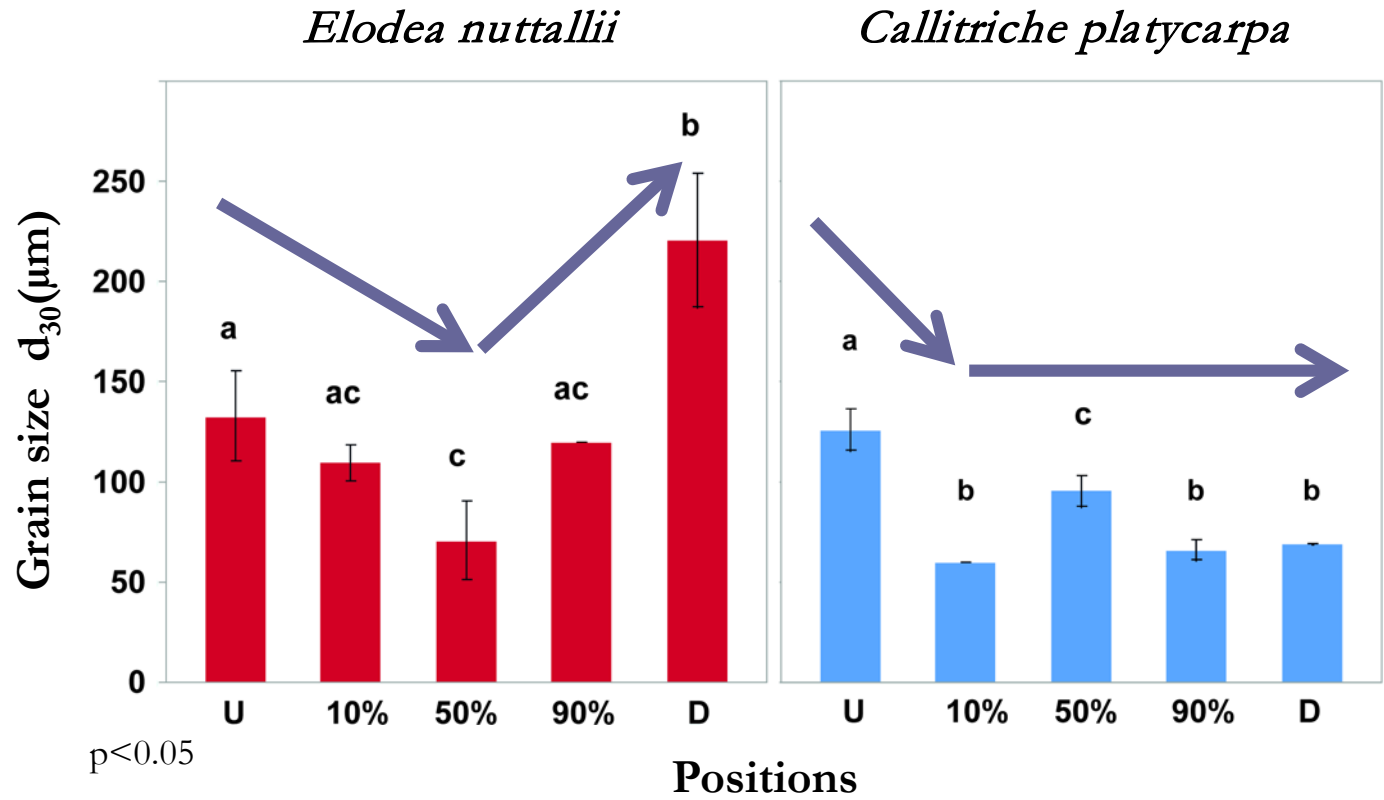
Elodea nuttallii



Callitriche platycarpa



Sediment Characteristics – Percentile value d_{30}

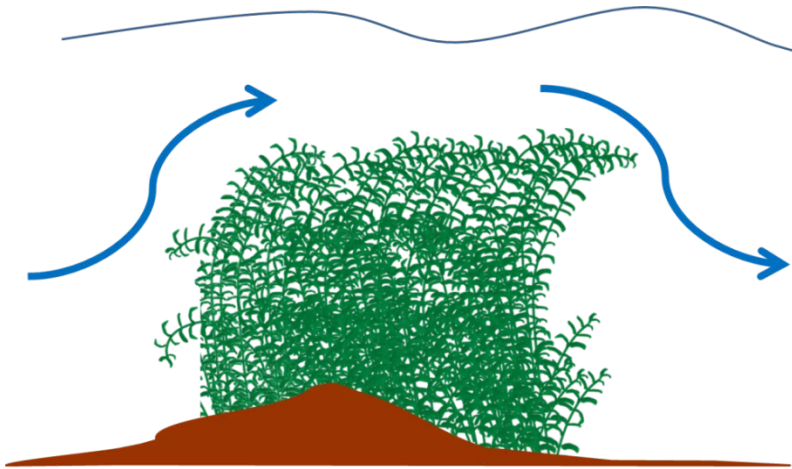


$d_{30} \propto$ Near-bed Vertical Relative Turbulence Intensity

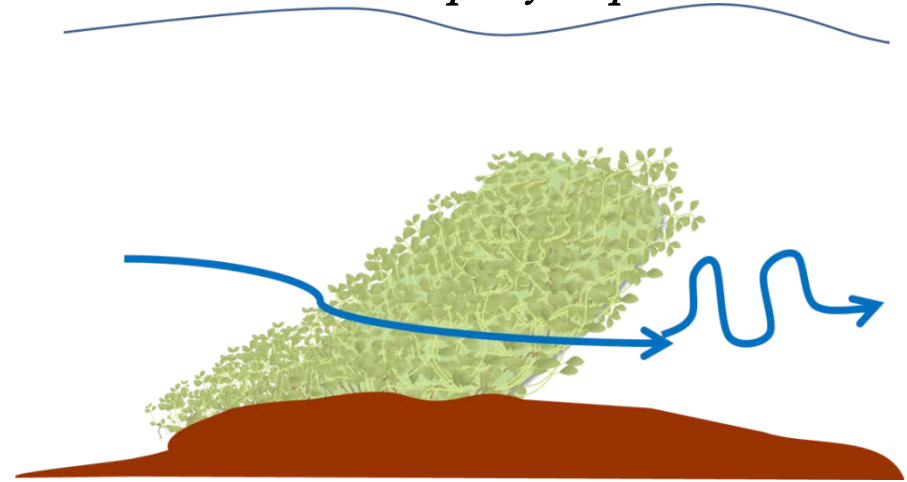
$r^2 = 0.82, p < 0.05$ $r^2 = 0.77, p = 0.05$

CONCLUSIONS

Elodea nuttallii



Callitriche platycarpa



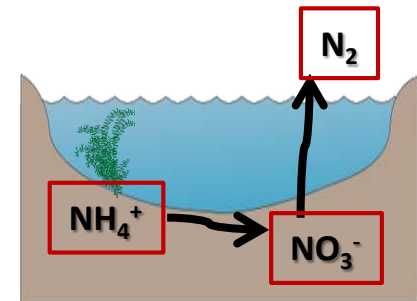
Flow and sediment characteristics were **controlled** by **plant morphology** and **patch structure**, both inside and downstream the patch.



The presence of different species contributes to increase hydrodynamic and geomorphological **heterogeneity** and hence **biodiversity** in lotic ecosystems.

Further investigation of:

- the role of other **architectural properties** (*e.g.* stem/leaf length, leaf surface, flexibility, patch size) on plant-flow-sediment interactions.
- effects on **biogeochemical processes** (interstitial water characteristics and microbial activity) of plant-flow-sediment interactions.



THANKS for YOUR ATTENTION!



Questions and comments are welcome!

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