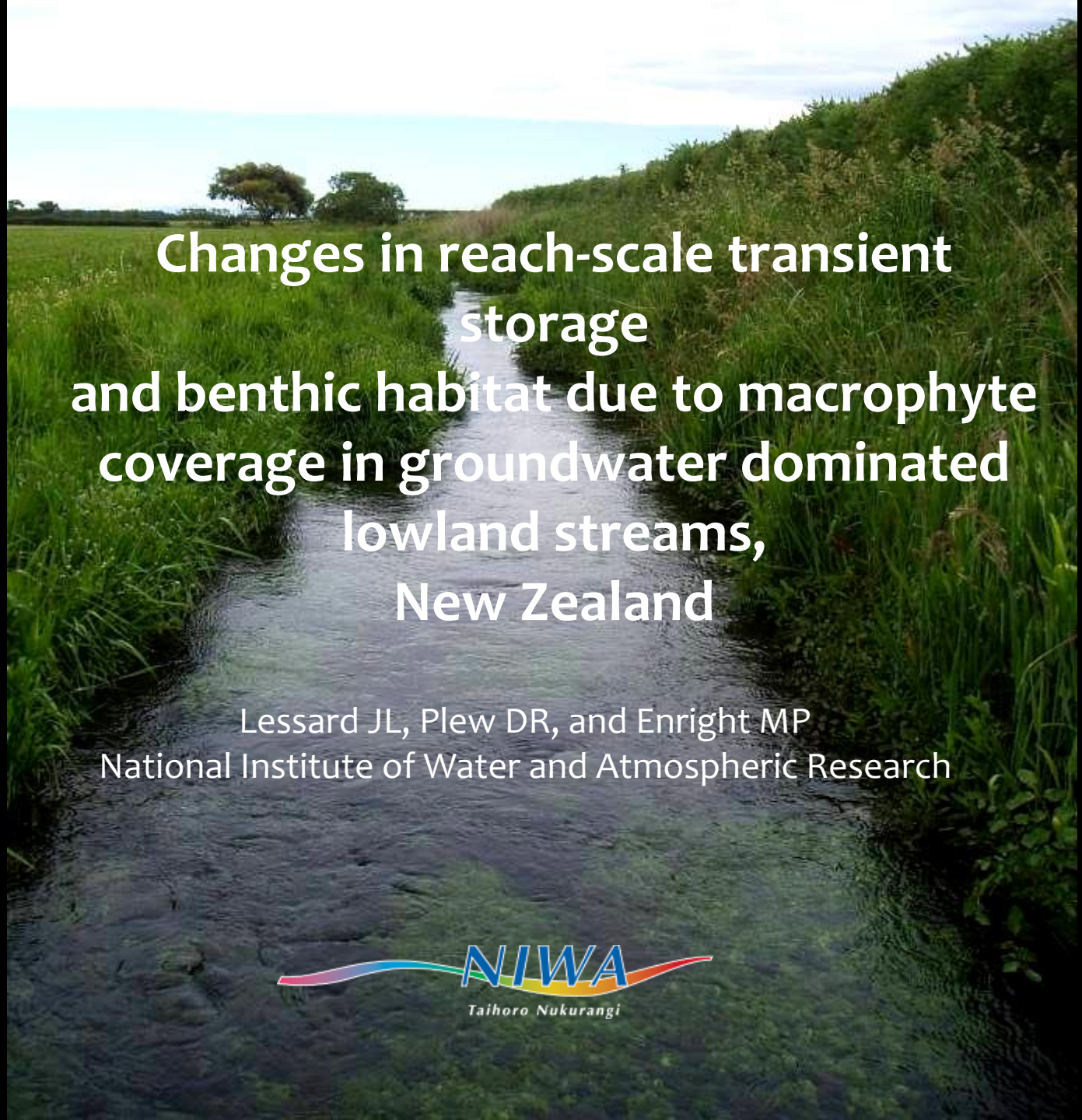
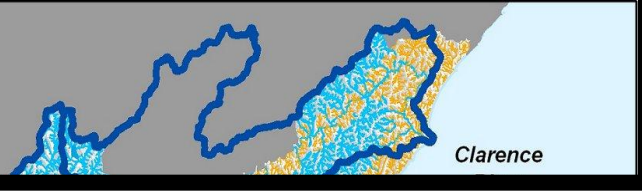


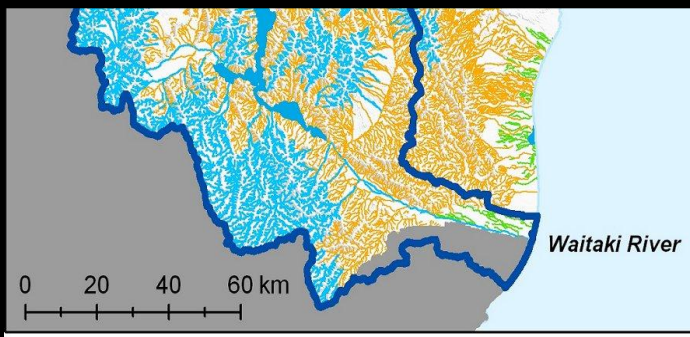
Changes in reach-scale transient storage and benthic habitat due to macrophyte coverage in groundwater dominated lowland streams, New Zealand

Lessard JL, Plew DR, and Enright MP
National Institute of Water and Atmospheric Research

NIWA
Taihoro Nukurangi

River Types Within Canterbury





Alpine Rivers

Hill Country Rivers

Lowland Rivers

Lakes

Major Alpine Catchments

What will happen in these rivers as the allocation of water increases and surrounding catchments become increasingly irrigated???

What we know:

- Dominated by groundwater upwelling
- Discharge generally stable throughout the summer
- Primary production is naturally dominated by aquatic macrophytes with some bryophytes and algae
- Nutrient levels tend to be elevated in nitrates
- Macrophytes alter the hydraulics of streams, take up nutrients and provide habitat and cover
- Many of these streams are annually managed for nuisance growth of invasive plant species

What we need to know:

- Spatial and temporal variation of GW inputs
- Shape of an annual hydrograph
- Relative biomass and species distributions of primary producers
- The spatial and temporal variation of water quality
- Relative importance of these various functions
- Ecological effects of this management

Project Objectives:

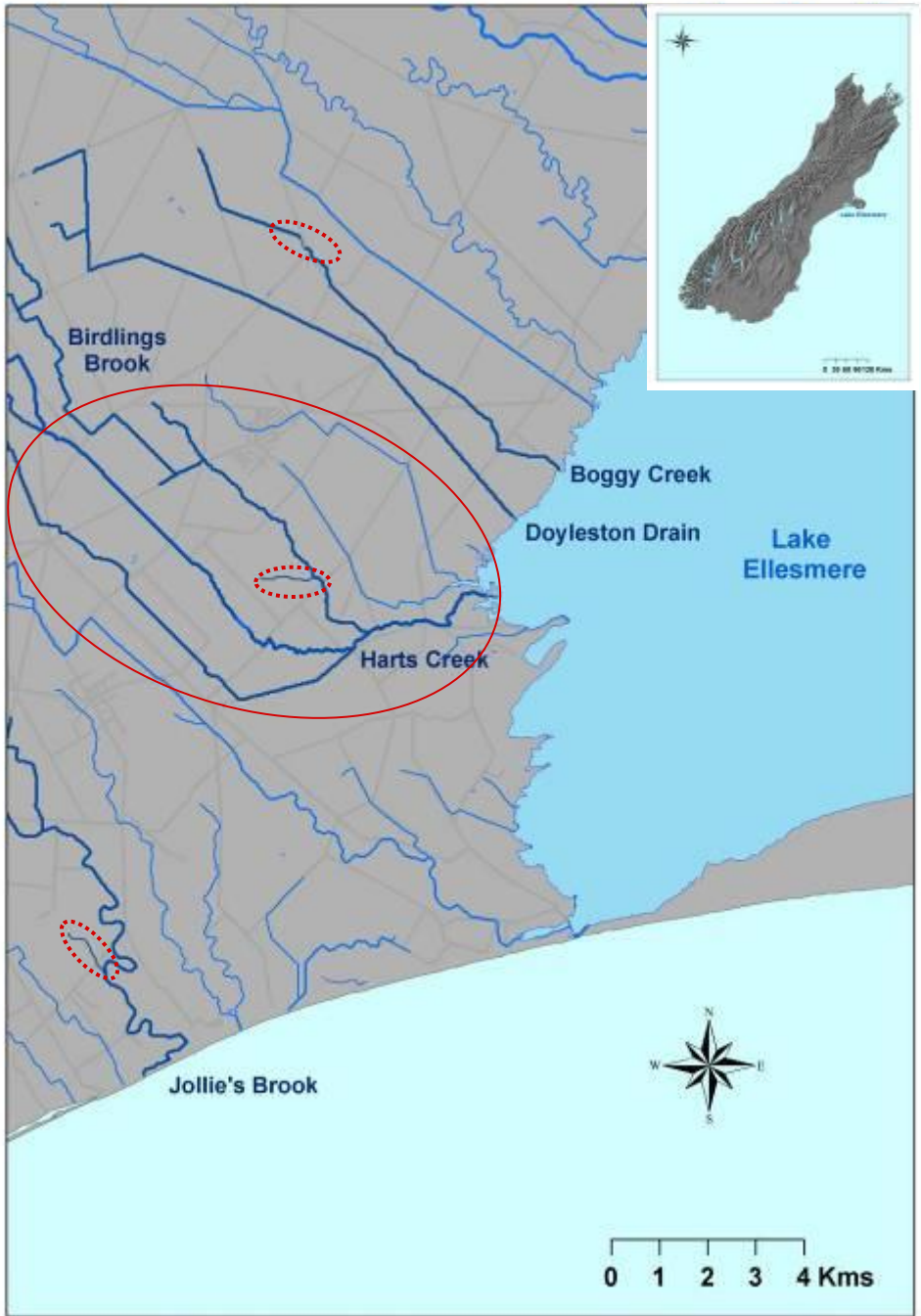
Macrophyte-flow interactions

-Relate flow resistance to macrophyte coverage

-Investigate reach-scale solute dispersal

-Benthic macroinvertebrate communities

Study Reaches



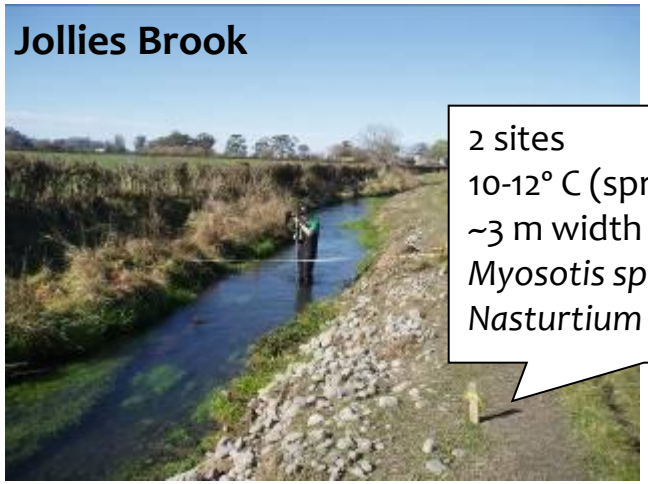
Boggy Creek

13-18° C (some surface flow)
~3.5 m width
P. crispus

Halcombe Creek

11-13° C (spring-fed)
~2.5 m width
Ranunculus sp.

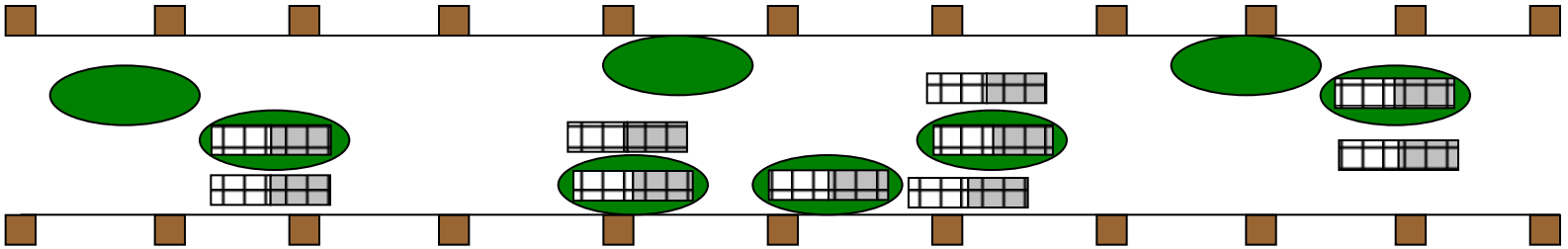
Jollies Brook



2 sites
10-12° C (spring-fed)
~3 m width
Myosotis sp. and Nasturtium sp.

Study Schematic

- Selected four 30 meter reaches (2 sites in Jollies)
- 11, equally spaced transects at each site, marked with numbered stakes
- 20 numbered, gravel-filled boxes placed in stratified random design inside and outside of plant beds

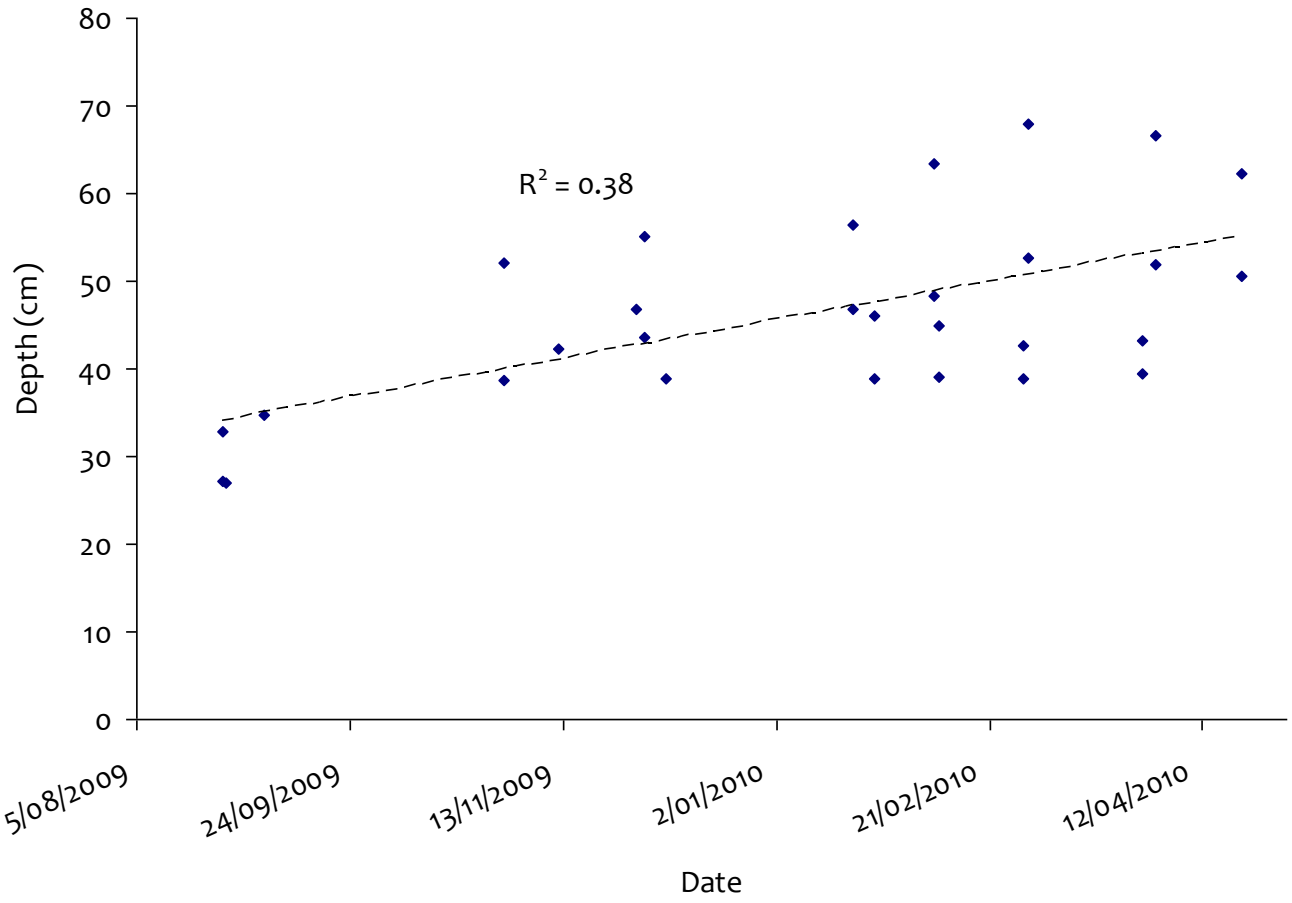


Methods

Weekly: flow velocity profiles (inside and outside of beds)
stream gauging and slope measurements
sediment box samples (inside and outside of beds)
In-situ Water quality

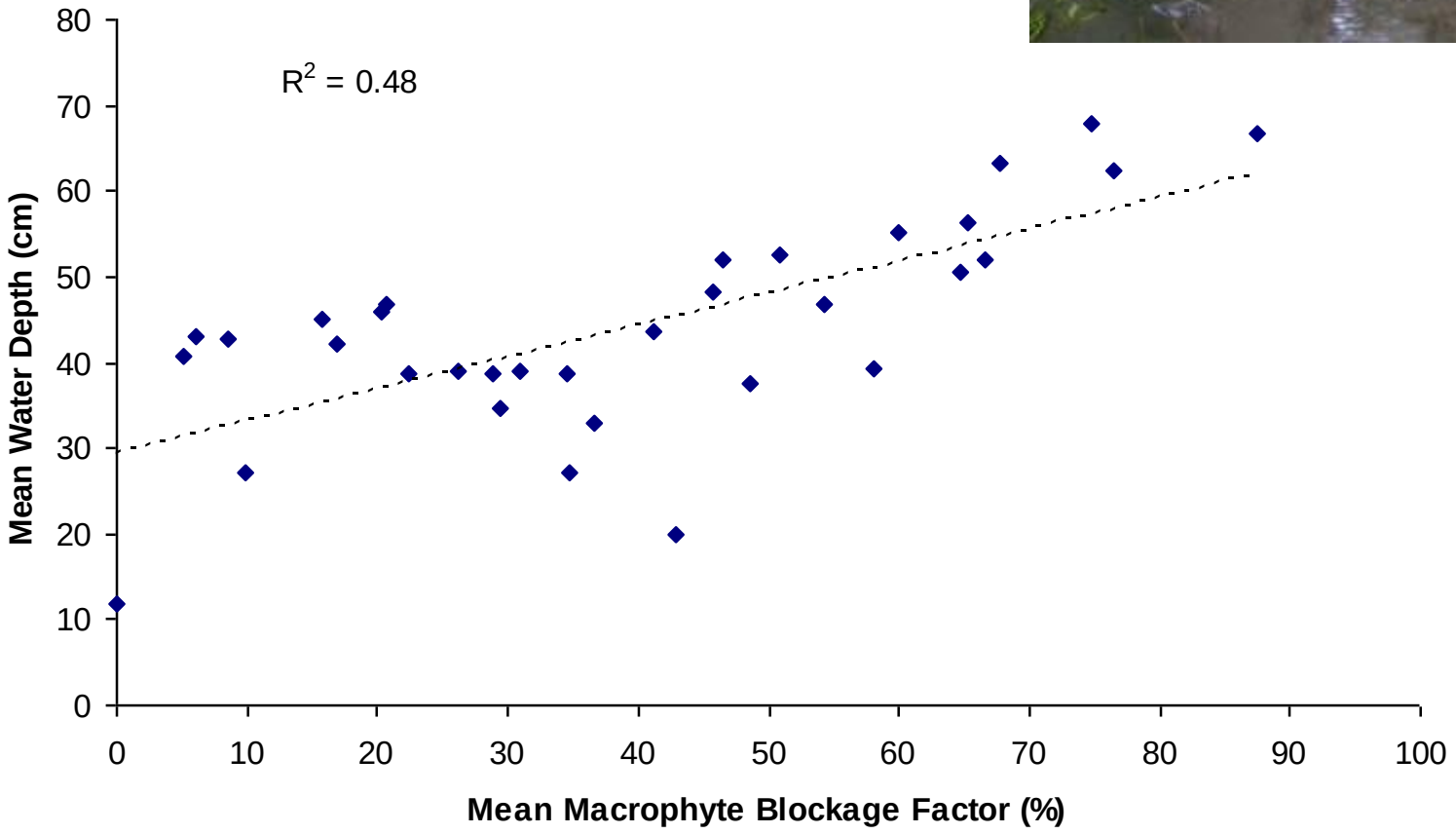
Six Weeks: Macrophyte growth and bed mapping (at transects)
Benthic invertebrate rock basket sampling
Salt-tracer releases
Nutrient samples (taken once)

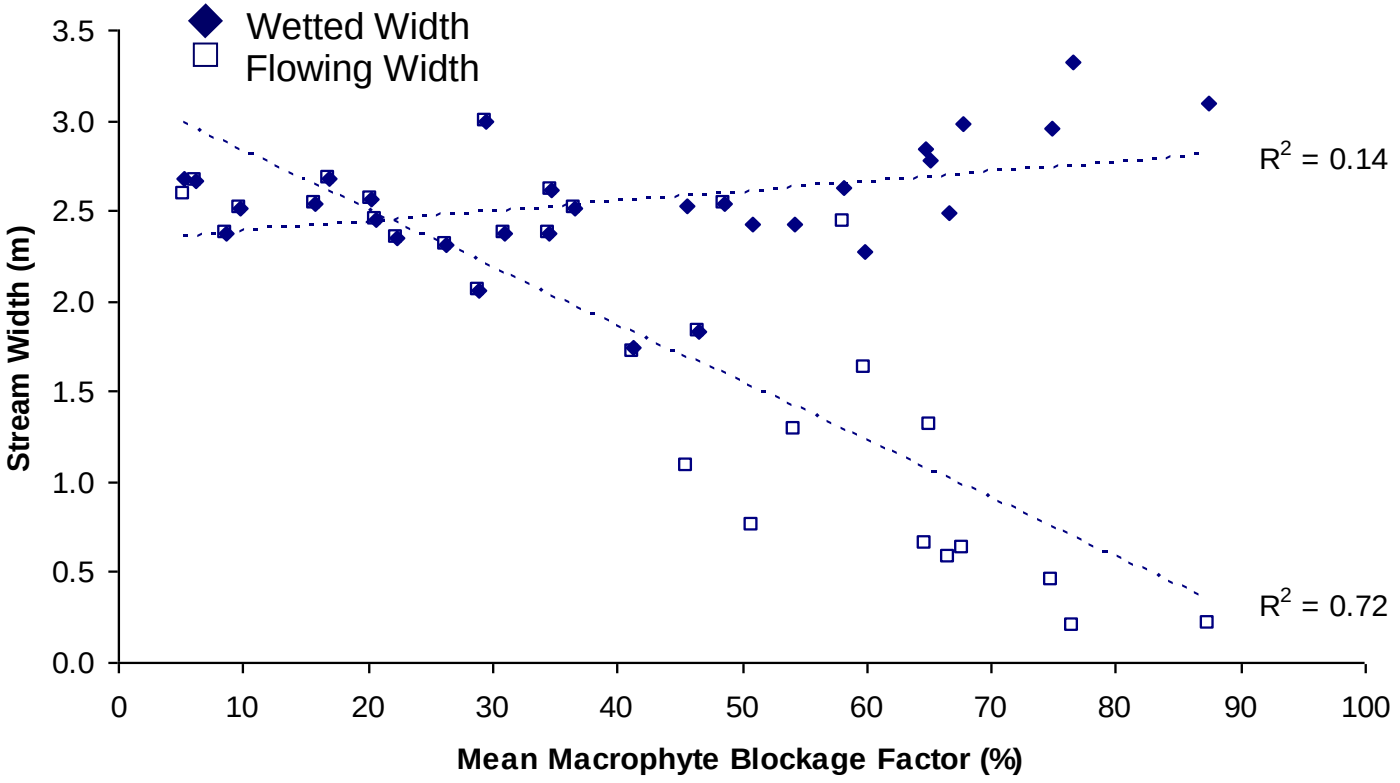
Stream Depth Over Time



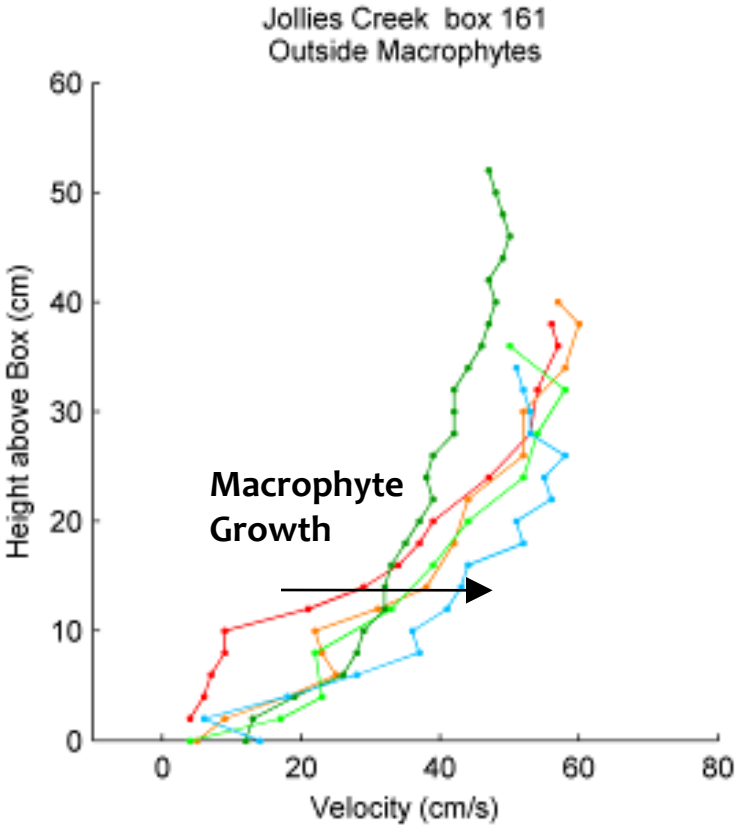
Stream Depth vs. Macrophyte Growth

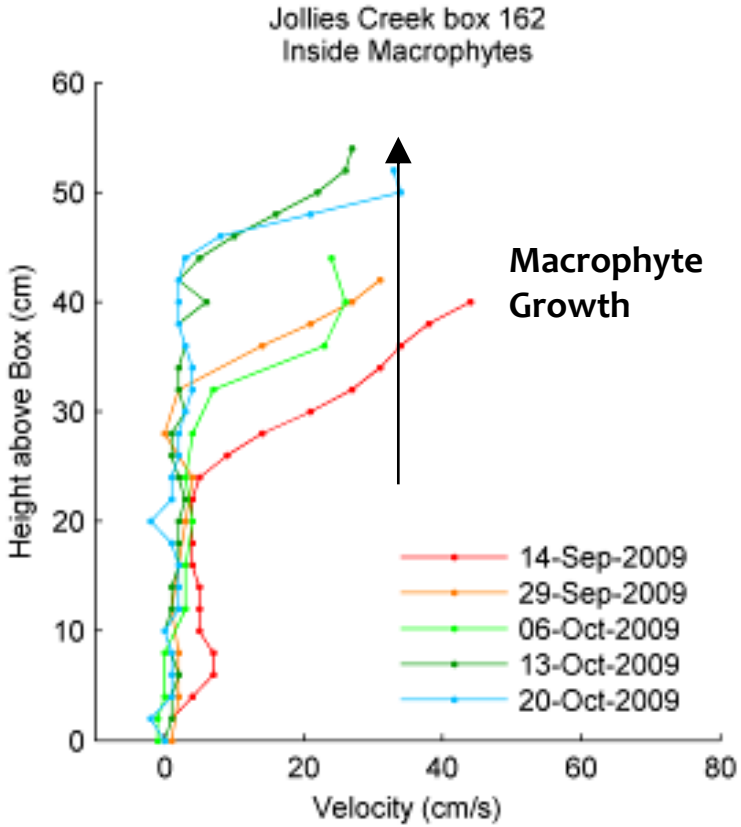
Blockage= Cross sectional area occupied by macrophytes
Wetted Cross sectional Area



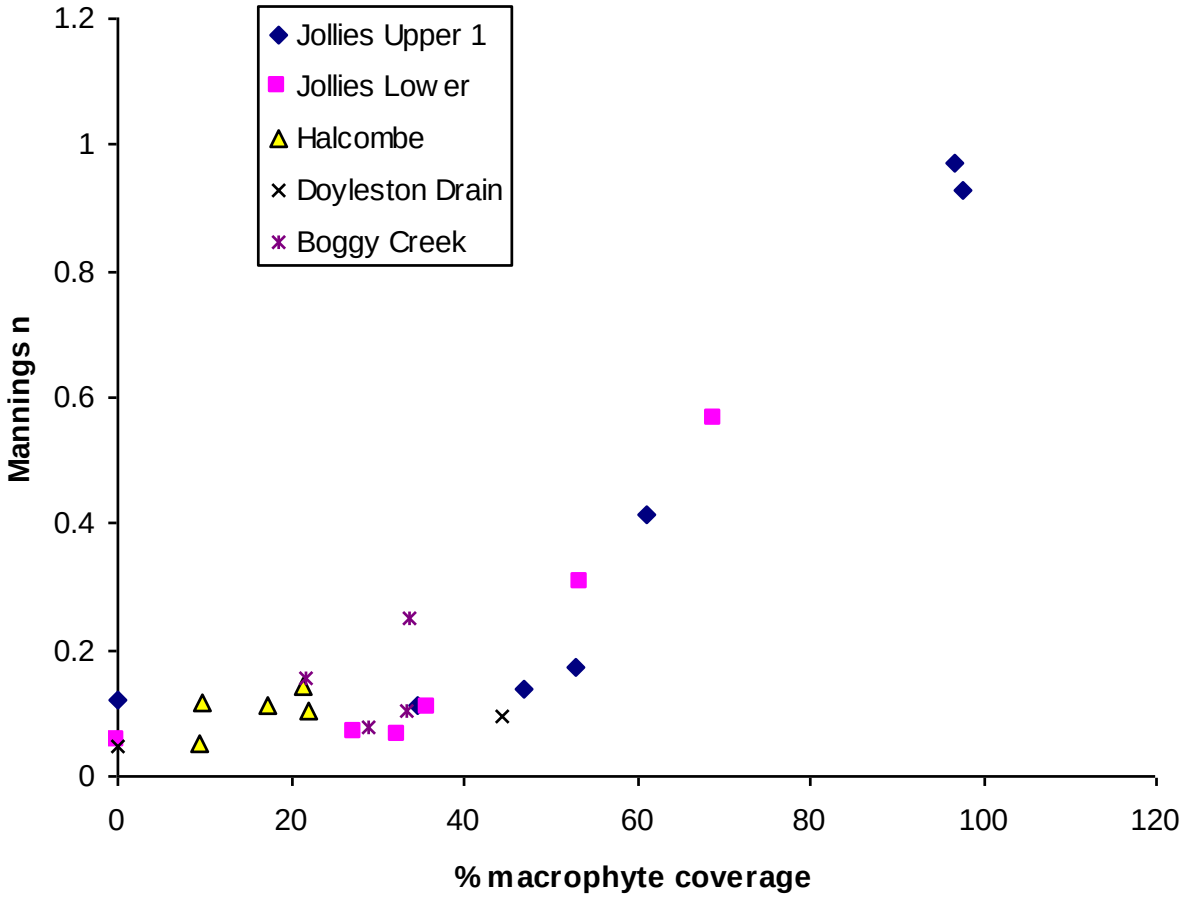

Wetted Width
Flowing Width
Stream Width (m)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
Mean Macrophyte Blockage Factor (%)
R2 = 0.14
R2 = 0.72

Velocity profiles over invertebrate boxes



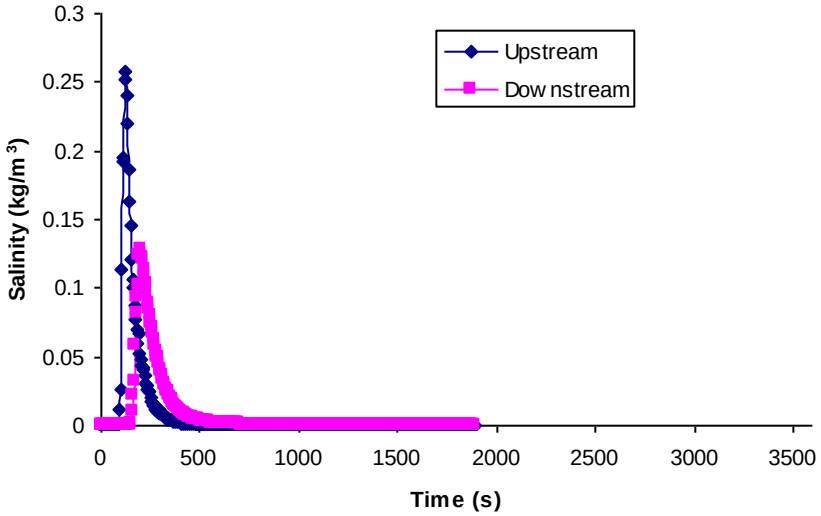


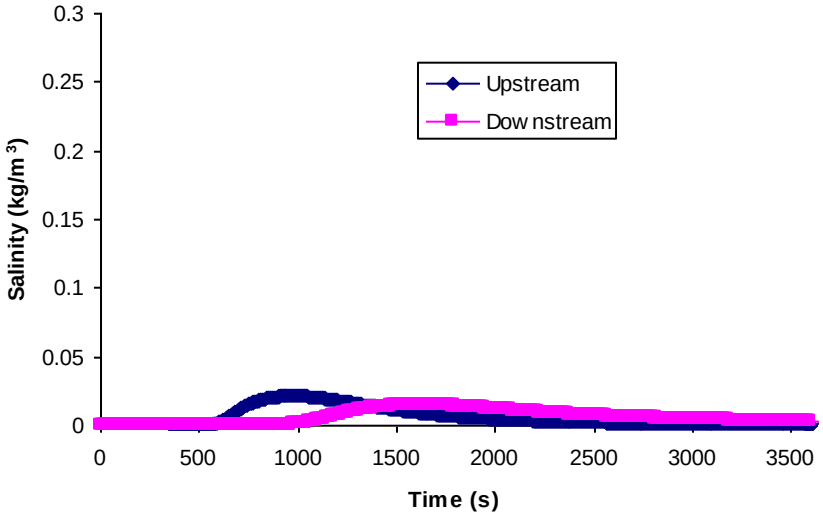
Effect of macrophytes on flow resistance: Channel roughness



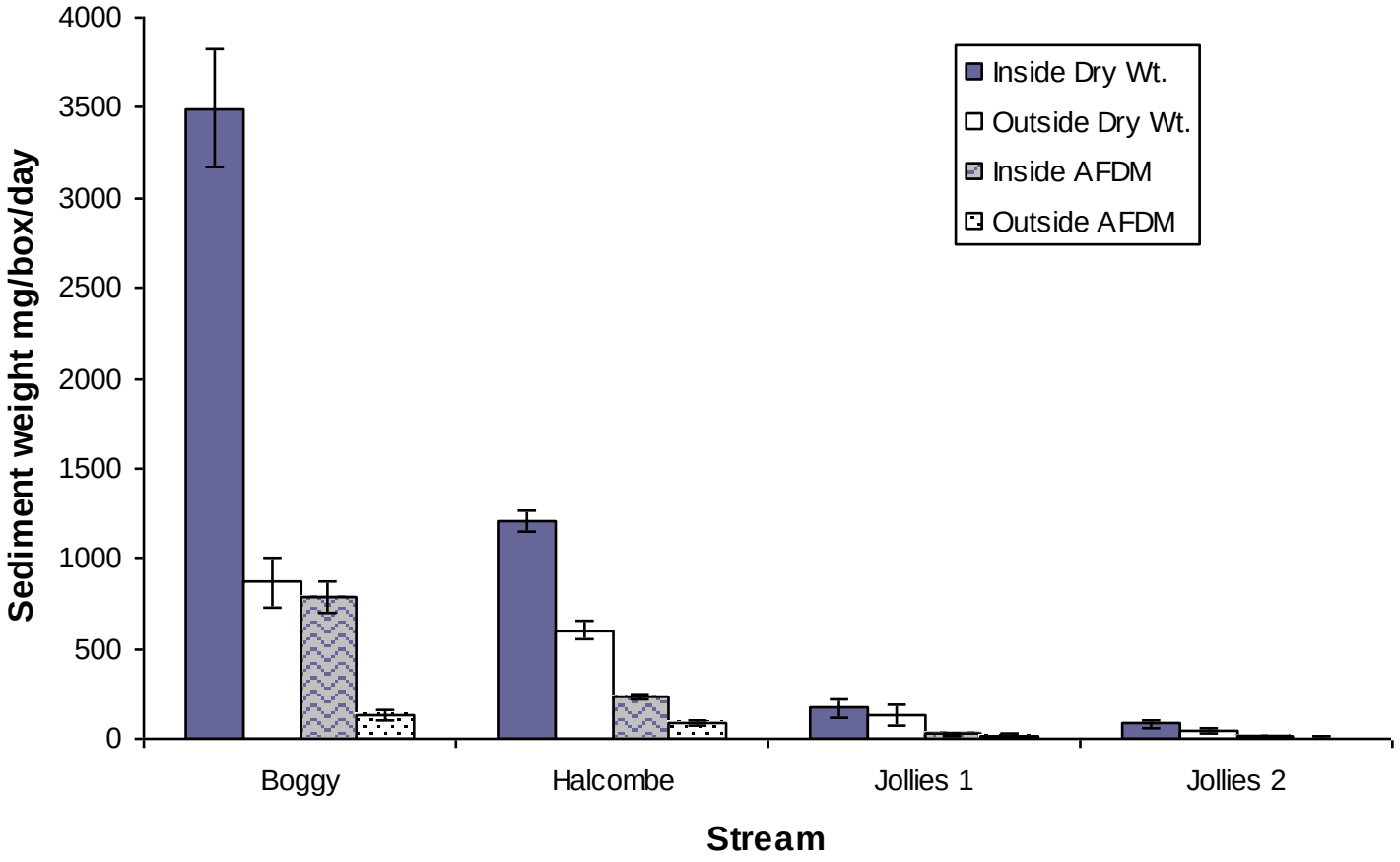

Winter 2009 (August)


Summer/Fall 2010 (March)

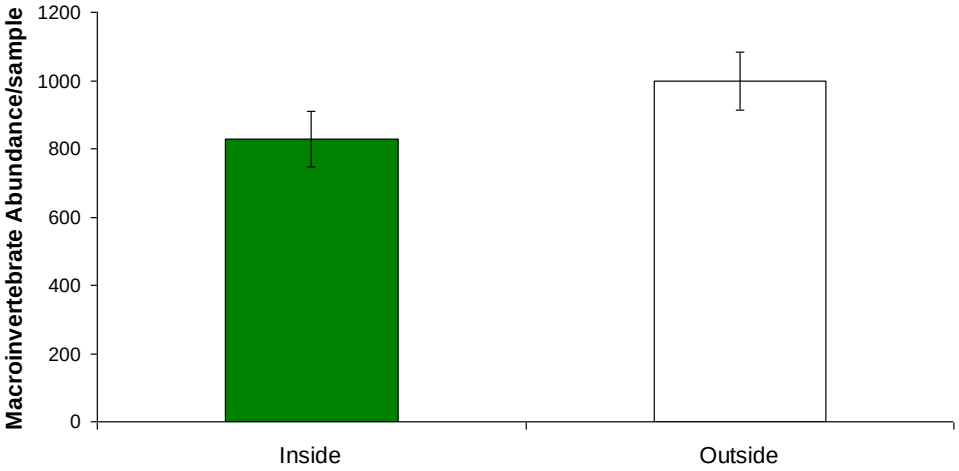

Upstream
Dow nstream
Salinity (kg/m 3)
Time (s)
0.3
0.25
0.2
0.15
0.1
0.05
0
0
500
1000
1500
2000
2500
3000
3500

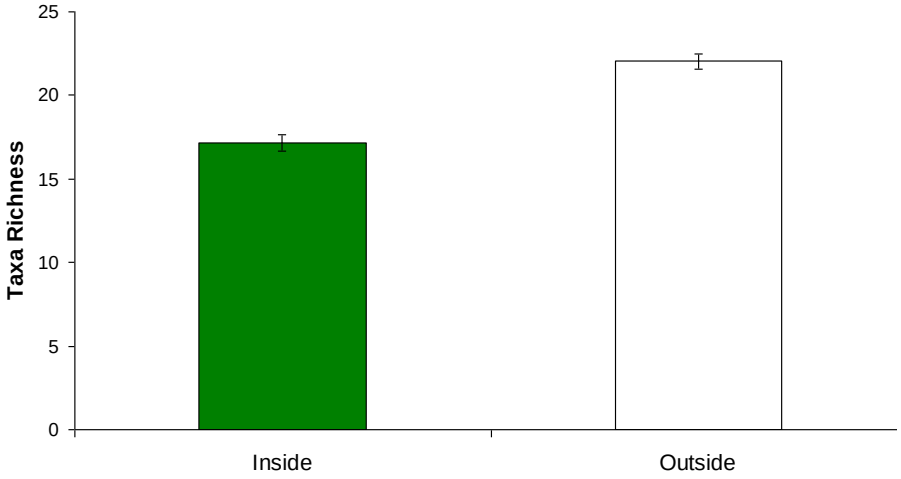

Upstream
Dow nstream
Salinity (kg/m 3)
Time (s)
0.3
0.25
0.2
0.15
0.1
0.05
0
0
500
1000
1500
2000
2500
3000
3500

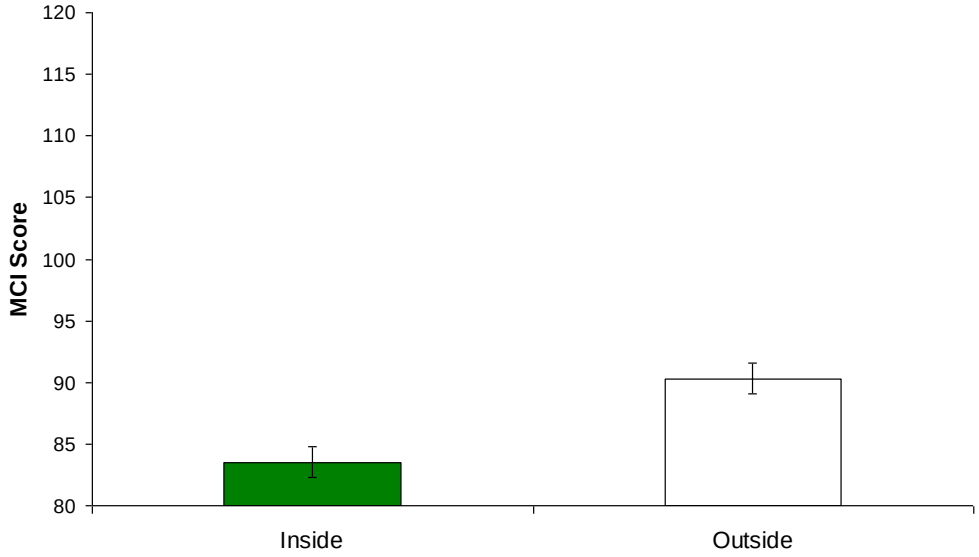
Sedimentation Results



Benthic Macroinvertebrates: Rock Basket Samples



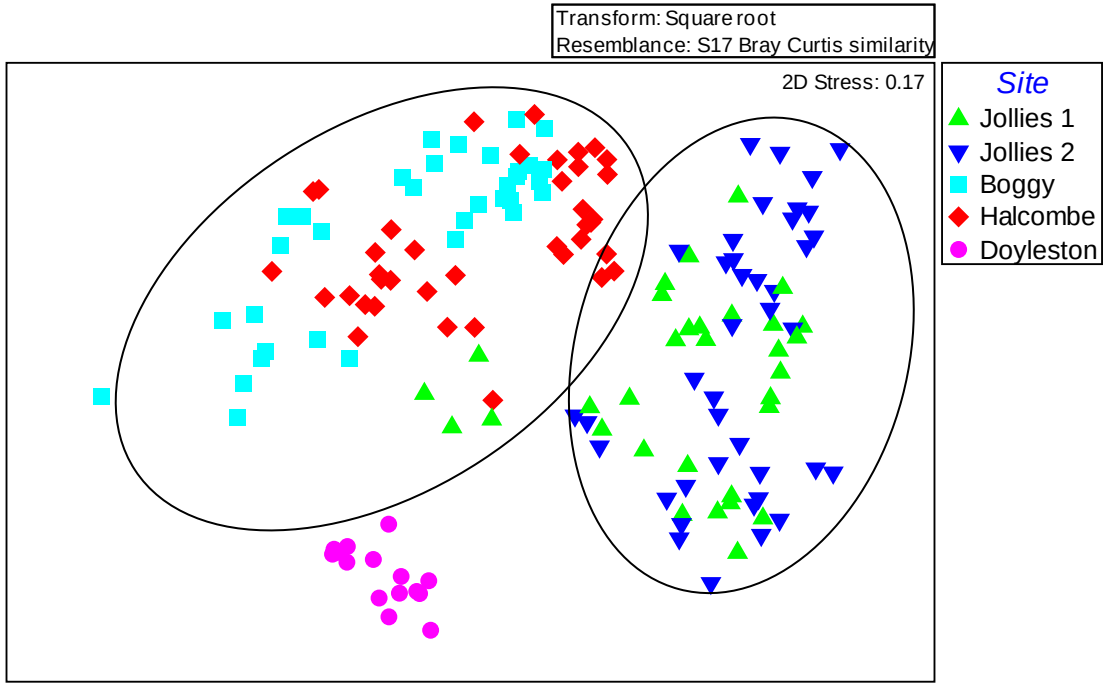




Benthic Macroinvertebrates: Community Comparison

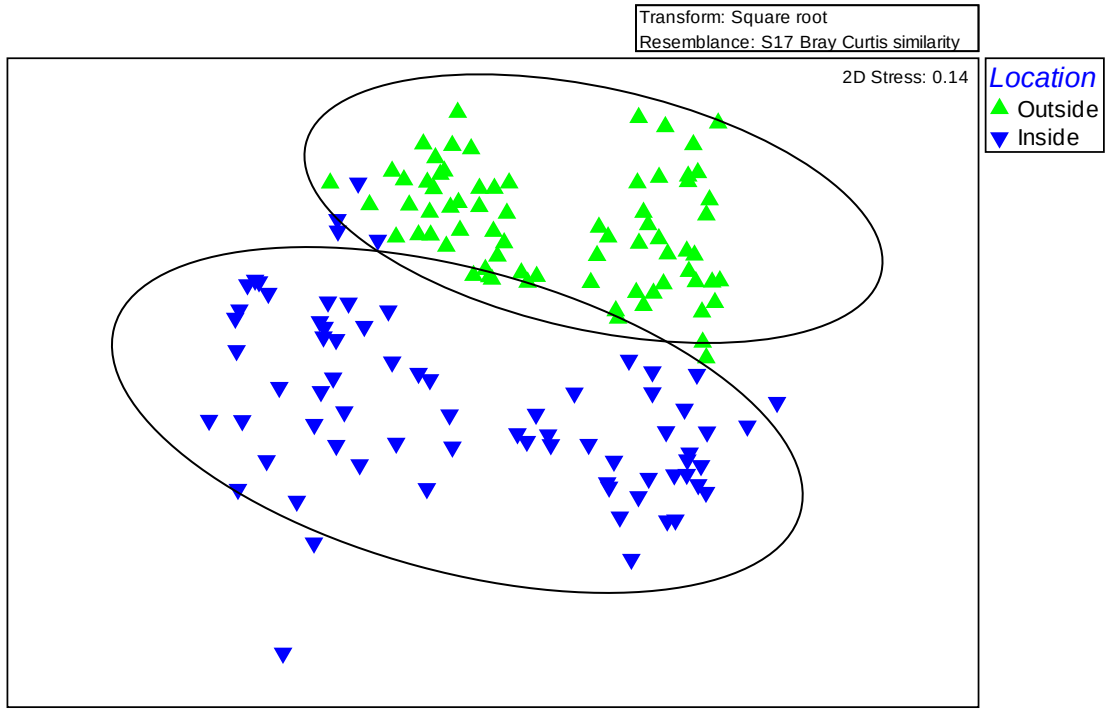
MDS Ordination Result:

- Sq. Rt. data transformation
- Site as factor
- Bray-Curtis Similarity



MDS Ordination Result:

- Sq. Rt. data transformation
- Location as factor
- Bray-Curtis Similarity



Summary of Results:

With increasing macrophyte coverage

- Streams get deeper and wider
- Flow within the beds and canopy is reduced (sometimes to zero)
- Sedimentation within the plant beds increases

**Habitat for benthic invertebrates that prefer gravel/flow is reduced (sometimes to zero)

**Solute transport is severely reduced

- We hypothesize that reduced solute transport (i.e, increased transient storage) promotes nutrient uptake and in-stream processing (i.e., reducing nutrient export, at least during the growing season)
- We have shown that the quantity and quality of benthic habitat for macroinvertebrates (particularly aquatic insects) changes as plant coverage increases, to habitats supporting less diverse non-insect communities.

Should we manage lowland streams for in-stream habitat quality and biodiversity or nutrient uptake and retention?

Future research Objectives:

- Evaluate the role of macrophyte-flow interactions on nutrient retention, uptake and transformation
- Map and quantify macrophyte growth patterns and biomass at the catchment scale
- Investigate spatial variation in GW inputs
- Map macrophyte species distributions

Acknowledgements

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