Identifying important aspects of the discharge regime associated with densities of juvenile (age-0+) Atlantic salmon (*Salmo salar*) and trout (*Salmo trutta*)

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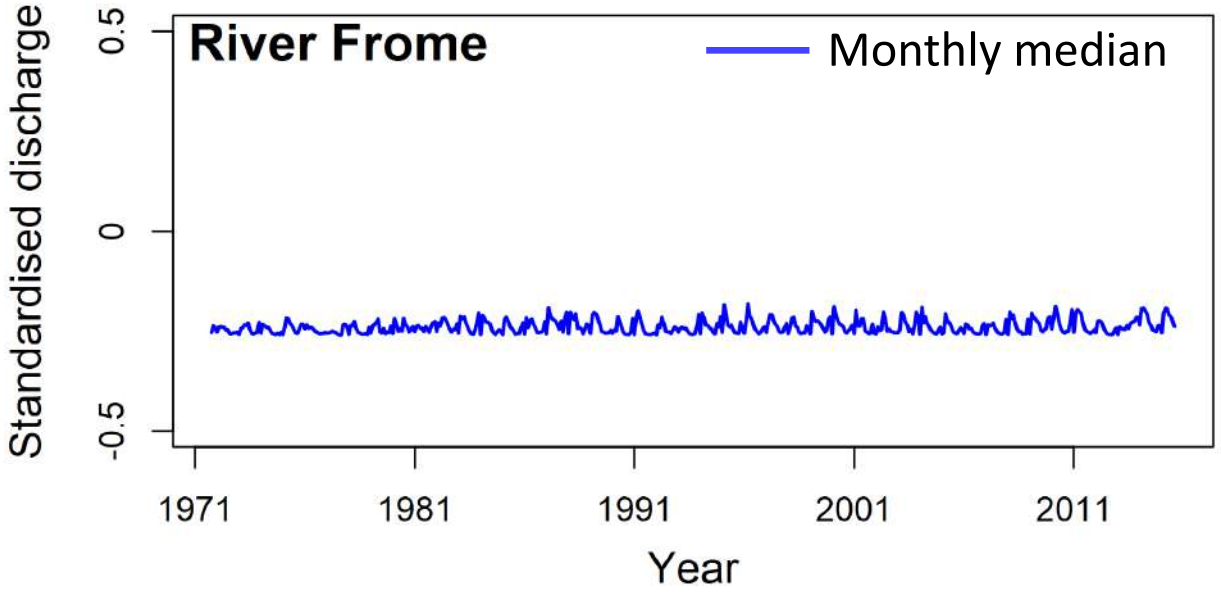
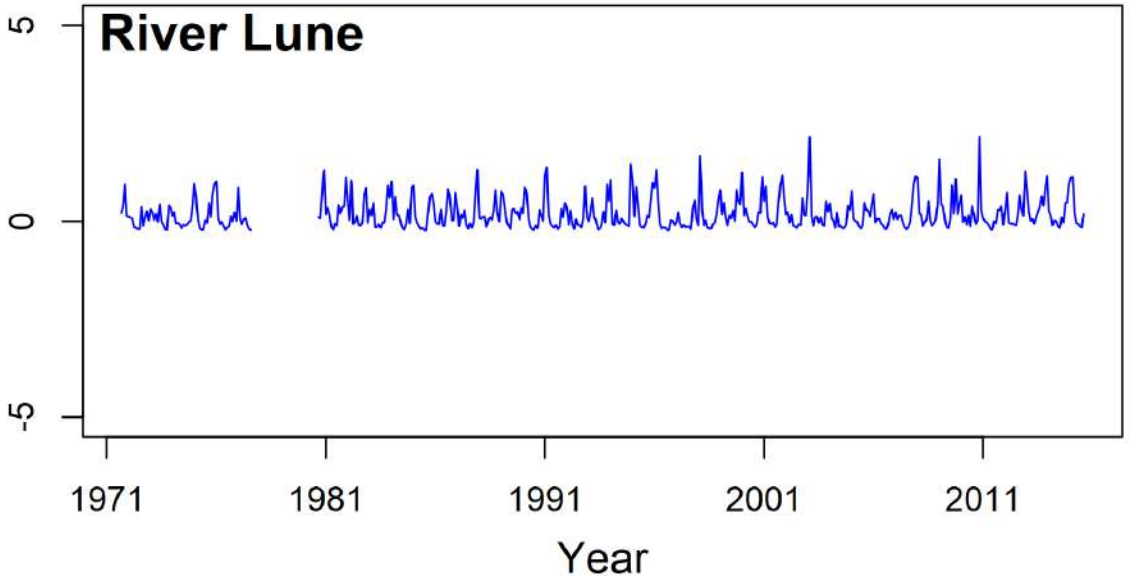
Cefas

Nature of river discharge

- Climatic variation influences river discharge by altering rainfall and temperature patterns
- Discharge (m^3s^{-1}) is a "master variable" that affects a myriad of environmental factors in rivers





Links between river discharge and salmonids

- Every stage of Atlantic salmon and trout life histories in rivers is influenced by discharge

- Despite consistent links between discharge and juvenile salmonid abundance, the casual mechanisms remain poorly understood

Proposed causal mechanisms

1) Physical changes in habitat availability

2) Nutrient enrichment increasing primary production

3) Altered accessibility of natal spawning grounds

4) Density-dependent competition among conspecifics

5) Recruitment variation due to changes in adult returns and altered mortality in gravel spawning nests

River discharge requirements

- A substantial research effort has been made into the river discharge requirements of juvenile salmonids
- Juvenile abundance should be greatest at intermediate flow velocities and decrease beyond an optimum limit
- Discharge *per se* may not be as important in affecting juvenile abundance as extreme discharge events

Extreme discharge events

- Extreme discharges disturb freshwater habitats beyond their typical limits, which can lead to local extirpations of salmonid populations

- Floods and droughts have been identified as a major cause of severe reductions in the number of young-of-the-year salmonids

River Derwent – April 2012

River Derwent – April 2017

Study aim

Analyse the relationship between hydrological variables and annual age-0+ Atlantic salmon and trout densities

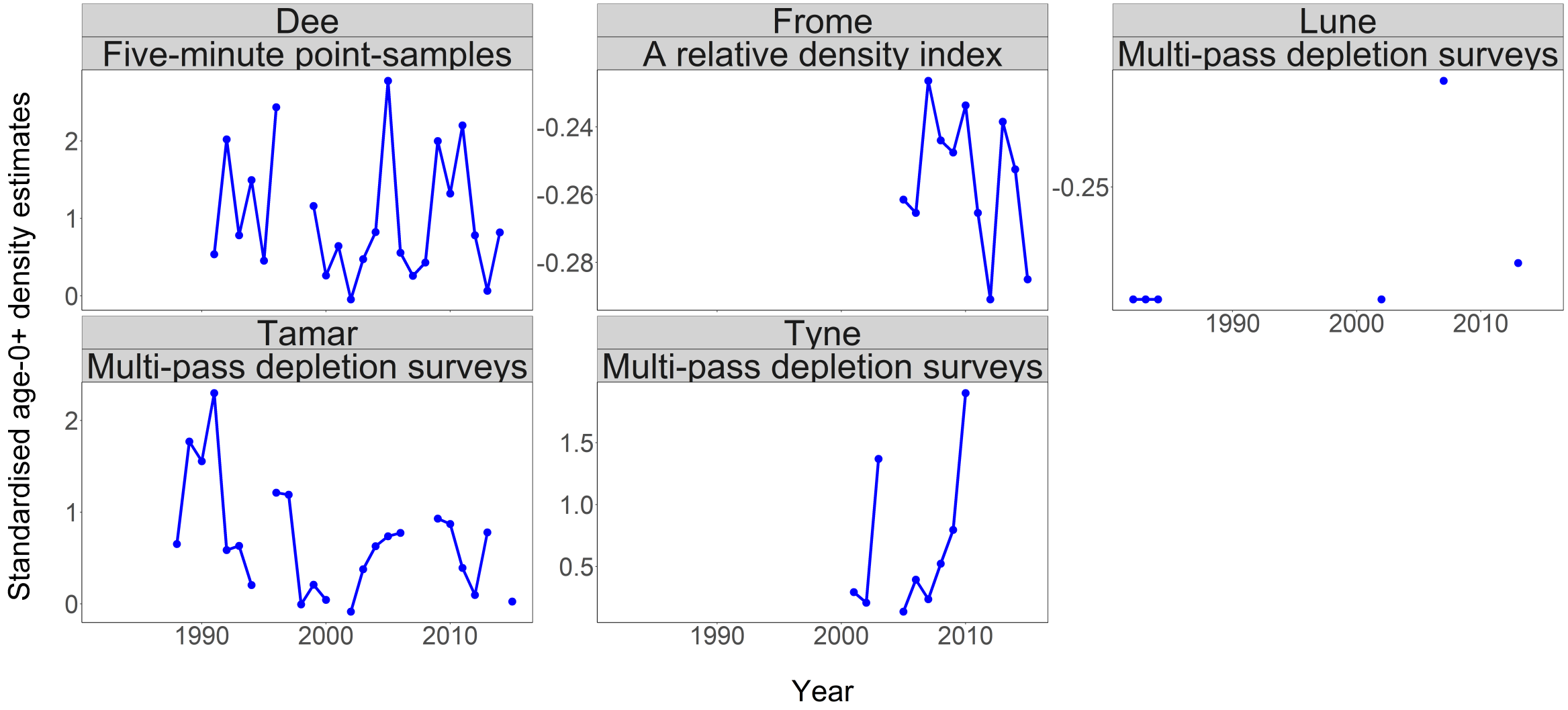
- A total of 14 hydrological variables were considered to evaluate a broad range of aspects of the discharge regime

1) Identify important aspects of the discharge regime most strongly associated with juvenile salmonid densities

2) Explore the ecological mechanisms driving these changes

Rivers investigated

Fisheries data



Hydrological data

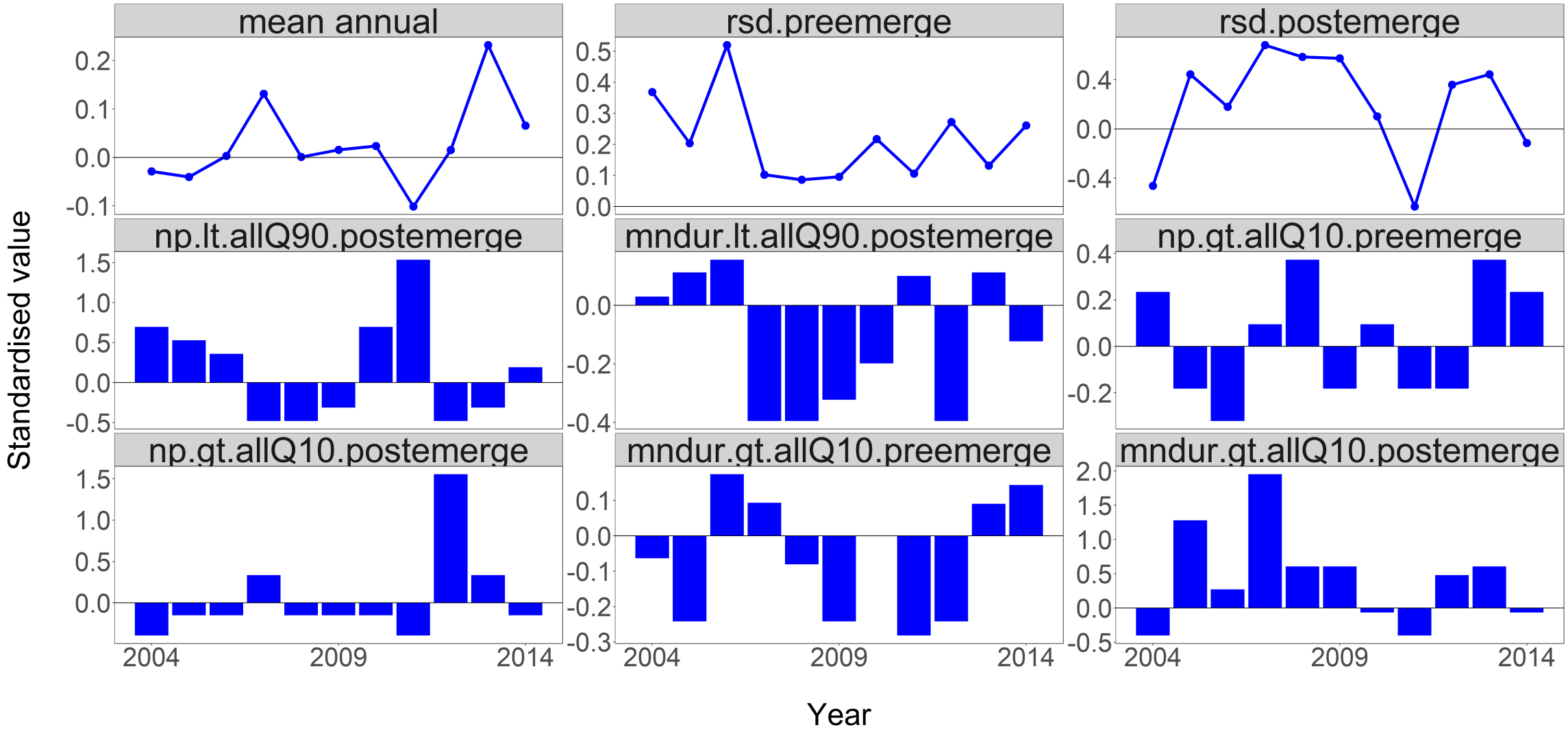
- Two spatial selection criteria were used to match the locations of discharge gauging stations and fishery sites

1) the station had to be less than 1 km upstream or downstream from the site

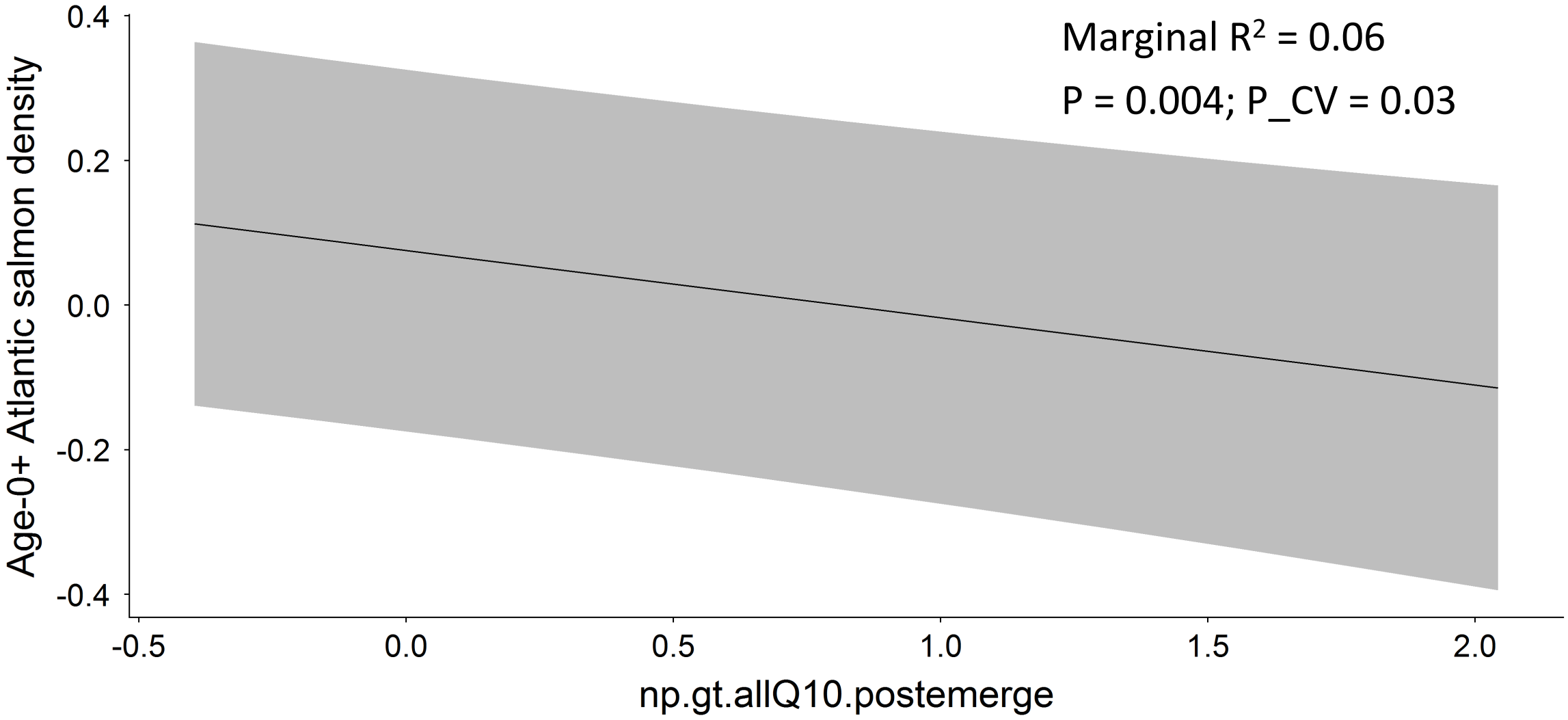
2) within the same river reach

- Gauged daily flow data for the selected stations were extracted from the UK NRFA (http://nrfa.ceh.ac.uk)

Hydrological variables



Discharge and juvenile salmon densities



Discharge and juvenile trout densities

- The null model was the ‘top-ranked’ model
- None of the hydrological variables considered had strong associations with juvenile trout densities
- Discharge variation did not have a discernible effect on inter-annual changes in juvenile trout densities

Main findings for juvenile salmon

- The most important aspect of the discharge regime was the number of high pulses above Q10 of daily discharge during the post-emergence period
- More frequent, elevated discharges during the post-emergence period negatively affected juvenile salmon densities across sites and rivers
- High discharges during the post-emergence period might act as a limiting factor on juvenile salmon densities

Main findings for juvenile trout

- A discernible discharge effect on juvenile trout densities was lacking
- Discharge variation might not be a major factor affecting inter-annual changes in juvenile trout densities
- Trout have a more widespread distribution throughout the catchment and greater plasticity in habitat use than Atlantic salmon, which might buffer the effects of discharge variation at the population-level

Analysing historic monitoring databases?

Advantage

Opportunity to analyse 36 time-series of fisheries and hydrological data, ranging from 6-23 years of observations

Disadvantage

A lack of coherence in the spatial distribution of fishery survey sites and discharge gauging stations, which limited matches between fisheries and hydrological data

Conclusions

- Discharge variation had a discernible effect on annual densities of juvenile Atlantic salmon but not trout
- High discharges during the post-emergence period might act as a limiting factor on juvenile salmon densities
- Catchment management strategies designed to prevent high discharges during the post-emergence period are recommended to enhance juvenile salmon production

Questions?