

# Removal of bank protection to restore hydromorphology and salmonid habitat for freshwater pearl mussel conservation



**Kenneth MacDougall**  
EnviroCentre Ltd.

[kmacdougall@envirocentre.co.uk](mailto:kmacdougall@envirocentre.co.uk)

Hannah Barker (EnviroCentre), Stephen Addy & Susan Cooksley (The James Hutton Institute)

# Restoration Project Overview

- 'Pearls in Peril' securing the future of the freshwater pearl mussel in Great Britain
- LIFE + NATURE project 2012-2016
- Co-funded by 14 organisations (Scotland, England & Wales)



Scottish Natural Heritage  
Dualchas Nàdair na h-Alba

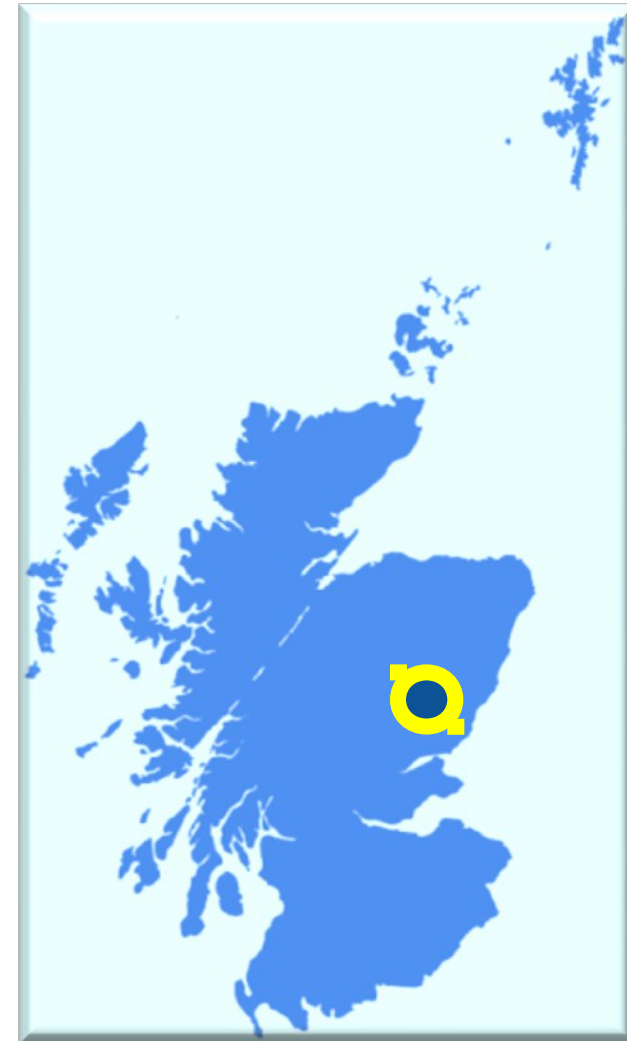
All of nature for all of Scotland  
Nàdar air fad airson Alba air fad

- Prioritise restoration of sites on the basis of benefits to freshwater pearl mussels and restoration of natural processes



# River South Esk

- Special Area of Conservation (SAC)
- Internationally important populations of freshwater pearl mussel and Atlantic salmon
- Catchment area of 564 km<sup>2</sup> , mean flow 13m<sup>3</sup>/s
- Study areas:
  - Upland gravel bed river
  - 250-280 m above sea level
  - catchment areas 20-56 km<sup>2</sup>
  - mean flows 1.1-2.3 m<sup>3</sup>/s
  - median annual maximum flood 14-39 m<sup>3</sup>/s



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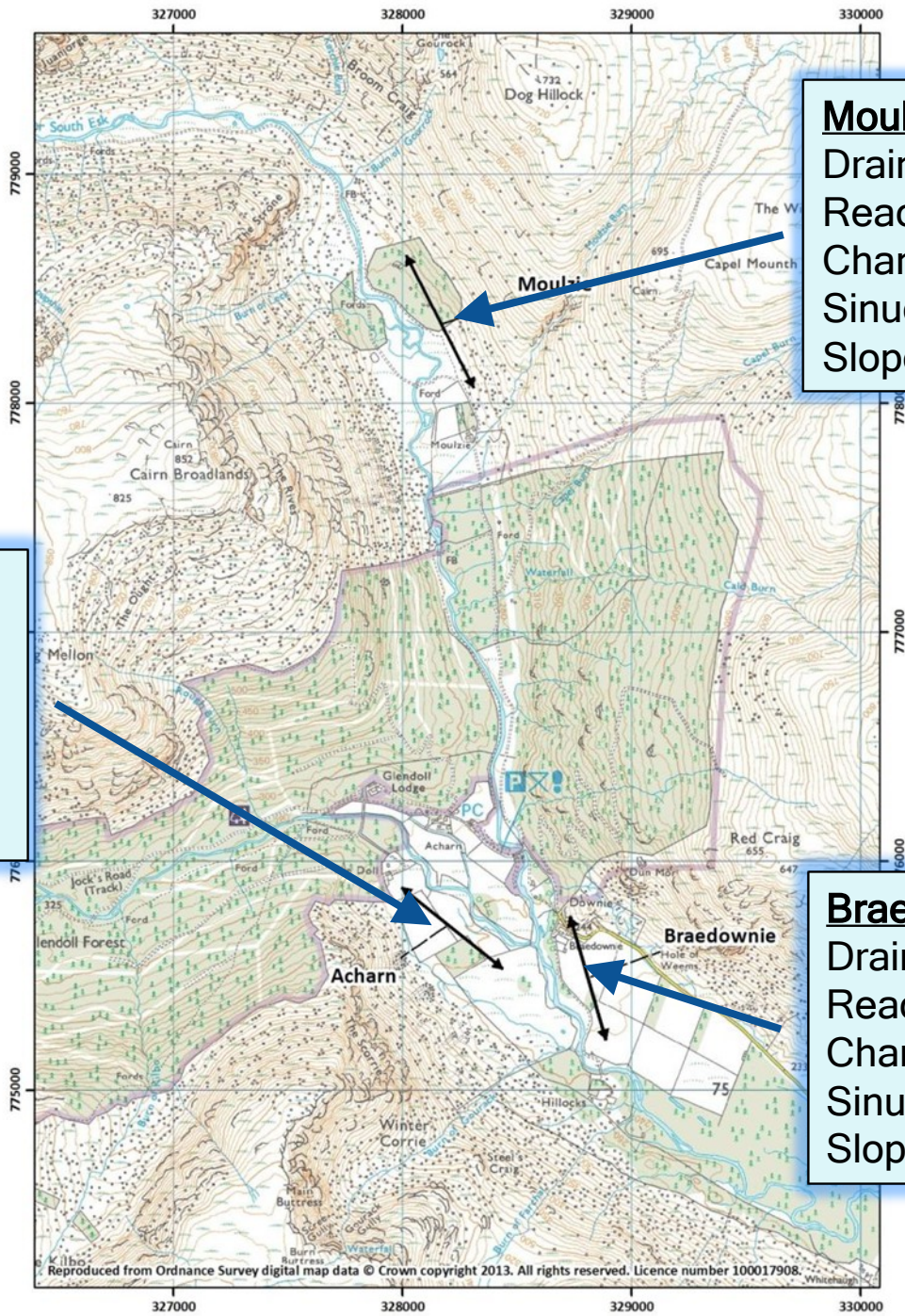
# Project Aims

Prioritise restoration of sites on the basis of benefits to freshwater pearl mussels and restoration of natural processes through:



- i. Assessment of baseline hydromorphology (including impacts of bank protection) and habitat.
- ii. Identification of restoration measures and prediction of impacts (channel, habitat and flood risk).
- iii. Prioritise, design and cost restoration measures.
- iv. Outline effective monitoring methods to evaluate success of restoration work.

# Study Reaches



**Moulzie**

Drainage area:	18.0 km <sup>2</sup>
Reach length:	1,202 m
Channel width:	13.5 m
Sinuosity:	1.24
Slope :	0.009

**Acharn**

Drainage area:	25.7 km <sup>2</sup>
Reach length:	809 m
Channel width:	13.8 m
Sinuosity:	1.23
Slope :	0.013

**Braedownie**

Drainage area:	56.1 km <sup>2</sup>
Reach length:	712 m
Channel width:	23.4 m
Sinuosity:	1.19
Slope :	0.010

# Establishing baseline conditions

- Bank protection
- Perceived impacts of bank protection
- Conditions historically more dynamic and complex
- Field surveys
- Hydrological assessment
- 1D hydraulic models
- Hydromorphological assessment

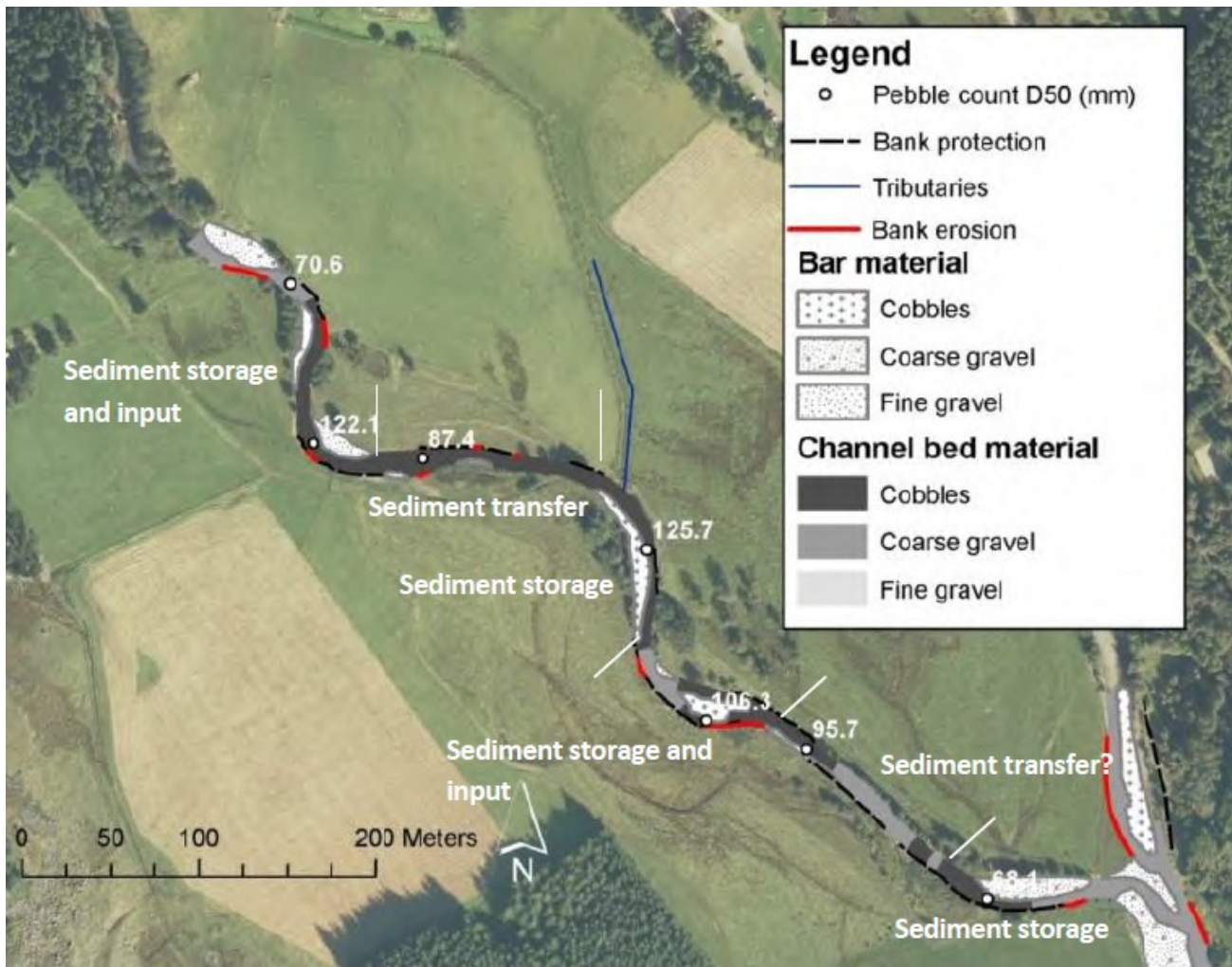


# Hydromorphology

- Wide alluvial valley, single thread
- Historically more dynamic processes with more channel branches
- Active bank erosion processes are still occurring despite bank protection

	Moulzie	Acharn	Braedownie
Reach length (m)	1,202	809	712
Drainage area (km <sup>2</sup> )	18.0	25.7	56.1
Total length of bank protection (m)	738	487	190
Bank erosion length (m)	458	112	206
Max bank erosion length (m)	82	34	112
Stream power $\omega$ (W/m <sup>2</sup> )	97	295	177
Boundary shear stress $\tau$ (N/m <sup>2</sup> )	34	69	43
Sheilds parameter $\tau^*$ (-)	0.027	0.047	0.032

# Geomorphic Mapping





# Predicted hydromorphological effects

Short term (<1 year)	Longer term (1-10 years)
<ul style="list-style-type: none"><li>• Bank erosion and input of destabilised sediment</li><li>• Bank erosion may be limited due to riparian vegetation and straight planform</li><li>• Geomorphic predictions suggest slight increase in bed mobility</li></ul>	<ul style="list-style-type: none"><li>• Meander migration and extension</li><li>• Further aggradation</li><li>• Channel widening</li><li>• Decrease in bed sediment size due to channel widening and greater local sediment input</li><li>• Future responses may be limited due to natural structure erosion and adjustment already occurred</li></ul>

# Predicted benefits to local habitats

- Increased diversity of morphology in:
  - existing channel
  - reconnection with palaeochannels
- Finer riffle substrate more suitable for spawning salmonids
- Bank undercutting and block input providing cover for fish
- Increased input of sediment for sustaining freshwater pearl mussel habitats downstream



# Restoration Strategy

- Remove and restore bankside rock armouring
- Enhancement: bank reprofiling and reconnection of paleochannels
- Promote more natural distribution of sediments benefiting local habitats (salmonids, freshwater pearl mussels and other biota)
- Multi-criteria analysis to prioritise sites:
  - greatest impact on natural processes
  - potential benefit for habitat improvement
  - risk posed to receptors (farmland and infrastructure).
- Following discussion with local stakeholders, four zones selected for design, which focus on seven of the prioritised sites

# Outcomes and Next Steps...

- Bank protection structures are a common but impacts are rarely documented
- Case studies of removal in high energy gravel bed rivers are rare.
- Assessment provides a quantified analysis and demonstrates a simple, relatively low cost approach to predicting the effects of restoration actions and prioritising sites.
- Restoration works are scheduled to commence in May 2015.
- Robust monitoring to inform future restoration works.



# Thank you



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