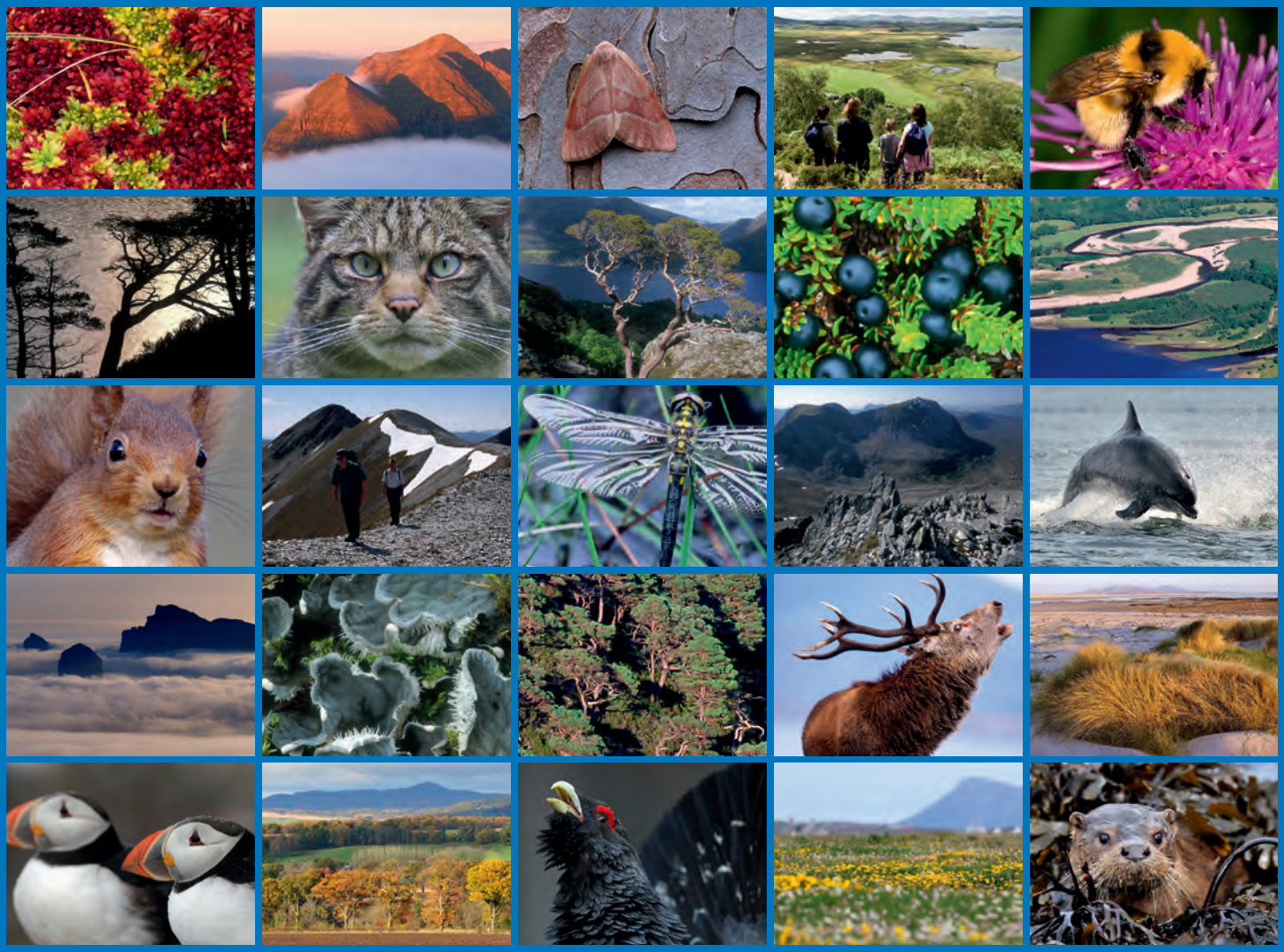
Scottish Natural Heritage
Commissioned Report No. 392

The Scottish Beaver Trial: Collection of fluvial geomorphology and river habitat baseline data 2008



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COMMISSIONED REPORT

Commissioned Report No. 392

The Scottish Beaver Trial: Collection of fluvial geomorphology and river habitat baseline data 2008

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COMMISSIONED REPORT

Summary

The Scottish Beaver Trial: Collection of fluvial geomorphology and river habitat baseline data 2008

Commissioned Report No. 392 (iBids No. 7062)
Contractor: Centre for River EcoSystem Science, University of Stirling
Year of publication: 2010

Background

A five year trial reintroduction of the European beaver in Knapdale, Argyll began in spring 2009. An independent monitoring programme has been established to determine what effects the beavers will have upon aspects of the natural heritage including aquatic and semi-aquatic macrophytes; damselflies and dragonflies; fish; fluvial geomorphology; river habitat; and water chemistry. The collection of an adequate baseline data set is required, in a repeatable and cost effective manner, to allow an assessment of the effect the beavers have on the Knapdale area.

Main findings

The report outlines the approach used to collect baseline data on the fluvial geomorphology and river habitat of the streams of Knapdale prior to the reintroduction of beaver. This is based on both a standard application of the River Habitat Survey method and a bespoke geomorphic assessment. The method outlined has provided robust baseline data against which any future alteration to the fluvial geomorphology or river habitat will be assessed. The data collected has been supplied to Scottish Natural Heritage in electronic *Microsoft Excel* and *Access* format and linked spatially within *ArcMap GIS 9*. The specific future monitoring requirements during the trial reintroduction of beaver to Knapdale, in terms of frequency and method of future surveys, are also presented.

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Note that raw data have also been supplied to SNH in tabular and digital format.

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Acknowledgements

The authors wish to acknowledge the permission of the Forestry Commission in allowing access to the streams of Knapdale. The method was drawn up in liaison with Angus Tree, Martin Gaywood and Duncan Blake at SNH, who also provided comments on the draft reports.

This project was supported through a partnership of Scottish Natural Heritage and the University of Stirling Centre for River EcoSystem Science as part of the monitoring of the Scottish Beaver Trial. The authors thank the Royal Zoological Society of Scotland, the Scottish Wildlife Trust and Forestry Commission Scotland for their help and cooperation. The Royal Zoological Society of Scotland and the Scottish Wildlife Trust will also contribute funds to the overall monitoring programme.

1 INTRODUCTION

A five year trial reintroduction of the European beaver at Knapdale in Argyll started in the spring of 2009. The aims of the trial include an assessment of the effects of beaver activities on the natural environment and the ability to inform further releases of beavers at sites with differing habitat characteristics. The success of the trial will be judged against criteria that include positive contribution to ecosystem function and an absence of significant or unsustainable damage to ecosystems within the release site.

The trial is contingent on an independent monitoring programme that will consider, *inter alia*, the impacts of beavers on the fluvial geomorphology and physical habitat of the rivers and burns within the Knapdale area. To support this monitoring it is critical that adequate baseline data are collected to establish the condition of the geomorphology and physical habitat in advance of the beaver release. This should be of suitable quality and resolution to discriminate between the effects of the trial beaver reintroduction and a range of other possible future influences on the physical quality of the stream environment. It should also be suitable for integration with other studies being undertaken in relation to the trial beaver reintroduction including beaver ecology monitoring and fish surveys.

The aims and objectives of the work and key challenges are outlined in section two of this report. A method for identifying changes in physical habitat and the primary data against which any change in the physical habitat of the in-stream and riparian zones of the streams of Knapdale is presented in section 4. All of the data collected using the outlined method have been submitted to Scottish Natural Heritage (see also section 5). Section 6 outlines the outcomes and recommendations for future monitoring.

The present work follows that undertaken by the University of Stirling in 2002 when hydrological and geomorphological baseline data was collected (Gilvear, 2002).

2 AIMS AND OBJECTIVES

The aims of the project were:

i To develop an appropriate method for collecting fluvial geomorphology and river habitat data against which any future changes due to the trial release of beavers in Knapdale will be measured.

ii To use the method developed to undertake a baseline survey of the fluvial geomorphology and river habitat of streams within the area of Knapdale identified as suitable for the trial release of the European beaver.

The specific objectives of this project were:

i To map and characterise the key physical habitat attributes that may be impacted by or indicative of any future beaver activity. These were:

- in-channel fluvial features and substrate types;
- bankside vegetation presence and structure;
- wider riparian woodland and wetland habitat features;
- hydraulic meso-habitats;
- bank morphology and stability; and
- the extent and significance of woody debris.

ii To use the attributes listed above to establish simple baseline indicators that will be used to quantify the effects of beaver activity on sediment, channel stability and physical habitat quality in the long term.

The data collected during this project have been supplied to SNH and will be analysed at the end of the trial reintroduction.

3 KEY CHALLENGES

The key challenges for the development of the method were:

i the uncertainty about precisely where the beavers will establish their territory following their release;

ii the related uncertainty about precisely where the beavers will forage and have localised, direct physical impact; and

iii establishing how to assess indirect impacts, e.g. the consequences for geomorphology and habitat that may be some distance downstream of beaver dams that trap sediment.

4 METHODS

Fifty-five reaches were identified for survey in the Knapdale area. These coincided with the locations of the previous surveys undertaken by Stirling University in 2002 (Gilvear, 2002). Most reaches were 500 m long. However, 18 were less than 500 m long either because a confluence with a larger watercourse was reached before the full 500 m was surveyed, or because a reach terminated at its tidal limit before the full 500 m reach distance was achieved.

River Habitat Surveys (RHS) were undertaken between November 2008 and January 2009 by Ms Roser Casas Mulet (RHS accreditation number LT088) with a support team of, variously, one or two individuals.

A modified geomorphic assessment pertinent to the impacts of beaver activities was undertaken in the same 55 reaches and allowed the recording of key attributes (see section 4.2 for details).

The surveys were complemented by GPS mapping (hand-held GARMIN GPS) and the photography of cross-sections and significant features. In some reaches where there was no GPS reception or it was not possible to download data, grid references were derived manually using Ordnance Survey (OS) maps. The location of the start and finish of each RHS reach was permanently marked with a metal peg and yellow marker.

4.1 The use of River Habitat Survey

River Habitat Survey was designed to be a rapid and repeatable method of providing quantifiable information about stream physical habitat, specifically the presence, abundance and structure of habitats within 500 m reaches (Fox *et al.*, 1998; Raven *et al.*, 1998).

The normal protocol is for RHS to be undertaken in the summer months. However, in summer the majority of the length of the stream network in the study area is poorly illuminated or obscured as a result of dense riparian woodland canopy and bankside vegetation. Winter conditions allowed easier access and upstream and downstream views of the streams for photography.

River Habitat Survey provides only a basic photographic record (two photographs per 500 m reach), easting and northing coordinates of only three out of 10 spot-checks, basic information on stream dimensions which are assessed at only one point in a 500 m survey, assignment of bed material into coarse bed material classes, and the presence/absence of riparian woodland and woody debris. Therefore, a bespoke, bolt-on method, which was termed a ‘modified geomorphic assessment’, was undertaken to provide detailed information on stream attributes that could potentially be affected by beaver activity but which are not recorded by the standard RHS method. River Habitat Survey also allows a Habitat Quality Score (HQS) to be calculated. This is a measure of the structural complexity and habitat diversity of a 500 m long RHS site. This score cannot be calculated for surveys where less than 10 spot-checks are completed.

Based on the experience of members of the survey team in monitoring beaver activities (Jones *et al.,* 2009), it is suggested that any significant changes in morphology associated with beaver will mainly be in response to the building of dams or the introduction to the channel of woody debris generated by felling.

4.2 Modified geomorphic assessment

A standard pro forma sheet was developed for the modified geomorphic assessment and was applied to every RHS reach surveyed. This pro forma sheet is shown in Appendix 1A.

Based upon field work experience, an improved version of the pro forma sheet was developed. This is shown in Appendix 1B. It is recommended that this version is used for future field surveys. In order to avoid confusion, the method explained below refers to the improved version of the geomorphic assessment pro forma sheet.

Data associated with channel dimensions, bankside vegetation, fallen trees and hydraulic meso-habitats were collected at each RHS spot-check. More specific details of how and what data were collected are given in the following sections. Figure 4.1 lists the variables assessed at each spot-check.

Woody debris, erosion/deposition and wetland/pond feature data were collected independently of spot-check data and were noted as the walk over survey was being undertaken (see the related sections below for details and Figures 4.2, 4.3 and 4.4).

Along with these measurements and the data collected, GPS coordinates of each spot-check were recorded and a comprehensive photographic record was established, with upstream, downstream and at-a-site photographs taken at all RHS spot-checks.

4.2.1 Channel dimensions

The standard RHS method measures channel dimensions at only one location in a 500 m survey reach. The modified geomorphic assessment included the measurement of channel dimensions at each RHS spot-check. These measurements included: left and right bank top height; bankfull channel depth, measured at approximately every 40 cm across the width of the channel; and bankfull width. 'Bankfull' was determined by using the first major break of slope or occasionally by the limit of terrestrial vegetation presence on the river bank. Bed material type ('consolidated' or 'unconsolidated') was also noted (see Figure 4.1).

4.2.2 Bankside vegetation

The standard RHS provides information on vegetation structure in 10 spot-checks within each 500 m reach but only notes the presence of alder species. Information on vegetation structure is not linked to vegetation communities or key species relevant to beaver foraging activity.

At each spot-check, the left bank (LB) and right bank (RB) riparian broadleaf woodland was characterised in terms of: width (0-1 m, 1-5 m, 5-10 m, 10-15 m, >15 m); and vegetation distribution and density (None, None (CP) which refers to the presence of coniferous plantation immediately next to the stream, Isolated, Scattered, Semi continuous, Continuous). The relevant species considered were: birch (*Betula* sp.); alder (*Alnus* sp.); and willow (*Salix* sp.). These three species are an important element of the beaver diet (Jones *et al.,* 2003). Two other broadleaf species (*Corylus* sp. and *Acer* sp.) were also recorded. All species were classified according to structure (tree (T), shrub (S)) and coverage (%).

This protocol was considered to provide a more detailed assessment of the impacts upon the composition and structure of riparian species than the one included in the current version of RHS (see Figure 4.1).

4.2.3 River corridor

River Habitat Survey provides general land use information from within 50 m of bank top only. Thus, in addition to the RHS data, we found it important to note the presence of valley floor wetland and ponds as well as any fallen trees. Based on the findings of Jones *et al.* (2003), we worked on a 25 m wide river corridor (12.5 m either side of the watercourse) for this purpose. We noted the total number of fallen broadleaf branches and trees present in a 25 m wide river corridor that could potentially be confused with future beaver activity (see River corridor I in Appendix 1B). To enable a standard recording system, fallen trees were recorded at each spot-check only. Fallen trees were classified by: type (branch or tree); length (small <1 m, medium 1-5 m, big >5 m); and, where identifiable, species (see 'Fallen Trees' section in Appendix 1B and Figure 4.1). All wetlands and ponds present in a 25 m width of river corridor were recorded (see River corridor I in Appendix 1B). Their location was mapped with a GPS, their dimensions and characteristics were noted and photographs of them were taken (see Figure 4.3.).

4.2.4 Hydraulic meso-habitats and salmonid habitat assessment

A change in the hydraulic features of meso-scale habitat will occur in, and adjacent to, any reaches affected by beaver dam building activity. River Habitat Survey provides information on presence and extent of flow types and channel features, but it does not map the location of meso-habitats.

A salmonid hydraulic habitat assessment was undertaken at each spot-check (see Figure 4.1), allowing the mapping of six different habitat types (riffle, riffle-run, glide, deep glide, pool and bedrock/cascade). A detailed assessment of fish populations and spawning activity is the focus of a separate study (Argyll Fisheries Trust, in prep.).

4.2.5 Woody debris features

The standard RHS only reflects the presence/absence of woody debris features. It was felt that it was important to set-up a baseline dataset that would allow significant changes in the amount of woody debris as a result of beaver activity to be quantified.

Every individual woody debris feature that was >1 m^2 or 1 m long was therefore characterised and geo-referenced. Woody debris features were classified by type (leaf (L), twig (Tw), branch (Br), trunk (Tk)) and by the amount of channel they covered (full width (fw), half width (hw), marginal (m)). Woody debris dimensions (length and width in m) were also noted and a photograph of each feature was taken (see Figure 4.2 and Appendix 1B).

4.2.6 Bank stability and deposition

The standard RHS does not map areas of bank erosion or deposition unless they fall within a spot-check. As part of the modified geomorphic assessment the location of all areas of significant bank erosion and deposition were noted, characterised, photographed and geo-referenced (see Figure 4.4 and Appendix 1B). This baseline data will allow the quantification of any future beaver induced changes to channel stability.

4.2.7 Bed material

The standard RHS method collects qualitative information on channel and bank substrate in all 10 spot-checks. However, a quantifiable measure of bed material is important to reflect future changes and so two armour layer pebble counts, each of 100 particles, were undertaken within every 500 m reach. A standard pebble plate was used. The pebble counts

were located at spot-checks 1 and 6 except where conditions did not allow, e.g. in bedrock reaches or those with heavily silted substrates.

Figure 4.1 Information associated with each spot-check

			Channel dimensions / characteristics							Bankside vegetation												River corridor (I)													
Spot check code	RHS	Photo ref (IMG)	Bankfull width (m)	LB Bank top height (m)	Bankfull depth 1 (m)	Bankfull depth 2 (m)	Bankfull depth 3 (m)	RB Bank top height (m)	Bed material type	LB width vegetation	LB vegetation distribution	LB *Alnus* structure / coverage	LB *Betlula* structure / coverage	LB *Salix* structure / coverage	LB Other broadleaf structure / coverage	RB width vegetation	RB vegetation distribution	RB Alnus structure / coverage	RB Betlula structure / coverage	RB Salix structure / coverage	RB Other broadleaf structure / coverage	Fallen branches number	Small (<1 m) fallen trees number	Medium (1-5 m) fallen trees number	Big (>5 m) fallen trees number	Fallen trees key dominant specie	Salmon habitat type	Peg location	Water course	Tributary to	X	Y	Date	Data type

Figure 4.2 Information associated with each woody debris features point

Woody Debris Feature characteristics													
WD feature code	WD feature composition	WD channel coverage	WD feature Length (m)	WD feature Width (m)	Number of WD features	WD feature photo ref (IMG)	RHS	Water course	Tributary to	X	Y	Date	Data type

Figure 4.3 Information associated with each wetland/pond features point

River Corridor Feature characteristics												
RC feature code	RC feature type	RC feature Length (m)	RC feature Width (m)	RC feature location	RC feature photo ref (IMG)	RHS	Water course	Tributary to	X	Y	Date	Data type

Figure 4.4 Information associated with each deposition/erosion features point

Erosion / Deposition Feature characteristics														
ED feature code	ED feature type	ED feature substrate	ED feature location	ED feature Length (m)	ED feature Width (m)	Number of ED features	ED feature photo ref (IMG)	RHS	Water course	Tributary to	X	Y	Date	Data type

5 DATA PROCESSING AND SUBMISSION

Completed RHS forms were provided to SNH, both as hard copy and electronically in PDF format.

In order to provide all the other field data in a meaningful way it was added to *Microsoft Excel* and *Access* databases and spatially linked using *ArcMap GIS 9*.

An attribute table was created for each spot-check location and provided the information listed in Figure 4.1. Features recorded at locations other than spot-checks, for example the location of any woody debris, erosion or deposition features, were also mapped, tabulated and spatially referenced using *ArcMap GIS 9*, providing the information listed in Figures 4.2 to 4.4.

Figures 5.1 and 5.2 illustrate some of the spot-check and woody debris feature location outputs from the GIS; the associated attribute tables are shown. The information associated with each spot-check was submitted to SNH in the following formats: *Excel* and PDF tables; an *Access* database; a Personal Geodatabase; and Shapefiles. Maps illustrating the location of RHS spot-checks, river corridor features, erosion and deposition features and woody debris features and are shown in Appendix 2.

Figure 5.1 Example of output information (attribute table in ArcMap 9) related to an individual spot-check

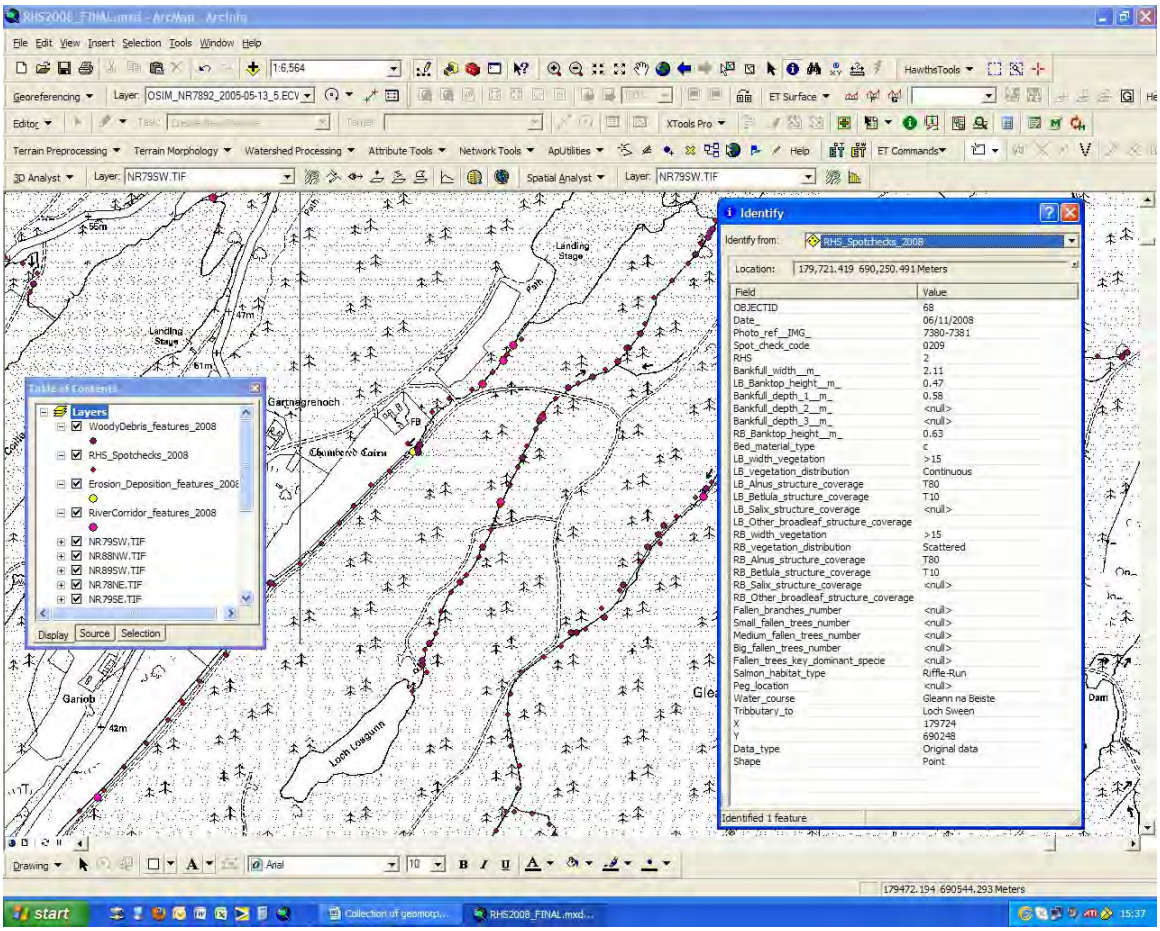
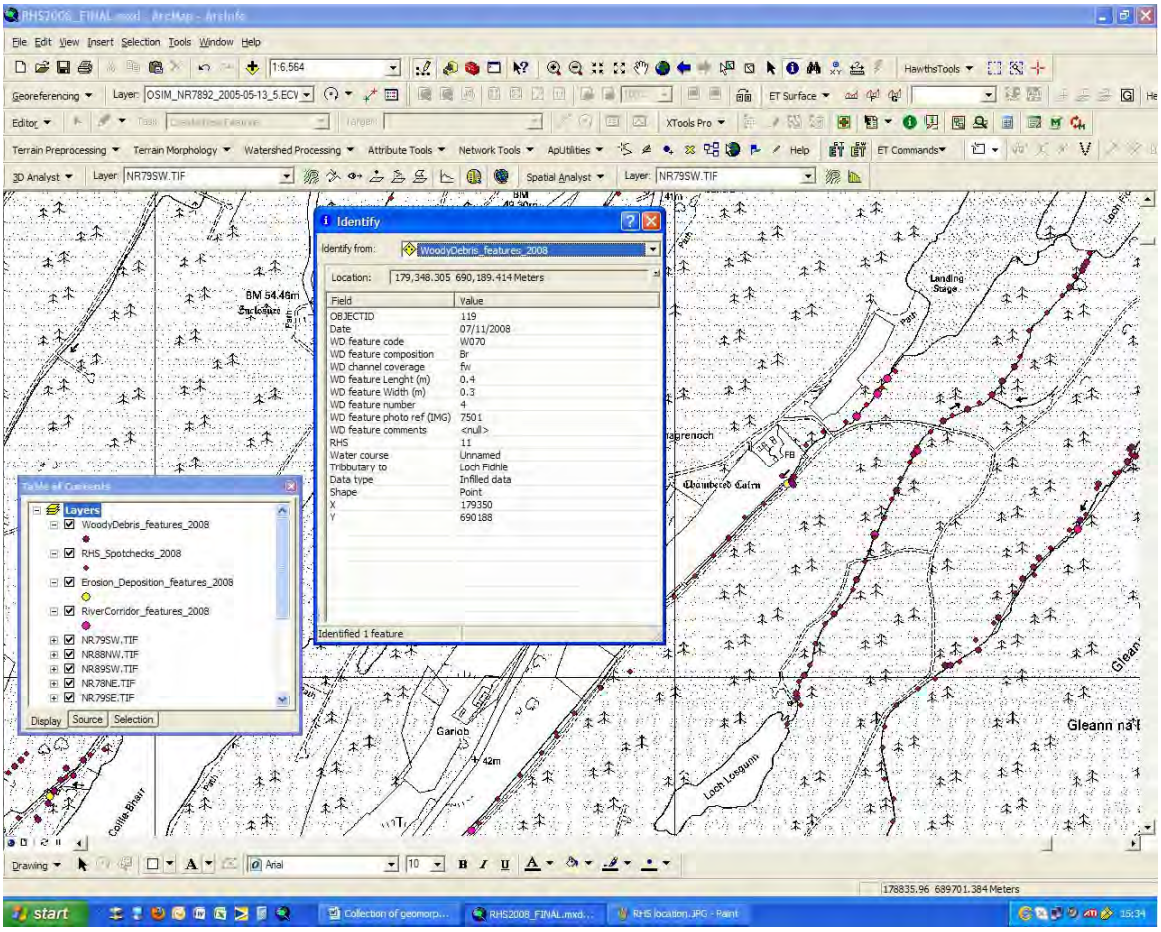


Figure 5.2 Example of output information (attribute table in ArcMap 9) related to an individual woody debris feature



A complete photographic library was also supplied to SNH in electronic format.

6 OUTCOMES AND FUTURE MONITORING

6.1 Outcomes

Application of the above methods to the streams of Knapdale has allowed the collection of standard RHS data and additional data on the physical habitat through the development of a modified geomorphic form.

River Habitat Survey data collected for this project will be used in the future for comparisons with the work undertaken in 2002 by the University of Stirling (Gilvear, 2002). Both sets of data may also be analysed to assess changes in the stream systems that occurred without beavers present. Both datasets were collected according to the prescribed RHS method and for the same reaches.

Data collected in the modified geomorphic assessment was based upon a good understanding of beaver activity and its potential impacts upon the physical habitat of the streams in Knapdale. The application of this assessment demonstrates a robust approach towards recording physical habitat and, therefore, when the results of future surveys are compared with the baseline data any significant changes in fluvial geomorphology and physical habitat should be clear.

At this stage a limited number of significant findings can be reported about the current status of the streams in Knapdale. These are:

- The stream network is sandwiched by coniferous forestry plantations in some reaches.

- In a number of reaches the stream network has been subjected to heavy morphological modification by dredging, straightening and the construction of drainage ditches associated with forestry operations.

- Woody debris was observed in some of the streams and occasional debris dams are present.

A detailed analysis and interpretation of the data collected will be undertaken later in the trial.

6.2 Programme for future monitoring

It will be necessary for the Scottish Beaver Trial field officers to ensure that they have walked the whole area for which RHS and the modified geomorphic assessment was undertaken and to note areas where beaver activity is changing physical habitat and where any fluvial impact is occurring. This should be done at least annually and linked to the beaver ecological monitoring (Campbell *et al.*, 2010). The beaver activity signs that should be noted include: beaver felled or partially felled trees or gnawed trees; beaver feeding platforms and caches; debarked woody fragments; beaver tracks; and any obviously fresh areas of bank erosion or deposition. A protocol and standard recording sheet has been produced in liaison with the beaver ecological monitoring work (Campbell *et al.*, 2010) and supplied to the field officers. The field officers have also been given details about recording geographic information and standard approaches to photographic recording.

In reaches where beaver activity is identified by the field officer 14 months after the reintroduction of beavers, RHS surveys and modified geomorphic assessments will be repeated by University of Stirling specialists to provide an understanding of the development of in-stream and riparian habitat such as the re-growth of felled willow (see Jones *et al.,*

2009). A comprehensive RHS and modified geomorphic assessment will take place for the whole area at the end of the trial period.

In some of the areas where changes have been recorded, more in-depth geomorphological investigations will help to shed light on the nature and processes of change. There will therefore be a need for a number of small investigations to describe change at selected sites over the course of the five year trial.

The most significant overall index of any change in the physical habitat of the streams of Knapdale will be the RHS Habitat Quality Assessment (HQA). Others indices against which potential change in habitat due to the beaver reintroduction may be established include:

- bed material size, specifically D_{50} and D_{90};
- density of woody debris features, i.e. number of woody debris features (>1 m^2 or 1 m in length) per 500 m reach;
- channel dimensions, i.e. the ratio of channel bankfull width to bankfull depth; and
- photography and the location of special habitat features

The derivation of these indices from the data collected and comparison with future surveys will allow the impact of the beaver reintroduction upon the physical habitat of the streams of Knapdale to be quantified. Once repeat surveys have been conducted, a detailed analysis of and comparison with the baseline data will be undertaken. At that stage a comparison of the baseline data with an earlier RHS dataset collected in 2002 will also be undertaken.

7 REFERENCES

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APPENDIX 1A: Original version of the modified geomorphic form (see section 4.2 for details)

Modified geomorphic form (I)

Surveyor(s):	Date:	Water course:	RHS ref:

CHANNEL DIMENSIONS (linked to L in RHS)

Spot Check GPS	Meso Habitat type	LEFT BANK			CHANNEL					RIGHT BANK			Bed material (c / u)	Photo reference
		Banktop height (m)	Bkt = Bkf ?	Embank height (m)	Bnkfull width (m)	Water width (m)	Water depth (m)			Banktop height (m)	Bt = Bf ?	Embank height (m)		
1.														
2.														
3.														
4.														
5.														
6.														
7.														
8.														
9.														
10.														

BED MATERIAL CHARACTERISATION (linked to E in RHS)

Wolman 1	Spot Check / GPS ref:	**Wolman 2**	Spot Check / GPS ref:
3		3	
4		4	
5.6		5.6	
8		8	
11.2		11.2	
16		16	
21.4		21.4	
31.5		31.5	
45		45	
63		63	
90		90	
128		128	
180		180	
256		256	
>256		>256	

BANK STABILITY

Natural Erosion features / processes

Feature name	GPS location	Dimensions (m x m) RB	Dimensions (m x m) LB	stable / unstable	Substrate + c/u

Slump (Sp) Creep (C) Freeze-thaw (Ft) Toe scour (Ts)
Slide (Sl) Wash (W) Eroding bank (Eb) Bed scour (Bs)

DEPOSITON

Natural Deposition features / processes

Feature name		GPS location		Dimensions (m x m) RB	Dimensions (m x m) Channel	Dimensions (m x m) LB	Substrate + c/u

Point bar (Pb) Mid-channel bar (Mb) Berm deposit (Bd)
Side bar (Sb) Discrete deposit (Dd) Floodplain dep. (Fd)

WOODY DEBRIS FEATURES

Feature no	GPS location	Coverage RB	Coverage Channel	Coverage LB	Length (m)	Type

Type: leaf (L) branch (B)
twig (T) trunk (TK)

Feature no	GPS location	Coverage RB	Coverage Channel	Coverage LB	Length (m)	Type

Type: leaf (L) branch (B)
twig (T) trunk (TK)

Modified geomorphic form (II)

Surveyor(s):	Date:	Water course:	RHS ref:

BANKSIDE VEGETATION (linked to F & Q in RHS)

Spot Check GPS	Birch (*Betula sp.*)		Alder (*Alnus sp.*)		Willow (*Salix sp.*)		Aspen (*Populus tremula*)							
	Coverage	Structure	Coverage	Structure	Coverage	Structure	Coverage	Structure	Coverage	Structure	Coverage	Structure	Coverage	Structure
1.														
2.														
3.														
4.														
5.														
6.														
7.														
8.														
9.														
10.														

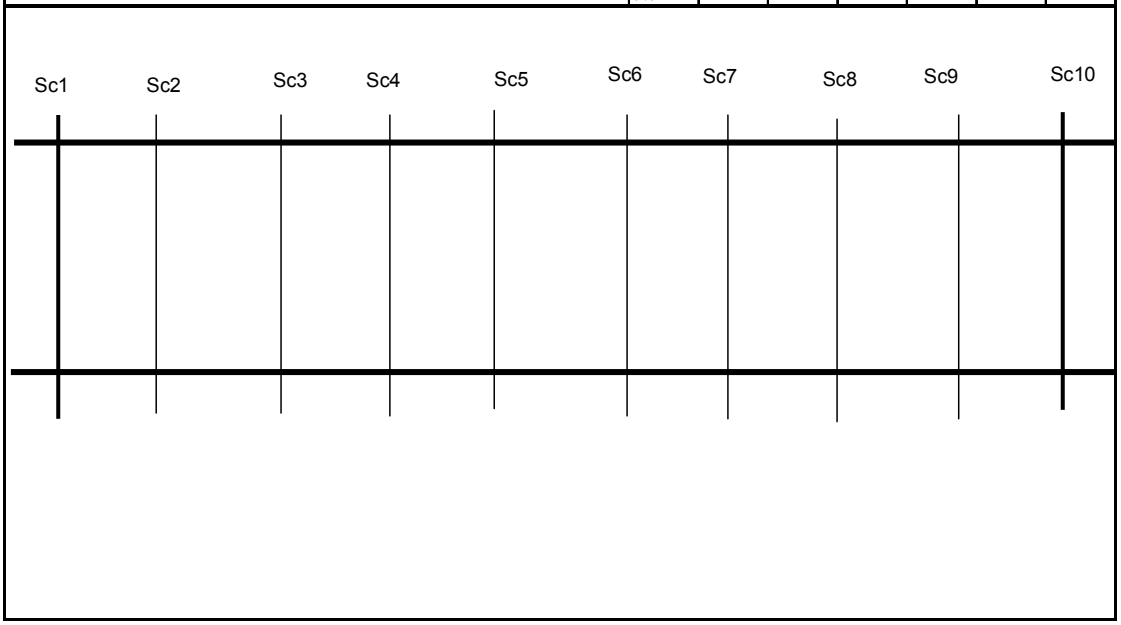
RIVER CORRIDOR (linked to H in RHS)

GPS ref:	Type	Dimensions (m x m)		Characteristics		GPS ref:		Type		Dimensions (m x m)		Characteristics	
		RB	LB							RB	LB		

wetland (W) pond (P)	felt trees (FT)

SALMONID HABITAT ASSESSMENT (linked to K in RHS)

Type		Characteristics	Colour / code	Habitat quality score					
				5	4	3	2	1	0
Riffle (shallow)	*Fry habitat*	gravel, pebble							
Riffle - Run (unbroken standing waves)	*Mixed juvenile*	cobble, pebble, boulders		x	x	x	x	x	x
Glide (< 0.5m)	*Deep juvenile*	boulder, cobble (>40cm deep but suitable substrate)							
Deeper glide (> 0.5m)	*Glides*	small substrate, smooth surface		x	x	x	x	x	x
Pool	*Holding habitat-pools*	generally >1m depth		x	x	x	x	x	x
Bedrock / Cascade	*Bedrock*	bedrock pools		x	x	x	x	x	x
Spawning habitat			**Sp**	x	x	x	x	x	x
Obstacles			**Obs**	x	x	x	x	x	x



APPENDIX 1B: Final version of the modified geomorphic form (see section 4.2 for details)

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Modified geomorphic form (I) . vers2

RESS

Surveyor(s):	Date:	Water course:	RHS ref:

CHANNEL DIMENSIONS (linked to L in RHS)

Spot Check GPS	Meso Habitat type		Bed material (c / u)		LEFT BANK	CHANNEL						RIGHT BANK	Photo references
					Banktop height (m)	Bnkfull width (m)	Bankfull depth (m)					Banktop height (m)	
1.													
2.													
3.													
4.													
5.													
6.													
7.													
8.													
9.													
10.													

BANKSIDE VEGETATION (linked to F & Q in RHS)

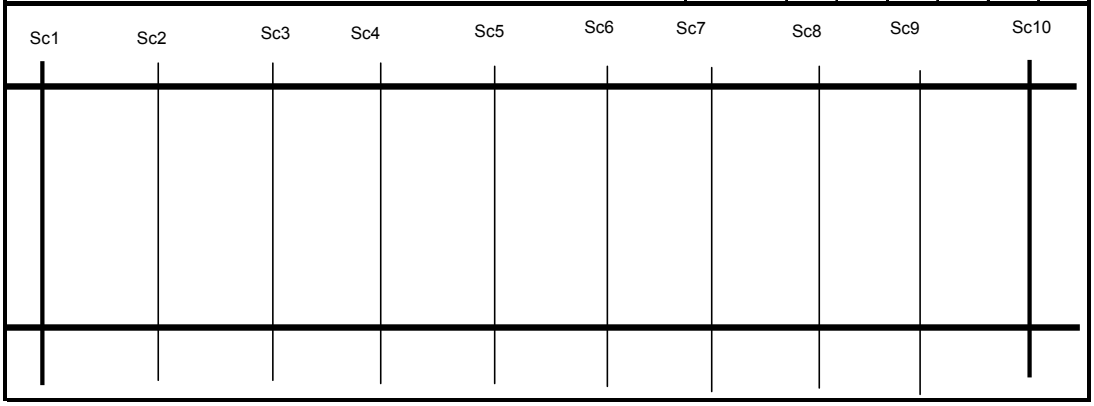
Spot Check GPS	LEFT BANK										RIGHT BANK									
	Buffer width (m)	Buffer structure	Birch (*Betula sp.*)		Alder (*Alnus sp.*)		Willow (*Salix sp.*)		Aspen (*Populus tremula*)		Buffer width (m)	Buffer structure	Birch (*Betula sp.*)		Alder (*Alnus sp.*)		Willow (*Salix sp.*)		Aspen (*Populus tremula*)	
			Structure	Coverage	Structure	Coverage	Structure	Coverage	Structure	Coverage			Structure	Coverage	Structure	Coverage	Structure	Coverage	Structure	Coverage
1.																				
2.																				
3.																				
4.																				
5.																				
6.																				
7.																				
8.																				
9.																				
10.																				

RIVER CORRIDOR (I) - Fallen trees (linked to H in RHS)

Spot Check GPS																				
	Type	Dimension	Specie	Number	Type	Dimension	Specie	Number	Type	Dimension	Specie	Number	Type	Dimension	Specie	Number	Type	Dimension	Specie	Number
1.																				
2.																				
3.																				
4.																				
5.																				
6.																				
7.																				
8.																				
9.																				
10.																				

SALMONID HABITAT ASSESSMENT (linked to K in RHS)

Type		Characteristics	Colour / code	Habitat quality score					
				5	4	3	2	1	0
Riffle (shallow)	*Fry habitat*	gravel, pebble							
Riffle - Run (unbroken standing waves)	*Mixed juvenile*	cobble, pebble, boulders		x	x	x	x	x	x
Glide (< 0.5m)	*Deep juvenile*	boulder, cobble (>40cm deep but suitable substrate)							
Deeper glide (> 0.5m)	*Glides*	small substrate, smooth surface		x	x	x	x	x	x
Pool	*Holding habitat-pools*	generally >1m depth		x	x	x	x	x	x
Bedrock / Cascade	*Bedrock*	bedrock pools		x	x	x	x	x	x
Spawning habitat			**Sp**	x	x	x	x	x	x
Obstacles			**Obs**	x	x	x	x	x	x



Modified geomorphic form (II). vers2

	Date:	Water course:	RHS ref:

WOODY DEBRIS FEATURES

Feature no	Location / GPS code	Channel coverage			Length x Width (mxm)	Type	Photo reference	Feature no	Location / GPS code	Channel coverage			Length x Width (mxm)	Type	Photo reference
		total width	half width	marginal						total width	half width	marginal			

Type: leaf (L) branch (B) twig (T) trunk (TK)

Type: leaf (L) branch (B) twig (T) trunk (TK)

RIVER CORRIDOR (II) - Wetlands and ponds (linked to H in RHS)

GPS ref:	Type	Dimensions (m x m)		Characteristics		GPS ref:	Type	Dimensions (m x m)		Characteristics	
		RB	LB					RB	LB		

wetland (W)
pond (P)

wetland (W)
pond (P)

BANK STABILITY

Natural Erosion features / processes

Feature name	GPS location	Dimensions (m x m)			Substrate + c/u
		RB	Channel	LB	

Slump (Sp) Creep (C) Freeze-thaw (Ft) Toe scour (Ts)
Slide (Sl) Wash (W) Eroding bank (Eb) Bed scour (Bs)

DEPOSITON

Natural Deposition features / processes

Feature name	GPS location	Dimensions (m x m)			Substrate + c/u
		RB	Channel	LB	

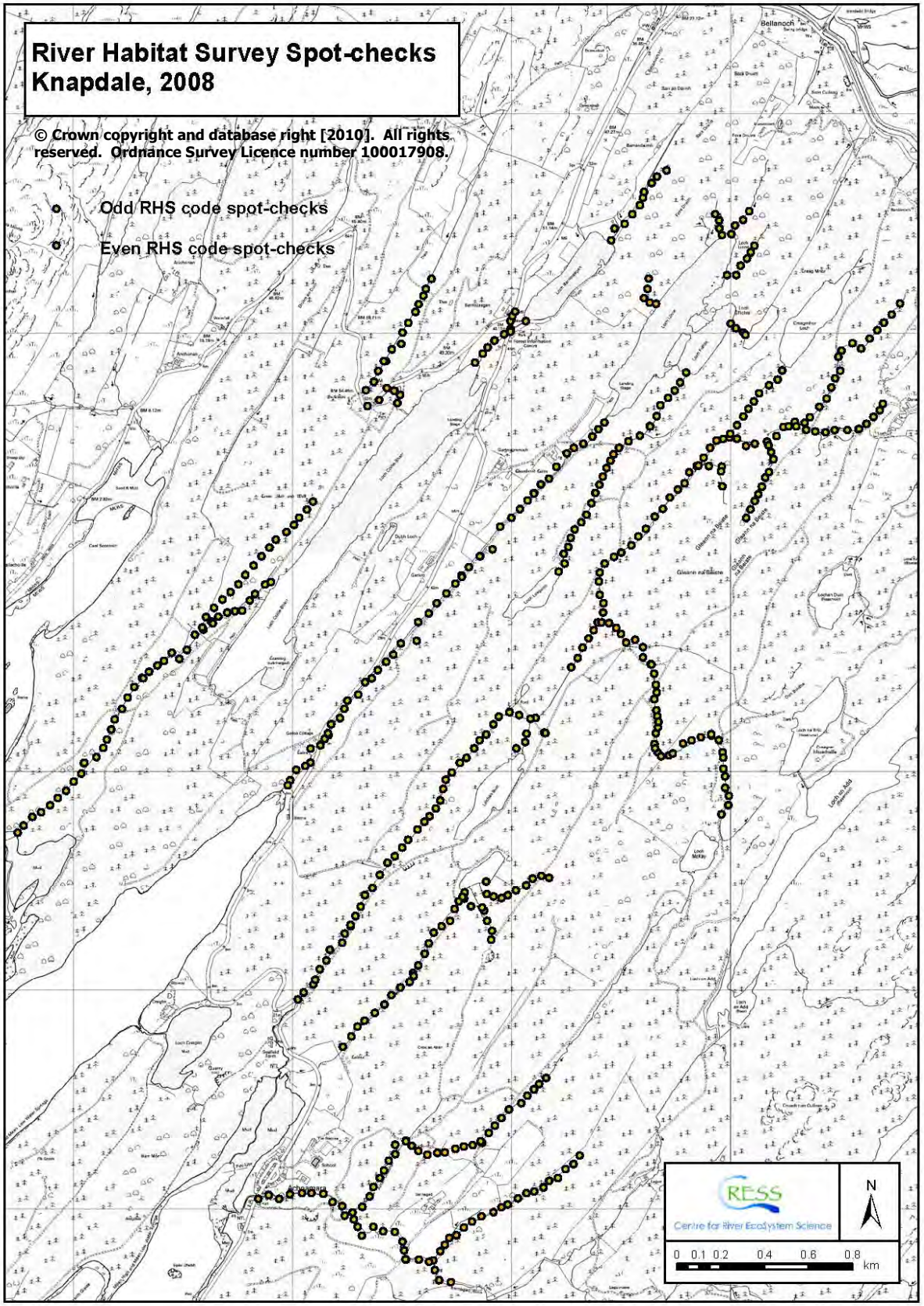
Point bar (Pb) Mid-channel bar (Mb) Berm deposit (Bd)
Side bar (Sb) Discrete deposit (Dd) Floodplain dep. (Fd)

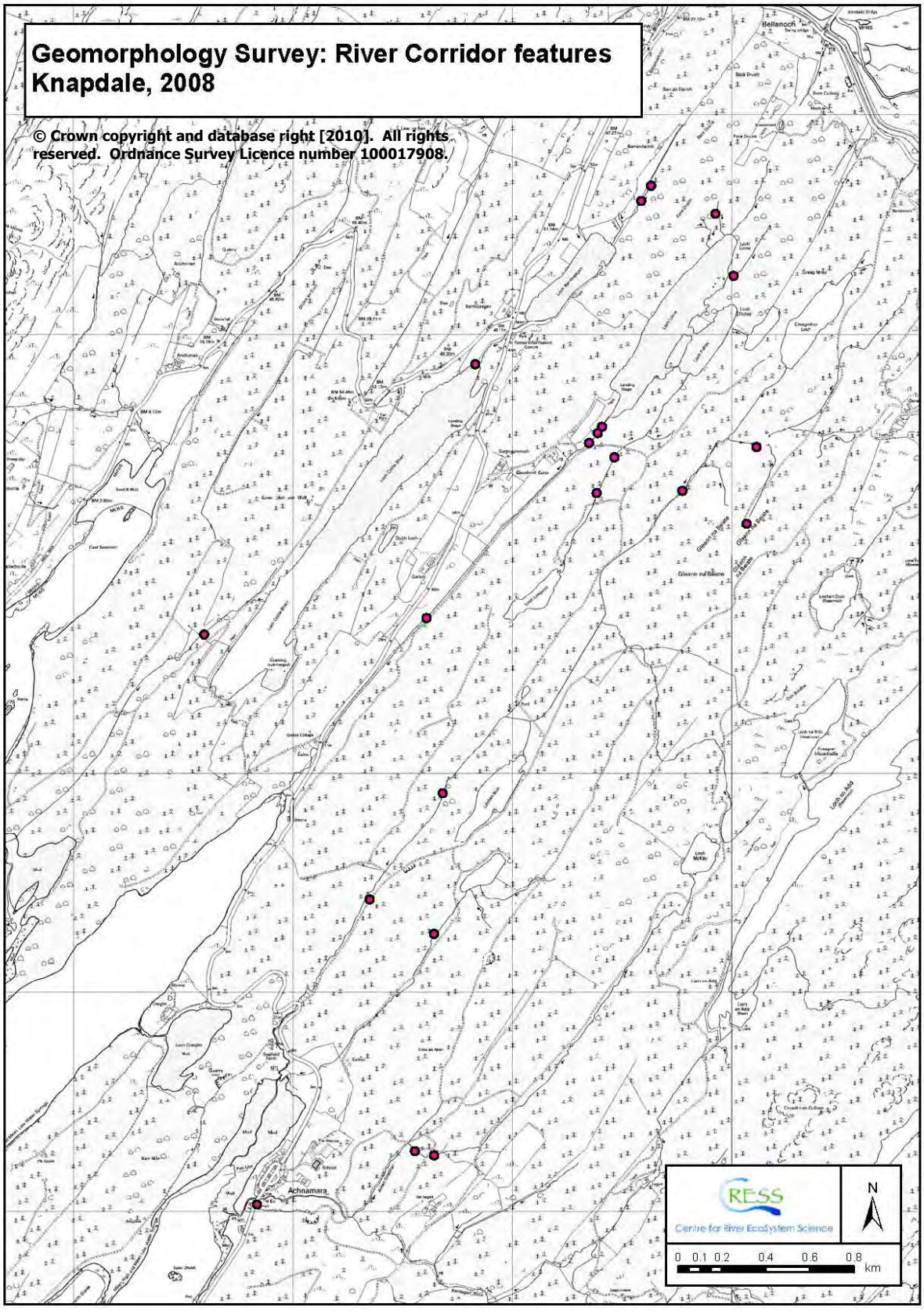
BED MATERIAL CHARACTERISATION (linked to E in RHS)

Wolman 1	Spot Check / GPS ref:
3	
4	
5.6	
8	
11.2	
16	
21.4	
31.5	
45	
63	
90	
128	
180	
256	
>256	
Bedrock	

Wolman 2	Spot Check / GPS ref:
3	
4	
5.6	
8	
11.2	
16	
21.4	
31.5	
45	
63	
90	
128	
180	
256	
>256	
Bedrock	

APPENDIX 2: Maps illustrating the location of RHS spot-checks, river corridor features, erosion and deposition features and woody debris features




Geomorphology Survey: River Corridor features
Knapdale, 2008
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Bellanoch
Achnamara
RESS
Centre for River Ecosystem Science
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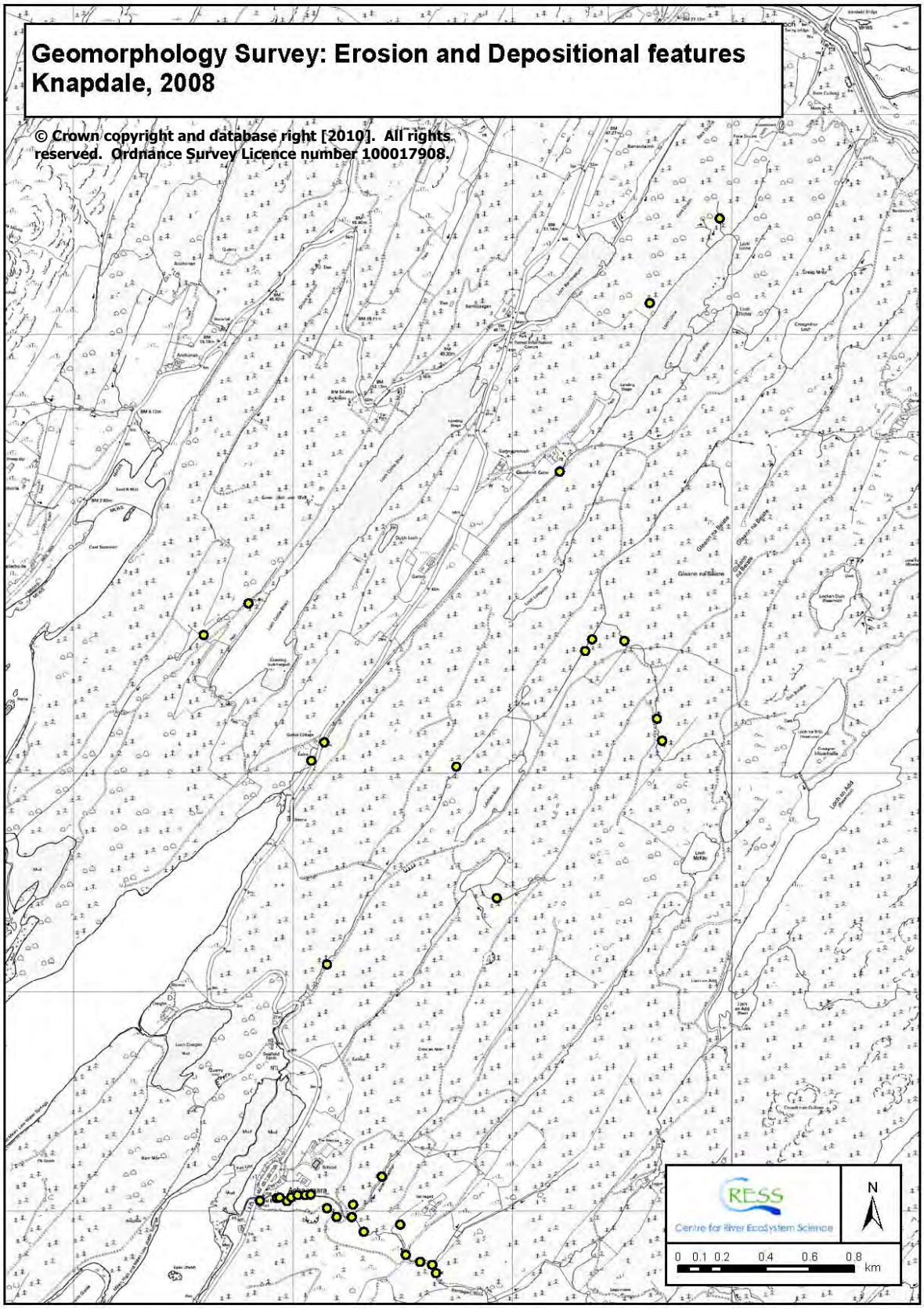
0 0.1 0.2 0.4 0.6 0.8
km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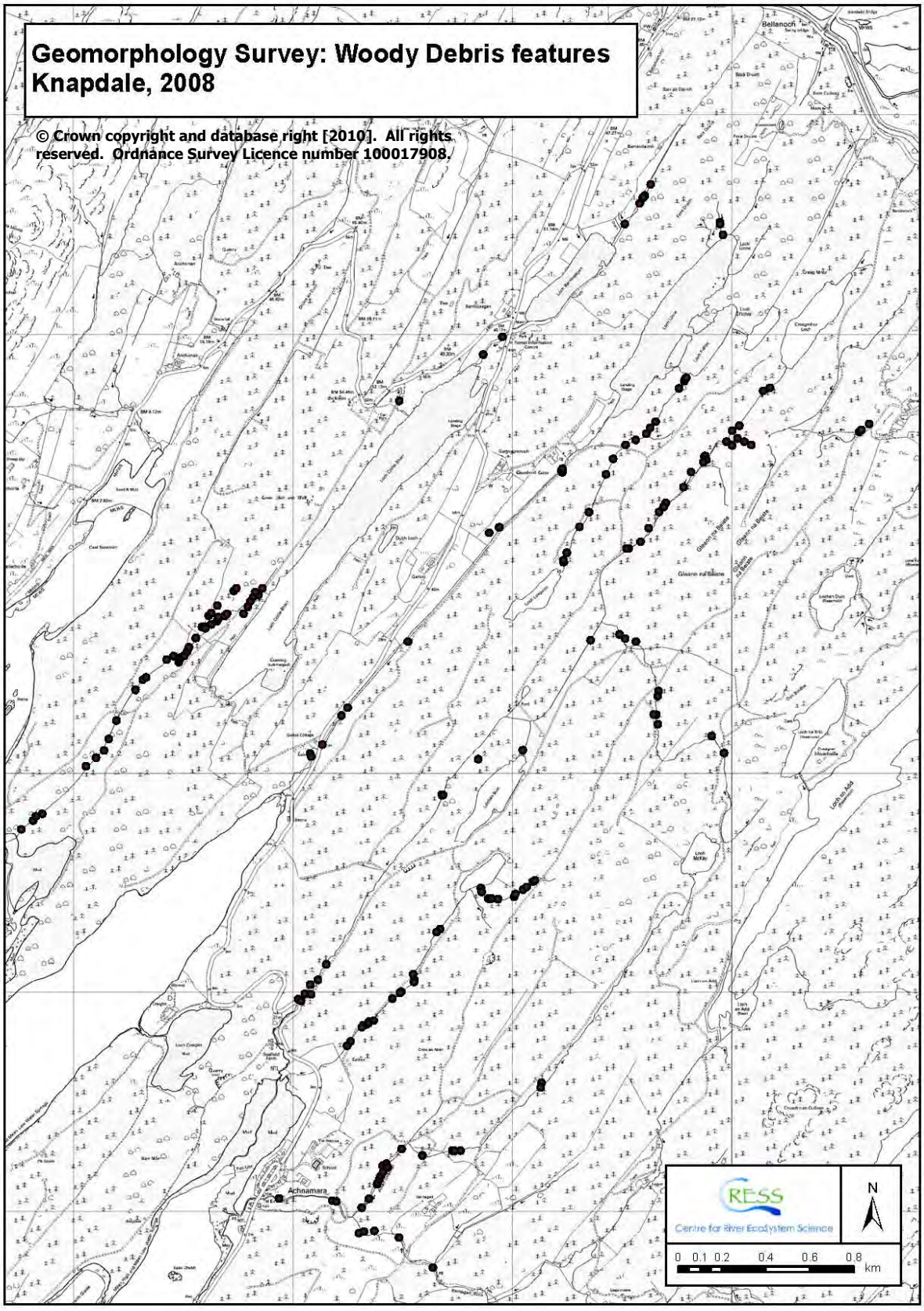
Centre for River Ecosystem Science
N
0 0.1 0.2 0.4 0.6 0.8
km


Geomorphology Survey: Woody Debris features
Knapdale, 2008
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