Management Plan Glenlude Estate
2012-2017

Introduction

1. Background

Glenlude Estate is approximate 6 miles south of Innerleithen on the B709, in the Scottish Borders. It is a relatively small property of 140 ha

The Glenlude estate was gifted to the John Muir Trust in 2004 by the late Shelia Bell who retained a life time tenancy until her death in November 2010. Sheila Bell had purchased the property in two roughly equal parts during 2000. These were Glenlude Forest (formally Kirkhouse) which had been planted by the Forestry Commission in 1995 and the open hillside of Glenlude hill farm as well as a strip of land on the west of the B709. Prior to 1995 both sections had been managed together as rough sheep pasturage within Glenlude hill farm.

The John Muir Trust took over day to day management of Glenlude upon Sheila Bells death and included it in the remit of the East Schiehallion Conservation Manager post on its creation in March 2011. In March 2012 the Trust appointed a part-time conservation ranger to be based at Glenlude.

2. Vision for Glenlude Estate

The John Muir Trust intends to manage Glenlude in line with its vision for wild land to support natural habitats and species. The Trust wishes to create and support a diverse landscape of native woodland, sustainable numbers of grazing animals, rich flora and abundant wildlife. These are defined with in the Trusts Wild Land Management Standards at www.wildlandmanagement.org.uk

During the process of creating this diverse landscape the Trust intends to maximise opportunities for the involvement of volunteers at all stages. The Trust intends to encourage educational use of the estate by initiatives such as the John Muir Award as well as linking up with formal & informal educational and training establishments at all levels.

3. Aim & Objectives

The overall aim for the estate is to move towards natural vegetation and natural processes, this will be achieved by:

- Re-structuring and ultimately replacing existing commercial woodland,
- Enhancing native habitats and species,
- Maximising engagement with volunteers and education opportunities,
- Creating a very small, sustainable work base on site consisting of a volunteers shelter, composting toilet and secure tool store.

4. Actions

WLM - STANDARDS	WLM - ACTIONS	YEAR 1	YEAR 5 OUTCOMES
1. Audit existing state and condition	Map all man-made structures	All structured mapped	
	Digitise woodland	All woodland digitised	
	Conduct archaeological survey	Archaeological survey complete	Add to list of known archaeological features any new ones which are discovered
	Collate all relevant data		
2.Establish survey and monitoring programme	Conduct habitat monitoring programme	Establish monitoring for marked seedlings, heath plots & flushes	A full programme of habitat monitoring in line with other Trust properties established plus additional monitoring in response to opportunities from individual volunteers or outside organisations
	Conduct species monitoring programme	Establish deer dung monitoring, breeding birds, butterfly transects, water voles (and other small mammals) surveys and black grouse lek counts	A full programme of species monitoring in line with other Trust properties established plus additional monitoring in response to opportunities from individual volunteers or outside organisations
	Monitor deer and livestock exclosure plots	Establish fenced exclosure plots by various methods including brash hedges	
	Maintain species records		Data records shared with Wildlife Recording Centre
	Take fixed point photographs		
	Monitor people counters / car park useage		Monitor car parking impacts on B709
	Conduct visitor survey	n/a	n/a
3. Develop SMART actions	Develop SMART actions	First management plan. Deer management plan. Forest plan. Year 1 work plan.	Five year management plan produced. A deer management plan produced. A twenty year Forest plan including detailed ten year felling and planting plans produced. .One year work plans will be produced within this prioritising actions and allocating tasks.

4. Consult stakeholders	Consult on plan with stakeholders	Management plan and Forest plan consulted on with stakeholders (Forestry Commission, SNH, local people, Tweed Forum, LBAP, SUP)	
5. Maximise water tables on peatlands	Block drains to raise water table		All appropriate drains on property blocked to enhance wetland habitats and bogs.
6. Minimise exposure, burning and grazing	Minimise burning	n/a	
7. Minimise pollution	Remove litter	Install composting toilet	No trace priniciples maintained
8. Maintain in favourable condition	Implement SNH advice	Obtain site condition monitoring data and results from SNH for SAC	
	Educate and work with other groups / users	Engage with JMA groups, SAC, IEEM	
	Advance SRDP applications to deliver management		
9. Maximise native habitats	Maximise native habitats		
10. Biodiversity species management	Map and remove non-native invasives (plants)		
	Develop and implement a control strategy (animals)		
11. Re-structure woodlands	Develop / implement a forest plan	Draft and submit 25 year forest plan	First thinnings or fellings of non-native species
	Additional native woodland planting projects		
12. Re-introductions	Consider re-introductions		
13. Minimise deer impacts	Deliver cull targets	Deer management plan developed, cull initiated	Deer plan agreed and implemented

	Engage with local Deer Management Group / Section 7 group to deliver cull targets	n/a	
	Collect and analyse relevant deer / habitat data	dung monitoring to be established	
14. Leave deer carcasses for eagles	Leave carcasses	n/a	n/a
	Monitor carcasses with camera traps		
15. Minimise livestock impacts	Control stock numbers	Ensure boundary fences / dykes secure, livestock confined to 2 ponies	
	Monitor incursions and liaise with neighbouring owners		Sheep incursions prevented / minimised
16. Staff training	Incorporate sustainability into staff training plans	Establish training plan for Glenlude Conservation Ranger	Training plan implemented
17. Infrastructure & heritage maintenance	Monitor and maintain condition of paths	Strimming used to create routes. Routes varied to minimise erosion. Walkers opening to be installed adjacent to gate on B709 opposite Paddock Slack	
	Monitor and maintain condition of buildings, fences and other structures	Maintain fences and boundary walls.	Fences and walls maintained. Volunteer shelter maintained.
	Run conservation work parties	27 days of work parties	
18. Reduce, re-use, recycle	Minimise resource use and waste		
19. Minimise carbon footprint	Maximise energy efficiency	Insulate volunteer shelter,	
20. Explore local renewable energy	Explore local renewable energy options	research and install sustainable energy soiurces eg Photovoltaics	Monitor energy usage
21. Remove redundant structures	Remove redundant structures		All redundant fencing removed

	Remove, reduce or narrow roads where possible		
22. Sensitive new build techniques	Apply sensitive techniques to any new build	New tool store and composting toilet built sensitively	
23. Sensitive footpath techniques	Apply sensitive techniques to any new footpath	n/a	n/a
24. Provide responsible access	Provide guidance on large scale events	n/a	
	Provide guidance on fishing policy		
	Advise on responsible campfires and clean up		
25. Meet responsibilities towards local people	Liaise with neighbours	ongoing	
	Attend relevant local meetings		
	Hold open meetings	Hold one open community meeting annually to inform those within the community of the work of the Trust in the Glenlude area	Hold one open community meeting annually to inform those within the community of the work of the Trust in the Glenlude area
	Use local contractors where possible		
26. Joint project work	Liaise with local Scottish Natural Heritage staff		
	Contribute to relevant regional projects and events		
27. Maximise interpretation	Review and update leaflets, ensure leaflet dispensers filled	Maintain interpretation material in Volunteers shelter	Investigate interpretation at entrance opposite Paddock Slack
	Review and maintain website information		

	Review and maintain interpretation panels		
	Consider providing interpretation in Gaelic		
28. Maximise education opportunities	Hold events such as talks, open days and guided walks to encourage wild land awareness	Run two guided walks or other public activities	
	Produce articles for local media		Put out regular press releases and articles and maintain website entry for Glenlude
	Encourage local John Muir Award activity	promote & enable John Muir Award use of Glenlude	Explore use by other groups such as forest schools, SAC, IEEM

5. Additional information

5.1 Designations

A small section of the Paddock burn (north of NT 311 295) falls within the River Tweed SAC, this is an area of about 1 Ha and forms less than 1% of the total area of the protected site.

5.2 Management Agreements

Forest Plan – A Statement of Intent to write a 25 year forest plan with detailed 10 year felling & planting plans was accepted by the Forestry Commission in January 2012. This process has started with initial meetings due with the FC case officer in April.

Initial aims have been drafted for discussion – to establish a windfirm edge to the commercial block in the next five years, as this will increase the range of options available for dealing with the core crop (phased clearfell, small-scale harvesting/extraction, CCF, LISS etc) and will also be of biodiversity and amenity benefit It will also keep options option for a commercial felling in 20-25 years time (see concept map in appendix two)

5.3 Location

The estate is approximately 140ha centred on NT313 285 within the Scottish Borders. The Trust is in the process of registering Land Parcel Identifier (LPID) with the Scottish Government Rural Payments and Inspections Directorate (SGRPID) The boundary between Peebleshire and Selkirkshire runs across the estate roughly east/west centres on the top of Glenlude Hill. See Appendices 5 boundary map and 6 aerial photograph

5.4 Tenure

The 140 ha area of Glenlude was gifted by Sheila Bell to the John Muir Trust with Land Certificates being registered to the Trust in 2004. There are no tenancies on the estate. Rights of access exist across the estate by the track from the B709 at NT 312 298 to;

- The Traquair estates and tenant (Robin Simpson)
- Glenlude House (Angus & Stephanie Wolfe Murray)
- Glenlude Farmhouse formally Kirkhouse farmhouse (Janet Firminger)

The Traquair estate and tenants have a further right of access from this track to the sheep fank at NT 302 298

There are no recorded wayleaves or rights of way although the Southern Upland Way runs close to Glenlude approximately 800 metres to the North West of the boundary.

5.5 Site Definition and Boundaries

Boundary Neighbours

- Traquair Estates (tenant Robin Simpson) to the north
- Buccleuch etste (tenant James Irving) to the south
- Kirkhouse forest (managed by Scottish Woodlands Ltd)to the west
- Glenlude Farm house (private ownership Janet Firminger)

Glenlude house (private ownership Angus & Stephanie Wolfe Murray) are close neighbours but without contiguous boundary

5.6 Management responsibilities

The property is managed within the John Muir Trust Land and science department by a part-time Conservation Manager (Shared with the East Schiehallion estate). This is currently Sandy Maxwell who is based out of the Pitlochry head office of the John Muir Trust. From March 2012 a 0.5 part-time (permanent) Conservation Ranger will be based at Glenlude working from home in the Borders Area. This is currently Karen Purvis who is line managed by the Glenlude Conservation Manager.

5.7 Additional environmental information

- Geomorphology see appendix 7 study by Dr WA Mitchel
- Hydrology

Glenlude lies on the watershed between the catchments of the Tweed and Yarrow Water with the Paddock burn draining northwards to the River Tweed and the Mountbenger Burn drains the site southwards to the Yarrow Water (a tributary itself of the Tweed). The watershed coincides with the track off the B709 at NT 313286 leading up to the volunteer's shelter.

The area planted in 1995 had drains constructed over its extent draining to both the Paddock and Mountbenger burns. There is evidence of much earlier field drains on the northern face of Glenlude Hill draining to the Glenlude and Paddock burns.

5.8 Appendices

1. Deer Management Plan *prepared by Lester Standen JMT Deer Officer*
2. Concept map for Forrest Plan *prepared by Gary Servant of Upland Ecology*
3. Phase one vegetation survey *prepared by Liz Auty JMT Biodiversity Officer*
4. Species list observed at Glenlude
5. Boundary map and location
6. Aerial photograph of estate *Scottish Borders Council*
7. Geomorphology study of Glenlude *prepared by Dr W A Mitchell Department of Geography, Durham University*

Appendix 1. DEER MANAGEMENT PLAN

Glenlude
2013-17

1. Rationale

John Muir Trust recognises that:

- Native deer species are an integral part of the natural heritage,
- Deer management can bring environmental, social and economic benefits,
- At inappropriate population levels, deer impacts can damage habitat condition and suppress natural processes.

Deer populations will be manipulated through culling:

- To achieve John Muir Trust's charitable objective to "conserve and protect wild land encouraging natural processes",
- In line with industry Best Practice Guidance,
- Not impeding public access at any time.

2. Audit

2.1 Geology, soils, habitats and species

Bedrock mapping around Glenlude indicates that the rock here is primarily greywacke attributed to part of the Gala Group (Llandovery age; lowest Silurian) (Peach and Horne, 1899). A desk based report on the geomorphology of the site has been prepared for the Trust by Dr W A Mitchell Department of Geography, Durham University (appendix 7).

A range of habitats are present on the property of 140Ha in total, with 75Ha under conifer plantation a mixture of Larch and Sitka Spruce. There are also some small areas of native tree planting. The open areas are a mainly a mix of acid grassland and small areas of heath and bog. There are some interesting areas of neutral grassland, and also small patches of calcareous grassland associated with flushes at the South of the property. To the north of the property on the paddock burn there are some areas of willow scrub with some regeneration occurring.

2.2 Designations, biodiversity priorities, habitat conditions

A small section of the Paddock burn falls within the River Tweed SAC, this is an area of about 1 Hectare and forms less than 1% of the total area of the protected site. Key habitats for biodiversity on the property:

Blanket bog (0.7 Ha)
Wet heath (5 Ha approx.)
Native tree planting areas
Calcareous flushes
Wetlands along water courses and recently created ponds
Neutral grassland.

Many of the planted trees are protected by tree tubes and have not grown above that level. A programme of brash fencing protection for these trees is

planned along with removal of tree guards, addition of vole guards and an annual monitoring programme.

2.3 Livestock

The perimeter of the estate is effectively stock fenced and incursions are unusual.

2.4 Employment and income

Deer management is carried out by a local contract stalker at a cost of approximately £1,500 per annum. There is no income from venison due to the cost of transporting them to a game dealer being higher than their value. There is currently no sport stalking on the estate.

2.5 Deer population estimates and cull figures

No count data is available for the property. The main species of deer present is roe deer. Sika deer are also present in the area but have not been seen on the estate. There are signs that they are now visiting the site

Year	Count estimate				Cull			
	Bucks	Does	Kids	**Total**	Bucks	Does	Kids	**Total**
2005/06	-	-	-	-	3	4	2	9
2006/07	-	-	-	-	4	5	12	21
2007/08	-	-	-	-	4	3	7	14
2008/09	-	-	-	-	2	3	7	12
2009/10	-	-	-	-	3	4	3	10
2010/11	-	-	-	-	6	10	0	16
2011/12	-	-	-	-	10	4	6	20
2012/13					5	3	6	14
2013/14								
2014/15					**4**	**9**	**14**	**27**
2015/16					**3**	**5**	**11**	**19**

3. Objectives, targets and constraints

3.1 Habitat

To manipulate the deer population through culling to enable:

- All habitats (designated and non-designated features) to be in or move towards favourable condition,
- Natural habitat processes (such as woodland regeneration) to continue or to start,
- Populations of priority species to be maintained or enhanced.

3.2 Deer population and cull

A specific target deer density has **not** been set. Instead culls will be adjusted in line with monitoring information to achieve the above objectives. Culling will not be focussed on target areas to achieve local scale habitat objectives due to the small size of the estate. Purely as a **guide** it is anticipated that a total annual cull of around 20 will be achievable for 2013-17. This figure will be reviewed annually.

3.3 Employment and income

The current annual level of employment is expected to be maintained with no income from stalking activity.

3.4 Constraints and mitigation

It is recognised that the habitat, natural process and priority species population objectives set out above may be constrained by external uncontrollable factors such as weather, fire etc. Wider deer management by neighbours may also impact on both the habitat objectives and the cull required. Where possible John Muir Trust will seek to negotiate or influence neighbours sharing deer range to meet objectives.

4. Monitoring

4.1 Habitats and species

A programme of habitat and species monitoring is in place on the property. Annual habitat impact monitoring (carried out in May / June) will be used to inform cull targets for the year.

4.2 Deer and livestock numbers

The key measures are habitat impact and condition. Due to the difficulty of counting deer on the estate, anecdotal evidence of numbers combined with impact assessment will be used to determine numbers in the first instance. Livestock incursions will be recorded. Deer cull data will also be recorded.

5. Review

Habitat, count estimate data and cull data will be reviewed annually with the plan adjusted accordingly. A review of the whole plan will take place in 2017.

Appendix 2. List of species observed on Glenlude Estate

Plants (28/7/11 by Liz Auty during Phase One preparation)

Group	Code	Common Name	Scientific Name	Date	Status
BSBI Complete	58	Alchemilla vulgaris agg.	Alchemilla vulgaris agg.	28/07/2011	
BSBI Complete	1495	Annual Meadow-grass	Poa annua	28/07/2011	
BSBI Complete	2559	Annual Pearlwort	Sagina apetala	28/07/2011	
BSBI Complete	1230.1	Apple	Malus domestica	28/07/2011	
BSBI Complete	841	Ash	Fraxinus excelsior	28/07/2011	
BSBI Complete	1596	Barren Strawberry	Potentilla sterilis	28/07/2011	
BSBI Complete	726	Bell Heather	Erica cinerea	28/07/2011	
BSBI Complete	2136	Bilberry	Vaccinium myrtillus	28/07/2011	
BSBI Complete	1616	Bird Cherry	Prunus padus	28/07/2011	
BSBI Complete	1191	Bird`s-foot-trefoil	Lotus corniculatus	28/07/2011	
BSBI Complete	1112	Bitter Vetch	Lathyrus linifolius	28/07/2011	
BSBI Complete	1250	Black Medick	Medicago lupulina	28/07/2011	
BSBI Complete	1299	Blood-drop-emlets	Mimulus luteus	28/07/2011	
BSBI Complete	1076	Blunt-flowered Rush	Juncus subnodulosus	28/07/2011	
BSBI Complete	1345	Bog Asphodel	Narthecium ossifragum	28/07/2011	
BSBI Complete	1576	Bog Pondweed	Potamogeton polygonifolius	28/07/2011	
BSBI Complete	2007	Bog Stitchwort	Stellaria uliginosa	28/07/2011	
BSBI Complete	414	Bottle Sedge	Carex rostrata	28/07/2011	
BSBI Complete	1748	Broad-leaved Dock	Rumex obtusifolius	28/07/2011	
BSBI Complete	2166	Brooklime	Veronica beccabunga	28/07/2011	
BSBI Complete	46	Bugle	Ajuga reptans	28/07/2011	
BSBI Complete	2111	Bulrush	Typha latifolia	28/07/2011	

BSBI Complete	1476	Burnet Saxifrage	Pimpinella saxifraga	28/07/2011
BSBI Complete	2198	Bush Vetch	Vicia sepium	28/07/2011
BSBI Complete	400	Carnation Sedge	Carex panicea	28/07/2011
BSBI Complete	1020	Cat's-ear	Hypochaeris radicata	28/07/2011
BSBI Complete	873	Cleavers	Galium aparine	28/07/2011
BSBI Complete	607	Cock`s Foot	Dactylis glomerata	28/07/2011
BSBI Complete	2109	Colt's-foot	Tussilago farfara	28/07/2011
BSBI Complete	40	Common Bent	Agrostis capillaris	28/07/2011
BSBI Complete	1481	Common Butterwort	Pinguicula vulgaris	28/07/2011
BSBI Complete	740	Common Cottongrass	Eriophorum angustifolium	28/07/2011
BSBI Complete	2218	Common Dog Violet	Viola riviniana	28/07/2011
BSBI Complete	1126	Common Duckweed	Lemna minor	28/07/2011
BSBI Complete	444	Common Knapweed	Centaurea nigra	28/07/2011
BSBI Complete	882	Common Marsh Bedstraw	Galium palustre	28/07/2011
BSBI Complete	467	Common Mouse-ear	Cerastium fontanum	28/07/2011
BSBI Complete	955	Common Rock-rose	Helianthemum nummularium	28/07/2011
BSBI Complete	1734	Common Sorrel	Rumex acetosa	28/07/2011
BSBI Complete	675	Common Spike-rush	Eleocharis palustris	28/07/2011
BSBI Complete	608	Common Spotted Orchid	Dactylorhiza fuchsii	28/07/2011
BSBI Complete	1173	Common Twayblade	Listera ovata	28/07/2011
BSBI Complete	2516	Common Vetch	Vicia sativa	12/05/2011
BSBI Complete	1063	Compact Rush	Juncus conglomeratus	28/07/2011
BSBI Complete	1660	Creeping Buttercup	Ranunculus repens	28/07/2011
BSBI Complete	597	Crested Dog`s Tail	Cynosurus cristatus	28/07/2011
BSBI Complete	731	Cross-leaved Heather	Erica tetralix	28/07/2011
BSBI Complete	875	Crosswort	Cruciata laevipes	28/07/2011
BSBI Complete	684	Crowberry	Empetrum nigrum	28/07/2011
BSBI Complete	331	Cuckooflower	Cardamine pratensis	28/07/2011

BSBI Complete	1742	Curly Dock	Rumex crispus	28/07/2011
BSBI Complete	231	Daisy	Bellis perennis	28/07/2011
BSBI Complete	2034	Dandelion	Taraxacum agg.	28/07/2011
BSBI Complete	1858	Deergrass	Trichophorum cespitosum	28/07/2011
BSBI Complete	2021	Devil's-bit Scabious	Succisa pratensis	28/07/2011
BSBI Complete	1787	Eared Willow	Salix aurita	28/07/2011
BSBI Complete	1815	Elder	Sambucus nigra	28/07/2011
BSBI Complete	2243	Euphrasia officinalis agg.	Euphrasia officinalis agg.	28/07/2011
BSBI Complete	1169	Fairy Flax	Linum catharticum	28/07/2011
BSBI Complete	169	False Oat Grass	Arrhenatherum elatius	28/07/2011
BSBI Complete	821	Festuca ovina agg.	Festuca ovina agg.	28/07/2011
BSBI Complete	1217	Fir Clubmoss	Huperzia selago	28/07/2011
BSBI Complete	408	Flea Sedge	Carex pulicaris	28/07/2011
BSBI Complete	640	Foxglove	Digitalis purpurea	28/07/2011
BSBI Complete	2168	Germander Speedwell	Veronica chamaedrys	28/07/2011
BSBI Complete	376	Glaucous Sedge	Carex flacca	28/07/2011
BSBI Complete	1437	Grass of Parnassus	Parnassia palustris	28/07/2011
BSBI Complete	1209	Great Wood-rush	Luzula sylvatica	28/07/2011
BSBI Complete	1488	Greater Plantain	Plantago major	28/07/2011
BSBI Complete	2010	Greater Stitchwort	Stellaria holostea	12/05/2011
BSBI Complete	401	Greater Tussock-sedge	Carex paniculata	28/07/2011
BSBI Complete	350	Green-ribbed Sedge	Carex binervis	28/07/2011
BSBI Complete	20	Ground Elder	Aegopodium podagraria	28/07/2011
BSBI Complete	2191	Hairy Tare	Vicia hirsuta	28/07/2011
BSBI Complete	244	Hard Fern	Blechnum spicant	12/05/2011
BSBI Complete	322	Harebell	Campanula rotundifolia	28/07/2011
BSBI Complete	744	Hare's-tail Cottongrass	Eriophorum vaginatum	28/07/2011
BSBI Complete	569	Hawthorn	Crataegus monogyna	28/07/2011

BSBI Complete	878	Heath Bedstraw	Galium saxatile	28/07/2011
BSBI Complete	1514	Heath Milkwort	Polygala serpyllifolia	28/07/2011
BSBI Complete	1075	Heath Rush	Juncus squarrosus	12/05/2011
BSBI Complete	2173	Heath Speedwell	Veronica officinalis	28/07/2011
BSBI Complete	610	Heath Spotted Orchid	Dactylorhiza maculata	28/07/2011
BSBI Complete	1204	Heath Wood-rush	Luzula multiflora	28/07/2011
BSBI Complete	309	Heather	Calluna vulgaris	28/07/2011
BSBI Complete	918	Herb Robert	Geranium robertianum	28/07/2011
BSBI Complete	698	Hoary Willowherb	Epilobium parviflorum	28/07/2011
BSBI Complete	2080	Hop Trefoil	Trifolium campestre	28/07/2011
BSBI Complete	2241	Horse-chestnut	Aesculus hippocastanum	28/07/2011
BSBI Complete	1054	Jointed Rush	Juncus articulatus	28/07/2011
BSBI Complete	888	Lady's Bedstraw	Galium verum	28/07/2011
BSBI Complete	2051	Lemon-scented Fern	Oreopteris limbosperma	28/07/2011
BSBI Complete	1649	Lesser Celandine	Ranunculus ficaria	12/05/2011
BSBI Complete	1888	Lesser Clubmoss	Selaginella selaginoides	28/07/2011
BSBI Complete	1651	Lesser Spearwort	Ranunculus flammula	28/07/2011
BSBI Complete	2009	Lesser Stitchwort	Stellaria graminea	28/07/2011
BSBI Complete	387	Long-stalked Yellow Sedge	Carex viridula subsp.brachyrrhyncha	28/07/2011
BSBI Complete	1442	Lousewort	Pedicularis sylvatica	28/07/2011
BSBI Complete	2102	Marsh Arrowgrass	Triglochin palustre	28/07/2011
BSBI Complete	82	Marsh Foxtail	Alopecurus geniculatus	28/07/2011
BSBI Complete	576	Marsh Hawk's-beard	Crepis paludosa	28/07/2011
BSBI Complete	1441	Marsh Lousewort	Pedicularis palustris	28/07/2011
BSBI Complete	310	Marsh Marigold	Caltha palustris	12/05/2011
BSBI Complete	520	Marsh Thistle	Cirsium palustre	28/07/2011
BSBI Complete	2215	Marsh Violet	Viola palustris	28/07/2011
BSBI Complete	697	Marsh Willowherb	Epilobium palustre	28/07/2011

BSBI Complete	2003	Marsh Woundwort	Stachys palustris	28/07/2011
BSBI Complete	1642	Meadow Buttercup	Ranunculus acris	28/07/2011
BSBI Complete	85	Meadow Foxtail	Alopecurus pratensis	28/07/2011
BSBI Complete	1116	Meadow Vetchling	Lathyrus pratensis	28/07/2011
BSBI Complete	833	Meadowsweet	Filipendula ulmaria	28/07/2011
BSBI Complete	976	Mouse-ear Hawkweed	Pilosella officinarum	28/07/2011
BSBI Complete	506	Opposite-leaved Golden-saxifrage	Chrysosplenium oppositifolium	12/05/2011
BSBI Complete	397	Oval Sedge	Carex ovalis	28/07/2011
BSBI Complete	1183	Perennial Ryegrass	Lolium perenne	28/07/2011
BSBI Complete	541	Pignut	Conopodium majus	28/07/2011
BSBI Complete	1506	Poa pratensis sens.lat.	Poa pratensis sens.lat.	28/07/2011
BSBI Complete	1607	Primrose	Primula vulgaris	12/05/2011
BSBI Complete	1767	Procumbent Pearlwort	Sagina procumbens	28/07/2011
BSBI Complete	1307	Purple Moorgrass	Molinia caerulea	28/07/2011
BSBI Complete	256	Quaking-grass	Briza media	28/07/2011
BSBI Complete	1210	Ragged Robin	Lychnis flos-cuculi	28/07/2011
BSBI Complete	1899	Ragwort	Senecio jacobaea	28/07/2011
BSBI Complete	2091	Red Clover	Trifolium pratense	28/07/2011
BSBI Complete	1454	Reed Canary-grass	Phalaris arundinacea	28/07/2011
BSBI Complete	1487	Ribwort Plantain	Plantago lanceolata	28/07/2011
BSBI Complete	1879	Rock Stonecrop	Sedum forsterianum	28/07/2011
BSBI Complete	1708	Rosa canina agg.	Rosa canina agg.	28/07/2011
BSBI Complete	477	Rosebay Willowherb	Chamerion angustifolium	28/07/2011
BSBI Complete	1130	Rough Hawkbit	Leontodon hispidus	28/07/2011
BSBI Complete	657	Round-leaved Sundew	Drosera rotundifolia	12/05/2011
BSBI Complete	1960	Rowan	Sorbus aucuparia	28/07/2011
BSBI Complete	1728	Rubus fruticosus agg.	Rubus fruticosus agg.	28/07/2011
BSBI Complete	1610	Selfheal	Prunella vulgaris	28/07/2011

BSBI Complete	1735	Sheep`s Sorrel	Rumex acetosella	28/07/2011
BSBI Complete	822	Sheep's Fescue	Festuca ovina	28/07/2011
BSBI Complete	696	Short-fruited Willowherb	Epilobium obscurum	28/07/2011
BSBI Complete	1584	Silverweed	Potentilla anserina	28/07/2011
BSBI Complete	1015	Slender St. John`s-wort	Hypericum pulchrum	28/07/2011
BSBI Complete	9	Sneezewort	Achillea ptarmica	28/07/2011
BSBI Complete	1067	Soft Rush	Juncus effusus	12/05/2011
BSBI Complete	522	Spear Thistle	Cirsium vulgare	28/07/2011
BSBI Complete	1285	Spearmint	Mentha spicata	28/07/2011
BSBI Complete	370	Star Sedge	Carex echinata	28/07/2011
BSBI Complete	121	Sweet Vernal-grass	Anthoxanthum odoratum	28/07/2011
BSBI Complete	5	Sycamore	Acer pseudoplatanus	28/07/2011
BSBI Complete	1800	Tea-leaved Willow	Salix phylicifolia	28/07/2011
BSBI Complete	2180	Thyme-leaved Speedwell	Veronica serpyllifolia	28/07/2011
BSBI Complete	1057.2	Toad Rush	Juncus bufonius	28/07/2011
BSBI Complete	1588	Tormentil	Potentilla erecta	28/07/2011
BSBI Complete	627	Tufted Hair Grass	Deschampsia cespitosa	28/07/2011
BSBI Complete	2189	Tufted Vetch	Vicia cracca	28/07/2011
BSBI Complete	35.2	Velvet Bent	Agrostis canina	28/07/2011
BSBI Complete	924	Water Avens	Geum rivale	12/05/2011
BSBI Complete	1322	Water Forget-me-not	Myosotis scorpioides	28/07/2011
BSBI Complete	1272	Water Mint	Mentha aquatica	28/07/2011
BSBI Complete	628	Wavy Hair-grass	Deschampsia flexuosa	28/07/2011
BSBI Complete	1246	Welsh Poppy	Meconopsis cambrica	28/07/2011
BSBI Complete	2092	White Clover	Trifolium repens	28/07/2011
BSBI Complete	1784	White Willow	Salix alba	28/07/2011
BSBI Complete	109	Wild Angelica	Angelica sylvestris	28/07/2011
BSBI Complete	2060	Wild Thyme	Thymus polytrichus	28/07/2011

BSBI Complete	720	Wood Horsetail	Equisetum sylvaticum	28/07/2011
BSBI Complete	2046	Wood Sage	Teucrium scorodonia	28/07/2011
BSBI Complete	1413	Wood Sorrel	Oxalis acetosella	28/07/2011
BSBI Complete	7	Yarrow	Achillea millefolium	28/07/2011
BSBI Complete	1038	Yellow Iris	Iris pseudacorus	28/07/2011
BSBI Complete	1221	Yellow Pimpernel	Lysimachia nemorum	28/07/2011
BSBI Complete	1678	Yellow Rattle	Rhinanthus minor	28/07/2011
BSBI Complete	983	Yorkshire Fog	Holcus lanatus	28/07/2011
BSBI Complete	2087	Zig-zag Clover	Trifolium medium	28/07/2011

Birds

Group	Code	Common Name	Scientific Name	Date
BTO Survey List	490	Grey Heron	Ardea cinerea	28/07/2011
BTO Survey List	3220	Cuckoo	Cuculus canorus	12/05/2011
BTO Survey List	3310	Tawny Owl	Strix aluco	12/05/2011
BTO Survey List	3650	Skylark	Alauda arvensis	12/05/2011
BTO Survey List	3700	Swallow	Hirundo rustica	28/07/2011
BTO Survey List	3950	Dipper	Cinclus cinclus	28/07/2011
BTO Survey List	4140	Stonechat	Saxicola torquata	12/05/2011
BTO Survey List	4890	Willow Warbler	Phylloscopus trochilus	12/05/2011
BTO Survey List	5390	Chaffinch	Fringilla coelebs	12/05/2011
BTO Survey List	5440	Goldfinch	Carduelis carduelis	12/05/2011
BTO Survey List	5610	Bullfinch	Pyrrhula pyrrhula	12/05/2011
		Black Grouse		
		Short eared owl		
		Hen harrier		
		Robin		

Crossbill

Glenlude	NT	3300	6295	NT300295	19/03/2010	C.Land		3mm	y
Glenlude	NT	3300	6295	NT300295	09/04/2010	C.Land		2mm	y
Glenlude	NT	3300	6295	NT300295	16/05/2010	C.Land		3mm	y

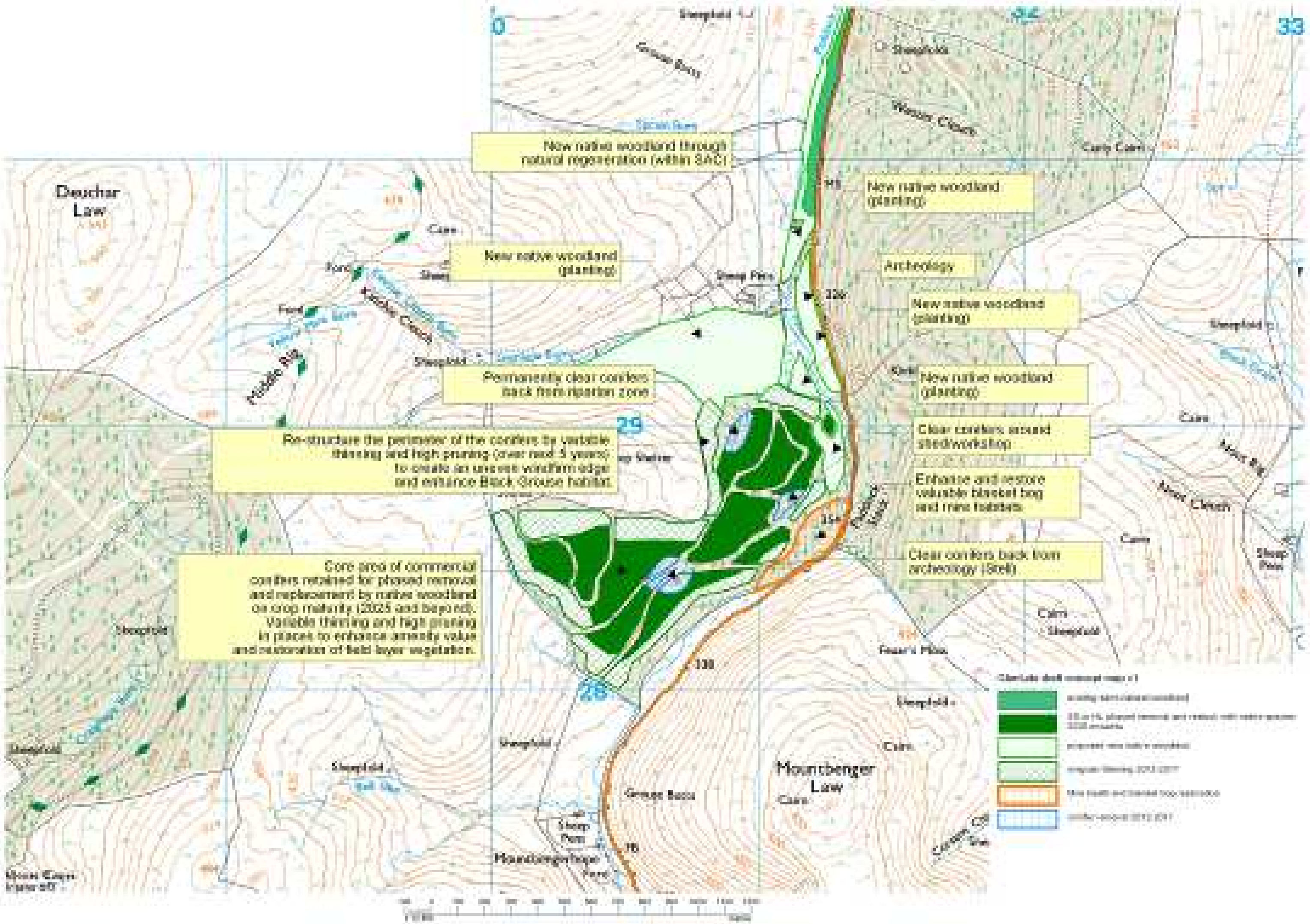
Butterflies & Moths (26/8/12 Recorded by Reuban Singleton with actinic trap)

Group	Code	Common Name	Scientific Name	Date	Status ukbap	Red listed
Butterflies and Moths	15510	Green-veined White	Pieris napi	12/05/2011		
Butterflies and Moths	15740	Common Blue	Polyommatus icarus	28/07/2011		
Butterflies and Moths	15930	Small Tortoiseshell	Aglais urticae	28/07/2011		
Butterflies and Moths	16270	Small Heath	Coenonympha pamphilus	28/07/2011	Yes	Yes
Butterflies and Moths	16370	Oak Eggar	Lasiocampa quercus	26/08/2011		
Butterflies and Moths	16430	Emperor Moth	Pavonia pavonia	12/05/2011		
Butterflies and Moths	17620	Dark Marbled Carpet	Chloroclysta citrata	26/08/2011		
Butterflies and Moths	17770	July Highflyer	Hydriomena furcata	26/08/2011		
Butterflies and Moths	20570	Garden Tiger	Arctia caja	26/08/2011	Yes	
Butterflies and Moths	21090	Lesser Yellow Underwing	Noctua comes	26/08/2011		
Butterflies and Moths	21170	Autumnal Rustic	Paradiarsia glareosa	26/08/2011	Yes	
Butterflies and Moths	21300	Dotted Clay	Xestia baja	26/08/2011		
Butterflies and Moths	21320	Neglected Rustic	Xestia castanea	26/08/2011	Yes	
Butterflies and Moths	21340	Square-spot Rustic	Xestia xanthographa	26/08/2011		
Butterflies and Moths	21350	Heath Rustic	Xestia agathina	26/08/2011	Yes	
Butterflies and Moths	21760	Antler Moth	Cerapteryx graminis	26/08/2011		
Butterflies and Moths	21980	Smoky Wainscot	Mythimna impura	26/08/2011		

Butterflies and Moths	22740	The Sallow	Xanthia icteritia	26/08/2011	Yes	
Butterflies and Moths	23210	Dark Arches	Apamea monoglypha	26/08/2011		
Butterflies and Moths	23500	Small Wainscot	Photedes pygmina	26/08/2011		
Butterflies and Moths	23530	Flounced Rustic	Luperina testacea	26/08/2011		
Butterflies and Moths	23610	Rosy Rustic	Hydraecia micacea	26/08/2011	Yes	
Butterflies and Moths	23670	Haworth's Minor	Celaena haworthii	26/08/2011	Yes	

Arachnids 20/8/12 Recorded & verified by Chris Catherine habitat Wet Heath/mixed woodland edge Collection method Active search (sweep net)

Group	Family	Common name	Genus	Species	Sex	Number	X	Y
Araneae	Araneidae	Garden-cross spider	Araneus	diadematus	Female	1	331022	628539
Araneae	Araneidae	Garden-cross spider	Araneus	diadematus	Female	1	331193	628596
Araneae	Araneidae	Four-spot orb-weaver	Araneus	quadratus	Female	3	331022	628539
Araneae	Araneidae	Four-spot orb-weaver	Araneus	quadratus	Female	4	331193	628596
Araneae	Linyphiidae	Common weaver	Bathyphantes	gracilis	Female	1	331022	628539
Araneae	Linyphiidae	Carr weaver	Bathyphantes	nigrinus	Female	1	331193	628596
Araneae	Linyphiidae	Yellow javelin-weaver	Bolyphantes	luteolus	Female	1	331022	628539
Araneae	Linyphiidae	Common hammock-weaver	Linyphia	triangularis	Female	1	331022	628539
Araneae	Linyphiidae	Common hammock-weaver	Linyphia	triangularis	Female	2	331193	628596
Araneae	Lycosidae	Black-palped wolf-spider	Pardosa	nigriceps	Female	1	331193	628596
Araneae	Lycosidae	Common wolf-spider	Pardosa	pullata	Female	2	331193	628596
Araneae	Lycosidae	Ground wolf-spider	Trochosa	terricola	Female	1	331193	628596
Araneae	Tetragnathidae	Summer orbweaver	Metellina	mengei	Female	1	331022	628539
Araneae	Theridiidae	Common false-widow	Steatoda	bipunctata	Female	1	331022	628539
Opiliones	Phalangiidae	Saddle-back harvestman	Mitopus	morio		1	331193	628596
Opiliones	Phalangiidae	Common harvestman	Paroligolophus	agrestis		1	331022	628539


New native woodland through natural regeneration (within SAC)
New native woodland (planting)
New native woodland (planting)
Archeology
New native woodland (planting)
Permanently clear conifers back from riparian zone
New native woodland (planting)
Re-structure the perimeter of the conifers by variable thinning and high pruning (over next 5 years) to create an uneven windfirm edge and enhance Black Grouse habitat.
Clear conifers around shed/workshop
Enhance and restore valuable blanket bog and mire habitats
Clear conifers back from archeology (Stell)
Core area of commercial conifers retained for phased removal and replacement by native woodland on crop maturity (2025 and beyond). Variable thinning and high pruning in places to enhance amenity value and restoration of field layer vegetation.
Deuchar Law
Mountbenger Law
Middle Rig
Sheepfold
Cairn
Grouse Butts
Sheep Pens
Mountbengerhope

Appendix Glenlude Estate, John Muir Trust: background geoscience information.

Dr W A Mitchell
Department of Geography, Durham University
February 2012

Introduction:
The Glenlude Estate lies in the remote central Southern Uplands across the watershed at Glenlude Hill (469 m OD) between the River Tweed and Yarrow Water that marks the former Peeblesshire-Selkirkshire county boundary to the south of Innerleithen (Fig. 1). The estate lies to the west of the B709 in the upper part of the Paddock Burn catchment which forms a southern tributary of the River Tweed as well as the upper part of the Mountbenger Burn, a tributary of the Yarrow Water. This part of the Southern Uplands is a dissected plateau with an average elevation of 500 m OD into which the present stream network is incised by up to 200 m. The Paddock Burn, of which the Glenlude Burn is the major upper tributary, forms the central sector of a greater catchment including the Quaich Water to the west and Fingland Burn in the east encompassing c. 50 sq km. To the west, the interfluve is a major ridge stretching from Cardrona Forest south-westwards to the high point of Dun Rig (743 m OD) and continuing to the high ground around the second highest summit in the Southern uplands, Broad Law (840 m OD). This forms the northern part of a 'horseshoe' of high ground around the upper Tweed encompassing the Tweedsmuir Hills (Moffat Hills) and Eskdalemuir Forest (Townsend, 2010). The southern part of the interfluve between the Tweed and Yarrow Water is at slightly lower elevations of c. 500 m OD reaching a high point at Deuchar Law (542 m OD) which forms the western limit of the Glenlude Burn catchment. A number of notable gaps can be observed along this southern interfluve; most notable is Paddock Slack (357 m OD) between Glenlude Hill and Mountbenger Law (543 m OD) which is exploited by the B709 to cross this interfluve into the upper Mountbenger Burn. The drainage is a broadly dendritic pattern but with a number of linear fluvial reaches reflecting clear structural control by the presence faults, one of which has been exploited by the Paddock Burn.

Figure 1: Google Earth vertical satellite image of the Glenlude Estate (outlined) and surrounding area. The image was taken in 2007.

Bedrock Geology:
The Southern Uplands are composed of a thick sequence of marine sedimentary rocks associated with the formation of an accretionary

prism (terrane) during the closure of the Iapetus Ocean during the Ordovician-Silurian Periods (495-420 Ma) (Stone *et al.,* 2003). The rocks are primarily coarse sandstones (greywackes) deposited by turbidity currents within the former ocean basin, interdigitated with fossiliferous black shales representing background deep ocean pelagic sedimentation. Pioneering research on fossils in the shales, particularly graptolites (Lapworth, 1878), has constrained the age of these sedimentary rocks and their subsequent structural disruption along faults initiated during basin compression. The rocks in Glenlude and adjacent areas were first mapped by Geikie and Young in 1862 – 1863, followed by Peach and Horne (1899) to place the ground-breaking palaeontology and biostratigraphical subdivisions of Lapworth (1878) into lithostratigraphic context. Bedrock mapping around Glenlude indicates that the rock here is primarily greywacke attributed to part of the Gala Group (Llandovery age; lowest Silurian) (Peach and Horne, 1899). These greywackes occur as a series of individual beds of variable thickness defining individual turbidity current events. A number of lithofacies have been identified; the main sedimentary rock is coarse grained sandstone with secondary siltstones. Exposures within the Glenlude Burn are not remarked upon; however, in the Paddock Burn thinly bedded micaceous siltstones are reported towards Newhall (1:10000 Sheet 24E Peebles: Geikie, 1862-3).

Following deposition, there was significant tectonic deformation associated with the closure of the Iapetus Ocean and the strata are now steeply inclined or vertical showing various phases of deformation. The weaker black shales appear to have acted as the weak layers over which the rocks have faulted to form a series of highly imbricate blocks defined along a series of major NE-SW faults, such as the Ettrick Valley Fault just to the south of Glenlude (Stone *et al.,* 2003). Along the Paddock Burn, evidence of fracturing and overturning of beds are reported at Cow Peel Bridge; this is along the line of a wrench fault (a strike-slip fault with a vertical surface) that was mapped from Cowan Knowe across Glenlude Hill northwards to Innerleithen (1:10000 Sheet 33SW Traquair/Sheet NT 32NW Mountbenger Burn: Geikie, 1862-3). Such strike-slip faults allow the formation of shatter belts of weaker rock which have been eroded by the present streams. Two further wrench faults that lie parallel to the Paddock Burn are defined by small streams draining the north side of Deuchar Law towards The Glen.

Geomorphology (Superficial Deposits and Landforms):

Early research on understanding Southern Uplands landscapes was directed towards two main themes. Firstly, the preglacial development of the main landscape elements of the high plateau (planation surfaces) and the resultant drainage development and secondly, the first appreciation of the impact of glaciation, particularly associated with former ice sheet cover and local glaciation (Geikie, 1875, Mackinder, 1901). Little detail on either of these topics has been reported for the Glenlude area. In the already noted early geological mapping, glacial deposits, specifically till (formerly termed 'boulder clay') were mapped across much of the area with a particular emphasis on the valleys such as Paddock Burn where such superficial deposits were generally thicker than on adjacent hillslopes. An interesting location in a quarry north of Glenlude showed a former river channel infilled with 'boulder clay' adjacent to the present channel of the Paddock Burn (Geikie, 1863: Peeblesshire Sheet XVIII). These early surveys also recorded the presence of glacial striations and ice moulding; for example, striations are recorded in the lower eastern slopes of Glenlude Hill indicating former ice flow in a north-east direction. A similar direction is

recorded from ice moulding on the eastern slopes of Mountbenger Law confirming the overall north-east direction of ice sheet flow across this area. At a regional scale, this is associated with a former major ice centre in the vicinity of the Tweedsmuir Hills (Moffat Hills Ice Centre) which acted as a major accumulation area of the last Scottish ice sheet from which ice flowed north-eastwards as a major ice stream that occupied to lower Tweed valley flowing around the northern flank of the Cheviot Hills which acted as a separate, smaller ice centre (Evans *et al.,* 2005; Stone *et al.,* 2010).

This ice sheet would have completely covered the Glenlude area during the Last Glacial Maximum (LGM) about 24-19 ka (thousand years ago) by ice that may have been > 1 km in thickness. Disappearance of this ice sheet during deglaciation is known to have occurred in two ways; firstly, the ice sheet margin retreated back (recession) towards the different source areas and as it did so, thinned to expose upper slopes as nunataks (Evans *et al.,* 2005). In contrast to this active retreat which may be recorded in a series of recessional moraines, a second style of deglaciation is associated with stagnation where the ice melted away in situ creating chaotic ridges and mounds (kames). In addition, the production of great volumes of meltwater, particularly during deglaciation, is recorded by the presence of meltwater channels in many areas; these are characterised by a number of criteria – for example, no present stream, up-and-down profiles and/or cut through cols in locations unconnected with present day drainage (Price, 1963; Greenwood *et al.,* 2007). Such channels are also defined with respect to formational environment, specifically with respect to under the ice (subglacial) or marginal to the edge of former glaciers.

No detailed work has been published on the style of deglaciation across the Glenlude Estate; preliminary evaluation of aerial photographs, digital elevation models (DEM) and Google Earth imagery does not indicate any geomorphological evidence for either active ice recession across the area or ice stagnation. Rather the imagery clearly shows ice streamlining across the area from south-west to north east which has enhanced underlying bedrock structure (Fig. 2). Meltwater channels can be seen on the southwest side of Paddock Slack (NT 314288) (but recorded as possible 'landslides' in the early surveys; Sheet NT 32 NW: Geikie, 1863). These appear to indicate meltwater flow north-east out of the Mountbenger catchment into Paddock Slack. How these relate to the possible abandoned col channel on the northeast side of

Figure 2: Glenlude Estate – oblique Google Earth view from east showing overall smoothing of Glenlude Hill by the ice sheet from southwest (left) to northeast (right). Paddock Slack is the large gap followed by the road across the Glenlude and Mountbenger catchments. Note the meltwater channels eroded into the far side of Paddock Slack within areas of recent forestation.

Mountbenger Law towards Catslack Burn is unclear at present. Kinchie Cleugh which forms the northern stream on Middle Rig at the NW corner of the Glenlude Estate appears as a possible meltwater channel (Fig. 1). A further set of channels can be observed near Glenshiel Banks (NT 278310) in The Glen also appear to indicate north-east meltwater flow but may be marginal to a former ice margin. No detailed information is currently published on this phase of deglaciation within the Tweed catchment; rather, attention has focussed in the landforms and sediments associated with meltwater channels and subsequent ice stagnation which formed thick sequences of glaciofluvial sediments in the nearby Eddlestone valley (Sissons, 1958) and the upper part of the Tweed, west of Innerleithen (Price, 1963). In both valleys, complex channel patterns and association with kames and kettle-holes (where blocks of stagnant ice have melted out) have been mapped demonstrating dead ice.

As the ice sheet wasted away, increasingly larger areas of the Southern Uplands became exposed to non-glacial geomorphic processes. To begin with, although the ice disappeared, the climate remained extremely cold allowing the operation of periglacial freeze-thaw processes; such processes have nothing to do with glaciation but to low freezing temperatures allowing the formation of frozen ground (permafrost) both over long periods of time and over a yearly cycle with summer melting on a ground surface with minimal vegetation cover (Ballantyne and Harris, 1994). This would have been enhanced by the continued persistence of a snow cover giving rise to a distinctive hydrological regime associated with an early summer melt season. Such repetition of freeze-thawing of the rock and soil allows enhanced mechanical breakdown of bedrock to form large quantities of angular rock fragments which can form talus (scree) slopes below rock cliffs. Secondly, melting of the frozen upper part of the sediment profile as well as any snow cover, would have allowed the sediment to become saturated with water which then flowed for considerable distances downslope by a process that is termed solifluction (Ballantyne and Harris, 1994). Such geomorphic activity has been recorded in specific areas of the Southern Uplands; talus is not well developed except where there are sufficient crags such as around Loch Skene. However, the overall character of the Southern Uplands, in terms of bedrock susceptibility and gentle topography, is better adapted to the widespread operation of solifluction and the formation of 'surface wash' deposits which can be c. 8 min thickness in the Innerleithen area (Geikie, 1869). This leads to the downslope movement of unconsolidated sediment reworking it into solifluction sheets and lobes and forming thick sequences of head (Tivy, 1962; Ragg and Bibby, 1966). This is then incised by the present streams to form valley floor solifluction bench that forms a characteristic landform in the Cheviot Hills and Southern Uplands (Galloway, 1961, Ballantyne and Harris, 1994; Mitchell, 2008).

No details on periglacial processes and products have been reported for the Glenlude area; however, preliminary observations on aerial photographs, DEM and Google imagery show the incised nature of the Glenlude Burn along the northern slopes of Glenlude Hill forming a distinctive solifluction terrace (Fig. 3).

Figure 3: Glenlude Burn looking east. The prominent scarp (riser) of a distinctive solifluction terrace at the base of the northern slopes of Glenlude Hill is in shadow and marks the downslope edge of soliflucted sediment (arrow) that underlies the bracken covered north-facing slopes; similar deposits will underlie the more gentle south facing slopes (left). Note the small scarp at the right edge of the arrow and the crenulated shape of the riser which is the result of a number of small rotational landslides within the deposits.

This indicates that the development of a sediment infill is present on the lower slopes which have failed as a series of small rotational landslides suggesting the presence of superficial deposits rather than bedrock. Similarly, the Paddock Burn has also incised itself into a valley infill. The forest cover on the eastern side of this valley makes remote inferences difficult; however, the more gentle western slopes of Blake Muir show a sediment cover incised by the Sprain Burn and with a number of abandoned channels possible associated with dewatering related to solifluction. A possible alluvial fan associated with solifluction can be seen on the southern side of Glenlude Hill within the upper part of the Mountbenger Burn. From field experiences elsewhere in the Southern Uplands (Mitchell, 2008), much of this superficial deposit cover, reported by early workers as 'till' or 'surface wash', is more likely to be reworked solifluction deposits overlying limited exposures of true till in the valley bottoms. Observations also suggest that the upper slopes are covered by a thin layer of superficial deposits with bedrock apparent as a degraded scarp along some parts of the north side of Glenlude Hill.

Chronology:

The last glaciation is now known to have reached its maximum extent sometime between 24.5 and 19 ka followed by a period of ice sheet reorganisation and recession with the final disappearance of ice in the Southern Uplands c. 15 ka (Clark *et al.,* 2012). The operation of cold

climate periglacial processes continued to dominate deglaciation until an abrupt change in climate at 14.7 ka when there was a dramatic rise in temperature to warmer than present. This marks the commencement of a period of rapid fluctuations in climate termed the Last Glacial Interglacial Transition during which time, vegetation expanded with the replacement of tundra by the development of juniper-birch woodland. This was sharply terminated by a rapid return to glacial conditions when small corrie glaciers re-established themselves in the Merrick Hills and around Loch Skene during a period termed the Loch Lomond Stadial. Elsewhere in the Southern Uplands, periglacial tundra conditions prevailed for about 1000 years until the climate again warmed rapidly into the present interglacial (Holocene; 11.7 ka to present).

Holocene Environments:

Colonisation of the slopes by vegetation had been achieved by 9 ka with the presence of oak and elm by c. 8 ka with pine on the higher slopes of the Galloway Hills (Tipping, 1999). There are few pollen sites within the immediate area; however, there is an interesting high elevation site at Rotten Bottom at 620 m in the source area of the Tweed and Yarrow in the Tweedsmuir Hills. This is an important site where the oldest yew bow in Britain was discovered in the peat. This initiated background palaeoenvironmental investigations which have provided useful palaeoclimatic information at a high elevation in the Southern Uplands (Tipping, 1999). These investigations and dating indicate blanket bog development commenced in the early Holocene and continued until even steep slopes were covered by 5.5 ka. Climate reconstructions from peat cores indicate a series of dry and wet climatic phases through the Holocene leading to changes in the elevation of the treeline with the densest woodlands in the mid-Holocene (6 ka). Thereafter, anthropogenic influences begin to change the natural environment with grazing pressure, even on the highest hills, increasing through to the early Medieval Period (Tipping, 1999). There are no detailed investigations on how these climate changes affect geomorphic processes with respect to slope stability and river channel development in the wider area of the Border country.

Conclusions:

The present landscape reflects the former operation of a number of distinctive geomorphic systems driven by the remarkable climate changes that characterise the last glacial to interglacial period as well as the increasing environmental changes associated with anthropogenic activity in the Mid to Late Holocene. As with many parts of the Southern Uplands, few detailed investigations have been published to allow appreciation of these landscapes and the upper Tweed – Yarrow is an area that has been neglected even relative to other areas of the uplands. Although the area has been glaciated on many occasions, there is little evidence for earlier events. Rather the overall landscape reflects the limited effects of the last glaciation and more particularly the periglacial modifications that accompanied deglaciation. A number of questions can be raised to promote geoscience research in this area:

1. What was the impact of the last ice sheet across Glenlude Hill?
2. What was the pattern of deglaciation across the area?

3. What is the evidence for periglacial modification of the landscape?
4. How has the present landscape developed during the Holocene?

Detailed geological and geomorphological mapping of the Glenlude Estate would allow valuable information and better understanding on landscape evolution of this neglected part of the Southern Uplands. This would allow better appreciation of how such landscapes have developed under a range of geomorphic conditions and provide useful information on land management.

Note:

This report is a preliminary desk based assessment of the geological and geomorphological character of the Glenlude Estate and surrounding area and is based on a literature survey and consulting of the original county mapping series of the British Geological Survey.

References:

Ballantyne, C K and Harris, C, 1994. *The Periglaciation of Great Britain.* Cambridge University Press. 330pp.

Clark, C D, Hughes, A L C, Greenwood, S L, Jordan, C and Sejrup, H P, 2012. Pattern and timing of retreat of the last British-Irish Ice Sheet. *Quaternary Science Reviews*. doi:10.1016/j.quatscirev.2010.07.019.

Evans, D J A, Clark, C D and Mitchell, W A. 2005. The last British Ice Sheet: a review of the evidence utilised in the compilation of the Glacial Map of Britain. *Earth Science Reviews,* **70**, 253-312.

Galloway, R W. 1961. Solifluction in Scotland. *Scottish Geographical Magazine,* **77**, 75-87.

Geikie, A. 1869. Explanation of Sheet 24: Peeblesshire with Parts of Lanark, Edinburgh and Selkirk. *Memoirs of the Geological Survey, Scotland.* 24pp.

Geikie, A. 1875. *The Great Ice Age.*

Greenwood, S I, Clark, C D and Hughes, A L C. 2007. Formalising an inversion methodology for reconstructing ice-sheet retreat patterns from meltwater channels: applications to the British Ice Sheet. *Journal of Quaternary Science,* **22**, 637-645.

Lapworth, C. 1878. The Moffat Series. *Quarterly Journal of the Geological Society, London.* **38**, 537-666.

Mackinder, H. 1901. Britain and the British Seas.London.

Mitchell, W A. 2008. Quaternary geology of part of the Kale Water catchment, western Cheviot Hills, southern Scotland. *Scottish Journal of Geology,* **44**, 51-63.

Peach, B N and Horne, J. 1899. *The Silurian Rocks of Britain, Vol. 1: Scotland.* Memoir of the Geological Survey.

Price, R J. 1963. A glacial meltwater drainage system in Peeblesshire, Scotland. *Scottish Geographical Magazine,* **79**, 133-141.

Ragg, J M and Bibby, J S. 1966. Frost weathering and solifluction products in southern Scotland. *Geografiska Annaler,* **41**, 12-23.

Sissons, J B. 1958. Supposed ice-dammed lakes in Britain with particular reference to the Eddleston valley, southern Scotland. *Geografiska Annaler,* **40**, 159-187.

Stone, P, Rigby, S and Floyd, J D. 2003. Advances in Scottish graptolite biostratigraphy: an introduction. *Scottish Journal of Geology,* **39**, 11-15.

Stone, P, Millward, D, Young, B, Merritt, J W, Clarke, S M, McCormac, M and Lawrence, D J D. 2010. *British Regional Geology: Northern England.* 5th edition, British Geological Survey, Nottingham. 294pp Stone

Tipping, R. 1999. Rotten Bottom – Holocene upland environments. In: Tipping, R (ed) *The Quaternary of Dumfries and Galloway: Field Guide.* Quaternary Research Association, London, pp. 171-181.

Tivy, J. 1962. An investigation of certain slope deposits in the Lowther Hills, Southern Uplands. *Transactions of the Institute of British Geographers,* **30**, 59-72.
Townsend, C. 2010. *World Mountain Ranges: Scotland*. Cicerone Press, Cumbria.