Laois Esker survey 2005

Volume I: Report Text

Report prepared for Laois Heritage Forum

An Action of the Laois Heritage Plan 2002-2006

The Ridge Graveyard, Portlaoise,is on "The Ridge of Portlaoise" esker

Mieke Muyllaert and Mary Tubridy

Mary Tubridy and Associates September 2005

An Chomhairle Oidhreachta The Heritage Council

CONTENTS

List of tables and figures

List of Plates

Acknowledgements

We would like to acknowledge the valuable assistance provided by the following individuals and organisations:

- The landowners who allowed their land to be surveyed and answered questions about farming and land use.
- The IFA who invited us to a meeting of the county executive and committee members of IFA branches in Stradbally, Vicarstown, Emo and the Heath.
- The County Council Information Technology section kindly prepared maps and photos for use in fieldwork. The Planning and Development Section briefed us on planning issues and Portlaoise Library provided access to relevant Environmental Impact Statements.
- Dr Evelyn Moorkens, plant recorder for County Laois for the Botanical Society of the British Isles who provided BSBI records for eskers surveyed.
- The Laois Heritage Forum and particularly members of the Eskers Working Group, assisted with meetings and directed us to local sources of information.
- Funding for this study was provided by Laois County Council and the Heritage Council.

Summary

The report contains the results of a biodiversity survey of nine esker systems in the north-east of county Laois. The surveyed eskers cover 635 acres (255 ha) and represent 50% of the total eskers in Laois. They include two esker systems the "Ridge of Portlaoise" and Timahoe esker which contain proposed Natural Heritage Areas.

Information on biodiversity was collected principally through fieldwork. Some additional information was sourced from National Parks and Wildlife Service files, records compiled by members of the Irish branch of the Botanical Society of the British Isles and Environmental Impact Statements.

Initially eskers were located using the EPA Soil and Subsoil mapping project (formerly FIPS-IFS). For fieldwork the esker outline was put on vector maps and aerial photographs produced at the 1:6,000 scale. All esker segments were examined directly in the field after obtaining permission from landowners. During fieldwork habitats were mapped and lists compiled of flowering plants. Birds and butterflies were surveyed in a sample of eskers. Information was collected on the location of noteworthy species including invasive exotics.

The survey revealed that while the majority of esker segments have been damaged by various forms of development a significant number of intact segments remain with habitats and species of value. Eskers are managed principally for intensive farming and the commonest habitat found is productive grassland. Despite the dominance of intensively managed grassland, habitat diversity is high. Eighteen habitats are found on the eskers. Habitats include important semi-natural types such as oak ash woodlands and species-rich calcareous grasslands. Naturally recolonising quarries add to species and habitat diversity While none of these are types listed under the EU Habitats Directive, further survey work could reveal evidence for a priority habitat type "orchid rich grasslands" in certain fields.

Species diversity is high on Laois eskers. A total of 281 species of flowering plants, 36 birds and 11 butterflies were identified. This diversity is principally associated with habitats such as old grasslands, quarries, woodland, hedgerow and scrub. Some of the plant species found are rare in Ireland, such as the bell flower and fleabane. Bird species was high particularly in areas of high habitat diversity. Birds recorded included kingfisher, listed in the Birds Directive and several species rated as being of conservation concern within Ireland; sand martin, swallow, yellowhammer and snipe. Butterfly diversity was high and included some species which had rarely been recorded in Laois.

Current proposals to infill old quarries threaten their biodiversity value. The report contains a number of suggestions for actions to support sustainable development. Their implementation relies on a partnership approach. They include measures to raise awareness and ensure that farming and other forms of development are compatible with maintenance of the biodiversity and geodiversity value of eskers.

1 Introduction

1.1 The Brief

The brief requested that the study address the following tasks:

- To collect ecological data for the main esker areas in County Laois, using a standardised habitat mapping technique.
- To record other features and groups of ecological interest as appropriate.
- To make policy recommendations for future conservation of these areas, based on the findings of the survey.

According to the detailed brief the study should involve:

- A literature survey and consultation (relevant individuals, organisations and datasets) to identify priority areas for survey and to draw together relevant existing ecological and geological information.
- Adherence to the guidelines laid down in the Draft Habitat Survey Guidelines produced by the Heritage Council to identify, describe, map and evaluate habitats, following habitat descriptions to Level 3 in the Guide to Habitats in Ireland.
- Preparation of target notes for habitats or features of value which take up an area less than the standard minimum for recording (50m x 50m).
- The recording of dominant and notable plants (including invasive exotics such as Japanese knotweed), and other groups of interest (birds, invertebrates, mammals).
- Seeking permission from landowners before entering private land.

1.2 Background

The study fulfils an aim of the County Laois Heritage Plan 2002-2006 and supports the County Development Plan. In the Laois County Development Plan a stated policy objective is to safeguard NHAs including those on the Ridge of Portlaoise esker and Timahoe esker. Objective 8 of the Heritage Plan is to maintain and enhance the landscape quality of County Laois. Under this objective, aim 8.14 is "to survey the esker from Tullamore to Portlaoise and make proposals for its preservation".

The term "esker" is an English rendering of the Gaelic word eiscir which means ridge. The Irish origin of the word is not surprising given the abundance of eskers in the Midlands of Ireland (Fig. 1.1).

Fig. 1.1 The eskers of Ireland.

Mapped photogrammetrically as part of EPA Soil and Subsoil mapping project (formerly FIPS-IFS, Teagasc, Kinsealy, 1998-2005).

Eskers are one of several types of landforms associated with deglaciation, the others being moraines, deltas, outwash fans and kames. They formed in water filled tunnels under the ice (Fig. 1. 2) where sand and gravels accumulated due to the action of water. Once the walls of the tunnels melted the deposits slumped, resulting in steep sided linear deposits.

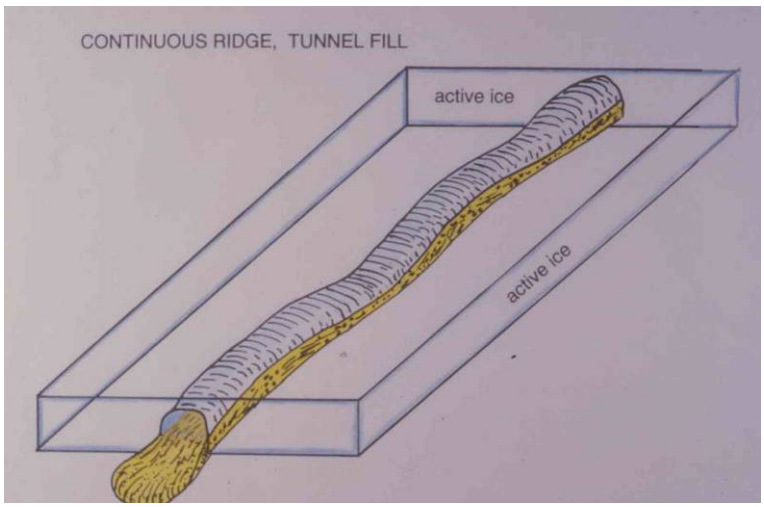

Fig. 1.2. Diagrammatic representation of esker formation

The eskers in Laois (Fig.1. 3) were all formed at the same time; either under the ice, or parallel to the main ice flow between 70,000 and 60,000 years ago.

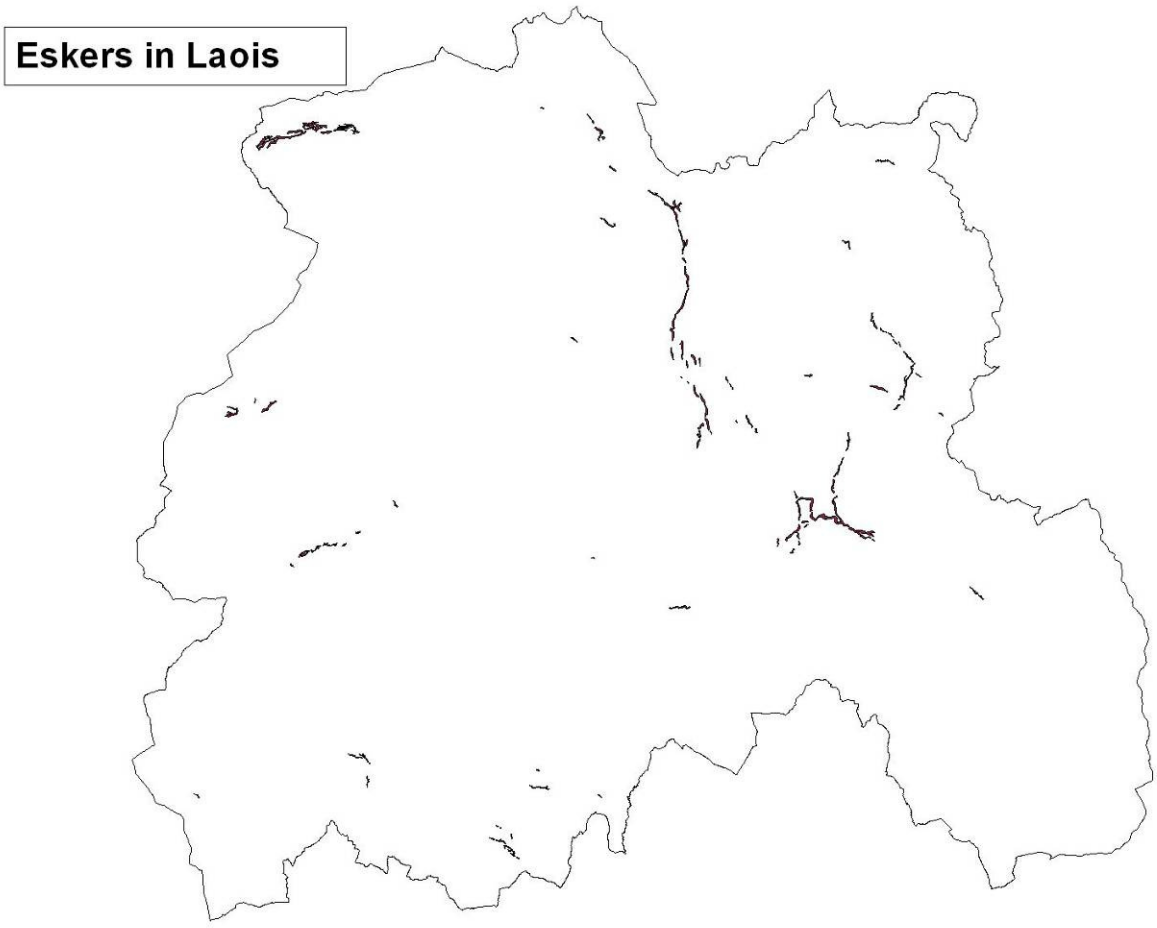

Fig. 1.3 Eskers in Laois.

Mapped photogrammetrically as part of EPA Soil and Subsoil mapping project (formerly FIPS-IFS, Teagasc, Kinsealy, 1998-2005).

There are no eskers formed at the edge of the ice, or transverse to the main ice flow. Such eskers are found in more extensive systems, e.g. in Westmeath, but are not found in Laois because the systems are relatively small. There was one ice lobe moving and retreating. The movement was generally from north-northwest to east-southeast.

Plate 1.1 Cross-section through an esker showing sand and gravel deposits

The value of eskers lies in their importance to local history, farming and quarrying, the local landscape, biodiversity and earth science conservation. The "Ridge Road" between Portlaoise and Mountmellick is an example of an early transport route which runs along the dry summit of an esker.

The importance of eskers as part of geological heritage is being highlighted nationally. The Irish Geological Heritage Programme which is a partnership between The Geological Survey of Ireland (GSI) and the National Parks and Wildlife Service has been set up to identify, document, and protect geological heritage and also to promote its value to landowners and the public. It is leading to the identification of geological Natural Heritage Areas. The programme started by identifying sixteen categories of sites. Eskers are included in the Quaternary category. Site selection and ranking was then carried out by expert panels. Three esker systems in Laois have been considered by the quaternary panel. There are the Clonaslee esker, the "Ridge of Portlaoise" and the Timahoe esker. All are considered important as " County Sites". The IGH has also produced a document 'Geology in Local Authority Planning' which provides guidelines to Local Authorities on managing impacts such as building, quarrying, landfill, forestry, road cuttings, tunnels and major drainage works, as well as advice on planning conditions for all types of geological sites not only eskers.

Eskers have particular potential as areas of value for biodiversity. While none are covered in the original vegetation which was found on the eskers before the development of farming (a type of oak-ash-hazel woodland) some have areas with semi natural habitats such as less intensively managed grasslands, woodlands or scrub, as exploitation was difficult on their steep sides.

Within Laois parts of several eskers are designated as proposed Natural Heritage Areas. The Ridge of Portlaoise pNHA (Site code 876); and the Timahoe Esker pNHA (Site code 421), are within the study area defined for the survey. The Timahoe pNHA is owned by the state and has the status of a National Nature Reserve.

The Ridge of Portlaoise pNHA has primarily been proposed for protection due to the presence of two nationally rare plant species, the nettle-leaved bellflower and blue fleabane. The former is found in open woodland, and the latter on open gravelly areas. Nettle-leaved bellflower is a nationally rare species, which was protected under the Flora Protection Order 1987, but was removed from this list when the new (1999) Order was made. It is listed in the Irish Red Data book for vascular plants. It is now almost completely confined to swampy woodland habitats on the Barrow and Nore rivers. The dry, open woodland in which it occurs in Laois is more typical of the habitat in which it is most commonly found in Britain. This pNHA includes woodland, scrub and old sandpits which have been recolonised naturally by plants. A full survey has not been carried out for this site.

The Timahoe Esker Nature Reserve has been proposed as an NHA as the best example of an intact esker with semi-natural woodland in County Laois. It contains the nationally scarce plant species, buckthorn. The woods are managed by the National Parks and Wildlife Service which have carried out clear felling of conifers.

Research and survey work in the past has focused on some eskers and within them, on esker woodlands, as this habitat is most "natural". This survey offered an opportunity to carry out a comprehensive survey of esker habitats using the classification system and draft survey guidelines developed by the Heritage Council (Heritage Council 2002). This approach will clarify the status of rare habitats such as semi-natural broadleaved woodlands and species rich grasslands, and the status of rare plants such as the red hemp-nettle, (protected plant) and the two plants found on the Ridge of Portlaoise esker (which are listed in the Red Data Book).

Under the Habitats Directive, certain habitat types which are considered important on a European level are listed for protection. Each member state is required to protect a proportion of any of these habitats occurring in the state. Additionally, certain habitats are deemed to be in greater need of protection and are called 'priority' habitats. Old grasslands on eskers may be examples of the priority habitat "Semi-natural dry grassland and scrubland facies on calcareous substrates (Festuco-Brometea) (*important orchid sites) (6210)" which is listed in the Habitats Directive (92/43/EEC).

The survey will also describe other obvious features of biodiversity interest such as birds and butterflies, particularly as some of these groups may be under recorded in Laois.

As the purpose of the survey is to make policy recommendations to the Heritage Forum the surveyors have assessed the biodiversity status of eskers, gathered information on the current management of eskers, and considered pressures and management opportunities. These types of insights were gained from fieldwork, discussion with landowners and the statutory authorities. The resulting guidelines should be regarded as draft guidelines and as a basis for further discussion with interested groups.

2 Methodology

2.1 Locating eskers

Initially eskers in the study area were put on a 1:50,000 Discovery map using data contained in the EPA Soil and Subsoil mapping project (Figs.4 and 5). Eskers have been mapped for this project using sub soil data, aerial photographs and a limited amount of fieldwork. The esker mapping was produced as part of a project initiated by the Forest Service of the Department of Agriculture and Food (FIPS-IFS Project, 1998-2001), and further funded by the Department of Environment and Local Government and managed by the Environmental Protection Agency (EPA Soil and Subsoil Mapping Project, 2002-2005). The datasets from this project can be accessed in the public domain.

Fig. 5 shows the eskers in the study area. It contains nine esker systems. Each system is made up of a number of individual segments which were deposited at the same time. Appendix B contains details of the esker segments. There are 54 esker segments in total in the study area, ranging from 957 m² to 0.3 km² in area. Esker systems range from those having one segment (the Cloonagh esker) to twenty four (the Ridge of Maryborough/Portlaoise). Additionally, the Ridge Graveyard in Portlaoise is part of the Ridge of Portlaoise esker. These nine esker systems cover 244 ha or 50% of the esker cover in Co Laois.

2.2 Ancillary data

The National Parks and Wildlife Service (NPWS) files on relevant areas designated for nature conservation in Laois were consulted for information on eskers in the county. The Laois county recorder of the Botanical Society of the British Isles was provided with a map of the eskers and asked for records of notable plant species. Through Laois County Council and ENFO in Dublin, a list of Environmental Impact Statements (EISs) potentially relevant to the study area was compiled and examined. The Planning and Environment sections of Laois County Council were also consulted regarding quarrying and waste licensing in eskers. To assist with the interpretation of butterfly records from this survey were compared with the 10km2 species distribution maps coving the periods pre-1990 (Hickin, 1992), 1995 – 1999 (Dublin Naturalists Field Club/ Butterfly Conservation Project (www.searchnbn.net/dataset)) and 2000 – 2004 updated to September 2005 (Butterfly Ireland (www.butterflyireland.com). A data set of Irish butterfly records up to the mid-1990s were also examined for relevant records (Tom Cooney, personal copy).

2.3. Consultations

Meetings were held with members of the Heritage Forum. A leaflet providing information about this project and the habitat survey was distributed to libraries, local authority offices and to all landowners and rural residents encountered by the surveyors. Landowners were asked for information on past and current land management practices, their aspirations for further development and whether they would be interested in obtaining information about the results of the survey. Their surnames were recorded by surveyors.

2.4 Fieldwork

Prior to fieldwork, a certain amount of information was obtained through remote sensing. On aerial photographs it was possible to distinguish the sites of quarries and thus the extent of esker removal. By examining the FIPS landcover data it was possible to discover which eskers had significant woodland and scrub cover. This preliminary analysis helped to orientate fieldwork.

In the field the 1:50,000 (Ordnance Survey 'Discovery' series) on which the eskers were outlined were used to roughly locate the individual segments. Informed by the 1:50,000 map Laois County Council IT dept provided copies of six-inch OS maps (second edition), vector maps and aerial photographs (on which the esker outline from EPA mapping was superimposed) for all esker segments (Fig. 6) at a scale of 1: 6,400. The survey was carried out using the Heritage Council draft Habitat Survey Guidelines, and habitats were classified using 'A Guide to Habitats in Ireland' (Fossitt, 2000).

Before each segment was visited a certain amount of habitat mapping was carried out using aerial photographs. For example homogenous dark green fields was identified as improved grassland, while darker areas were marked as woodland or scrub. This allowed the field survey to target habitats that appeared more semi-natural, while avoiding homogenous less interesting areas i.e. large improved fields. Examination of OS map sometimes indicated the past presence of features of habitat interest. Following this preliminary assessment all unknown habitats and features of interest shown on aerial photos or OS maps were examined directly.

On the ground, the aerial photographs enabled fieldworkers to locate the esker segment, or the site of the esker segment. Landowners were located by identifying the nearest farmhouse or other premises on aerial photos or maps. Obvious farmhouses were first visited to establish ownership of the land on which the esker was found. All landowners were asked permission for access and engaged in consultations on land management practices. If the landowner could not be located and their land could not be surveyed, habitats on these eskers were assigned using aerial photographs and visual inspection from the road.

The land was surveyed by walking along the esker, through different areas such as grassland, scrub or woodland and in some cases along the road where this followed the esker. Habitat codes were added to the vector map. All habitats even those which occupied an area less than 50m X 50m were mapped as small scale habitat diversity is common on these eskers. Lists of plant species were taken for each esker and each habitat type. Where particularly interesting species or habitats were found, a target note was taken and the area marked with a unique number on the map. Target notes were compiled on the sites of badger setts or on the location of invasive exotic species. Photographs were taken of features of interest and a range of habitats.

Particular efforts were made to locate species rich grasslands which had potential as the priority habitat type. All sites of old grasslands were examined directly. Based on a review of the literature on such grasslands, the description in the EU Habitats Manual (European Commission 2003) and field experience, for the purposes of this study such grasslands were defined as those which had at least six indicator species.

These grasslands were indicated as GS1* in habitat maps.

A preliminary bird and butterfly survey was carried out in a selection of esker segments. Due to time constraints and the lateness of this survey in the bird nesting season it was not feasible to visit all eskers. On the basis of the habitat survey a short list of seven priority sites were selected for the bird survey. These were esker segments 2s, 2g/h, 2q, 2w, 6h, 6m and 9a. Recording was therefore confined to compiling a 'species list' for these sites. Particular note was made of species of conservation interest in Ireland (Newton et al, 1999). Each esker segment was surveyed by systematically field walking and recording bird and butterfly species encountered.

2.5 Constraints

Timing affected the survey results. Plants in the woodland understorey may have been under-recorded as many flower in Spring before fieldwork took place. The bird survey provided a preliminary account of birds as it took place after the bird nesting season. Despite these constraints the survey provided an adequate account of the biodiversity interest of the eskers.

2.6 Reporting

During fieldwork, a large amount of data was gathered. This included species lists, digital photographs, rough habitat maps and notes on individual sites. The species lists, as well as a checklist of habitat types and any landowner details, were compiled into an Excel spreadsheet within one or two days of fieldwork. The rough maps were used to produce clean maps. All habitats were coded following Heritage Council guidelines. Target notes were typed up in Word. The original field sheets and raw data will be stored in the Heritage Office of Laois County Council.

3 Results

3.1 Summary

Compared to other Midland counties, e.g. Westmeath (Tubridy 2005), there are fewer eskers in Laois and they generally cover a relatively small land area. The total cover of eskers is 1,172 acres or 0.3% of the county. With the exception of the Ridge esker and parts of the Timahoe esker which are high and steep, many of the esker segments are not immediately obvious, but most of them are still visible to some extent, at least as a slight ridge in pasture or arable land, or as unusually high and winding sections of road with adjoining hedgerows.

The majority of Laois esker segments have had their structure greatly modified through agricultural improvement, development or by having their gravel and sand removed. Of the 54 segments surveyed, 10 are intact or almost so, with steeply-sloping sides and little or no evidence of past extraction. Additionally, the Ridge Graveyard is intact. A total of 22 segments are moderately modified, with low, gently sloping sides, small areas of extraction and/or a predominance of very modified habitats. The remaining 22 are partially or completely modified through extraction and/or agricultural improvement and development.

Habitats and plants

The dominant habitats over most of their length are associated with improved grassland or quarries. Despite the dominance of these habitats eighteen different habitat types are still found (Table 2). They include grasslands, woodlands, scrub and hedgerows, arable land, built areas, disturbed ground and a small amount of wetland. While no good examples of priority or non-priority habitats were identified, many of the habitats recorded are semi natural and are rare elsewhere in the countryside.

From within these habitats, a total of 284 plant species were recorded (see Appendix C for lists of plants). Notable species include the nationally rare nettle-leaved bellflower and blue fleabane. BSBI data revealed a small further number of records of uncommon plant species within a 1km square containing esker segment 2s (At Summerhill, behind Portlaoise Town Park). These are listed in Appendix F.

Table 3.1 List of habitats recorded during Laois esker study

Habitat category	**Habitat code**
Improved agricultural grassland	GA1
Dry calcareous and neutral grassland	GS1
Wet grassland	GS4
Other artificial lakes and ponds	FL8
Oak-ash-hazel woodland	WN2
Mixed broadleaved/conifer woodland	WD2
Scattered trees and parkland	WD5
Scrub	WS1
Immature woodland	WS2
Recently felled woodland	WS5
Hedgerows	WL1
Exposed sand, gravel or till	ED1
Recolonising bare ground	ED3
Active quarries and mines	ED4
Arable crops	BC1
Tilled land	BC3
Stone walls and other stonework	BL1
Buildings and artificial surfaces	BL3

Birds

At the time of surveying, the habitats were found to support 36 species of birds (Table 3). The list includes one species protected under the Birds Directive. This is the kingfisher which was seen on esker segment 2g/h which is adjacent to the Owenass River.

Several species listed as being of conservation concern in Ireland were recorded. One Red List bird species, yellowhammer, was recorded. Of the four Amber List bird species recorded, sand martins are the only species directly associated with esker habitats. Sand martin colonies were found in two eskers in the vertical faces of old extraction areas which are now disused. The other two Amber List species, snipe and swallow, do not use the eskers for nesting. Common snipe and kingfisher were recorded on the Owenass River where esker segment 2h forms the riverbank. Swallows were observed feeding over most eskers but do not use them for nesting. Also of interest was a rookery at esker segment 2s.

A large rookery containing 100-120 nests was found on the “Ridge” esker. Rookeries in pine trees are not uncommon in central Ireland however the size of the rookery is slightly above normal (Macdonald, 1985).

Plate 3.1 Sand martin colony in an esker quarry face

Table 3.2 Bird species recorded at selected esker segments in County Laois, 2005

Species	**Status***	**Esker segment**						
		2q	**6h**	**2g/h**	**9a**	**2s**	**6m**	**2w**
Grey Heron				x				
Sparrowhawk				x				
Pheasant		x	x		x			
Common snipe	Amber 1			x				
Moorhen			?					
Wood pigeon		x	x	x	x	x	x	x
Kingfisher	Birds Directive Amber 1, 3			x				
Sand martin	Amber 3		x		x			
Swallow	Amber 3	x	x	x	x	x	x	
House martin		x	x	x	x			
Meadow pipit				x				
Wren		x	x	x	x	x	x	x
Dunnock		x		x		x	x	
Robin		x	x	x	x	x	x	x
Blackbird		x	x	x	x	x	x	x
Song thrush		x	x	x	x	x		x
Blackcap		x		x			x	
Willow warbler		x	x	x			x	
Goldcrest		x			x	x		x
Long-tailed tit		x			x	x		
Coal Tit		x	x		x	x	x	
Blue tit		x	x	x	x	x	x	x
Great tit		x	x	x	x	x	x	
Treecreeper						x		
Magpie		x	x	x	x	x		
Jackdaw		x	x			x		
Rook		x	x		x	x		
Raven			x					
Starling		x	x			x		x
Chaffinch		x	x	x	x	x	x	x
Greenfinch		x	x		x	x		
Goldfinch		x			x			
Linnet			x	x	x			
Bullfinch		x	x	x		x		x
Yellowhammer	Red 1			x	x		x	
Reed bunting		x						
Totals		25	23	22	21	20	13	10

Status Key

Birds Birds Directive Annex 1 species (Council Directive (79/409/EEC)

Red 1 Red List – High Conservation Concern: 1 declining breeder (Newton, et al 1999).

Amber 1 Amber List – Medium conservation Concern: 1 Breeding species (localised moderate decline, rare, internationally important)

Amber 3 Amber List – Medium conservation Concern: (Newton, et al 1999).

Butterflies

A total of eleven butterfly species were observed over the esker sites visited (Table 4). In terms of overall biodiversity, the range of butterfly species recorded at eskers in 2005 compares very favourably with published and unpublished data for each of the three 10 km squares (Table 5).

Table 3.3. Butterfly records from selected eskers in County Laois, 2005.

10km square	**N 24 20**		**S 24 19**		**S 25 19**		
Esker segment	**2q**	**2g/h**	**2s**	**2w**	**6h**	**6m**	**9a**
Large white *Pieris brassicae*	x	x	x	x	x	x	x
Small White *Pieris rapae*	x			x	x	x	
Green-veined White *Pieris napi*	x	x				x	x
Small Copper *Lycaena phlaeas*						x	
Common blue *Polyommatus icarus*		x	x	x			x
Small Tortoiseshell *Aglais urticae*	x	x		x	x		
Peacock *Inachis io*	x		x	x	x	x	x
Speckled Wood *Pararge aegeria*	x	x	x	x	x	x	x
Meadow Brown *Maniola jurtina*		x	x	x			x
Painted Lady *Vanessa cardui*	x						
Red Admiral *Vanassa alalanta*	x	x	x	x	x	x	x
Total species recorded from esker segment	8	7	6	8	6	7	7
10km^2 Totals	10		8		10		

Plate 3.2 Peacock butterfly on field scabious

Table 3.4 10km^2 butterfly species diversity in 2005 compared with 1990-98 and 2000-04.

10 Km Square	*1990-98	**2000-04	Eskers 2005
N 24 20	1-5	0	10
S 24 19	1-5	1-6	8
S 25 19	6-15	7-12	10

Sources: * Butterfly Conservation, 1999
** Butterfly Ireland, 2005

The only archival record that is of any relevance to eskers is of a dingy skipper *Erynnis tages* at "Ridge of Maryborough" in June 1976. The grid reference with the record suggests this was seen near or at esker 2q.

Mammals

Sightings and signs of rabbits were seen on or adjacent to most eskers. A small number of badger setts were found. The unconsolidated nature of esker sand and gravel means it is easy for these animals to dig into them; however it also means that burrows and setts would be prone to collapse. This aspect of esker biodiversity deserves further study.

Plate 3.3 Badger sett in the hedgerow bank of an old esker pit

3.2 Habitats on eskers

The following is an account of the habitats found throughout eskers. Individual eskers are profiled in Section 3.3.

3.2.1 Grasslands

Improved agricultural grassland (GA1)

Reseeded and fertilized grassland is found over much of the eskers, particularly where the typical steep sides of the esker have collapsed or been reduced through past extraction or levelling. These grasslands are typically low in species diversity, being dominated mainly by perennial rye-grass

with smooth and rough meadow-grasses. White clover can be frequent. Other species such as daisy, ribwort plantain and creeping thistle are occasional.

As the soils are thin and free-draining, the sward is generally found to be thin compared with improved grassland on deep soils. Calcareous grassland species can often be found scattered through the improved sward. The most frequent of these are crested dog's-tail, red fescue, sweet vernal and common bent grasses, as well as black knapweed, yarrow, dove's-foot cranesbill and red clover.

Improved grassland often grades into a more species-rich calcareous grassland sward where the sides of the esker are particularly steep, making tractor-work difficult and thus less likely that fertilizer or lime are spread

Dry calcareous and neutral grassland (GS1)

This typical esker habitat type is represented to varying degrees on the Laois eskers. Its species-richness varies depends on the degree to which it is managed, but it is typified by a thin grassy sward with abundant broad-leaved herbaceous species. It is found in pasture, old pits that have recolonised, road verges and the ridge graveyard in Portlaoise. Species-rich areas on intact eskers are quite limited in extent within the study area. This habitat is related to the priority habitat type "orchid rich grasslands".

The most abundant grasses are crested dog's-tail, red fescue, sweet vernal, common and creeping bent and cock's-foot. Among the more abundant broad-leaved species are cat's-ear, black knapweed, yarrow, red clover, dog daisy, lesser hawkbit, bird's-foot trefoil, wild carrot and selfheal.

As well as those species, the more species-rich grasslands support a variety of plants that are only found on calcareous, well-drained soils that are not fertilized. The most frequent of these on the Laois eskers include downy oat-grass, quaking grass, yellow oat-grass, spring-sedge, burnet saxifrage, wild marjoram, field scabious, cowslip, lesser trefoil, fairy flax, lady's bedstraw, mouse-ear hawkweed, common centaury, creeping cinquefoil, common spotted-orchid and bulbous buttercup.

A number of less common species were also recorded, such as upright brome, kidney vetch, yellow-wort, lady's mantle, carline thistle, pyramidal orchid and blue fleabane.

Plate 3.4 Carline thistle, a plant of open esker grassland and disturbed areas

Some segments support grassland which had potential to be identified as "orchid rich type" The habitat 'dry neutral and calcareous grassland' on fifteen esker segments had at least six of the species among those which are typical of orchid-rich grasslands. Of these, ten segments supported areas of open grassy sward, two had a mosaic of recolonising ground and grassland, and on four the grassland was present as a narrow hedgerow margin/roadside verge only.

Plate 3.5 Species-rich grassland with pyramidal orchid

Wet grassland (GS4)
This atypical esker habitat is found in old quarries where a combination of lowering of the quarry floor to the local water table and dumping of clay till which had previously covered the sand and gravel has caused small wet areas to develop. It is found in conjunction with small ponds (FL8, below). This habitat is dominated by grasses, particularly creeping bent, Yorkshire fog and floating sweet-grass, with soft rush and sharp-flowered rush. Brooklime, creeping buttercup, water mint, fool's water-cress, water plantain, marsh stitchwort and water-cresses are the most common species in these habitats.

3.2.2 Freshwater

Other artificial lakes and ponds (FL8)
Eskers are very free draining and surface water is not found on them when they are intact. Those that have been modified through quarrying can contain pools on the quarry floor, where this is level with or lower than the surrounding countryside. As well as some of the wet grassland species described above, the ponds contain branched bur-reed and stoneworts. The presence of these habitats accounts for the presence of wetland birds near eskers.

3.2.3 Woodlands and scrub

Oak-ash-hazel woodland (WN2)
This woodland type is typical of calcareous soils in general and eskers in particular. There are a small number of intact examples of this semi-natural woodland cover over most Laois eskers. In many cases it is represented as vestigial remains along the margin of old pits, or hedgerows or at the foot of reseeded eskers.

The most abundant tree species are ash, pedunculate oak, hazel, wych elm, holly and sally. The non-natives sycamore and beech are also abundant. Two less common species of calcareous woodlands are locally frequent on the Laois eskers, namely spindle and buckthorn. One fine example of a mature yew was found. Bramble is abundant. Whitethorn and blackthorn are frequent as understorey shrubs, as are honeysuckle and dog rose. Guelder-rose is occasional. Ivy is found both as a shrub and in the ground layer.

The species diversity of the ground flora varies greatly, depending on factors such as the degree of grazing in the wood. Heavily grazed examples are species-poor with a predominance of plants that tolerate or thrive on enriched soils, such as rough meadow-grass, wood dock, garlic mustard, nettles, burdock, hogweed, upright hedge-parsley, wood avens, herb Robert, nipplewort and enchanter's nightshade. There is usually a high proportion of bare ground and/or soil poaching in these woods, and the esker sides may be eroding. Depending on the degree of grazing, other more typical species as described below are usually present, though in limited abundances.

Where grazing intensity is low or absent, the shrub layer is more dense and the ground flora more varied. The most abundant calcareous woodland species encountered are pignut, wood false-brome, wild strawberry, scaly male-fern, wood sedge, wood speedwell, wild strawberry, bluebell, soft shield-fern, primrose, wood sanicle and violets. Wood melick, bugle, opposite-leaved golden saxifrage, goldenrod, tutsan and the Red Data book species nettle-leaved bellflower, are locally frequent to occasional.

Plate 3.6 Oak-ash-hazel woodland on the Ridge Road north of Portlaoise

Mixed broadleaved/conifer woodland (WD2)
Found where planting has taken place, this woodland usually contains a mixture of remnant native ash and oak, with planted species mainly comprising sycamore, European larch, silver fir, beech, sitka spruce, scots pine, and lime. It is distinguished from the semi-natural woodland type described above by the presence of non-native and/or conifer species in high proportions, and its modified nature due to planting.

The ground flora varies between species-poor in grazed areas or under a dense canopy of e.g. beech or pine, to moderately species-rich where grazing is light or absent, and where there is a higher proportion of native tree species and/or a more open canopy. In some cases a calcareous grassland flora is found in this mixed woodland habitat.

Scattered trees and parkland (WD5)
Scattered trees are found where left behind following woodland clearance, or through parkland planting on eskers managed as grassland. They can be either native or non-native. Lone ash or oak are found occasionally.

Scrub (WS1)
Scrub is found at the margins of woodlands, in grasslands where management is unintensive, and in areas which are not currently managed. It ranges from scattered bushes in grassland to dense stands of blackthorn or hazel. Whitethorn and gorse scrub is common. The floors of old pits are being colonised by willow scrub. Bramble and bracken are found associated with this habitat.

Plate 3.7 Scrub/grassland mosaic on a remnant esker

Dense scrub generally has a species-poor ground flora, though late-successional stage areas, where trees are becoming re-established can have a more diverse ground flora with some woodland species. Scattered scrub usually occurs on calcareous or neutral grassland of varying diversity.

Immature woodland (WS2)
Young plantations of broadleaved trees are found at a few locations. The trees are typically of a uniform age and height, and ground flora a mixture of grassland, scrub and recolonising ground. This is a highly modified habitat.

Recently-felled woodland (WS5)
Found at one site where a conifer plantation had been clearfelled, this habitat presented a mixture of woodland and grassland species, as well as some recolonising ground. This is a modified but moderately species-rich habitat.

Plate 3.8 Clearfelled area recolonising with semi-natural woodland species

3.2.4 Hedgerows (WL1)

As eskers are linear features, hedgerows following their long sides are common features. On many segments, the hedgerows are the only reservoir of a diversity of esker species, the adjacent land having been modified through extraction, agricultural improvement or building.

As well as the tree and shrub species described for oak-ash-hazel woodland above, hedgerows were found to contain different species of poplar, most of which are probably planted. Aspen is locally frequent in esker hedgerows. Non-native trees and shrubs were occasional, such as Leyland cypress, field maple and lilac.

Ground flora is generally a mixture of woodland and grassland species, depending on adjacent habitats. One hedgerow supports a few plants of the rare nettle-leaved bellflower.

Plate 3.9 Species-rich grassy verge under hazel hedgerow on the Ridge Road

3.2.5 Disturbed ground

The following categories are often found in conjunction with each other, sometimes in a complex mosaic. Additionally, they usually grade into areas of semi-natural grassland and woodland habitats. They are characterised by their low vegetation cover (usually less than 50%), which usually comprises a mixture of typical calcareous grassland and woodland species with some opportunistic ruderal (weed) species.

Exposed sand, gravel or till (ED1)

This category mostly applies to parts of eskers that are eroding or have been extracted from until very recently (but not where quarrying is ongoing). The sediments are exposed due to grazing and trampling, scrub clearance, and quarrying, and are unstable. Sand martins nest in these exposed sand deposits. The Red Data Book plant blue fleabane is found in this habitat.

Recolonising bare ground (ED3)

These areas were disturbed in the past but are now revegetating. Plant cover is over 50%, and is usually a mixture of ruderals, calcareous grassland species, and scrubby trees and shrubs. Some of the larger eskers, particularly around Timahoe, have large areas of recolonising ground where sand and gravel extraction has ceased. While the esker structure is gone, the exposed calcareous sediments are revegetating with species typical of calcareous grassland.

Weed species particularly associated with this habitat include scarlet pimpernel, shepherd's purse, common poppy, long-headed poppy, teasel, rosebay willowherb, St. John's worts, silverweed, dandelions and coltsfoot. In areas where colonisation is more advanced calcareous grassland species can dominate and in some instances thrive on the more open ground, for example carline thistle. The uncommon wall lettuce is locally frequent in this habitat.

Plate 3.10 An old pit recolonising with willow scrub and calcareous grassland flora

Active quarries and mines (ED4)
Active sand and gravel extraction is ongoing in a small number of pits on the Laois eskers. These areas are virtually devoid of vegetation cover due to continuous disturbance.

3.2.6 Cultivated and built land

Arable crops (BC1)/Tilled land (BC3)
Some eskers are entirely or almost entirely under arable crops. In these cases the flora is dominated by opportunistic weed species which can tolerate intensive management They may provide valuable feeding habitat for birds at certain times of the year.

Stone walls and other stonework (BL1)
A small number of stone walls are found following the eskers, usually along the roadside. For example the Ridge road north of Portlaoise is supported by old retaining walls of cut stone. Some calcareous grassland species may be found growing on mortar in cracks in the walls. Wall-plants such as maidenhair spleenwort and wall-rue are also found.

Plate 3.11 Old stone retaining wall along the Ridge Road

Buildings and artificial surfaces (BL3)
In many instances roads have followed the eskers, resulting in the top surface being covered in tarmac. There are also houses and other buildings built on wider eskers or areas where sand and gravel was extracted in the past.

3.3 Profiles of eskers

Table 6 is a summary of the habitat types found at each esker. The account of esker biodiversity should be read in association with habitat maps.

Table 3.5 Habitat diversity in individual esker systems

Esker system Number & name	**Habitat types in esker system**	**Total no. habitats**
1. Cloonagh esker	Improved grassland, dry neutral calcareous grassland, , hedgerow, tilled land, stone walls, buildings and artificial surfaces	6
2. Ridge of Portlaoise	Improved grassland, dry calcareous neutral grassland *, oak-hazel ash woodland, mixed woodland, scattered trees and parkland, scrub, immature woodland, hedgerow, exposed sand and gravel/till, recolonising bare ground, active quarries, arable crops, tilled land, stone walls, buildings and artificial surfaces	15
3. Ballytegan esker	Improved grassland, dry calcareous and neutral grassland, scrub, hedgerow, arable crops.	5
4. Borris Little esker	Improved grassland, dry calcareous and neutral grassland, hedgerow, arable crops, stonewalls, buildings and artificial surfaces.	6
5. Ballyroan esker	Improved grassland, dry calcareous and neutral grassland, hedgerow, buildings and artificial surfaces.	4
6. Ballymooney-Derry-west Timahoe esker	Improved grassland, dry calcareous and neutral grassland, wet grassland, artificial lakes and ponds, oak-ash-hazel woodland, scattered trees and parkland, scrub, hedgerow, exposed sand and gravel/till, recolonising bare ground, active quarries, arable crops, stonewalls, buildings and artificial surfaces.	14
7. Raheenduff Little esker	Improved grassland, dry calcareous and neutral grassland, mixed woodland, hedgerow, arable crops, stonewalls, buildings and artificial surfaces.	6
8. Stradbally esker	Improved grassland, dry calcareous and neutral grassland, mixed woodland, scrub, recently felled woodland, hedgerow, exposed sand gravel/till, recolonising bare ground, active quarries, arable crops, tilled land, stone walls, buildings and artificial surfaces.	13
9. Timahoe esker	Improved grassland, dry calcareous and neutral grassland, oak-ash-hazel woodland, mixed woodland, scrub, hedgerow, exposed sand gravel/till, recolonising bare ground, active quarries, stone walls, buildings and artificial surfaces.	11

3.3.1 Esker 1 – Cloonagh esker

Overall system area - 5.12 ha; no. of segments - 1
This small 1km-long section of esker lies west of Mountmellick at Cloonagh. Most of this has been removed in the past and apart from the elevation of the road and the hedgerow lines, there is little evidence of esker remaining. There had been some recent scrub clearance in a small field parallel to the road. The roadside verges are quite rank and apart from some hazel and aspen do not support an interesting esker assemblage. The eastern half has been modified through the building of houses with associated gardens.

3.3.2 Esker 2 – The Ridge of Portlaoise/Maryborough

Overall system area – 112.12 ha; no. of segments - 24
This esker stretches from north west of Mountmellick to just south of Portlaoise.
Between the two towns it is an obvious landscape feature known as the 'Maryborough Ridge' with the old ridge road lying on top of it for much of its length. Though narrow in places and modified by road widening in the past, some good examples of oak-ash-hazel woodland and pockets of calcareous grassland are found along this esker. Much of the bigger areas have been quarried out in the past or are managed as improved grassland and arable land. In some places the hedgerows support the only remnants of the woodland and grassland species. Generally speaking, the more interesting areas for biodiversity are found along the southern part of the system.

The best examples of dry calcareous grassland are found at 2g/2h in Townparks west of the Owenass River, in areas of old quarrying along 2p at Knocknagroagh, the east-facing slope of 2s at Summerhill, and the northern portion of 2w at Cappoley. Of these, 2h and 2p were disturbed in the past and are moderately grazed by cattle. The eastern slope of 2s is grazed by horses and had a short sward, but is in good condition with no erosion. It merges into scrub and mixed woodland near the top of the slope, and improved grassland towards the bottom.
The northern half of 2w comprised closed meadows with the sward at full height at the time of surveying. There is some low scrub scattered along the esker in this grassland, with abundant pyramidal and common spotted orchids in the northern field.

The most intact woodland habitat in esker system 2 is found along the Maryborough Ridge in segment 2q at Rossleaghan/Cooltoran. The sides of the esker are mostly intact, and support oak-ash-hazel woodland. Some parts are dominated by hazel, though as this is greater than 5m high it falls into the woodland category. Livestock generally have access to the slopes resulting in an open shrub layer. In some land parcels the esker is used for wintering cattle, resulting in a patchy ground flora and erosion. Another reasonably intact example is found on 2t at Downs, which has a similar tree and shrub species composition, but lacks a reasonably developed shrub layer and has an impoverished and enriched ground flora due to cattle grazing.

Plate 3.12 Fungi on the woodland floor under the Ridge Road

Much of the typical esker flora in system 2 is found in hedgerows and the grassy verges or margins associated with them, particularly along parts of the Ridge Road where the adjoining land has been improved right up to the boundary or where the road has been realigned. Hedgerows were found to be reservoirs for esker species where the greater part of the esker was removed and/or improved. In particular, buckthorn was found in hedges in 2b (Dernacart) and 2c (Forest Upper). Aspen was found in 2o (Kyletalesha). The hedgerows along the Ridge Road have a high diversity of species.

Fieldwork revealed that the pNHA includes land which is not part of the esker. This area, south of Portlaoise at Downs, is now a mixture of improved grassland and new development. Other areas of the land originally proposed for inclusion and on the esker, also now comprise developed or improved land.

Fieldwork confirmed the continued survival of the rare plants, nettle-leaved bellflower and blue fleabane which are associated with the pNHA and were recorded in an NPWS sponsored survey carried out in 1994. Populations of nettle-leaved bellflower were found north of Portlaoise in segments 2o, 2p, 2q.They appear to be stable and thriving. It was not found on 2s, though the landowner remembered that NPWS found the plant there during an survey a few years ago (1994). A few plants were found in a remnant hedgerow in 2t, a vestige of the “Woods of Maryborough”.

Plate 3.13 Nettle-leaved bellflower, a rare species found in esker woodland

Plate 3.14 Blue fleabane, a rare plant found in open grassy and disturbed areas on eskers

Blue fleabane is also listed in the Red Data book (Curtis & McGough 1988), and has a scattered, mainly central distribution in Ireland. Again, its population appears to be stable where re-found (2p). It is obviously vulnerable to agricultural improvement or gravel extraction.

The BSBI plant records showed a small number of uncommon plant species in the 1km-square in which esker 2s is found, namely opposite-leaved golden saxifrage, dogwood, common whitlow-grass and imperforate St. John's Wort. These were not recorded during this (2005) survey. Opposite-leaved golden saxifrage is found in damp woods and so is more likely to have that the past record is from a low-lying shady area within the 1km square. Common whitlow-grass is a very small and inconspicuous plant which could have been passed over during the 2005 survey, while imperforate St. John's Wort is similar in appearance to the more common slender St. John's Wort which was found in 2005. Dogwood is a large shrub of damp areas which was not found on the esker. None of these are protected or listed in the Red Data Book for vascular plants.

The Environmental Impact Statement for the development of Lismard Industrial Park (Dunne 1997), which was developed within the original NHA boundary, refers to this plant as a reason for designation of the NHA. The EIS states that the 'adjacent esker ridge' is 'now worked out' and that 'site surveys showed no evidence of this plant'.

A second EIS for a development within the boundary of the pNHA (Portlaoise Waste Water Treatment Plant, located near segment 2r in Maryborough townland) (MCOS 2001), concluded that the adjacent esker was of poor quality, was below the standard for inclusion in the protected area and did not contain either of the protected plants. As described in the EIS, the boundary of this pNHA has not changed since it was first put forward as an Area of Scientific Interest in the 1970s, and much of the land within the protected area boundary has since been developed. It appears from the site notes for this pNHA that a full boundary survey was never carried out. Field work in 2005 appears to confirm the assessment of the 2001 EIS, that the lands around the WWTP comprise (semi) improved agricultural pasture which is unlikely to support either of the two notable plant species. The esker itself in this immediate area is largely intact as a geomorphological feature, but supports a low species diversity and would not merit protection on habitat or species diversity alone.

Several segments of this esker supported an impressive diversity of bird species.
Twenty five bird species were recorded in the woodland area of segment 2q including one amber list species. the swallow. More species were recorded at this intact oak-ash-hazel esker than at all the other sites visited. The woodland provides a good habitat for a wide range of bird species although some parts are heavily grazed. It is likely that up to 21 species of the 25 recorded nest at this site, with the exception of swallow, house martin, rook and jackdaw. Common species such as blue tit, great tit, wren, dunnock, robin, blackbird and chaffinch were found throughout the site. The east and southeast of the esker contained a good mix of native vegetation attracting a good variety of species including willow warbler and blackcap. Along the fringe of the southeast part of the esker there was a healthy population of reed buntings (15-20 birds) associated with a wetland habitat.

In segments 2g/h 22 species were recorded including the Red List species yellowhammer and amber list birds common snipe, kingfisher, swallow. A male yellowhammer was seen in scattered scrub in 2h and probably nests in the immediate area. Common snipe and kingfisher were disturbed from where esker 2h forms a river bank with the Owenass River. The snipe was likely to be a migrant bird but the kingfisher was seen several times perched in the same area and almost certainly uses this river for nesting. The low ridged esker 2g is dominated by grassland habitat with patches of scrub and hedgerows. Few birds were noted in the grassland but typical small songbird species occurred in the adjoining hedgerows and patches of scrub e.g. blue tit, blackbird, robin and song

thrush. Although very small in area, esker 2h benefited from the presence of open scrub and adjacent aquatic habitat. In addition to yellowhammer, snipe and kingfisher, this was the only esker where grey herons, sparrowhawk and meadow pipits were recorded. Apart from the common song birds there was also blackcap, willow warbler and a flock of 40+ song thrushes.

Segment 2s provided records for 20 bird species including the amber listed swallow. Swallow use the area for feeding only and do not nest.

The main bird interest at this site is a rookery with an estimated 100-120 nests in pine trees along the entire length of the esker. Rookeries in pine trees are not uncommon in central Ireland however the size of the rookery is slightly above normal (Macdonald, 1985). This is the only site where treecreeper was recorded, reflecting the maturity of the woodland. The remainder of species were common songbirds. Birds were generally less numerous on the western side of the esker probably because it was dominated by beech trees, was heavily grazed by horses and lacked a native woodland understorey. Birds were notably more common on the top and east side of the esker where more open and scrubby habitat graded into grassland (GS1).

On a smaller segment of esker (2w) only 10 bird species were recorded. This low esker segment dominated by grassland with hedgerows and patches of scrub was of less bird interest. However the hedgerows contained typical small songbirds e.g. robin, blackbird, song thrush and chaffinch.

The butterflies of this esker were noteworthy. Records of small tortoiseshell, small white and common blue butterflies on esker system 2 appear to be new records for the 10km squares in which these eskers lie. In addition, the large white, speckled wood and meadow brown records appear to be the first for over 15 years in these 10km squares.

3.3.3 Esker 3 – Ballytegan esker

Overall system area – 8.25ha; no. of segments - 2
A small portion of segment 3a remains at Knockshee. This tree covered area is too small and scrubby to be classed as woodland, though there are a few taller ash and hazel. The centre has been extracted in the past and is now managed as improved grassland. Calcareous grassland is found on open parts of the slope. Livestock graze in through the scrub. The hedgerow around the field containing the esker portion has a diversity of tree and shrub species, including hazel, wild cherry, Irish whitebeam, dog rose, and ash.

3.3.4 Esker 4 – Borris Little esker

Overall system area – 4.37ha; no. of segments - 1
Segment 4a is an example of a moderate diversity of esker grassland and woodland species surviving along a roadside verge; however this is very narrow (1-2m). Kidney vetch, quaking grass, downy oat-grass, field scabious, devil's-bit scabious, all typical esker grassland species, are still found on this verge.

3.3.5 Esker 5 – Ballyroan esker

Overall system area – 2.06ha; no. of segments - 2
Segment 5b is a small, low section which appears to have been extracted from in the past, and is now in permanent grass, grazed by horses. Both the esker and the lower-lying parts of the field appear to receive very little, if any, fertilizer, and some calcareous grassland species are found throughout, being most abundant and diverse on the esker itself. The hedgerows surrounding the field are also moderately diverse.

3.3.6 Esker 6 – Ballymooney-Derry-west Timahoe esker

Overall system area – 34.14ha; no. of segments - 14

Esker system 6 contained some of the bigger eskers in Laois, but the biggest segments have been worked out for sand and gravel up to recent times. Most of this system is now represented by gravel pits which are recolonising with calcareous grassland and scrub, and usually with a more or less intact wooded margin along the pit edge. Though disturbed, the pit floors support to a greater or lesser extent the typical calcareous grassland species. The owners of some of the pits are applying for licenses to infill them with waste.

Of the surviving portions of the system, 6c at Derry is typical improved grassland for most of its length, except for the steeper slopes near its southern end where calcareous grassland species are more prevalent, with some gorse scrub. 6d at Derry is the best example of woodland in the system, with ash, hazel and some very large willows, as well as a mature yew. Grazing on the esker is moderately intense.

The intact northern portion of 6g at Esker supports some woodland with a number of fine mature oak, though this is very eutrophic, heavily grazed with a poor ground flora, and contains some Scots pine and sycamore.

Plate 3.15 Species-poor ground flora in woodland on segment 6g

The southern part of 6g, and all of 6h (Timahoe) were quarried in the past. 6g has revegetated and is managed as grassland. The southern part of this is quite eutrophic and in some places marshy, where extraction went down to the water table. The core central part of 6g supports a moderately diverse calcareous grassland flora with an ash-hazel margin on the slopes. 6h is typical of the large, recently disturbed pits (also seen in system 9). The pit floor is characterised by bare spoil with recolonising bare ground. Pockets of calcareous grassland are found at the roadside bank and the less disturbed parts of the banks. The outside slope of the pit is largely intact, with a strip of oak-ash-hazel woodland remaining. This merges into scrub of gorse and willow on the disturbed ground. Ground flora in the wooded sections is of low-moderate diversity.

The segment 6k has been infilled and reseeded. A small portion of calcareous grassland remains along its western margin. This appears to have a low diversity of herbaceous species. The segment 6m is dense blackthorn/hawthorn scrub.

Several segments of this esker were surveyed for birds. In section 6h 23 bird species were identified including the Amber List species sand martin and swallow. The disused quarry in this section contains two small sand martin colonies. One colony in the northern quarry contained 7 – 15 burrows and a smaller colony of 4 - 6 burrows in the southern quarry. Swallows use the area for feeding only. This site contained a range of common songbirds usually associated with similar scrub habitat elsewhere. The weedy nature of the vegetation attracted several finch species. Two ravens appeared briefly but probably only use the site occasionally for feeding. A moorhen was heard calling in the southern quarry and assumed to be present at a small shallow wet area that also contained a range of aquatic insects.

In segment 6m 13 species were found including the red list species yellowhammer. A female yellowhammer was present on 13th September. This small esker is surrounded by arable land (wheat) and hedgerows that appear to be suitable for this species. The esker is composed of two distinct habitats. No birds were recorded in the small area of arable land that formed part of a larger wheat field. A small but dense scrub that recolonised an old extraction area contained typical small songbird species including the summer visitors blackcap and willow warbler.

The small copper butterfly was recorded from this segment. This record is apparently only the second record for this species in this 10km square.

3.3.7 Esker 7 – Raheenduff Little esker

Overall system area – 1.76ha; no. of segments - 1
This system is represented by one segment which has been greatly modified. A small amount of mixed woodland with a eutrophic ground flora is found on intact esker. The remainder has been cleared and is agricultural land. The hedges and verges are moderately eutrophic with a low species diversity.

3.3.8 Esker 8 – Stradbally esker

Overall system area – 25.75ha; no. of segments - 4
Much of this system is either gone, having been quarried out in the past, or is under arable or improved grass. The most interesting part of 8a is a middle portion in Rankin Wood at Oldmill, where the landform remains and is under planted woodland of beech; however this has a low species diversity. The remainder of this segment has been removed and planted over (northern and southern sections) or is under improved grass. The segment 8b at Bauteogue is in a Coillte woodland, which has been clear-felled in the past few years. The esker is intact, and broadleaves, mainly ash, that were growing in the plantation have been retained. Though the esker is slightly disturbed, having been used for the forestry access road, it is recovering and has good potential to return to ash-oak woodland. There is a small amount of intact broadleaved canopy. Segments 8c and 8d are either gone or under arable/improved grass, except for tiny remnants along the road at Kyle.

3.3.9 Esker 9 – Timahoe esker

Overall system area – 61.88ha; no. of segments - 5
This system contains the Timahoe esker pNHA. Much of the esker is quarried out with quarries retaining a wooded margin around the top of the pits. The segment 9a at Coolnabacky is quarried out to the west, and small portions of intact calcareous grassland are found at the edge of the pit. These are very small in extent. The southern part of this segment is part of the intact esker covered in mature oak-ash-hazel woodland which is owned and managed by the National Parks & Wildlife Service as a National Nature Reserve. This and 9b are the best of examples of intact woodland in this system and in the whole of the survey area.

While scattered conifers in the wood have been felled in the past, there is currently no active management of the woodland. As it has been recently surveyed as part of a national survey of native woodlands a good species list exists for a sample site in the woodland and it has been assigned an overall evaluation and threat number (Higgins, Martin, & Perrin 2004, refer to NPWS web site to see report).

The eastern part of 9b is as described for 6h, having been quarried out. This esker segment contained the Red Data book plant species, blue fleabane. This is a new record for this species on this site and in this 1km square. The rare plant buckthorn, which had previously been seen at this site was not refound.

The segment 9c at Cloondoolagh and Orchard Lower, has some intact portions. The most complete of these is at its eastern end, where calcareous grassland is found north of the road, and scrub/woodland/grassland is found south of the road. Part of the grassland north of the road has been cleared of scrub in the past year or so, and is now eroding. Where it is intact, it presents a moderately diverse flora. Other small portions to the west of this support calcareous grassland and scrub habitats. These are of moderate diversity though somewhat disturbed/enriched. The segments 9d and 9e are now in improved grassland.

Plate 3.16 Recolonising ground on old spoil in esker 9a

Timahoe esker pNHA woodlands are shown in the background

Segment 9a was surveyed for birds. A total of 21 bird species were recorded including the Red list species yellowhammer and the amber list birds sand martin and swallow. Yellowhammers (male and female/immature) were present in scrub in the old extraction area. The old extraction area contained a small sand martin colony of 30+ burrows. Swallows use the area for feeding only. Bird diversity depended on the nature of the habitats in the segments. A total of fifteen species were recorded in the old extraction area/grassland habitat including pheasant, greenfinch, goldfinch and linnet. The oak-ash-hazel woodland held only eleven common species such as robin, blackbird and woodpigeon. This scarcity of species in the woodland may, in part, be due to the timing of the survey.

4 Conclusions

4.1 Baseline

The survey provides the first account of esker biodiversity in County Laois, including pNHAs. Habitats have been mapped and species lists compiled for certain groups. Some of the species identified are rare in Ireland or are under threat. The brief autumn survey of birds shows that eskers provide a range of habitats that attract a diverse and interesting range of bird species. This survey has provided new information on the biodiversity of butterflies in County Laois. The eskers visited are clearly important for many habitats and for many species some of which are under-recorded, uncommon or scarce in the county

The information contained in the baseline survey can be used to raise public awareness of the biodiversity value of these landscape features. As a baseline it can be used as a benchmark to manage future change and the survey and the analysis can be used to inform the County Biodiversity Plan.

4.2 Relative value of esker systems

Based on the proportion of semi-natural habitats (particularly woodland, scrub and calcareous grassland), structural integrity and size, an attempt was made to rank eskers for their biodiversity value. Results are shown on Table 7.

Table 4.1 Relative biodiversity value of esker systems

Ranking	**Esker system no. & name**	**Interest**
Most important for biodiversity ↓	9. Timahoe	National (& County Geological Importance) – parts already designated
	2. Ridge of Portlaoise	
	6. Ballymooney-Derry West-Timahoe	Regional
	8. Stradbally	Local
	4. Borris Little	
Least important for biodiversity	5. Ballyroan	
	3. Ballytegan	
	7. Raheenduff	
	1. Cloonagh	

4.2.1 Eskers of national importance

Esker 9 at Timahoe is of high biodiversity value as it has a large area of intact semi-natural woodland, which is both a Nature Reserve and a proposed Natural Heritage Area (9a/9b) and therefore has particular potential for biodiversity management. It contains other smaller areas of intact calcareous grassland and scrub (9c). Though large parts of the system have been quarried, they now contain a good calcareous flora including the rare blue fleabane and uncommon carline thistle (9b/c). These old workings have good potential to revegetate with a mixture of calcareous grassland and ash-oak-hazel woodland.

Esker 2 "The Ridge" esker is ranked of national interest due to the continued presence of the rare plants nettle-leaved bellflower and blue fleabane, as well as the presence of smaller amounts of semi-natural woodland and calcareous grassland. The grassland includes a small area of potential orchid-rich type which is not in the current pNHA (2w).

The amount of NHA-quality habitat is considerably less than that mapped within pNHA boundary, as much of the area proposed for inclusion in 1994 has been developed or agriculturally improved. The remaining areas of interest are small but of good quality, namely 2p, 2q and 2s. Segments 2r and 2t have been largely damaged but contain some diverse pieces of hedgerow, grass verges and pockets of woodland. Segments 2b, 2c and 2d contain a notable species (buckthorn) as well as supporting small pockets of calcareous grassland and oak-ash-hazel woodland. Segment 2f was previously quarried but contains calcareous grassland and scrub. Segments 2g and part of 2h support species-rich hedgerows and calcareous grassland. Segment 2o is of local interest for its hedgerows and small areas of scrub with nettle-leaved bellflower, and is also fairly intact in structure. The Ridge Graveyard in Portlaoise is of value as it supports a moderately diverse calcareous flora.

Both these eskers are ranked as being of local value for geomorphology.

Plate 4.1 The Ridge Graveyard in Portlaoise

4.2.2 Eskers of regional importance

Esker 6 (Ballymooney-Derry West-Timahoe) is of regional value as it contains some small pockets of intact woodland, as well as large areas of recolonising pits which support calcareous grassland flora with oak-ash-hazel woodland margins. These are reservoirs of these species in an otherwise improved agricultural landscape. Segments 6g, 6h, 6f and 6m. 6c and 6d have some calcareous grassland and intact woodland.

4.2.3 Eskers of local importance

The remaining esker systems are of local value, in the order in which they appear in Table 7, as they contain small areas of semi-natural habitats associated with eskers, as well as supporting a range of calcareous grassland plant species and native tree and shrub species. Most segments of local value have a less distinct esker shape, having been eroded, quarried or ploughed in the past. Generally

their sides are much more gently sloping than those of intact eskers, or the centre may be missing through quarrying. Their main value is as local reservoirs of a diversity of grassland and woodland species that are otherwise largely absent in the surrounding improved agricultural land.

Esker segments 3a (Ballytegan) and 4a (Borris Little) are relatively more important as they contain fragments of scrub, hedgerow and calcareous grassland of local interest. Segment 8b (Stradbally) is disturbed but has good potential to recover to oak-ash-hazel woodland, the esker structure here is also intact.

Plate 4.2 Common blue butterfly

Overall, the biodiversity found on eskers compares very favourably with the broader landscape in County Laois, given the relatively small area covered by eskers. The 2005 Laois Habitat Survey covered 78 square kilometres, yielding 42 habitat types containing 331 species of flowering plants. The esker systems cover 2.58 square kilometres, and were found to support 18 habitat types and 281 species of flowering plants. Due to their unique topography and soils, the biodiversity value of the eskers is high relative to the area that they cover. They are most important for dry nutrient-poor habitats, while wetland habitats are not found on intact eskers. The bigger number of habitats and species recorded in the Habitat Survey comes primarily from wetlands such as wet grassland and marsh, habitats that may be found on low ground adjacent to eskers, but not on them.

5 Management guidelines

5.1 Management issues

A number of management practices affect the integrity and biodiversity of eskers in Laois, in negative and positive ways. This section looks at what these issues are, and suggests initiatives which would aim to maintain and enhance the biodiversity and geological interest of eskers. These should be considered as starting points for discussion among members of the Heritage Forum and other stakeholders.

5.1.1 Public awareness

Few landowners consulted were aware of the nature of eskers, or the special value of this type of land or of the relevance of certain management practises to the retention and enhancement of these values. However many, if they had time for some discussion, became interested. The natural inclination of most farmers is to reclaim scrubby rough land as this is regarded as a sign of a bad farmer. Many regard the old pits as liabilities because they are perceived as being unsightly, possibly dangerous, and can attract illegal dumping. This suggests that there is a need to highlight the value of these features and the habitats on them as a resource within the county. Active involvement of farmers and farm organizations is necessary to provide such information to landowners.

5.1.2 Quarrying

Aerial orthophotograph mapping (dated 2000) showed the presence of 38 pits in the eskers. Among these pits 13 were large pits. Nine were seen in the Timahoe esker and four were associated with The Ridge of Portlaoise esker.

Fieldwork revealed that the number of quarries appears to be consistent with what was shown on aerial photographs. Active quarrying is still occurring. It is carried on to varying degrees in parts of segments 2l, 2m, 2t, 9a, and 9b. As the number of quarries appears to be consistent with what was shown on aerial photographs, the pressure to continue to exploit eskers for sand and gravel has not increased since 2000. Quarrying is obviously undesirable on intact eskers. Few intact segments remain and the removal of sand and gravel may result in the removal of a valuable habitat.

While further new exploitation of intact eskers should not be encouraged, the baseline survey revealed that old disused sand and gravel pits are of significant biodiversity value. They provide habitat for rare species, and the mosaic of open grassland, scrub and woodland is important for bird diversity. In particular, they are recolonised by calcareous grassland plants that cannot compete in the surrounding agricultural land. Most of these pits are of local ecological value and should be maintained or redeveloped in a way which is sympathetic to biodiversity.

There is a need to address the increasing pressure to infill old sand and gravel with waste. The old pits are regarded as liabilities because they are perceived as being unsightly, possibly dangerous, and can attract illegal dumping. Consultations revealed that many owners of old quarries are now seeking waste licences to backfill quarries with inert materials such as building rubble and subsoil from building sites, with a view to building on them, reseeding or planting native trees.

Introducing such material will remove the biodiversity value of these pits and reduce their geomorphological interest. The deposits will be obscured and landscaping or reclamation is unlikely to provide habitats of equal biodiversity value to that which is currently present. Instead old spoil, where it exists in the quarry might be used to help level the old pits. Using esker pits for general

dumping is also problematic due to the highly porous nature of the sediments, leading to a high risk of groundwater contamination.

Plate 5.1. Early recolonisation on an old pit near Timahoe

5.1.3 Roads/Development

While eskers are the often sites of old roads, and this has sometimes protected them from removal, road developments in recent years have resulted in some parts of the esker being levelled and tarred over, for instance on the main Mountmellick-Tullamore road, where segment 2b is represented only by a short section of hedgerow. The Portlaoise bypass removed the southern tip of 2t. There is particular pressure on the ridge road north of Portlaoise as it is used as a shortcut for traffic when the Mountmellick road is busy at peak times. It was improved by the council a few years ago, and is just about wide enough for two cars, but most of the esker apart from the very top is still intact. The esker is quite narrow and steep and in some places is eroding where it falls away from the road. Some local residents concerned with the road have suggested that the traffic issue could be resolved by lowering the road in order to widen it. This response to the traffic issue would result in the removal of a part of one of the few intact esker segments in the county and thus would significantly reduce the geological and biodiversity interest of this esker system.

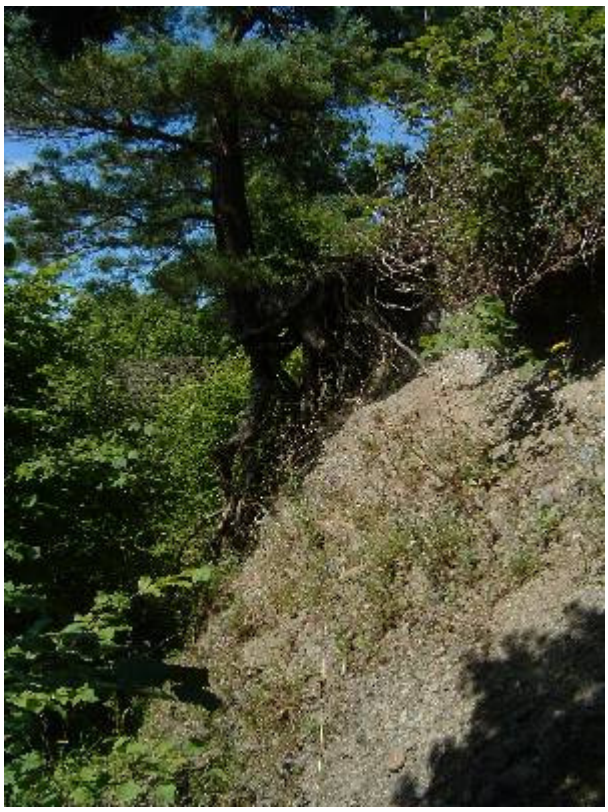

Plate 5.2 Erosion under the Ridge Road

Tree roots are helping to hold the top of the esker together

5.1.4 Agriculture

Over the last 7,000 years the original woodland habitat on eskers has been removed principally to facilitate farming. In common with land elsewhere land improvement is still occurring on eskers. In the 5 years since the aerial photographs were taken, at least one significant portion of old quarry workings has been reseeded and is now improved grassland. Scrub clearance has taken place along one section causing the collapse of the steep side of an esker and the removal of its associated species-rich grassland. The maintenance of species rich grasslands depends on grazing, absence of ploughing and negligible inputs of fertilizer and lime. If grazing stops the grassland will revert to a less valuable type. If fertilizers are applied the diversity of native species will be reduced, particularly legumes, and the sward will be replaced by a few fast growing species which will crowd out the less common types.

Plate 5.3 Recent scrub clearance on a steep-sided esker, leading to erosion

In contrast to the intensive and productive focus, in recent years some esker farmers have joined the Rural Environment Protection Scheme (REPS). This scheme, run by the Department of Agriculture with funding from the EU, sets out to reward farmers for carrying out their farming activities in an environmentally-friendly manner. Some landowners have joined the scheme because their land is in the Ridge of Portlaoise NHA. Landowners with part of their land in NHAs or SACs (Special Areas of Conservation) will ultimately all have to either be in REPS or have a National Parks & Wildlife Service farm plan drawn up. Farmers can currently draw down supplementary payments under REPS for land which is in an area designated for nature conservation, provided they adhere to guidance in their plan which aims to maintain and enhance the biodiversity value of the protected area.

The small number of esker landowners known to be in REPS showed a wide variance in farming practices. One of the best pieces of intact esker with calcareous grassland, in segment 2w, is currently farmed under REPS. This scheme could safeguard the survival of this species-rich grassland, but it is vulnerable as it is quite small and currently not under any nature designation. It seems that it is being managed as closed meadow, and so is at risk from under grazing, which would lead to a rank grassland type with more scrub cover, i.e. a reduction in biodiversity.

At least one landowner on the Ridge north of Portlaoise is in REPS. Some farmers here have fenced off the steep esker slope from the adjacent field, while others leave it open to livestock. It is particularly useful for out wintering as it is dry and sheltered. However grazing and trampling by stock is causing some erosion, and placing of round feeders in old pits is leading to enrichment of the pit floor. It appears that stocking levels are not high enough to cause wholesale damage but are leading to a reduction in ground flora cover. Some grazing of esker woodland is desirable to maintain an open woodland structure which is favoured by the nettle-leaved bellflower. Overgrazing will damage biodiversity as it will remove the native herb flora and trees and shrubs cannot regenerate as animals damage seedlings. All farmers whose land covered the ridge were aware of its existence, but it seems there is a lack of baseline information on the status of habitats on the ridge and the best way to manage them. While areas covered by nature designations have some input or data from NPWS, other eskers had little or no information on them prior to this study.

Without detailed background data it is difficult for land managers/policy-makers to make decisions on the best appropriate management for sensitive parts of the landscape, such as eskers.

Plate 5.4 Winter feeding of livestock is leading to some erosion and enrichment in this area

5.2 Guidelines

5.2.1 Partnership approach

The role of the Heritage Forum is to provide a local network to support interested individuals and relevant agencies with a direct or indirect role in heritage management. The initiatives suggested below could be promoted immediately or they could be developed and implemented as part of a County Biodiversity Plan. While the ideal vehicle for implementation is a County Biodiversity Plan, this should not prevent the Forum providing information and raising awareness which will hasten the progress of the County Biodiversity Plan.

The immediate priority for the Forum is to highlight the biodiversity ranking and interest of the eskers surveyed, noting that eskers of county geological importance are a significant landscape feature and of limited extent in Laois ; activities affecting the structure of intact examples are to be avoided and even disturbed habitats such as old pits are of interest for some rare plants and bird and butterfly populations. In the short term some publicity should be given to the biodiversity value of old quarries many of which are threatened due to plans for landfills.

If work is carried out on the County Biodiversity Plan the group assembled to develop that plan should set targets for esker biodiversity such as a target % area occupied by GS grassland and woodland by 2010 compared with % area from this study (calculated after the results are mapped for the Laois GIS database), retention of a particular number of intact eskers. As part of the development of a biodiversity action plan an action plan should be developed for esker habitats.

The suggested initiatives should be used as a basis for discussion. While some could be initiated directly by the Heritage Forum, the active promotion by other organizations would be equally valuable.

5.2.2 Provide information, raise awareness and maintain interest in esker biodiversity

A. Target audience: the public and farmers

- Survey all remaining eskers in the county
- Publicise the results and conclusions in this report,
- Make copies of survey and habitat maps available to public and landowners in Libraries.
- Put maps and report on council web site.
- Set up an informal group "Friends of the Ridge" comprised of interested persons and landowners who own land and houses along the ridge esker. Hold information meeting locally to inform them of the results of the study
- Develop themed heritage trails in Timahoe Esker Nature Reserve as a local amenity.
- Manage the Ridge Graveyard to maintain and enhance its biodiversity value and provide an interpretive panel at the site explaining the biodiversity and geodiversity significance of the site and the reasons for management.

B. Target audience: schoolchildren

- Make results of this survey available to locally based specialists who go into schools as part of the INTO Heritage in Schools Scheme and encourage schools and specialists to cover this part of the county's heritage in school visits.
- If an opportunity arises promote a schools project on esker butterflies.
- Provide esker habitat maps and explanation to secondary school biology teachers interested in ecological field studies.
- Develop a woodland ecology module for teachers using the Timahoe esker pNHA.

C. Target audience: advanced students/environmental activists

- Compare results of both habitat and esker surveys.
- Survey breeding birds in sites surveyed for this report.
- Encourage a student of local history to use GIS to compare the types of settlements within FIPS esker line and outside it within 50m.
- Monitor GS* sites for orchids
- Monitor rare plants (bellflower and fleabane)

5.2.3 Managing change

Suggested initiatives include:

- Production of an information leaflet on farming esker land, mentioning the need to maintain light grazing, retaining small amounts of scrub, all esker hedgerows where fields are now intensively managed, controlling grazing and feeding of cattle in woods. This leaflet could refer directly to the types of biodiversity measures (under REPS 3) which would be particularly appropriate for esker land such as restoring hay meadows, maintaining species rich grasslands, planting small woodlands or scrub areas particularly adjacent to species rich hedgerows and to the reclamation of quarried land by spreading old spoil and allowing the ground to revegetate naturally.
- Training/information for REPS planners on how to identify eskers, use habitat maps and develop prescriptions for eskers.

- Promotion of the Native Woodland Scheme to landowners wishing to manage their esker woodlands or develop woodlands on eskers.
- Identification of an esker farm to be used as a demonstration site for good esker land management.

5.2.4 Partnership with the statutory authorities

Suggested initiatives involving NPWS include:

- An assessment of the "Ridge" esker NHA to determine the appropriate boundary of the area of interest to assist in the development of a management plan.
- Development of Timahoe Nature Reserve as a demonstration site for esker woodland management
- Suggested initiatives involving Laois County Council include:
- Including policy statements on esker conservation and listing esker sites of national and regional interest identified by this study in the next County Development Plan.
- Asking all developers or consultants preparing local area plans to consider the impacts of their development on esker biodiversity and geodiversity, as assessed by this report.
- Provide landscaping guidelines for developers and householders which will support esker biodiversity.
- Consider developing an amenity area in the old quarry east of the Ridge road (X on habitat map)
- Applications for waste licences in intact esker segments should be asked to consider the value of the esker for biodiversity with reference to this report. This includes both habitats and species that would be directly impacted, and local groundwater, adjacent habitats and species that could be indirectly disturbed. If permission is given for landfills then a condition of this permission should be that the infill material be covered with local sand and gravel and allowed revegetate naturally.
- Undertake traffic calming measures on the "Ridge" esker.

Plate 5.5 Old pit revegetated with species-rich calcareous grassland and native tree species

5.3 Conclusions

Though eskers in Laois cover a relatively small area and many are damaged, they provide valuable areas of semi-natural and species-rich habitats in an area that is dominated by large areas of species-poor improved grassland and arable land.

The area of very good quality semi-natural habitat is quite small. Therefore limited resources are needed to manage the areas of biodiversity importance and few landowners will be directly affected.

Information and education on the value of esker habitats and appropriate land management is a priority to conserve the best examples of semi-natural habitat. This could be carried out by developing locally based education initiatives in partnership with the community.

In the medium term greater recognition must be given to esker heritage in the County Development Plan. The preparation of a County Biodiversity Plan would assist in setting goals for biodiversity conservation in the county.

As there are immediate threats to esker sand and gravel pits which are being considered for landfill developers and planning authorities should be informed about the biodiversity value of these sites and their options for redevelopment.

References

Curtis, T.G.F. & McGough, H.N. (1988) *1 Vascular plants. The Irish Red Data Book*. The Stationery Office, Dublin.

Dublin Naturalists Field Club. 1999. *A guide to the Butterflies of Ireland*. The Dublin Naturalists Field Club, Dublin.

Dublin Naturalists Field Club. 2005. Butterfly Ireland at www.butterflyireland.com.

Dunne, A. (1997) Environmental Impact Statement for Lismard Industrial Estate at Borris Little Townland, Portlaoise. Unpublished report held at ENFO, Dublin

European Commission (1999) Interpretation Manual of European Union Habitats. Eur 15/2 October 1999

Fitter, R., Fitter, A. & Blamey, M. (1985) *Wild flowers of Britain and Northern Europe*. Collins, London.

Fitter, R., Fitter, A., & Farrer, A. (1984) *Grasses, sedges, rushes and ferns of Britain and Northern Europe*. HarperCollins, London.

Flora (Protection) Order 1999. Statutory Instrument No. 94 of 1999. The Stationery Office, Dublin.

Fossitt, J. (2000) *A guide to habitats in Ireland*. The Heritage Council, Kilkenny.

Haslam, S., Sinker, C. & Wolsely, P. (1995) *British Water Plants*. Field Studies Council, Shrewsbury.

Heritage Council (2002) *Habitat Survey Guidelines. A standard methodology for habitat survey and mapping in Ireland*. Kilkenny

Hickin, N. (1992) *The Butterflies of Ireland. A field guide*. Roberts Rinehart Publishers, Cork.

Higgins, G. T., Martin, J. R. & Perrin, P. M. (2004) National Survey of Native Woodland in Ireland. National Parks & Wildlife Service, Dublin

Laois County Council (1989) Environmental Impact Statement for Portlaoise Bypass. Unpublished report.

Laois County Council (No date) Waste Management (Permit) Regulations, 1998. Statutory Instrument 165 of 1998. Regulations, permit application form and site notice sheet. Unpublished guidance document.

Macdonald, R. 1985. The breeding density of the Rook in eastern Ireland. In: O'Halloran, J. et al. Current ornithological research in Ireland. *Irish Birds* 3 (1): 150.

MCOS (2001) Environmental Impact Statement for the Upgrade of Portlaoise Waste Water Treatment Works. Laois County Council, unpublished report.

National Parks & Wildlife Service (1994) Ridge of Portlaoise Site Synopsis. Dublin.

National Parks & Wildlife Service (1994) Timahoe Esker Site Synopsis. Dublin.

Newton, S., Donaghy, A., Allen, D., Gibbons, D. 1999 Birds of Conservation concern in Ireland. *Irish Birds* 6 (3): 333-344.

Preston, C. D., Pearman, D. A. and Dines, T. D., eds (2002). *New Atlas of the British and Irish Flora*. Oxford University Press, Oxford.

Stace, C. (1997) *New flora of the British Isles*. Cambridge University Press, London.

Tubridy (2005) Survey of biodiversity and geomorphology of eskers in south Westmeath (Sheet 48), in prep. Unpublished report for Westmeath County Council.

Webb, D. A., Parnell, J. & Doogue, D. (1996) *An Irish Flora*. Dundalgan Press, Dundalk