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THE FORTH NATURALIST AND HISTORIAN

The Forth Naturalist and Historian was set up in 1975 as an informal enterprise of Stirling University. At that time it was administered by staff from the University and Central Regional Council, with the purpose of providing a focus for interests, activities and publications on environmental, historical, heritage and related topics. The coverage is across the Forth area, now generally comprising the Stirling, Falkirk and Clackmannan Council areas.

The annual *Forth Naturalist and Historian* journal has appeared yearly since 1976 and an annual conference has been held at the University since 1975; more recently, wildlife and heritage fairs have been held across the area.

The journal has published numerous important papers; together the volumes now form a significant body of local information, complementing the earlier *Transactions of the Stirling Field and Archaeological Society* series (1878-1939). The journal includes some regular items such as meteorological and bird reports.

In addition, two books have been published. *The Stirling Region* (edited by Timms, 1974) and *Central Scotland; Land, Wildlife, People* (edited, by Corbett et al. 1993). These, along with most back issues of the journal, are available, free, online via the website, which also has an Index to the papers in the Journal; website http://www.fnh.stir.ac.uk/journal/

Copies of recent volumes of the Journal can be purchased through local outlets or via the Secretary (address below).

Forth Naturalist and Historian is now an independent, membership organisation, retaining close links with the University. It is a registered charity (SCO 13270).

We are pleased to discuss ideas for future conferences (including partnerships and sponsorship) or for papers in the journal (contact the Secretary, address below). Detailed guidance and support on preparation of papers can be given, if required. Outline Instructions for Authors are at http://www.fnh.stir.ac.uk/journal/jnl_instructions_to_authors.pdf

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Forth Naturalist and Historian 40th Anniversary

Report of the *Forth Naturalist and Historian* Man and the Landscape Conference Saturday November 15th 2014

The Inner Forth: Formed by Nature, Shaped by People

For this year's conference, the *Forth Naturalist & Historian* was partnered by the Heritage Lottery Funded *Inner Forth Landscape Initiative* (IFLI) partnership in exploring the past and present dynamics of this constantly changing landscape.

The Inner Forth estuary has changed out of all recognition over the last 500 years or so. Land has been claimed and protected from tides and storms. Farming has become increasingly commercial. Major industries in the past, such as salt-making, coal mining and iron-working have needed the Forth as a gateway to international trade. As a result the natural world has been forced to retreat, communities have turned their backs on the river, and often the outside world sees only the refineries and power stations that now dominate the landscape. The Inner Forth Landscape Initiative aims to reawaken our pride and understanding of this complex mix of the old and the new, the natural and the built, aims clearly central to those of the *Forth Naturalist & Historian*.

Anne McCall, Regional Director of the RSPB, the lead body in IFLI, opened the meeting and **Jess Dolan**, Programme Manager of IFLI described the scope and scale of the initiative (www.innerforthlandscape.co.uk) in the next 4 years, the purpose, to create an holistic and balanced approach to the management of our heritage and the vision to make an Inner Forth landscape where the natural, cultural and historical wealth of the area is revealed, valued, enhanced, and made accessible to both residents and visitors and better able to cope with change. The Inner Forth is an area of 200 km^2 from the Forth estuary and intertidal zone to the floodplain and coastal margins and settlements on both banks. IFLI will deliver 50 discrete but interlinked projects around the Inner Forth to reveal, protect and enhance its unique natural and historic heritage.

Donald McLusky, formerly of the University of Stirling, described the changes to pollution levels of the waters of the estuary since the 1960s. These have been overwhelmingly beneficial, a 'good news' story. In the 1960s the water from just below Stirling to Grangemouth was anoxic, with dissolved oxygen at 20-25 % in which fish could not survive. By 1979 values were greater than 60 %. The Cornton reach of the estuary, which is saline to the M9, is now the richest salmon beat in Scotland and the Forth is now a nursery for fish, the single most important in the North Sea, so significant that commercial fishing is banned. Mercury and cadmium releases were stopped entirely in 1983 with changes in industrial operations, with funding for better water treatment: pollution is reversible.

Yvonne Boles, RSPB Conservation Officer for Central Scotland, talked about the significance of the Inner Forth for bird populations. The Firth of Forth Special Protection Area regularly supports a wintering waterfowl assemblage of European importance, in particular a winter population of 95,000 waterfowl, some 45,000 wildfowl and 50,000 wading birds. It is the second most important estuarine area for wintering birds in Scotland, and 12th in the UK. Most of the wildfowl and waders in the Firth of Forth are found at internationally or nationally important levels. The invertebrate-rich mudflats are used for feeding at low tide whilst higher ground, including saltmarsh, provides high tide roosts and feeding sites. The largest expanses of mud are in the inner Forth at Kinneil Kerse, Skinflats, Torry Bay and Alloa Inches. The internationally important wintering species within the Forth are shelduck, which includes an important post-breeding moult flock , a rare feature in Britain. At Kinneil Kerse, bar-tailed godwit, knot, golden plover, redshank and pink-footed geese are found.

There are many threats and pressures. There has been about a 50 % loss of intertidal habitat in the past 300 years, through industry, land claim and coastal squeeze. Global warming led sea level rise, increasing storminess and wave heights threaten to become major drivers of biodiversity loss. Encouraging floods to spill onto reclaimed land, as at Skinflats near Grangemouth, should enable management to keep pace. A range of local projects should, delivered through genuine partnerships, lead to the collective desire to future-proof the Inner Forth.

Brownfield sites are any places that have been altered by human activity and are not currently fully used. Their importance for conservation has been assessed by **Suzanne Bairner** of Buglife (suzanne.bairner@buglife.org.uk). They can have a very high diversity of wild flowers, with many weed species of bare or disturbed ground, in contrast to more natural habitats. Very complex mosaics of habitats develop quickly. Some 12-15 % of rare and scarce invertebrates have been recorded on Britain's brownfields, including Red Book species. Brownfield sites can be one of the United Kingdom Biodiversity Action Plan's priority habitat, 'open mosaic habitats' if they fulfil criteria such as size, history, loose bare ground and early successional plant communities, though diversity tends to peak after 5-12 years of abandonment as open ground is lost.

Nationally there are over 10,000 hectares of vacant and derelict land. Remote sensing assessments by Buglife has identified 5500 ha of this as potentially being open mosaic habitat. Of 66 sites in the Inner Forth, 22, over 107 ha, potentially meet open mosaic habitat criteria. The Inner Forth was at the heart of Scotland's industrial revolution and was particularly important for our coal industry. Large spoil heaps (bings) have been left scattered across the landscape and are an important reminder of our recent past. Fallin coal-working ended in 1987 and was re-graded in 1994 with the hydro-seeding of wild flowers and the planting of trees. Today there are populations of Nationally Scarce (Notable B) of the ground beetle *Amara praetermissa*, the leafcutter bee *Megachile willughbiellia* and the ant hunting spider *Steatoda*

phallerata. Millhall Bing is a wetland today, good for dragonflies such as four-spot chaser, large red, common darter and common blue damselfly. Other open mosaic habitat sites are at Manor Powis Bing and Garibaldi Bing near Falkirk.

The loss of local colour and diversity of products in orchards has been an intriguing subject of research and restoration in recent years. **Crispin Hayes**, an ecological consultant (www.eco-consultancy.co.uk) gave an overview of traditional orchards in the Forth Valley, some 27 orchards in an area of 2500 km^2. Early orchards were linked closely to the great religious houses at Cambuskenneth (founded 1140), Linlithgow (1401) and Culross (1217). Before the Act of Union, religious orders provided a direct cultural bridge between Scotland and the more sophisticated France, and pomology was part of that culture. Orchardland at Airth was recorded in 1489, at Bothkennar in 1630 and at Stonehouse in 1707 when Stonehouse was "a fine orchard of very good fruit trees belonging to it". Orchards spread from monastic centres. In Stirling itself there were orchards at the King's Knot, the Brig and in St. Ninians. "Indeed, no soil seems to be more favourable for fruit trees than the Carses of Stirlingshire", opined an expert in 1812. The recent survey by Dr. Hayes recorded that of the 27 orchards in the Forth Valley, 18 have some heritage value, though most have been neglected for at least half a century. Neglected orchards often have high biodiversity value, and veteran trees satisfy multiple criteria for biodiverse habitat. New plantings need to be made soon if these orchards are to survive in the long term.

A deeper history of the Carse was given by two stalwarts of local societies, **John Reid** from Falkirk and **John G Harrison** from Stirling. John Reid explored settlement on the Carse east of Stirling in the centuries before AD1600, arguing that the evidence from Scots place-names implied that settlement and farming, the latter already commercial and producing a surplus, were common and widespread by or in the Middle Ages. He suggested that activities usually associated with the modern period such as ditching and draining were well advanced, the driving forces being the large monastic granges. Raised mosses close to Stirling had been removed for fuel by the early 14th century, and the big raised mosses at Wester, Dunmore and Letham had been substantially reduced.

John Harrison examined the history of the carse in the last few centuries. He began with the idea that the carse adjacent to the Forth Estuary was a fertile fringe with large estates and large agrarian surpluses in the 16th century and for long after this. The key to this lay in the ease of transport on the water of very bulky materials such as lime and coal. The lime kilns on the shore at Fallin were, for example, commissioned in 1767. Limestone could be delivered, broken down in coal- and coke-fired kilns and sold on along the Forth. The 'loops' of the Forth became very valuable assets, needing to be defended against storms and tides. He drew on General Roy's Military Survey (1747-1755) to show the depiction of sea walls around the mouth of the River Carron. Early sea walls are known at Airth, a key port and protecting the Queenshaugh

below Abbey Craig in Stirling. Yet there is passing mention in the early 17th century of older, 'ancient sea dykes', but how old and where they are remain unknown. The 18th century 'improvements' encouraged reclamation of mud flats, using low-tech and cheap methods, for arable, and later for navigation and industry. But have we now seen the end of land claim as food imports are cheaper than walls and conservation concerns encourage managed retreat?

Salt-making was another shoreline industry, and the large amounts of ash helped build the sea-walls, as **Geoff Bailey** of the Falkirk Community Trust explained. Salt-making on the Forth can be traced to at least the 12th century AD. Salt can be concentrated by evaporation, though in Scotland this has always been unlikely. Sea water and estuarine mud need to be boiled in pans, a process called sleeching. Ash is a by-product of this. To make 3 tons of salt required 97 tons of sea water and huge amounts of fuel. Wood very quickly gave way to peat from the coastal raised mosses near Stirling, but by the 13th century panners were moving east to secure coal reserves: to complete the equation, 48 tons of coal had to be burnt to produce those 3 tons of salt. In 1614 salt was after wool and fish Scotland's main export, mostly to the Dutch Empire, and by 1630 one half of all Scottish ships carried either salt or coal. Bo'ness was second only to Leith as a trading port. But working conditions were appalling: Pennant in 1771 wrote that "Nothing ever exhibited such an idea of the infernall regions as this horrid furnace and the poor miserable naked wretches attending it". Workers being tied to their place of work with no freedom to move, a form of serfdom, which persisted into the 18th century in both coal mining and salt-making.

Kirsty McAlister is the historian on the IFLI Project and gave a presentation celebrating the trading heritage of the Inner Forth. Much of this has disappeared from view and memory, or almost, but the project will begin to retrieve this from archival research, archaeological survey and oral history at places like Alloa harbour, described in 1803 as "very commodious, receiving vessels of greatest burden", Kennetpans and Higgins Neuk near Airth, the southern end of the link to Alloa on the north bank. There are exciting times ahead.

Richard Tipping

CELEBRATING 40 YEARS OF THE FORTH NATURALIST AND HISTORIAN

Murray Dickie

In 2015 one of the corner-stones of the region's cultural life celebrates its 40th anniversary. The Forth Naturalist and Historian (FNH) has since 1975 encouraged curiosity and supported individuals and groups wishing to undertake research on our beautiful, ever-changing region, given them a voice, shared a range of materials on the natural history and history of the area, created an invaluable archive for the future, provided public access to this and provided, each year, conferences and other outlets to engage everybody who is interested in our natural history and history.

In 1974 the British Association for the Advancement of Science (BA) met in Stirling (1). It brought the spotlight on to the natural history and history of the area and highlighted the lack of recently published material. The late Robert Innes, of the Department of Education at Stirling University, and Ian Collie, Director of Education for the newly formed Central Regional Council, were anxious to encourage joint working between their two organisations. They brought together a group of university and local authority staff to look at ways of promoting and supporting research into local natural history and history, together with the publication and dissemination of that research. The group were also tasked with encouraging interest in learning about and conserving local heritage in the area covered by Central Regional Council and the three District Councils of Clackmannan, Falkirk and Stirling.

Dr David Bryant, Mr Lindsay Corbett, Mr Robert Innes and Dr John Proctor of the University of Stirling joined Mr Murray Dickie and Dr Kenneth Mackay of Central Regional Council Education Department and Mr George Thomson, a graphic designer from Dunblane, who together constituted the first Forth Naturalist and Historian Editorial Board in 1975 (2). The aim of the group was summed up in the editorial of the first Volume of the Forth Naturalist and Historian (FNH), published in 1976: "The Transactions of the Stirling Natural History and Archaeological Society ceased at the outbreak of the Second World War and were never revived. The first widely available publication since 1939 that drew together a range of contributions from the Stirling region was the survey, edited by Professor Timms, which was produced for the visit of the British Association to Stirling University in 1974. This survey, despite its shortcomings, must represent a landmark in the study of our region. Its main message for many was that the Scottish Central Region is as interesting as any area of Britain and yet has received relatively little recent attention. There is a need to revive the type of local studies carried out in the late nineteenth century and first decades of the present century, when men of immense scientific standing, such as Harvie-Brown, Kidston and Buchanan White, as

well as many less famous authors, published papers concerned with our region. However, much has changed since their times, both in the region itself and in the range of new information and techniques available to the investigator. The missing ingredient has been the enthusiastic amateur naturalist and historian. There have been notable exceptions but, even for these, there has been no suitable local journal in which to publish in full their researches and observations. The University community reinforces these studies but it is pleasing to note that the band of amateurs is growing once more and they contribute the majority of papers in this first volume. Our aim in launching the *Forth Naturalist and Historian* is primarily to increase our knowledge of a neglected part of Scotland. We hope that by providing a vehicle for publication we will not only stimulate existing workers to present their results but also encourage others to take up new researches."

The first Journal of the Forth Naturalist and Historian included papers on *the Geomorphology of the Upper Forth Valley*, J.B. Sissons; *The Return of the Hen Harrier*, Edward A. Blake; *Habitat Selection in the Birds of Woodland and Open Woodland of the Stirling Area*, C.J. Henty; *Stirling and Clackmannan Bird Report (1974 & 1975),* C.J. Henty; *The Golden Eagle Aquila chrysaetos in the West of Scotland,* D.H. Merrie; *Our 'Disappearing' Butterflies*, George Thomson: *Ecological Aspects of Some of the More Local Flowering Plants of the Western Ochil Hills*, Edward A. Blake; *The Red German Catchfly in the Western Ochil Hills*, Edward A. Blake, Peter R. Wallis and John Proctor; *Cultivation Terraces Along the Ochil Escarpment,* D.M. Dickie and *On First Looking Into Chapman's Ledger,* K.J.H. Mackay.

The members of the Board produced and sought articles for future Journals. The journals were initially edited by Lindsay Corbett and graphic support was provided by George Thompson. Volumes 1 to 6 were typeset and printed by The Education Resources Unit, a Job Creation Scheme run by Central Regional Council Education Department and bound and finished by the print department of the University of Stirling (3). Since Volume 7, in 1983, the Journal has been typeset and printed by Meigle Colour Printers in Galasheils (4).

The Board was fortunate in obtaining generous grant support for the cost of producing and printing the cover of the Journal. From Volume 3 in 1979 to Volume 28 in 2005 British Petroleum provided an annual grant (5) and (6). This support was continued by INEOS from Volume 29 in 2006 to Volume 36 in 2013 (7). In 2014 the Stafford Trust helped fund the publication costs (8).

The collected editions of the Journal from 1976 onwards represent a large and significant data set, covering a wide range of natural and historical issues over a significant period of time. There is, for example, a regional bird report covering each of the last forty years and an annual climate report since 1980 (9). The publication of *Central Scotland, Land – Wildlife – People* in 1993 was undertaken by the FNH Board, supported by the University of Stirling, assisted by a wide range of individuals and local and national organisations (10) and

sponsored by the British Petroleum Companies in Grangemouth (11). It built on the work of the 1974 *Stirling Region* and still provides the most authoritative description of the region.

Responding to the growing demand for on-line research, the Board undertook a pilot study in 2010 to look at the best way of making the information in the Journal publically available. Meigle Colour Printers were able to supply files from Volume 21 onwards. Volumes 1 and 2 were scanned in and it was agreed that there was a need to make the information available in a searchable format. In 2011 a grant was obtained from Scottish Natural Heritage to enable Volumes 11 to 20 to be scanned (12). Volumes 1 and 2 and volumes 11 onwards (with the exception of the last three years, which are still being sold) are available on the FNH website. In 2015 grants have been obtained from the Mercer's Company and The Marc Fitch Fund (13) enabling Volumes 3 to 10 together with copies of the original *The Stirling Region,* 1975, (Stirling University) and *Central Scotland – Land, Wildlife, People,* 1993, (FNH) to be scanned and made available on-line. When this is completed, all of the volumes of the Journal, except the most recent three, and the two most significant regional publications will be available on line in an easily searchable format on the FNH web site and at http://archaeologydataservice.ac.uk/

During the past forty years, the FNH Board has produced and supported the publication of a number of other local books and booklets (14). These have included: *Alloa Tower and the Erskines of Mar* (Clackmannanshire Field Studies Society – CFSS); *Doune and Kilmadock – Historical Notes* (Mackay, K.); *Clackmannan and the Ochils – illustrated architecture heritage* (Swann, A.); *The Lure of Loch Lomond – the islands and environs* (McAllister); *The Making of Modern Stirling* (Lannon, J.); *Mines and Minerals of the Ochils* (CFSS); *The Ochil Hills – Landscape, Wildlife, Heritage, Walks* (CFSS/FNH) and *Woollen Mills of the Hillfoots (*Park, B.). The board has also supported a further 26 smaller publications.

The Forth Naturalist and Historian Editorial Board organised the first conference at the University of Stirling in November 1975 (15), entitled The Forth Estuary, Carse and Moorlands. Following the success of this venture, an annual conference has been held at the University of Stirling every year since then. From 1976 to 1989 the conferences covered a diverse range of topics. These included natural history topics such as: scenery; geology; fossils; earthquakes; climate, rainfall; the Forth; lochs; flowers; woodlands; Dutch Elm disease; Flanders Moss; birds of Central Scotland, the Devon Valley, Gartmorn Dam and Loch Lomond; sand martins; peregrine falcons; wildlife; butterflies; fish; conservation and recreation; country parks and Loch Lomond side. Historical topics have included: bronze and iron age sites; brochs; the Antonine Wall; run-rig systems; the Battle of Stirling Bridge; oral history; graveyards; waterpower; the coal industry; woollen mills; the Howieton fish farm; Robert Burns; Robert Louis Stevenson and historical studies of Bridge of Allan, Culross, Doune, Muckhart and Shieldhill.

From 1989 the conferences have been themed, covering: Man and the Forth; Loch Lomond; Focus on Falkirk; The Environment – 25 Years of Change; Clackmannanshire, Environment and Heritage; The Waters of Central Scotland; Mountains, Muirs and Mosses; Environmental Awareness and Education; Transportation, People and the Environment; Woodlands Past and Present; a 25 year celebration of the FNH; Conserving Biodiversity and Heritage; Loch Lomond and the Trossachs; Scotland's Weather and Climate – living with change; Water, Life and the Landscape; Landscapes of the Mines; Landscapes by Design; Stirling, Scotland's Central City; Forth Valley's Changing Countryside; Conservation in a Changing Climate; Maps for All Reasons; Trees, Woods and People; Geodiversity; How Green is My Valley – Environmental Health in the Forth Valley; The Changing Biodiversity of Central Scotland and, in 2014, The Inner Forth – formed by nature, shaped by people. The 2015 conference is entitled The Mountains of Central Scotland, Past, Present and Future.

During the 40 years since it was inaugurated the Board of the Forth Naturalist and Historian has been supported by 46 different individuals, who between them have given 412 years of voluntary service (16). Four Board Members have served for over 30 years, five over 20 years and ten over 10 years. While it is always difficult to mention specific individuals, the FNH owes a great debt to its two inspirational initiators, Ian Collie and the late Robert Innes, who also served as a Board Member for 13 years. Perhaps the greatest contribution was made by the late Lindsay Corbett who was secretary, treasurer and editor for over 30 years and who managed the original formation of the Board and its successful application to become a Scottish Registered Charity (Forth Naturalist and Historian) in 1992 (17). There are eight other individuals who have served more than twenty years as board members: Ken Mackay, Murray Dickie, John Proctor, David Bryant, Neville Dix, George Thomson, John Elliot and S. John Harrison. Special thanks are also due to Michael Thomas, Michael Usher and Richard Tipping, who have chaired the FNH Board through its last ten years, moving from an Editorial Board with Scottish Charitable Status to a Scottish Charitable Incorporated Organisation; Neville Dix who has served as editor since 1997; Roy Sexton who is deputy editor and also manages the organisation and distribution of the Journal and Marilyn Scott who is the secretary and webmaster.

Grants from Scottish Natural Heritage in 2010 (18) greatly helped FNH adjust to the changing nature of charitable funding, encourage partnership working, adopt a new constitution, become a membership organisation, introduce an annual lecture at the Annual General Meeting and move towards becoming a Scottish Charitable Incorporated Organisation (incorporated in March, 2015 (19)).

The FNH has also recently sponsored a series of environmental fairs with support from Stirling Council (20), which encouraged local natural history groups in the area to meet, share information and encourage new members;

supported a NatureFest group in the Falkirk area with grant support from the Falkirk Environment Trust (21) and is seeking to encourage local history groups to meet on a regular basis. FNH organised a major volunteer research project in 2013 entitled "What's Changed" with support from Scottish Natural Heritage (22) and collaborated with the Inner Forth Landscape Initiative to organise an extremely successful conference, "The Inner Forth – formed by nature, shaped by people" (23).

In celebrating 40 years of success, current Board members recognise the huge commitment of past members, the some three hundred contributors to the Journal and the nearly two hundred presenters who supported the annual conferences. In addition, the Journal owes its continued existence to the many hundreds of individuals and organisations who have purchased it and the annual conference has continued with the support of thousands of attendees.

FNH looks forward to the future, continuing to encourage and support individuals and groups who wish to undertake research and make available information of the natural history and history of the area, provide public access to this information and support conferences and fora which enable the wider public to engage.

Details of journals, publications, events and membership are available on the Forth Naturalist and Historian website http://www.fnh.stir.ac.uk/

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Minutes of 155th, meeting of the FNH Board on Wednesday 21st May 2014.

Associate Editors: Neville Dix; FNH Editorial Board.

Plant Report 2014

THE ORCHIDS OF DUMBROCK LOCH MEADOWS

William Parkes and Sarah Longrigg

Introduction

While not appearing quite as exotic as their tropical relatives, our native terrestrial orchids nevertheless possess a charm of their own and exhibit an interestingly wide variety of shapes, colours and patterns in their flowers. To find a meadow full of mixed species is a striking experience in mid-summer. A fascinating diversity of seven orchid species which exemplifies this unusual botanic variability can be found on the moorland pasture around Dumbrock Loch, immediately to the north of Mugdock Country Park in the vice-county of Stirlingshire. The more usual common spotted orchid (*Dactylorhiza fuchsii*) and heath spotted orchid (*D. maculata*) are always numerous. In addition northern marsh orchid (*D. purpurella*), greater butterfly orchid (*Platanthera chlorantha*), heath fragrant orchid (*Gymnadenia borealis*), common twayblade (*Neottia ovata*), and frog orchid (*D. viridis,* previously *Coeloglossum viride*) have appeared in variable numbers. Hybridization occurs frequently between *Dactylorhiza* species and occasionally between the genera *Dactylorhiza* and *Gymnadenia.* Rarely an eighth species, lesser twayblade (*N. cordata*), has been found through careful searching under mature heather. It should be noted that only two of the meadow SSSIs in the Forth Valley area have more orchid species than Dumbrock Loch Meadows. They are Quoigs Meadow SSSI near Greenloaning and Morenish Meadow SSSI on north Loch Tayside, both of which have nine species (R. Sexton, personal communication).

Starting in 1983 a number of botany enthusiasts have contributed to the annual recording of each species and have assisted in conserving the habitat. This activity has continued with a few short gaps for individual species for over 30 years. The first 10 years of this work were reported in an earlier paper, Dickson and Parkes (1994). On a semi-continual basis the more sensitive sites in the pastures have been managed by periodic clearing of invasive species of ling heather (*Calluna vulgaris*), bracken (*Pteridium aquilinum*) and lesser knapweed (*Centaurea nigra*). Following consultation with Scottish Natural Heritage, cattle were introduced in 2005 and the land immediately bordering the loch side was fenced off, thus supposedly isolating a number of orchids from the grazing.

The orchid site

The areas of interest at Dumbrock Loch Meadows are within the SSSI which was notified in 1986 (site code 552). The greatest concentrations of orchids are

found in a region bounded approximately between the grid references NS546781-547781-548783-550784, which covers about one-half of the whole SSSI area of 27.58 hectares (Figure 1). Although there is a small percentage of cover by trees and bushes, the ground is essentially open and almost all orchid plants enjoy full daylight.

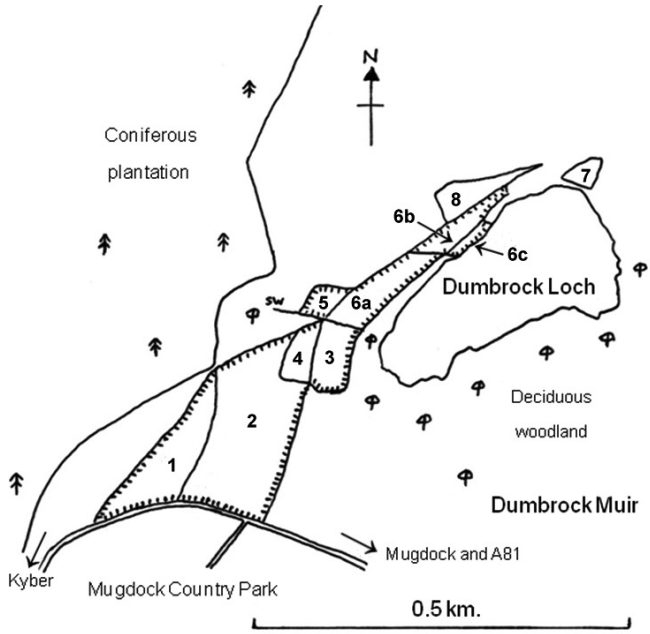

Figure 1. Sketch of Dumbrock Loch Pastures site, showing subdivisions used for recording. Numbered areas: **1** Marsh by Road; **2** Bank and South Plateau; **3** Bowl; **4** Above Bowl; **5** Marsh north of wall; **6a** West Bank south-central; **6b** West Bank north above fence; **6c** Picnic Area and Loch Side; **7** Pool; **8** North Plateau. **SW** = Stone dividing wall.

The loch side and most of the adjacent areas are underlain by a basalt, with the exception of the south-west corner which is boulder clay (British Geological Survey 1961). The soils on the site are therefore moderate to rich in nutrients, with habitats varying from dry to heavily flushed with groundwater, providing for a variety of plant communities. However there is a gradual advancement of invasive species on the drier ground, notably bracken, ling and knapweed as well as species of rush. The descriptions of the areas in Figure 1 are presented in Table 1.

Area no.	Description	Grid location	Principal orchid species recorded	Annual spike counts
1	Marsh by Mugdock – Kyber Pass road	NS546781	common spotted heath spotted northern marsh *Dactylorhiza hybrids*	14 - 94 8 - 107 3 - 53 *1-28*
2	South Plateau - Grassland bank and plateau by road	NS547781	greater butterfly common spotted northern marsh *Dactylorhiza hybrids* *intergeneric hybrids*	10 - 233 69 max. 0 - 7 *27 max.* *0-1*
3	Bowl - steep depression to S.W. of loch, grassland	NS548782	common twayblade greater butterfly heath fragrant common spotted heath spotted *intergeneric hybrids*	50 - 271 20 - 139 25 - 740 7 - 204 33 max. *0 - 3*
4	Grassland area just west of Bowl	NS547782	common twayblade greater butterfly heath fragrant common spotted	4 - 12 7 - 26 4 - 231 2 - 39
5	Marsh to north of boundary wall, with open water	NS548783	common spotted heath spotted lesser twayblade	126 max. 455 max. 0 - 2
6	West Bank - Grassland bank on north-west side of loch. Drier in southern and northern parts; wet-saturated in central section.	NS549783	frog orchid greater butterfly heath fragrant common spotted heath spotted northern marsh *Dactylorhiza hybrids* *intergeneric hybrids*	1 - 174 7 - 336 67 - 435 120 - 707 24 - 160 1 - 114 *37 max.* *0-9*
7	Marsh around open pool	NS550784	common spotted heath spotted	25 max. 187 max.
8	N. Plateau - grassland	NS550784	frog orchid (only)	1 - 96

Table 1. Description of site areas with key species. Annual maxima and minima counts are given where these were recorded.

The zones of interest on the SSSI can be divided into three kinds of habitat: marshes – areas 1, 5, 7; plateau expanses mainly with gentle slopes – areas 2, 4, 8; and banks with moderate to steep slopes - areas 3, 6 (a, b and c). Of particular importance to orchid lovers are the southern and upper parts of the amphitheatre-shaped area 4 (called the 'Bowl') and most of area 6 (known as the West Bank). Of more general interest, we found lesser bladderwort (*Utricularia minor*) in the open water of area 7. This is a carnivorous plant on

which the submerged bladder shaped leaves act as suction traps to capture small water organisms (Sexton and Longrigg 2012).

Location of species

The more colourful orchid species are either predominantly pink flowered (spotted and fragrant orchids), purple (northern marsh) or are nearly white (greater butterfly and sometimes heath spotted) and therefore quite easy to identify among even rank vegetation. However it is more difficult to find and count the twayblades and frog orchids which have either green or brownish inflorescences. Table 1 summarises the main orchid species found in each of the areas studied, with the range in annual numbers recorded (where available) over the 31 year period.

Frog orchid (*Dactylorhiza viridis*) depicted on Plate 6a top left is perhaps the most fascinating of the local species, with its curiously shaped flowers and its unpredictability of occurrence. When it first began to be studied at this site, it seemed to be confined close to a rocky location enjoying short grass just above the north-west edge of Dumbrock Loch in area 6c. Later a wider search revealed that it was spreading along the edges of adjacent paths in area 6b and encroaching into area 6a. In 1997 examples were found to inhabit a much larger territory extending into area 8. In recent years the frog orchids growing on the original lower ground have almost vanished and the species has meanwhile become more established further uphill. The count rose considerably in 1997, initially to 170 but was raised to 204 by S. Longrigg when she began to survey area 8. It reached a peak in 1998 of 266 over the whole site, but it has subsequently declined dramatically, as shown in Figure 2. In the most recent five years (2009-2013) a repeated search has been made 2 to 3 weeks later than the initial survey in view of the fact that the frog orchid count tends to peak later in July. Despite this augmented effort, the lowest count occurred in 2013 when only two specimens were recorded.

The possible causes of the decline in numbers are difficult to pin down with any certainty, but the species has been declining nationally and is a priority species in the UK and Scottish biodiversity action plans. Frog orchids have grown traditionally in the zone that is now bisected into areas 6b (grazed) and 6c (initially ungrazed) by a fence which was erected when the cattle were introduced. It would be of interest to examine how much difference the trampling and grazing made on the uphill side. However, coarser grass had been introduced by human activity on the lower site and the situation was confused by the increasing roughness and height of the grass below the fence. At the same time the cattle trampling seemed to encourage the coarser grasses above the fence by pock-marking the ground with water-filled holes. Finally it was found in 2011 and 2012 that the cattle had occasionally grazed the ground in area 6c, no frog orchids being found there in 2012 and 2013.

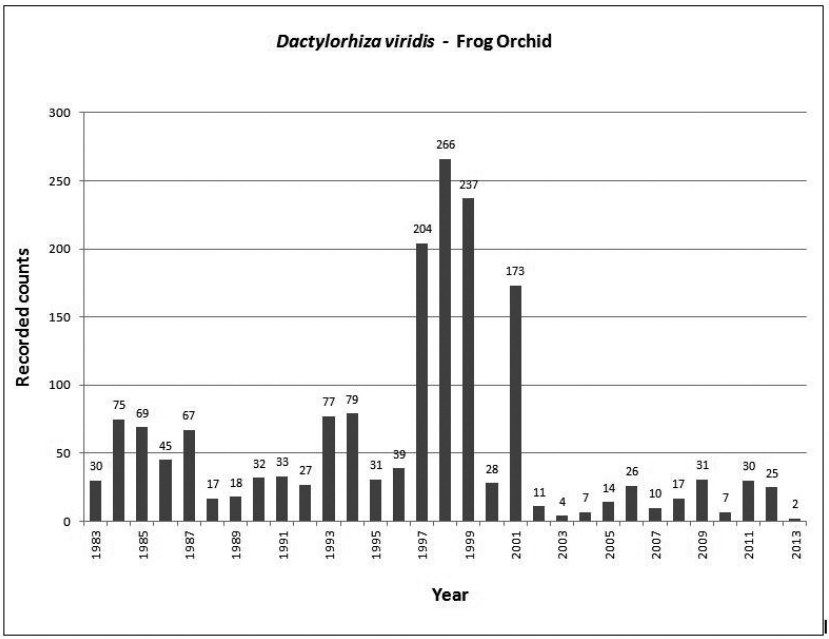

Figure 2. Summary of Frog Orchid records for the period 1983-2013 at Dumbrock Loch Meadows. All counts were from areas 6b, 6c and the adjacent border of 6a, with the addition of area 8 from 1997 onwards.

Common twayblade (*Neottia ovata*) with its uniformly green flowers is almost exclusively confined to the south part of the Bowl and the plateau immediately above, and in prolific years over 100 can be found in flower. Isolated plants have occurred occasionally on the bank above the loch in area 6b. At Dumbrock it tends to grow in groups, which makes the somewhat undistinguished plants easier to find in the taller vegetation.

Lesser twayblade (*Neottia cordata*)*:* By comparison with its taller relative this short species is extremely inconspicuous. It is typically 5-8 cm tall, with a small pair of heart-shaped leaves and tiny red-brown flowers, and it tends to grow in moss under mature rank heather. Because it is difficult to detect, it is probably present more frequently than these records would suggest. It was discovered at this site as a single specimen for the first time in 2004 among moss under heather on the low bank above the open marsh (area 5). One plant was found again in 2008, two in 2010 and two in 2011. The only site for lesser twayblade known to us which is close to Dumbrock is a little over 1 km away among damp sphagnum under the shelter of open trees, just to the south of Mugdock Loch (NS 553 771**)**, where a number of plants can usually be found in flower in June and July each year (Plate 6b top right). At Dumbrock the suitable habitat of sheltered moss is not extensive and is drier.

Greater butterfly orchid (*Platanthera chlorantha*) is generally very numerous and has over the long term remained fairly constant, although showing variations over periods of several years. By early July a great many are usually scattered around the drier areas, drawing attention with their large creamy-white inflorescences having a long curved spur extending backwards and a greenish tinge to their protruding lip (Plate 6c lower left). At evening time they exude a sweet scent to attract pollinating moths, and Charles Darwin established that they are pollinated by means of their club shaped pollen masses becoming affixed to the moths' eyes. John Knowler the VC86 moth recorder has reported a number of moths with pollinia from greater butterfly orchids on their eyes which have been caught in the Rothampstead light trap in Mugdock Country Park. While just a few examples of the species occur in the park itself, most of the pollinia probably originated in the larger greater butterfly orchid population nearby on Dumbrock Loch Meadows.

Around 1990 the greater butterfly orchid was numerous (60-90 individuals) on the drier plateau ground adjacent to the Mugdock Road (area 2), but the numbers there significantly decreased from about 1994. Between 1999 and 2009 the population fluctuated between just 1 and about 30. Then in 2010, the count rose to around 50 and in 2011 a fairly precise survey recorded as many as 148 plants, rising to 233 in 2012.

It is always tempting to explore the possibility in Scotland that wherever greater butterfly orchid occurs there may also be some specimens of lesser butterfly orchid (*P. bifolia*). While we have never made systematic searches over such a large site, the more slender aspect of the latter is normally apparent and if it were present some examples should have been discovered during the long period of the survey. There is a single record of lesser butterfly orchid for nearby Loch Ardinning for 1990, while the nearest site where it regularly grows is Wester Balgair Meadow SSSI some 14 km to the north-east just beyond the Campsies (Sexton et al. 2011). However, no lesser butterfly orchids have ever been found in our surveys at Dumbrock.

Heath fragrant orchid (*Gymnadenia borealis*) has most attractive carnation- or clove-scented flowers that vary in colour from light to strikingly dark pink, contrasting specimens often being found side by side, for example in Plate 6d lower right. This is the northern relative of the common fragrant orchid (*G. conopsea*) found mostly further south, and is now classified as a separate species. It can grow in considerable numbers in areas 3 and 6, sometimes in groups of up to about 20 plants. They reached a recorded peak in area 3 in 1984 at 740 with a minimum of 25 in 2008. The year 1992 showed an explosion in numbers to 1021 recorded for the whole site with 435 in area 6 alone. However their numbers are usually fewer than greater butterfly and in recent times they have maintained around 40-80 and 60-120 in the two respective areas. A fascinating feature of this species is its not infrequent tendency to hybridise with the spotted and marsh orchids (see below).

Spotted and marsh orchids

Common spotted orchid (*Dactylorhiza fuchsii*) is indeed very common throughout Britain, but nevertheless it creates an impressive show of pink flowers from late June to mid-July. As in the case of bluebells, in rare instances the odd white specimen can be discovered. At Dumbrock the common spotted orchid can always be seen in flower by the hundred. By early to mid-July this species and greater butterfly orchid are prominent in the meadows, together with hawkweeds and in the damper places the lesser spearwort, *Ranunculus flammula*.

Heath spotted orchid (*Dactylorhiza maculata*) is similar but its flower has a wider labellum and it appears a week or two earlier. While it is predominant in marshes, when several hundred can be recorded in an isolated year, it also occurs in low to moderate numbers in all of the drier areas at Dumbrock. It hybridizes quite freely with both common spotted and northern marsh orchids and not infrequently with the heath fragrant orchid, usually showing a consistent mix of characteristics.

The most striking of the more common *Dactylorhiza* species is the northern marsh orchid (*D. purpurella*) with its dark velvet purple or alternatively paler mauve flowers. It is sometimes difficult to decide whether some examples of northern marsh orchid are hybrids or simply paler variants of the dark species but with stable characteristics (see descriptions by Allan and Woods 1993, Harrap and Harrap 2009 concerning lip shape and presence of leaf spots). Hence the numbers of recorded 'pure' and paler purple 'hybrid' have been aggregated in the table. Northern marsh orchid at Dumbrock has clearly undergone a reduction in numbers from around 1993 onwards. The species has declined over the whole marsh in area 1, despite the fact that the environment has changed little in the long term. Numbers have also reduced on the West Bank and the species has completely disappeared from above the Bowl in area 5.

Hybrids

The spotted and northern marsh orchids interbreed quite freely at Dumbrock, although it can be difficult to determine which are the parent species in an individual plant (Delforge 1995 pp.131-2). An example of northern marsh orchid which displays some heath spotted orchid characteristics is shown in Plate 7a top left. The marsh of area 1 has been a site for small hybrid swarms of the genus *Dactylorhiza* (Lang 1980; Lord and Richards 1977), and to a lesser extent hybridization occurs in the other areas. In prolific years, several dozen hybrids among these three species have been counted on the whole SSSI site. Frog orchid is closely related to them and indeed has now been included in the same genus as a result of DNA sequencing, but our detailed searches have never discovered hybridization at Dumbrock between the frog orchid and the three spotted and marsh orchids.

Hybridization at Dumbrock extends to fertilisation between different genera (Delforge 1995 pp.446-9), in this case heath fragrant orchid and the *Dactylorhiza* species. A diagram of the relationships between the different European orchid genera (e.g. in Delforge 1995) shows that *Dactylorhiza* has a close affinity with *Gymnadenia.* Distinct flower characteristics are apparent in one form of evidently heath spotted and heath fragrant orchid, i.e. X *Dactylodenia legrandiana* (Plate 7b top right). Over the whole site, recorded intergeneric examples are rare, a maximum of 9 having occurred in 2001.

Effects of land management

Historically, the pastures had been maintained as unimproved grassland by winter grazing until about 1981 (Dickson and Parkes 1994). From the mid-1980s a long-term active policy has involved removing invasive species, and this has succeeded in preserving much of the open short vegetation on the Bowl and West Bank, which are two of the most interesting areas, and where ling, lesser knapweed and bracken are a particular problem. Parties of volunteers have cleared selected areas annually where the encroachment appears to be the most severe.

In 2005 Scottish Natural Heritage invited the re-introduction of cattle to assist in clearing the taller vegetation and trampling the bracken, about 15 animals being noted for the first time on 16 July of that year. This has led to progressive alteration of the land surface on the West Bank, although changes are not so evident elsewhere at the site. The bank where the frog orchids were originally found is shown in lower Plate 7c, where the considerable effects of trampling had become evident by 2012. The result has been a significant poaching of the soil, encouraging wetter ground conditions. While the cattle had not been particularly effective in cropping the rank vegetation above the dividing wire fence in area 6b, the fence had a notable effect up to 2010 in protecting the sensitive short turf in 6c below. However the surveys in 2011 and in 2012 discovered that the cattle had made their way below the fence and had extensively trampled the surface close to the boundary. In early June 2012 the vegetation was found close cropped over the lower site in area 6c, so that while a few flowering plants were recovering, very few orchids were recorded. It would seem that the animals had removed many of the young flower stems, resulting in the reduction of inflorescences.

The overall effect of cattle grazing is as yet difficult to evaluate. While to an extent there has been benefit in keeping down some of the coarser grasses generally over the site outside the marshes, the effect on heather and bracken appears negligible. In combination with wetter seasons the generation of swathes of waterlogged muddy ground has been detrimental to the spread and survival of the orchids and other sensitive species.

Although the frog orchids have evidently moved their territory, they are still under the influence of grazing. The plateau area which they now principally

inhabit is less prone to water logging, which may well be a strong factor as the species prefers less saturated ground. However it is noted that the decrease in the frog orchid numbers began around 2002 and the fragrant orchid made a gradual decline after 1992, before the introduction of cattle in 2005. Even the resurgence of the greater butterfly orchid had begun a year or two before that date, and the main territory of the diminishing northern marsh orchid is in the sphagnum marsh adjacent to the road, where the animals do not appear to venture.

Acknowledgements

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BROWNFIELD BIODIVERSITY IN THE INNER FORTH AREA

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Introduction

Since the 18th Century, the Inner Forth area has experienced industrial growth and decline, leading to disused areas of land being re-colonised by plants and animals, allowing novel and diverse ecosystems to develop. Brownfield land is the name that has been applied to ex-industrial sites and indeed any land that has been subject to human activity, but is no longer fully in use (National Statistics, 2014). These spaces can act as valuable refuges for biodiversity, frequently supporting rare or threatened species that have suffered from loss of more natural habitats in recent decades (Gibson, 1998; Harvey, 2000). In an agricultural landscape with only fragmented patches of more natural habitat remaining, brownfield sites can play an important role as 'stepping stones' that can aid the movement and dispersal of species. Across Scotland, over 10,000 hectares have been identified as vacant and derelict land, presenting a potentially important habitat network (Macadam, 2012). Brownfields often have thin, low nutrient soils, which prevent fast growing, dominant plant species from taking over and allow the development of rich floral diversity (Buglife, 2012). In turn, the variety of wildflowers provides excellent conditions for a range of invertebrate species; particularly pollinating insects, as well as specialists of bare ground and sparse vegetation. Varied previous land uses give rise to a mosaic of habitats in close proximity to one another, such as bare ground, scrub and species-rich grassland. These habitats can provide suitable conditions to allow a wide variety of invertebrate species to complete complex life cycles on the same site.

Despite the biodiversity importance of these habitats, brownfield conservation lags behind that of other habitats. Brownfield land was only officially recognised for its ecological importance in 2007 when Open Mosaic Habitats on Previously Developed Land (OMHPDL) (Maddock, 2008) became a UK Biodiversity Action Plan (UK BAP) priority habitat; primarily because of its importance to invertebrates. This slow general acceptance of the value of brownfields may be due to the unnatural and often untidy appearance of this so-called 'waste ground'. These issues have meant that valuable sites are often overlooked for conservation or even promoted for development. Even lower intensity uses involving landscaping or 'greening' can be detrimental to their biodiversity, since many of the important habitat features are likely to be lost. In general brownfield ecology has received relatively little attention, particularly in Scotland. However, recent surveys such as Bairner and Macadam (2011) found many species present on brownfield sites around Falkirk had not been previously recorded in the area, suggesting both under-recording and the presence of specialist species suffering from loss of

traditional habitats. The Inner Forth Landscape Initiative recently developed by Royal Society for the Protection of Birds (RSPB) Scotland has renewed focus on the industrial heritage within Fife, Falkirk, Stirling and Clackmannanshire. The current study expands on previous work in Falkirk by assessing which sites support OMHPDL habitats followed by in-depth surveys of key sites.

Methods

Habitat assessment

A desk study was undertaken in accordance with the Remote Assessment Approach for OMHPDL Priority Habitat Sites (Riding *et al*. 2010). Data on sites listed as 'vacant' on the Scottish Vacant and Derelict Land (SVDL) Register 2011 were assessed to determine which met the size and characteristics outlined by Riding *et al*. (2010). Definitions of vacant and derelict land are available from the Scottish vacant and Derelict Land Survey 2013 at http://www.scotland.gov.uk/Publications/2014/02/7170/0. Following this, each site was visited to be 'ground truthed' using Buglife's *Brownfield Habitat Assessment Form*. Both the remote assessment and ground truthing followed the same methodology as Bairner and Macadam (2011), which involved determining whether important features such as a mosaic of habitats, diversity of plant species and early successional conditions were present. 'Ground truthing' assessments were carried out in November 2012 and several species of flowering plant may have been missed given the time of year.

Four sites were selected for invertebrate surveys, two in Stirling (Fallin Bing and Millhall Bing), The Shore in Clackmannanshire, and Manor Powis Bing which is located on the boundary of Stirling and Clackmannanshire. Each site differed in their current management, former use and the time since they were last used. Surveys for invertebrates were undertaken between 28 March 2013 and 17 August 2013. Two further sites: Concrete Works and Ashley terrace were only surveyed in April 2013; species recorded from these two sites have been included in invertebrate species totals but are not discussed in this study as too little data was collected to provide a comparison with the other four sites. Although Millhall Bing did not meet the OMHPDL criteria due to the late stage of ecological succession it had reached, it was considered an interesting comparison to similar sites at different stages of succession or management.

Site descriptions

Fallin Bing

Fallin Bing (NS838912) is to the south-east of the village Fallin, near Stirling and consists of spoil extracted from a disused coal mine. This bing stands alone as a raised feature in an otherwise largely flat area of the Forth Valley. The site covers 26.9 hectares (ha) and the bing itself is a largely rounded mound with a slightly flattened plateau. Fallin Bing is not on the Scottish Vacant and Derelict Land (SVDL) register and is adjacent to the Site of Special Scientific Interest

(SSSI) Wester Moss, which is owned by Stirling Council and managed by Butterfly Conservation.

This former coal mine closed in 1987 and a third of the material was removed of the bing in 1993/94 for safety reasons. A total of 12.35 ha of woodland were planted around the base of the bing with a variety of native tree species including silver birch (*Betula pendula*), ash (*Fraxinus excelsior*), alder (*Alnus glutinosa)*, rowan (*Sorbus aucuparia*) and larch (*Decidua* spp.). Since being planted, limited thinning of trees has occurred and because of shading there is little ground flora present within the woodlands. During the tree planting, grassland habitat was re-established through hydro-seeding where seed of native wildflower species including oxeye daisy (*Leucanthemum vulgare*) and common knapweed (*Centaurea nigra*) was mixed with slurry and sprayed across the site.

Currently, the plant communities on Fallin Bing can be divided into three main areas, wooded stands, meadow areas at the base and sides of the bing and the sparsely vegetated exposed spoil, which has little soil content on the upper slopes and plateau. The base-rich conditions from the spoil support a variety of flowering plants including common bird's-foot trefoil (*Lotus corniculatus*), common knapweed and oxeye daisy that are found in abundance in the meadows of the lower slopes, while cowslip (*Primula veris*) and northern marsh orchid (*Dactylorhiza purpurella*) are present in a few smaller patches. The bing also supports wild strawberry (*Fragaria vesca*), perforate St. John's wort (*Hypericum perforatum*) and common centaury (*Centaurium erythrea*) that are widespread on the more exposed plateau of the bing. At the main entrance to the site broom (*Cytisus scoparius*) and bramble (*Rubus fruticosus* agg.) have become dominant and are displacing other species.

Fallin Bing has a great network of footpaths that are well used by the local community for dog walking, running and cycling.

Manor Powis Bing

Manor Powis Bing (NS830947) is about 2 km northeast of Stirling and is located on the boundary of Stirling and Clackmannanshire. This site is 18.4 ha in size and is not on the SVDL but is a well-known brownfield site. The River Forth passes to the south of the site and the Stirling to Alloa railway line to the north. Most of the site is flat although there is an area of exposed spoil with mounds and sheltered dips is to the north-east of the site. There is currently no management of the site, although, it is used unofficially as an off-road driving course by people with motor bikes with tyres being used as route markers. This has kept areas of ground disturbed and at an early stage of succession, but may also have aided in the spread of giant hogweed (*Heracleum mantegazzianum*) across the site.

A mosaic of habitat types are supported on Manor Powis Bing including trees, scrub, tall grassland, sparsely vegetated areas of coal spoil and an area of

marshland. Giant hogweed is present across much of the site with some large areas dominated by dense stands. The sparsely vegetated area of exposed coal spoil that lies to the north-east of the site has been colonised by calcareous-tolerant species such as colt's foot (*Tussilago farfara*), viper's bugloss (*Echium vulgare*), common centaury, wild strawberry and perforate St. John's wort. Scrub includes goat willow (*Salix caprea*), hawthorn (*Crataegus monogyna*), alder, silver birch and broom with extensive ground coverage of bramble.

Open grassland meadows are scattered throughout the site, supporting a variety of wildflower species including red clover (*Trifolium pratense*), common vetch (*Vicia sativa*), common bird's-foot trefoil and oxeye daisy. Wetland species such as great reedmace (*Typha latifolia*), common reed (*Phragmites australis*), soft rush (*Juncus effusus*) and northern marsh orchid are restricted to an area of marshland to the central northern part of the site.

Millhall Bing

Millhall Bing (NS813919) is located on the south eastern fringe of Stirling and is 12.7 ha in size. This former colliery which was paired with Fallin Bing has had material removed from the central area making the bing bowl shaped and resembling a volcano cone. The steep sides which are bare with rubble strewn banks drain into the sheltered inner area, forming a wetland at its centre. Young woodland covers much of the site and scrub encroachment has resulted in large areas becoming shaded in recent years. This site is not on the SVDL but is known for its diversity of wildlife and plant species.

The site has reached a late stage of succession and is now largely dominated by woodland. The north side of the site has areas of rosebay willowherb (*Chamerion angustifolium*) and common nettle (*Urtica dioica*), which gives way to denser woodland. Trees present include silver birch, goat willow, hawthorn and ash. The central crater holds water throughout most of the year and great reedmace thrives in this wetland habitat. Raised mounds present within the wetland area support willow carr (*Salix* spp.) and silver birch. Although largely covered by woodland, there are small patches of reed canary grass (*Phalaris arundinacea*) and clearings dominated by common knapweed across the site. Other features include exposed spoil colonised by lichen species (*Cladonia* species).

The Shore

The Shore (NS884920) is located in Alloa next to the River Forth and is made up of two sites, a small area owned by Clackmannanshire Council (0.59 ha) and a larger area owned privately (4.79 ha); this study focused on the Clackmannanshire Council owned land. The council owned area was formerly a depot and since its closure a building has been demolished and the rubble has been gathered into mounds at the west side of the site. The former site of the building is now an open area of sand and rubble. The River Forth is on the south side of the site and its proximity to the open water means the site is exposed to high winds at times. The larger area of brownfield land that joins

onto this site was formerly a stone masonry yard and supports only short, sparse, flower rich vegetation across much of its area. This site is listed as derelict land and buildings on the SVDL (SVDL site code CALOA047).

The rubble mound on the east of the site has been colonised by a variety of plants such as common ragwort (*Jacobaea vulgaris*) and white stonecrop (*Sedum album*). The central area is very open and sand and building rubble supports only sparse vegetation and is rich in wildflower species such as mugwort (*Artemisia vulgaris*), common comfrey (*Symphytum officinale*), hairy bittercress (*Cardamine hirsuta*), mouse-ear chickweed (*Cerastium fontanum*) and red clover. This area gives way to tall ruderals such as rosebay willowherb and bramble on the north-east side of the site. The south-east section has richer soil supporting tall grasses and tree species such as silver birch and goat willow. Due to the proximity of this site to residential areas, it is well used by local dog walkers and children.

Concrete Works

This former concrete works to the south of the village Kincardine is 0.49 ha in size and is listed as derelict land and buildings on the SVDL (SVDL site code HWV005, grid reference NS933870). Parts of the previous buildings remain on site with walls and rubble. Many of the walls are cracked in places and this offers plentiful habitat for invertebrates and other small wildlife. There are several piles of rubble of varying size some of which are south facing with bare patches. Several large areas of bare concrete and tarmac have become weathered and cracked and this has allowed colonisation by mosses as well as other plant species.

The majority of the site's vegetation is dominated by well established grassland and tall ruderals such as broad-leaved dock (*Rumex obtusifolius*) and rosebay willowherb. Michaelmas daisy (*Aster* species) is also present and may have been introduced from surrounding residential areas. One particularly exposed area of concrete and thin earth appears to support more drought resistant species such as stonecrops (*Sedum* species). Bare earth is also exposed along desire line paths and this site is used by dog walkers and as a through route to a neighbouring amenity grassland area. There are also a few scattered small trees and shrubs present including silver birch.

Ashley Terrace

This site in the centre of Alloa was previously a community hospital and is 0.63 ha in size and is listed as vacant land on the SVDL (SVDL site code CALOA049, grid reference NS888934). The buildings have only recently been demolished and cleared and vegetation is currently at a very early stage of succession.

The site consists of a flat terrace and there is a slight slope to the north of the site up towards the surrounding housing. The road Ashley Terrace runs along the south of the site. The clearing of the previous buildings has left very thin

gravelly soils across much of the site and this has encouraged patchy vegetation and wildflower species diversity. Activity on site from construction vehicles has also left a heterogenous micro-landscape with various bumps and ridges. Wildflowers present at the site include large stands of creeping buttercup (*Ranunculus repens*) and red clover. Bare ground is in small patches across the site with some larger areas of broken up tarmac. There is a brick wall in the eastern part of the site which is breaking up in places and provides important habitat for a range of species. Other habitat features include richer soil on the slopes that support rank grassland, areas with ruderals including rosebay willowherb and there are various garden escapes along the edges of the site, including some garden shrubs and michaelmas daisy.

Survey methods

A variety of methods were used to survey invertebrates including pitfall trapping, sweep and aerial netting to collect a wide range of species from different habitats at each site. The main groups targeted were ground beetles (Family Carabidae, Order Coleoptera), spiders (Order Araneae), harvestmen (Opiliones) and hoverflies (Family Syrphidae, Order Diptera). Any specimens collected during sweep netting, aerial netting, ground searches and shrub beating that could not be identified on site where preserved in a labelled pot with either 70 % isopropanol or ethyl acetate for later identification in the laboratory with a stereo microscope.

Pitfall trapping

At each site, one transect of six pitfall traps were set in open, dry, sparsely vegetated habitats to allow a direct comparison to be made between sites. The main invertebrate groups targeted with this method were ground beetles and spiders although a range of other groups were also collected. Traps were made from plastic tumblers, dug into the ground so the top was level with the soil. Wire mesh was secured over the top of the trap to prevent vertebrates and stones falling in. Pitfall traps were placed in locations where they would not be obstructed by vegetation as this has been shown to have an effect on catch rate (Melbourne, 1999). Traps were emptied every 2 weeks between 28 March 2013 and 30 May 2013 and from 3 July 2013 to 14 August 2013.

For the first phase of trapping (from March to May) a mixture of water with a few drops of washing up liquid was put into each trap and changed when the traps were collected every 2 weeks. During the second period of trapping (from July to August) traps were filled with a mixture of 60 % Ethylene Glycol antifreeze and 40 % water to preserve specimens between collection intervals. This liquid material was collected every 2 weeks along with the specimens, which were preserved in 70 % isopropanol.

Sweep and aerial netting

Invertebrates on flowers and tall vegetation were surveyed with a sweep net made of linen. During each site visit the net was swept vigorously in a

figure of eight for 10 minutes along a transect through grassland habitat. Groups targeted included soldier beetles (Family Cantharidae, Order Coleoptera), leaf beetles (Family Chrysomelidae, Order Coleoptera), true bugs (Order Hemiptera) and spiders. Aerial netting involved sweeping a fine mesh net to catch flying pollinators such as hoverflies and solitary bees (Family Apidae, Order Hymenoptera). This was achieved by waiting for species to visit flowers as well as sweeping the top of meadow vegetation. Around 30 minutes was split between different suitable locations on each site.

Ground searching and shrub beating

This involved searching under stones and other objects for ground beetles and wolf spiders (Family Lycosidae, Order Aranaea) and other specimens. Searches took place at six sampling points, roughly 5 metres apart, in order to maximise local habitat variation. Each of the six individual searches was carried out for 5 minutes per site visit. When searching for invertebrates on shrubs and small trees, a sheet was placed under a selected branch and the shrub or tree was beaten with either a stick or shaken by hand. This took place once a month at each site and one shrub/tree was selected and the shaking of a branch would last for 5-10 minutes.

Direct observations

Direct observations of several groups of invertebrates including butterflies and bumblebees were recorded as well as plants and vertebrates encountered on each site visit. Often, a sweep net was used to aid in identification of individuals.

Site comparison

The main invertebrate groups used to compare sites for biodiversity were ground beetles, spiders and hoverflies. These groups were chosen because they are all well studied and their distribution and habitat preferences are better known than for other invertebrate groups. This allowed them to be used as indicators to place records in context with the surrounding area. All spider species and most ground beetles are predatory and should reflect the lower levels of the ecological community. Some species in these groups are habitat specific, so are useful as indicators of variation in habitat type. Spiders were identified using Roberts (1996), which only covers a small number of species from the Family Linyphiidae, therefore, no attempt was made to identify those within this family that were not described in the book. Many hoverfly larvae are also very habitat specific and while this project looked at the adults, which are highly mobile, their presence should still reflect the larval habitat preferences to a large extent.

Analysis involved comparing species numbers at each site and similarity in species composition using the Sørensen similarity index. This index compares the number of species in common between each site, giving a value of similarity which can be used to compare ecology between sites.

The Sørensen similarity index C_S is calculated using the formula: $\mathbf{C_S = 2ab/a+b}$

Where C_S is similarity between sites, *ab* is number of species present at both sites, *a* is total number of species recorded at site 1 and *b* is total number of species recorded at site 2.

Results

Habitat assessment

Of the 66 sites that were remotely assessed for this study, 25 were in Falkirk, nine in Fife, ten in Clackmannanshire and 22 in Stirling. Of these sites, 21 (32 %) were selected as potentially having OMHPDL which amounts to a total of 107.10 ha. Of these sites, five were previously used for mineral extraction activity including coal and shale mining. Uses of the other sites were varied, mostly falling into the categories of commercial or public buildings. Fourteen sites are listed as derelict land with a total of 98.34 ha. The remaining eight sites are listed as vacant land and this totals 8.76 ha.

Forty of the 66 sites that were remotely assessed were visited for ground truthing to identify habitats present. Sites that could not be ground truthed included 14 sites that were under 0.25 ha in size and 12 sites with no access including those within Grangemouth Docks (SVDL site codes F/GRAN/017, F/GRAN/020, F/GRAN/022 and F/GRAN/044), Rosyth Dock (SVDL site code RD57 SITE) and sites owned by Scottish Power at Longannet (SVDL site code WV022) and also the former power station at Kincardine (SVDL site codes IWV016 and IWV017) and agricultural land at Borrow Meadow (SVDL site code VD0031). A further 12 sites had restricted access but could be assessed to some extent from outside security fencing.

Of the 40 sites visited, 11 were identified as having OMHPDL and a further six showed some of these characteristics. Twenty three sites were designated as not supporting OMHPDL with reasons for not meeting the criteria including: development of late successional vegetation (seven sites); a lack of habitat mosaic (five sites); currently being developed (seven sites); sites with buildings present, little surrounding land or lacking vegetation (four sites).

Invertebrate survey

A total of 231 species of invertebrate were identified from the six sites surveyed. This includes 65 species of Coleoptera, 47 species of Aranaea and 44 species of Diptera as well as a range of other species that were also identified (Table 1). Over 10 % of the total Aranaea species and 45 % of the total Opiliones species known to occur in Scotland were recorded. Lepidoptera where well represented and this is probably because they are often highly visible and many can be identified by direct observation (Table 1).

Order	Common name	Number recorded
Coleoptera	Beetle	65
Araneae	Spider	47
Diptera	True-fly	44
Lepidoptera	Moth and butterfly	22
Hymenoptera	Bee, wasp and ant	18
Opiliones	Harvestmen	9
Gastropoda	Snail and slug	7
Hemiptera	True bug	6
Odonata	Dragonfly	5
Orthoptera	Grasshopper	4
Diplopoda	Millipede	2
Dermaptera	Earwig	1
Mecoptera	Scorpionfly	1
	Total number species	231

Table 1. Total number of species recorded in each invertebrate order for all six sites surveyed.

When comparing invertebrate species collected using all methods, Fallin Bing had the total highest number with 115 species recorded (Figure 1). This was followed by Manor Powis Bing with a total of 112 species, 93 species were recorded at The Shore and Millhall Bing had the fewest totalling 81 species (Figure 1).

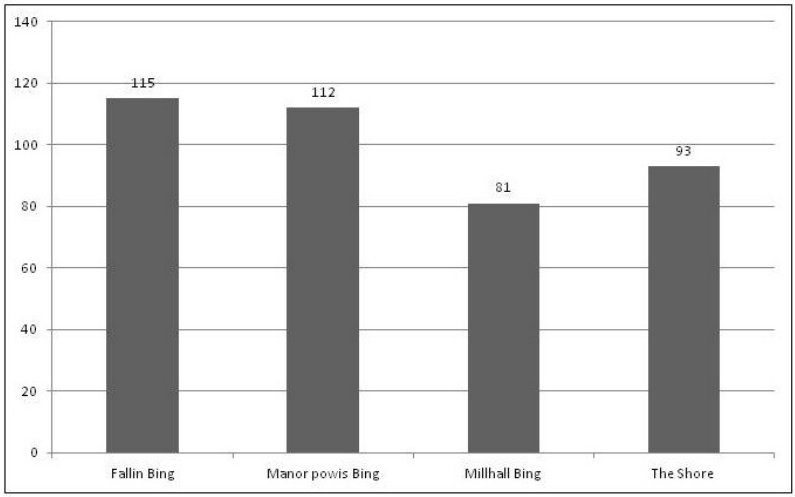

Figure 1. Total number of invertebrate species recorded at each site.

Similarly, the highest number of plant species was recorded at Manor Powis Bing which had a total of 69 species and Fallin Bing with 66 species, Millhall Bing had the fewest plant species with a total of 59 species (Figure 2).

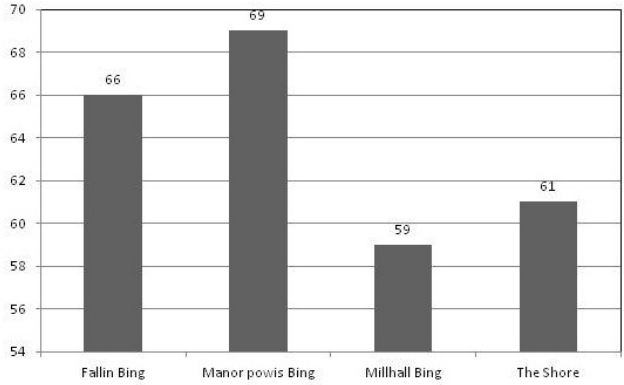

Figure 2. Total number of plant species recorded at each site.

Species of local distribution

A number of invertebrate species recorded in this study are local in their distribution either within a Scottish or UK context based on British Arachnological Society's Spider recording Scheme (SRS) or National Biodiversity Network (NBN) Gateway and Luff (2007).

Beetles (Order Coleoptera)

Ground beetles (Family Carabidae)

Amara eurynota has a local distribution in Scotland and is associated with open and dry habitats. Several individuals were recorded in pitfall traps and hand searches at The Shore.

Amara praetermissa is a Nationally Scarce (Notable B) species that feeds on seeds and is often associated with brownfield sites as it requires open, dry and well drained habitats. It is a local species throughout the UK with only a few records in Scotland. During this study, three individuals were collected by pitfall traps at Fallin Bing and an individual was collected at The Shore during hand searches.

Asaphidion flavipes is a small beetle usually found on open soils near fresh water. It is thought to be widespread in Britain but only a small number of records exist for Scotland. One specimen was collected in a pitfall trap at The Shore.

Bembidion bipunctatum is locally distributed in Britain and is designated as Nationally Scarce (Notable B). Several individuals were collected from sparsely vegetated ground at The Shore. This species is typically associated with sandy and silty soil near water.

Leistus rufomarginatus is an immigrant species of beetle which has a local distribution in Scotland and is associated with woodlands. An individual was collected at Fallin Bing in a pitfall trap.

Nebria salina is local throughout much of Britain, requiring dry, well-drained soil. Two specimens were collected in pitfall traps at Fallin Bing.

Spiders (Order Araneae)

Funnel web spider (Family Agelenidae)

The Hobo spider (*Tegenaria agrestis*) is in the same genus as the familiar house spider *Tegenaria domestica* and has a similar long-legged appearance (Plate 3a). It is found on sparsely vegetated areas and under stones and is often associated with brownfield sites. This species has also been recorded around Falkirk in similar situations, but there are very few other records in Scotland. It is however a colonising species that appears to be moving north. An individual was collected in a pitfall trap at The Shore.

Ground running spider (Family Clubionidae)

Clubiona compta is typically associated with trees and bushes and is common in the UK, although local in Scotland. One individual was recorded at Fallin Bing in a pitfall trap.

Wolf spiders (Family Lycosidae)

Arctosa perita has a local but widespread distribution along the coasts of Britain. Inland populations are scattered and restricted to sites with suitable habitat with bare ground and sparse vegetation. Two individuals were collected at Fallin Bing in hand searches and in a pitfall trap.

Pardosa saltans is usually associated with woodland edges and clearings and in Britain it is widespread, although more localised in Scotland. Three males were collected in pitfall traps set in woodland at Fallin Bing.

Pardosa monticola is locally distributed, particularly in Scotland. It is associated with open grassland with short vegetation. Several individuals were recorded at Fallin Bing through collection in pitfall traps.

Jumping spider (Family Salticidae)

Talavera aequipes is a small species of spider which favours warm and sunny habitats with bare ground and sparse vegetation. Within the UK it is widespread but local and uncommon, with very few records in Scotland. An individual was collected in pitfall traps both at Fallin Bing and Manor Powis Bing.

Comb footed spider (Family Theridiidae)

Steatoda phalerata is an ant hunting spider, which is found in low vegetation and is associated with dry grassland habitats. It is local and generally uncommon throughout the UK. Several individuals were recorded at Fallin Bing and one from Manor Powis Bing in pitfall traps.

Crab spider (Family Thomisidae)

Xysticus sabulosus is usually associated with heathland and is found on the ground or low vegetation. It is uncommon and very local and has undergone a significant decline throughout the UK. One individual was collected in a pitfall trap at Fallin Bing.

UK BAP Priority Species

The survey sites were used by a range of vertebrate species including amphibians, birds and mammals. The UK BAP priority species recorded are listed in Table 2.

Species	Common name	Fallin Bing	Manor Powis	Millhall Bing	The Shore
Bufo bufo	Common toad			●	●
Carduelis cannabina	Linnet				●
Emberiza citrinella	Yellowhammer	●			
Emberiza schoeniclus	Reed bunting		●		
Passer domesticus	House sparrow				●
Pyrrhula pyrrhula	Bullfinch		●		
Sturnus vulgaris	Starling	●			●
Turdus philomelos	Song thrush		●		
Coenonympha pamphilus	Small heath		●		
Coenonympha tullia	Large heath	●			

Table 2. UK BAP priority species recorded at the four main survey sites.

The highest number of invertebrate species with a total of 115 was recorded at Fallin Bing, highlighting the importance of this site. This was followed closely by the number of species recorded at Manor Powis Bing which had a total of 112. Such high species diversity may reflect the mosaic of different habitats present at both of these sites. Interestingly, Fallin Bing and Manor Powis Bing also had the highest number of plant species recorded with a total of 66 and 69 respectively. Plants are important as they provide a range of structures and food sources for many invertebrates. In spite of large areas of Manor Powis Bing being dominated by the non-native and invasive giant hogweed, a high number of invertebrate species were recorded at this site, suggesting that the open habitats are still of high importance. The fast growth and large size of giant hogweed can shade out wildflower species and if allowed to spread this invasive is likely to reduce the site's biodiversity and value to wildlife.

Given that the area surveyed at The Shore is much smaller than the other three sites surveyed, it would be expected to have less habitat variation and therefore a lower species count. Despite this, the species number was comparable with the other sites, however greater survey intensity in high quality habitats may have compensated for this.

Millhall Bing had the lowest number of species present which may be because it is in a late stage of ecological succession with dense tree cover. The shade from the trees may have reduced the number of plant and animal species present and recorded during this study, suggesting that bare ground and early succession conditions are an important factor in the biodiversity value of brownfield sites. One habitat feature present at Millhall Bing is a wetland area and if aquatic sampling had been carried out, then the species total may have been considerably higher.

The results of this study demonstrate the importance of brownfield sites within the Inner Forth area for a wide range of invertebrate species including those that are specialists, locally distributed and widespread generalists. Grassland and scrub habitats are important for many invertebrate groups that are declining in the wider countryside such as pollinating insects. The Shore provides an important foraging resource to large numbers of bumblebee workers due to the abundance of pollen rich forage such as red clover. Similarly, Fallin Bing can support huge numbers of six-spot burnet moths (*Zygaena filipendulae*) because its larval food plant, common bird's-foot trefoil, is abundant across the bing (Plate 3b). Fallin Bing, Manor Powis Bing and The Shore also provided important habitatt for a number of bare and dry ground invertebrate specialists whose natural habitats in the wider countryside are relatively restricted and are therefore vulnerable to habitat loss. The hobo spider (*Tegenaria agrestis*) and the jumping spider *Talavera aequipes* that were recorded in this study have been recorded only a few times in Scotland, but were also found during Buglife's 2010 surveys of Falkirk brownfield sites (Bairner and Macadam, 2011). Species such as these may be widespread on brownfield sites but under-recorded. This survey not only recognised these sites as being important for invertebrates but also for a wide range of other species including several UK BAP priority species of bird. Despite most of these species remaining widespread, all have experienced considerable declines across the UK. So their presence on brownfield sites demonstrates the importance of such habitats as refuges for threatened species. Although comparisons were not made between biodiversity and species abundance between brownfield sites surveyed in this study and other urban habitats, it is likely that the biodiversity on these sites is considerably higher due to their size and variety of habitats compared to urban green space such as gardens, parks and road verges.

Dry and bare early successional habitats were shown to be important for the specialist species recorded, so active management work will be required to maintain these conditions and arrest succession. This could be achieved by

implementing a rotational management regime to retain a mosaic of habitats throughout each site. Under this regime one section of later successional habitat could be cut back at a time to 're-set' the ecological succession, which would reduce the risk of losing species associated with any stage of succession. Alternatively a network of similar brownfield sites at a range of successional stages may also provide a similar outcome on a landscape scale (Kattwinkel *et al*. 2011). By protecting and managing the most valuable sites both wildlife and local people will benefit.

However, if brownfield sites are to be protected, they must first be recognised and valued by society as a whole. Many brownfields are already informally used by local people as a recreation space as this study found at The Shore. Despite the challenge of people viewing brownfields as 'messy' spaces, positive experiences associated with these sites can help to change people's perceptions (Hunter and Hunter, 2008). A further step for suitable sites is to formalise this relationship by encouraging access for local people to enjoy the open space and wildlife offered in these special places. Fallin Bing provides an excellent example of how an ex-industrial area can be managed by a local authority for the benefit of residents by providing footpaths and ranger led events. Developing further opportunities for people to enjoy and engage with brownfield sites will be vital in their protection for the future in the face of development pressure.

A complete list of all invertebrates, wildflowers and other wildlife recorded during the survey is available from the authors at Buglife- The Invertebrate Conservation Trust, Balallan House, 24 Allan Park, Stirling, FK8 2QG or from the report: 'Assessment of invertebrate biodiversity on four brownfield sites in the Inner Forth Area Identifying Open Mosaic Habitat on vacant and derelict land in the Inner Forth' available on the Buglife website:
http://www.buglife.org.uk/advice-andpublications/publications/campaigns-and-reports

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FORTH AREA BIRD REPORT 2014

C.J. Pendlebury and N. Bielby

This is the 40th bird report for the Upper Forth SOC (Scottish Ornithologists Club) recording area. The area covered by the report comprises the council areas of Falkirk, Clackmannanshire and Stirling but excludes parts of the Clyde drainage basin such as Loch Lomondside and the Endrick Water area (including Fintry and Balfron), all of which are covered by the Clyde bird report. The report consists of a summary of the main bird news from 2014 followed by detailed species accounts.

Chris Pendlebury, the current SOC recorder, can be contacted by e-mail at chris@upperforthbirds.co.uk, by leaving a message on 07798711134, or by mail to 3 Sinclair Street, Dunblane FK15 0AH. Records can be provided through the BTO BirdTrack system or by an Excel spreadsheet that can be sourced from Chris.

In this report a coded summary of general distribution is included after the species name. The codes used in this report are:

B	Breeding status: widespread (present in more than five 10 km squares)
b	Breeding status: local, scarce (present in fewer than five 10 km squares)
W	Winter status: widespread or often in groups of more than ten
w	Winter status: local, scarce or usually fewer than ten in a group
P or p	Passage (used for species usually absent in winter); P and p used for widespread and local/scarce, respectively, as in winter status above
S or s	Summer visitor (used for species present in summer but which do not normally breed); S and s used for widespread and local/scarce, respectively, as in winter status above.

Rarer species for which a full list of records are provided are highlighted with the use of an asterix (*). Records of rare species are subject to acceptance by the BBRC, SBRC or the local rarities panel. The latter currently consists of Graeme Garner, Cliff Henty, Mark Lewis, Duncan Orr-Ewing, Chris Pendlebury and Andre Thiel. A list of local rarities is available from Chris Pendlebury.

HIGHLIGHTS OF THE YEAR

January

A redhead smew was at Blairdrummond GPs all month, with a visit to nearby Blackdub on the 2nd. 1 female snow bunting was seen on The Nebit,

Alva on the 12th. 2 snow geese were with pink-footed geese at Skinflats on the 19th, whilst a razorbill was off Blackness on the same day. At the end of the month 6 waxwings were at Laurieston on the 31st.

February

The month started with a common scoter on the Lake of Menteith on the 1st, whilst the smew at Blairdrummond remained until the 22nd. A Slavonian grebe was found at Gart GPs, Callander and remained till the 2nd March. A guillemot was off Blackness on the 14th. On the 16th 50 snow buntings were found on Ben Cleugh, and there was a brent goose off Bo'ness.

March

At Gart GPs, Callander the Slavonian grebe remained until the 2nd. 15 waxwings were at Doune on the 15th, with 2 snow buntings found at Glen Gyle on the same day. On the 16th a brent goose was at Skinflats.

April

Male garganeys were found at Skinflats on the 20th and at Cambus on the 27th. At the end of the month a black-necked grebe was found at Skinflats on the 30th.

May

The black-necked grebe stayed at Skinflats until the 21st, and there was a male garganey at Cambus until the 27th. A black-throated diver was on Loch Tay from Killin on the 5th. On the 9th there was an avocet at Kinneil and a marsh harrier at Alloa Inch. A Temminck's stint was at Killin by Loch Tay on the 11th and 20th. An Egyptian goose was seen at Blairdrummond GPs on the 12th and 17th. A spotted crake was singing at Killin Marshes, Loch Tay between the 15th and 19th. A spoonbill was at Cambus on the 25th, and the month finished with a great white egret at Polmont on 30th.

June

An immature glossy ibis was at Cambus on the 2nd and 11th. On the 15th a rose-coloured starling visited a garden in Bo'ness, and there were 2 great northern divers on the Lake of Menteith. A common rosefinch was in the Crianlarich area on the 23rd.

July

A spoonbill was at Skinflats on the 12th and 13th. The Egyptian goose was relocated at Gart GPs, Callander on the 20th.

August

A wood sandpiper was at Kinneil from the 9th until the end of the month, with 2 there on the 17th, whilst 2 pomarine skuas passed there on the 25th.

September

There was a wood sandpiper at Kinneil until the 13th, with 2 again on the 7th.

A marsh harrier was at Tullibody Inch on the 5th. On the 6th 2 roseate terns were at Blackness and an immature black tern visited both Blackness and Kinneil. The returning adult ring-billed gull was seen on a single date this winter, on the 8th. A roseate tern was seen at Blackness again on the 9th. A nightjar was seen in a garden near Bridge of Allen on the 20th. A honey buzzard was recorded flying over Dollar on the 21st, and a little stint was at Skinflats on the 28th.

October

A Slavonian grebe was a Kippen Muir Dam on the 12th, and the Egyptian goose was again at Gart GPs, Callander on the 19th.

November

Two immature/female long-tailed ducks were on Lake of Menteith on the 5th until the end of the year. On the 6th a great skua and a common scoter were seen off Kinneil. The only waxwing of the winter, a single at Lochearnhead, was seen between the 9th and 13th. A white-tailed eagle was seen from Ben Ledi on the 15th, and 6 taiga bean geese flew past Blackness on the 26th.

December

The 2 long-tailed ducks remained at Lake of Menteith all month, and a white-tailed eagle was seen at Argaty, Braes of Doune on the 7th. The wintering taiga bean goose flock at Slamannan Plateau peaked at 181 on the 7th

CONTRIBUTORS

This report has been compiled from records submitted by the contributors listed below. Where initials are given, the contributors are listed in species entries of birds that are rare, uncommon or otherwise noteworthy. The editors are grateful to all the contributors for submitting their records. Thanks also go to Mike Bell and Neil Bielby who made available WeBS and BBS count data, and also to the Central Scotland Raptor Study Group (CSRSG). Apologies to anyone who has been inadvertently missed out.

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SYSTEMATIC LIST

Codes – F, C and S refer to Falkirk, Clackmannanshire and Stirling Council Areas.

MUTE SWAN *Cygnus olor* (B, W)
Inland WeBS: 274 in Jan, 260 in Feb, 272 in Mar, 164 in Sep, 148 in Oct, 190 in Nov and 206 in Dec.
Forth Est WeBS: 22 in Jan, 14 in Feb, 15 in Mar, 24 in Sep, 52 in Oct, 65 in Nov and 16 in Dec.

F Breeding: 2 pr each with 5 Y Union Canal, Falkirk 31 May; pr + 5Y Forth/Clyde Canal Camelon 7 Sep. Max: 114 Skinflats 2 Nov.

C Breeding: Delph Pond, Tullibody (1Y) and Kersiepow Pond (4Y). Max: 129 R. Devon, Alva-Tillicoultry 16 Feb; 34 R. Devon, Tullibody-A907 17 Mar; 55 Gartmorn Dam 9 Nov.

S Breeding: 2 pr Airthrey L, BoA (10Y) 6 Jun; Gart GPs, Callander (4Y); Cullen Pond, Cromlix (1Y); Doune Ponds (1Y). Max: 33 Airthrey L, BoA 8 Jan; 12 Gart GPs, Callander 9 Feb; 17 Lake of Menteith 24 Mar; 22 Blairdrummond GPs 4 May.

WHOOPER SWAN *Cygnus cygnus* (W)
Spring departure: 4 L Venachar 13 May (JB). Autumn arrival: 5 Airth 28 Sep (DP).
Inland WeBS: 22 in Jan, 16 in Feb, 14 in Mar, 0 in Sep, 27 in Oct, 31 in Nov and 77 in Dec.
Forth Est WeBS: 0 in Jan, 0 in Feb, 0 in Mar, 0 in Sep, 0 in Oct, 1 in Nov and 1 in Dec.

F Winter/spring max: 6 Stenhousemuir 4 Jan. Autumn/winter max: 13 Blackness 9 Nov; 36 Skinflats 19 Nov.

C Winter/spring max: 19 Alloa Inch 8 Mar; 40 Alva 9 Mar. Autumn/winter max: 23 Gartmorn Dam 12 Oct; 17 Dollar 17 Nov.

S Winter/spring max: 9 Lake of Menteith 18 Feb; 31 > Kinbuck 2 Mar; 25 > Dunblane 4 Mar; 21 L Dochart 26 Mar; 12 L Lubhair 6 Apr. Autumn/winter max: 34 Carron Valley Resv 7 Dec; 23 Crianlarich 9 Dec; 24 Doune 27 Dec.

BEAN GOOSE *Anser fabalis* (W)

F Regular wintering flock of Taiga race birds in the vicinity of the Slamannan Plateau. Winter/spring max: 86 Slamannan 19 Jan. Autumn/winter: 60 Slamannan 20 Nov, with max of 181 on 7 Dec (RD, WH).
Elsewhere: 6 >W past Blackness 26 Nov (KDS).

PINK-FOOTED GOOSE *Anser brachyrhynchus* (W)
Spring departure: 220 Alloa Inch 9 May (GG). Autumn arrival: 27 Skinflats 12 Sep (JB).
Forth Est WeBS: 377 in Jan, 2721 in Feb, 800 in Mar, 7 in Sep, 3315 in Oct, 2663 in Nov and 614 in Dec.

F Winter/spring max: 3000 Skinflats 26 Feb; 1000 Airth 28 Feb. Summer: 10 Airth 22 May and 17 July, with 7 on 14 Aug. Autumn/winter max: 1000 S Alloa 30 Sep; 1000 Dunipace 11 Oct; 3330 Skinflats 17 Oct.

C Winter/spring max: 1440 Blackgrange 30 Jan; 2400 Cambus 12 Mar; 520 Alloa Inch 5 Apr. Summer: 7 Alloa Inch 29 June and Kennet Pans 15 Aug. Autumn/winter max: 637 Cambus 5 Dec.

S Winter/spring max: 2050 Drip Moss 16 Jan. Summer: 1 Lake of Menteith 15 Jun. Autumn/winter max: 400 Doune 9 Nov.

WHITE-FRONTED GOOSE (Greenland race) *Anser albifrons* (w)

F One Skinflats 26 Oct (DOE).

C One Blackgrange, Stirling 29 Mar.

S One Fallin 29 Mar (ACC).

GREYLAG GOOSE *Anser anser* (b, W)
Spring departure and autumn arrival are muddied by the presence of resident feral birds.
Forth Est WeBS: 15 in Jan, 0 in Feb, 0 in Mar, 231 in Sep, 163 in Oct, 48 in Nov and 0 in Dec.

F Winter/spring max: 40 Blackness 3 Jan. Summer: 3 ad and 13 Y Skinflats 27 Jul. Autumn/winter max: 194 Skinflats 9 Aug; 415 Blackness 20 Oct.
C Winter/spring max: 420 Alva 19 Jan; 200 Alva 2 Feb. Summer: 124 Cambus 26 Jul. Autumn/winter max: 255 Alloa Inch 15 Aug; 460 Cambus 31 Aug; 880 Cambus 24 Sep.
S Winter/spring: 105 L Watston, Doune 17 Jan; 184 Blairdrummond GPs 11 Mar. Autumn/winter: 593 Gart GPs, Callander 19 Oct; 271 L Coulter 24 Oct.

SNOW GOOSE *Anser caerulescens*
F Two blue-morphs at Skinflats 19 Jan (MJW, TM).

CANADA GOOSE *Branta canadensis* (b W)
Inland WeBS: 279 in Jan, 452 in Feb, 374 in Mar, 835 in Sep, 1234 in Oct, 760 in Nov and 968 in Dec.
Forth Est WeBS: 0 in Jan, 0 in Feb, 0 in Mar, 91 in Sep, 38 in Oct, 3 in Nov and 2 in Dec.
F Site max: 80 > Carronshore 4 Sep; 285 Skinflats 14 Sep; 150 St Helen's Loch, Bonnybridge 18 Nov.
C Breeding: 2 pr Gartmorn Dam 11 Mar. Site max: 70 Gartmorn Dam 12 Jan; 80 Alloa Inch 15 Aug.
S Breeding: 2 pr and 6 Y L Arklet 19 May; 16 Y Gart GPs 15 Jun. Max: 150 Throsk 24 Aug; 439 L Coulter 29 Sep; 215 L Rusky 17 Oct; 117 Blairdrummond GPs 25 Oct; 420 L Venachar 29 Oct; 417 Lake of Menteith 2 Dec.

BARNACLE GOOSE *Branta leucopsis* (w)
In our area it is difficult to distinguish between wild migrants and feral birds resident in Britain.
F One Kinneil 19 Sep (JB). 21 L Ellrig 14 Oct (NB); 2 Skinflats 17 Oct (DMB), 6 there 26th (DOE).
S Max: 18 Drip Moss, Stirling 8 and 15 Jan (RTW). Elsewhere: 1 Flanders Moss 25 Jan and 16 Feb (RTW); 1 Blairdrummond GPs 2 Mar (DOE); 1 L Coulter 16 Feb and 13 Dec (RW, NB); 4 Gartartan, Aberfoyle 5 Oct (NB).

*BRENT GOOSE *Branta bernicla* (w)
F One Bo'ness 16 Feb (JRC). One pale-bellied form Skinflats 16 Mar (MVB).

*EGYPTIAN GOOSE
S One Blairdrummond GPs 12 and 17 May (DOE, CJP) and Gart GPs, Callander 20 Jul and 19 Oct (NB).

COMMON SHELDUCK *Tadorna tadorna* (b, W)
Inland WeBS: 0 in Jan, 2 in Feb, 8 in Mar, 0 in Sep, 0 in Oct, 0 in Nov and 1 in Dec.
Forth Est WeBS: 403 in Jan, 304 in Feb, 436 in Mar, 3116 in Sep, 1895 in Oct, 904 in Nov and 654 in Dec.
F Moult flock max count of 4392 Kinneil 4 Aug (DMB).
C Site max: 37 Tullibody Inch 12 Jan; 30 Cambus 24 Oct.
S Max: 2 Lake of Menteith 7 Jan; 16 Blackdub 24 Feb; 6 Lecropt Carse 3 Mar; 1 Blairdrummond GPs 25 May.

EURASIAN WIGEON *Anas penelope* (s, W)
Inland WeBS: 502 in Jan, 269 in Feb, 68 in Mar, 43 in Sep, 171 in Oct, 405 in Nov and 382 in Dec.
Forth Est WeBS: 211 in Jan, 140 in Feb, 27 in Mar, 73 in Sep, 388 in Oct, 467 in Nov and 243 in Dec.
F Winter/spring max: 380 S Alloa 18 Feb; 190 Polmont 16 Mar. Summer: up to 8 at Skinflats, on 20 Jul. Autumn/winter max: 250 Skinflats 24 Sep; 610 Blackness 9 Oct.
C Max: 106 Gartmorn Dam 16 Feb; 20 Alva 2 Mar.
S Winter/spring max: 241 Blackdub 2 Jan; 60 L Dochart 11 Jan; 326 Alloa Inch 16 Feb; 47 Kinbuck 16 Feb; 60 Gart GPs, Callander 1 Mar; 47 Killin 6 Mar. Autumn/winter max: 60 Gart GPs, Callander 16 Nov; 135 L Coulter 23 Nov; 73 L Dochart 6 Dec.

GADWALL *Anas strepera* (s, w)

F Skinflats: max of 4 in Apr; max of 7 in May; max of 3 in Sep; max of 4 in Oct (DOE, DMB, MVB *et al*.); 2 St Helen's Loch, Bonnybridge 14 Oct (NB).

C Cambus: 5 on 5 Apr, 9 on 17th (GG). Gartmorn Dam: 29 on 12 Oct; 6 on 9 and 22 Nov (SR, GG, MVB). 1 pr Blackdevon Wetland 26 Apr (DMB).

S Three North Third Resv 24 Oct (NB). 1 Cultenhove Dam, Bannockburn 13 Dec (NB).

EURASIAN TEAL *Anas crecca* (b, W)

Inland WeBS: 1241 in Jan, 1050 in Feb, 871 in Mar, 446 in Sep, 989 in Oct, 1176 in Nov and 1447 in Dec.

Forth Est WeBS: 934 in Jan, 967 in Feb, 398 in Mar, 498 in Sep, 745 in Oct, 1738 in Nov and 1572 in Dec.

F Winter/spring max: 654 Kinneil and 313 Skinflats 16 Feb. Autumn/winter max: 1236 S Alloa 29 Oct; 474 Kinneil and 425 Skinflats 7 Dec; 150 Airth 30 Dec.

C Winter/spring max: 18 Gartmorn Dam 12 Jan; 72 Cambus 7 Mar. Autumn/winter max: 75 Blackdevon Wetlands 15 Oct; 710 Alloa Inch 9 Nov.

S Winter/spring max: 251 R Forth, Stirling 12 Jan; 112 L Coulter 14 Jan; 145 L Mahaick 16 Jan; 89 L Watston, Doune 17 Jan; 68 Fallin 30 Jan; 73 Gart GPs, Callander 9 Feb; 70 Lecropt Carse 16 Feb. Autumn/winter max: 63 Lake of Menteith 5 Nov; 103 L Dochart 6 Dec; 251 Gart GPs, Callander 7 Dec; 92 L Coulter and 176 Ashfield 13 Dec.

MALLARD *Anas platyrhynchos* (B, W)

Inland WeBS: 2350 in Jan, 2025 in Feb, 1156 in Mar, 1682 in Sep, 2179 in Oct, 2152 in Nov and 2228 in Dec.

Forth Est WeBS: 262 in Jan, 132 in Feb, 85 in Mar, 219 in Sep, 286 in Oct, 298 in Nov and 199 in Dec.

F Max: 102 Skinflats 18 Jan; 56 Stenhousemuir 11 Oct; 50 Blackness 20 Dec.

C Max: 60 Gartmorn Dam 12 Jan; 20 Alva 2 Mar; 36 Cambus 3 Jul.

S Max: 105 L Mahaick, BoD 1 Feb; 110 Callander 26 Sep; 130 Airthrey Loch, BoA 30 Sep; 187 Blairdrummond GPs 17 Oct; 75 Balquhidder Glen 25 Nov; 96 Lake of Menteith 2 Dec; 83 L Coulter 13 Dec.

NORTHERN PINTAIL *Anas acuta* (W)

Forth Est WeBS: 81 in Jan, 13 in Feb, 4 in Mar, 0 in Sep, 31 in Oct, 38 in Nov and 59 in Dec.

F Winter/spring max: 85 Kinneil 30 Jan. Autumn/winter max: 75 Skinflats 19 Nov.

C One Gartmorn Dam 19 Jan and 16 Feb (RE, SR).

S L Mahaick, BoD: 3 on 1 Feb and 4 on 4 Feb (DOE). 2 Blackdub, Stirling 3 Mar (DMB).

*GARGANEY *Anas querquedula* (s)

F One M Skinflats 20 Apr to 26 May (RS, DOE, RD), and 23 Aug (DOE, AE). These are the 23rd and 25th records of this species in Upper Forth.

C One M Cambus 27 Apr to 27 May (GG, DMB). This is the 24th record of this species in Upper Forth.

NORTHERN SHOVELER *Anas clypeata* (p)

F Skinflats: singles on 9 Aug, 30 Aug and 8 Oct, with 3 on 5 Oct (AB, DOE). 4 Kinneil 12 Sep (JB).

C Cambus: 1 on 11 Mar, 8 on 4 Apr and 1 on 9 May (DMB, DH, GG). Gartmorn Dam: 1 on 4 Apr; 2 on 10 Oct and 2 on 20 Nov (RE, SR, DMB). 1 Longcarse, Alloa 18 Sep (NB).

S Two Alloa Inch 16 Mar (LO).

COMMON POCHARD *Aythya ferina* (W)

Inland WeBS: 3 in Jan, 4 in Feb, 2 in Mar, 1 in Sep, 7 in Oct, 72 in Nov and 1 in Dec.

F Skinflats: max of 3 in July; singles in Sep (AB, DMB, DOE). 1 M Kinneil 15 Nov (RS).

C Max: 69 Gartmorn Dam 9 Nov (SR).
S Lake of Menteith: 1 in Jan; 3 on 18 Feb (RTW, NB). 1 Killin 15 Feb and 1 Mar (JPH). Gart GPs, Callander: singles Mar to May and Nov (DOE, NB). Blairdrummond GPs: max in Sep of 5 on 15th (DOE).

TUFTED DUCK *Aythya fuligula* (B, W)
Inland WeBS: 369 in Jan, 283 in Feb, 385 in Mar, 228 in Sep, 445 in Oct, 478 in Nov and 310 in Dec.
F Max: 14 Larbert Pond 26 Mar; 33 Skinflats 4 May; 18 L Ellrig 18 Nov.
C Winter/spring max: 46 Gartmorn Dam 16 Mar. Autumn/winter max: 253 Gartmorn Dam 12 Oct.
S Breeding: Gart GPs: three broods of 4, 4 & 2 20 Jul; F with 7 chicks 15 Aug. Winter/spring max: 119 N Third Resv 16 Jan; 37 Lake of Menteith 18 Feb; 42 Airthrey Loch, BoA 27 Feb; 60 Blairdrummond GPs 11 Mar. Autumn/winter max: 117 Gart GPs, Callander 15 Aug; 35 Carron Valley Resv 12 Oct; 44 N Third Resv 24 Oct; 48 Blairdrummond GPs 13 Nov; 76 Lake of Menteith 2 Dec.

GREATER SCAUP *Aythya marina* (s, w)
Forth Est WeBS: 4 in Jan, 0 in Feb, 0 in Mar, 5 in Sep, 2 in Oct, 4 in Nov and 0 in Dec.
F Kinneil max: 5 in Jan, 8 in Feb and Mar, 10 in Apr, 6 in May, 1 in Aug, 8 in Sep, 3 in Oct, 4 in Nov. Skinflats: singles in May and Jul. 1 Blackness 9 Oct.
C One imm M Cambus 22 Oct (DMB).
S Lake of Menteith: F and imm M 5 Feb to 6 Mar, and ad M 6 Mar and 25 Apr (RTW). N Third Resv: 3 M 14 Feb and 4 M 14 Mar (NB). 1 M Blairdrummond GPs 14 Sep (CJP, DOE).

COMMON EIDER *Somateria mollissima* (s, w)
Forth Est WeBS: 13 in Jan, 26 in Feb, 0 in Mar, 8 in Sep, 2 in Oct, 0 in Nov and 0 in Dec.
F Blackness max: 5 in Jan, 12 in Feb, 17 in Mar, 40 in Aug, 15 in Sep, 35 in Oct, 1 in Nov, 22 in Dec. Kinneil max: 14 in Feb, 8 in Mar, 3 in Aug, 15 in Sep, 2 in Nov. Grangemouth max: 13 in Jan, 24 in Feb, 16 in Mar, 2 in Oct, 27 in Nov.

*LONG-TAILED DUCK *Clangula hyemalis* (w)
S Two imm/F Lake of Menteith 5 Nov to year-end (NB, DT).

*COMMON SCOTER *Melanitta nigra* (w)
Forth Est WeBS: 0 in Jan, 0 in Feb, 0 in Mar, 0 in Sep, 0 in Oct, 1 in Nov and 0 in Dec.
F One Kinneil 6 Nov (JRC).
S One Lake of Menteith 1 Feb (RTW).

COMMON GOLDENEYE *Bucephala clangula* (W)
Inland WeBS: 432 in Jan, 443 in Feb, 342 in Mar, 0 in Sep, 13 in Oct, 338 in Nov and 340 in Dec.
Forth Est WeBS: 3 in Jan, 5 in Feb, 9 in Mar, 2 in Sep, 1 in Oct, 39 in Nov and 5 in Dec.
F Max: 8 Skinflats 22 Mar; 29 Kinneil 6 Nov.
C Max: 30 Gartmorn Dam 4 Feb; 20 Alva 24 Feb; 45 Alloa Inch 8 Mar.
S Max: 20 Lecropt Carse 10 Jan; 189 Lake of Menteith 5 Nov.

*SMEW *Mergellus albellus* (w)
S One redhead Blairdrummond GPs 24 Nov 2013 to 22 Feb 2014 (CJP, PB, DOE) and at Blackdub 2 Jan (NB).

RED-BREASTED MERGANSER *Mergus serrator* (B, W)
Inland WeBS: 12 in Jan, 24 in Feb, 12 in Mar, 1 in Sep, 4 in Oct, 2 in Nov and 0 in Dec.
Forth Est WeBS: 16 in Jan, 20 in Feb, 25 in Mar, 18 in Sep, 77 in Oct, 53 in Nov and 48 in Dec.
F Max: 70 Kinneil 6 Sep; 14 Blackness 1 Dec; 15 Skinflats 7 Dec.
C Max: 2 Tullibody Inch 12 Jan; 10 R Devon, Menstrie 22 Feb; 2 Alloa Inch 8 Mar; 2 Cambus 3 Nov.
S Max: 6 Lecropt Carse 1 Feb; 3 Carron Valley Resv 12 Oct.

GOOSANDER *Mergus merganser* (B, W)
Inland WeBS: 119 in Jan, 89 in Feb, 111 in Mar, 67 in Sep, 90 in Oct, 78 in Nov and 135 in Dec.
Forth Est WeBS: 1 in Jan; 0 in Feb, 3 in Mar, 40 in Sep, 7 in Oct, 6 in Nov and 5 in Dec.
F Max: 12 Forth/Clyde Canal, Bonnybridge 19 Jan; 14 Black Loch, Limerigg 12 Dec.
C Max: 32 Alloa Inch 16 Mar; 16 R Devon, Dollar-Tillicoultry 11 Oct.
S Max: 21 R Forth, Stirling 12 Jan; 13 Lecropt Carse 22 Jan; 11 Gart GPs, Callander 20 Jul; 14 L Ard 10 Sep; 13 Killin 11 Sep; 28 Blairdrummond GPs 17 Oct; 21 R Forth, Teith-Allan conf's 8 Dec.
RED GROUSE *Lagopus lagopus* (B, W)
S Records from: Earlsburn; Sheriffmuir; Balquhidder Glen; G Lochay; Ben Lawers (ACC, DOE, JPH).
*PTARMIGAN *Lagopus muta* (b, w)
S Two Ben Vorlich 1 Jun (MB). 2 Ben More 19 Apr (KR). 2 Meall Ghaordaidh 21 Sep (JHN). 1 An Caisteal 12 Jun (PJR). 1 Creag Mhor 27 May (GC)
BLACK GROUSE *Tetrao tetrix* (b, w)
S Records from: Callander, Menteith Hills, L Arklet, Meall Liath (DOE, VW, JPH, RTW).
RED-LEGGED PARTRIDGE *Alectoris rufa* (b, w)
S Recorded in small numbers (max 5) from BoD, Dunblane and Callander (DOE, CJP).
GREY PARTRIDGE *Perdix perdix* (b, w)
F Max: 13 Skinflats 16 Nov (DOE); 9 Powfoulis 28 Dec (AB).
C Max: 12 Alva 27 Aug (RE).
S Max: 2 Cowie 4 May (DMB); 2 Throsk 3 Jun (ACC). Also introduced birds at Blairdrummond GPs (max of 16 on 14 Sep).
*COMMON QUAIL *Coturnix coturnix* (b)
F One West Lothian golf course, Bo'ness 17 Jul (TG).
S One Ledcarrie, G Dochart 31 May and 1 Jun (JPH).
COMMON PHEASANT *Phasianus colchicus* (B, W)
Large numbers released on shooting estates, otherwise widespread but in smaller numbers.
S Max: 27 G Ample 2 Nov.
*RED-THROATED DIVER *Gavia stellata* (b, w)
F Two Kinneil 8 Jan (DT). 1 Blackness 19 Jan (DMB). 2 Blackness 14 Feb (DOE). Kinneil: 2 on 5 Oct (CJP), 2 on 11 Oct (JRC), 1 on 6 Nov (JRC).
S Two at undisclosed location in Trossachs 19 May (ASJ).
*BLACK-THROATED DIVER *Gavia arctica* (b)
S One Killin, L Tay 5 May (JPH). Also present at 3 undisclosed locations in Trossachs in Mar, Apr and May (NB, FAM, JC).
*GREAT NORTHERN DIVER *Gavia immer* (w)
S Two Lake of Menteith 15 Jun (RTW).
LITTLE GREBE *Tachybaptus ruficollis* (B, w)
Inland WeBS: 47 in Jan, 52 in Feb, 60 Mar, 100 in Sep, 71 in Oct, 64 in Nov and 47 in Dec.
F Breeding: Skinflats and Larbert Pond. Max: 5 Darnrig Moss 7 Aug; 8 Little Denny Resv 4 Sep; 10 at Skinflats 23 Sep; 8 Drumbowie Resv 18 Nov.
C Breeding: Aberdona. Max: 5 R Devon, Alva 13 Oct; 1 Cambus 3 Nov; 2 Dollar 13 Dec.
S Breeding: Sheriffmuir Big Wood; Ochlochy Park, Dunblane. Max: 9 L Lubnaig 17 Feb; 9 L Dochart 12 Mar; 7 Blairdrummond GPs 7 Sep; 19 Gart GPs, Callander 21 Sep; 10 L Ard 17 Oct.
GREAT CRESTED GREBE *Podiceps cristatus* (b, W)
Inland WeBS: 12 in Jan, 18 in Feb, 26 in Mar, 36 in Sep, 24 in Oct, 27 in Nov and 19 in Dec.

Forth Est WeBS: 3 in Jan, 4 in Feb, 4 in Mar, 10 in Sep, 8 in Oct, 16 in Nov and 3 in Dec.
F Max: 35 Kinneil 28 Sep; 74 Blackness 9 Oct.
C Max: 8 Gartmorn Dam 16 Mar.
S Max: 8 Gart GPs, Callander 13 Apr; 33 Lake of Menteith 1 Sep.

*SLAVONIAN GREBE *Podiceps auritus*
S One Gart GPs, Callander 9 Feb to 2 Mar (NB, CJP, DOE, RTW). 1 Kippen Muir Dam 12 Oct (JS, AM).

*BLACK-NECKED GREBE *Podiceps nigricollis*
S One Skinflats 30 Apr to 21 May (DOE, RS, AB, CJP *et al*.).

*NORTHERN FULMAR *Fulmaris glacialis* (s, p)
F One Skinflats 29 Mar (AB). 2 > E past Kinneil 25 Aug (DMB). 1 Kinneil 6 Sep (AB). 1 > E past Kinneil 9 Sep (DMB).

NORTHERN GANNET *Morus bassanus* (p)
F One ad Kinneil 22 Jul (DT). 1 imm Kinneil 14 Sep (DT). 1 Blackness 19 Sep (JB). Kinneil: 1 imm 25 Sep (DT); 3 on 28th (RDG); 2 on 30th (JB). 1 Blackness 30 Sep (JB). 1 imm Skinflats 3 Oct (AB). 1 Kinneil 5 Oct (CJP). 2 imm Airth 14 Oct (DMB).
S One L Ard 2 Oct (LMcB)

GREAT CORMORANT *Phalacrocorax carbo* (S, W)
Inland WeBS: 56 in Jan, 60 in Feb, 31 in Mar, 62 in Sep, 59 in Oct, 71 in Nov and 58 in Dec.
Forth Est WeBS: 14 in Jan, 22 in Feb, 15 in Mar, 66 in Sep, 131 in Oct, 79 in Nov and 38 in Dec.
F Max: 50 Kinneil and 37 Skinflats 11 Oct.
C Max: 45 Alloa Inch 16 Mar.
S Max: 29 Carron Valley Resv 7 Sep; 18 L Lubnaig 1 Oct; 22 Lake of Menteith 5 Nov.

LITTLE EGRET *Egretta garzetta* (w)
F Two Skinflats / Airth 2013 to 16 Apr (AE, AB, ACC, DMB). Up to 6 in Skinflats / Kinneil / Grangemouth / Airth area 4 Aug to year-end (RS, ACC, DOE, CJP *et al*.)
C 2 Cambus / Kennet Pans / Tullibody / Alloa Inch 9 Aug to 7 Sep (DH, GG, DMB, TG).
S One > N over Dunblane 13 Sep (CJP).

*GREAT WHITE EGRET *Ardea alba*
F One ad Polmont 20 May (ZS, PB, DMB, CJP *et al*.).

GREY HERON *Ardea cinerea* (B,W)
Inland WeBS: 69 in Jan, 75 in Feb, 45 in Mar, 68 in Sep, 69 in Oct, 81 in Nov and 82 in Dec.
Forth Est WeBS: 1 in Jan, 8 in Feb, 1 in Mar, 55 in Sep, 53 in Oct, 36 in Nov and 14 in Dec.
F Breeding: 22 AONs Dunmore 19 Apr, 67 discarded eggs (AB). Max: 26 Skinflats 7 Sep; 19 Kinneil 19 Sep.
C Max: 6 Gartmorn Dam 16 Feb; 5 Blackdevon Wetlands 15 Oct; 6 Alva 8 Nov.
S Max: 9 Eas Gobhain, Callander 30 Jan; 9 Blairdrummond GPs 1 Jan; 11 Gart GPs, Callander 20 Jul.

*GLOSSY IBIS *Plegadis falcinellus*
C One imm Cambus pools 2 Jun (GG, CJP) and 11 Jun (NB).

*SPOONBILL *Platalea leucorodia* (s)
F Two Skinflats 12 and 13 Jul.
C One Cambus 25 May (GG).

*HONEY BUZZARD *Pernis apivorus* (b?)
C One over Dollar 21 Sep (DI).
S Female at undisclosed location in Trossachs on 8 May, 21 May and 10 Sep (CMcI, RTW).

RED KITE *Milvus milvus* (b ,W)
C One Colsnaur Hill 16 Jun (AE). One Dollar 8 Dec (RE).
S Breeding: of 33 prs 27 laid eggs, 17 prs successfully fledging 31 Y (DOE, MMcD, DA). Argaty, BoD max: 49 on 22 Jan (DOE). Regular in areas of BoD, Stirling, and Callander.

*WHITE-TAILED EAGLE *Haliaeetus albicilla* (s, w)
All likely to refer to birds from the Fife reintroduction scheme.
S Two Ben Ledi 15 Nov (DOE). One Argaty, BoD 7 Dec (DOE).
*MARSH HARRIER *Circus aeruginosus* (p, s)
C One F Alloa Inch 9 May (GG). 1 imm Tullibody Inch 5 Sep (GG).
*HEN HARRIER *Circus cyaneus* (b, w)
C One Cambus 12 Dec (RG)
S One ringtail Killin 2 Jan (TG). 1 Thornhill 27 Feb (DOE). 1 M Dumyat 8 Aug (RE). 1 G Dochart 7 Sep (JPH). 1 ringtail L Mahaick, BoD 22 Sep (NB). 1 ringtail G Lochay 22 Oct (FJM). 1 L Ard 24 Oct (BD). 1 M Kippen Muir 3 Nov (DT). 1 ringtail Flanders Moss (DT).
*NORTHERN GOSHAWK *Accipiter gentilis* (b, w)
S Breeding: 2 pairs (CSRSG). Also: 1 Strathyre 17 Aug (RTW); 1 Blairdrummond GPs 7 Sep (DOE).
SPARROWHAWK *Accipiter nisus* (B, W)
Inland WeBS counts: 2 in Jan, 1 in Feb, 5 in Mar, 1 in Sep, 1 in Oct, 7 in Nov and 5 in Dec.
Recorded throughout the majority of the recording area. Contributors are encouraged to submit breeding records.
BUZZARD *Buteo buteo* (B, W)
Recorded throughout the majority of the recording area. Contributors are encouraged to submit breeding records.
Inland WeBS counts: 33 in Jan, 56 in Feb, 47 in Mar, 28 in Sep, 38 in Oct, 45 in Nov and 33 in Dec.
*GOLDEN EAGLE *Aquila chrysaetos* (s, w)
S One Lochearnhead 1 Jan (TG). 2 G Lochay 16 Feb (JPH). 1 2Y M Lake of Menteith (RTW). 1 Crianlarich 1 Jun (JS). 1 pr confidential location (DOE, DC *et al*.).
OSPREY *Pandion haliaetus* (B)
First record of the year: 1 Lake of Menteith 23 Mar (RTW).
F One Skinflats 29 Mar (AB).
S Summer: present throughout region, particularly Callander, Doune, Lake of Menteith, L Tay.
KESTREL *Falco tinnunculus* (B, W)
Inland WeBS counts: 5 in Jan, 4 in Feb, 2 in Mar, 6 in Sep, 0 in Oct, 4 in Nov and 4 in Dec.
Recorded throughout most of the recording area. Contributors are encouraged to submit breeding records.
*MERLIN *Falco columbarius* (b?, w)
F F / imm Skinflats 2 Feb (AB).
C One Blackdevon Wetlands 20 Jan (RG).
S Singles: Craigforth, Stirling 28 Feb (DOE); Sheriffmuir 24 Mar (DOE); Tigh Na Blair 25 May (DOE); Lecropt Carse 6 Dec (DOE). Two Slymaback, BoD 21 Jun (BD).
PEREGRINE FALCON *Falco peregrinus* (B, W)
F Up to 2 regular in Airth / Skinflats / Kinneil area; also recorded from Blackness, Bonnybridge and L Ellrig.
C Records of singles at Alva, Alloa Inch, Blackgrange and Clackmannan.
S Recorded from Ben Venue, Stirling Carse, G Finglas, Killin, Stirling Carse, Blairdrummond and BoA.
WATER RAIL *Rallus aquaticus* (b, w)
F Max: 3 Kinneil 29 Jan; 3 Skinflats 9 Nov.
C Max: 4 Tullibody Inch 20 Aug; 9 Alloa Inch 18 Oct. Also recorded from: Blackdevon Wetlands; Cambus; R Devon, Alva and Dollar; Gartmorn Dam.
S Recorded from: Killin Marshes, L Tay; L Watston, Doune.

*SPOTTED CRAKE *Porzana porzana*
S M calling from Killin Marshes, L Tay 15-19 May (JPH, DW).
MOORHEN *Gallinula chloropus* (B,W)
Inland WeBS: 81 in Jan, 58 in Feb, 51 in Mar, 104 in Sep, 85 in Oct, 93 in Nov and 94 in Dec.
F Max: 6 Larbert pond 11 Oct; 31 Skinflats Pools and 10 Callendar Park 9 Nov.
C Breeding: 14 (incl. 11 Y) Cambus 1 Aug. Max: 13 Gartmorn Dam 12 Oct; 11 R. Devon, Alloa 13 Oct; 13 Alloa Inch 2 Nov; 11 Cambus 5 Dec.
S Max: 7 Ochlochy Park, Dunblane 6 Jun; 18 Airthrey Loch, BoA 7 Feb; 7 Cultenhove Dam, Bannockburn 23 Nov.
COOT *Fulica atra* (B, W)
Inland WeBS: 183 in Jan, 100 in Feb, 98 in Mar, 137 in Sep, 69 in Oct, 130 in Nov and 153 in Dec.
F Max: 8 Callendar Park, Falkirk 19 Jan; 12 Larbert pond 27 Feb; 41 Skinflats 25 Aug.
C Max: 67 Gartmorn Dam 9 Nov; 6 Alloa Inch 5 Apr; 12 Cambus 11 Apr.
S Max: 87 Lake of Menteith 16 Jan; 12 L Watston, Doune 15 Feb; 95 Airthrey Loch, BoA 30 Sep.
OYSTERCATCHER *Haematopus ostralegus* (B, W)
Inland WeBS: 27 in Jan, 304 in Feb, 457 in Mar, 1 in Sep, 2 in Oct, 1 in Nov and 1 in Dec.
Forth Est WeBS: 220 in Jan, 240 in Feb, 119 in Mar, 339 in Sep, 122 in Oct, 137 in Nov and 287 in Dec.
F Max: 130 Bo'ness 3 Jan; 120 Blackness 14 Feb; 600 Kinneil 3 Aug; 128 Skinflats 7 Sep.
C Max: 40 Alva 9 Mar; 57 Tillicoultry 13 Mar.
S Max: 91 Lecropt Carse and 86 Blairdrummond 16 Feb; 95 Forth / Teith conf. 16 Mar; 43 Ashfield 1 Mar.
*AVOCET *Recurvirostra avosetta*
F One Kinneil 9 May (RS).
RINGED PLOVER *Charadrius hiaticula* (b, W)
Forth Est WeBS: 34 in Jan, 2 in Feb, 0 in Mar, 8 in Sep, 2 in Oct, 17 in Nov and 0 in Dec.
F Max: 34 Kinneil 18 Jan; 46 Blackness 13 Aug.
C Spring passage of *tundrae* type birds: peak of 70 at Kennet Pans 20 May; also 2 Tullibody Inch 27 May.
S Summer: 2 pr Kildean, Stirling 1 Jun; up to 4 Gart GPs, Callander Apr and Jun.
EUROPEAN GOLDEN PLOVER *Pluvialis apricaria* (B, W)
Forth Est WeBS: 0 in Jan, 55 in Feb, 0 in Mar, 5 in Sep, 288 in Oct, 640 in Nov and 307 in Dec.
F Winter/spring max: 135 30 Jan. Autumn/winter max: 124 Blackness 9 Oct; 700 Kinneil 31 Oct.
C One Bengengie Hill 16 Jun.
S One Cruach Ardrain 1 Jun. 1 L Tay, Killin 10-11 Sep.
GREY PLOVER *Pluvialis squatarola* (W)
F Five Skinflats 2 Feb. 1 Blackness 16 Sep. 1 Kinneil 8 Oct. 2 Skinflats 17 Oct. 2 Blackness 28 Oct. 2 Skinflats 2 Nov.
NORTHERN LAPWING *Vanellus vanellus* (B, W)
Inland WeBS: 11 in Jan, 171 in Feb, 106 in Mar, 125 in Sep, 106 in Oct, 146 in Nov and 101 in Dec.
Forth Est WeBS: 469 in Jan, 571 in Feb, 0 in Mar, 759 in Sep, 684 in Oct, 1046 in Nov and 368 in Dec.
F Max: 391 Skinflats 16 Feb; 134 Gardrum Moss 7 Aug; 710 Kinneil 18 Oct.
C Max: 150 Alva 24 Feb; 600 Tullibody Inch 8 Sep; 530 Alloa Inch 25 Oct; 300 2 Nov.
S Max: 103 Lake of Menteith 3 Jan; 139 Blackdub 24 Feb; 60 Lecropt Carse 1 Feb; 79 Gart GPs, Callander 20 Jul.

RED KNOT *Calidris canutus* (W)
Forth Est WeBS: 1251 in Jan, 14 in Feb, 163 in Mar, 1 in Sep, 0 in Oct, 905 in Nov and 785 in Dec.
F Winter/spring max: 1251 Kinneil 18 Jan. Autumn/winter max: 2300 Kinneil 4 Dec; 275 Blackness 16 Dec.

*SANDERLING *Calidris alba*
F One Skinflats 5 Aug (DMB). 1 Blackness 15 Aug (DMB).
S One L Tay, Killin 20 May (JPH).

*LITTLE STINT *Calidris minuta*
F One Skinflats 28 Sep (DOE).

*TEMMINCK'S STINT *Calidris temminckii*
S One L Tay, Killin 11 and 20 May (KB, JPH).

*CURLEW SANDPIPER *Calidris ferruginea* (p)
F Skinflats in Sep: 1 on 7th, 2 on 8th, 2 on 24th (MVB, DOE) .

DUNLIN *Calidris alpina* (b?, W)
Forth Est WeBS: 2673 in Jan, 2112 in Feb, 323 in Mar, 671 in Sep, 1195 in Oct, 1723 in Nov and 2054 in Dec.
F Winter/spring max: 4300 Kinneil 30 Jan; 200 Blackness 14 Feb. Autumn/winter max: 1720 Bo'ness 18 Nov; 3720 Kinneil 4 Dec; 900 Skinflats 30 Dec.
C Max: 15 Kennet Pans 22 May.
S Summer: 1 Killin, L Tay 21 and 25 May (JPH).

RUFF *Philomachus pugnax* (w, p)
F Singles at Kinneil in Jan and at Skinflats in Jan – Apr and Jun – Jul. Aug max: 4 Skinflats Tidal Exchange and 2 Skinflats on 9th; 5 Kinneil on 26th. Sep max: 4 Kinneil on 6th and 16th; 6 Skinflats on 14th. 7 L Ellrig 4 Sep. Singles Kinneil Oct – Nov and Skinflats 1 Dec.

JACK SNIPE *Lymnocryptes minimus* (w)
Inland WeBS: 0 in Jan, 1 in Feb, 0 in Mar, 0 in Sep, 1 in Oct, 2 in Nov and 2 in Dec.
F Three Airth saltmarsh 18 Feb (RS). 1 St Helen's Loch, Bonnybridge 14 Oct (NB). Skinflats: singles on 26 Oct and 16 Nov; 2 on 30 Dec (DOE). 2 Skinflats Tidal Exchange 28 Dec (AB).
C One R Devon, Alva 23 Apr (RE). 1 Kennet Pans 14 Oct (DMB).
S One Howietoun, Bannockburn 14 Feb. Singles Gart GPs, Callander: 13 Apr, 9 Nov, 7 Dec (NB) 1 Torrie, Callander 27 Nov (DOE). 2 Argaty, BoD and 2 Kilbryde, BoD 28 Nov (DOE). 1 L Coulter 13 Dec (NB).

COMMON SNIPE *Gallinago gallinago* (B,W)
Inland WeBS: 151 in Jan, 197 in Feb, 176 in Mar, 17 in Sep, 62 in Oct, 208 in Nov and 165 in Dec.
F Winter/spring max: 39 Airth saltmarsh 18 Feb; 11 Darnrig Moss 12 Mar; 23 St Helen's Loch, Bonnybridge 17 Mar. Autumn/winter max: 20 Skinflats 26 Oct; 21 L Ellrig 14 Oct; 10 Airth saltmarsh 30 Dec.
C Max: 25 Blackdevon Wetlands 20 Jan; 88 and 103 R Devon, Tillicoultry-Alva 15 Feb and 16 Mar; 15 Cambus 23 Sep.
S Max: 28 R Forth, Stirling 12 Jan; 66 L Coulter 14 Jan; 104 Gart GPs, Callander and 21 Netherton Marsh, Lecropt Carse 9 Nov; 38 Hillhead Pond 2 Dec.

EURASIAN WOODCOCK *Scolopax rusticola* (B, W)
F Recorded from: Larbert (AB), Kinneil (DT), Darnrig Moss (RD), Slamannan (BCM).
C Recorded from: Forest Mill (MVB) and Solsgirth (RG).
S Max: 4 Kilbryde, BoD 28 Nov; 5 Torrie, Callander 27 Nov; 3 Argaty, BoD 28 Nov; 4 Lanrick, Doune 13 Dec (DOE). Also recorded from: Touch, Stirling; Dunblane; Sheriffmuir; Callander; Lake of Menteith.

BLACK-TAILED GODWIT *Limosa limosa* (W)
Forth Est WeBS: 345 in Jan, 27 in Feb, 249 in Mar, 580 in Sep, 651 in Oct, 554 in Nov and 353 in Dec.
F Winter/spring max: 360 Kinneil 5 Jan; 150 Airth 30 Jan. Autumn/winter max: 900 Kinneil 28 Sep; 195 Airth 13 Dec.
C Max: 140 Tullibody Inch 11 Mar; 95 Alloa Inch 5 Apr; 120 Cambus 24 Apr.
S One Killin marshes 5 Apr (JPH).
BAR-TAILED GODWIT *Limosa lapponica* (W)
Forth Est WeBS: 448 in Jan, 216 in Feb, 5 in Mar, 94 in Sep, 109 in Oct, 119 in Nov and 60 in Dec.
F Winter/spring max: 448 Kinneil 18 Jan; 50 Blackness 14 Feb. Autumn/winter max: 15 Blackness 28 Oct; 115 Kinneil 6 Nov.
C Six Tullibody Inch 11 Mar.
WHIMBREL *Numenius phaeopus* (p)
F Spring: 2 Skinflats 22 Apr (DOE); 1 Skinflats Tidal Exchange 30 Apr (DOE); 1 Kennet Pans 1 May (DMB); 1 Airth 16 May (ACC). Autumn: singles at Skinflats and Kinneil in Jul (RS, DMB, JB); max of 2 in Sep at Kinneil and Blackness (RS, DMB); last at Skinflats on 28 Sep.
C One Alloa Inch 17 Apr; 3 there 9 May (GG). 1 Kennet Pans 19 May (DMB). 7 Tullibody Inch 27 May (DMB).
S Singles Killin, L Tay 29 Apr and 19 May (JPH). 67 Cowie 4 May (DMB).
EURASIAN CURLEW *Numenius arquata* (B, W)
Inland WeBS: 75 in Jan, 132 in Feb, 167 in Mar, 194 in Sep, 1 in Oct, 58 in Nov and 141 in Dec.
Forth Est WeBS: 402 in Jan, 503 in Feb, 344 in Mar, 868 in Sep, 680 in Oct, 888 in Nov and 695 in Dec.
F Winter/spring max: 276 Skinflats 16 Feb. Autumn/winter max: 240 Kinneil 29 Jul; 200 Blackness 15 Oct; 451 Skinflats 9 Nov.
C Winter/spring max: 309 Tullibody Inch 12 Jan; 215 Kennet Pans 30 Jan; 220 Alloa Inch 8 Mar. Autumn/winter max: 185 Blackgrange 24 Sep; 150 Cambus 30 Nov; 162 Kennet Pans 16 Dec.
S Max: 128 Lecropt Carse 15 Mar; 180 Fallin 24 Sep.
COMMON SANDPIPER *Tringa hypoleucos* (B)
First of year: 2 Blairdrummond GPs (DOE) and 1 Dollar (KBf) 13 Apr. Last of year: 1 Carron Valley Resv 12 Oct (JS).-
F Max: 4 Kinneil 22 Jul; 5 Skinflats Tidal Exchange 13 Aug. Also recorded from Airth and Skinflats.
C Up to 2 recorded in summer at Cambus and Blackdevon Wetlands.
S Max: 6 L Tay 29 May. Also recorded from: Ashfield; Kinbuck; Blairdrummond GPs; Callander; BoD; L Venachar; G Finglas; Lake of Menteith; L Katrine; L Ard; G Dochart; G Lochay; Crianlarich.
*GREEN SANDPIPER *Tringa ochropus* (w, p)
F One Gilston, Polmont 1 Jan and 1 Feb (RS, GG). Skinflats: up to 2 recorded in Jul and Aug (RS, AB).
C Two Cambus 5 Jan (GG). 1 Longcarse, Alloa 6 Feb (NB). 1 Cambus 23 Apr (GG).
S One Blairdrummond GPs 27 Sep (DOE).
*SPOTTED REDSHANK *Tringa erythropus* (p)
F Kinneil: singles present Feb - Apr, Aug, and Oct - Dec (DMB, RS, AB, RS *et al*.). 1 Skinflats 26-27 Apr (AB).
GREENSHANK *Tringa nebularia* (w, p)
F Kinneil: up to 2 in Jan-Apr; up to 4 in Jul; up to 9 in Aug; up to 7 in Sep and Oct; up to 5 in Nov; up to 3 in Dec. Skinflats: singles in Jan-Mar; up to 2 in Jul; up to 4

in Aug; up to 2 in Sep; singles in Nov and Dec.
C Two Tullibody Inch 27 May. 1 S Alloa 15 Jul. Singles Cambus in Jul and Sep.
*WOOD SANDPIPER *Tringa glareola* (p)
F One Kinneil 9 Aug to 13 Sep, with 2 on 17 Aug and 7 Sep (CJP, RS, JRC *et al.*).
REDSHANK *Tringa totanus* (B, W)
Forth Est WeBS: 1148 in Jan, 938 in Feb, 1308 in Mar, 2032 in Sep, 2019 in Oct, 1858 in Nov and 2223 in Dec.
F Winter/spring max: 250 Blackness 14 Feb; 781 Kinneil and 527 Skinflats 16 Mar. Autumn/winter max: 1018 Kinneil and 1015 Skinflats 7 Dec; 150 Blackness 1 Oct.
C Max: 8 Cambus 23 Oct.
S Max: 20 Blairdrummond Moss 27 Apr. 4 Gart GPs, Callander 15 Jun.
TURNSTONE *Arenaria interpres* (W)
Forth Est WeBS: 4 in Jan, 4 in Feb, 0 in Mar, 0 in Sep, 13 in Oct, 4 in Nov and 3 in Dec.
F Max: 4 Grangemouth 18 Jan (MVB); 2 Blackness 13 Aug (DMB); 7 Kinneil 8 Oct (AR); 13 Carriden 11 Oct (JRC); 1 Skinflats 18 Dec (SP).
C 4 Kennet Pans 19 and 20 May (DMB).
*POMARINE SKUA *Stercorarius pomarinus* (p)
F Two Kinneil 25 Aug (DMB, DT).
*ARCTIC SKUA *Stercorarius parasiticus* (p)
F Kinneil: 1 on 24 Aug (CJP), 5 on 25 Aug (DMB), 7 on 6 Sep (AB), 1 on 7 Sep (JRC), 2 on 9 Sep (JB).
*GREAT SKUA *Stercorarius skua* (p)
F One Kinneil 6 Nov (JRC).
* KITTIWAKE *Rissa tridactyla* (P, w)
F Two Blackness 3 Jan (DOE). Kinneil: 1 on 15 Jan (JB); 3 on 18 Jan and singles on 16 Jan and 7 Sep (JRC). Singles S Alloa 30 Oct and 16 Dec (DMB).
BLACK-HEADED GULL *Larus ridibundus* (B,W)
Inland WeBS: 1929 in Jan, 1292 in Feb, 828 in Mar, 296 in Sep, 337 in Oct, 912 in Nov and 1445 in Dec.
Forth Est WeBS: 302 in Jan, 640 in Feb, 157 in Mar, 1558 in Sep, 279 in Oct, 488 in Nov and 385 in Dec.
F Max: 2500 Kinneil 18 Sep; 517 Skinflats 20 Nov.
C Breeding: 14 AON Alloa 18 Jun. Max: 1180 Alloa 23 Dec.
S Max: 450 Fallin 30 Jan; 1070 Blackdub 24 Feb; 300 Blairdrummond GPs 13 Nov.
*LITTLE GULL *Larus minutus* (p)
F Skinflats: 1 1-6 May, rising to 6 on 10th, then 3-4 until 25th, and singles on 27th and 8 Jun; and 1 on 17 Jul (DMB, RS, AB, CJP *et al.*). 1 Kinneil 31 Aug (CJP). 2 Blackness 6 Sep (DOE). Singles Kinneil 7 and 18 Sep. 1 Blackness 24 Sep (DOE).
*MEDITERRANEAN GULL *Larus melanocephalus* (w)
F One Blackness 6 and 9 Sep (DOE). 1 Kinneil 7 Sep (JRC). Skinflats: 1 2w bird on 14 Sep; 1 ad 20-24 Sep, 24 Oct and 30 Nov (AB, DOE). 1 ad Kinneil 18 Oct. 1 Blackness 3 Nov (JB).
COMMON GULL *Larus canus* (B,W)
Inland WeBS: 762 in Jan, 774 in Feb, 693 in Mar, 134 in Sep, 244 in Oct, 526 in Nov and 135 in Dec.
Forth Est WeBS: 50 in Jan, 274 in Feb, 108 in Mar, 158 in Sep, 197 in Oct, 104 in Nov and 119 in Dec.
F Max: 500 Skinflats 24 Oct; 252 L Ellrig 18 Nov.
C Max: 40 Gartmorn Dam 5 Mar; 30 Dollar 25 Dec.
S Max: 100 Blairdrummond GPs 20 Jan; 400 Blairlogie 26 Jan.
*RING-BILLED GULL *Larus delawarensis*
F Ad Kinneil 8 Sep (DT); returning bird since 2007.

LESSER BLACK-BACKED GULL *Larus fuscus* (b, S)
Inland WeBS: 42 in Jan, 75 in Feb, 141 in Mar, 295 in Sep, 614 in Oct, 265 in Nov and 206 in Dec.
Forth Est WeBS: 4 in Jan, 4 in Feb, 21 in Mar, 114 in Sep, 28 in Oct, 5 in Nov and 3 in Dec.
F Max: 61 Skinflats 13 Aug; 127 Gardrum Moss 4 Sep; 150 Kinneil 18 Sep.
C Max: 100 Gartmorn Dam 5 Mar; 60 Cambus 16 Nov.
S Max: 40 Argaty, BoD 24 May; 479 Gartartan, Aberfoyle 7 Oct; 160 Thornhill 5 Nov; 93 Lake of Menteith 2 Dec.
HERRING GULL *Larus argentatus* (b, W)
Inland WeBS: 177 in Jan, 667 in Feb, 86 in Mar, 42 in Sep, 56 in Oct, 66 in Nov and 519 in Dec.
Forth Est WeBS: 111 in Jan, 194 in Feb, 890 in Mar, 323 in Sep, 384 in Oct, 57 in Nov and 117 in Dec.
F Max: 200 Blackness 6 Sep; 300 Kinneil 18 Sep.
C Max: 20 Cambus 27 Apr.
S Max: 60 Fallin 19 Jan; 37 Lake of Menteith 3 Mar.
GREAT BLACK-BACKED GULL *Larus marinus* (S,W)
Inland WeBS: 1 in Jan, 4 in Feb, 6 in Mar, 2 in Sep, 10 in Oct, 2 in Nov and 3 in Dec.
Forth Est WeBS: 5 in Jan, 4 in Feb, 0 in Mar, 9 in Sep, 3 in Oct, 5 in Nov and 6 in Dec.
F Recorded in small numbers (1-2) from: Airth; Skinflats; Kinneil; Blackness.
C Max: 6 Alloa Inch 8 Mar.
S Recorded in small numbers (1-2) from: Lecropt Carse; Blairdrummond GPs; Gart GPs, Callander; Lake of Menteith; L Coulter.
*BLACK TERN *Chlidonias niger* (p)
F One imm Blackness (RS, DOE) and Kinneil 6 Sep (AB).
SANDWICH TERN *Sterna sandvicensis* (s, P)
F Max: 300 Blackness and 100 Skinflats Tidal Exchange 6 Sep (DOE). Last of year: 4 Blackness 28 Oct (JB).
COMMON TERN *Sterna hirundo* (S)
First of year: 1 Skinflats 2 May (AB). Last of year: 2 Blackness 24 Sep (DOE).
F Max: 20 Blackness 6 Sep; 21 Kinneil 7 Sep.
C Thirty-five Cambus 10 Aug.
S Two S Alloa 22 May.
*ROSEATE TERN
Two Blackness 6 Sep, with 1 there on 9th (DOE, DMB). 2 Kinneil 7 Sep (JRC).
*ARCTIC TERN *Sterna paradisaea* (s)
F Kinneil: 2 on 14 Aug; 1 on 25 Aug; 2 on 7 Sep; 1 on 14 Sep (RS, DMB, JRC, CJP). Blackness: 1 on 15 Aug; 1 on 26 Aug; 2 on 9 Sep (DMB).
*RAZORBILL *Alca torda* (s, w)
F One Blackness 19 Jan (DMB).
*GUILLEMOT *Uria aalge* (s, w)
F One Blackness 14 Feb (DOE).
FERAL PIGEON *Columba livia* (B,W)
BBS: recorded at 1.1 b/lkm (1997-2013 average: 1.1 b/lkm).
F Max: 930 Skinflats 7 Dec.
C Max: 109 Clackmannan 29 Oct; 100 Alva 16 Dec.
S Max: 50 Stirling 8 Mar.
STOCK DOVE *Columba oenas* (B, W)
F Max: 21 Kinneil 30 Jan; 80 Skinflats Tidal Exchange 12 May.
C Max: 10 Alloa Inch 17 Apr; 19 Cambus 18 Sep. Also recorded: Kennet Pans; Gartmorn Dam.
S Max: 65 Biggins Wood, Dunblane 6 Jan. Also recorded: BoA; Doune;

Blairdrummond GPs; Doune; Lake of Menteith.

WOODPIGEON *Columba palumbus* (B, W)
BBS: recorded at 2.9 b/lkm (1997-2013 average: 3.6 b/lkm).
F Max: 300 Larbert 15 Feb.
C Max: 56 Alloa 23 Dec; 92 Clackmannan 28 Dec.
S Max: 780 Dunblane 26 Feb; 200 Blairdrummond GPs 6 Dec.

COLLARED DOVE *Streptopelia decaocto* (B, W)
BBS: recorded at 0.1 b/lkm (1997-2013 average: 0.3 b/lkm).
Recorded throughout region. Max: 20 Skinflats 13 Nov; 15 Blairdrummond GPs 13 Dec.

COMMON CUCKOO *Cuculus canorus* (B)
First spring record: 1 Falkirk 19 Apr (BP) was within 6 year range (15 to 27 April).
F Singles recorded from: Polmont; Bo'ness; Kinneil; Skinflats; Darnrig Moss.
C One Hillfoot Hill 22 May.
S Max: 5 Tyndrum 27 May; 4 G Dochart 31 May. Also recorded: Sheriffmuir; Dumyat; L Venachar; Aberfoyle; Brig o' Turk; G Finglas; L Arklet; Killin; G Lochay; Crianlarich.

BARN OWL *Tyto alba* (b, w)
F Recorded from: Kinneil; Linlithgow; Falkirk; Bonnybridge; Larbert.
C Recorded from: Blackdevon Wetlands; Kennet.
S Recorded from: Cowie; Manor Powis, Stirling; Sheriffmuir; Doune.

TAWNY OWL *Strix aluco* (B, W)
F Recorded from: Airth; Skinflats; Carronshore; Falkirk.
S Recorded from: BoA; Dunblane; Blairdrummond; BoD; Doune; Thornhill; Killin.

*LONG-EARED OWL *Asio otus* (b, w)
F One pr and 2 Y near Bo'ness 21 May (TG). 1 Airth 28 Sep (DOE).
S One pr and 2 Y near Dunblane 16 Jun (BD, SR). One Cambusbarron 24 Jun (DD). One BoD 28 Nov (DOE).

SHORT-EARED OWL *Asio flammeus* (b, W)
F Two Kinneil 9 Nov (JB).
C One Gartmorn Dam 8 May (ABa). 1 Blackdevon Wetland 9 Nov (RG).
S Four territories Sheriffmuir (CSRSG). Also recorded from: L Arklet; Slymaback.

*NIGHTJAR
S One at confidential location in Trossachs (per DOE). 1 BoA 20 Sep (KT).

COMMON SWIFT *Apus apus* (B)
Recorded throughout region. BBS: recorded at 0.2 b/lkm (1997-2013 average: 0.5 b/lkm).
Spring arrival: 2 BoA 14 Apr (DMB) was earlier than 9 year range (24 April to 4 May). Last: 23 Aug (AE).
F Max: 45 Skinflats 10 May.
C Max: 30 Cambus 19 Jul.
S Max: 30 Callander 28 Jun; 50 BoA 23 Jul; 38 Dunblane 7 Aug.

KINGFISHER *Alcedo atthis* (b, w)
Inland WeBS: 3 in Jan, 3 in Feb, 6 in Mar, 14 in Sep, 15 in Oct, 12 in Nov and 7 in Dec.
F Recorded from: Skinflats Tidal Exchange; Kinneil; Larbert; Stenhousemuir; Falkirk.
C Recorded from: Dollar, Kennet Pans; Alva; Tillicoultry; Cambus.
S Recorded from: Fallin; Dunblane; Ashfield; Blairdrummond GPs; Doune; Gart GPs, Callander; Callander; Lake of Menteith; G Dochart; Killin; Tyndrum.

GREEN WOODPECKER *Picus viridis* (B, W)
C Recorded from Menstrie and Alva.
S Recorded from: Plean; North Third Resv; BoA; Sheriffmuir; Doune; BoD; L Venachar; Brig o' Turk; Strathyre; Lake of Menteith.

GREAT SPOTTED WOODPECKER *Dendrocopos major* (B, W)
Recorded throughout region.

SKYLARK *Alauda arvensis* (B, W)
BBS: recorded at 1.5 b/lkm (1997-2013 average: 1.7 b/lkm).
F Max: 100 Skinflats Tidal Exchange 28 Dec.
C Max: 19 Clackmannan 29 Oct.
S Max: 70 Lecropt 10 Jan.
SAND MARTIN *Riparia riparia* (B)
BBS: recorded at 0.6 b/lkm (1997-2013 average: 0.5 b/lkm).
First for year: 1 Skinflats 17 Mar (SP) was within 9 year range of 4 Mar to 11 Apr. Last: 1 Sheriffmuir 19 Sep (ACC).
F Max: 70 Skinflats 25 Apr.
C Max: 50 Alva 31 Mar.
S Breeding: 880 AON Cowie 4 May (DMB); 82 AON Lecropt 1 Jun (CJH); 20 AON Kinbuck 26 Apr (CJP). Max: 350 Lake of Menteith 2 May; 1000 L Tay 7 May.
SWALLOW *Hirundo rustica* (B)
BBS: recorded at 1.6 b/lkm (1997-2013 average: 2.4 b/lkm).
First for year: 1 Cambus 5 Apr (DH) was late in 9 year range of 6 Mar to 13 Apr. Last: 2 Lake of Menteith 7 Oct (NB).
F Max: 150 Skinflats 25 Apr; 200 S Alloa 27 Aug; 90 Larbert 4 Sep.
C Max: 330 Alloa and 100 Cambus 18 Sep; 100 Gartmorn Dam 20 Sep.
S Max: 85 Lake of Menteith 25 Apr; 100 Blairdrummond GPs 14 Sep; 500 Pendreich Resv, BoA 11 Sep
HOUSE MARTIN *Delichon urbica* (B)
BBS: recorded at 0.7 b/lkm (1997-2013 average: 0.8 b/lkm).
First of year: 1 Blairdrummond GPs 13 Apr (DOE) was late in 9 year range of 6-16 Apr. Last: 2 Doune 27 Sep (DOE).
C Max: 50 Gartmorn Dam 20 Sep.
S Max: 45 Blairdrummond GPs 4 May.
TREE PIPIT *Anthus trivialis* (B)
First of year: 1 Lanrick, Doune 17 Apr (DOE) was within the 9 year range of 12-27 Apr.
F One Larbert Pond 22 Aug (AB). 1 Kinneil 31 Aug (CJP).
C Singles Menstrie Glen 1 Jun and 1 Jul (RDG, JB).
S Max: 20 AOT Tyndrum 27 May (DMB). Also recorded from: Blairdrummond GPs; Dunblane; BoD; Doune; Callander; Kilmahog; Brig o' Turk; Flanders Moss; Lake of Menteith; Aberfoyle; L Achray; Balquhidder Glen; G Lochay; G Dochart.
MEADOW PIPIT *Anthus pratensis* (B, W)
BBS: recorded at 7.0 b/lkm (1997-2013 average: 4.5 b/lkm).
Recorded throughout region. Max: 100 Killin 29 Mar.
*ROCK PIPIT *Anthus petrosus* (w)
F One Kinneil 2 Apr (JB). Blackness: 1 on 30 Sep; 2 on 9 Oct; 1 on 9 Oct (JB). Singles Airth 13 and 30 Dec (DMB, DOE). 1 Skinflats 18 Dec (SP).
C Longcarse, Alloa: 1 on 18 Oct; 2 on 8 Nov; singles in Dec on 5th, 14th and 29th (GG, NB).
GREY WAGTAIL *Motacilla cinerea* (B, w)
Recorded in small numbers in suitable habitat throughout region.
Inland WeBS: 5 in Jan, 3 in Feb, 29 in Mar, 27 in Sep, 11 in Oct, 9 in Nov and 10 in Dec.
F Max: 8 R Carron, Larbert 11 Oct.
PIED WAGTAIL *Motacilla alba yarrellii* (B, w)
BBS: recorded at 0.4 b/lkm (1997-2013 average: 0.4 b/lkm).
F Max: 35 Darnrig Moss 20 Jan. White wagtail *M.a.alba*: 2 at Skinflats on 21-22 Apr and 5 May (AB, DOE).
C Max: 8 Cambus 11 Aug.
S Max: 110 at Stirling train station roost 3 Feb and 80 at Stirling M9 services 26 Nov

(DOE); 70 Killin 20 Sep (JPH).

*WAXWING *Bombycilla garrulus* (w)

F Six Laurieston 31 Jan (JF).

S Nine Doune 15 Mar. 1 Lochearnhead 9-13 Nov (PG).

DIPPER *Cinclus cinclus* (B, W)

Recorded in small numbers in suitable habitat throughout region.

Inland WeBS: 38 in Jan, 53 in Feb, 34 in Mar, 33 in Sep, 45 in Oct, 37 in Nov and 27 in Dec.

F Max: 10 R Carron, Larbert 9 Nov.

C Max: 25 R Devon, Tillicoultry Feb.

WREN *Troglodytes troglodytes* (B, W)

Widespread and common. BBS: recorded at 1.7 b/lkm (1997-2013 average: 1.9 b/lkm).

C Max: 18 Gartmorn Dam 8 May.

S Max: 22 L Venachar 4 Jun.

DUNNOCK *Prunella modularis* (B, W)

Widespread and common. BBS: recorded at 0.3 b/lkm (1997-2013 average: 0.5 b/lkm).

ROBIN *Erithacus rubecula* (B,W)

Widespread and common. BBS: recorded at 1.4 b/lkm (1997-2013 average: 1.2 b/lkm).

F Max: 10 Skinflats 28 Sep.

C Max: 12 Longcarse, Alloa 18 Oct.

S Max: 15 L Ard 5 May; 12 Blairdrummond GPs 28 Sep; 12 Holmehill, Dunblane 12 Oct.

REDSTART *Phoenicurus phoenicurus* (B)

First of year: 1 Lanrick, Doune 17 Apr (DOE) was within 9 year range of 12 to 27 Apr. Last: 1 BoA 15 Sep (JB).

F Singles Skinflats 15 Jul and 7 Sep (AB).

S Max: 8 AOT Kilmahog and 6 Bracklinn, Callander 24 May; 7 AOT Tyndrum 27 May. Also recorded from: Cowie; Sheriffmuir; BoD; Doune; Blairdrummond GPs; Flanders Moss; Brig o' Turk; Lake of Menteith; L Katrine; Killin; G Dochart; G Lochay; Crianlarich.

WHINCHAT *Saxicola rubetra* (B)

First spring record of 2 Gleann Meann 30 Apr (NW) was within 9 year range of 24 April to 2 May.

F Four Slamannan 23 Jun 23 Jun; 1 juv Airth 31 Jul; 1 Skinflats 20 Sep.

C Singles Menstrie Glen 1 Jun and 1 Jul; Two juv Tullibody Inch 20 Aug.

S Max: 11 Sheriffmuir 21 Jun. Also recorded from: Sheriffmuir; BoD; Doune; Callander; G Finglas; G Dochart; G Lochay.

STONECHAT *Saxicola torquata* (b, w)

This species is still recovering from the cold winters of 2009 and 2010, with an increase of records in 2014.

F One juv Skinflats Tidal Exchange 17 Jul; 5 Skinflats 20 Sep; 1 Darnrig Moss 20 Nov; 1 Kinneil 24 Nov.

C Two Blackdevon Wetlands 26 Apr; 1 Menstrie Glen 1 Jun; 1 Cambus 18 Sep.

S Breeding: 1 pair Waltersmuir Resv, Dunblane; 3 families Sheriffmuir Aug; 1 family Kilmahog 2 Sep. Also recorded (up to 4) from: L Coulter; BoD; Callander; Flanders Moss; Menteith Hills; L Katrine; Kirkton, Crianlarich.

WHEATEAR *Oenanthe oenanthe* (B)

BBS: recorded at 0.3 b/lkm (1997-2013 average: 0.2 b/lkm).

First of year: 1 Ochils 31 Mar (KJD) was within previous 9 year range of 21 Mar to 8 Apr. Last: 1 Airth 8 Oct (ACC).

F Max: 6 Slamannan 18 Apr; 5 Skinflats 27 Apr.

C Three Ben Ever, Alva 20 Apr.

S Max: 6 Flanders Moss 27 Apr; 8 Sheriffmuir 27 May.

*RING OUZEL *Turdus torquatus* (b)
S One Creag Gharbh 1 Apr (JGD). 1 Cruach Ardrain, Crianlarich 1 Jun (JGR). 2 The Stob, Balquhidder Glen 14 Jun (DHi). 2 Inverlochlarig 27 Jun (DOE). 1 Monachyle, Balquhidder Glen 11 Jul (DOE).

BLACKBIRD *Turdus merula* (B, W)
Widespread and common. BBS: recorded at 1.4 b/lkm (1997-2013 average: 2.3 b/lkm).
F Max: 25 Skinflats 8 Jan.
C Max: 15 Gartmorn Dam 8 May; 14 Alva woodland park 26 May; 15 Alloa Inch 2 Nov; 15 Cambus 16 Nov.
S Max: 25 Airthrey Loch, BoA 8 Jan; 39 Kinlochard 12 Jan; 21 Holmehill, Dunblane 13 Dec.

FIELDFARE *Turdus pilaris* (W)
Last spring record of 2 Drumloist, BoD 14 Apr (DOE) was within 9 year range: 25 Mar to 14 May.
First autumn record of 3 Skinflats 17 Oct (DMB) was towards end of 9 year range: 3 Sep to 22 Oct.
F Max: 300 Skinflats Tidal Exchange 2 Nov.
C Max: 101 Gartmorn Dam 4 Dec; 90 Cambus 5 Dec.
S Max: 225 Lake of Menteith 20 Jan; 140 Stockbridge, Dunblane 7 Dec.

SONG THRUSH *Turdus philomelos* (B, W)
Widespread. BBS: recorded at 0.4 b/lkm (1997-2013 average: 0.5 b/lkm).
F Max: 13 Skinflats 28 Sep; 15 Larbert Pond 7 Oct.
S Max: 10 Doune 18 Sep; 10 Blairdrummond GPs 28 Sep.

REDWING *Turdus iliacus* (W)
Last spring record of 15 Alva 6 Apr (RE) was within the previous 9 year range: 7 Mar to 1 May.
First autumn record of 9 Airthrey, BoA 9 Oct (JB) was within the previous 9 year range: 27 Sep to 12 Oct.
F Max: 150 Skinflats 2 Nov.
C Max: 40 Gartmorn Dam 4 Feb; 41 Cambus 3 Nov.
S Max: 110 Lake of Menteith 20 Jan; 60 Airthrey, BoA 22 Jan; 60 Lanrick, Doune 9 Nov.

MISTLE THRUSH *Turdus viscivorus* (B, W)
Widespread. BBS: recorded at 0.2 b/lkm (1997-2013 average: 0.2 b/lkm).
F Max: 15 Larbert Pond 7 Oct.
S Max: 25 G Dochart 7 Sep; 28 Arnprior 11 Aug; 30 Lanrick, Doune 9 Oct.

GRASSHOPPER WARBLER *Locustella naevia* (b)
First spring record of 1 Skinflats 20 Apr (GR) was within 9 year range of 17 to 27 Apr.
F Singles Skinflats 20 Apr, 3 May and 9 May.
C One Alloa Inch 9 May.
S Recorded from: Flanders Moss; L Venachar; Brig o' Turk; Lake of Menteith; G Dochart; Tyndrum.

SEDGE WARBLER *Acrocephalus schoenobaenus* (B)
First of year: 1 Skinflats 22 Apr (DOE) was in early part of 9 year range of 21-31 Apr. Last: 1 Skinflats 15 Sep (DOE).
F Max: 9 singing M Skinflats 12 May.
C Max: 3 Alloa Inch 9 May; 3 Alva 8 Jun; 3 Cambus 3 Jul.
S Max: 3 Blairdrummond GPs 12 May; 4 L Venachar 4 Jun.

*REED WARBLER *Acrocephalus scirpaceus*
Breeding of the species in the Upper Forth area was first confirmed in 2011.
F Skinflats: singles 10 May, 22 Jun and 28 Jun; 2 on 31 Jul; 3 on 23 Aug (GG, AB, RS, DOW). 1 Kinneil 15 Jul (RS).
C Alloa Inch max: 3 singing M 29 Jun (GG).

EURASIAN BLACKCAP *Sylvia atricapilla* (B)
First spring record: 1 Dunblane 2 Apr (CJP) was within 9 year range of 23 Mar to 13 Apr.
F Max: 6 Skinflats 20 Apr. Winter: 1 Skinflats 9 Nov.
C Max: 5 Gartmorn Dam 8 May. Winter: 1 Cambus 10 Nov.
S Max: 5 Holmehill, Dunblane 18 Apr; 5 Blairdrummond GPs 11 May; 5 Kilbryde, BoD 31 May.
GARDEN WARBLER *Sylvia borin* (B)
Recorded throughout region in small numbers.
First spring record of 1 Dunblane 24 Apr (DMB) was within 9 year range of 15 Apr to 2 May.
C Max: 3 Gartmorn Dam 8 May.
S Max: 3 L Venachar 13 May.
COMMON WHITETHROAT *Sylvia communis* (B)
BBS: recorded at 0.2 b/lkm (1997-2013 average: 0.2 b/lkm).
First of year: 2 Kinneil 25 Apr (DMB) was within 9 year range: of 9 Apr to 2 May. Last:1 Skinflats 6 Sep (DOE).
F Max: 7 Kinneil 10 May; 5 Skinflats 23 Aug.
C Max: 5 Gartmorn Dam 8 May; 6 Alva 8 Jun.
S Max: 5 Blairdrummond GPs 11 May; 5 Hill of Row, Dunblane 31 May.
WOOD WARBLER *Phylloscopus sibilatrix* (B)
First spring record of 1 Lake of Menteith 19 Apr was within the previous 9 year range: 17 Apr to 5 May.
S Also recorded from: Dunblane; BoD; Callander; Brig o' Turk; Aberfoyle; Kilmahog; Aberfoyle; Killin; G Dochart; G Lochay; Crianlarich.
CHIFFCHAFF *Phylloscopus collybita* (B)
First spring record of 1 singing Larbert Pond 11 Mar (CJP) was at start of 9 year range of 11 to 31 Mar.
F Max: 10 Bo'ness – Kinneil 5 May.
S Max: 6 Holmehill, Dunblane 18 Apr.
WILLOW WARBLER *Phylloscopus trochilus* (B)
BBS: recorded at 1.9 b/lkm (1997-2013 average: 1.7 b/lkm). First of year: singles Falkirk (RS), Skinflats (AE) and L Katrine (FAM) 5 Apr were at start of 9 year range of 3-18 Apr. Last: 1 Gartmorn Dam 28 Oct (RE).
C Max: 26 Gartmorn Dam 8 May.
S Max: 60 Tyndrum 27 May; 30 L Venachar 4 Jun.
GOLDCREST *Regulus regulus* (B, W)
Widespread. BBS: recorded at 0.4 b/lkm (1997-2013 average: 0.5 b/lkm).
S Max: 10 Blairdrummond GPs 1 Jan; 12 Lanrick, Doune 26 Oct.
SPOTTED FLYCATCHER *Muscicapa striata* (B)
First of year: 1 Killin 17 May (JPH) was within 9 year range: 2 to 20 May.
F Breeding: 1 ad and 2 Y Larbert Pond 22 Aug. 2 Skinflats Tidal Exchange 23 Aug.
C Max: 1 Tillicoultry 3 Sep.
S Recorded from: Blairdrummond GPs; Dunblane; Sheriffmuir; BoD; Doune; Callander; G Finglas; Lake of Menteith; Aberfoyle; L Katrine; Killin; G Lochay; G Dochart; Crianlarich; Tyndrum.
*PIED FLYCATCHER *Ficedula hypoleuca* (b)
S One L Katrine 1 Jul (ACC).
*BEARDED TIT
C One pair bred at a confidential location, for second consecutive year, with at least 2 juv recorded (JRC, DMB).
LONG-TAILED TIT *Aegithalos caudatus* (B, W)
Widespread. BBS: recorded at 0.1 b/lkm (1997-2013 average: 0.2 b/lkm).

F Max: 14 Stenhousemuir 5 Jan.
C Max: 18 Alva 17 Jan.
S Max: 12 Blairdrummond GPs 11 Jan; 13 Lake of Menteith 7 Feb; 12 Holmehill, Dunblane 13 Dec.

BLUE TIT *Cyanistes caeruleus* (B, W)
Widespread. BBS: recorded at 1.1 b/lkm (1997-2013 average: 1.7 b/lkm).
C Max: 14 Alva 12 Feb.
S Max: 24 Holmehill, Dunblane 23 Nov.

GREAT TIT *Parus major* (B, W)
Widespread. BBS: recorded at 0.9 b/lkm (1997-2013 average: 0.9 b/lkm).
C Max: 12 Gartmorn Dam 4 Feb.
S Max: 20 Holmehill, Dunblane 11 Jan.

COAL TIT *Periparus ater* (B, W)
Widespread. BBS: recorded at 0.4 b/lkm (1997-2013 average: 0.5 b/lkm).
S Max: 12 Blairdrummond GPs 20 Sep.

NUTHATCH *Sitta europaea*
After the first record in 1999 and first breeding recorded in 2009, the species is spreading particularly in Stirlingshire.
F Recorded at Larbert Pond.
S Recorded at: BoA (Hermitage Wood, Mine Wood, Abbey Craig); Dunblane (Holmehill, Ochlochy, Darn Walk); BoD (Argaty); Blairdrummond GPs; Doune; Callander; Pass of Leny; Brig o'Turk; Lake of Menteith; Aberfoyle; Kinlochard.

TREECREEPER *Certhia familiaris* (B, W)
Widespread in small numbers.

JAY *Garrulus glandarius* (B, W)
Widespread in small numbers.
F Max: 5 Skinflats 17 Oct.
S Max: 5 Lanrick, Doune 9 Nov.

MAGPIE *Pica pica* (B, W)
Widespread in Falkirk and Clackmannan districts and Stirling area.
BBS: recorded at 0.4 b/lkm (1997-2013 average: 0.5 b/lkm).
F Max: 28 Larbert pond 26 Feb; 40 Bo'ness 5 May.
C Max: 14 Alva 5 Jan.
S Max: 19 Dunblane 29 Jan.

JACKDAW *Corvus monedula* (B, W)
BBS: recorded at 2.4 b/lkm (1997-2013 average: 2.5 b/lkm).
F Max: 225 Carronshore 22 Jul; 60 Kinneil 15 Sep.
C Max: 55 Clackmannan 29 Oct.
S Max: 400 Doune 26 Oct; 170 BoA 12 Dec; 250 Blairdrummond GPs 13 Dec; 500 Argaty, BoD 19 Dec.

ROOK *Corvus frugilegus* (B, W)
BBS: recorded at 1.7 b/lkm (1997-2013 average: 3.7 b/lkm).
F Breeding: 25 nests Larbert Pond 12 Mar. Max: 150 Falkirk 8 Feb; 150 Kinneil Ponds 3 Aug.
C Max: 81 Alloa 8 Apr.
S Breeding: 301 nests Dunblane in Apr, up 6 compared to 2013 and up 31 compared to 2012 (MVB). Max: 330 Fallin 3 Jul; 200 Blairdrummond GPs 6 Dec.

CARRION CROW *Corvus corone* (B, W)
BBS: recorded at 2.0 b/lkm (1997-2013 average: 3.4 b/lkm).
F Max: 49 Kinneil 11 Oct; 61 Stenhousemuir 12 Oct.
C Max: 40 Alva 2 Mar.
S Max: 23 Lake of Menteith 3 Jan; 30 Drip Moss 19 Apr; 32 Dykedale, Dunblane 26 Sep.

HOODED CROW *Corvus cornix* (b, w)
S Widespread in northwestern part of region. Max: 35 Stob Coire an Lochain 24 Aug.
RAVEN *Corvus corax* (B, W)
F Recorded in small numbers (max 4) from: Airth; Skinflats; Kinneil; Polmont; Slamannan.
C Recorded in small numbers (max 4) from: Ochils; Menstrie; Dollar; Gartmorn Dam; Alloa Inch; Kennet Pans.
S Recorded in small numbers throughout. Max: 18 Aberfoyle 20 Aug; 16 Strathyre 1 Oct; 12 L Mahaick, BoD 13 Nov.
STARLING *Sturnus vulgaris* (B, W)
BBS: recorded at 3.9 b/lkm (1997-2013 average: 5.3 b/lkm).
F Max: 300 Skinflats 30 Aug.
C Max: 500 Tullibody Inch roost 30 Nov.
S Max: 400 Drip Moss 2 Feb; 100 L Mahaick, BoD 4 Feb.
*ROSE-COLOURED STARLING
F One visiting a feeder and photographed in a Bo'ness garden 15 Jun (AMcK).
HOUSE SPARROW *Passer domesticus* (B, W)
BBS: recorded at 1.4 b/lkm (1997-2013 average: 1.8 b/lkm).
F Max: 40 Skinflats 6 Sep.
C Max: 40 Clackmannan 29 Oct.
S Max: 40 Frew 2 Feb; 40 Dunblane 9 Mar.
TREE SPARROW *Passer montanus* (B, W)
F Max: 15 Airth 28 Sep; 36 Skinflats and 30 Skinflats Tidal Exchange 7 Dec.
C Max: 15 Alva 17 Jan; 30 Tullibody Inch 20 Aug.
S Max: 10 Ashfield 5 Jan; 10 Keir, Dunblane 1 Feb; 10 Biggins, Dunblane 27 Apr; 10 Killearn 29 Jul; 45 Drip Moss 12 Sep; 23 Kippenross, Dunblane 30 Oct; 14 Greenyards, Dunblane 20 Nov; 25 Lecropt Carse 6 Dec.
CHAFFINCH *Fringilla coelebs* (B, W)
BBS: recorded at 2.9 b/lkm (1997-2013 average: 4.0 b/lkm).
C Max: 40 Gartmorn Dam 12 Jan.
F Max: 100 Kinneil 1 Nov.
S Max: 750 Landrick, Dunblane 24 Jan; 240 Greenyards, Dunblane 1 Feb; 280 Dykedale, Dunblane 29 Nov.
BRAMBLING *Fringilla montifringilla* (W)
F Max: 14 Kinneil 1 Nov.
S Max: 8 Laighhills 22 Mar; 5 Blaquhidder Glen and 5 L Voil 25 Nov.
GREENFINCH *Carduelis chloris* (B, W)
Widespread. BBS: recorded at 0.1 b/lkm (1997-2013 average: 0.6 b/lkm).
S Max: 160 Dykedale, Dunblane 16 Dec.
GOLDFINCH *Carduelis carduelis* (B, W)
BBS: recorded at 0.4 b/lkm (1997-2013 average: 0.5 b/lkm).
F Max: 85 Skinflats Tidal Exchange 23 Aug; 40 Bo'ness 8 Sep.
C Max: 40 Gartmorn Dam 25 Jan; 30 Cambus 31 Aug.
S Max: 40 Argaty, BoD 22 Jan; 40 Essmitchell, BoD 17 Oct; 45 Balquhidder Station 31 Oct.
SISKIN *Carduelis spinus* (B, W)
BBS: recorded at 0.3 b/lkm (1997-2013 average: 0.3 b/lkm).
F Max: 40 Falkirk 26 Dec.
C Max: 180 Gartmorn Dam 4 Dec; 50 Dollar 13 Dec.
S Max: 100 Eas Gobhain, Callander 25 Nov; 40 Craigforth, Stirling 15 Nov.
LINNET *Carduelis cannabina* (B, W)
F Max: 150 Skinflats Tidal Exchange 9 Jan.

S Max: 214 Drip Moss 11 Oct; 750 Greenyards, Dunblane 20 Nov.

TWITE *Carduelis flavirostris* (b, W)

F Max: 110 Skinflats Tidal Exchange 2 Nov; 70 Airth 9 Nov; 60 Skinflats 24 Dec.

S Fifteen 60 Kinneil 21 Feb ; G Gyle 15 Mar (DOE). 4 Duncroisk, G Lochay 27 Apr (JPH).

LESSER REDPOLL *Acanthis cabaret* (b, W)

F Max: 12 Darnrig Moss 20 Nov.

C Max: 16 Gartmorn Dam 9 Nov.

S Max: 14 Lake of Menteith 19 Jan; 30 Killin 23 Mar.

COMMON CROSSBILL *Loxia curvirostra* (b, W)

F Two Torwood 19 Sep.

C Three Gartmorn Dam 16 Apr.

S Max: 14 Sheriffmuir 16 Nov; 100 Aberfoyle 28 Nov; 20 Strathyre 7 Dec.

*COMMON ROSEFINCH

S One Crianlarich area 23 Jun (JPH).

BULLFINCH *Pyrrhula pyrrhula* (B, W)

F Max: 9 L Ellrig 18 Nov.

C Max: 10 Gartmorn Dam 4 Feb.

S Max: 18 Tyndrum 14 Jan; 18 Dykedale, Dunblane 29 Nov.

*SNOW BUNTING *Plectrophenax nivalis* (W)

C One F The Nebit, Alva 12 Jan (GG). 50 Ben Cleuch 16 Feb with 20 there 18th (JGR, MCB).

S 2 G Gyle 15 Mar (DOE).

YELLOWHAMMER *Emberiza citrinella* (B, W)

BBS: recorded at 0.5 b/lkm (1997-2013 average: 0.5 b/lkm).

F Max: 35 Skinflats Tidal Exchange 9 Jan; 37 Skinflats 7 Dec.

C Max: 70 Tullibody Inch 12 Jan; 38 Jellyholm, Alloa 23 Dec.

S Max: 46 Greenyards, Dunblane and 40 Ashfield 4 Feb; 65 Lecropt Carse 6 Dec.

REED BUNTING *Emberiza schoeniclus* (B, W)

BBS: recorded at 0.2 b/lkm (2004-2013 average: 0.2 b/lkm).

F Max: 30 Skinflats Tidal Exchange 9 Jan; 26 Skinflats 7 Dec.

C Max: 15 Tullibody Inch 12 Jan; 14 Gartmorn Dam 4 Feb; 10 Alloa Inch 18 Oct; 19 Jellyholm, Alloa 23 Dec.

S Max: 10 Thornhill 2 Feb; 13 Blairdrummond GPs 13 Dec.

ESCAPED SPECIES

MANDARIN DUCK

S One Callander Meadows 13 Oct to year-end (APD, EJM, NB *et al*.).

CHECK LIST OF THE BIRDS OF THE UPPER FORTH SCOTTISH ORNITHOLOGISTS' CLUB REPORTING AREA (UFBRA)

N. Bielby and C.J. Pendlebury

The following is an update on the original 'Check List of the Birds of Central Scotland' by C.J. Henty and W.R. Brackenridge which was published in volume 15 of this journal (1992). The original Check List covered what was the administrative area of Central Region and which is currently occupied by the administrative Councils of Clackmannanshire, Falkirk and Stirling. However, in order to tie in with the annual bird reports (which have been published in this Journal since their inception in 1974) the area covered by this update is that of the Scottish Ornithologists' Clubs (SOC) 'Upper Forth Bird Recording Area' which differs from the Central Region in that it excludes that area of Stirling District which drains into the Clyde basin. The Forth estuary is referred to as the 'estuary'. The additional information in this update has been sourced from the above mentioned bird reports up to and including 2013. Information prior to the start of 'modern' bird recording in 1974 is patchy and scattered through various publications, most of which are out of print and difficult of access. The original authors researched these, most notably Rintoul and Baxter's *Vertebrate Fauna of Forth* (1935). However, further records may surface from these, either by research or chance, and if so, the authors would like to hear of them along with any other, more recent records. For some vagrant species reference has been made to *The Birds of Scotland* (Forrester, Andrews *et al*. 2007) for further information. We hope that there are no significant omissions or mistakes and all judgements and errors are the responsibility of the authors.

As in the initial Check List, emphasis is placed on breeding distribution except when a species is common at other seasons and rarely breeds. The occasional non-breeding appearances of a species outwith its main seasons are ignored.

The definitions used in the Check List following each species name are as follows:

For annual numbers of birds (or pairs in terms of breeding species)[1]:

rare[2]	1 to 10
scarce	11 to 100
fairly common	101 to 1000
common	1001 to 5000
very common	5001+

For distribution[3]:

local, locally	occurs in up to 10 % of 10 km^2
thinly	from 11 % to 50 % of 10 km^2
widespread	in more than 50 % of 10 km^2

For temporal status:

resident	breeding and recording throughout the year but winter and summer populations do not necessarily consist of the same individuals
summer visitor	breeding annually but not present in winter
winter visitor	present only outside the breeding season
migrant	recorded on passage through the area
vagrant[4]	does not normally occur
irregular[5]	less than annually
visitor	occurs at any time of the year but does not breed

Clarifications to the above:

[1]: Allocation to categories is based on the knowledge of the authors.
[2]: Assumed to be 'local' unless stated otherwise.
[3]: Based on results from comprehensive work carried out for the 2007 – 2011 BTO Atlas.
[4]: Number of records indicated if 10 or less. Details of last record shown. Assumed to be 'rare' numerically and local in distribution.
[5]: Last five years. Details of last record shown. Assumed to be 'rare' numerically unless stated otherwise.

As in the original, this list is intended as a brief, handy guide. Comments have been mainly kept to a single line and only give broad features of occurrence and many important details of local or seasonal distribution or yearly differences have had to be omitted. More detailed notes on the present status of local birds can be found in the annual aforementioned bird reports. Additionally, comprehensive information about the avifauna of Clackmannanshire can be obtained from the recently published *The Birds of Clackmannanshire* (Bielby *et al*. 2013) n.bielby@sky.com . The status of the birds of the Upper Forth is constantly changing (already several known records for 2104/2015 would update this list but as these have yet to be verified by the bird reporting process they haven't been added) and information on them is always welcome. Details of how to submit this can be obtained either from the current recorder C.J. Pendlebury chris@upperforthbirds.co.uk or on the SOC website www.the-soc.org.uk The species are ordered as per the latest instructions from the British Ornithologist's Union (BOU) who maintain the British List. Species names are their English vernacular ones.

Check List of the Birds of the Upper Forth

Species on the Scottish List (categories A-C)

Mute Swan	Scarce, widespread resident. Fairly common & widespread in winter.
Bewick's Swan	Vagrant. Nine records: last Blackgrange 02/11/2003.
Whooper Swan	Scarce, widespread winter visitor.
Bean Goose	Fairly common, local winter visitor. to Slamannan Plateau. 'Taiga' race birds.
Pink-footed Goose	Very common, thinly distributed winter visitor and migrant.

White-fronted Goose	Irregular winter visitor. Mostly 'Greenland' race birds.
Lesser White-fronted Goose	Vagrant. Only record: one Cambus 20/01/1960
Greylag Goose	Fairly common local resident. Numbers augmented in winter by visitors from Iceland when common and widespread. Local population increasing steadily.
Snow Goose	Vagrant / escapes. Last adjudged 'wild' bird Alva 29/12/2011.
Canada Goose	Fairly common, widespread resident & migrant. Population increasing rapidly.
Lesser Canada Goose	Vagrant / escapes. First Carse of Lecropt 22/02/2000 (subject to BBRC acceptance). Last Doune area 29/01/2012.'
Barnacle Goose	Scarce, local migrant and winter visitor. Small number of local and passage feral birds can cause confusion.
Brent Goose	Irregular winter visitor. Last Cambusmore GP 26/10/2013.
Red-breasted Goose	Vagrant. Only record: one Haugh of Blackgrange 03/02/2007-15/04/2007.
Egyptian Goose	Irregular visitor/escape. Two records (multiple records between Jan 2003 - Sep 2006 are thought to refer to same bird/birds) Last two Kinneil 23/08/2011.
Shelduck	Scarce local resident. Common on estuary.
Mandarin Duck	Irregular visitor. Confusion caused by occasionally released birds. Nine records. Last Blairdrummond GPs 01/08/2011.
Wigeon	Rare resident. Common & widespread winter visitor.
American Wigeon	Vagrant. Two records: last Kinneil 25/04/1998.
Gadwall	Scarce migrant & summer visitor. Occasional breeder.
Teal	Scarce local resident. Common & widespread in winter.
Green-winged Teal	Vagrant. Nine records but thought to involve only 2-3 individuals; last Kinneil 31/12/2012.
Mallard	Common, widespread resident and winter visitor. Supported by releases.
Pintail	Scarce & local winter visitor to estuary. Rare inland.
Garganey	Rare summer migrant.
Shoveler	Rare visitor and passage migrant.
Red-crested Pochard	Vagrant / escape. Only record: one Gartmorn Dam 10/01/1988
Pochard	Scarce, thinly distributed, winter visitor.
Ferruginous Duck	Vagrant. Two records: 1st one Cambusmore GP 24/09/2005; 2nd one Skinflats 25/07/2009.
Tufted Duck	Scarce, thinly spread resident. Fairly common and widespread in winter.
Scaup	Scarce visitor to estuary, irregular inland.
Lesser Scaup	Vagrant. Five records: 1st one Cambusmore GP 19/06/2004, last one Blairdrummond Ponds 18/04/2009.
Eider	Scarce visitor to estuary.
Long-tailed Duck	Irregular winter visitor. Last record: one Lake of Menteith 18/11/2013.
Common Scoter	Irregular and scarce visitor to estuary, vagrant inland.
Velvet Scoter	Vagrant. Four records: last 26/11/2006.
Barrow's Goldeneye	Vagrant. One record: and R. Teith Callander 19/11/2006 - 27/04/2007. (1st for area & 3rd for Britain)
Goldeneye	Fairly common, widespread winter visitor.
Smew	Irregular, winter visitor. Last record: one Blairdrummond Ponds 31/12/2013.

Red-breasted Merganser	Rare resident. Scarce on estuary in winter.
Goosander	Scarce, local resident. Fairly common and widespread in winter.
Ruddy Duck	Irregular visitor. Last Lake of Menteith 12/01/2013. Has bred. Virtually eradicated in the UK by an official cull.
Quail	Rare summer visitor, probably has bred.
Red-legged Partridge	Fairly common, local resident. Heavily supported by releases with small feral population not thought to be self-sustaining.
Red Grouse	Fairly common, widespread resident
Ptarmigan	Scarce, thinly spread resident.
Black Grouse	Fairly common, thinly spread resident.
Capercaille	Irregular resident. Last one Trossachs April 2011. Now probably extinct locally.
Grey Partridge	Scarce, thinly spread resident.
Pheasant	Common, widespread resident. Heavily supported by releases. Includes a small, self-sustaining feral population.
Red-throated Diver	Rare resident.
Black-throated Diver	Rare summer visitor. Irregular in winter.
Great Northern Diver	Irregular winter visitor. Nine records: last Kinneil 15/12/2013.
Fulmar	Rare visitor, mainly to estuary.
Manx Shearwater	Irregular autumn migrant to estuary. Last Kinneil 12/10/2012.
Storm Petrel	Vagrant. Last record 1946.
Leach's Petrel	Vagrant. Six records: last 1979.
Gannet	Scarce, occasionally fairly common, migrant mainly to estuary.
Cormorant	Fairly common, widespread visitor.
Shag	Irregular winter visitor to estuary. Last record Blackness 14/10/2013.
Bittern	Vagrant. 1st Skinflats Pools 31/01/1997, 2nd Skinflats Pools 10/03/2010.
Little Egret	Rare visitor. 1st Skinflats Pools 21/04/02. No breeding to date.
Great White Egret	Vagrant. Two records: 1st Loch Katrine May 1887. 2nd Kinneil 26/10/2011.
Grey Heron	Fairly common, widespread resident.
White Stork	Vagrant ('wild' birds only). Last Fallin 10/05/2008.
Glossy Ibis	Vagrant. Only record: one Airth 09/11/2009.
Spoonbill	Irregular visitor. Last Kinneil 22/08/2013.
Pied-billed Grebe	Vagrant. Only record: one Airthrey Loch 03-05/06/1998.
Little Grebe	Scarce, widespread resident.
Great Crested Grebe	Scarce, thinly spread resident.
Red-necked Grebe	Irregular winter visitor. Last Bo'ness 28/10/2012.
Slavonian Grebe	Irregular migrant. Last Kinneil 05/10/2012.
Black-necked Grebe	Vagrant. Two records: 1st 1972, 2nd R. Carron, Larbert 19/09/2010.
Honey Buzzard	Irregular summer visitor. Last Trossachs 03/09/2013.
Red Kite	Scarce, thinly spread resident.
White-tailed Eagle	Rare visitor. Probably all from the E. Scotland release scheme.
Marsh Harrier	Rare migrant.
Hen Harrier	Rare resident.
Montagu's Harrier	Vagrant. Bred 1952, 1953 & 1955.
Goshawk	Rare resident.
Sparrowhawk	Fairly common, widespread resident.
Buzzard	Fairly common, widespread resident.

Rough-legged Buzzard	Vagrant. The only record is of a bird at Sheriffmuir 01/11 - 13/12/1980.
Golden Eagle	Rare, thinly distributed resident.
Osprey	Scarce, widespread summer visitor.
Water Rail	Scarce, thinly spread resident.
Spotted Crake	Vagrant. Last Skinflats 03/09/1999.
Corncrake	Once resident, now an irregular visitor. Last G. Dochart 08/07/2000.
Moorhen	Fairly common, widespread resident.
Coot	Fairly common, thinly distributed resident.
Common Crane	Vagrant. Three records: 1st Airthrey 12/10/2003, last Broich Fm, Doune 19/08/2013.
Avocet	Irregular visitor. Last Kennet Pans 12/04/2013.
Oystercatcher	Common, widespread resident.
American Golden Plover	Vagrant. Only record: one Kinneil 26/10/2002.
Golden Plover	Scarce, thinly distributed resident. Common on estuary in winter.
Grey Plover	Scarce visitor to estuary.
Lapwing	Common, widespread resident. Common on estuary in winter.
Little Ringed Plover	Rare summer visitor. One confirmed breeding 2011.
Ringed Plover	Scarce, thinly spread resident and passage migrant.
Killdeer	Vagrant. Only record: one Bo'ness 16/01-17/03/1983.
Dotterel	Irregular migrant. Last record: three Stob Binnein 28/04/2011.
Whimbrel	Scarce, thinly spread migrant.
Curlew	Common, widespread resident. Common on estuary in winter.
Black-tailed Godwit	Fairly common visitor, mainly to estuary.
Bar-tailed Godwit	Fairly common winter visitor, rare migrant inland.
Turnstone	Scarce, winter visitor to estuary.
Knot	Common winter visitor to estuary.
Ruff	Scarce migrant, mainly to estuary. Irregular inland.
Curlew Sandpiper	Scarce migrant to estuary.
Broad-billed Sandpiper	Vagrant. Only record: one Skinflats 23 – 25 July 1967.
Temminck's Stint	Vagrant. Two records: 1st W. end L. Tay 12/07/1987, 2nd Skinflats Pools 03/07/2004.
Sanderling	Rare migrant to estuary.
Dunlin	Rare resident. Very common on estuary in winter.
Purple Sandpiper	Vagrant. Two records: 1st Lake of Menteith 15/11/1987, 2nd Kinneil 05/11/2010.
Little Stint	Rare migrant to estuary.
Pectoral Sandpiper	Vagrant. Four records: last Skinflats tidal exchange 19/05/2011.
Red-necked Phalarope	Vagrant. Only record: one Skinflats 18/08/1968.
Grey Phalarope	Vagrant. 1st record Sept 1991; 2nd Skinflats 19/09/2010.
Common Sandpiper	Fairly common, widespread summer visitor.
Spotted Sandpiper	Vagrant. Only record: one Kinneil 24/12/2007- 14/04/2008.
Green Sandpiper	Rare migrant and winter visitor.
Spotted Redshank	Rare migrant to estuary.
Greenshank	Scarce, thinly spread migrant.
Wood Sandpiper	Irregular migrant. Last two Blackdevon Wetlands 06/05/2011.
Redshank	Fairly common, widespread resident. Common on estuary in winter.

Jack Snipe	Scarce, thinly spread winter visitor.
Woodcock	Fairly common, widespread resident.
Snipe	Fairly common, widespread resident.
Great Snipe	Vagrant. Only record: one 1955.
Pomarine Skua	Irregular migrant, mainly to estuary. Last off Bo'ness 04/10/2012.
Arctic Skua	Scarce migrant to estuary. Vagrant inland.
Long-tailed Skua	Irregular migrant, mainly to estuary. Last Earlsburn Resr. 25/06/2013.
Great Skua	Rare migrant to estuary. Vagrant inland.
Puffin	Vagrant. Three records: 1st 65 Grangemouth 12/07/1996, last alive Pow Burn 11/10/2002. One dead Blackness 10/04/2013.
Black Guillemot	Vagrant. Only record: one Blackness 28/08/1983.
Razorbill	Irregular visitor. Last 11 R. Forth, Cambus 24/03/2013.
Little Auk	Vagrant. Nine records: last Kinneil 10/03/2013.
Guillemot	Scarce winter visitor. Irregular inland. Subject to occasional wrecks.
Sooty Tern	Vagrant. Only record: one Denny May 1939.
Little Tern	Vagrant. Three records: last Skinflats 02/09/1999.
Gull-billed Tern	Vagrant. Two records: 1st Skinflats 06/09/1969 (two birds), 2nd estuary May 1977.
Caspian Tern	Vagrant. Only record: Skinflats 08/07/2002.
Black Tern	Irregular migrant. Last Kinneil 08/09/2013.
White-winged Black Tern	Vagrant. Only record: one Skinflats 12-14/08/2004.
Sandwich Tern	Fairly common summer migrant.
Common Tern	Fairly common, local summer visitor.
Roseate Tern	Irregular migrant. Last Kinneil 12/09/2012.
Arctic Tern	Irregular migrant. Last Kinneil 30/09/2013.
Sabine's Gull	Vagrant. Four records: last off Blackness 25/09/2012.
Kittiwake	Scarce migrant to estuary. Vagrant inland.
Black-headed Gull	Scarce, thinly spread resident. Common and widespread in winter. .
Little Gull	Rare visitor to estuary.
Mediterranean Gull	Rare visitor, mainly to estuary. Vagrant inland.
Common Gull	Scarce, thinly spread resident. Common and widespread in winter.
Ring-billed Gull	Vagrant. One record: returning bird to Kinneil 2007-2013.
Lesser Black-backed Gull	Fairly common, widespread summer visitor & passage migrant. Scarce in winter.
Herring Gull	Scarce, local resident. Common, widespread visitor.
Iceland Gull	Irregular winter visitor. Last Skinflats 29/12/2012.
Glaucous Gull	Irregular winter visitor. Last Kinneil 26/12/2009.
Great Black-backed Gull	Fairly common, widespread visitor.
Pallas's Sandgrouse	Vagrant, last influx May - July 1888
Feral Pigeon	Common, widespread resident.
Stock Dove	Fairly common, thinly distributed resident.
Woodpigeon	Very common, widespread resident.
Collared Dove	Fairly common, widespread resident.
Turtle Dove	Vagrant. Three records: last Thornhill 08/05/1995.
Cuckoo	Scarce, widespread summer visitor.
Barn Owl	Scarce, widespread resident.
Tawny Owl	Fairly common, widespread resident.

Long-eared Owl	Scarce, thinly spread resident.
Short-eared Owl	Scarce, thinly spread resident.
Nightjar	Irregular summer visitor. Last L. Ard Forest 15/07/2006.
Swift	Fairly common, widespread summer visitor.
Hoopoe	Vagrant. Three records: last one Thornhill 07/06/2006.
Kingfisher	Scarce, widespread resident.
Wryneck	Vagrant. Five records: last one Kirkton, Tyndrum 06/06/2011.
Green Woodpecker	Scarce, thinly spread resident.
Great Spotted Woodpecker	Fairly common, widespread resident.
Kestrel	Scarce, widespread resident.
Merlin	Rare, thinly distributed resident
Hobby	Irregular migrant. Seven records: last Torrie, Callander 19/09/2013.
Gyrfalcon	Vagrant. Only record: one November 1960.
Peregrine	Scarce, thinly distributed resident.
Golden Oriole	Vagrant. Two records: 1st Airth June 1969, last one Doune Ponds15/05/1984.
Red-backed Shrike	Vagrant. Six records: last Kinneil 16/05/2009.
Great Grey Shrike	Irregular winter visitor. Last Milton, Kilmahog 19/02/2012.
Chough	Long extinct breeding resident.
Magpie	Common, thinly distributed resident. Scarce N of a line from Dunblane – Callander.
Jay	Fairly common, widespread resident.
Jackdaw	Very common, widespread resident.
Rook	Very common, widespread resident.
Carrion Crow	Very common, widespread resident.
Hooded Crow	Scarce, thinly distributed resident in NW of Stirling district.
Raven	Fairly common, widespread resident.
Goldcrest	Very common, widespread resident.
Firecrest	Vagrant. Only record: one Polmonthill, Falkirk 03/01/08.
Blue Tit	Very common widespread resident.
Great Tit	Very common, widespread resident.
Crested Tit	Vagrant. Only record: one near Stirling 21/02/1981.
Coal Tit	Very common, widespread resident.
Willow Tit	Once breeding resident, no records for at least 39 years.
Bearded Tit	Rare resident. 1st two Skinflats 28/12/12. 1st breeding 2013.
Skylark	Common, widespread resident.
Sand Martin	Common, widespread summer visitor.
Swallow	Very common, widespread summer visitor.
House Martin	Common, widespread summer visitor.
Red-rumped Swallow	Vagrant. Only record Blackness 03/11/2012.
Long-tailed Tit	Fairly common, widespread resident.
Yellow-browed Warbler	Vagrant. Only record Buchlyvie 06/11/1960.
Wood Warbler	Scarce, thinly spread summer visitor.
Chiffchaff	Common, widespread summer visitor. Rare resident.
Willow Warbler	Very common, widespread summer visitor.
Blackcap	Common, widespread summer visitor. Rare resident.
Garden Warbler	Fairly common, widespread summer visitor.
Lesser Whitethroat	Rare and irregular summer visitor. Last Camelon, Falkirk 26/06/11.
Whitethroat	Common, widespread summer visitor.
Grasshopper Warbler	Fairly common, widespread summer visitor.

Sedge Warbler	Common, widespread summer visitor.
Reed Warbler	Rare summer visitor. 1st breeding 2011.
Waxwing	Scarce winter visitor, subject to irregular irruptions.
Nuthatch	Scarce, thinly spread resident. Colonization of the area continues.
Treecreeper	Common, widespread resident.
Wren	Very common, widespread resident.
Starling	Very common, widespread resident.
Rose-coloured Starling	Vagrant. Four records: last Lochearnhead 09/06/2011.
Dipper	Fairly common, widespread resident.
Ring Ouzel	Scarce, thinly spread summer visitor.
Blackbird	Very common, widespread resident.
Fieldfare	Common, widespread winter visitor and passage migrant.
Song Thrush	Common, widespread resident.
Redwing	Common, widespread winter visitor and passage migrant.
Mistle Thrush	Fairly common, widespread resident.
Spotted Flycatcher	Fairly common, widespread summer visitor.
Robin	Very common, widespread resident.
Nightingale	Vagrant. Only record: one Stirling 14/05 - 22/07/1952.
Bluethroat	Vagrant. Only record: one Grangemouth May 1980
Pied Flycatcher	Scarce, thinly spread summer visitor.
Black Redstart	Vagrant. Five records: last one Blackness 20/11/2011.
Redstart	Fairly common, widespread summer visitor.
Whinchat	Fairly common, widespread summer visitor.
Stonechat	Scarce, thinly spread resident. Fairly common prior to 2009 winter.
Wheatear	Common, widespread summer visitor and passage migrant.
Desert Wheatear	Vagrant. Only record: one Alloa 26/11/1880.
Dunnock	Very common, widespread resident.
House Sparrow	Very common, widespread resident.
Tree Sparrow	Fairly common, thinly distributed resident.
Yellow Wagtail	Irregular passage migrant. Last two Skinflats 10/05/2013.
Grey Wagtail	Fairly common, widespread resident.
Pied Wagtail	Common, widespread resident.
Tree Pipit	Fairly common, widespread summer visitor.
Meadow Pipit	Very common, widespread resident. Scarce & thinly spread mid-winter.
Rock Pipit	Scarce winter visitor to estuary.
Water Pipit	Vagrant. Only record Kinneil 13/11/1977.
Brambling	Fairly common, widespread winter visitor. Annual numbers vary greatly.
Chaffinch	Very common, widespread resident.
Hawfinch	Once resident, now a vagrant. Two Kippen 02/02/13 was 1st for Upper Forth since 1991.
Common Rosefinch	Vagrant. Eight records: last Ledcharrie, G. Dochart 11/06/2011.
Bullfinch	Fairly common, widespread resident.
Greenfinch	Fairly common, widespread resident.
Linnet	Common, widespread resident.
Twite	Scarce, thinly distributed resident. Fairly common in winter.
Lesser Redpoll	Common, widespread resident.
Common Redpoll	Irregular winter visitor. Last Br. of Allan 13/05/2013.

Two-barred Crossbill	Vagrant. One record: one Carron Valley 14/10/1985-31/03/1986.
Common Crossbill	Scarce, widespread resident. Fairly common but erratic visitor.
Goldfinch	Common, widespread resident.
Siskin	Common, widespread resident.
Snow Bunting	Scarce, thinly distributed winter visitor.
Lapland Bunting	Vagrant. Five records: last one Skinflats 27/02/1994.
Yellowhammer	Common, widespread resident.
Reed Bunting	Common, widespread resident.
Corn Bunting	Once resident now locally extinct. Last Skinflats 26/11/2000.

Escaped Species (Category E)

White Pelican	Presumed escapes. Four on estuary May 1973.
Black-crowned Night Heron	Presumed escape from Edinburgh Zoo. Last Br. of Allan 21/05/2006.
White Stork	Last Stirling 01/06/2012.
Chilean Flamingo	1st Skinflats 17/06/1989. 2nd Kinneil 25/07/1993.
Black Swan	Last Lake of Menteith 11/08/2013.
Chinese Goose	At Airthrey Loch since at least 2003.
Bar-headed Goose	Last Gartmorn Dam 24/06/2009.
Lesser Canada Goose	Last Doune area 29/01/2012.
Ross's Goose	1st Alloa Inch 09/05/2009.
Muscovy Duck	Last Gartmorn Dam 17/02/2005.
Ruddy Shelduck	Three records: 1st Dunmore, Forth Estuary 08/10/1994; Last R. Forth, Stirling 14/10/2001.
Wood Duck	Last Union Canal, Polmont 13/03/2012.
Southern Pochard	Last Kinneil 11/07/2004.
Turkey Vulture	One N. Third Resr. 30/09/1996. Overwintered in area, recaptured April 1996.
Harris's Hawk	Only record: one Clackmannan 25/01/2009.
Saker Falcon	Poss. bird Lecropt 26/04/2003.
Guinea Fowl	Last five at Kippenross 12/03/1995.
Eagle / Horned Owl.	One Braes of Doune Sep-Nov 2000. Probably also in Stirling.
Barbary Dove	1st record Bo'ness 06/07/2008.
Cockatiel	Last Cambus Pool 13/05/2007.
Ring-necked Parakeet	Only record: one Cambusbarron 09/11/2013.
Budgerigar	One Skinflats 26/08/2001. An albino.
Pin-tailed Whydah	Only record: one Alva 13/11/2008.
Black-throated Tit	One Polmont 10/11/1998 (Himalayan Sp).
Java Sparrow	Only record: two Bo'ness 13/12/2011.
Red-headed Bunting	One Dunblane June 1974.

UPPER FORTH RECORDING AREA RINGING REPORT 2014

Ben Darvill

The following report highlights a selection of notable observations from bird ringing activities. For access to additional information, visit: http://www.bto. org/volunteer-surveys/ringing/publications/online-ringing-reports

Birds ringed

A total of 3,446 birds were ringed in the Upper Forth recording area (hereafter UFRA), with the commonest species ringed being Blue Tit (646), Siskin (629), Great Tit (589), Tree Sparrow (130) and Swallow (103).

Comparing the Central region to Britain and Ireland ringing totals, of particular significance were the ringed totals for Short-eared Owl (5/66=7.6 %), Buzzard (47/654=7.2 %), Hooded Crow (3/45=6.7 %), Raven (21/385=5.5 %), Tawny Owl (102/2,429=4.2 %) and Osprey (7/232=3.0 %).

Other notable species ringed in the region in 2014 include Golden Eagle (1), Woodcock (24), Willow Warbler (82), Redstart (36), Sparrowhawk (13), Kestrel (36), Jack Snipe (2), Barn Owl (102), Nuthatch (10), Pied Flycatcher (32) and Sedge Warbler (13).

It should be noted that the above information is based on data reported to the British Trust for Ornithology (BTO), so there may be discrepancies for species where final totals for 2014 have yet to be provided. This is likely to be the case for buzzard and red kite, for example.

Ringing Recoveries

Notable ringing recoveries during 2014 were as follows:

Shag ***Phalacrocorax aristotelis***

This is an unusual species to be recovered in the UFRA, particularly inland. An individual which was ringed in 2013 as a nestling on Inchmickery island, Firth of Forth, was recovered dead on the River Forth in Stirling on 3rd April 2014 (8 months and 18 days after ringing).

Little Egret ***Egretta garzetta***

One of only three recorded 100 km+ movements for this species in 2014 involved the UFRA. The bird was colour-ringed in North Cotes (Lincolnshire) on 7th May 2015 and was then seen at RSPB Saltholme (Stockton-on-Tees) on 27th July before being observed at Kinneil (Falkirk) on 20th September 2014. A total distance of 365 km.

Osprey ***Pandion haliaetus***

There were two notable Osprey ringing recoveries involving UFRA in 2014. A

nestling ringed in Torrie Forest (Stirling) was sadly found dead, having hit overhead wires, at Wheal Alfred in Cornwall (673 km, 2 month and 4 days after ringing). A nestling ringed near Chapel Beck Thorn (Cumbria) was handed in dead to Fishcross SSPCA on the 18th Sept 2014 (2 months, 7 days). This bird presumably set off on migration in the wrong direction.

Great Tit ***Parus major***

An adult caught in Menstrie in 2014 was among the oldest recorded anywhere in the UK in 2015. Having been ringed as a first-year female in Sept 2009 it was caught again at the same ringing site in December 2011 and then once more in November 2014 (0 km, 5 years, 2 months).

Chiffchaff ***Phylloscopus collybita***

Two interesting recoveries highlight both the migratory tendencies of this species and also the extent of site fidelity by individual birds. Firstly a full-grown bird was ringed in Oct 2012 Wimereux (France) and then caught in a mist net at Lionthorn Community Woods (Falkirk) in May 2014 (680 km, 1 year and 6 months). At the same ringing site, an individual ringed as an adult male in Sept 2012 was re-trapped at the same site in July 2013 and then once again in May 2014.

Siskin ***Carduelis spinus***

This species produced some notable recoveries in 2014. An individual that was killed by a cat in Dunblane (Stirling) had been ringed as a Juvenile in Norfolk in July 2009, caught in Brandon (Suffolk) in March 2010 and then in the intervening years moved 509 km north. At 5 years, 0 months, 4 days this is one of the oldest Siskins reported in 2014, though not close to the longevity record for this species (8 years, 1 month, 27 days).

Finally, a number of long-distance Siskin recoveries related to the UFRA:

First-year Fem. |01-04-2013 |Whitstable (Kent) >> Caught by ringer |22-04-2014 | Callander (Stirling) = 644 km, 1 y 0m 21 d

Adult Male | 14-12-2013 | Dukes Warren (Surrey) >> Caught by ringer |28-02-2014 | Airthrey Loch (Stirling) = 600 km, 2 m 14 d

Adult Male | 28-02-2014 | Wisley (Surrey) >> Caught by ringer | 01-04-2014 | Airthrey Loch (Stirling) = 582 km, 1 m 4 d

Full-grown Male | 18-02-2014 | Iver Heath (Buckinghamshire) >> Caught by ringer | 21-03-2014 | Callander (Stirling) = 576 km, 1 m 3 d

First-year Male | 19-02-2014 | High Bridge (Somerset) >> Caught by ringer | 17-05-2014 |Callander (Stirling) = 567 km, 2 m 28 d

Get Involved

If reading about these fascinating ringing discoveries has inspired you to find out more, or to get involved, visit http://www.bto.org/volunteer-surveys/ringing/ringing-scheme

DUNBLANE WEATHER REPORT 2014

Neil Bielby

The weather station is my suburban back garden in Ochiltree, Dunblane. This is situated 50 m to the east of the Dunblane Hydro ridge, 100 m a.s.l., in a shallow, sheltered valley. (G.R. NN 78990143).

I have been recording the weather since 1995 and all averages etc. refer to the last 20 years. (Note: because there is much variation from year to year in Britain in the parameters used to define climate, climatological averages are usually taken over periods of 30 years for temperature and 35 years for rainfall. Therefore, all averages in this report should be viewed with some caution). I am indebted to Dr. John P. Holland for providing Met Office and additional weather records from Kirkton Farm, Strathfillan (NN 359283; 170 m a.s.l.) and Killin. Weather recording began in 1991 at Kirkton Farm and means etc. for this site date from that year. Killin means date from 2000. The data from Kirkton allows for some interesting meteorological comparisons between the far north-west (highland) and central (lowland) areas of our region.

Daily rainfall (> 0.2mm), maximum and minimum temperatures, barometric pressure, cloud cover, wind direction and speed (Beaufort scale) are recorded. All except the maximum daily temperature are recorded at 09.00 hours. A brief description of the day's weather is also noted along with exceptional and unusual weather phenomena across the UK. Unless indicated otherwise, daily (24 hour) rainfall amounts are measured from 09.00 hours on the date mentioned until 09.00 hours the following morning.

2014 was warmer than normal but with average precipitation. The mean temperature of 9.36°C was 0.88°C above the average with a maximum temperature of 28.3°C (25th July) and a minimum of –7.8°C (29th December). There were only 37 air-frosts, the lowest ever (mean 71) while snow lay on the ground at 09.00 hours on only five occasions (mean 21). Precipitation of 1100.4 mm was just 1 % below the norm with 230 'rain-days', 12 above the average. The highest 24 hour total was 25.1 mm at 09.00 hours on 6th July. The average barometric pressure was 1008 mb (mean 1011 mb) with a high of 1039 mb (29th Dec.) and a low of 961 mb (9th February). Turning to the seasons: winter (December-February) was warmer (+0.51°C) and much wetter (+71 %) than average. The 553.8 mm of precipitation being the highest to date (eclipsing the 467.2 mm in 2006/7). Spring (March-May) was also warmer (+1.03°C) and wetter (+20 %) then the norm. Summer (June-July) was warmer (+0.58°C) but drier (–18 %) with autumn being similar with temperatures 1.37°C above the norm and 36 % less rainfall.

The most marked difference between Dunblane and the Met Office weather station at Kirkton Farm (Tyndrum) is in the amount of precipitation. The latter recorded 2896.7 mm, 15 % above the 20 year (1991-2010) mean and 263 % above that received in Dunblane. The wettest month was October (491.6 mm) while there were only 4 days without precipitation from January 1st to April 14th. In contrast, only 29.4 mm was recorded at Kirkton in September (only 14 % of that month's average) making it the driest September and the 5th driest month there since recording began in 1991. The highest rainfall in a single 24 hour (09.00-09.00) period was 80.0 mm on October 27th while the highest rainfall in a calendar week (Monday-Sunday) was 215.8 mm between the 20th and 26th October (this is greater than for any month in Dunblane). The mean temperature at Kirkton was 8.69°C with a maximum of 27.7°C (25th July) and a minimum temperature of –7.2°C (29th December). There were 44 air-frosts (mean 86) while snow lay on the ground at 09.00 hours on 12 occasions. While amounts of snow were lower than normal in the valley it accumulated to exceptional depths on the hills surrounding Tyndrum and Crianlarich with the final snow patch on Ben More not melting until the 18th August. There were only 2 days when sustained gale force winds were recorded at Kirkton (19th and 20th March) and 3 days when thunder and lightning were recorded (18th October, 10th December and 11th December).

Lying some 13.5 miles (21.6 km) to the east of Kirkton, Killin (at the head of L. Tay), received 78 % of the formers precipitation in 2014 – roughly the same difference as in 2013.

Compared to the 1981-2010 period, January to October was the warmest on record across the UK and with all months apart from August being warmer than average, it was the warmest year on record with the mean temperature of 9.9°C being 1.1°C above the 1981-2010 mean (Plate 1). The number of frosts across the UK was the lowest in a series dating back to 1961. The average UK rainfall of 1,297 mm was 112 % of the 1981-2010 average (Plate 2) making 2014 the fourth wettest year in a series from 1910 (after 2012, 2000 & 1954). Despite this, September was the driest ever (dating back to 1910). UK wide, it was slightly sunnier than normal.

January was milder and wetter than normal. The mean temperature of 3.44°C was 1.11°C above the norm (+0.9°C across Scotland) with a high of 7.8°C (7th; 9.0°C Kirkton, 24th) and a low of –2.9°C (11th; –2.3°C Kirkton 12th). There were only five air-frosts (average 14) which was the lowest number at this station for January. Precipitation of 172.9 mm (415.2 mm Kirkton) was the 2nd highest for this month (after 265.4 mm Jan. 2008), 70 % above the norm (+16 % across Scotland). Measurable rain was recorded on 26 days (average 20). The average pressure of 994 mb was the 2nd lowest here (after 993 mb December 1999) and only the 5th time below 1000 mb for any month at this location. There was significant snowfall in the Scottish hills but very little at lower altitudes. Across the UK the mean temperature was 4.8°C (1.1°C above the norm) while rainfall totals were 51 % above average making it the third wettest

January in a series dating back to 1910. For the region of South-east and Central South England it was the wettest ever calendar month, again dating back to 1910. A maximum temperature of 14.1C was recorded at Bude, Cornwall (5th) and a minimum of –6.6°C at Altnaharra, Sutherland the same day.

The conveyor belt of deep Atlantic depressions and associated fronts continued relentlessly throughout the month. Heavy rain from 14.30 on the 1st to 02.00 the following morning produced 19.0 mm. The 3rd was a stormy day with gusts of up to 72 mph in the Central Belt (106 mph at the Needles, Isle of Wight) and a tidal surge combining to flood the sea-fronts of several towns on the Clyde coast from Helensburgh to Ayr. 61.2 mm of rain fell at Kirkton. The 9th and 11th brought brief respites from the wet weather with sunny days, light winds and night frosts (–2.9°C, 11th). The wet and often gloomy conditions resumed on the 12th with rain every day until the 20th. It was, a little surprisingly, mostly calm during this period. After a single dry day, Atlantic lows along with their associated fronts resumed their inexorable procession with 24 hour rainfalls of 17.0 mm and 19.0 mm at 09.00 on the 21st and 25th respectively. Wet and windy weather remained the norm until the month end (a gust of 81 mph was recorded on South Uist, 26th when 56.4 mm of rain was recorded at Kirkton) with a weak ridge of high pressure providing a dry, if overcast day on the 30th.

February was also milder and wetter than normal. The mean temperature of 4.16°C was 1.08°C above the norm (Scotland +1.2°C above the 1981-2010 average) with only seven air-frosts. Precipitation of 155.4 mm (434.8 mm Kirkton) was 60 % above average with measurable rainfall on 26 days – a record (mean 17). Across the whole of Scotland precipitation was 62 % above average making it the 5th wettest February in a series dating back to 1910. Snow lay on the ground at 09.00 hours on two occasions. The average pressure of 986 mb was the lowest for February while the 961 mb on the 9th was also the lowest ever recorded. It was also milder and wetter across the UK with the mean temperature of 5.2°C being 1.5°C above the 1981-2010 long-term average. Rainfall was 84 % above the norm making it the 4th wettest February in the historical series. South-east and central southern England took the brunt of this rainfall with 170 % of the February average. In the UK, the maximum temperature was 14.9°C (London, 23rd) while the minimum was –7.7°C (Altnaharra, 17th). 125.6 mm of rain fell at Sligachan, Skye in the 24 hours up to 09.00 on the 23rd. A wind gust of 109 mph was recorded at the Needles, Isle of Wight (14th) while a depth of 20 cm of snow was measured at Tulloch Br., Highlands (12th).

The unending sequence of Atlantic depressions and fronts continued throughout the month with a particularly deep low of 961 mb (9th). There was rain every day with temperatures remaining in a narrow band of –1.9°C (16th) to 9.9°C (26th). Unlike the south of England, where extensive flooding south of the M4 corridor caused much personal suffering and political angst, rainfall amounts in Central Scotland were moderate. Yet another intense low brought

hurricane winds to the south and west of Britain during the 12th. There were gusts of up to 100 mph in Wales and north-west England which caused much structural damage, blew over several lorries, most notably on the M6 at Shap, and caused the loss of power to c.400,000 homes. The accompanying rain added to the flood water with the Thames Valley, Somerset Levels and R. Severn the most severely affected. Slightly less severe weather accompanied another deep low (962 mb) during the 14th. This time winds gusted to 80 mph along the English south coast accompanied by substantial rainfall. In Dunblane rain at 16.00 turned to snow within the hour which continued until late evening. A thaw set in overnight so that only 0.5 cm of wet snow remained at 09.00 on the 15th. The 16th was a rare sunny day but more rain that night saw a return to 'Atlantic' weather with some rain every day until the month end. There were strong south-westerly winds accompanying this rain (53.8 mm Kirkton, 22nd) from the 20th-23rd while the last 3 days of the month were a mixture of sunshine and showers.

March was milder and wetter than normal. The mean temperature of 5.84°C was 0.94°C above the norm with a high of 13.9°C (19th; 12.5°C Kirkton 31st) and a low of –5.2°C (–5.7°C Kirkton 24th). There were seven air-frosts (average 11) and no snow fell. Rainfall of 100.1 mm (285.6 mm Kirkton) was 33 % above the average with measurable rain on 22 days (average 16). The 24 hour high rainfall total was 25.1 mm (6th). The mean barometric pressure was 1010.6 mb with a high of 1035 mb (11th) and a low of 979 mb (3rd).

The unsettled 'Atlantic' weather pattern continued until the 10th when high pressure built over England (1035 mb, 11th). The evening and night of the 6th/7th were particularly wet with 25.1 mm of rain falling in the 24 hours up to 09.00 on the 7th. The 7th was a day of squally showers (some with hail) and strong westerly winds. The 11th and 12th were calm, cloudless days when the warmth of the sun heralded spring. There were also frosts with –4.1°C on the morning of the 12th being the lowest temperature since the 22nd November last year. As the high pressure system drifted south-west into the Atlantic, a fresh to strong south-west and westerly airstream became established. It was mostly overcast during this period with occasional 'driven' drizzle, showers and the occasional short spell of rain. Kirkton, as usual, was wetter with 44.0 mm of rain (19th). It was, however, quite mild with temperatures reaching a year high of 13.9°C (19th). A high pressure system built over the UK from the 23rd bringing more settled weather and night frosts (–5.2°C; –5.7°C Kirkton 24th, the lowest temperature of the year to date) and several days of unbroken sunshine. However, as this high pressure system drifted to the north of the UK, an easterly airstream between it and low pressure to the south of the UK became established. This was accompanied by blanket cloud and lower daytime temperatures.

April was a little milder and wetter than the norm. The mean temperature of 7.86°C was 0.87°C above the average while rainfall of 84.1 mm (153.0 mm Kirkton) was 31 % above average. The maximum temperature was 18.7°C

(29th; 19.3°C Kirkton) while the minimum of –0.9°C (–2.7°C Kirkton, 18th) was the only frost (average 8). The mean pressure of 1014 mb was 3 mb above the average. Across Scotland the mean temperature was 1.8°C above the 1981-2010 average making it the fourth warmest April in a series since 1910. UK wide it was the fifth month in a row with above average temperatures with the mean temperature of 9.2°C also being 1.8°C above the 1981-2010 average. The maximum April temperature in the UK was recorded at Aviemore with 22.0°C (28th).

The weather was changeable with rain most days during the first 14 days; 46.0 mm of rain fell at Achfary, Sutherland during the 24 hours from 09.00 on the 9th – the wettest day of the month across the UK. It was mild with no frosts and some blustery south-westerly winds between the 10th and 12th with a gust of 62 mph at Altnaharra, Sutherland (12th). A spell of settled weather between the 14th and 20th had several days of unbroken sunshine with temperatures reaching 20.4°C in Wigtownshire (21st). The weather then became unsettled for the rest of the month with rain most days, being particularly heavy during the night of the 25th/26th producing 18.8 mm; the wettest day of the month.

May was warmer and slightly drier than usual. The mean temperature of 11.91°C was 0.94°C above the average with a maximum of 22.7°C (31st) and a minimum of 2.1°C (13th). The mean low of 7.29°C was the highest to date, 1.46°C above the average. Rainfall of 64.6 mm (145.8 mm Kirkton) was 94 % of the norm with measurable amounts on 20 days. Barometric pressure ranged from 994 mb (11th) to 1032 mb (15th). For Scotland as a whole, the mean temperature was 1.0°C above the 1981-2010 average while the mean low equalled the highest in a series dating back to 1910.

An unsettled and cool start to the month with rain most days until the 13th when a ridge of high pressure (1032 mb, 15th) building from the south brought four warm, mostly sunny days with temperatures peaking at a year high of 19.1°C (21.6°C Edinburgh, 16th). On the 17th the band of rain which had been affecting the north and west of Scotland (48.8 mm Cluanie Inn) edged south-east giving a cooler day with light rain from 15.00 hours. The weather remained changeable with cool, damp days interspersed with the occasional sunny, warm day (20.0°C, 19th). The airflow was largely from an easterly direction from the 19th until the month end. A weak ridge of high pressure during the last 3 days of the month produced sunshine and the highest temperature of the year to date, 22.7°C (31st).

June was warmer than normal with average rainfall. The mean temperature of 15.98°C was 1.95°C above the norm making this the warmest June at this station (after 15.63°C in June 2010). The average low of 10.69°C was also a new high here. Precipitation of 74.5 mm (71.3 mm Kirkton) matched the average as did the number of rain days with 15. Atmospheric pressure (1019 mb) remained within a narrow band of 1007 mb-1031 mb. Across Scotland, the mean

temperature was 1.2°C above the 1981-2010 average while the minimum mean was the highest in a series dating back to 1910. Stornaway recorded its warmest June in 140 years whereas Shetland had its dullest June in 82 years of records.

Unsettled conditions returned on the 1st with rain most days until the 16th. A humid morning on the 4th produced a heavy and persistent downpour from 14.00 hours (17.2 mm). After an overcast start the 6th was warm and cloudless (22.0°C). Humid north-easterly winds on the morning of the 7th heralded the approach of a low pressure system from the south-west with steady rain from 15.00 (10.8 mm). Heavy rain during the afternoon and night of the 9th/10th produced 19.9 mm by 09.00 hours on 10th with frequent heavy and prolonged showers added a further 10.0 mm that day. Throughout this period temperatures remained at or above the seasonal norm reaching a year high of 24.8°C (14th). A high pressure system became established to the west of Scotland which resulted in a spell of very warm and mostly sunny weather from the 16th-23rd. The 17th and 18th were particularly humid and hot with a year to date high temperature of 27.4°C on the 18th (25.8°C Kirkton; 27.0°C Cupar, Fife). There was no measurable rain for 9 days. From the 24th a mostly light easterly airstream persisted bringing more overcast and cooler conditions but little rain.

July was warmer and drier than usual. The mean temperature of 17.01°C (14.67°C Kirkton) was 1.07°C above the norm with an average daily high of 22.7°C. Rainfall of 39.1 mm (108.2 mm Kirkton) was only 47 % of the average making this the driest July since 2005 (21.1 mm). Average barometric pressure was 1015 mb in a range of 998 mb to 1024 mb.

After a warm (25.7°C) and sunny 1st the next 7 days were a little unsettled with a mixture of sunshine, cloud and a little rain. The 9th-11th were sunny and warm (25.6°C) but rain during the afternoon and evening saw a return to unsettled conditions which continued until the 20th when a ridge of high pressure (1024 mb max.) extended up central Britain. It continued quite warm (23.8°C, 17th) but not as hot as the south-east of England where temperatures peaked at a year high of 32.3°C in Gravesend, Kent (18th). Maximum daytime temperatures rose steadily from 24.9°C (20th) to 27.6°C (the hottest day of the year (25th); 27.7°C Kirkton) as Britain sweltered in the heat. It remained dry during this period although east coast haar, penetrating through the Central Valley during the night from the 22nd-24th, usually persisted until mid-morning before being burnt off. The heatwave ended when low pressure to the north-west of Scotland brought some light rain during the afternoon of the 26th. There were sunny spells and occasional short, light showers for the rest of the month with daytime maximum temperatures ranging from 19.8°C to 25.5°C.

August's mean temperature of 13.84°C was 1.35°C below the average making it the coldest August yet here. Rainfall of 82.2 mm (170.6 mm Kirkton) was 93 % of the average. The mean temperature for Scotland of 12.1°C was 0.9°C below the 1981-2010 average with rainfall 62 % above the norm. The

Northern Isles were particularly wet with Lerwick enduring its wettest August in 100 years of records while Fair Isle, with 132.0 mm (12th), had its highest daily total since records began there in 1974. The UK mean temperature of 13.9°C was 1.0°C below the 1981-2010 mean making this the coolest August since 1993. The UK overall received 56 % more rainfall than normal. A maximum temperature of 27.2°C was recorded in London (7th) while a minimum temperature of –2.1°C was recorded at Braemar (25th).

The first low pressure system for some time (1000 mb) moving up from England early on the 2nd produced a day of increasingly steady rain (13.0 mm; 35.4 mm Kirkton), the highest 24 hour total since the 9th of June. Mostly sunny days were then occasionally punctuated by heavy showers until the morning of the 10th when the remnants of hurricane 'Bertha' reached Britain. It rained all that day (13.0 mm) but Dunblane got off quite lightly compared to the north-east of Scotland where some places received 120.0 mm of rain in 24 hours. The most badly affected areas were in and around Elgin and Kingussie where the local rivers overtopped their banks flooding roads and the railway stations at both towns – these didn't open again for 2 days. The weather was quite autumnal until the 13th (max temp. 14.8°C). Although daytime temperatures improved (21.0°C max) it remained unsettled with sunny spells interspersed with wind and rain. Autumnal weather returned on the 17th with minimum night temperatures falling to 3.1°C (27th; –1.1°C Kirkton, 25th) and maximum daytime temperatures being within a narrow range of 16.3°C to 18.2°C. Days were typically sunny with occasional showers – these mostly in the afternoon. Winds were predominantly from an easterly direction during this period. Low pressure crossing eastwards to the north of Scotland produced spells of rain between the 28th and 29th before a weak ridge of high pressure encroaching from the south resulted in a dry and sunny end to the month.

September 2014 was the warmest and driest yet with the mean temperature of 13.93°C being 1.69°C above the average (+1.5°C Scotland wide). The mean maximum temperature of 18.02°C was also the highest after 17.61°C in 2006. Precipitation of 20.5 mm (29.4 mm Kirkton) not only made this the driest September (after 35.3 mm in 1996) but also the third driest month at this station (after 18.7 mm (May 2008) and 19.9 mm (May 2001)). There were only 6 days with measurable rainfall with over 50 % (11.9 mm) occurring on the 5th. Overall rainfall in Scotland was 27 % of the norm making this the second driest September on record. Across the UK the mean temperature of 13.9°C was 1.3°C above the 1981-2010 average making it only the fifth time that the September mean temperature equalled or exceeded that for the preceding August. Overall, rainfall in the UK was only 23 % of the average making this the driest September in a series dating back to 1910 and the driest calendar month since August 1995. The maximum UK temperature was 26.3°C in West Sussex (18th).

High pressure remained over the UK until the 23rd. Up until the 13th the weather was warm and mostly dry (21.5°C, 3rd; 24.0°C Lossiemouth, 4th).

However, only the 10th was a day of unbroken sunshine with the norm being overcast until around midday by which time diffuse sunshine would break through. Exceptions to this pattern were patchy rain during the 5th followed by prolonged heavy showers that night which produced 11.9 mm. The weather turned cooler from the 14th with overcast conditions and occasional drizzle and light rain until the 20th when a sunny afternoon raised the temperature to 20.5°C. The 21st was a day of unbroken sunshine but a succession of weak fronts crossed Scotland from north-west to south-east from the 22nd until the month end. Rainfall was patchy and light during this period but it was quite windy between the 24th and 26th with westerly gales across the Western and Northern Isles.

October was warmer and drier than usual. The mean temperature of 9.11°C was 0.58°C above the norm with a maximum of 17.7°C (18th; 15.8°C Kirkton 17th) and a minimum of 0.2°C (29th; –2.5°C Kirkton 14th). This was the first October without an air-frost since 2006 but there was one ground frost (29th). Total rainfall of 112.1 mm (491.6 mm Kirkton) was 83 % of the norm with measurable rain occurring on 24 days. The highest 24 hour rainfall total was 19.0 mm (3rd). Scotland wide the mean temperature was 1.1°C above the 1981-2010 average while rainfall was 41 % above the average making this the wettest October since 1954.

Autumn began in earnest on the 3rd with 24 hours of increasingly heavy rain producing 19.3 mm by 10.00 hours on the 4th (74.8 mm Eskdalemuir; 96.1 mm Drumburgh, Cumbria). It was also distinctly colder with a maximum temperature of only 12.6°C (3rd). The 5th/6th was a night of wind and rain (19.00 mm). Despite low pressure (989 mb, 9th) the next few days were quiet with some sunny spells. However, the north and north-east of Scotland suffered 48 hours of almost continuous rainfall (72.2 mm Cawdor Castle, 7th) accompanied by high winds. The Skye Bridge was closed to all traffic on the 6th with gusts of up to 84 mph recorded on South Uist while flooding closed both the Aberdeen-Inverness railway line between Elgin and Keith as well as the A96 near Huntly along with several other roads in north-east Scotland. Dense fog was slow to lift on the 12th but the late morning and the afternoon were sunny and calm. The 13th-15th were mostly sunny days with a light north-easterly airflow. A 2014 autumn low night temperature of 2.3°C was recorded at 09.00 hours on the 14th (–2.3°C, Tyndrum; –3.7°C Altnaharra). A large and deep depression out in the mid-Atlantic drew up increasingly warm tropical air culminating in an unseasonable 17.7°C on the 18th. This depression fed in bands of heavy rain and showers with north-west Scotland bearing the brunt. Fresh to strong blustery south-westerly winds developed during the 18th continuing until the 22nd when a weak ridge of high pressure eased their strength. The remnants of hurricane 'Gonzalo' reached Scotland during the early hours of the 21st causing all high level bridges in the country to be closed to high sided vehicles and the Skye bridge to be closed to all traffic that day. The south-westerly winds picked up again on the 25th being particularly blustery until the 28th. Throughout this period there was a classic east/west

split in the weather with frequent gales and heavy rain in the west (80.0 mm Tyndrum, 26th with a further 78.0 mm the following day) and little in the east. Although having rain most days, amounts were mostly small in Dunblane. It was a different story further west where several days of prolonged heavy rain caused landslips which blocked several roads including the A82 near Connel; the A835 at Garve; the A890 at Stromeferry and, inevitably, the A83 at the 'Rest and be Thankful'. The last day of the month was unusually mild (15.6°C; 19.0°C Edinburgh; 23.6°C Gravesend and Kew Gardens – the warmest Halloween on record for the UK).

November was milder and drier than normal. The mean temperature of 6.50°C was 1.83°C above the average while there were only two frosts (mean 8). Rainfall of 80.2 mm (182.4 mm Kirkton) was 72 % of the norm with measurable amounts falling on 22 days. The mean temperature across both Scotland and the UK was 1.4°C above the 1981-2010 average while rainfall across Scotland was 79 % of the norm with the north-west receiving only half the normal amount whereas Aberdeenshire and Fife were much wetter than usual.

The first 17 days of the month were unsettled with varying amounts of rain most days. The morning of the 5th saw the first air-frost of the winter (–1.0°C). A cloudless and calm day ensued but light rain during all of the following day turned heavy during the evening/night with 17.0 mm accumulated by 09.00 the next morning (122.6 mm Isle of Skye). The rain was accompanied by strong south-easterly winds during the night of the 13th/14th. A ridge of high pressure (1027 mb, 20th) brought drier weather and a light easterly airflow. The weather remained quiet but largely overcast with either calm days or light easterlies. Rainfall amounts were light consisting mostly of drizzle. The 23rd and 30th were rare days of unbroken sunshine.

Both the mean temperature and amount of precipitation in **December** were very close to average at 1.91°C and 114.7 mm (408.8 mm Kirkton) respectively. There were 15 air-frosts and one ground frost while snow lay on the ground at 09.00 hours on three occasions. Scotland wide, the mean temperature was 0.3°C above the 1981-2010 average with precipitation 33 % above the norm. The latter masked an east/west split with some locations in the north and west receiving double the long-term norm while Aberdeen had only half. Across the UK it was slightly milder and wetter than normal but with 146 % of average sunshine making it the 2nd sunniest December in a series dating back to 1929.

A ridge of high pressure provided two cloudless days, four frosts and little wind for the first 5 days of the month. Increasingly heavy rain during the 6th yielded 13.9 mm by the following morning. A rapidly deepening, intense low pressure system over Iceland created a so called 'Weather Bomb' with gale force winds across the Western and Northern Isles between the 9th and 11th. Gusts of up to 80 mph (90 mph Needles, Isle of Wight) were recorded and with these winds stretching all the way back across the Atlantic waves of 15 metres hit the islands. All ferries were cancelled as were trains north-west of a line

between Glasgow and Inverness. This severe weather was accompanied by electrical storms and lightning strikes from these left the Western Isles without power for several hours. The Stirling area was much less affected but wintery showers gave a thin covering of snow on the morning of the 11th – the first of the winter. With night frosts (–4.4°C 13th) and cold days this lasted until the morning of the 13th when strong south-westerly winds raised the temperature quickly. The weather then became quite variable alternating between short mild and cold spells. There was the occasional day of low winter sun and although it rained at some point during each 24 hour cycle amounts were low. The 21st was a day of continuous heavy rain (25.0 mm; 78.8 mm Kirkton; 80.2 mm Benmore, Argyll) and strong winds which resulted in flooding in south-west Scotland and more locally in Glen Dochart. Christmas Day was cloudless and calm and saw the start of six successive night frosts culminating in –7.8°C (29th; –7.2°C Kirkton), the lowest of the year. Unfortunately, dense fog persisted on some days keeping maximum temperatures below freezing. At Kirkton, the year ended as it began, wet, with 46.4 mm of rain on the 31st.

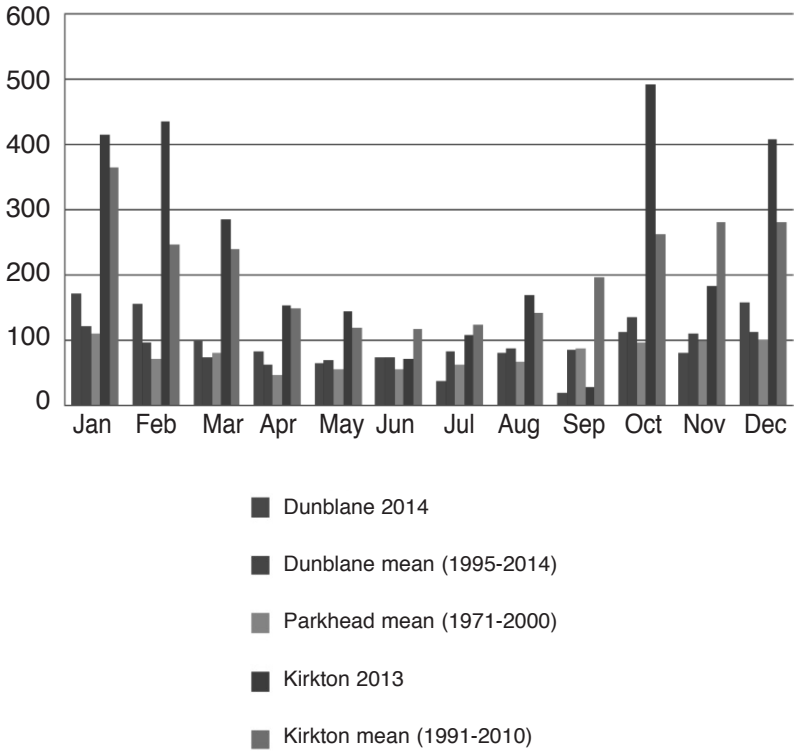

Figure 1. Rainfall 2014

Table 1. Temperature and precipitation 2014. Climatological Station Dunblane.

	Temp Mean minima		Temp Mean maxima		Number of air frosts		Total precipitation (mm)		Greatest 24 hour total (mm)		Number of days of measurable precipitation	
January	1.8 / 1.4	(0.2)	5.1 / 5.9	(4.5)	5 / 7	(14)	172.9 / 415.2	(121 / 364)	19.0	(35.0)	26 / 31	(20)
February	2.0 / 1.5	(0.3)	6.3 / 6.4	(5.9)	7 / 4	(13)	155.4 / 434.8	(97 / 248)	19.1	(38.0)	26 / 27	(17)
March	2.4 / 2.5	(1.3)	9.2 / 8.8	(4.9)	7 / 5	(11)	100.1 / 285.6	(75 / 240)	25.1	(30.5)	22 / 28	(16)
April	4.7 / 5.0	(3.4)	12.7 / 12.2	(12.3)	1 / 3	(5)	84.1/ 153.0	(64 / 149)	18.8	(27.8)	18 / 23	(15)
May	7.3 / 6.6	(5.38)	16.5 / 14.4	(16.1)	0 / 0	(2)	64.6 / 145.8	(69 / 120)	10.0	(27.1)	20 / 25	(17)
June	10.7 / 8.9	(8.9)	21.3 / 18.3	(19.1)	0 / 0	(0)	74.5 / 71.3	(74 / 118)	19.9	(39.8)	15 / 18	(15)
July	11.3 / 9.5	(10.8)	22.7 / 19.8	(21.1)	0 / 0	(0)	39.1 /108.2	(83 / 124.1)	9.0	(33.5)	8 / 18	(16)
August	9.3 / 7.9	(10.5)	18.4 / 16.6	(19.9)	0 / 2	(0)	82.2 / 170.6	(87 / 143)	13	(40.0)	21 / 26	(16)
September	9.8 /8.5	(8.4)	18.0 / 17.4	(16.0)	0 / 0	(<1)	20.5 / 29.4	(85 / 196)	11.9	(36.5)	6 / 13	(16)
October	6.9 / 5.6	(5.4)	11.3 / 12.6	(11.7)	0 / 3	(3)	112.1 /491.6	(135 / 262)	19.0	(41.9)	24 / 28	(22)
November	4.3 / 3.2	(2.0)	8.7 / 9.5	(7.3)	2 / 6	(8)	80.2 / 182.4	(112 / 282)	17.0	(39.0)	22 / 24	(20)
December	-0.4 / -0.4	(-0.3)	4.0 / 6.0	(4.0)	14 / 14	(15)	158.3 / 408.8	(114 / 282)	20.2	(35.0)	18 / 30	(19)
Year	5.9	(4.8)	12.9	(12.2)	37 / 44	(71)	1100 / 2897	(1117 / 2528)	25.1	(41.9)	230 /291	(209)

The climatological means for Dunblane are shown in ( ). Where either two 2014 values or climatological means are given, the first relates to Dunblane and the second to Kirkton. Figure in parenthesis in the 'Greatest 24 hour total (mm)' table refer to the highest ever 24 hour value for that month (09.00 hours to 09.00 hours). Temperatures are given in degrees Celsius.

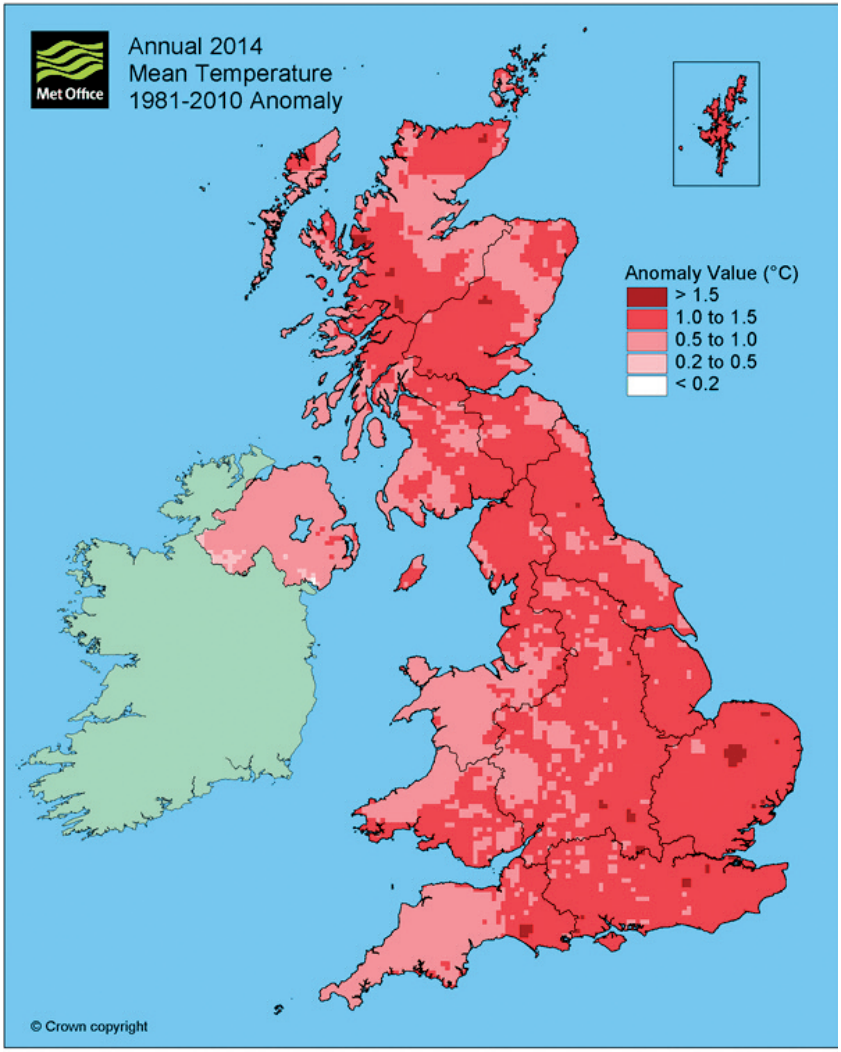

Plate 1. Mean temperature for 2014.
Values represent the deviation from the averages of temperatures between 1981 and 2010.

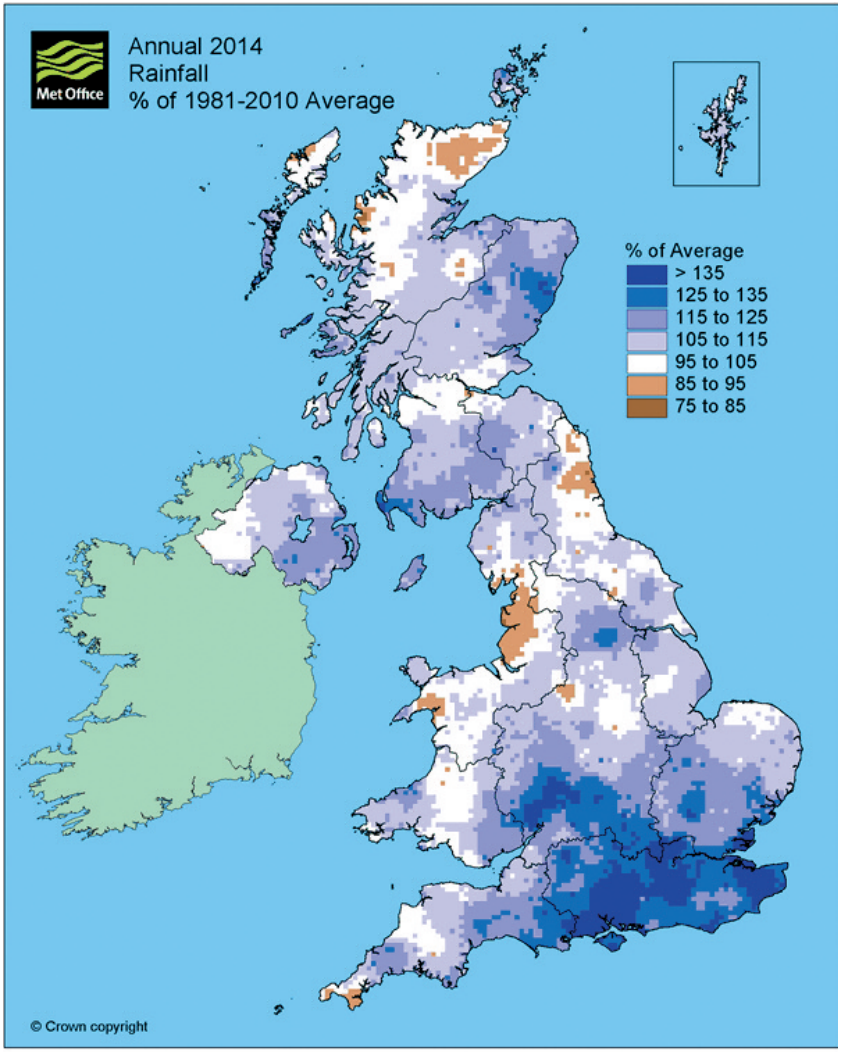

Plate 2. Rainfall average for 2014.
Values are expressed as percentage of the 1981-2010 average rainfall.

Plate 3a. The Hobo spider (*Tegenaria agrestis*) is a brownfield site specialist in Scotland © Steven Falk

Plate 3b. Wildflowers at Fallin Bing, such as this creeping thistle (*Cirsium arvense*), are important for a range of pollinating insects such as six-spot burnet moths (*Zygaena filipendulae*) and common red soldier beetles (*Rhagonycha fulva*) © Suzanne Bairner.

Plate 4a. View of the old road to MacRae Monument, from the west.

Plate 4b. The MacRae Monument, erected in 1915.

Plate 5. Musket balls and silver shilling.

Plate 6a. Dark version of frog orchid at Dumbrock Loch Meadows, July 2008.

Plate 6b. Lesser twayblade in *Sphagnum* moss near Mugdock Loch, May 2014.

Plate 6c. Greater butterfly orchid in Dumbrock Loch Meadows, June 2008.

Plate 6d. Contrasting shades in heath fragrant orchids at Dumbrock, June 2004.

Plate 7a. *Dactylorhiza* hybrids, northern marsh orchid in appearance but with admixture of heath spotted orchid characteristics.

Plate 7b. Intergeneric hybrid between heath spotted orchid and heath fragrant orchid (long spur and characteristic scent).

Plate 7c. The original frog orchid site looking towards the loch. The orchids were found in area 6c (Figure 1) to the left beyond the fence, which was installed in 2005. Photograph taken on 27 November 2012 showing extensive puddling by cattle.

THE FORTH ESTUARY – 40 YEARS OF CHANGE (1970-2010)

Donald S. McLusky

Introduction

In a recent article in the Forth Naturalist and Historian, Dobson (2013) has described the water quality of the Forth estuary and the extent to which it has improved over recent years. The present article attempts to review the published work on the Forth estuary over the period 1970 to the present day. This period has seen a remarkable transformation of the Forth estuary. By the mid-20th century uncontrolled disposal of domestic and industrial waste to the Forth estuary had led to a serious degradation of water quality in the estuary, most notably with periods of total anoxia in the upper estuary (Alloa-Stirling) and of severe industrial contamination in the middle estuary (around Grangemouth).

The transformation of the estuary reflects on the work undertaken by the Forth River Purification Board (FRPB) and its successor the Scottish Environment Protection Agency (SEPA). The biology of the estuary and other aspects has at the same time been extensively studied by staff and students of Stirling University, Heriot-Watt University and other organisations. Much of the published work on the estuary appeared in two publications which appeared after major symposia on the estuary. These appeared as Proceedings of the Royal Society of Edinburgh, Volume 93B, pages 235-571, 1987 and as Coastal Zone Topics, Volume 3, pages 1-205, 1997 both of which were edited by the present author as McLusky (1987, 1997).

In both of these publications, as well as the relevant legislation, the Forth estuary is defined as being from the tidal limit at Stirling, down to the Queensferry bridges (Figure 1). This definition of the estuary was upheld in a legal case involving the Clyde estuary (Western Ferries v. HMRC, 2011). Although this case concerned another estuary the conclusions of the court provided a legal definition for any estuary in the UK, which is equally relevant to the Forth estuary. The definition of an estuary is based on the salinity gradient, namely that:

An estuary is a semi-enclosed coastal body of water, which has a free connection to the open sea, and within which sea water is measurably diluted with fresh water derived from land drainage.

An alternative definition is that: An estuary is an inlet of the sea reaching into a river valley as far as the upper limit of tidal rise, usually divisible into three sections: a) a marine or lower estuary, in free connection with the open sea, b) a middle estuary subjected to strong salt and freshwater mixing, and

c) an upper estuary characterised by freshwater but subject to strong tidal action. These definitions are also reflected in the E.U. Water Framework Directive which designates so-called 'transitional waters' and which have been taken into Scottish legislation as the Water Environment and Water Quality (Scotland) Act. These acts also define the limits of the estuary, with the lower estuary being Queensferry-Boness, the middle estuary as Boness-Kincardine Bridge, and the upper estuary as Kincardine Bridge-Stirling (Dobson, 2013).

It is quite erroneous to refer to waters seaward or east of the Queensferry Bridges as being part of the estuary – these waters are usually referred to as the Firth of Forth, notwithstanding that the legal case mentioned above ruled that the term Firth is ill-defined. The waters east of the Queensferry Bridges are fully saline or marine, are part of the North Sea, and are clearly out with any legal or scientific definition of the estuary.

The waters above Craigforth at Stirling are correctly referred to as the Rivers Forth and Teith, being freshwaters not subject to tidal movement. The term River Forth does appear on some maps for the Forth as far as Kincardine Bridge or even below – this is debatable in both scientific and legal terms, although the term Estuary of the River Forth could be considered appropriate. The present paper sticks to the well-established legal and scientific definitions of the Forth estuary as being from Stirling to Queensferry.

When referring to the salinity of the estuary it should be noted that this paper uses the practical salinity scale, using what are called Practical Salinity Units (PSU). Salinity is a scale and is thus a dimensionless unit (like pH). In older publications salinity was often expressed as parts per thousand (often abbreviated to ppt, ‰ or g kg-1) being the total concentration of salts in grams contained in one kg of seawater. For the past 30 years salinity has been defined solely in terms of electrical conductivity. Electrical conductivity units are unfamiliar to some scientists, and have therefore been converted into the practical salinity scale. It is correct to say that 'the salinity of seawater is 34', but incorrect to say 34 PSU, ppt, ‰ or g kg-1 (McLusky and Elliott, 2004).

Pre-1970

The environmental history of the impact of pollution on the estuary and Firth of Forth is very well described in Chapter Seven of Smout and Stewart (2012). Inevitably their detailed account of the decline of the Forth since the mid-1700s is focussed on the problems created by growth of Edinburgh. The estuary's problems of pollution have always been quite distinct from those of the Firth of Forth, and centre on two regions. Firstly, the upper estuary (Stirling to Alloa) has suffered from chronic anoxia (lack of oxygen) due to organic wastes accumulating in the area, and secondly, the middle estuary has suffered from industrial waste mostly associated with the development of the port and industries of Grangemouth and its hinterland. The lower estuary has

throughout history been much less affected, with the only major impact being the development of the port of Rosyth.

In all estuaries, even the most pristine ones, the upper estuary is a potential area of stress. It is in the upper estuary that the downstream currents from the river meet the upstream tidal currents flooding in from the sea. This area is known as the Freshwater- Seawater- Interface or FSI (McLusky and Elliott, 2004). As the river and tidal currents enter an estuary they begin to slow. As currents slow the coarser sediments (sand and gravel) being transported are deposited first, whilst the finer sediments (silt, muds and clay) remain in suspension. It is normal for a river to have gravels and sands on their bed, and for open sea-shores to be sandy or rocky, but for estuaries to be dominated by muddy sediments. Within estuaries the finest muds are to be found at the FSI, and indeed the finest materials often remain in suspension, creating a turbidity maximum in the upper estuary. These fine materials include both organic as well as inorganic particles. As the fine organic particles decompose they consume the oxygen in the water, creating an oxygen sag. Since the oxygen capacity of water is affected by temperature, and warm waters contain less oxygen than cold waters, this oxygen sag is always more pronounced in summer periods.

The upper estuary of the Forth is thus a natural area for deposition, for the turbidity maximum and for an oxygen sag. These natural processes have been exacerbated by mankind, who have used the estuary as a dumping ground for many years, but especially since 250 years ago. In 1766 the laird of Blair Drummond, Lord Kames, embarked on a major scheme to drain the Carse of Stirling. This involved recruiting tenants who were offered rent-free land in return for their work in removing the over-lying peat bog. The 12 foot (4 m) deep peat was cut and placed into a mill lade, and at the Mill of Torr (near the present-day Safari Park) deposited into River Teith. The Mill of Torr operated for 61 years, from 1779 until 1840, by which time it had assisted in the removal of 20 million cubic yards of peat, moss and other vegetation. The peat and moss were carried down to Forth estuary and deposited there by natural processes. This deposition was so ruinous that the oyster gatherers and other fishermen of the estuary found their livelihoods ruined, and took the matter to court (Cadell, 1913). They succeeded in preventing further extensions of this work, such as the proposed drainage of Flanders Moss, by a court order of 1865. By this time however the peat and moss had silted up the Forth estuary from Stirling to Bo'ness, and effectively finished Stirling as a sea-port. The damage to the estuary had thus largely been done by the time of the 1865 prohibition. Since that date the towns of Stirling and Alloa have grown in size. Stirling added its domestic waste to the estuary. Alloa added not only domestic waste but also large quantities of brewery and distillery waste and this is then carried on the flood tide upstream into the upper estuary.

Grangemouth developed as a port to serve as the eastern terminus of the Forth and Clyde Canal, and the harbour there gradually grew. When the petro-

chemical industries developed, firstly refining paraffin with shale oil from the Bathgate area, and later refining imported oil for many products, and finally with North Sea Oil, Grangemouth was an obvious site with both convenient flat-land, as well as an adjacent harbour for the refinery and associated chemical works. The waste from the BP refinery and the adjacent chemical works was discharged through pipes located at the high-water mark of the Kinneil mudflats. Waste from other chemical works, such as ICI, was discharged to a submerged outfall located just off the Skinflats area. In addition contaminated water, derived from domestic wastes of the Falkirk area, plus inland industries (such as Westfield paper works, or Carron Ironworks) was discharged into the Rivers Carron and Avon and carried then to the Grangemouth area. The middle estuary was thus the recipient of considerable amounts of waste, both from the Grangemouth industries, but also from inland sources.

Pollution of the Forth got progressively worse from 1860 to 1950 and various attempts at control were ineffective. Only with the establishment of the Forth River Purification Board (FRPB) in 1951 did matters begin to improve. As Collett (1961, 1972) has described, the estuary suffered from severe pollution, especially in the upper estuary, with regular periods of anoxia in the summer months, and in the middle estuary from contamination from Grangemouth industries. In 1961, for example, the impassable barrier of oxygen-sag water above Alloa prevented the movement of fish for 18 out of 25 days sampled.

1970-1979

The FRPB began to control waste discharges into the estuary, so that by 1976 the upper estuary was only impassable for fish on three out of 21 days sampled. The introduction of the Control of Pollution Act in 1974 further helped the RPBs impose standards, and in 1975 the FRPB merged with the Lothians RPB to create a larger FRPB. The newly-enlarged FRPB created a Tidal Waters Division, under the leadership of W. Halcrow with a laboratory at Port Edgar, South Queensferry and with their own Research vessel, RV Forth Ranger.

The Tidal Waters Division of the FRPB was now able to sample the estuary and firth regularly, and they were able to study the water quality, fish, sub-tidal benthos and plankton of the estuary in a way which had never been undertaken before. At the same time the staff and students of the relatively new University of Stirling began to sample the intertidal areas of the Forth estuary. Between these two organisations a series of publication on the estuary emerged.

Most of the published papers of the 1970s refer to the fauna of the intertidal areas, with the results of the sub-tidal studies not appearing until the next decade. McLusky, et al. (1976) gave a summary of the status of the intertidal invertebrates and their bird predators for the middle and lower estuary, in particular highlighting the importance of the three large intertidal areas of

Skinflats, Kinneil and Torry Bay, and indicating the impact of discharges in the Grangemouth area as well as the threat from several reclamation proposals. McLusky, Elliott and Warnes (1977) and McLusky (1979) extended the study area to include the upper estuary, showing that the impact of the oxygen sag resulted in a fauna consisting only of pollution-tolerant Oligochaete worms. Stout (1976) calculated the oxygen deficits associated with effluent inputs to the Forth estuary.

The Skinflats area was one the first areas of the estuary to be designated as a nature reserve, due to its bird populations. The Shelduck there were studied by Bryant and Leng (1976), and the waders by Bryant (1979). Warnes (1981) undertook her Ph.D. thesis on the impact of overwintering birds at Skinflats on the production of the benthic fauna. The Torry Bay area was studied, mainly for its rich mollusc fauna, by McLusky and Allan (1976) followed by the Ph.D. thesis of Elliott (1979) much of which later appeared in McLusky and Elliott (1981) and Elliott and McLusky (1985). In 1976 McLusky began an annual study of the Kinneil area on behalf of BP industries.

1980-1989

Probably the key publication of the 1980s was the Royal Society of Edinburgh's Proceedings Volume 93B in 1987 which was devoted to the estuary and Firth of Forth (McLusky, 1987). It contains 26 papers about the estuary and firth. Rather than try and summarise each paper, the titles and authors are listed in Table 1. The range of papers from geology, climate and water quality through to birds, fish and seals represents the most complete record of the Forth estuary in the 1980s. All the papers to some extent reflect on the pressures from inputs that affected the Forth, but at the same time they show that the ecosystem of the middle and lower estuary, and the adjacent firth, was functioning and productive.

In addition, many of the studies which had begun in the 1970s appeared as publications of the 1980s. McLusky (1982) gave the first detailed results of the impact of the Grangemouth refinery discharges on the Kinneil area, indicating gross or severe pollution at distances of up to 500 m from the discharges, pollution at 0.5-1.5 km distance, and moderate pollution of recovery beyond 1.5 km distance. Further data in McLusky and McCrory (1989) indicated recovery from the effects of pollution as improvements to the discharges were implemented.

One group of animals which has dominated the fauna of the inner and middle Forth estuary are the Oligochaete worms. These worms are regarded as 'opportunistic' and tend to increase in number in polluted areas, in contrast to other groups such as polychaete worms, molluscs or crustaceans which decrease in polluted areas. The populations of oligochaetes throughout the Forth estuary from Stirling to Boness were described by McLusky, Teare and Phizacklea (1980) showing how they dominated the fauna of the upper estuary.

Bagheri and McLusky (1982, 1984) studied these worms in greater detail looking especially at populations at Skinflats, Culross and Kinneil.

In the lower estuary, McLusky, Anderson and Wolfe-Murphy (1983) examined the impact of bait-digging on worm and other populations near Blackness, whilst in the upper and middle estuary McCraw (1985) studied the populations of the polychaete worms *Nereis* and *Nephyts*. Roddie, Leakey and Berry (1984) reported on the populations of the planktonic copepod *Eurytemora affinis* in the upper reaches of the estuary, and Berry (1989) described the *Retusa obtusa* populations at Torry Bay.

In the upper estuary, Proctor, Fraser and Thompson (1983) described the saltmarshes, noting the reduction in their extent due to reclamation, whilst Maitland et al. (1984) reported on the status of the river lamprey, *Lampetra fluviatilis*; Harrison and Phizacklea (1985, 1987) meanwhile examined the heat storage capacity of the mudflat at Skinflats.

The results from the sub-tidal studies undertaken by the FRPB appeared as Elliott and Taylor (1989a, b) and Elliott et al. (1988) examining both the sublittoral benthos and the fish communities of the estuary. Elliott and Griffiths (1986) described the levels of mercury contamination in many components of the estuary's fauna, with Clark and Topping (1989) providing further results on mercury concentration in fish. Collett and Leatherland (1985) gave an overview of the management of water pollution control in the estuary to that date.

During the 1980s the FRPB exercised its powers by requiring many local authorities to install or upgrade their sewage works, and industries to modify their processes to reduce or eliminate their discharges. Table 2 indicates the key capital works begun or completed at that time. One major change was the UK-wide implementation of the need to reduce discharges of all the most persistent toxic chemicals (Red-List substances) to the catchment of the North Sea. For the Forth estuary this meant the cessation of mercury and cadmium discharge from ICI/Zeneca in 1985.

1990-1999

More of the findings of the FRPB's Tidal waters Division's studies appeared throughout this decade. Elliott, Griffiths and Taylor (1990) showed the importance of the Forth estuary as a nursery ground for North Sea fishes. Taylor (1993) described the full range of zooplankton from freshwater sites, through the estuary to the fully marine firth. Harper, Ridgeway and Leatherland (1992) gave the concentrations of the so-called 'Red-List Substances' hexachlorobenzene and other related chemicals.

The dissolved elements of the estuary were described in a series of publications from the Aberdeen Marine Laboratory's staff and their associates.

These include Balls (1992) for the nutrients, nitrate, silicate and phosphate, Laslett and Balls (1995) for dissolved Mn, Ni and Zn, Balls et al. (1994) for nutrients and trace metals over a complete tidal cycle, Balls et al. (1996) for dissolved oxygen and nitrification in the upper estuary, Lindsay et al. (1996) for the effects of tidal range and river discharge on suspended particulate matter fluxes, Owens et al.(1997) on suspended particulate matter, Lindsay et al.(1997) on a comparison between the Forth and a South African estuary. Balls, Hull, et al. (1997) looked at trace metals throughout Scottish estuaries and coasts, and Bell et al. (1997) looked at contaminated sediments of the Clyde and Forth estuaries. Balls, Owens and Muller. (1997) showed that rivers were now the main source of metals (Pb, Cu, Cd, Zn) to the Forth estuary. Lindsay et al. (1998) gave a further report on the contaminated sediments of the Forth.

The impact of land-claim (sometimes miscalled Reclamation) on the intertidal areas of the Forth estuary was calculated by McLusky, Bryant and Elliott (1992). Their original map (here Figure 2), which has been much copied, showed that almost 50 % of the intertidal area has been destroyed for a variety of purposes, including agriculture, harbours, waste and refuse disposal and industrial development. They calculated that land-claim has removed 24 % of the natural fish habitats of the estuary, and thereby removed 40 % of their food supply.

Many of the major capital works initiated or begun in the 1980s came to fruition in the 1990s (Table 2). Griffiths (1997) gives a clear overview of the improving quality status of the Forth estuary, noting in particular the significant improvements in the disposal of domestic and industrial effluents made since 1985. The proportion of the estuary regarded as being of good condition increased from 32 % in 1989 to 44 % in 1994, whilst the area of poor condition area has decreased from 23 % in 1989 to 15 % in 1994, with the biggest single factor being the improvements to Quest International's yeast factory effluent produced at Menstrie but discharged at Alloa which prior to treatment contributed over 70 % of the oxygen demand load to the estuary. Miller and Dobson (1997) gave further classification of the condition of the Forth estuary on the basis of trace metals in fucoid algae.

Significant improvements to the water quality of the Skinflats area were reported by Riddle (1997) in his modelling study of the impact of the Zeneca/ICI effluent in relation to the improvements implemented since 1985. Reflecting on the changes made to mercury discharges to the estuary from this source, Mathieson undertook a detailed study of the eelpout *Zoarces viviparus* as a means of bio-monitoring for mercury. His results appeared as Mathieson et al. (1996)

Wallis and Brockie (1997) developed a water quality model for the estuary, and Dobson (1997) was able to use the model to help identify the factors influencing the dissolved oxygen budget of the estuary. She found that suspended solids consumed approximately 40 % of the total oxygen deficit in the upper estuary, whilst domestic and industrial inputs accounted for

approximately 50 % of the total oxygen deficit. She predicted that the importance of particulate matter in the consumption of oxygen meant that the benefits of reducing inputs would be long-term rather than short-term. This has indeed been proved to be the case – see Dobson (2013).

The economic costs of pollution control came under scrutiny. Moffatt, Hanley and Hallett (1991) provided a framework for water management of the estuary in respect of economic incentives. Faichney et. al. (1997) were able to calculate the economic costs of the environmental improvements made to the estuary. Hanley et al. (1998) combined economic and environmental modelling of the estuary.

The intertidal fauna of the Kinneil area (in front of the refinery complex) has been studied annually since 1976, and McLusky and Martins (1998) were able to show clear increases in density, expressed either as mean number of species, or as diversity indices over a 20-year period. These increases in diversity were shown to be a clear community response to the improvements made to the petro-chemical wastes discharged to the area. In addition to the studies of the macrofauna of Kinneil, Telfer and Wilkinson (1997) measured the effect of the petrochemical effluents on transplanted Fucus vesiculosus.

The major shrimp (mostly *Crangon*) populations of the Forth estuary were studied by Jayamanne and McLusky (1997), emphasising the shrimps as a key role in the food web linking the benthic invertebrates to the fish populations. The crab populations of the estuary (five species) were fully described by Mathieson and Berry (1997). Bryant and McLusky (1997) showed how the bird predators of the Forth estuary had responded to changing food densities. At Kinneil, redshank increased in association with an increase in *Corophium volutator*, and bar-tailed godwit with polychaete worms. At Skinflats, knot and oystercatcher rose in response to *Hydrobia ulvae* and *Cardium edule* densities respectively.

Ross and Berry (1991) examined the winkle, *Littorina saxatilis*, populations at several sites in the estuary and firth. Berry et al. (1992) examined the breeding of *Retusa* in relation to its prey *Hydrobia ulvae*, Berry (1994) looked the foraminiferan prey of *Retusa* and Berry (1997) gave further details of his study of the biology of *Retusa* at Torry Bay.

The upper reaches of any estuary are a region of stress for the animals inhabiting the estuary. Typically the number of species decreases in a gradient from the seaward mouth of the estuary, and from the riverine head of the estuary (McLusky and Elliott, 2004). The minimum number of species is typically recorded at a salinity of four. Apart from this natural decline of species the upper estuary of the Forth has suffered from 200 years of decline due to the clearance of Blair Drummond moss, followed by the domestic and industrial organic discharges from Stirling and Alloa, creating marked oxygen sag. As a result the upper estuary was for years only inhabited by pollution-tolerant

Oligochaete worms (McLusky, Hull and Elliott, 1993). As recovery began to occur it became possible to plot the reinvasion of other species. McLusky and Lassiere (1993) noted that the rag worm *Nereis diversicolor* had gradually moved up from Dunmore to Alloa and by 1993 had reached Cambus. The next species to move upstream from Kincardine to Alloa were the amphipod *Corophium volutator*, the bivalve *Macoma balthica* and the small snail *Hydrobia ulvae*. In the water column the copepod *Eurytemora affinis* inhabited the freshwater-seawater interface area, and in the fishes Herring and Sprat now regularly reached Alloa, and most dramatically the Sparling (*Osmerus eperlanus*) returned to the upper estuary after an absence of many years (Maitland, 2010). At the head of the estuary is a rarely-studied zone – the Tidal Freshwater zone, which on the Forth is from the tidal limit at Craigforth down to between Cambuskenneth and Fallin, a distance of 9-21 km (McLusky, 1994). McLusky, Hull and Elliott (1993) reported that there were 10 species at the tidal limit (mostly insect larvae) reducing to two species (Oligochaetes) by 8 km (Cambuskenneth).

The FRPB which had done such sterling work in restoring the Forth estuary was incorporated (along with all the other PRBs) into the new national Scottish Environment Protection Agency (SEPA) in 1995. Whilst SEPA is now responsible for monitoring and policing the estuary it must be acknowledged that the quality of the estuary was effectively turned around by its predecessor, the FRPB.

2000-2010

The Urban Waste Water Treatment Directive of the 1990s was followed in 2000 by the Water Framework Directive (WFD) and widened the focus of environmental legislation from protecting water quality to encompass the protection of wildlife (Dobson, 2013). Unlike previous legislation the WFD takes account of the impact on wildlife of the physical modification of the estuary in addition to water quality.

By the year 2000 the quality of the Forth estuary had so improved that authors were able to review the considerable progress made. Dobson, Edwards, Hill and Park (2001) reviewed a variety of criteria, especially noting the increase in water quality, as dissolved oxygen, in the upper estuary. Dobson (2000) was now able to report on long-term trends in trace metals in biota in the estuary from 1981-1999, confirming a steady decline. Davis (2001) was able to analyse the considerable improvements that had occurred at the Kinneil area, as the petro-chemical effluents there had been either removed or controlled. Greenwood, Hill and McLusky (2001) reported on the fish populations, showing no trend in species richness from 1982-2001, but a reduction in total abundance, largely due to reductions in whiting and eelpout. Greenwood also studied the fish mortality by impingement at Longannet Power Station (Greenwood, 2008a) and compared the cooling-water intakes versus trawls as estuarine fish sampling tools (Greenwood, 2008b). He found large quantities of

herring and sprat and small individuals of all species collected at the cooling-water intake which were largely omitted from trawl samples. The fish assemblages of European tidal marshes were fully described by Mathieson et al. (2000), with a comparison based on species, families and functional guilds. This study covered six European estuaries with the Forth and the Humber as the UK examples.

Whilst the chronic sources of pollution have been successfully dealt with during the period 1970-2010, so pollution from other sources may become apparent. In particular the presence of diffuse sources of pollution may become detectable. The presence of potentially carcinogenic substances in European flounder was investigated by Lyons et al. (2004) at eight UK estuaries, with the Forth populations being grouped with those estuaries showing only background levels of DNA damage. Kirby et al. (2004) reported on endocrine disruption in male flounder from several UK estuaries over the period 1996-2001, and showed a decrease in oestrogen contamination in Forth populations. A survey of the Forth estuary in 2000 by Smith et al. (2001) identified low levels of alkyl phenols in water samples from the Forth estuary, and suggested that the concentrations determined were consistent with a contaminated though not grossly polluted estuarine system. Emerlogu et al. (2013) has given more recent information on dissolved organic contaminants in the estuary.

Turner (2000) reviewed the trace metal contamination from six UK estuaries including the Forth and Clyde, and gave an empirical evaluation of the role of hydrous iron and manganese oxides. Graham et al. (2001) looked at the importance of both natural and anthropogenic sources of organic matter in the sediments of the Forth estuary, and found consistent results throughout the estuary, with no specific anthropogenic source detected.

Augley et al. (2007) described the use of carbon stable isotopes as migration markers for nursery fish stocks, and Augley et al. (2008) evaluated the effect of salinity on juvenile plaice collected from the estuary and maintained in a laboratory experiment, with those at a salinity of 25 doing best. Barnes and Upstill-Goddard (2011) reported on the dissolved nitrous oxide and dissolved inorganic nitrogen of the estuary. Barras and Paul (2000) described the post-reclamation changes that had occurred in estuarine mudflats adjacent to the Skinflats area. Another recent studies of the estuary was Elliott and Neill (2007) on the tidal flow into the estuary at Queensferry,

The monitoring of water quality of the estuary continues (Dobson, 2013) and shows a steady recovery in all parts of the estuary. There is however still sufficient organic matter in the bed of the upper estuary to produce some depletion of oxygen particularly when the turbidity increases during the summer spring tides. The intertidal and sub-tidal benthos, especially of the middle estuary, is monitored on a bi-annual basis by SEPA and partners under the Forth Environmental Assessment Programme (FEEAP). This programme shows a continual steady improvement in all areas as they recover from

centuries of damage. The lower estuary is now classified as being of good ecological status.

This literature review of the environmental history of the Forth estuary has been able to record the many publications which have appeared since the acceptance of the very poor state that the estuary had been allowed to reach by the mid-20th century. The estuary has suffered catastrophically from the effects of mankind, firstly from 1766 onwards by the clearing of Blair Drummond moss and the deposition of vast quantities of moss and peat into the estuary. Although this was prohibited in 1865, the damage had already been done. Thereafter the expansion of the towns of Stirling and Alloa both of which discharged their sewage in to the estuary, plus the organic-rich effluents from the brewing and distillery wastes from Alloa, Cambus and Menstrie led to a serious situation in the upper estuary. Meanwhile the middle estuary suffered from the rise of industry in the Grangemouth and Falkirk area.

The formation of the FRPB in the 1950s started the reversal of two centuries of decline for the estuary, but the recovery did not really gain momentum until additional powers were granted in 1970s. Major capital works followed in the 1980s, so that by the mid-1990s and the formation of SEPA the estuary's recovery was well under way. By the year 2000 much of the recovery had been achieved or was well underway, but the process is proving to be a slow and steady process as much organic debris remains in the upper estuary. Whilst the chronic sources of pollution have been successfully dealt with during the period 1970-2010, so pollution from other sources may become apparent. In particular the presence of diffuse sources of pollution may become detectable. Diffuse sources include, for example, the oil-contaminated run-off from motorways, or the drainage of excess fertiliser nutrients from agricultural fields.

In contrast to the clear recovery of the estuary in terms of organic, domestic and industrial waste contamination, the effects of land-claim are largely permanent, and it can be seen that in a historical context that land-claim has affected the estuary more than pollution. Although some limited schemes for the reversal of land-claim have been undertaken in the Kincardine area, it must be accepted that most land-claim can never be reversed, and as a consequence the best that can ever be achieved for upper and middle parts of the estuary is Good Ecological Potential rather than Good Ecological Status. The lower estuary is now classified as being of Good Ecological Status and supports a variety of fish.

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Table 1
The natural environment of the estuary and Firth of Forth. A symposium organised by the Royal Society of Edinburgh on 7-8 May 1987. List of contents of Proceedings of the Royal Society of Edinburgh, Volume 93B.

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Table 2.
Principal changes in municipal and industrial effluent treatment facilities of the Forth estuary between 1987 and 1997. After Griffiths (1997)

Site	Nature of improvement	Completion date
Stirling Sewage treatment works (STW)	Secondary treatment	1987
Bo'ness STW	Long sea outfall and primary treatment	1992
South Queensferry STW	Long sea outfall and preliminary treatment	1992
Alloa STW	Secondary treatment	1993
Ironmill Bay STW	Long sea outfall and secondary treatment	1993
Grangemouth West	Untreated discharge diverted to Falkirk STW for secondary treatment	1993
Cambus distillery	Site closed	1993
Limekilns STW	Septic tanks and long sea outfall	1994
BP refinery	Process water biological treatment	1994
BP Chemicals	In-plant works. Wet oxidation and stream stripper units installed	1994
Weir Paper	Biological treatment	1995
Weir Paper	Sea outfall	1994
Torryburn village	Reed-bed treatment of sewage	1995
Quest International, Menstrie	Biological treatment	1995
Zeneca (formerly ICI)	Source control of red-list substances (Hg, HCB, TCB). Containment facilities	1994
Zeneca (formerly ICI)	Biological treatment	1997

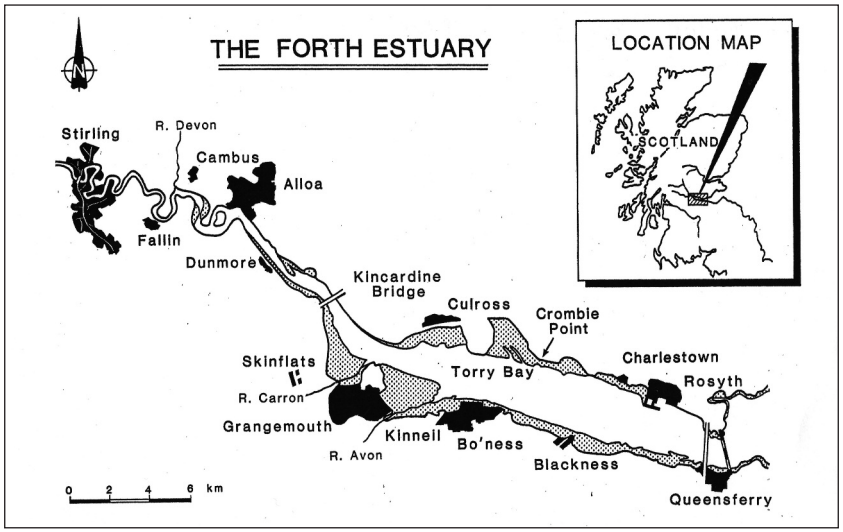


Figure 1. The Forth Estuary. After McLusky (1987). The lower estuary is Queensferry – Boness, the middle estuary is Boness-Kincardine, the upper estuary is Kincardine-Stirling (see Dobson, 2013).

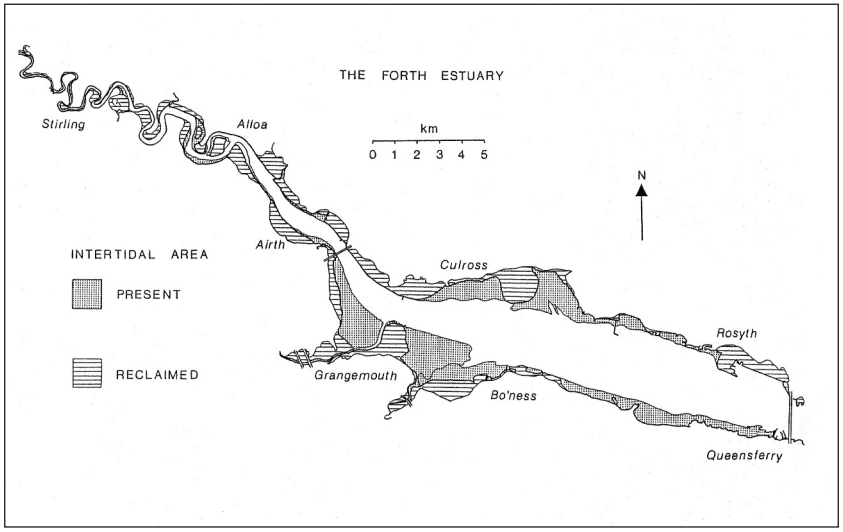


Figure 2. The intertidal areas of the Forth estuary, indicating the present intertidal area (stippled) and the areas of the intertidal which have been subject to land-claim (or reclamation) (horizontal lines. After McLusky, Bryant and Elliott (1992).

THE CLACKMANNANSHIRE WAGGONWAYS

Murray Dickie

Introduction

The Clackmannanshire Field Studies Society obtained a Heritage Lottery Fund grant through the Inner Forth Landscape Initiative to undertake a four year research project on aspects of the development of the Two Estates of Alloa and Clackmannan, with particular emphasis on the 18th and 19th centuries. The grant enabled local volunteers to be trained and supported to research a number of topics. Both estates had been extremely active in coal mining and extensive horse-drawn waggonway networks had been constructed to transport coal away from their pits. These networks played a key part in the development of coal mining and had never been comprehensively researched. In addition, the physical remains, while still substantial, are being steadily removed by industrial, commercial and residential development. It was decided to concentrate the first year's work on researching the rise and decline of these waggonways and recording their remains. The research was extended to include the other three colliery waggonways which had been constructed at Kennetpans, Coalsnaughton and Alva. Twenty local volunteers were involved in undertaking the desk and field based research into these waggonways from May 2014 to June 2015. This article records the development and decline of the largest network, the Alloa Waggonway.

At the close of the 17th century the Alloa Estate was owned by John, 6th Earl of Mar. The estate bordered on the shore of the upper estuary of the river Forth and had access to a pow, a small tidal stretch of the Brothie Burn adjacent to the estuary. This provided the estate with access to maritime trade, in particular enabling the transport of coal by sea. The earliest known record of a coal pit on the Alloa estate was in 1519 and by the middle of the 17th century a mine drained by a day level was working in the Carsebridge area. At that time much of Scotland's trade was centred round the North Sea and the Alloa estate was transporting coal by road to Alloa Pow for export. In 1631 John, 2nd Earl of Mar, wrote a letter of support for Peter Breware, declaring that he "*trades in transporting coal to Flanderis [Vlaanderen, Belgium] and importing other wares to Scotland*" and a request to "*all and sundry to give him aid*".

In addition to this export trade, there was a market for "panwood" (i.e. small coals) from the salt pans springing up along the Forth estuary and this growing industrial market became a great encouragement to the development of coal mining. The domestic demand for coal was still very limited and for another century peat remained in use as the main domestic fuel in most country districts.

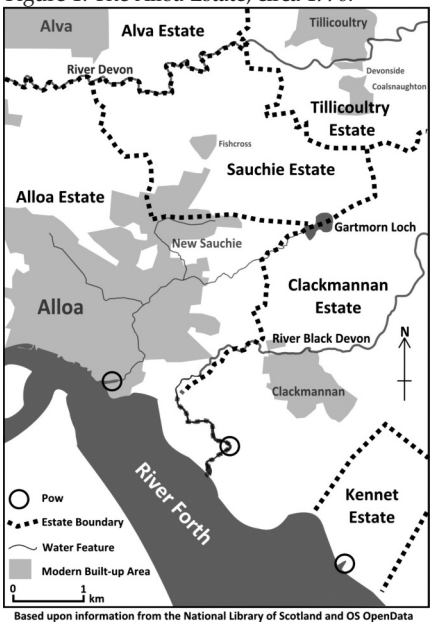
The earliest pits at the Alloa colliery were either very small surface workings or pits drained by a day level (a tunnel dug into the side of a valley to drain the coal seams above). The introduction of horse powered gins offered the chance to work seams which could not be drained by day levels but they were costly to run. There is a record of a horse powered drainage engine at the Alloa colliery in the late 17th Century being "*cog and run – a wheel with teeth running into a trunion or lanthorn pinion, as in the old corn mill*", with chains and buckets used to drain to a depth not exceeding 15 fathom (30 metres). By the end of the 17th century, the general introduction of water powered drainage machines offered the potential for mining deeper seams of coal at a much lower cost and, by 1713, a water powered drainage gin had been installed at Alloa. The gin at the Alloa colliery was described as a water wheel located in the Carsebridge colliery with buckets and pudding link endless chains, draining a shaft 40 fathoms (80 metres) deep to the Nine Foot coal.

Most of the coal from early pits in the Forth estuary was exported by sea and was mined as Great or Sea Coal. These were large pieces of between one and one and a half cwts. (51 to 102 kilogrammes) which were carefully cut by the miners, dragged to the shaft bottom, carried by women bearers up stair pits to the surface and packed carefully into ships to prevent breakage. Ships carried only small loads and any Great Coal damaged in transit lost a great deal of value and sometimes was not worth anything. An agreement between Sir John Bruce of Airth and a London coal merchant in 1614 stipulated that "*…all the dust or smaller coal be cast and not accepted*" and that each ship "*should contain 40 tons of coals and no more*". Coal seams were worked by the method of stoop and room (sometimes called pillar and stall) with the stoops or pillars being left unworked to hold up the roof. This meant that a substantial proportion of coal was not mined. This unmined amount of coal was estimated by Robert Bald in 1841 as about one third of the seam. He also noted that chews (small pieces of coal) and culm (coal dust) were not of great worth and were sometimes thrown into the waste areas of the pit.

Roads were so poor that coal for inland sale had to be borne on the backs of ponies that carried two hundred weights (100 kilogrammes) while coal carried to the shore was transported in small farmers' carts holding only about six hundred weights (306 kilogrammes). A description of carts of this period was given in the Old Statistical Account of Alloa: "*The carts in common use consisted of a few boards, ill-put together, and of a size not larger than a good wheel barrow, placed upon a thick wooden axle, which was fixed to some low wheels, composed of three pieces of wood, joined together by two or three large wooden pins. The axle turned round with the tumbrill wheels.*" As well as being capable of carrying only a small quantity of coal, this means of transporting coal was mainly limited to drier weather and not considered reliable.

Helped by Alloa becoming a customs port in 1710, the trade in coal and salt from Alloa began to grow. By 1750 it is reported that as many as one hundred and seventy vessels lay in the Forth at one time to receive the produce of the

Figure 1. The Alloa Estate, circa 1770.



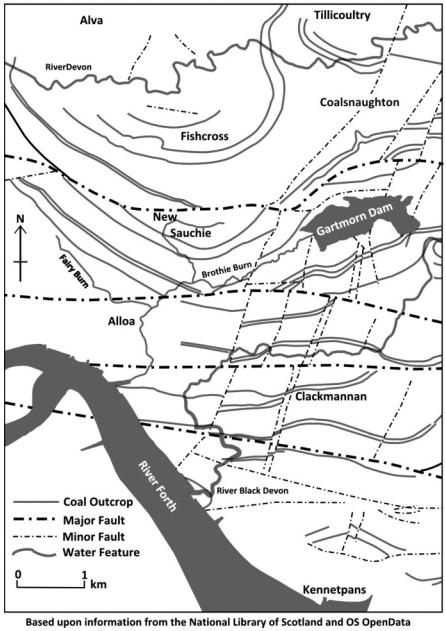
mines and salt pans from Alloa to Culross. However, the Erskine family of Alloa were unable to take advantage of this. Sir John Erskine, the 6th Earl of Mar, was exiled to France for his part in the unsuccessful Jacobite uprising of 1715 and the Alloa estate was managed for a time by the Commission for Forfeited Estates. It was purchased back by the Erskine family of Grange in 1724 and, as the son of the purchaser married the daughter of the 6th Earl, returned to the control of the Erskine family of Alloa.

In the late 17th century, with drainage provided by extensive day levels or drainage engines, mining in Clackmannanshire moved from small scale, shallow workings to slightly larger, deeper pits. As a result of mining deeper seams, the nature of the coal seams and the shape of the landscape began to play a more significant part in the development of mining. In the Second Statistical Account of Alloa in 1841 Robert Bald, an eminent 19th century mining engineer, provided a concise description of the Clackmannanshire Coalfield and noted the opportunities and challenges it offered to mine owners. The coalfield was known to be in the form of an elliptical basin, extending some eleven kilometres from the west of Alva to the east of Dollar and some seven kilometres from the Ochil hills in the North to the river Forth in the South. As a result of the basin shape, most of the coal seams dipped to the North or North East at a slope of about 1 in 6.

The basin was crossed by three major West to East faults. These were the Abbey Craig fault [a throw of 91 metres], the Alloa fault [a throw of 146 metres] and the Polmaise fault [a throw of 165 metres]. These faults divide the basin into four coalfields. The Coalyland coalfield lay to the North of the Abbey Craig fault, the Carsebridge coalfield lay between the Abbey Craig fault and the Alloa fault and the Clackmannan and Kennet Coalfields lay between the Alloa fault and the River Forth, divided into north and south sections by the Polmaise fault. There were also many North to South faults, mainly in the eastern half of the basin. The Coalyland coalfield and the western area of the Carsebridge coalfield had very few such faults, while the other coalfields were divided into small wedges by many North to South faults. This meant that the Coalyland collieries and the collieries in the western section of the Carsebridge coalfield were easier to work, as their coal seams were largely undisturbed.

Robert Bald noted that the surface of the lower land in Clackmannanshire could be divided into three major types. Next to the river Forth was a wide, level alluvial plain or Carse of heavy clay, rising landwards. This was separated by a sharp rise from another relatively level area of heavy clay at about 40 metres. Above this were rolling clay ridges orientated in a West to East direction, with a blunt end to the West. A modern interpretation of this landscape indicates the lowest area is composed of marine and estuarine alluvium known as Carse clays and has a landward edge at about 10 metres Ordnance Datum marked by a steep feature separating it from level, raised marine deposits at about 40 metres. Above this, the landscape was underlain by glacial clay, moulded by the flow of ice into West to East ridges called drumlins. The thickness of glacial clay varies greatly, from a thin skin to a depth of 60 metres North of Alloa. Although most of the land was ideally suited for the construction of waggonways, being mostly gently sloping or nearly flat, there was a sharp 30 metre drop in level to be negotiated to get down on to the Carse.

Figure 2. The Geology of the Clackmannanshire Coalfield.



Based upon information from the National Library of Scotland and OS OpenData

The Erskine family had developed and were maintaining a Coal Road through their estate to the town of Alloa and on to the shore. They also had established the right to charge other landowners for using it and loading their coals at Alloa harbour. As a result, other local estates wishing to export coal from Alloa had to bear the additional cost of this "gate mail". The Roy Military Survey of Scotland (Highland area – circa 1750) shows the line of this Coal Road from its junction with the Tullibody to Coalsnaughton road at modern day Fishcross (NS 8989395363), south past the 6th Earl of Mar's 1713 "*Water Engine*" and the Erskine's mining settlement of "*Coleton*" through the northern edge of the town of Alloa by way of the High Street, through the Coalgate and down Broad Street to the harbour (NS 884920). Wood's map of the Town of Alloa in 1825 shows the route crossing the Fairy Burn by means of the *Coal Bridge*.

By the middle of the 18th century it was clear that the transport of coal from the pits of the Alloa and neighbouring estates to the shore using the Coal Road was becoming a serious issue. While the gatemail was a source of income to the

Alloa Estate, the maintenance of the Coal Road was a drain on it. More importantly, the use of small, heavily loaded carts on poor quality roads meant that the movement of coal was difficult, unreliable, costly and, as great or sea coals (large pieces) were being transported, likely to lead to damage and loss of value. The use of horse drawn waggonways had become common in English and Welsh coalfields and several had been introduced in other parts of Scotland. These waggonways were constructed by using a number of cross pieces of wood (sleepers) upon which two wooden rails were pinned. Waggons had cast iron, flanged wheels which kept them on the rails. The waggonways were usually single tracks, with regular passing places and routes were carefully planned to offer a gentle slope down which waggons could be pulled with ease. The gentle slope meant that the main tasks of the horse were to get the waggons moving when loaded and pull them back up the slope when emptied.

As the second half of the 18th century began, several events came together which must have encouraged the Erskine family to consider constructing a waggonway. In 1757 a new 265 feet (81 metres) long quay had been built on the north bank of Alloa Pow. By 1759 they had coal workings in both the Carsebridge colliery at Coleton and in at the Collyland colliery. In 1760 there was a serious trade slump, reflected in the accounts of the Alloa colliery, perhaps encouraging Lady Frances Erskine to set up her Glassworks at Alloa Shore to provide a new market for coal. Essential raw materials for making glass were easily available – sand and ashes of seaweed from lower down the Forth Estuary, salt from the saltpans at Kennetpans and Clackmannan and coal from the Erskine's collieries. Alloa harbour was extended again in 1761 with an additional 181 feet (54 metres) long quay linking two older ones. The Nine Foot coal at the Alloa Carsebridge colliery was worked out by 1763 and in 1764 new workings were opened at 48 fathoms (88 metres) to access the Upper Five Foot coal at the Carsebridge colliery. These new workings were drained by a waterwheel at the Watermill Pit (NS 8947293708) driving pumps made from hollowed out plane trees. In the same year a Newcomen steam engine was built at the Collyland colliery to drain the Nine Foot coal there. All of these developments would enable the Erskine family to increase their coal extraction and facilitate export from the shore at Alloa.

The First Alloa Waggonway, 1767-68

The Estate of Mar was at this time entailed, meaning that it was passed on to the eldest male in the family with restrictions on the sale or rental of the property and managed by trustees. In 1767, with the consent of Lady Frances Erskine, a contract was agreed by the trustees to let the coal workings to a co-partnership of Haig, Deas and Company for a period of seven years, ending in 1774. The co-partnership was formed mainly of Alloa merchants and some Edinburgh merchants and they were required to consult with members of the Erskine family. A later contract indicates that this first waggonway was funded by a loan with both the Erskines and the co-partnership contributing to the

payment of the interest and the repayment of the capital being undertaken by the Erskine estate. It also suggests that the co-partnership had been responsible for the construction of the waggonway and then leased it along with the coal workings. There is further evidence supporting the completion and opening of the first waggonway in 1768.

An anonymous sketch suggests a route for this waggonway. Although it is undated, it is thought to have been drawn up shortly before the waggonway was built. Starting at Alloa harbour, a single track would turn northwards across the Carse, with a cutting taking the waggonway up on to the higher ground. A passing place would afford the opportunity for waggons going up to pass waggons coming down. The valley of the Fairy Burn was to be crossed by a bridge and the route would then turn eastwards, leading to a long straight terminating at a coal fauld. The sketch also shows the Erskine's "Coal Road" crossing the Fairy Burn on a "Coal Bridge" and the waggonway then skirting the southern edge of the Coal Road. Another anonymous, undated sketch shows the detail of a proposed wooden waggonway bridge across the Fairy Burn. This was to be five feet (1.52 metres) broad and made of five inch (12.7 cm) planks supported by 10 inch (25.4 cm) couples.

Comparison with the actual route of the waggonway shown on the First Edition Ordnance Survey 25 inch maps of 1861-63 shows the same key points of harbour, cutting, passing place, bridge and straight section, suggesting that the sketch plans were implemented more or less as proposed. The First Statistical Account of Alloa indicates that this waggonway was constructed with the rails formed from "*Scots fir scantlings 4 inches by 5 inches* (10 to 12.5 cms.) *fixed by wooden pins to sleepers near to each other"* A second top rail of the same material was soon added, but this wore rapidly and was replaced with a rail of beech. The waggonway was transporting horse drawn waggons weighing about one ton (1.02 metric tons) and carrying a chalder of coal (1.52 metric tons). Although there is no contemporaneous evidence, it is likely that this first waggonway had an early branch near the shore to the Erskine's Alloa Glass Works, the line of which is shown on Woods map of Alloa in 1825. The waggonway carried much more coal than could be transported along the Coal Road by cart and the journey was also faster, more reliable and very much smoother, therefore there was less danger of the Great Coals being damaged.

The Collyland Extension, 1772-1774

By 1771 the first waggonway had been so successful that the Erskine's considered extending it to their colliery at Collyland. Tracking the route of this extension proved much more difficult as it did not appear in its entirety on any early maps and there are two conflicting suggestions in secondary sources. There are several references which suggested a route from near the Whins in the Carsebridge area (NS 8941693522), via Fairfield Road to Collyland (NS 884953). These included a local publication by Adamson in 1980 where it is stated that the waggonway ran up the "Tinker's Loan" towards Collyland, a

route which locals called the "Coalin Road". There were also suggestions that it might have reached Collyland by way of Fishcross to Diverswell (NS 890958), to the south of Collyland.

A record in the Erskine Family papers details the proposals for the construction of an extension of the waggonway to Collyland in 1772. Unfortunately, while it gives many details of the work required and the financial arrangements, it does not give any indication of the route. In return for a seven year tack (lease) of the coals the tacksmen (lessees) would be required to pay the estate a fixed rate for each chalder (1.52 metric tons) from the Alloa colliery of 6s 4½d (32 new pence) and the Collyland colliery of 7s 2½d (36 new pence) and deliver the coal to the shore and load on board ship. Once the coal was sold at the shore, they would be required to pay the estate half the value of any sale price beyond the fixed rates. The proposed contract estimated that the tacksmen could make a profit of some £300 per annum. The contract also includes a requirement to build a pier to the west side of the Pow at Alloa, enclose a 100 acres (40.5 hectares) of land with hedges and ditches, construct a barn and stables and run the resulting farm for a year.

The proposed contract stipulated that the lessee would be responsible for constructing the waggonway, provide waggons and horses and have the pier, farm and the waggonway operating by September 4th, 1774. The contract mentions an earlier tack which had still two years to run, which is referred to as "*your present tack*" and offered the new lease on the same condition, except the prices required for coals. Although the contract does not name the potential tacksmen (lessees), the reference to "*your present tack*" with two years still to run, suggests that this proposal was linked to the seven year tack granted to Haig, Deas and Company in 1767.

The terms of the second contract suggest that the first waggonway was funded by a loan and that a new loan for the improvements to the pier and farm and construction and fitting out of the waggonway was £2,020. It was indicated that the Erskine estate would meet most of the costs of interest and all of the capital repayments. The proposed new contract suggests that the average volume of coals produced in the previous three years was: "*Alloa Coals – 7,640 Chalders* (11,644 metric tons) *of the Coalyland Coals – 6,000 chalders* (9,144 metric tons)*".* It goes on to indicate that money would be provided by the estate for the wages of the shoregrieve at Alloa harbour and for loading the coal on board ship, which would usually be undertaken as soon as the waggons reached the shore. The tacksmen would be responsible for paying for a shore guide and £101 annual interest on a loan of £2,020.

The proposed contract concludes by suggesting that the tacksmen could make 6½d (2.9 new pence) profit per chalder (1.52 metric tons) on the Alloa Coal and 4½d (1.75 new pence) profit per chalder (1.52 metric tons) on the Collyland coals, making a gross profit of £300. It also suggested that the price of the Collyland coals might increase, giving a possible additional profit of

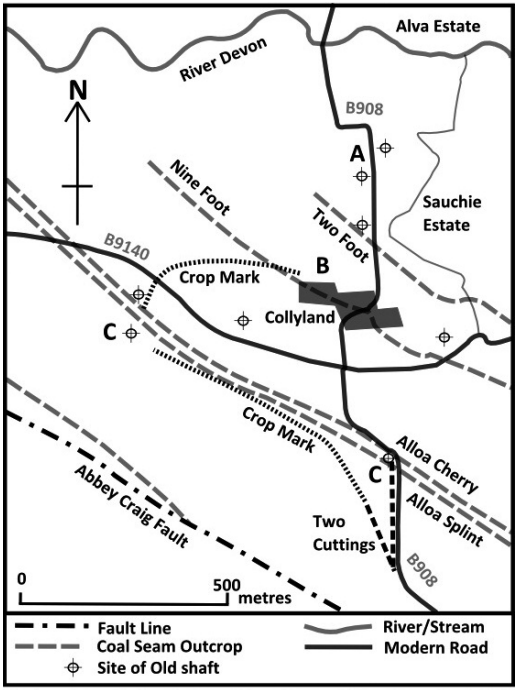
some £62 per annum. This suggestion is supported by an advertisement in the Edinburgh Caledonian Mercury on the 14 December 1772 which stated that "*There are now offered, at both Alloa and Coalyland, some new pits of coal, of the finest quality, and at the following prices : Coaly land Main Coal, being of the same seam of the well-known Old Sauchy coal, at 8s. 4d.* (42 new pence) *per waggon. Alloa Newton coal, hard and splinty, fit for any market, at 7s 6d (37.5 new pence) per waggon. Alloa Old Gin coal at 7s* (35 new pence)." The reference to the Coalyland coal being the same seam as the Old Sauchy coal, fits with it being the Nine Foot coal, which outcrops in the southern part of the Old Sauchie colliery.

Research into the various aerial photographs of the area around the hamlet of Collyland identified a series of crop marks and lines to the South West of the hamlet. Field research showed that two lines on the aerial coverage at the summit of the ridge to the South of Collyland were substantial cuttings, two to three metres wide at the base and two to three metres in depth. The route from these cuttings runs downhill all the way to the Alloa shore. The line of a crop mark extended from the summit of the more westerly cutting and would have taken the waggonway downhill in a north westerly direction, creating a gradient up which waggons would have had to be pulled. The route chosen runs across the slope, rising up from the possible pit site (elevation 44 metres) to the summit of the route (elevation 56 metres) over a distance of some 657 metres (Google Earth). This gives an average gradient of 1 in 55, which would not have been a difficult task for a horse drawing a waggon and coals weighing two and a half tons. On the modern Google Earth aerial coverage a second crop mark shows up in two fields to the west of the hamlet of Collyland. This connects to the first crop mark coming down from the cutting at the summit. The remains of the mining hamlet at Collyland are adjacent to the outcrop of the Nine Foot coal. The March (estate boundary) between the Alloa estate and the Sauchie estate is a small burn immediately to the east of this hamlet, so the Nine Foot coal seam within this area of the Alloa estate lie to the west of this stream.

In 1764 the first steam powered pumping engine in Clackmannanshire, a Newcomen engine "*supposed to be one of the best of the old construction*", was built at the Erskine's Collyland colliery (NS 886958) "*near to the river Devon to drain the 9 Foot Coal at a depth of 48 fathoms*" (90 metres). The Nine Foot coal outcrops near the hamlet of Collyland at an elevation of 29 metres and the elevation of the land adjacent to the River Devon is 16 meters lower, at about 13 metres. As the average dip of the coal seams in the Clackmannanshire basin is 1 in 6 to the NE, the drainage shaft would need to be located roughly 620 metres away from the outcrop to be at a depth of 90 metres. This would place it along the line of the Diverswell Farm track (NS 8876295747 to NS 8879995749). The Second Edition of the Geological Survey map shows two old shafts in that area on the Alloa Estate (area A on figure 3).

Women bearers were still carrying coals to the surface in of most of the shallower coal pits in Clackmannanshire at this time. Access shafts were generally located close to the outcrop, so that the bearers had the minimum

Figure 3. Collyland Cuttings and Crop Marks.



distance to climb, placing them in area B in figure 3. The two shafts marked C on Figure 3 are further upslope on the ridge on the outcrop of the Upper Five foot coal (also known as the Alloa Cherry coal) and possibly represent a later working at Collyland. The connection to shafts at C suggests that the waggonway moved coal from these pits.

The Second Statistical Account of Alloa states that the extension to pits at Collyland increased coal sales from 10,000 to 11,000 chalders to 15,000 to 16,000 chalders (15,000 metric tons to 24,000 metric tons). In 1773 John Frances Erskine succeeded to the Mar Estates and in 1774 appointed Alexander Bald as manager of his collieries and the waggonway. There are papers in the Erskine family collection indicating concerns in 1779 regarding the debts of Haig, Deas and Company. There is also a proposal to lease the Great Coal of Alloa to James Stein, merchant at Kilbagie, John Stein, merchant at Kennetpans, and John Jameson [Jamieson], sheriff clerk of Clackmannan. It is not known whether this proposal was acted upon but, by 1779, the second seven year tack of the coals and the waggonway would have run out.

The historical and field research points to the Collyland colliery working an extensive area of the Nine Foot coal in 1767, accessed by a shaft or shafts near the hamlet of Collyland. The cost of installing a Newcomen engine and pumps to drain the workings would provide a strong incentive to get coals to market. The physical remains and crop marks suggest that there were two different periods of coal extraction linked to the waggonway: the first in 1764 to access shafts close to the outcrop of the Nine Foot coal near to the hamlet of Collyland (area B in Figure 4) and the second at a later date to access shafts on the Upper Five foot coal higher up on the ridge to the south (shafts C in Figure 4). Research found no direct evidence of a line to Collyland via Fishcross. The strength of evidence currently favours a route via Fairfield, but the route via Fishcross remains open to further research.

The Redevelopment and Extension of the Waggonway, 1774-1800

The Second Statistical Account of Alloa (circa 1841) gives a detailed listing of the various stages of improvements carried out on the Alloa Waggonway, some of which are roughly dated. Prior to 1785 there had been a trial using cast iron plates to protect the upper wooden rail from wear. This was described as "*plating the wooden rails with cast-iron in pieces of four feet long, of an inch and a quarter square; each piece of rail having three projecting ears with holes, through which a pin was driven to fix the iron-rail in its place. This plan proved quite abortive, for the instant the wood gave way or yielded, the cast-iron was broken, and it was found so useless and so expensive that it was thrown aside altogether. The engineers then never once contemplated the substitution of cast-iron rail of a proper form, in lieu of the wooden-rail*".

The First Statistical Account of Alloa (c.1791) was co-authored by the Reverend James Frame and John Francis Erskine, owner of the Alloa estate. A very detailed description is given of the construction of the new waggonway in 1785 when the original Alloa waggonway was considered to be worn out and the track was replaced with two wooden rails with a malleable iron bar on top. "*The sleepers are very broad, and only 18 inches (45 cms) from centre to centre. A rail of foreign fir, 4 inches (10 cms) square is pinned down to them; and another rail, of the same dimensions, is laid over it, and the whole beat up in good clay; and on top of the upper rail is laid a bar of malleable iron, of 1 3/4 inches (4.45 cms) breadth and nearly 6/8th thick (2 cms). The waggons have cast iron wheels, 27 ½ inches diameter (70 cms), and are supposed to weigh altogether about a ton (*1 metric ton*). A waggon carried 30 cwts of coals* (1.52 metric tonnes), *and three waggons are linked together by chains, so that one horse draws 4 ½ tons of coal at once, and the declivity of the way is so gentle that the same horse draws with ease the 3 empty waggons back to the coal-hill. The advantage of putting the weight into 3 waggons, in place of 1, is very considerable: They are easier to fill and empty, and the throwing the weight over a greater surface, does less damage to the waggon way, and is likewise easier for the horse as it is well known, that almost the only stress that a horse has, on a good waggon way, is in the starting of the waggon; therefore, if the whole 4 ½ tons were put into one waggon, the difficulty would be great; as the waggons, when standing still, are close to one another, and the chains that link them together are 2 feet long, the horse has only 30 cwts of coals to put in motion; for, when he starts the first waggon, the impetus of it, if it does not actually move, greatly assists in moving the second and third. The first expense of making this kind of waggon way, is undoubtedly great, being at least 10s. (50 new pence) per running yard (0.914 metres), yet the proprietor has long been reimbursed, and is a considerable gainer, for although this road has been made these six years, it has required no repair worth mentioning, and is now near as good as when first laid.*" The Account also notes that "*The collieries in the neighbourhood use a considerable quantity of hay; Their usual price is 4d (0.4 new pence) per stone (6.35 kilogrammes)*".

A painting by David Allan in 1786 shows a horse drawing a waggon with the words "Alloa No 15 – 40 cwts" on the side. A waggon driver is walking alongside beside a very large brake handle. The waggon is constructed of wood

and has four cast iron wheels. An etching of the new dry dock at Alloa by Allan in 1796 shows a similar waggon, horse and driver in the background. Again the waggon has a large rear brake and the driver is at the rear. The painting and etching suggest that single waggons were still being used at times, despite the upgrading in 1785. The shape of the waggon is the same in both the painting and etching, being much broader at the top than the base.

There is evidence that the route of the Collyland waggonway extension was added to in 1790 with a branch to the new Fly (NS 8831094357) and Pompee (NS 8857394111) pits. These pits lie to the south of Collyland and are separated from it by the Abbey Craig fault so were working in the Carsebridge coalfield. They may have been working at the same time as the pits at the top of the ridge near the summit of the B908. The First Edition Ordnance Survey 25 inch map shows that by 1863 all these pits had been abandoned. Field research shows that, while substantial parts of the eastern sections of these routes have been lost to housing developments, parts of the western sections have been preserved as farm tracks and field boundaries or are visible on aerial coverage as crop marks.

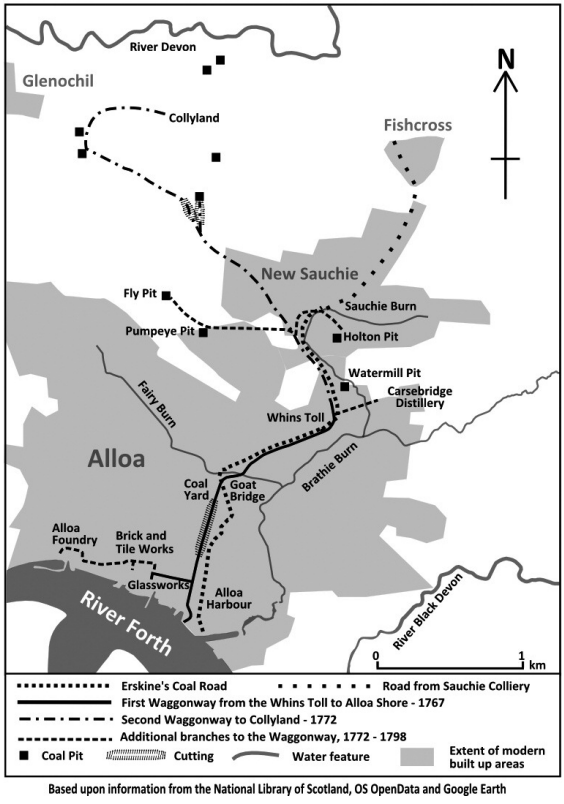
The First Statistical Account of Alloa indicates (circa 1794) the importance of the export trade in coal, noting that "t*he Port has 115 ships registered of 7,241 tonnage with some 500 men employed. Greatest number of vessels engaged in the coal trade with exports to the Firth of Forth and the east and north of Scotland of some 50,000 tons, also some 6,000 tons, together with valuable quantities of glass bottles from the glass house are exported to Denmark, Norway, Germany, Holland and Portugal.*". It was also noted that "*Large coal is sent to sea from the shore - sold at between 8s.6p per chalder of 30 cwts* (1.52 metric tons) *while smaller coal or chaws are sold from the coal hill at the pit for 13d per cart of 6 cwts (*305 kilogrammes)". Small coals were selling at nearly half the price of large coal, a great attraction to coal using industries. The Account notes that an iron foundry and brick and tile works had been established for some time at the shore at Alloa. It is likely they were connected by branches to the Alloa waggonway, possibly as soon as they were established. The First Statistical Account goes on to record that for the iron foundry "*The metal was generally brought from Carron and used to cast waggon wheels and small pots, etc."* The route of the branch to the Brick and Tile works is shown connected to the Glass Works branch (NS 8805092429) on Wood's map of the Town of Alloa in 1825. Field research shows that parts of these routes are preserved in the lines of Castle Street, Glasshouse Loan, Craigward Place and Kelliebank.

In 1798 a lease was granted by John Francis Erskine to "*John Bald and Company, distillers, of Waulkers Park near the Carse Bridge in the parish of Alloa.*" By the end of this period, the main spinal waggonway from Alloa harbour to Collyland had been rebuilt with wooden, iron plated rails and had branches at the shore to a glassworks, foundry and brick and tile works, branches to three pits in the Fairfield area of Sauchie and a possible branch to the Carsebridge distillery.

New Coalfields and Partners, 1793-1840

In 1793 the Devon Company was set up and negotiated a lease with the Cathcart family for land at Eastside, to the NE of modern Fishcross (NS 897958) in order to construct an iron works and to mine coal and ironstone. The Devon Iron Works had no local access to limestone for the blast furnaces and had to import supplies from the eastern areas of the Forth Estuary at Charleston in Fife and Skateraw in East Lothian. As well as carting limestone from Alloa harbour to the works, cast iron had to be carried down the Coal Road to the shore. This increased two-way traffic would have had an impact on the quality of the road surface. In 1798 the owners of the Devon Iron Works wrote to John Francis Erskine demanding that he make repairs to the Coal Road and he then enquired of his legal advisers how far he "*is bound to keep the above road in repair at least for carriages which now contain a load of about 18 cwts in place of 6 cwts as formerly.*" In 1802, some of the pressure was taken off the Erskine's Coal Road when the Ochil Turnpike Trust built a road from Tillicoultry to Alloa.

Figure 4. The extent of the Alloa Waggonway in 1798.



The trade in coal continued to expand and new markets were being sought. Alexander Bald, the long serving manager of the Alloa Collieries, suggested using the Forth and Clyde canal to send coal to the towns growing up around Glasgow. Unfortunately, in 1804 there was a major fire in the Collyland workings. This was reported by Robert Bald as being "*in the Nine Feet coal at Collyland. This was an accidental fire occasioned by a candle igniting rotten prop-wood. The fire lasted 18 months. The pumps were stopped and a brook was brought along the surface and poured some 300 feet* (93metres) *into the pit. The fire was extinguished but the pit remains drowned to this day* (1828)." The colliery

was abandoned and in 1806, almost certainly in response to the loss of this substantial seam, John Francis Erskine commissioned new pits at Holton Square, (Holton Nos. 1 and 2), the Peackock Pit near the Whins Toll and leased seams in the South (New) Sauchie colliery from the Estate of the Earl of Mansfield where new pits were sunk in the area immediately to the South and West of modern day Fishcross. The South Sauchie colliery lay to the South of the Tullibody to Coalsnaughton road, while the North (Old) Sauchie colliery lay to the North of it.

Sometime between 1806 and 1810, the Alloa waggonway network was again rebuilt, this time with a gauge of 3′ 3″ (1.10 metres). The line was laid with cast iron edge rails and sleepers, allowing eight one ton waggons to be brought down by one horse. In order to move coal from the new Sauchie pits to the shore, a further extension was built to the waggonway. The route of this new branch is shown on the First Edition 25 inch OS maps (1862-63) running from the line of the waggonway extension to Holton (NS 8916794112) heading north eastwards up the slope behind the miners' houses of New Sauchie and along the western edge of the new Ochil Turnpike road. It then entered a cutting, curving round to the North West (NS 8966794895 to NS 9000795037) before heading towards the South Sauchie engine pit site (NS 899951).

In 1823 Alexander Bald suggested the Erskine family take a more hands-off approach to the Alloa Collieries and that they should be managed by a trust. The Erskine Trust was set up in 1825, with Robert Bald and Robert Jameson as trustees and including representatives of the Erskine family. In 1824 a branch line was built to connect the waggonway extension to the Sauchie colliery across the Ochil Turnpike Trust road to pits sunk on a new lease of coals on the Sauchie estate. A map of the town of Alloa, dated 1825, shows the line of the Alloa waggonway from the shore to the Whins. The earlier connection at the shore to the glassworks and the brick and tile works are also shown. There is another connection shown from Castle Street (NS 8795092450) to the Grange Distillery, owned by Stein and Company (NS 8794092711) and, close to the Whins Toll, there was a short link from the waggonway into the Hutton Park brewery (NS891932).

The Alloa estate suffered the loss of three owners in an extremely short period of time. In 1825 John Frances Erskine, having just regained the title of the 7th Earl of Mar, sold the Alloa Glassworks and, following his death later in that year, the estate passed for a short time to his son, Thomas, 8th Earl Mar. Thomas died in 1828 and the estate then passed to his son, John Francis Miller Erskine, 9th Earl of Mar, who began extensive improvements to it. After the death of the 9th Earl of Mar in 1835, a number of prominent business men in Alloa formed a co-partnery, the Alloa Coal Company, to take over the lease of the Alloa colliery and waggonway and the lease of the South Sauchie colliery. The partners were William Mitchell, John Moubray, John Craich (manager for the Mar), David Ramsay (merchant in Leith – acted as selling agent for the Earl

of Mar's coal), Alexander Meldrum (manager of the Devon Iron Works) and Ebenezer Ramsay (a solicitor in Alloa).

In 1835 the Alloa Coal Company extended the waggonway at the South Sauchie Engine pit eastwards to connect with pits at Burnie, Brandyhill and Bailliesdub. William Mitchell, John Craich and William Wingate had new ships built at Kincardine to carry coals from Alloa to Leith and they were followed by a number of Alloa merchants who became involved in the coastal export of coal. The Devon Iron Company's works lay on the east side of the new turnpike road from Tillicoultry to Alloa (NS 898959). As the Iron Company wished to use the Alloa Coal Company's waggonway they entered into an agreement with the Alloa Coal Company in 1837, so that a short length of waggonway (the Sauchie waggonway) could be constructed to link the iron works to the Alloa waggonway. The Trustees of the Ochil Turnpike objected to this arrangement as it would cross the turnpike road, but an agreement was entered into between them and the Devon Iron Company that, for an annual payment of £220, the Devon Iron Company should take "*from the lessees of the Alloa and South Sauchie collieries the use of the colliery railways*". The route of the Sauchie waggonway from the iron works is shown on a scroll plan of the North Sauchie colliery, drawn in 1839. It came eastwards out of the iron works (NS 89870958810), crossed the turnpike road by means of a bridge (NS 9019395784), looped around the back of Devon Village (NS 901956), crossed the Fishcross to Coalsnaughton road (NS 9022995386) and then joined the main Alloa waggonway close to the Sauchie Engine pit (NS 9000994992).

By 1839 the Devon Iron Company negotiated wayleaves with the estates of Sauchie, Alloa and Clackmannan to construct a waggonway from the Sauchie waggonway southwards across part of the Alloa estate and into the Clackmannan estate. The contract drawn up with the Alloa estate to lease land at Jellyholm Farm had a restrictive clause indicating that the extension from the Sauchie waggonway to link with the Clackmannan waggonway was to be constructed solely to allow the iron works to access supplies of coal, ironstone and fireclay from the Clackmannan collieries. Unfortunately a revision error to the contract meant that it was signed without this restriction. The Second Statistical Account of Clackmannan indicates that by 1841 the Sauchie-Clackmannan waggonway was in operation and the Devon Iron Company had access to both Clackmannan and Alloa harbours.

The Alloa Coal Company re-opened the Collyland colliery in 1838, this time working the coals from the area of the South Sauchie engine pit. Mackie's 1845 map of the waggonway from the harbour at Alloa to the Sauchie Collieries shows the waggonway extending from the South Sauchie Engine pit (NS 8997495088), northwards to a pit at Crophill (NS 8991295177) on the North Sauchie colliery with a second link to the Devon Iron Works and a branch leading from the South Sauchie engine pit eastwards to pits at Brandyhill (NS 9080295409) and Garnstars (NS 9122895341). In the same year

a waggonway branch was built to connect the Sauchie Number 9 pit (NS 8807694670).

The Shift to Malleable Iron Rails and Competition, 1841 to 1867

The Alloa waggonway was rebuilt again in 1841, this time using Bedlington Patent edge rails of malleable iron, fixed to stone blocks with cast iron chairs. This improvement allowed a horse and driver to move eight one ton waggons. The gauge of the new construction is not known but by this time most railways were being constructed to the British Standard gauge of 4 feet 8½ inches (1.23 metres). The first Edition 25 inch OS map shows the Alloa waggonway with one direct connection to the Devon Valley railway line at the Devon Iron Works, suggesting that they might have shared the same gauge.

In the same year the Ochil Turnpike Trust raised a legal action against the use of the Alloa waggonway, suggesting that coal should be carried by the turnpike road. However, the court found in favour of the Erskine family. A similar challenge was offered to the waggonway in 1850 when the Stirling to Dunfermline Railway extension was proposed to the Devon Valley Railway. The railway company proposed construction work which would cut across the route of the waggonway, preventing coal being taken to the harbour. The Coal Company took the issue to Parliament and the conditions of the original Act were upheld. The Railway Act included bridges at Alloa (NS 8879593117), Sauchie (NS 8928093912, NS 8936094280 and NS 8939094285) and Fishcross (NS 8980095385). The Devon Valley branch line from Alloa reached a temporary terminus at Glenfoot (NS 9095896166) in 1851 and then Tillicoultry in 1852.

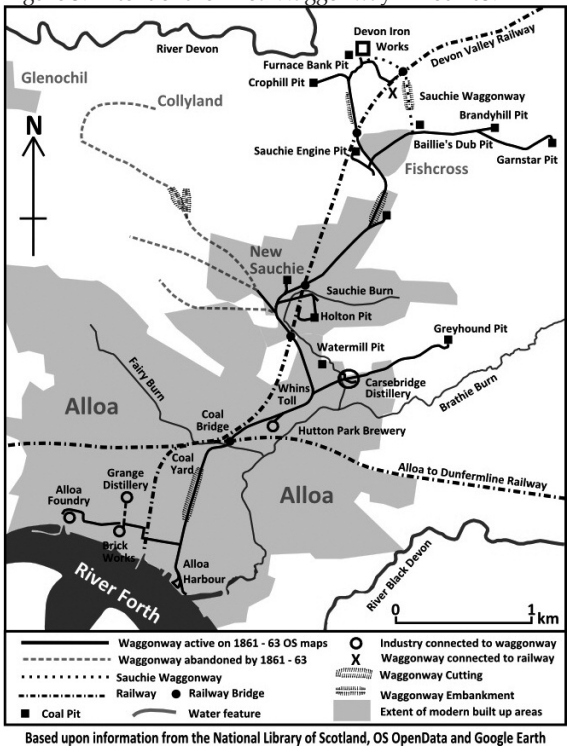
A map of the Alloa colliery in 1853 shows that a branch of the waggonway had been built from the Carsebridge distillery (NS 8967393555) to the Greyhound pit (NS 9049193789). This was the last branch built to a smaller-sized pit. In 1854 mining at the Devon colliery was stopped due to a serious flood and the workings did not resume until 1880. At the same time the Devon Iron Works was suffering serious financial difficulties leading to its sale that year. The furnaces were finally drawn in 1858 and, while their closure represented a loss of a 30,000 ton contract for the supply of coals from the Alloa Coal Company, the steady growth in sea trade and increasing demands from the railways helped to mitigate this loss.

The First Edition OS 25 inch maps of 1861 to 1863 show the waggonway was still extensive, despite having lost several of its earlier branches. An additional, separate "tramway" was shown alongside the shore at Alloa, connecting a brick and tile works (NS 8795392494) to the Alloa Foundry (NS 87601925910). There was a complex set of waggonway sidings at the shore (NS 883920) with two turntables leading towards the quay. The Alloa mainline railway had reached to sidings close the shore but there were no direct connections to the Alloa waggonway.

A New Partnership and a Change of Scale

The Alloa Coal Company was reconstituted in 1872, forming a joint partnership with the Clackmannan Coal Company. In the years before and after this reconstitution a considerable number of smaller pits were closed, accompanied by the abandonment of several of the waggonway branches.

Figure 5. Extent of the Alloa Waggonway in 1861-63.

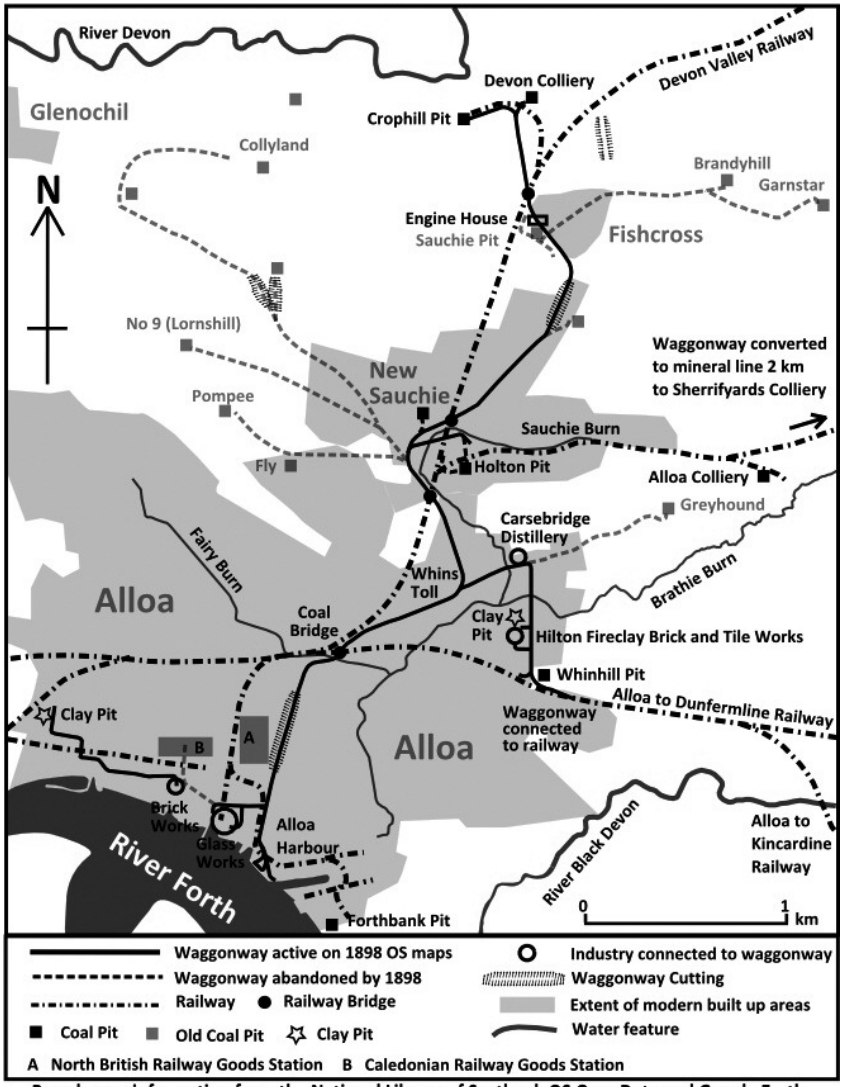


Based upon information from the National Library of Scotland, OS OpenData and Google Earth

During the same period, the Alloa Coal Company opened a smaller number of larger and deeper pits. Whinhill pit (NS 9009592838) was opened in 1872 and connected to the waggonway from part of the branch line to the Carsebridge distillery and the former Greyhound pit (NS 8993093597). It had a small branch into the Hilton Fire Clay Brick and Tile Works (NS 898933) and sidings alongside the Alloa to Dunfermline railway, but no direct connection to it. The Forthbank pit (NS 8867291783) was opened in 1875 with a main line railway connecting it to the Alloa Shore. The Alloa colliery (NS 9091193996) was opened in 1887 and the waggonway extended to it in 1889 from the Holton branch line (NS 8945394284). Sherrifyards colliery was opened in 1895 and Adamson noted a waggonway connecting it to the branch line to the Alloa colliery. However, both the Alloa colliery and the Sherrifyards pit are shown on the 1898 OS maps as being connected to the Devon Valley railway at Holton by a "mineral line", with no connection to the Alloa waggonway.

The Devon colliery became one of the largest Alloa Coal Company pits and the Second Edition OS 25 inch map of 1899 shows an "Engine House" (NS 8989995182) sitting across the single track line of the waggonway leading from the Devon colliery. Interviews with local residents suggest that this engine house was associated with an inclined plane used to pull waggons up the slope from the Devon colliery.

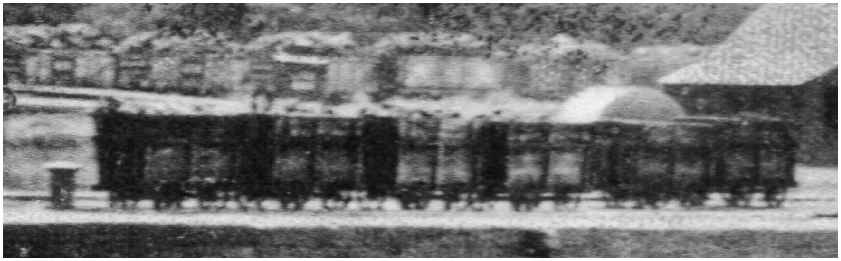
Figure 6. The extent of the Alloa Waggonway in 1898-99.



A postcard published circa 1903 shows a three-masted sailing vessel flying a Danish flag tied up at the quay of the wet dock.

Figure 7. A View of Alloa Wet Dock, circa 1903, © Yvonne Gill-Martin, 2015.

Figure 8. Detail of waggons.



A train of six coal waggons is shown on the left hand side of this postcard. They have a larger top than base, several vertical and horizontal strengthening pieces and spoked wheels. Note the contrast in size and shape compared with the larger, box-shaped railway waggons in the mainline siding in the background.

A Limited Company and Larger, Deeper Pits

In 1898 the Alloa Coal Company became a Company Limited by Guarantee and the Second Editions of the OS maps show the Alloa Waggonway as a single main line, connecting the Devon colliery (NS 897958) down past Holton to the Shore at Alloa. The branch line to Alloa and Sherrifyards Collieries was no longer connected to the waggonway at Holton, but was now a mineral line connected to the Devon Valley railway. There were still branch lines to the Carsebridge distillery, the Hilton Fire Clay Brick and Tile Works, the Whinhill pit and the Alloa Glassworks.

The Final Closure, 1924

The 1920 Second Edition, Revised 25 inch OS maps show the Alloa waggonway reduced to a main line running from Holton to the Alloa Shore with a branch into the Glassworks. There was a single branch to the Whinhill pit with a connection to the Hilton Fire Clay Brick and Tile Works (NS 898933) and the Carsebridge distillery. The small tramway from the brick and tile works at the shore to the clay pit had now been abandoned.

Following the end of the First World War a period of depression ensued, with rising costs, falling prices and industrial action in both mines and railways. The Alloa Coal Company was developing interests in even larger pits, many of them outside Clackmannanshire and, following further sales and price drops, the Alloa waggonway was finally closed in 1924

Conclusion

The Alloa waggonway was in turn a major asset to the Erskine family, the Erskine Trust and the Alloa Coal Company. In 1792, following the construction of the waggonway to the Alloa and Collyland collieries, the author of the First Statistical Account of Alloa reported that the "*Port has 115 ships registered of 7,241 tonnage with some 500 men employed. Greatest number of vessels engaged in the coal trade with exports to the Firth of Forth and the east and north of Scotland of some 50,000 tons, also some 6,000 tons, together with valuable quantities of glass bottles from the glass house are exported to Denmark, Norway, Germany, Holland and Portugal.* Previously this movement of coal would have required some 180,000, 6 cwt cart trips. Using the waggonway in 1792, it now only required some 12,000 waggon trips (3 waggons carrying 4.5 tons) and these trips were faster, less demanding of horses and drivers and caused much less damage to the valuable Great Coal. The introduction of malleable iron rails, circa 1840, enabled a horse and driver to move eight one ton waggons.

The value of the waggonway to the various owners is reflected by the regular upgrading of the line, its continuous use over a period of 157 years and its coexistence with mainline railways for 75 years, nearly half of its life span. While a substantial proportion of the network has been lost to redevelopment,

the lines of many have been preserved by their use as roads and pathways and a few have been well preserved in undeveloped land. The best preserved section is now a well-used pathway between the shore area and Alloa town centre.

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MOSSES, MAPS AND MUSKET BALLS: PINPOINTING THE LOCATION OF THE SHERIFFMUIR BATTLEFIELD

Tony Pollard

Introduction

This paper presents a summary of the results of an archaeological survey carried out by the author in 2006 in an attempt to establish the exact location of the Battle of Sheriffmuir, fought between government and Jacobite troops on 13 November 1715 in the Ochil Hills above Dunblane. The project was funded by Scottish Hydro-Electric Transmission Ltd and SP Transmission Ltd in advance of the construction of the 400Kv overhead power-line between Beauly and Denny.

The results of the fieldwork and associated research were first outlined in a preliminary 'grey literature' report by the author (2006a) and then in a published paper resulting from a battlefield archaeology conference in Halle, Germany (2009a), with the present contribution drawing especially heavily on the latter. Despite the previous appearance of much of the following the author is pleased to have the opportunity in the year of the battle's 300th anniversary to revisit the discussion and offer updated information where appropriate in a publication local to the battlefield.

Historical Background

With the death of Queen Anne in 1714, sister of Mary and the last Stuart monarch to reign (William and Mary having died without issue), and her replacement by George of Hanover all hope of a peaceful Stuart restoration was lost. The scene was set for a Jacobite 'rising', the first since 1689, one in 1708 having failed thanks to the interception of a French fleet by the Royal Navy off the east coast of Scotland. Conflict was fomented further when John, 6th Earl of Mar, who had served both William and then Anne, was denied royal favour by George, in part for his Tory affiliations. Mar returned to Scotland and in his *chagrin* raised the Stuart royal standard at a gathering of the clans at Braemar on 6 September 1715. In return, James Stewart, who probably only learned of Mar's intentions after the event (Szechi 2006: 99), showed him favour by confirming him as commander in chief, a post that had been expected to be held by Atholl, and raising him to the Duke of Mar. Thus, the 1715 rebellion was set in motion. The Jacobite cause quickly gained momentum.

The Jacobites took Perth without struggle and there the army grew. By October, Mar had well over 7,000 men under his command. On the government side it was left to the Duke of Argyle (*sic*), who unlike Mar was an experienced soldier, to put down the rebellion. Taken somewhat by surprise, the government

army in Scotland at the time totalled only around 3,500 men. But the Jacobites did not intend to confine their operations to Scotland, and in late October some 2,000 Jacobites under MacIntosh of Borlum joined with a force of English Jacobites at Kelso, though not before they had failed to take Edinburgh castle on their way south. The English campaign was to be confined to the north as the network of Jacobites tasked with rising for James in the southwest were either arrested or fled before they could be. The combined Scots-English force got as far as Preston before they were forced to stand and fight. The battle, which in reality was a short siege, lasted from 12 November to 14 November. After a bitter struggle the Jacobites were forced to surrender just the day after the battle of Sherrifmuir had sealed the fate of the cause in Scotland.

After leaving Perth on 10 November, the Jacobites under Mar, numbering some 6,290 foot and 807 horse (Historic Scotland Battlefields Inventory) halted on the eastern banks of the Allan Water around three kilometres to the north of the small town of Dunblane, to the immediate north of which Argyle's government army was camped. On the morning of 13 November the Jacobites approached the high ground of Sheriffmuir to the east of the town from their position on Kinbuck Moor. The long, upward march in formation, which required a move into column from line and then back into line again, proved too much for some elements of the inexperienced army and coherence was lost by the time they reached the top of the moor. The government force under Argyle, consisting of 2,200 infantry and 960 dragoons, advanced onto the moor from Dunblane in the west. Due to topographic features, including marshy ground, poor lines of sight and the hurried nature of the advance both armies outflanked the other's left (Reid 2004: 115-117).

On the Jacobite right, a charge, which went in after a delivery of musket fire, threw back the government left wing as it was taken in the flank, with the Jacobites pursuing them off the field to the south and east. On the Jacobite left the opposite occurred; a government charge by the dragoons put the left and centre into retreat – though contemporary accounts suggest that their departure was a little less rapid than that of their government foes on the other side of the field. With a running fight stringing out to both north and south the field was essentially abandoned. The retreating Jacobites fought their way back as far as the Allan Water, the government pursuit ceasing only once the crossing was made. Refugees from the government left flank ended up as far away as Stirling but the Jacobites had given up pursuit long before then.

When Argyle and Mar, who were heading the respective successful wings, returned from their forays, the Jacobites took up position on the hilltop and the government army in enclosures at the bottom of the hill. The day was drawing on and with a general unwillingness to re-engage, the battle drew to a close. Casualties on the Jacobite side are thought to be around 250 killed and wounded and on the government side, around 700 killed and wounded – around 600 were killed overall with the greater proportion being government troops (Historic Scotland Battlefields Register).

The battle is usually referred to as inconclusive, but there can be little doubt that Mar's failure to take the initiative and press home a second attack when the government army was still in disarray led to the failure of the short term strategic aim of the campaign, which was to cross the Forth and occupy the commercial and political heartland of Scotland. In turn, this failure led to the slow fizzling out of the uprising in the face of a continually reinforced government army. Even the arrival of the James from the continent in December was not enough to resuscitate the cause. But the Jacobites had only to wait until 1719 to rise again, though this time with Spain, not France as their ally.

Locating the battlefield

Just as there have been long standing debates surrounding the location of battlefields such as Bannockburn, historians have also disagreed about the battlefield of Sheriffmuir, with no less than five sites proposed. In truth though, these are within the same general area and not scattered about the landscape as much as the alternatives suggested for Bannockburn. Not surprisingly for a battle fought in 1314 there are no maps for the battle of Bannockburn, but the same might not be the case for a battle fought in 1715, by which time military cartography was a developed field (Pollard 2009b). However, there are no known contemporary battle maps for Sheriffmuir, nor is there a written account giving the locational information to be found on a map. A map in the National Map Library of Scotland (MS.1645.2.3/45b: not reproduced here), drawn up just after the battle, shows the initial Jacobite position on low ground near the Allan Water. Rather frustratingly, annotations on this sheet inform us that there is a second half of the map which depicted the actual battle location on the moor, but this sheet went missing long ago (Pollard 2006a).

Most historians place the initial battle lines to lie west of the Sherifffmuir Inn. Some have proposed an east to west orientation for the opposing battle lines (Reid 2004; Inglis 2005; Szechi 2006), while others favour a north to south orientation (MacKay 1898; Seymour 1979; Smurthwaite 1995). In addition, these writers also provide slightly different battle locations. The uncertainty may at first appear inconsequential to anyone but the fastidious military historian, but recently, the need to know the core of the battlefield's exact location became a key issue when it was proposed to run a high voltage power line across the area. It would obviously have been beneficial to be able to gauge the threat, if any, posed by this development to the site and any archaeological remains that might exist, including graves. Pinpointing the battle's location is probably the most basic function that archaeological survey techniques, such as controlled use of metal detectors, can perform, and so, putting this claim to the test, the present author was commissioned to do just that at Sheriffmuir.

The exercise was to prove the true value of combining documentary research, topographic survey and metal detector survey as part of a focused research strategy. Though there is a lack of contemporary battle maps, which contrasts with the battles of Glenshiel (1719) and Culloden (1746), there is a

relative wealth of battle accounts, from participants on both sides, including the commanders, Mar and Argyle. Other accounts passed down into local oral tradition, and some were collected in the 19th century. One such account came from *'An old woman, then residing at the farm-house of Linns, in the immediate vicinity of the scene,'* who *' used to tell that she saw eleven red coats killed on her own midden – the poor fellows defending themselves to the last…'* (Monteath 1885: 18). As the farm of Linns still exists in the landscape today, this account may provide an important clue as to the location of the lines and indeed their orientation, as it was the government left that fled and it is this incident which appears to be described here.

A further source of information is provided by a contemporary painting of the battle which has been reproduced in a number of histories (e.g., Smurthwaite 1995; Inglis 2005) but has never been given serious consideration as a possible source of evidence for the battle's location. The identity of the artist is currently a subject of some debate, with John Wootton and Peter Tillemans variously suggested (Wills pers. comm.). Whoever the artist might be, the painting is generally agreed to have appeared quite soon after the battle and represents an important contribution to the portfolio of battle paintings from the Jacobite era, which also include depictions of the battle of Glenshiel (1719) and Culloden (1746), the former by Tillemans and therefore possibly by the same hand.

Although the painting shows the armies' lines arrayed with parade ground neatness, which was far from the reality, there are touches of detail, which do suggest familiarity with the events of the battle. The government army is shown in the foreground still marching past the Jacobite line, presumably having turned off the road to the left, where the line is outflanked by the Jacobite right. Very much in accord with eyewitness accounts, the Jacobite right is delivering fire into the government dragoons opposing them.

Close correlations between the actual and painted landscapes at Sheriffmuir were noticed by the author. A similarity is seen between the hills in the background of the painting and the road which runs down its left side, on which the Jacobite right and government left flanks are anchored, and the range of hills to the east of the site and the old road which can still be seen today as a footpath skirting the north side of the field, to the west of the MacRae monument (Plate 4a – photo taken from west). This appears to be the same road which is shown on the 1766 Division of Commons map by J. Lesslie (Figure 1) running to the south of the Gathering Stone and to the north of Linns. The date of the present road to the west of the MacRae monument is somewhat uncertain (the old road and new road merge at the MacRae monument but further to the west the newer road runs roughly parallel about 200 metres to the south of the old road, at least in the vicinity of the survey area – Figure 2). The newer road first appears on the 1817 map of the Kippendavie estate, which clearly shows it running past Stonehall Farm (this map is not reproduced here). Whenever it came into being, it does not appear on the

painting, which shows a distinct bend in the road which could be taken to correspond to the site of the MacRae monument built in 1915 (Plate 4b).

There is no trace in the modern landscape of the substantial ditch which runs alongside the road in the painting. This might represent one of the mill lades which appear on the 1766 Division of Commons map and the 1817 estate plan. On the 1766 map (Figure 1) two lades are shown, running parallel to one another in an east to west direction. The most northerly of these is marked as 'vestages of an old Water lead to Ardnbee Mill, Kippandavie', while the one not far to the south is labelled, 'Mullins new water lead to Kippandavies mills.' Of the two, the most likely to be on the moor at the time of the battle is obviously the old lade, which, as in the painting, runs quite close to the road. The new lade also appears on the 1817 estate plan and then on the 1st Edition Ordnance Survey map of 1866. This later feature can still be seen today as it passes across the moor to the east of Linns (running through Area 3 in Figure 2) and in places has been recently re-cut as a drain.

The apparent relative accuracy of the features depicted suggest that the artist might have visited the battle site, although this does not necessarily mean he portrayed the battle in the right place within the landscape. But based on this interpretation of the landscape, as depicted by the painting, the opposing sides would appear to be oriented north to south. This position accords with the locations of the initial battle-lines previously proposed by several historians (Smurthwaite, MacKay and Seymour), though matching most closely to MacKay's and Seymour's placements.

The assumption that the painting depicts a view which could be relocated in the landscape motivated the next stage of the survey. This was an attempt to recover evidence for the delivery of fire from the Jacobite left, which according to contemporary accounts must have resulted in the deposition anywhere on the field of the most concentrated quantities of musket balls, and which therefore might provide a location which could be tied down archaeologically through metal detector survey.

Some idea of the heavy nature of this fire can be gleaned from a description of the situation on the Jacobite left by a government officer, Colonel Blackadder: '*The Highlanders fired by ranks each rank retreating and not in platoons. They were fifteen man deep. My Lord Argyle seeing this disposition and that they did not endeavour to outwing him though so numerous concerted with Major Cathcart who commanded the Grays that he should march to the right leaving about 100 paces open and so flank them as they stood 15 man deep'* (Steuart 1910: 70-71). It should be noted that Blackadder was the commander of the Glasgow Militia, which during the battle was tasked with protecting Stirling Bridge, so his accounts of the fighting, though collected almost immediately, are second hand. The annotation to the contemporary map notes that in forming the Jacobite second and first lines became confused and *'made but one line 6 or 7 men deep'* (MS.1645.2.3/45b). This heavy fire from the Jacobite left is also alluded to by

others. Rae, drawing on various accounts states: *'The Highlanders, as was there custom, begun the fire, levelled particularly at the Dragoons (the weight whereof fell most up Evans's, which made that brave corps reel a little) was as good, perhaps as ever came from any disciplined troops'* (1718: 305). Rae is the only person to place a time on events, stating: *'…the constant fire of the Platoons of Foot in less than half an hour, put the Left Wing of the Front Line and the whole of second line of rebels to the rout'* (ibid: 305).

Rae's 'The History of the Late Rebellion,' published in 1718 is important because it is in part based on interviews with those present. Frustratingly, neither book includes a map of the battlefield though the author does make reference to a plan (which could be the 1715 map discussed above).

If a north to south orientation is assumed, then a likely location for the Jacobite line was along a ridge which runs south of the Macrae monument and rises to the west from the Linns field. This area fits well with the painting and would certainly provide an advantageous position for the Jacobites, giving them a slope down which they could launch one of their infamous Highland charges into the face of their foe (a reputation most obviously earned at the Battle of Killiecrankie in 1689).

In order to test this orientation, a metal detector transect was established on the south end of the ridge, commencing on the ridge itself and running down slope to the west. The transect location was in part dictated by gaps in the vegetation and also influenced by the presence of a watercourse that ran down the slope from a marshy depression. Many accounts mention a morass, which disrupted the Jacobite left, preventing the deployment of the cavalry on that wing and forcing the infantry to stand in deep ranks. It was hoped that the transect would provide at least some impression of the Jacobite fusillade in the form of musket balls and perhaps the government assault in the form of horseshoes shed during the charge up the relatively gentle slope. Alas, not a single find related to the battle was recovered.

To maximise the possibility of recovering evidence, a second transect was set up on the same orientation further north. Once again, not a single relevant find was made. It is possible that the musket balls landed on the level ground at the base of the ridge slope, which unfortunately at the time of the survey was covered by a screen of trees. Beyond the trees in the field itself, just two musket balls were recovered from a transect running along the eastern edge of the field (Area 1 on Figure 2). These might have been fired by Jacobites on the ridge but the fact that only two were recovered is not suggestive of the massed volleys fired by the Jacobite left into the oncoming dragoons.

This absence of battle material related to the action on the Jacobite left did not fit with the orientation of the battle lines portrayed in the painting, which of course may have been subject to some artistic licence by the painter. Counter to the earlier argument for accuracy in 18th century battle paintings, it would

not be the first time that an artist had taken liberties with the landscape when depicting a battle. In his depiction of the battle lines at Culloden, for instance, Thomas Sandby, who was at the battle and created a very accurate map, chose to depict the view from the north but showing the Moray Firth in the background to the south, when actually it was to the north of the battlefield. This movement enabled Sandby to not only show the battle to best advantage but also the British fleet anchored in the Firth.

Although it is important to note that the metal detector survey's extent and location was in some cases severely limited by the availability of suitable ground, large tracts of which are today covered by conifer plantations or tall grasses and dense moorland vegetation, the total absence of finds did cast doubt on this north to south orientation for the battle lines. The field at the base of the ridge, occupied by the farmstead at Linns did contain some battle-related artefacts, with the first survey transect running across it containing musket balls, a complete horse bit, and several coins and buttons. However, the dispersed patterning of this material was suggestive of peripheral action, possibly related to the retreat of Argyle's left, rather than the intense fighting expected closer to the initial action.

In order to expand these early results, the survey was extended to the field north of the modern road (Figure 2). The old road, apparently used by the government army to get onto the moor, and thought to be depicted in the painting, runs along the field's northern edge. After finding three musket balls on a single transect running through the centre of the field, it was decided to detect as near 100 % of the field as possible. Five more musket balls were recovered: local information suggested that more had been recovered in the past by a metal detectorist. Other finds that could be associated with close quarter fighting, including buttons were also recovered here. A number of horseshoes possibly dating to the time of the battle were encountered. Horseshoes are problematic as they could be expected to appear in any farmer's field. At Sheriffmuir, however many horseshoes appear to be of some antiquity, on the basis of their rough and ready style. They were certainly present in far greater numbers than one might expect for a typical field, on the basis of many metal detector projects carried out across agricultural land in the UK. Perhaps tellingly, the horseshoes were accompanied by two broken snaffle bits, one of them from close to Linns farm, which might indicate violent action. They are certainly not something usually lost in casual use.

Overall though, relatively low concentrations of battlefield material were recovered from this part of the site, and their location and character suggested that they related to the retreat of the government's left flank. Perhaps the most striking find was a silver shilling of William III, which dates to around 1695-1700; it is not possible to be more specific in date as the coin is well worn, with only the top of the king's head visible (Plate 5). Despite its poor condition, or perhaps because of it, the coin is of some interest as it possibly represents an example of the proverbial 'king's shilling' given to a recruit when he joined the

army. Some soldiers kept these pieces as charms and this appears to have been the case here, with the coin rubbed almost flat between its owner's fingers; similar examples have come from Culloden and the site of Fort George. There seems little doubt therefore that this coin was dropped by a government soldier as he fled the field; it may even mark the site of his death.

The pattern building up in the detected fields certainly tied in with the accounts which referred to a running fight, which given its location around Linns seems associated with the collapse of the government left. However, the evidence was not enough to establish the two armies' orientation, as the government line could effectively swing through the pivot point provided by the left, not far, from the foregoing, from the Macrae monument, which could therefore lie either north to south or east to west.

The Morass (Location B)

The earliest known map, the 1766 Division of Commons, depicts the traditional 'crossed swords' symbol for a battle site not far south-east of the Gathering Stone and north of the old road. The Gathering Stone is a collapsed prehistoric standing stone today popularly associated with the location of the Jacobite standard, which was known in 1766 as the Karlingstone. Although either location A or B could be interpolated from this pinpoint location (which does not show battle lines), the only morass shown which was likely to have interrupted the Jacobite left's deployment (the Black Moss of Cairnstoun) would place the Jacobite line in Location B. No areas of moss or morass are shown in the area corresponding to Location A, although a series of water courses shown running off the moor here might suggest wet ground and there was some indication of this during the survey.

The position of the morass or moss, which appears to be quite extensive, in relation to the roads on the moor (as shown on the map) suggests that it was not far from the Sheriffmuir Inn, the construction of which post-dates the map. It should be noted that no areas of morass or moss are shown on the mid 19th century 1st Edition Ordnance Survey map in either location. The location of the moss/morass suggested by the 1766 map would place it somewhere in the forest north and west of the Inn. Even at the time of the survey in 2006, the ground within this woodland was so wet and mired as to make passage down firebreaks and through clearings almost impossible, with considerable standing water in places. It therefore seems likely that this overly wet ground corresponds to the moss shown on the 1766 map.

In different circumstances, the Jacobites could have used the morass to their advantage, protecting their left, but the fact that the government army was matching them in line almost as soon as they crested the hill gave them little opportunity to pick their ground. However, the ground did not make the fight on the Jacobite left a walkover for the government right, as Anstruther, a government dragoon, describes: *'…my horse got on end and his hind feet sunk in*

the marshy ground we were formed which made him fall back upon me and I concluded he had been killed dead but he immediately got off me, I kept the reins and got him mounted again with great difficulty for the balls were flying so thick that the horse did not stand long in one posture and I had the good fortune to escape with some bruises' (quoted in Inglis 2005: 48).

The Division of Commons map may also hold a further vital clue to the exact location of the armies when battle commenced. In his account of the battle General Whitman, who was in command of the infantry on the government right and followed up Argyle's pursuit of the Jacobite left, wrote: *'The right of their line, which vastly out-wing'd us, lay in a hollow Way, which was not perceived by us, nor possible for us to know it, the enemy having possession of the Brow of the Hill; but the Left of their army was very plain to view* (Patten 1717: 159). Given the east-west location of the armies proposed above, could it be that the hollow way Whitman refers to is the 'old water-leat' shown in the location where the Jacobite right is likely to have been positioned. The leat crosses the road from the north, opposite the Black Moss of Cairnstoun and then runs in a roughly westerly direction to the north of the old road. Although a 'vestage' in 1766 it might well have represented a ditch of some substance in 1715, and thus provided some concealment for Jacobites as the government army marched across their front.

The reality of accepting an east to west orientation (location B) is that much of the battlefield had, at least in 2006, been lost beneath the tree plantations which then extended to the west of the Sheriffmuir Inn and surround the Gathering Stone. Pockets of archaeological survival do exist, as demonstrated by this project, but these in the main appeared to relate to the periphery of the main battle site.

Since the survey took place in 2006, a large area of forest (probably well in excess of 400 metres by 500 metres) has been cut down in the area to the west of the Sheriffmuir Inn. The impact of this clearance on the perception of space is dramatic, exposing as it has an impressive area of flat open ground with the capacity to accommodate large numbers of men in battle formations. This makes it much easier to envisage the core battle taking place in this location. Alas, an attempt to locate the mill lade shown on the 1766 map failed, the most likely conclusion being that thanks to the impact of forestry planting it no longer survives as a visible feature. Likewise an attempt to locate battle artefacts through metal detecting also failed. The destructive impact of forestry on battlefield remains has already been identified at Culloden, where not a single relevant artefact has been recovered from within the area formally occupied by forest (Pollard 2009a).

The importance of the peripheral areas should not however be underestimated as the battle of Sheriffmuir was characterised by running fights to which much evidence seems to relate. The retreat routes would certainly benefit from further investigation, with local accounts suggesting the

presence of burials in the vicinity of Linns, and large open areas suitable for detector survey still remain un-examined. With this in mind, it should also be noted that areas some distance from the core of the battle might also contain archaeological evidence for fighting. Most notable is the area close to the Allan Water, east of Kinbuck, where the Jacobites were hard pressed by Argyle's army as they tried to cross the river.

Afterthoughts

The archaeological survey at Sheriffmuir resulted in the recovery of a low-density scatter of battle-related material from across a relatively wide area. When viewed in isolation it would be difficult to apply much in the way of a meaningful interpretation to this pattern. However, when viewed in conjunction with the written accounts, the cartographic evidence and the topography a clearer picture emerges. An east to west orientation seems far more likely than the north to south position suggested by the painting and some of the modern historical interpretations of the event.

This conclusion does not accord with the best visual correlation between the painting and the landscape, or rather, that was until it was pointed out to the author by local land-owner Richard Stirling-Aird that the hills in the painting may in fact represent a range some further distance away to the north west of the battlefield, a perspective which would make the orientation of the armies depicted as from east to west, as appears to have been the reality. Such a conclusion might also tie in with the depiction of a body of troops on one of the hilltops. These most likely represent Rob Roy's men, who according to tradition were positioned at Culling, near Cromlix, to the west of the battlefield, from where they observed events and remained neutral due to the apparent inability of either side to secure a victory (Reid 2014: 162). This location would certainly tie in with the hills in the painting being to the north-west of the battle rather than the east, as was first proposed, and therefore with the battle lines oriented east to west. This does, however, place the road in the wrong place, as it runs perpendicular to the alignment of the armies rather than parallel to them. What this latter point perhaps emphasises is that there will always be some artistic licence in such paintings and that too much reliance should not be placed on them as sources of information.

An unfortunate implication of this conclusion, that the battle lines were drawn up in position B rather than A, is that today the site of this initial encounter lies beneath forestry which covers the northern flank and summit of the moor. It may be possible to get a better impression of the landscape as it existed in 1715 if areas of forestry were removed: indeed at the time of writing trees were being cleared from the area of the Black Moss of Cairnstoun as the wet ground does not provide a stable foundation and the trees are prone to toppling in high winds. However, work carried out at Culloden (Pollard 2006b) has suggested that metal artefacts do not survive well in areas which have been previously commercially forested – the deep ploughing causes serious damage

and then the acid soils promoted by the trees can cause accelerated metal erosion. Pockets of archaeological survival do exist outside the forested areas but most of these are likely to relate to the pursuit of the right and left flanks by their opposing numbers.

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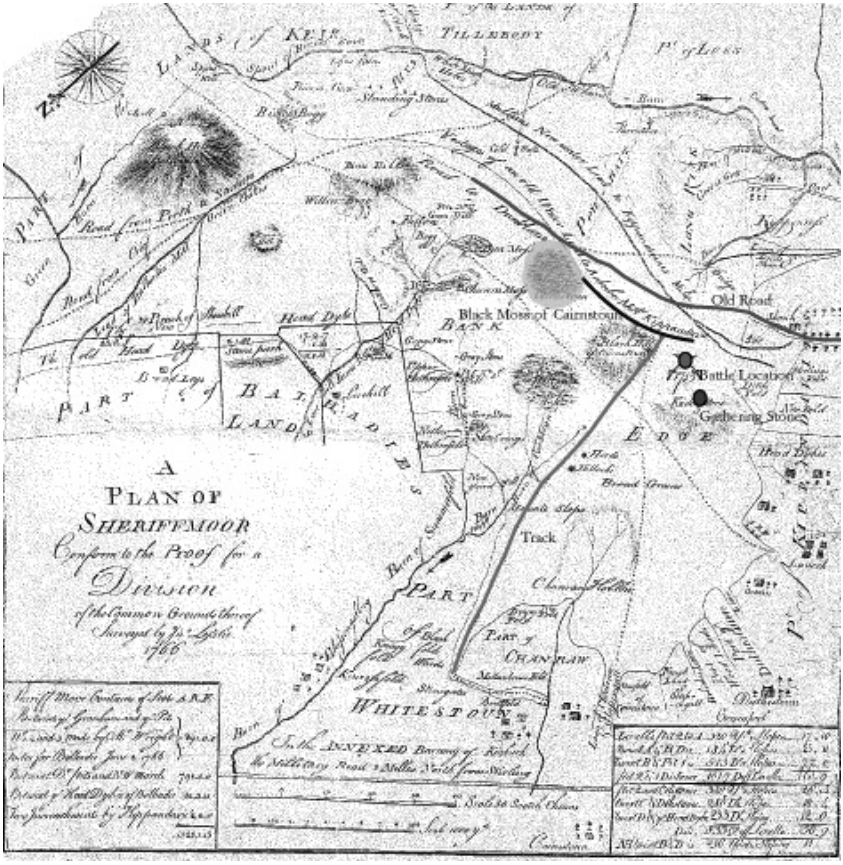

Figure 1. The 1766 Division of Commons Map of Sheriffmuir with features in the text superimposed.

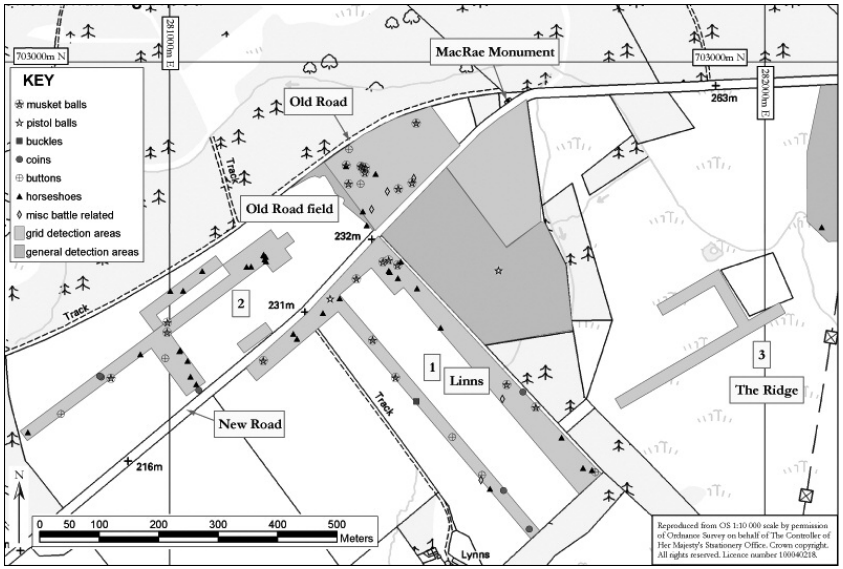

Figure 2. Areas surveyed and the finds.

AN ENVIRONMENTAL HISTORY OF THE DEVON COLLIERY 1792-2014

Jennifer L. Geller

Summary

This paper seeks to expand the concept of edgelands, originally proposed by Marion Shoard, to include the natural and cultural qualities that identify and describe their evolution. The primary aim of this study is to formalize the concept of edgelands in order to better preserve their legacy. In order to accomplish this goal, the study focusses on the natural and cultural evolution of the site of the former Devon Colliery and Iron Works, located in Clackmannanshire, Scotland, between 1792 and 2014. Historical records as well as scientific data are used to examine the impact of coal mining on the site's environment. The story of the site is then used to analyse the processes which create, maintain, and transform edgeland spaces. Three criteria are used to define edgeland status: the location and physical qualities of the Devon Colliery site, management practices used at the site, and the site's environmental quality. These criteria are examined in each of four chronological periods covering the life of the site. Finally, the paper concludes by arguing that an expanded conceptualization of edgelands is necessary for the most effective preservation of their legacy.

Key words: Alloa Coal Company, Clackmannanshire, Devon Colliery, Edgelands, River Devon.

Background

"There is probably no Scottish county so underrated as Clackmannan," wrote John Carvel in 1944. "One would never gather," he continued, that "the slopes rising from the plain of Clackmannan were grander than those in any other part of the range…hillscape, romantic river stretches, deep ravines, woodlands, fertile carselands, all are here" (Carvel 1944). Yet the real mystery is why Carvel chose to conclude his history of Alloa Coal Company, one of biggest industrial concerns in Clackmannanshire from 1835 to 1946, with this paean to the pastoral sublime. He would have been more than well aware that the Ochils and the River Devon valley had cloaked not only coal pits, but also silver mines, textile mills, distilleries and bleach works throughout its history. Carvel's remarks highlight the two hundred year paradox of the wee county's historical landscape: the county, despite its pockets of industrialisation, never urbanised. The hillfoots villages remained villages and agriculture never completely disappeared from the carseland, but neither did the region's rural environment remain pristine.

Of particular interest within this landscape is the transformation of the site of Devon Colliery, originally owned by the Erskine family, as well as the

location of the former Devon Iron Works, established in 1792 by the Earl of Mansfield (Carvel 1944). The colliery and iron works sat on the banks of the River Devon, almost exactly half-way along a six mile transect between the Ochils to the north and Alloa to the south, and on the apex of a triangle between the hillfoots villages of Alva and Tillicoultry. Thanks to the efforts of the Erskine family and the Earls of Mar, developments particular to the site began to set it apart as a unique environment in Clackmannanshire even before the full onslaught of industrialisation made itself felt nationally. From its earliest inception the site was an ambiguous one, as the colliery and iron works began to send out shoots of industrialisation into the surrounding pastoral landscape. Even after Robert Bald resigned his post as Devon Colliery mine manager and John Francis Miller Erskine relinquished control of the site to the newly formed Alloa Coal Company in 1835, the paradoxical nature of the landscape remained strongly evident (Carvel 1944). Mine flooding in 1854 prompted Alloa Coal to suspend production at Devon Colliery and in 1858, Devon Iron Works went out of business (Carvel 1944; *Alloa Advertiser* 29 March 1856). Contemporary accounts of the area virtually ignored these developments, favouring instead to depict the Devon district as the "…most beautiful, attractive, and salubrious locality" (Lothian 1861). By 1882, however, responding as did the rest of Scotland and Britain to the greater demand for coal, Alloa Coal reopened the colliery, sinking a 600 foot shaft and investing heavily in other infrastructure in order to begin mining on a truly industrial scale (*Alloa Advertiser*, 1 May 1880; 9 September 1882). The attempt to master the natural environment of the coal mine between 1835 and 1882 resulted in the creation of a wasteland unfit for any further agricultural pursuits. Furthermore, such substantial anthropogenic activity led to tensions between above and below ground developments at the site, thus reinforcing its enigmatic qualities.

Over the course of the next half century, Devon Colliery became increasingly isolated in the landscape as it expanded under the river and underwent further mechanization. Along with this invisible expansion came correspondingly greater amounts of visible pollution. The first report attributing pollution on the River Devon to coal mining surfaced in 1893, followed by further complaints made in subsequent decades up until National Coal Board (NCB) take over of the Devon Colliery in 1946 (National Archives of Scotland, DD13/2662). Despite the mine's visible impact on the environment by the mid twentieth century, the mine itself remained invisible to the public eye. The lack of effective local or national intervention in mitigating the problem at its source indicated the ambivalence felt by the public toward a place it found so easy to ignore, further isolating it from the surrounding landscape. Indeed, this was to remain the case during NCB takeover of the mine in 1946 and into the final fourteen years of the Colliery's existence.

Following its closure by NCB in 1960, the Devon Colliery site remained disused for fifteen years, a classic wasteland, even more easily avoided by the public than when it served a crucial economic role in the community (National Archives of Scotland, CB276/14/1). The Central Region Council (CRC) took

responsibility for mitigating the derelict site beginning in 1976, then, upon completion of this task, purchased it from NCB in 1979 (Stirling Council Archives LB7, CR1/1/10). Subsequently, the CRC and the Clackmannanshire District Council (CDC) shared management of the site, leasing it to various organizations and individuals until the land was transferred to CDC in 1988 (Stirling Council Archives LB256, CR1/1/26). Today, one can no longer, as Carvel did, look "back across the valley from the main road into Tillicoultry" and "pick out the old slag-heap of the Iron Works projecting toward the river" (Carvel 1944). Instead, haphazard farms and the Scottish Society for the Prevention of Cruelty to Animals' (SSPCA) wildlife rescue centre have superimposed themselves on the mitigated bing of the former Devon Colliery.

In contemporary terms, this site can be classified as an edgeland, a concept first introduced by Marion Shoard in 2002. Located beyond urban centres, not quite rural, yet still isolated, oftentimes a wasteland of former or neglected industrial activity, sometimes unregulated and unmanaged, edgelands are ambiguous, contested and difficult to categorize and as such, capture our imagination as well as our desire to define and quantify (Shoard 2002). The Devon Colliery site represents what Shoard would refer to as an "interfacial rim" separating Alloa from Alva and Tillicoultry (Shoard 2002). The River Devon itself serves as the boundary between the poorer grazing land which replaced the mine on the south bank and the more aesthetically-pleasing carseland on the north bank. The various incarnations of the colliery site following abandonment also fit Shoard's description of edgelands as places that "…assemble themselves in response to whatever needs are thrust upon them," including in this case grazing, horseback riding and wildlife rescuing (Shoard 2002; Stirling Council Archives LB113, CR1/1/10; LB256, CR1/1/26).

Despite their present-day designation, edgelands have existed at the intersection of nature and culture ever since industrialisation began to transform the British landscape in the late eighteenth century. This study seeks to expand the current notion of edgelands and give them an historical context by examining the natural and cultural changes wrought by coal mining at the site of the Devon Colliery and Iron Works between 1792 and 2014. From its origins as an industrial base in an otherwise agricultural setting through its maintenance as a "space between" followed by its attempted transformation through mitigation, this study uses methodologies from both history and science to define the former Devon Colliery as edgeland according to three criteria: location and landscape transformation, management and planning, and environmental quality and change. Finally, this study demonstrates that formalising the concept of edgelands has important implications for the future management of these spaces as symbols of Scotland's industrial heritage.

Agriculture Versus Industry 1792-1835

The origins of the ambiguity of the Devon Colliery and Iron Works site reach at least as far back as the late eighteenth century when when local estate

owners including the Erskines and the Earls of Mansfield began to take interest not only in the new agricultural techniques that had helped generate the improvement across Scotland, but also in other forms of income-generating activities, including coal mining and iron smelting. Between 1792 and 1835, these estate owners created a landscape in which agriculture and industry coexisted uneasily along the banks of the River Devon. Within its boundaries, this landscape contained the means to industrialisation, yet the profits produced there were used to enhance established agricultural estates. During Robert Bald's tenure as the Erskines' mine manager in particular, the need for these profits was countered by an early awareness of the impact of industrial activity on a pastoral environment. His decisions indicate that he never fully resolved the dilemma between environmental and economic interests, resulting in an inconclusive impact on the environmental quality of the site.

Contemporary accounts of the site reveal the tension between nature and culture in this particular corner of Clackmannanshire. In his *General View of the Agriculture of the County of Clackmannan*, John Francis Erskine himself described the "pleasant vale of the Dovan," which was "very fertile and bears excellent grain" in practically the same breath as he described the Devon Iron Works with its "two furnaces, each upwards of 40 feet high by 14 feet in diameter" (Erskine 1795). The *Old Statistical Account* (*OSA*) reported similarly that "[T]he improvement of agriculture has, indeed, been most uncommonly rapid in this little corner," while also noting with admiration that the Devon Iron Works "merit the attention of the curious in mechanicks and architecture…Inftead of the ufual method of building with ftone and lime, the ferveral parts of the works have been formed…by excavations made in the rock" (*OSA* 1799). Iron making in the midst of Erskine's "pleasant vale," then, was part and parcel of the "natural" landscape, with the land itself providing not only the raw materials, but also the facilities for processing these materials.

The same held true for mining at Erskine's Devon Colliery which produced the coal powering the Iron Works' blast furnaces (*OSA* 1799). As part of the Sauchie coalfield, Devon Colliery would have had access to four coal seams, including the three feet, the upper and lower five feet seams, and the nine feet seam. At the turn of the eighteenth century, the engine pit was 282 feet deep (*OSA* 1799). The OSA, however, made disparaging remarks concerning the under-utilisation of these natural resources, noting: "[T]he Devon company have been tackfmen of the coal for more than a year and a half, but have wrought non, except a very fmall quantity for land fale. The defign of taking a coal, without working it, is *incomprehensible*. While coals remain underground, they are of no value, either to the proprietor or the tackfmen" (*OSA* 1799). The *OSA* had similar reservations about the ability of the iron works to develop fully. It "acknowledged…that the eftablishment of the Devon Company, in the immediate neighbourhood, will, perhaps, overbalance all thefe apparent disadvantages, though the writer of this account is by no means fanguine in his expectation of that effect" (*OSA* 1799). Despite the activities at both the iron

works as well as the colliery, then, the site was not fully exploited for industrial purposes at the turn of the eighteenth century.

This, however, did not mean that tension did not exist between the landscape of the colliery and iron works and the adjacent agricultural land. By 1819, thanks to the ingenuity of the Balds, the pit at Devon Colliery had extended to 704 feet, thereby easily accessing the nine feet seam (Bald 1819). Such decisions by the Balds to alter the natural landscape by sinking coal pits hundreds of feet below the surface began to define a landscape which, once these pits were excavated, would not be fit for future agricultural purposes. Although not yet an "industrial" site, its physical qualities including the locations of the coal seams, the River Devon and the use of the sandstone banks themselves for blast furnaces set the site apart from both its more urban as well as agricultural neighbours, establishing its origins as an edgeland.

The planning and management of the Devon Colliery site in the early nineteenth century was not a straightforward question of sacrificing the environment for economic gain and the environmental results of this dilemma created the origins of this edgeland. Robert Bald's writing indicated that he was presciently aware of the impact of coal mining on the environment. In 1819 he noted: "[T]hough the total removal of the alluvial cover might, in one view, appear to be of great advantage…this advantage would be greatly outweighed by the disadvantages, not only in the want of soil for cultivation, but…the coal-mines would be deluged with water every rainy season" (Bald 1819). Nowhere is Bald's understanding of the environmental consequences of coal mining more apparent than in his comments about the exhaustibility of Scotland's coal mines. He wrote: "Even if the Grampian mountains were composed of coal, we would ultimately bring down their proud and cloud-capped summits, and make them level with the vales" (Bald 1808). How these ideas informed Bald's practice at Devon Colliery is unclear. One is tempted to conclude based on them that Bald did not fully exploit the Erskines' coal although whether this practice was motivated by the quantity or price of coal or concern for the environment is also not evident. Regardless of intentions, Bald's decisions resulted in environmental change. The continued ambiguity of the site lies in whether or not this change had actually damaged the site's environment as early as 1835, or whether the degradation was yet to come.

Below Versus Above Ground Development 1835-1882

Under the management of the Erskines and Balds, conflict between the natural and the cultural landscape created the origins of the Devon Colliery edgeland, but between 1835 and 1880, tensions between above and below ground environments replaced this struggle and lead to the initial formation of a wasteland. In 1838, William Mitchell, co-founder of Alloa Coal along with John Moubray agreed "to erect two steam engines and engine houses, the one for pumping water and draining and the other for winding the coal in the aforesaid (five feet) seam….The tack also includes the whole machinery, engine

houses, shops and warehouses erected or to be erected by the tenants" (National Archives of Scotland CB24/150). Then, according to mining engineer David Landale in 1851, at the Furnace Bank pit of Devon Colliery, "[A] large fitting was begun which would have won at least 1,680,000 tons of coal or 60,000 tons a year for 28 years. The pit was sunk about 90 fathoms and has only ten more to go to the lower five foot seam" (National Archives of Scotland CB24/143). The age of steam power and the subsequent ability to significantly expand mining processes had arrived on the banks of the Devon, dominating the above as well as below ground landscape. With the colliery no longer part of an agricultural estate, there was little danger that agricultural concerns might override mining decisions and the space as defined by the coalfield was free to become wholly industrial.

Despite its new license to expand, however, Alloa Coal still faced discrepancies between its above and below ground operations, lending the Devon Colliery landscape its edgeland qualities. William Paton, manager of the colliery from 1835 to 1865 deferred the fitting of the Furnace Bank pit as a result of excess water rising from "certain ill advised mines" in neighbouring Glenfoot (National Archives of Scotland CB24/143). In 1854 he suspended pumping, allowing "the enormous waste, extending for miles on the south, east and west…to fill with water" (*Alloa Advertiser* 9 September 1882). Excess water weakened underground mine structures such as roofs, pillars and floors designed to keep the pits open and workable, eventually causing these structures to collapse or sink, creating surface subsidence. In 1863, a plump opened up on James Johnstone's Alva property on the north side of the River Devon which he claimed was due to operations at Devon Colliery. Mining engineer John Williamson's report revealed that "[T]he plump is situated…12 yards from the River Devon….Its dimensions are 18 feet long…by 16 feet….It is six feet deep in centre…The bank has subsided into the hole." He concluded: "[I]t certainly requires a rather strong stretch of the imagination to conceive that so strong workings…at such a depth and filled with water could have been the occasion of such a hole as we have attempted to describe" (National Archives of Scotland CB 24/143). The invisible, underground cause of the visible surface damage along with Alloa Coal's continued inability to master the natural environment contributed to the enigmatic, edgeland character of the site.

The key turning point in Alloa Coal's above/below ground conflict came in 1873 when the new manager, Alexander Roxburgh began to prepare for the reopening of the Devon Colliery (Carvel 1944). Underground challenges were set aside in light of a report issued by mining engineers Mackenzies and Cowan revealing that nearly two million tons of coal were available in the 430 acre area of the Devon Colliery (National Archives of Scotland CB24/143). Over the next decade, Roxburgh led the charge above and below as Alloa Coal prepared to reopen its Furnace Bank pit at the site. A new 600 foot shaft was sunk, an 800 yard "dook" ran toward the valley of the river and a cross cut mine of 700 yards was excavated in order to access the nine feet and upper five

feet coal seams. This three square mile underground operation naturally required corresponding above ground transformation. A new engine "enclosed in a neat and commodious building" and a 36 ton beam which could lift five tons of water per minute were among the most notable components of the new industrial infrastructure (*Alloa Advertiser* 1 May 1880). When the colliery reopened in 1882, the *Advertiser* reported with a great deal of pride that the new mine which "…promises to be one of the largest in Scotland has been laid out in a manner which reflects the greatest credit upon all concerned" (*Alloa Advertiser* 9 September 1882). The extent of below ground activity made possible by the new and highly visible surface infrastructure must have been difficult for the general public to fathom. Such mystery would have created a sense of dislocation characteristic of edgelands.

One characteristic of Devon Colliery as an edgeland under the management of the Balds was its ambiguous environmental quality. Its corresponding edgelands characteristic between 1835 and 1882 was the transformation of the site into an early wasteland. If a wasteland is a space wasted for further purpose, then the site of Devon Colliery became such a place as it gradually passed the point where it could serve any function other than mining during this period. One example of the site's increasingly negative impact on the surrounding environment involved an 1854 court case between Robert Bald's trustees and Alloa Coal concerning water damage and subsequent subsidence. As defendants, Robert Bald's family argued that the water which Alloa Coal pumped out of the nine feet seam resulted in damage to the house they leased from the Erskine family, including "…various sits or crushes in and around his Mansion House and Garden that the walls of both have been rent and cracked from the foundations" (National Archives of Scotland CB24/111). The jury ruled that "it was obvious that injury to the pursuers property would follow from withdrawing the water" and that "injury might have been prevented had precautions been taken." Alloa Coal was held responsible for damages worth £1350 (National Archives of Scotland CB24/111). This case was a clear example of land degradation resulting from mining. No longer was the Devon Colliery site simply changing. Activities there were having deleterious effects throughout the neighbourhood, rendering it, in the words of the Balds' lawyer, "now just next to uninhabitable" (National Archives of Scotland CB24/111).

An 1875 court case brought by James Blair against Alloa Coal for damage to his farm land points to further evidence of environmental damage caused by mining during this period. The court ruled "…that respondents have no right to drive any mines, &c., through the petitioner's lands for the purpose of obtaining access to coal or any other minerals outside the bounds thereof" (National Archives of Scotland CB24/161). The case dragged on for two more years. In 1877, a lawyer wrote that the previous findings were "…only for the surface damage arising from the mining operations" which differed from whether or not Alloa Coal were allowed to go through the coal wastes under Blair's farm land as part of the mining process. According to this lawyer, "…Alloa Coal Company does have the right to make and use passages through

the coal wastes in the whole three pieces of ground" (National Archives of Scotland CB241/161). In the end, Alloa Coal was forced to pay Blair £70 for "expenses connected to surface damage and breach of Interdict," making Blair, if not the environment, the winner (National Archives of Scotland CB241/161). Whether or not Blair's primary motive in bringing this case against Alloa Coal was born of fiscal or environmental concerns, or whether it was out of spite against the competition from the larger, more profitable industrial concern is immaterial. His case proved that physical landscape change was having a negative impact even on land intended for agricultural purposes. Such rendering of land as waste is, of course, a common feature of edgelands.

Despite the arrival of full scale industrial mining operations to the Devon valley by 1882, mention of the Devon Colliery remained notably absent from contemporary accounts of the county. David Beveridge, who grew up in the county, noted in 1888: "Here too, [the Devon valley] strikes a visitor as being divested of the prosaic and monotonous surroundings which are often the characteristics of factory life." Rather, in Clackmannanshire, "rocky glens and cascades abut on the factories, and beautiful mountain scenery is within five minutes walk of the whir of the spindles" (Beveridge 1888). The same sort of awareness of the peculiarity of the region was demonstrated by William Gibson, also a native of Clackmannan, who wrote in 1882: "to any one who wishes to see the lovely valley of the Devon in all its beauty, let them take a bird's-eye view of it…and they will be amply rewarded for their trouble" (Gibson 1882). Like Beveridge, Gibson dedicated significant passages to descriptions of various manufacturing firms in the hillfoots villages, yet he wrote not a single word about coal mining. Gibson's "birds-eye view" apparently did not afford him the sight of the Devon Colliery and its brand new, sprawling industrial apparatus. If the above ground mining infrastructure was so easy to overlook, then how much easier to disregard environmental damage caused by below ground activity? The disconnect between what was happening above ground and the underground activities of Alloa Coal made ignoring the site effortless. As Shoard would say, Devon Colliery had become a mysterious no man's land that passed unnoticed, a "repository for functions we prefer not to think about" (Shoard 2002). For fifty years, Alloa Coal maintained Devon Colliery's edgeland status first established by the Balds nearly a century prior.

The Invisible Versus the Visible 1882-1960

From Devon Colliery's reopening in 1882 to its takeover by NCB in 1944, the continued invisibility of the mine in the landscape contrasted with the increasingly visible pollution it produced, thus contributing to the edgelands quality of the site. Between 1883 and 1909 the Colliery itself became even more isolated from the non-mining public as Alloa Coal extended the mine under the bed of the River Devon. At the same time, though, underground expansion naturally had the effect of increasing surface pollution, particularly that of the River Devon itself. As the river moved the waste emanating from its banks into

a wider context, the invisible became so much more visible that in 1893 the County Medical Officer of Clackmannanshire reported that the bed of the river was "silted up with coal washing 8 to 10 inches thick" for miles below the colliery (National Archives of Scotland DD13/2662). Unfortunately, however, the response by local and national authorities to increased complaints about the Colliery's adverse impact on the environment remained inconclusive for the life of the mine, further emphasizing its ambiguous, edgelands status.

The most noteworthy change in the Devon Colliery landscape at the turn of the century was the extension of the mine beneath the River Devon and on under Mr Johnstone's land in Alva on the north bank of the river (National Archives of Scotland, CB 24/150). By 1909, Alexander Roxburgh, followed by manager James Bain, had overseen the expansion of Devon Colliery to a total extraction area of 258 acres (Carvel 1944; National Archives of Scotland, CB 24/150). Although some hesitancy as to the efficacy and safety of mining under the river was initially expressed by mining engineers David Landale and John Williamson, Alloa Coal ultimately followed the advice of David Rankin (National Archives of Scotland CB24/150). Rankin noted that keeping "the working at a safe distance from the River Devon so as not to disturb its bed by subsidence or check the flow of water there in" was critical to the performance of the mine, but felt the mine would be safe as long as the longwall method was not utilized and the stoops remained unworked (National Archives of Scotland CB24/150). The 1898 agreement with Mr Johnstone stipulated that Alloa Coal was "to continue the workings from Furnace Bank Pit and not to occupy any surface of Alva" (National Archives of Scotland CB24/150). Despite this precaution, the impact of this expansion was indeed felt even on the surface landscape. The deeper, more extensive pits created by increased mechanization brought with them greater amounts of waste. Six hundred tons of coal per day had to be separated from the dirt accompanying it to the surface. Washing plants were installed in 1913 and settling tanks became necessary by 1926 (National Archives of Scotland AF62/2360). Nevertheless, the waste ultimately ended up in the river. The transformation of the landscape brought about by greater quantities of pollution continued to set the colliery space apart from its surroundings, creating an even greater degree of isolation than did the establishment of the industrial infrastructure in the previous period.

Decisions made by James Bain, Devon Colliery's new manager beginning in 1899, had even worse repercussions for the environment than those of his predecessor. Up until Bain's 1910 renewal of the lease with Mr Johnstone, all agreements between Alloa Coal and surrounding landowners beginning in 1835 included the note that "…the lessees shall be bound…to restore the ground occupied by such pits, roads or waggon ways that are not necessary for the future carrying on of the colliery" (National Archives of Scotland CB24/161). Even the original 1887 agreement with Mr Johnstone stated that "for any such surface unrestored at the end of the Lease [the Company] will pay 25 years purchase of the agricultural value as provided in the current Lease" (National Archives of Scotland CB24/150). This language indicated that not

only were earlier managers of the colliery aware of mining's impact on the environment, they also recognized they held some financial responsibility for their role in rendering land unfit for future agricultural purpose. Unfortunately, in 1910, Bain abandoned this language. The proposed lease with Mr Johnstone which was to run until 1931 read: "[S]urface lowered or permanently damaged underlying the total area of extraction *not* to be claimed for, nor any compensation paid to agricultural tenants for crops grown thereon" (National Archives of Scotland 24/150). Bain's proposals were refutation of all previous leases signed by Alloa Coal and represented as great a turning point for the environmental quality of the site as did Roxburgh's more visible infrastructure changes (National Archives of Scotland CB24/150). James Bain and Alloa Coal were now making a clear statement about the supremacy of mining over the agricultural pursuits of their neighbours. The resulting degradation further isolated their territory by delineating it as a space in which they would have full latitude to pursue profits, regardless of the consequences of their ambition for future use of the land.

By the turn of the century, the environmental consequences of coal mining were gradually making the invisible more visible to public officials and private citizens alike. A report commissioned by the Scottish Board of Health in 1926 as part of an attempt to address river pollution pointed out that "[S]ettling tanks of a kind have been provided but are completely silted up and useless. The area is too restricted and adequate settling tanks are required to deal with the washing water, wagon drip and general surface drainage" (National Archives of Scotland DD13/2662). The impetus for this report came from the Devon Angling Association, formed in 1905 to "provide affordable trout fishing for the local community and to act to protect and enhance the river environment" (Devon Angling Association 2012). In 1926, the Association complained about the condition of the River Devon to George Donald, Assistant Sanitary Inspector for the Burgh of Tillicoultry. Donald corroborated the fishermen's observations that "one of the most serious sources of pollution is…the effluent from the Coal Washing Plant…at Devon Colliery" (Devon Angling Association Archives 1926). Even though the Scottish Board of Health ultimately ordered Alloa Coal to update their washers and settling tanks, the Angling Association at their 1927 annual general meeting reported that "coal dust from Devon Colliery…" remained "…the worst factor in the pollution question" (Devon Angling Association Archives 1927). The increased dereliction and contamination of the site itself during this time seemed to isolate it further from the surrounding communities even as it polluted them more.

In the early 1940s, national attention again focussed itself on the environmental quality of the River Devon and some effort was made to mitigate the effects of the colliery pollution. However, the reluctance to deal with Devon Colliery as the source of the waste highlighted the continued invisibility of the colliery itself to the public eye. A drainage scheme proposed by the Department of Agriculture and Fisheries in 1942 "for the improvement of agricultural land situated within the catchment area of the Devon" involved

dredging the stretch of the river directly below and above stream of the colliery. A draft of the drainage scheme noted: "[I]t is the opinion of the majority of landowners…that in addition to water from the pit workings being discharged into the river…a great deal of coal washings are also discharged directly into the river without going through any settling" (National Archives of Scotland AF44/282). Apparently the coal washing plants and settling tanks last updated in 1927 were insufficient to the task, yet there is no evidence that they received any further attention during the remaining eighteen year life of the mine. Dredging alleviated the symptoms, but there is no indication that any changes were made at the mine itself that could lessen its impact on the environment.

Indeed, this was to remain the case during NCB takeover of the mine in 1946 and into the final fourteen years of the Colliery's existence. The fact that no record of pollution complaints against NCB concerning Devon Colliery exist prior to abandonment in 1960 demonstrates just how much an edgeland the site had become, so isolated that it was impervious to regulation. From the 1880s, when the colliery became fully industrial through the turn of the century when James Bain refused to be held fiscally responsible for environmental damage, the Devon Colliery site was maintained as an edgeland, separate and free from the concerns of its neighbours. Ironically, the site's isolation only made its pollution more visible by the 1920s. Despite a growing public awareness of pollution and its consequences for the environment, the regulatory power held by either local, Scottish, or national authority was still too weak even by the mid twentieth century to have any demonstrable effect in controlling coal mine pollution. The Devon Colliery site remained an edgeland, caught between environmental concern on the one hand and legislative loopholes controlled by economic interests on the other.

Dereliction Versus Preservation 1960-2014

Following abandonment of the Devon Colliery by NCB in 1962, the site, derelict, unmanaged and without sanctioned purpose, entered the realm of the classic edgeland. Ironically, after two centuries of near invisibility, the landscape occupied by the former mine entered the eye of public officials as CRC began to make plans for its mitigation beginning in the mid 1970s. In taking responsibility for the site, CRC and later, CDC faced the edgelands management paradox: whether or not management of the abandoned site would allow it to maintain its edgeland legacy. However, management by regional authorities resulted in a resolution to this conundrum. They were able to simultaneously mitigate and preserve the legacy of the former colliery as an edgeland. Unfortunately there is little evidence of the impact of this management strategy on changes in the environmental quality of the site post abandonment, including the degree to which mitigation improved the sustainability and resilience of the site's soil. Laboratory analysis of the results of soil testing conducted at the site in spring 2014 do not give a clear picture of whether human and/or natural activity impacted the environment during

either mining or mitigation. This ambiguity only further emphasizes the edgelands characteristics of the site in the present day.

The former Devon Colliery site was officially classed as derelict by the Scottish Development Agency (SDA) in 1975 under the auspicies of the Town and Country Planning Act (Scotland) 1975 (Stirling Council Archives 9 CR1/1/4). Plans drawn by the CRC in 1977 for the rehabilitation of the derelict land at Devon Colliery show a tip 72.5 meters high adjacent to a space directly to the east consisting of extremely irregular, haphazard contours, with a peak elevation of 45 meters (National Archives of Scotland DD27/5114). An article in *The Scotsman* estimated the tonnage of waste at 40,000 (*The Scotsman* 1 December 1976). The proposed rehabilitation included spreading this waste north west to create a ten meter high bank on the Devon as well as using the spoil to even out the irregular contours on the east side of the bing so that at its highest elevation, the tip would measure 41 meters. The plans also indicate proposed plantings of a "deciduous/conifer mix planted as whips and forest transplants" along the boundaries of the rehabilitated bing (National Archives of Scotland DD27/5114). Meanwhile, soils were "being lifted from the low-lying agricultural land…the soils will be returned to cover the reshaped site…ready for grass seeding and tree planting in the Autumn" (Stirling Council Archives PD109, CR1/1/6). The actual mitigation of the site began on 30 August 1976 with the extraction of slurry of "marketable quality" by the South of Scotland Electric Board for use at the Methil Power Station (*The Scotsman* 1 December 1976). By January of 1979, I. Webster, the chief assistant director of planning for the CRC wrote to the SDA that "the derelict land rehabilitation scheme at the colliery is now virtually complete and I should like to undertake the proposed work to the Beam Engine House during the coming Spring" (National Archives of Scotland DD27/5114). Finally, on 19 April 1979, the rehabilitated Devon Colliery site extending to 131.39 acres was purchased by the CRC from NCB (Stirling Council Archives LB7, CR1/1/10). It could be argued that the deliberate wilding of the space by removing environmental hazards and returning the land to a more rural-looking landscape of grass and trees made the location ineligible for edgeland status. However, the effort to return the land to an agricultural state in conjunction with preserving the legacy of coal mining via the restoration of the beam house actually echoed the initial development of the space as edgeland between farming and industry two hundred years prior by the Erskines and Balds. If inadvertently, CRC's mitigation efforts preserved the enigmatic nature of the landscape, allowing its very ambiguity to become its legacy.

The CRC's interest in managing the rehabilitation of the former Devon Colliery demonstrates an intriguing attitude toward the site as an edgeland. Other sites designated for SDA rehabilitation funding during the same period, including the Nobel Explosives Factory in Redding or the Summerford Works in Falkirk had "potential after-use value," but the Devon Colliery was unique in its existence as a space intended only for rehabilitation (Stirling Council Archives CR1/1/4). The CRC noted that "[T]he site has a poor access and is not

well related to the labour market….it is not an attractive industrial site" (Stirling Council Archives CR1/1/4). Even though the site had no apparent economic value, CRC were willing to invest £200,000 in rehabilitation for environmental purposes, and paid NCB £112,750, or five times what they originally budgeted (Stirling Council Archives LB7, CR1/1/10). That the CRC was willing to pay so much more than the projected amount for the purchase of a site which did not have any immediate economic value indicates their commitment to creating a more environmentally sustainable area, along with the unintentional consequence of preserving an edgeland. The traditional conceptualization of edgelands management involves questions of how to manage without managing. The CRC answered this question by making the space safe without first assigning it another use.

Between 1979 and 1988, when CRC handed the site over to CDC, the land was let for grazing. Then in 1988, CDC invested £236,000 in capital expenditures to develop an equestrian centre on the site, in addition to repurposing the beam engine house as a ranger station and community space (Clackmannanshire District Council 1994). The Devon Equestrian Centre operated from 1992 to 2006 when management difficulties prompted the CDC to seek new tenants who would "make the most of Clackmannanshire's unique built and natural environment" (Stewart 2006). By 2010, the CDC was fortunate to be able to find just such tenants (Johnstone 2010). The SSPCA needed a location where they could care for injured wildlife that could not survive on their own in the true "wild," but a more urban setting for a wildlife centre was a contradiction in terms. The semi-rural, partially isolated nature of the former Devon Colliery location met the needs of the SSPCA whilst simultaneously allowing the CDC to fulfill their mission to utilize the site in a way that would "be compatible with the uses of the surrounding land" (Johnstone 2010). The CDC has managed to maintain the former Devon Colliery as a location neither urban or nor rural, almost invisible, yet still accessible, without having to resolve its paradoxical legacy.

Unfortunately, between abandonment in 1962 and mitigation in 1977, evidence of environmental change at the site grow thin, as might be expected of a location which has achieved classic edgeland status. That erstwhile keeper of the River Devon, the Devon Angling Association, reported only two possible coal related pollution problems between 1949 and 1971. In 1967, the Association did note that the river between Cambus and Tillicoultry needed to be dredged, yet they did not indicate whether coal waste was the culprit as it had been in the 1940s (Devon Angling Association Archives 1967). Between 1968 and 1973, mine pollution from the Dollar Mine was a significant concern to the Association (Devon Angling Association Archives 1968; 1971). The considerable pressure placed by the Association on NCB to clean up the discharge into the river from Dollar Mine indicate that, had similar issues of abandoned mine water drainage plagued the River Devon at the Devon Colliery site during this time, they would have likely been noted and even dealt with proactively by the Association.

To the naked eye, then, no obvious contamination of the Devon Colliery existed once mining ceased in 1960, but less obvious clues may have been left behind in the accumulation of the sediment layers from the lower slopes of the bing remnants to the bank of the river. The OSL/IRSL laboratory procedure utilised core soil samples from the bing to analyze the accumulation of its sediment layers. Older sedimentary material gives off a stronger OSL/IRSL signal, and would be expected to show up at greater depths. In the two cores from the Devon Colliery bing, material between a depth of 6 to 22 cm actually shows a stronger signal, indicating that in this case, older material has actually accumulated at less depth than might have been anticipated. In addition to the stronger signal at this depth, the physical characteristics of both cores also show marked change, becoming much darker and containing far greater amounts of coal debris. The OSL/IRSL evidence along with the changes in physical characteristics could possible help to corroborate the story of environmental change along the River Devon at the former Devon Colliery site although it cannot pinpoint the exact time of or reason for the change. The dredging of the Devon in the 1940s could have possibly deposited older sedimentary material on top of new, or regrading during mitigation could have moved older material from deeper regions of the bing over the top of newer material. Periodic flooding of the Devon could have also been a factor. This speculation, however, only emphasizes the edgelands quality of the site of the former Devon Colliery during its period of abandonment. If more definitive information about the site's environmental quality had been available, it may have attracted more attention, sooner, resulting in a different management strategy that could have destroyed its edgeland legacy. The OSL/IRSL results indicating the area was fairly physically stable, along with the Devon Angling Association's lack of evidence of visible contamination actually allowed the abandoned Devon Colliery to remain an edgeland.

A second laboratory procedure using x-ray fluorescence (XRF) was used to measure the concentration of expected heavy metal pollutants in the soil samples from the remnants of the Devon Colliery bing. XRF results, whilst they do reveal some concentrations of heavy metals, do not provide evidence for the potential impact of the CRC's mitigation efforts. In general, the results show a very small amount of heavy metal (Pb, Zn, Cu, Cr, Bi, As) contamination, particularly in the bottom portions of the cores, below approximately 20 cm (data not shown). Levels of phosphorus (P) above 1000 ppm are higher than normal field systems would indicate, possibly telling of the animal habitation of the area in the years it was used for grazing and horseback riding. However, since most of the heavy metals detected by XRF are associated with coal, there is no way of knowing whether their presence was naturally occurring or caused by anthropogenic activity. Similarly, there is no way of knowing whether levels of their concentration were higher prior to mitigation or whether their location in the bottom half of the cores is due to the fact that they were redistributed or buried during the course of mitigation. What XRF analysis does help to establish, however, is that pollution by itself should not determine edgeland status. If that were to be the case, then the evidence

present in the XRF results would disqualify the Devon Colliery site as currently too unpolluted to be an edgeland. Other qualities, including the evolution of the environmental quality of the site over time, are more important for determining edgeland status than are descriptions of the location in the present day.

This environmental history of a coal mine in Clackmannanshire was undertaken with the premise that conceptions of contemporary edgelands, while descriptive of a given place at a particular moment in time, do not quite capture their enigmatic nature. In part, edgelands have remained elusive because up to now, their origins have been mysterious and their evolution has not been explored. Arguments could be made that any culturally created landscape has a story concerning its origins and then undergoes change; that change in and of itself cannot define a space. Just because an environment undergoes transformation does not make in an edgeland. What the story of the transformation of the environment at the former Devon Colliery reveals, however, is that there are particular qualities that define the ways in which edgelands are established, maintained and perpetuated. These qualities are revealed through the three themes examined for the former Devon Colliery: landscape change, management practice, and environmental quality, and could be applied when attempting to determine whether any given landscape qualifies as an edgeland.

A more inclusive conceptualization of edgelands addresses the evolution of landscapes such as the former Devon Colliery as they have attempted to resolve the tension between nature and culture, including struggles between agriculture and industry common to spaces that are neither wholly rural nor wholly urban. The notion that industrialisation creates tension with the environment is not an argument unique to edgelands. However, in an edgeland environment, this tension is not fully resolved one way or the other. In the case of management practices, the central dilemma creating the edgeland is the question of whether profits or protection of the environment are paramount. As with landscape change, this dilemma is addressed in different ways at different points throughout the history of the site and is rarely definitively resolved. Management practices in turn naturally result in the varying degrees of environmental quality found at a site. Disregarding the historic environmental quality of a site in determining edgeland status means missing out on many layers of ambiguity, yet ambiguity is one of the key distinguishing characteristics of any edgeland.

Finally, broadening the scope of the nature of edgelands is critical for establishing their legacy. As deindustrialisation has progressed across Britain in recent decades, debates about its industrial heritage have began to smoulder like the coal tips left in its wake. Mining has become the lightning rod for the polarization of its legacy with the resulting edgelands representing the poles of the debate, setting the idea of dereliction as a positive expression of cultural identity against dereliction as a symbol of oppression, dislocation and loss.

Suitable edgelands management practices must be developed that address these dichotomies without attempting to resolve them. These practices must maintain the tensions and ambiguities that define edgeland spaces while also allowing them to be environmentally safe enough for the public to interact with them. Understanding the historical evolution of these sites serves as a key element in discovering the unique details of the dilemmas which need to be preserved as part of edgelands legacy.

For two centuries of Devon Colliery workers, the pit and the bing were, of course, anything but invisible, a central fact of their livelihood. As part of the landscape, though, they were disregarded, perhaps so much a part of everyday life that they went unremarked. Standing today on the remnants of the former bing, one's sight is drawn not downwards into the depths below the woody grass that now covers the site, but outward, to the summit of Ben Cleuch. In the end, the most enduring aspect of the legacy of the Devon Colliery is its invisibility. The site remains, but it should pass as unnoticed as it did during its working life. The eye should not seek the shadow of the bing. It should gaze instead, as Robert Burns did, on the "pleasant banks of the clear winding Devon" and allow the enigma of the landscape to speak for itself.

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Associate Editor: Catherine Mills

KING EDWARD VII'S LITTLE KNOWN RAILWAY HALT ON THE BLANE VALLEY LINE

John Mitchell

King Edward VII's two official visits by rail to Duntreath Castle in Strathblane, West Stirlingshire in September 1899 (while he was still the Prince of Wales) and in September 1909 were both well covered by the press (Mitchell, 2007). For the King's second appearance, Blanefield Station on the Blane Valley line excelled in its flower arrangements (Figure 1). On descending from the royal train, Edward was greeted by Sir Archibald Edmondstone (Grandfather of the present Sir Archibald Edmonstone of Duntreath) in front of a large and enthusiastic crowd. The above two events apart, it is now known that the King visited Duntreath Castle at other times, but on these occasions he was deliberately shielded from the public gaze (Souhami 1996). Ostensibly Edward (Figure 2) was there for the excellent grouse shooting to be had on the estate, but assignations with his long-term mistress Mrs Alice Keppel (youngest sister of Sir Archibald Edmonstone) is widely held to be the more likely reason.

The King's party having off-loaded the considerable amount of luggage brought with them to Blanefield Station, the royal train on these unannounced visits would carry on a mile or so further along the line to a private halt NS533810 at Dumgoyach, almost immediately opposite Duntreath (Lamont-Brown 1998). Unseen by newspaper reporters and the public alike, Edward

Figure 1. Blanefield Station staff preparing for the arrival of Edward VII in 1909.

(presumably accompanied by an attendant or two) would alight from his carriage onto a small platform built of wooden railway sleepers. From there a footbridge over the Blane Water gave access to a carriage driveway leading to the castle. As far as can be ascertained, the Dumgoyach halt seems to have fallen out of use after King Edward's death in 1910.

Like other rural lines in the district, both passenger and goods traffic on the Blane Valley Railway declined in the face of competition from an expansion in local road transport, with rail passenger services withdrawn in 1951 and freight in 1959 (Dryden 2003). Some ten years after the final closure of the line and the advent of the Loch Lomond Water Supply Scheme, a long stretch of the abandoned track bed was taken over for laying a five foot diameter steel pipe capable of carrying millions of gallons of water each day from a pumping station on the southern shore of Loch Lomond to a treatment plant at Balmore (*Central Scotland Water Development Board, 1971*). During the pipeline construction, the platform at the Dumgoyach rail halt proved to be an obstruction and removed, in consequence this unique piece of Stirlingshire's railway history with royal connections has become all but forgotten.

Acknowledgements

I am indebted to Sir Archibald Edmonstone of Duntreath and the late Alison Dryden of the Strathblane Heritage Heritage Society for sharing their first-hand observations on the Dumgoyach rail halt before the platform was demolished. My thanks also to Peter Smith of Killearn for preparing my illustrations for publication.

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John Mitchell first came to the Stirling area when he was appointed warden of the Loch Lomond National Nature reserve in 1966. On retirement from Scottish Natural Heritage in 1994 he received the award of Master of Arts from the University of Stirling for services to nature conservation and education. He has been a regular contributor to the Forth Naturalist and Historian Journal and also lectured on various subjects at the annual 'Man and the Landscape' symposium.

Associate Editor: Roy Sexton

Figure 2. King Edward dressed for the grouse moors.

EARLY SALT PRODUCTION IN THE FALKIRK DISTRICT

Geoff B. Bailey

Introduction

Falkirk district probably has the longest record of saltmaking of any place in Scotland. This circumstance arose from its unique geo-political position and the fortuitous occurrence of the fuel necessary for the process. In the former category we might include geographical and topographical elements such as the tidal estuary that provided the salt water as well as ready access to markets in Britain and northern Europe for the salt and its related materials such as coal, broad shallow mudflats that helped to concentrate the salt, proximity to Edinburgh, the seat of stable government that imposed peaceful conditions in the area throughout the medieval period, most of the time, and a large landward population forming a substantial home market. As for the fuel required to drive off the excess water, we had large peat mosses at Letham and Dunmore, woods at Callendar and Torwood, and latterly coal from the Stirlingshire and Lothian Coalfields.

Early History

There is circumstantial evidence for salt production in the area in the second century AD. In the Roman period the salt manufacturing industry in England appears to have been intensified with extensive working in the Fenland and Lincolnshire. Here too peat was plentiful. Pliny mentions the use of oak or hazel wood as the fuel in Germany and France (Natural History xxxi.73-92). In Saxon England wood was used as a fuel (Finberg 1972). Salt for the Roman army of occupation in Scotland was probably brought in with their other supplies using the established east coast trading routes. This sea-borne material could be landed at Carriden, Inveravon and Camelon at the eastern end of the Antonine Wall. Its trade may be reflected archaeologically by the imported pottery with which, or in which, it could have been transported. Large quantities of black-burnished ware jars are found on the sites along the Antonine Wall. This material was produced in Dorset and in the Thames Estuary, two of the major salt producing centres of this period.

Like the modern British army, the procurement of such supplies as the pottery indicates appears to have alternated between official civilian contracts and direct production by the state. The range of wares found on the Antonine Wall is far more limited that on contemporary sites in England, indicating selective sourcing. Salt extraction in the Roman Empire was normally an Imperial monopoly and there is a strong suggestion that the natural inland brine wells exploited in Britain came under the same control. At Droitwich, whose Roman name *Salinae* literally means 'saltpans', a large villa-like building

has been interpreted as a governmental headquarters for the administration of its production (Hurst 2006). It is probable that the salt imported to the large garrison along the Antonine Wall would have been supplemented by some official production in the zone where the Wall comes into intimate contact with the Forth, just the area where later medieval production occurred. Sites for neither period have been identified on the ground, but the latter are known from historical records.

Eric Birley put forward a cogent argument for the production of salt in the frontier zone in the Roman period (Birley 1936). This theory is based upon a passage in Justinian's Digest which reads: "A woman condemned, for a crime, to hard labour in the saltworks, was subsequently captured by bandits of an alien race; in the course of lawful trade she was sold, and by repurchase returned to her original condition. The purchase-price had to be refunded from the Imperial Treasury to the centurion Cocceius Firmus." From this extract it would seem that the woman was a slave in the household of the centurion when she committed her crime. She was then given a penal sentence by the governor of the province in which the crime had been committed, and put to work in a state-owned saltwork. Normally she would have served her time and then been returned to her lawful owner, the centurion. Whilst in state custody she was abducted by natives of a tribe which lay outside of the Empire. As it was through the negligence of the state that she was captured, they were compelled to refund the purchase price to the centurion. There were few provinces of the Roman Empire that could have possessed saltworks that were close enough to the frontier to be exposed to raids from tribes which owed no sort of allegiance to Rome. Britain and Dacia are the obvious two candidates. The former is confirmed by the discovery at Auchendavy on the Antonine Wall in 1771, during the construction of the Forth and Clyde Canal, of a series of altars dedicated by one Cocceius Firmus, centurion of the Second Legion Augusta. Cocceius Firmus is an unusual name and it is unlikely to have been a mere coincidence.

Figure 1. The four altars found at Auchendavy and dedicated by Cocceius Firmus (taken from Stuart 1852).

Medieval History

Salt production along the Forth very probably continued from the Roman period into the medieval, though it cannot be proven at present. There is charter evidence from the 12th century at Grangemouth and Airth. In this century we are given a glimpse of the flurry of activity in central Scotland as the church, in particular the monasteries, were being formalised by the monarchy. Many were endowed with lands, and with that important and necessary article, the means of producing salt. This privilege appears until then to have been largely reserved to the monarch, as indeed the Domesday Book shows to have been the case in England. Before the consolidation of regal power it was presumably in the hands of local leaders such as the Thane of Callendar. David I (1124-1153), whilst retaining many of the saltpans, made donations of individual pans on the upper reaches of the southern shore of the Forth Estuary to the abbeys of Holyrood, Newbattle and Dunfermline. These were confirmed by his successors and augmented by gifts to the abbeys of Kelso, Cambuskenneth, Jedburgh and Arbroath (Table 1). These sites lay alongside those of the king, as is made clear by the mandate of c1140 granting a saltpan near the King's saltpans on the Carse of Stirling to Dunfermline Abbey. The pan was to be apart and free as the King's pans and to be worked by the men of the Abbey sharing in the King's peace. In 1163 a second pan at this location was given to Cambuskenneth Abbey, a third in c1170 to Jedburgh, and a fourth in 1178 to Arbroath. A cluster of these pans occurred in what is now the petrochemical complex at Grangemouth and is reflected in the names of the internal streets taken from those of the farms.

The fuel for the evaporation of the water had to be found locally, whether in the form of wood or peat. At Airth the 1166 confirmation of a saltpan to Holyrood Abbey included the right to take wood in the King's own wood of Airth. At about the same time that abbey also received a pan on the Carse of Callendar (Grangemouth), the fuel for which was to come from the wood of that name. This suggests that wood for fuel was relatively scarce in that locality as Callendar Wood is some 4 km away. Similar conditions were allocated to the saltpan at Blanckelande, the exact site of which is unknown. Elsewhere, the fuel is not specified. Indeed, it has only been assumed in the last example as fuel could mean wood or coal, both of which are to be found in Callendar Wood. In later examples the term '*carbonum*' or '*carbonibus*' is used, meaning carbon, and again this could apply equally to coal or wood. Peat is certainly named in a grant of 1242 of a saltwork near to Aberdeen to the Abbey of Coupar Angus. There the pan came with sufficient peat moss for making the salt (Easson 1947, vol 1, 111). It may have been the provision of moss that is alluded to whenever a specified area of land is granted with the saltpan. The original provision for Holyrood Abbey at Airth, for example, was for 27 acres of land. Similarly, Cambuskenneth Abbey received as much land with its pan as was allocated to each of the King's pans. However, in a largely subsistence economy it would have been useful for the salters to have had the ability to grow their own food such that agricultural land may have been included in the total.

Other privileges granted in these early charters included the right for the monasteries to transport and sell the salt free of tax, and easements in pasture and water. These reflect the contemporary economic importance of salt production to the kingdom. Working the pans efficiently was a skilled task and every encouragement was given. Such concessions were also made necessary by the location of the saltworks on marginal land, usually salt greens unfit for cultivation but eminently suitable as pasture.

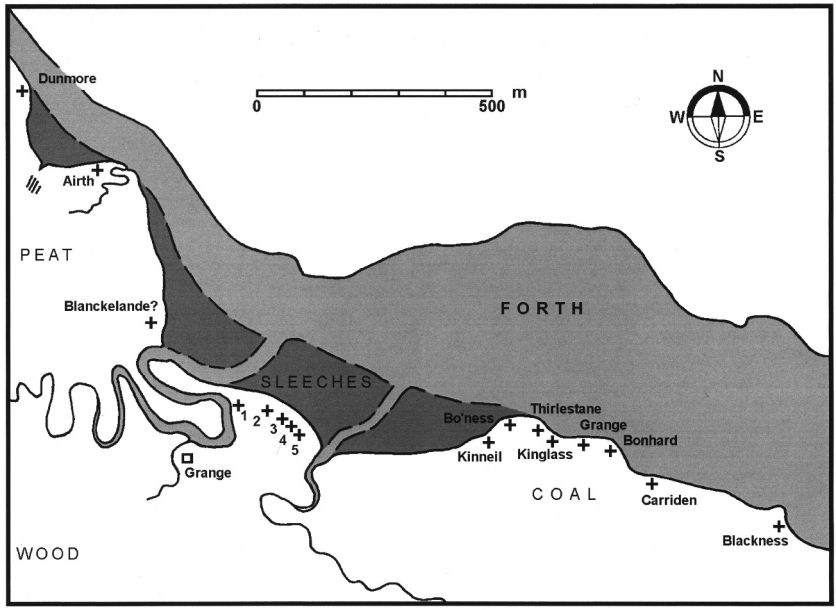

Figure 2. Map showing saltpans in the Falkirk district. Those at Grangemouth were 1: Panstead, 2: Powdrake, 3: Candie, 4: Overton, 5: Saltcoats.

The first fuels to be used in the saltpans were wood and peat. The use of these "primitive" sources of heat is termed 'eotechnic' operation by Clow (1952). They burn at moderate temperatures, which suited the early pans of clay or lead. Their extraction was relatively straight forward if somewhat labour intensive. They required traditional skills that were passed from generation to generation. Peat had to be cut, stacked, dried and transported. Woodland had to be properly managed to provide an annual harvest using techniques such as pollarding. However, this type of fuel and pan limited the scale of production, even though it satisfied the contemporary demand. Salt was used as a food preservative and flavouring, and in tanning, but not as part of a larger chemical industry. As metallurgical technology improved it became possible to make pans of iron, which required less structural support and transferred heat more evenly. Consequently they could be much larger. Hand

in glove with the development of iron production was the use of coal as a fuel, and its substitution for wood in the salt industry was inevitable. It soon became known as panwood. It burned at higher temperatures and was ideally suited to the new pans – the 'palaeotechnic' era had arrived. The basic technique remained essentially the same – salt water from the Forth was placed in a pan and heated to evaporate off the water. Little care was taken to use the coal efficiently, resulting in the profligate waste of this resource. Salters, who managed the panhouses, became skilled at managing their operation, but it was to be the late 18th century before 'scientific' empirical enquiry led to significantly increased efficiency, largely as a result of competition from outside. Lord Dundonald of Culross and Dr John Roebuck at Kinneil were in the van of such research.

The transition from 'eotechnic' to 'palaeotechnic' was gradual and did not occur at the same time throughout Britain. The Clows placed it around 1500 (Clow 1952). The Cheshire brine springs were amongst the last to adopt the new technique, probably due to their early economic advantage. The use of coal altered the balance of advantage between the different centres of production. In England it led to the convergence of salt-boiling on the Tyne where coal was easily wrought. The ready availability of iron plates for the pans was also an important factor, and saltpans were amongst the first products of the Carron Company after it was established in 1759, giving the Forth area an extra fillip. Salt production in the Forth valley moved away from the peat bogs to where coal was to be found at points along the coast (Adams 1965), and this adaptation can be used to date the 'palaeotechnic' transition in this area. Adams (1965) places this in the 13th century due to the absence of charter evidence for the continuance of the monastic saltpans, but there is no evidence for new pans in this period either. In 1474 a charter by James III conferred the barony of Kinneil on James Lord Hamilton with the five saltpans already constructed and others to be built (RGS 2, no. 1177; HMC 1887, 19). Shortly afterwards, in 1498, we hear about saltpans at Blackness, made over to the Viscount of Linlithgow as custodian of Blackness Castle (RGS vol 2, 528; Penny 1831). These involved noble families with money to invest in the new process. Over the next two centuries production spread to lesser lairds, exploiting their own coal reserves: Thirlestane (1608), Bonhard (1613), Grange (1610), Carriden (1627) and Kinglass (1691). The dates are, of course, the earliest that I have found and in each case the pans were already in existence. Conversely, the medieval pans may have continued to function long after they drop from view in the records, with added confusion caused by the persistence of place names containing elements for pans and salt. On balance the change may be placed in the period 1350-1450.

At Airth it was possible for coal to replace peat directly and here saltworking continued. It was, however, at an economic disadvantage to the saltworks in the Bo'ness area because the fuel had to be conveyed further and at Bo'ness the journey was downhill. Nevertheless salt was made at Airth until the mid 17th century, when land reclamation took its place. By then saltworking had been

augmented by new pans a little to the north where the coal outcropped closer to the coast at Elphinstonepans (modern Dunmore), and here salt boiling continued for another century.

There were three main sources available for the raw material used in the manufacture of salt in Britain. These were, in decreasing order of salinity, rock salt, brine and sea water. Rock salt is the mineral form of sodium chloride (NaCl) and can occur in vast beds of sedimentary evaporite minerals that resulted from the drying up of enclosed lakes and seas. Large quantities exist under Cheshire, where today it is extensively extracted. It was little known until the 18th century, but with its significantly higher yield of salt it eventually drove other sources out of the business. Brine is water saturated with salt and also occurs naturally, notably where ground water has passed through rock salt. It comes to the surface at springs at such places as Droitwich, Nantwich and even Newcastle. These sources were heavily exploited by the Romans, with surplus water driven off by evaporation in pans. Sea water is the least productive source material, but it is also the most readily available. It too was extensively used from the Iron Age onwards. However, it required far more water to be driven off than the other two sources. Lord Dundonald (Cochrane 1785) indicated that sea water from the Forth yielded 2 t 17 cwt 0 q per hundred tons, whereas that same water saturated with rock salt shipped from Liverpool to Scotland would produce 23 t 0 cwt 1 q of salt. Its use prolonged the life of the Scottish industry, but it was not available until the late 18th century.

It follows that saltworks on the shores of salt water estuaries should not be placed near to the debouchment of a fresh water river, as that would reduce the salinity of the water in the immediate vicinity. Yet the medieval salt industry in the Falkirk area was centred on Grangemouth, between the large rivers Avon and Carron. Airth, also with an important medieval pan, is even further up the estuary and hence the waters of the Forth are more dilute. These rather curious placements are not as strange as might first appear for the source material used at these sites was an odd mixture of those mentioned. Off the shallow coast at these sites are broad mudflats or sleeches that the tide continuously washes over, impregnating minerals into their fabric. The twice daily inundation led to considerable salt enrichment of the sleeches, and by using it rather than rock salt, it was possible to produce a saturated solution for panning (Smout & Stewart 2012, 183). The switch to using coal dross and larger pans made the use of sea water economically viable and the old form of working all but disappeared. One notable survival of this technique, however, occurred into the 19th century at Annandale (Whatley 1987, 13) where the salt-impregnated sand was gathered in dry weather during the summer months and taken by horse-drawn sledges to the pans. These pans were made of lead until after 1800, and output was exceptionally low.

The last saltpan in the Falkirk area, at Grangepans, utilised rock salt and local coal dross. It only ceased production in 1889, marking the end of almost 2,000 years of saltmaking.

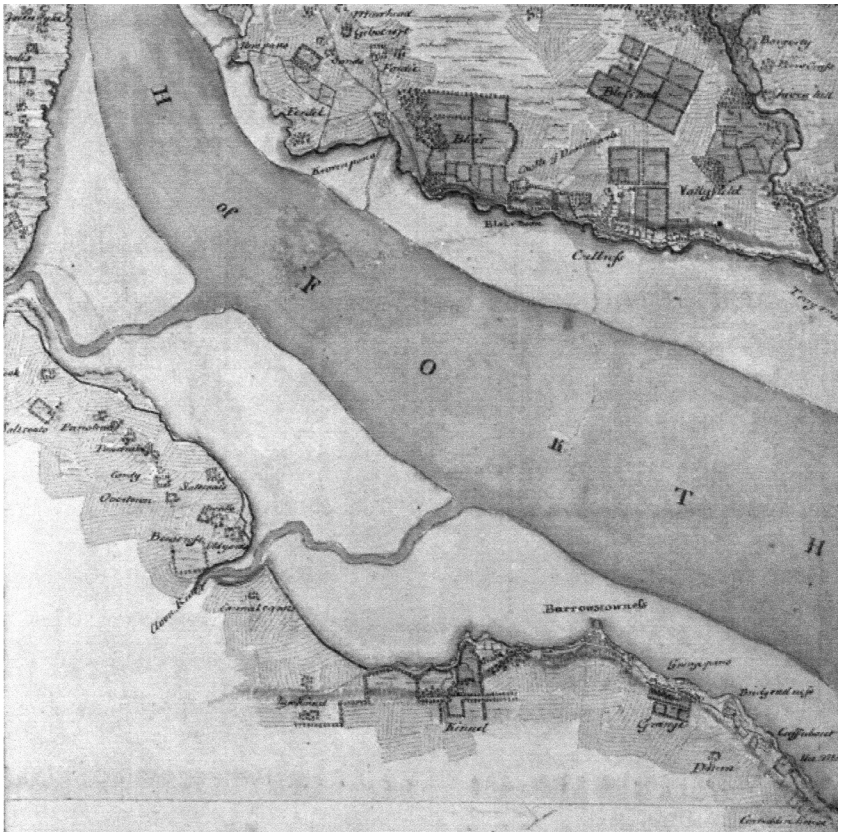

Figure 3. Roy's Military Survey of 1755 showing the broad sleeches between the rivers Avon and Carron.

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Table 1.

CALLANDER (GRANGEMOUTH)

c1160. One saltpan with common easements in pasture, water, and fuel for the saltpan in the wood of Callendar, to Newbattle Abbey (RRS vol 1, 176, no. 109; vol 2, 475, no. 546; Laurie 1905, 114; Newbattle no. 162, 163).
c1160. A saltpan which Walter, the son of Alan the Steward had given to Nicholas de Sules, to Newbattle Abbey (Registrum S. Marie de Neubotle (Bannatyne Club), 129; Charters of the Abbey of Inchcolm; Laurie 1905, 380-1).
c1160. William II. Confirmation to Newbattle Abbey of one satpan, with easements and all his arable in Callendar (RRS vol 2, 475, no. 546).
1236. All the Newbattle Abbey property in the Carse of Callendar let in feu-ferme to Holyrood (Newbattle no. 160).
1255. Holyrood Abbey leased 2 saltpans in the Carse of Kerse from Newbattle Abbey, which they held from Walter Olyfard and Sir David Cumyn (Porteous 1972, 123; Keir 1827, 69).

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