



**BTO Research Report No. 550**

**Second Year of Ornithological Surveys at  
House of Water, East Ayrshire:  
Breeding Season 2009 and  
Winter Season 2009-10**

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*A report to Scottish Coal*

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## EXECUTIVE SUMMARY

1. BTO Scotland together with Scottish Coal completed a survey of breeding and wintering birds within approximately 180 ha of a restored formerly opencast site at House of Water in East Ayrshire in 2009-10. The principal interest was the re-diverted River Nith, which at 3 km long is believed to be the largest river diversion project in Europe. This was the second year the river and its immediate surrounds had been surveyed but the first in which the wider restored area had been included.
2. Four transect surveys were undertaken in the breeding season (April – June 2009) and three in the winter season (November 2009 – February 2010). Transects followed the entire length of the re-diverted river and sampled nearby wetlands, rough grassland and other habitats within the restored area. Constant-effort-search surveys were used to assess the bird communities of the wider restored area. Again, four surveys were undertaken in the breeding season and three in the winter.
3. A total of 45 species was recorded within the study area during the seven survey visits. Thirty-nine species were recorded in the breeding season, including 19 recorded as using the re-diverted river channel. Behaviour indicative of breeding was recorded for 25 species of which 15 were associated with the river channel. Nineteen species were recorded in the winter survey visits of which seven were observed using the river channel.
4. Five piscivorous or specialist riparian bird species were recorded on the re-diverted stretch of the river in 2009-10. These were (1) Grey Heron seen in both summer and winter but not breeding, (2) Common Sandpiper with eight apparent territories along the river, (3) Sand Martin seen in summer but not breeding, (4) Grey Wagtail seen in summer but not breeding, and (5) White-throated Dipper which was seen in both seasons with two apparent breeding territories. In addition Goosander was seen in flight over the river in the breeding season. Other species seen on or immediately by the river were: Mallard (both seasons, including one apparent territory), Eurasian Teal (winter only), Eurasian Oystercatcher (3 apparent territories), Ringed Plover (2 apparent territories), Northern Lapwing (1 apparent territory), Dunlin (1 apparent territory), Common Snipe (both seasons), Jack Snipe (winter only), Eurasian Curlew (1 apparent territory), Common Redshank (1 apparent territory), Sky Lark (4 apparent territories), Meadow Pipit (both seasons, including 7 apparent territories), Pied Wagtail (2 apparent territories), Northern Wheatear (1 apparent territory), Common Grasshopper Warbler (2 apparent territories), Sedge Warbler (3 apparent territories) and Reed Bunting (7 apparent territories).
5. Principal changes between the 2008-09 and 2009-10 seasons indicative of the development of a riparian bird community were increases in the number of species using the river channel (from 13 to 20), amongst which were an increase in the number of apparently breeding Common Sandpiper (from 6 to 8), the first presence of displaying Dunlin in 2009, the colonisation by breeding White-throated Dippers in 2009, increases in the number of apparent territories of passerines associated with the river (Sky Lark (2 to 4), Meadow Pipit (3 to 7), Common Grasshopper Warbler (0 to 2) and Reed Bunting (2 to 7)), an increased presence of Sand Martins and the first recorded appearance of Grey Wagtail in 2009. In the wider study area there had been declines in numbers of apparently breeding Ringed Plover, Northern Lapwing and Common Redshank, potentially indicative of developing vegetation on restored ground. These declines potentially emphasise the importance of the developing ephemeral shingle beds in the river channel to maintain breeding wader populations at the site in the longer term. A marked reduction in the number of birds away from the river in winter 2009-10 compared to 2008-09 was probably associated with extremely severe winter conditions in the later season.
6. The House of Water site offers an excellent opportunity to quantify the relationships between bird populations, river structure and its associated vegetation and invertebrate communities. This information could be used to inform the success or otherwise of this specific restoration project,

potentially guide ongoing management of the site and provide valuable empirical data to inform river conservation management more widely.



## 1. INTRODUCTION

Coal extraction at House of Water, west of New Cumnock in East Ayrshire, necessitated the diversion in 2000 and subsequent re-diversion to its former route of the River Nith, a river of major importance as a salmon and sea trout fishery, and of one of its tributaries, the Beoch Lane. Completed in 2004, at 3 km in length this is believed to be the largest river diversion project in Europe. This report describes and gives the results of surveys of breeding birds in 2009 and of birds present in winter 2009-10, the second successive seasons of ornithological surveys of the restored section of the river. The principal focus is on birds that utilise the re-diverted section of the river but we have also taken the opportunity to survey birds in the adjacent area, including restored ground and newly created wetlands, comprising an area of about 180 ha. This is larger than the 72 ha surveyed in the original 2008-09 seasons (Calladine & Thiel 2009) when only immediately adjacent areas to the river were surveyed. The original 72 ha survey area was included in 2009-10 in its entirety, however, and direct comparisons between the two years are made.

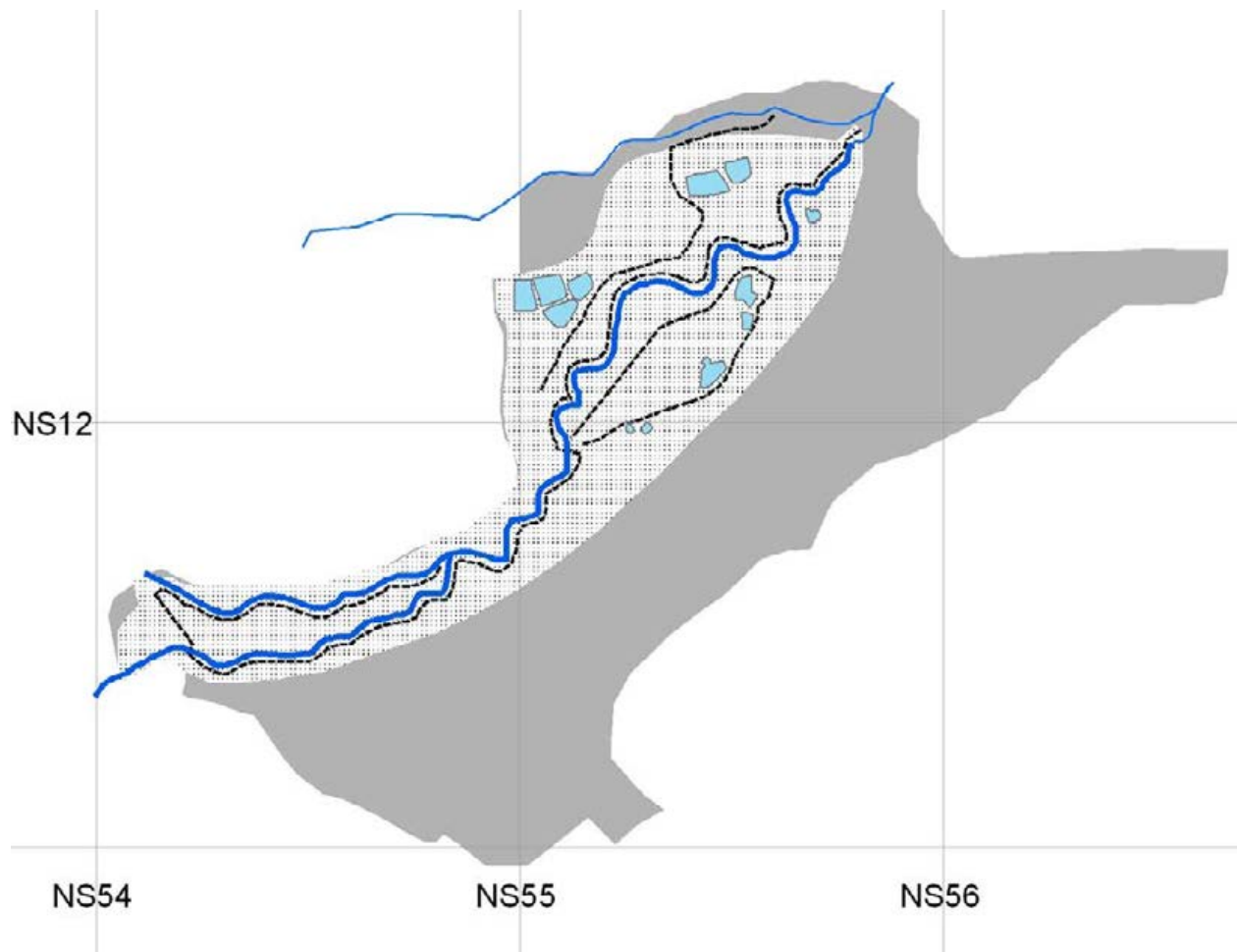
The development of vegetation and macro-invertebrate communities along the 3 km re-diverted section of the river are being monitored by the School of Biological and Environmental Sciences, Stirling University, following its restoration. Concurrent monitoring of bird populations that colonise and use the re-diverted section will give opportunities to (i) further quantify the success or otherwise of the project in its promotion of wildlife, (ii) ultimately identify relationships between different taxa in their colonisation of the section, and (iii) inform other similar restoration projects. As well as describing the surveys undertaken and presenting their results, this report includes direct comparisons with survey results from the 2008-09 seasons and also recommendations for future monitoring of the site.

## 2. METHODS

### 2.1 Study area

The re-diverted stretch of the River Nith flows from south-west to north-east between the altitudes of about 240-220 metres above mean sea level centred around 53°23' N, 4°16' W (grid reference NS553122) in East Ayrshire, south-west Scotland. As in the 2008-09 seasons, birds were surveyed along a 6.1 km long transect that followed the bank of the entire section of re-diverted river, including its tributary the Beoch Lane, with deviations to include adjacent wetlands to the south of the river on restored, formerly opencast land as well as land to the north that was both affected and unaffected by opencast operations (Figure 1). Although not specifically measured, we estimate that the water depth within the river is generally shallow (< 1 m) and its width varies between 3-5 m. The banks include both shallow muddy edges and steep, actively eroding banks and the developing substrate includes both rocks and soft mud and silt. Its course and nature aim to replicate the original section of the upper reaches of the River Nith prior to open-casting at the site (Halcrow Group Limited 2004). From this transect, an area of about 72 ha was covered. This included the river, restored (formerly open-cast) rough grassland, some small specifically created wetlands (shallow rush fringed pools), some steep-banked, concrete-lined settling ponds plus haul roads and some infrastructure associated with the neighbouring active open-cast workings.

In 2009 and winter 2009-10, a more extensive area (including an additional 108 ha) was surveyed. The additional areas were predominantly restored (formerly open-cast) rough grassland and were surveyed using a constant-effort-search approach whereby all parts were approached to within 100 m, taking the equivalent of 80-100 minutes to survey 1 km<sup>2</sup> (after Brown & Shepherd 1993, Calladine *et al.* 2009).



**Figure 1** The House of Water study area and survey transects used in 2009-10. The solid shaded and stippled areas represent the complete study area (*ca.* 180 ha). The stippled area represents that area which was also surveyed in 2008-09 (*ca.* 72 ha). The solid line represents the course of the re-diverted River Nith and the dotted lines the survey transects (*ca.* 6.1 km). The grid lines represent the 1-km divisions of the Ordnance Survey's national grid.

## 2.2 Breeding bird surveys

Four survey visits were carried out for breeding birds in 2009: 22<sup>nd</sup> April (Visit A); 7<sup>th</sup> May (Visit B); 20<sup>th</sup> and 22<sup>nd</sup> May (Visit C) and 2<sup>nd</sup> and 3<sup>rd</sup> June (Visit D). The transect surveys were completed within the first four hours of light, in relatively calm (less than Beaufort force 4) and dry conditions, when the likelihood of detecting most species is expected to be high. The constant-effort search surveys over the remainder of the restored areas continued until about noon. The identity, location, activity (as represented by standard BTO survey codes; Marchant 1983) and, where possible, the sex of each bird encountered were recorded on large-scale field maps. Birds recorded as singing, displaying or alarming or the finding of nests or dependent young were considered as indications of territory occupancy.

Where it was possible, simultaneous registrations of birds were used to identify different territories, otherwise slightly different approaches were adopted for the intensive transect surveys of the river channel and for the more extensive surveys of the restored grasslands. For waders along the river channel, where the separation of territories was not possible from simultaneous observation, and in view of their relatively high breeding density (and more intensive survey input) within a restricted area, the following rules were applied to identify apparent territories (after Reed & Fuller 1983):

- a) 1 bird recorded (displaying, alarming or otherwise territorial) alone and 50 m or more (for Common Ringed Plover), 75 m or more (for Common Sandpiper, Common Redshank and Northern Lapwing) and 125 m or more (for Eurasian Oystercatcher) from other birds were defined as an apparent territory;
- b) 2 individual birds (displaying, alarming or otherwise territorial) within 50 m (for Ringed Plover), 75 m (for Common Sandpiper, Common Redshank and Northern Lapwing) and 125 m (for Eurasian Oystercatcher) of each other were defined as an apparent territory;
- c) 3 or 4 birds together (displaying, alarming or otherwise territorial) were defined as 2 pairs;
- d) Any drumming, chipping or alarming Common Snipe was defined as an apparent territory.

The above distances are for registrations in the same survey visit. For registrations from different survey visits, we adopt a more conservative approach of a minimum separation distance of 500 m for different territories. In the absence of observations to suggest otherwise, separation distances of less than 500 m between registrations from different survey visits were assumed to refer to the same territory (after Brown & Shepherd 1993). Note that scientific names of species mentioned in this report are listed in Appendix 4

The following rules were applied to identify non-breeders to be excluded from the breeding summary maps (after Reed & Fuller 1983):

- i) 5 or more birds in a flock on the ground without vocal registration;
- ii) Any bird(s) which flew through the area in one direction for more than 150 m without landing or alarming.

For all other species (principally passerines) recorded either from the river transects or from the extensive constant-effort-search surveys, a minimum separation distance of 200 m between registrations (both within the same survey visit and between visits) was used to identify separate territories where simultaneous observation was not possible. The separation distance used here is somewhat arbitrary but is based on the 'typical' territory sizes of many passerines. Note that for our purposes, territorial behaviour recorded on just a single survey visit is sufficient evidence for inclusion as an apparent territory in the summary data. No territorial waders were recorded away from the areas covered by the transect surveys.

The above approach to identifying territories adopts a less conservative approach than some other census methods (e.g. Gilbert *et al.* 1998). For example, a single observation of territorial behaviour in a particular area is sufficient for us to recognise an 'apparent territory', whereas more than one registration is generally required for other territory mapping approaches where these generally require more frequent survey visits (e.g. Marchant 1983), though our current approach is comparable to that which is widely used for breeding waders on moorland that uses just two survey visits (Brown & Shepherd 1993). Also, we have not employed correction factors to counts of birds to estimate breeding population sizes for the survey area as a whole or for particular sections of it (e.g. as suggested by O'Brien & Smith 1992 for Eurasian Oystercatcher, Northern Lapwing, Common Snipe and Eurasian Curlew in enclosed lowland wet grassland). One of our priorities is to provide geographically referenced bird data that recognises areas by or close to the river channel that are likely to have been used for breeding. Therefore the population estimates that we give for the study area could in some cases differ from those employing an alternative

approach for interpretation. Given the proposed future use of our bird data to identify relationships with other biological and hydrological data, we suggest that the given estimates should be compatible with the most representative data that can be spatially referenced. Away from the river channel, it should be noted that the intensity of surveys of the restored grasslands (both in terms of the number of visits and spatial coverage) and their timing (generally not in the early mornings) will lead to underestimates of many passerine population sizes (Calladine *et al.* 2009).

Given the principal interest in the birds using the river channel, breeding birds were recorded as ‘using’ the river channel if the river was included within the boundary of the minimum convex polygon plotted around all the registrations associated with any apparent territory. Birds for which no territorial behaviour was observed were defined as ‘using’ the river channel if:

- a) Individuals were recorded on or in the water itself;
- b) Individuals were recorded on rocks or vegetated islets within the flowing river channel;
- c) Individuals used the immediate river banks – areas that are either regularly inundated with water or on the immediate bank or slope above the water but always within 2 m of the ‘normal’ water course;
- d) Individuals foraged in the air above the water and within 3 m of its surface.

### **2.3 Winter bird surveys**

Three survey visits were undertaken in winter 2009-10: 20<sup>th</sup> November (Visit A); 26<sup>th</sup> January (Visit C); and 28<sup>th</sup> February (Visit D). Unfortunately no survey was undertaken in December (the proposed Visit B) because of prolonged poor weather and other logistical problems. Surveys were undertaken between 09:00 and 14:00, avoiding the first and last hours of light when bird activity in winter is suggested to be low, and avoiding periods of heavy or persistent precipitation and wind speeds generally greater than Beaufort force 4. In common with the breeding bird surveys, the identity, location, activity and, where possible, sex of each bird encountered were recorded on large-scale field maps. However, the interpretation of surveys of birds in winter is more problematic than for birds during the breeding season, as they tend to be more mobile (not necessarily being attached to a particular territory) and can be more aggregated (often in flocks). Therefore we present counts seen on each survey visit and do not attempt any summarising of data for that season. As our principal aim was to record bird use of the re-established river, we recorded individuals within and away from the river channel itself separately. The same criteria as for including apparently non-breeding individuals as using the river channel were used (see the last paragraph of section 2.2).

### 3. RESULTS

A total of 45 species were recorded within the study area during the seven survey visits, four visits in the breeding season 2009 and another three during the winter 2009-10 (Tables 1 and 2). Thirty-nine species were recorded within the study area during the breeding season, which included 19 using the re-diverted river channel (i.e. seen in or on the river or on its immediate shore, or foraging above and within 3 m of its surface) (Table 1). Within the survey area that was common to both breeding seasons (2008 and 2009), 36 species were recorded in 2009 (c.f. 34 in 2008) of which 19 were using the re-diverted river channel (cf. 11 in 2008) (Table 3).

In 2009, territorial behaviour was recorded for 25 species within the survey area covered in 2008 compared to 20 in 2008 (Table 3). Within the river channel, 15 species were seen behaving as if holding territories in 2009 compared to 7 in 2008 (Tables 1 and 3). The distributions of the apparent territories in 2009 are shown in Appendix 1 and the locations of apparently non-breeding species that were using the river channel during the survey visits in April – June are shown in Appendix 2.

Nineteen species were recorded during the winter survey visits of which seven were observed using the river channel (Table 2). This compares to 24 species recorded within the smaller survey area in winter 2008-09 and eight that were seen to be using the river channel (albeit during four rather than three survey visits). The locations of all species using the river channel during the three winter visits in 2009-10 are shown in Appendix 3.

#### 3.1 Wildfowl

Five species of wildfowl were recorded within the survey area; Mute Swan, Greater Canada Goose, Mallard, Eurasian Teal and Goosander. In the 2009 breeding season, one apparent territory (AT) of Mallard was on the river and other birds were seen on the river elsewhere. In 2008, Mallards were recorded as just being present. At least three broods of Greater Canada Goose were seen on the settling lagoons to the north of the river (c.f. 4 in 2008; Table 3) and other adults were seen around the wetlands to the south of the river. Although Goosanders were seen in flight over the study area in the 2009 breeding season, they were not seen on the river during our surveys. Mute Swan and Eurasian Teal were seen in the winter only, the latter using the river channel (c.f. one apparent territory of Eurasian Teal in 2008; Table 3).

In 2008, no wildfowl were recorded along the river upstream of the haul road bridge, whereas in 2009, apparently non-breeding Mallard were seen on the Beoch Lane in summer (Appendix 2) and Eurasian Teal were seen on the Nith in winter (Appendix 3).

#### 3.2 Waders

Nineteen apparent territories of seven species of waders were recorded during the 2009 breeding season (Table 1). Of these, 16 apparent territories of six species included the river channel. The most notable changes from 2008 were:

- i) An increase in Common Sandpipers from 6 to 10 apparent territories, of which 8 were on the river;
- ii) The presence of Dunlin (1 apparent territory compared to none in 2008);
- iii) Declines in Ringed Plover (from 4 to 2 apparent territories), Northern Lapwing (from 3 to 1), Common Snipe (1 apparent territory to presence only) and Common Redshank (from 2 to 1).

The numbers of Eurasian Oystercatcher (3 apparent territory) and Eurasian Curlew (1 apparent territory) were the same in both 2008 and 2009. Although there were declines for four species of wader in the study area, the number of apparent territories that included the river channel remained the same in both years (Table 3). As in 2008, breeding Common Sandpipers occupied the full length of the re-diverted river, while the other species were concentrated within the downstream 1000 m of its course (Appendix 1).

Four wader species were recorded during the winter surveys (Table 2). Of these, Ringed Plover and Northern Lapwing were only seen on the last survey visit (28<sup>th</sup> February), as was the case in winter 2008-09, and are likely to have been birds returning to their breeding areas. Both Common Snipe and Jack Snipe were recorded in the first winter survey visit only. Jack Snipe was not recorded in the winter of 2008-09, while Common Snipe was recorded during three of the four winter 2008-09 survey visits (Table 3).

### **3.3 Other species**

Twenty-nine other species (i.e. neither wildfowl nor waders) were recorded during the breeding and winter season survey visits combined (c.f. 30 in 2008). Of these, 14 were thought likely to be breeding within the study area based on the observations of territorial behaviour (c.f. 16 in 2008). The majority of these species and their territories were associated with the restored rough grassland habitat, the planted and naturally established trees and shrubs and the wetlands, including the settlement lagoons. However there were eight species with apparent territories that were associated with the river (Tables 1 & 2), compared to just two in 2008 (Table 3).

Notable differences between the 2008 and 2009 breeding seasons were:

- i) The colonisation by breeding White-throated Dippers, with two apparent territories (and one nest found) in 2009, while they were only present in winter in 2008-09;
- ii) An increase in the number of Reed Buntings, from 7 to 15 apparent territories within the same survey area, including an increase from 2 to 7 apparent territories associated with the river;
- iii) An increase in the number of apparent territories of Sky Lark, Meadow Pipit and Common Grasshopper Warbler associated with the river, although overall numbers in the common survey area were very similar;
- iv) Increased presence of Sand Martins and Grey Wagtails – Sand Martins were seen on all four breeding season survey visits (just once in 2008), while Grey Wagtails were recorded for the first time.

In common with the 2008-09 winter season, relatively few ‘other’ species were recorded during the winter survey visits in 2009-10. The principal difference between the 2008-09 and 2009-10 winter seasons was the reduced frequency of recording Winter Wren (only seen on the first survey visit in 2009-10 compared to all visits in 2008-09), Stonechat (again only seen on the first survey visit in 2009-10 compared to three visits in 2008-09) and Reed Bunting which was not recorded during winter 2009-10 compared to three survey visits in 2008-09 (Table 3).

**Table 1** Species recorded during each of the four breeding season visits to the House of Water study area in 2009, the number of apparent territories identified within that area, the number of apparent territories that included the re-diverted river channel and additional species that were recorded as using the re-diverted river channel. ‘Y’ indicates that species were recorded either in the river channel or on a specific survey visit. Note that the totals for each survey visit are not mutually exclusive in that the ‘Total’ numbers include those using the river channel.

Species	Apparent territories	River channel	Visit A	Visit B	Visit C	Visit D
Greater Canada Goose	3		Y	Y	Y	Y
Mallard	1	1	Y	Y	Y	Y
Goosander	0		Y			
Grey Heron	0	Y			Y	Y
Common Buzzard	0		Y	Y	Y	
Eurasian Oystercatcher	3	3	Y	Y	Y	Y
Ringed Plover	2	2	Y	Y	Y	Y
Northern Lapwing	1		Y	Y	Y	Y
Dunlin	1	1		Y		
Common Snipe	0	Y	Y			
Eurasian Curlew	1	1	Y	Y	Y	Y
Common Redshank	1	1	Y	Y	Y	Y
Common Sandpiper	10	8	Y	Y	Y	Y
Black-headed Gull	3		Y	Y		Y
Mew Gull	1			Y	Y	Y
Lesser Black-backed Gull	0		Y			
Common Wood Pigeon	0		Y		Y	Y
Common Cuckoo	1				Y	
Sky Lark	42	4	Y	Y	Y	Y
Sand Martin	0	Y	Y	Y	Y	Y
Barn Swallow	0			Y		
Meadow Pipit	33	7	Y	Y	Y	Y
Grey Wagtail	0	Y		Y	Y	
Pied Wagtail	2	2	Y	Y	Y	Y
White-throated Dipper	2	2			Y	Y
Winter Wren	5				Y	Y
Whinchat	2				Y	Y
Stonechat	0		Y			
Northern Wheatear	1	1	Y	Y	Y	Y
Song Thrush	1					Y
Common Grasshopper Warbler	6	2	Y	Y	Y	Y
Sedge Warbler	14	3		Y	Y	Y
Willow Warbler	5				Y	Y
Eurasian Jackdaw	0				Y	Y
Carrion Crow	0		Y	Y	Y	Y
Common Raven	0		Y			
Chaffinch	9		Y		Y	Y
Lesser Redpoll	0				Y	
Reed Bunting	16	7	Y	Y	Y	Y

**Table 2** The numbers of each species recorded during each of the three winter survey visits to the House of Water study area in 2009-10, within the entire survey area and those seen as using the re-diverted river channel. Note that the totals for each survey visit are not mutually exclusive in that the ‘Total’ numbers include those using the river channel. Also note that no Visit B was undertaken winter 2009-10.

Species	Visit A		Visit C		Visit D	
	Total	River channel	Total	River channel	Total	River channel
Mute Swan	5					
Greater Canada Goose					4	
Mallard	2	2	13	5	2	2
Eurasian Teal	2		3	3	20	20
Grey Heron	1				1	1
Common Kestrel			1			
Ringed Plover					3	
Northern Lapwing					1	
Common Snipe	6	5				
Jack Snipe	1	1				
Great Black-backed Gull			1			
Sky Lark			1			
Meadow Pipit	9	4	1			
White-throated Dipper	3	3	4	4	3	3
Winter Wren	4					
Stonechat	1					
Fieldfare			11			
Carrion Crow	1		5		2	
Common Raven					1	



**Table 3** A comparison of the birds recorded within the original 71 ha study area between the 2008-09 and 2009-10 seasons. For the breeding seasons, the numbers of apparent territories identified is given and 'P' indicates that the species was recorded but no territorial behaviour was observed. For the winter seasons, the survey visits during which they were recorded are given. Note that no Visit B was undertaken in winter 2009-10.

Species	BREEDING SEASON				WINTER			
	Original study area		River Channel		Original study area		River channel	
	2008	2009	2008	2009	2008-09	2009-10	2008-09	2009-10
Mute Swan					A	A		
Greater Canada Goose	4	3	0	0	D	D		
Eurasian Teal	1	0	0	0	A, B, C, D	A, C, D	B, C, D	C, D
Mallard	P	1	P	1	A, B, C, D	A, C, D	B, C, D	C, D
Goosander	P	P	P	0	D			
Grey Heron	P	P	P	P	A, D	A, D	A	D
Common Buzzard	0	P	0	0	C			
Common Kestrel	Y	0	0	0	A, D	C		
Peregrine Falcon	Y	0	0	0	A			
Eurasian Oystercatcher	3	3	3	3				
Ringed Plover	4	2	2	2	D	D		
Northern Lapwing	3	1	3	1	D	D		
Dunlin	0	1	0	1				
Common Snipe	1	P	0	P	B, C, D	A	B, C, D	A
Jack Snipe						A		A
Eurasian Curlew	1	1	0	1				
Common Redshank	2	1	2	1				
Common Sandpiper	6	10	6	8				
Black-headed Gull	3	0	0	0				
Mew Gull	1	1	0	0				
Lesser Black-backed Gull	P	P	0	0				
Herring Gull	P	0	0	0				
Great Black-backed Gull	P	0	0	0	C			
Common Wood Pigeon	P	P	0	0				
Common Cuckoo	0	1	0	0				
Sky Lark	21	22	2	4	D	C		
Sand Martin	P	P	P	P				
Barn Swallow	0	P	0	0				
Meadow Pipit	18	20	3	7	A, B, C, D	A, C	A, B	A
Grey Wagtail	0	P	0	P				
White/Pied Wagtail	2	2	1	2				
White-throated Dipper	0	2	0	2	A, B, C	A, C, D	A, B, C	A, C, D
Winter Wren	0	1	0	0	A, B, C, D	A		
Whinchat	2	2	0	0				
Stonechat	0	P	0	0	A, B, C	A		
Northern Wheatear	1	1	0	1				

**Table 3 contd.** A comparison of the birds recorded within the original 71 ha study area between the 2008-09 and 2009-10 seasons. For the breeding seasons, the numbers of apparent territories identified is given and 'P' indicates that the species was recorded but no territorial behaviour was observed. For the winter seasons, the survey visits during which they were recorded are given. Note that no Visit B was undertaken winter 2009-10.

Species	BREEDING SEASON				WINTER			
	Original study area		River Channel		Original study area		River channel	
	2008	2009	2008	2009	2008-09	2009-10	2008-09	2009-10
Common Blackbird	P	0	0	0				
Fieldfare					B	C		
Common Grasshopper Warbler	3	3	0	2				
Sedge Warbler	8	10	0	3				
Willow Warbler	1	2	0	0				
Eurasian Jackdaw	0	P	0	0				
Carrion Crow	P	P	0	0	A, B, C, D	A, C, D		
Common Raven	0	P	0	0	B	D		
Chaffinch	1	3	0	0				
Lesser Redpoll	0	P	0	0				
Reed Bunting	7	15	2	7	B, C, D			

## 4 DISCUSSION

The bird communities recorded during the present survey will have largely colonised the study area during the previous five years. This will certainly have been the case for those species using the re-diverted river channel as it would not have been present until 2004. It should be noted, however, that a temporary diversion of the channel, which ran to the north and west of the original (and re-established) river course could have supported some birds that could have been displaced, thus facilitating rapid recolonisation. However, some marked differences in populations of birds using the restored river channel and its immediate surrounds between the two seasons for which we have data (2008 and 2009) provides strong support to suggest changing environmental conditions and/or colonisation of the riparian habitats by birds.

### 4.1 Piscivorous birds and other riverine specialist species

Two principally piscivorous species were recorded, Grey Heron and Goosander. Grey Heron was seen in both breeding and winter season surveys using the river channel as well as other water bodies within the surveyed area. Goosander was only seen in the breeding season and only in flight over the study area and so was not recorded using the river channel; Goosanders were recorded on the river channel in 2008. Breeding by both these piscivorous species within the study area may be limited by the availability of suitable nest sites. Grey Herons predominantly nest in trees (within the canopy; Marquiss 2007a), while Goosanders use holes, predominately in trees or amongst rocks (Marquiss 2007b). Both species could potentially breed close to the study area and Goosander could potentially do so within it should suitable nest sites develop and become available either naturally or through targeted management.

Three passerines associated with the river were White-throated Dipper, Sand Martin and Grey Wagtail. White-throated Dippers are almost exclusively associated with flowing water and feed principally on aquatic invertebrates (Tyler & Omerod 1994). The presence of breeding White-throated Dippers in 2009, with one nest site found (under the haul road bridge near the centre of the re-diverted river) and another apparent territory (centred on the Beoch Lane) represents a key development in the establishment of a riparian bird community along the river. Nest sites of White-throated Dippers include rock ledges, amongst tree roots and the cavities and ledges of bridges, walls and other structures by rivers (Shaw 1978). Currently, potential nest sites (stable ledges or developed root systems) may be limited but with continued development of the river bank and its associated vegetation further suitable sites may become available for use by nesting White-throated Dippers.

Sand Martins also feed on invertebrates but in contrast to Dippers they predominantly forage for them aerially, often above water courses and nest in burrows dug into steep sandy banks (Turner 2007). Increased presence during the 2009 breeding season (seen on all survey visits in 2009 compared to just one in 2008) is potentially another indicator for a developing riparian bird community. Given the development of some steep banks through natural erosion by the river, future colonisation by breeding Sand Martins is a possibility. Notable by its absence from the surveys in 2008 was Grey Wagtail because of their preference for fast flowing shallow water courses (e.g. Vickery 1991). However their presence on two of the breeding survey visits in 2009 potentially indicates the start of a colonisation process by that species too.

The most abundant breeding wader in the study area in 2009 and also one that was strongly associated with the river was Common Sandpiper. With eight apparent territories along 3 km of river, breeding densities in the study area are within the range of 0.13 - 4.67 pairs per km found for established rivers in southern Scotland (Dougall & Yalden 2007). This represents an increase from the six apparent territories that were associated with the river channel in 2008. Two apparent territories of Common Sandpiper away

from the river channel were also additional to those recorded in 2008 (when all were along the river) and is further indication of an increasing population density at the House of Water study area.

All the apparent territories of the other wader species found in the study area included the river channel where the principal differences between 2008 and 2009 were reduced numbers of Northern Lapwing and Common Redshank, which contrasts with an additional presence of Dunlin and Eurasian Curlew (Table 3).

## **4.2 Other species**

In common with 2008, Mallard, Eurasian Teal and Common Snipe were more numerous in the currently reported period in the winter than in the breeding season. Across the wider study area, within the surveyed area that was common to both seasons, the number of apparent territories of passerines in 2009 was broadly similar to those recorded in 2008, though the increase in Reed Buntings (from 7 apparent territories in 2008 to 15 in 2009) was notable. However, the number of apparent territories that were associated with the river channel was greater in 2009 for a number of species; Sky Lark, Meadow Pipit, Pied Wagtail, Northern Wheatear, Common Grasshopper Warbler, Sedge Warbler and Reed Bunting were all more numerous by the river channel. Both the abundance of, and the frequency of recording passerines was lower in the winter 2009-10 than in 2008-09.

## **4.3 Potential causes of change**

There were some marked changes in the bird populations at House of Water between the two years for which survey data are available. Given the aim of restoring the ecology of the re-diverted river, the most notable changes are those indicative of a developing riparian bird community (see Section 4.1) including some potential key species identified in 2008 (e.g. Common Sandpiper, Sand Martin, White-breasted Dipper and Grey Wagtail; Calladine & Thiel 2009).

Correlative modelling of extensive river habitat surveys and the presence of breeding birds on waterways indicated that the bird communities of fast flowing rivers, most typical of 'upland' situations such as that at House of Water, showed some of the closest links with hydromorphological features (Vaughan *et al.* 2007). Such changes at House of Water will include bank erosion, the development of shingle beds and the development of vegetation and invertebrate fauna. Increases in birds that are riverine specialists between the 2008 and 2009 breeding seasons, and indeed their colonisation of the site since 2004, indicate that these processes are indeed happening. The apparent movement by some breeding birds that are not specialist riparian species towards the river (see Section 4.2) provides further evidence of a changing or developing river environment.

Away from the river channel, there have been declines in some breeding waders between 2008 and 2009, though not for Common Sandpiper. In the absence of more detailed studies, potential factors contributing to the declines could include the natural development of vegetation on previously disturbed ground. If this was the case, then the development of ephemeral shingle beds within the river channel will become increasingly important in maintaining the breeding waders at House of Water.

Principal differences between the two winter seasons that have been monitored to date were the reduced abundance and occurrence of passerines and Common Snipe in the wider study area in 2009-10. Winter 2009-10 was exceptionally hard with prolonged snow cover and indeed extreme weather prevented one of the planned survey visits. The weather alone is perhaps sufficient to explain the observed difference

between years. However, the continued presence of wildfowl, White-breasted Dipper and Grey Heron on the river during the winter perhaps adds further evidence for the development of the re-diverted river channel into a useful resource for nature conservation.

#### **4.4 Future monitoring**

Biological monitoring is vital to inform river conservation, with birds as major candidates for that purpose because of their connections to riverine food webs and habitat features (Vaughan *et al.* 2007). Given the good relationships that have been demonstrated between birds and hydromorphological features for rivers such as that at House of Water (Vaughan *et al.* 2007) and also the fact that the bird populations appear to be developing rapidly, the site offers an excellent opportunity to further quantify the relationships between bird populations, river structure and its associated vegetation and invertebrate communities. To date, most information on factors affecting the distribution of birds on rivers is qualitative (Vaughan *et al.* 2007). A coordinated study of the bird communities with other biological and hydromorphological monitoring at House of Water could potentially identify some of the causal relationships between the occurrence of birds and riverine conditions and inform: (i) the success or otherwise of this specific river restoration project, (ii) potentially guide the ongoing management of the site, and (iii) provide valuable empirical data to inform river conservation management more widely. To achieve this we recommend:

- a) Annual monitoring of the bird communities in both summer and winter using the same methods as described in this report. Given the apparent rapid development of some bird populations since 2004 and the measured differences between 2008 and 2009, we suggest that monitoring should continue annually, initially at least, to avoid the risk of missing potentially important changes. The frequency of monitoring can be reviewed if changes prove to be less rapid in the forthcoming years;
- b) Monitoring should concentrate on the birds of the river with changes in the use of the site by the following potential key species being indicative of a developing riparian system: Grey Heron, Goosander, Common Sandpiper, Sand Martin, White-breasted Dipper and Grey Wagtail. Potential colonists such as Common Kingfisher and also waders such as Dunlin and Common Redshank also could be included in this list;
- c) The objectives for monitoring the wider restored area should be clarified and, if necessary, the survey methods revised to be more appropriate for the species involved. However monitoring of the areas immediately adjacent to the river could be continued (using the same methods as reported in Calladine & Thiel 2009) to (i) provide further insight into the developing bird communities of the wider site in a cost-effective way, (ii) potentially identify any influence of the developing river beyond the immediate boundaries of its channel, (iii) conversely potentially identify any influences on the riverine bird populations from beyond its immediate channel and (iv) ensure that some species that could be associated with developing riverside vegetation (e.g. Common Reed Bunting and Sedge Warbler) are monitored adequately;
- d) More detailed discussions should be held, notably with Stirling University staff, regarding future integration with other biological and hydrological monitoring.



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## APPENDICES

**Appendix 1** Distributions of apparent breeding territories at House of Water in 2009. Dots or dark shaded polygons denote single apparent territories. Polygons are the minimum convex polygons drawn around the plotted registrations deemed to refer to the same territory and are presented for the breeding waders Mallard and White-throated Dipper. Otherwise dots are placed centrally amongst the relevant registrations (and therefore some appear outside of the study area boundary) as the identification of territory boundaries is arguably less robust for other species based on just four survey visits. Note that for Greater Canada Goose, the dots refer to crèche locations.

**Greater Canada Goose**



**Mallard**



**Eurasian Oystercatcher**



**Ringed Plover**





**Northern Lapwing**



**Dunlin**



**Eurasian Curlew**



**Common Redshank**



**Common Sandpiper**



**Black-headed Gull**



**Mew Gull**



**Common Cuckoo**



**Sky Lark**



**Meadow Pipit**



**Pied Wagtail**



**White-throated Dipper**



**Winter Wren**



**Whinchat**



**Northern Wheatear**



**Song Thrush**



**Common Grasshopper Warbler**



**Sedge Warbler**



**Willow Warbler**



**Chaffinch**



**Reed Bunting**





**Appendix 2** The locations of apparently non-breeding species using the river channel during all four survey visits April – June 2009. Dots denote locations where individuals were first detected on any one of the four visits.

**Mallard**



**Grey Heron**



**Common Snipe**



**Sand Martin**



**Grey Wagtail**



**Appendix 3** The locations of birds using the river channel during three survey visits in winter 2009-10. Dots denote locations where individuals were first detected on any one of the four visits.

**Mallard**



**Eurasian Teal**



**Grey Heron**



**Common Snipe**



**Jack Snipe**



**Meadow Pipit**



**White-throated Dipper**



**Appendix 4** Scientific names of species mentioned in the report.

Species	Scientific name
Mute Swan	<i>Cygnus olor</i>
Greater Canada Goose	<i>Branta canadensis</i>
Eurasian Teal	<i>Anas crecca</i>
Mallard	<i>Anas platyrhynchos</i>
Goosander	<i>Mergus merganser</i>
Grey Heron	<i>Ardea cinerea</i>
Common Buzzard	<i>Buteo buteo</i>
Common Kestrel	<i>Falco tinnunculus</i>
Eurasian Oystercatcher	<i>Haematopus ostralegus</i>
Ringed Plover	<i>Charadrius hiaticula</i>
Northern Lapwing	<i>Vanellus vanellus</i>
Dunlin	<i>Calidris alpina</i>
Jack Snipe	<i>Lymnocyptes minimus</i>
Common Snipe	<i>Gallinago gallinago</i>
Eurasian Curlew	<i>Numenius arquata</i>
Common Redshank	<i>Tringa totanus</i>
Common Sandpiper	<i>Actitis hypoleucos</i>
Black-headed Gull	<i>Chroicocephalus ridibundus</i>
Mew Gull	<i>Larus canus</i>
Lesser Black-backed Gull	<i>Larus fuscus</i>
Great Black-backed Gull	<i>Larus marinus</i>
Common Wood Pigeon	<i>Columba palumbus</i>
Common Cuckoo	<i>Cuculus canorus</i>
Common Kingfisher	<i>Alcedo atthis</i>
Sky Lark	<i>Alauda arvensis</i>
Sand Martin	<i>Riparia riparia</i>
Barn Swallow	<i>Hirundo rustica</i>
Meadow Pipit	<i>Anthus pratensis</i>
Grey Wagtail	<i>Motacilla cinerea</i>
Pied Wagtail	<i>Motacilla alba ssp. yarrellii</i>
White-throated Dipper	<i>Cinclus cinclus</i>
Winter Wren	<i>Troglodytes troglodytes</i>
Whinchat	<i>Saxicola rubetra</i>
Stonechat	<i>Saxicola torquatus</i>
Northern Wheatear	<i>Oenanthe oenanthe</i>
Common Blackbird	<i>Turdus merula</i>
Fieldfare	<i>Turdus pilaris</i>
Song Thrush	<i>Turdus philomelos</i>
Common Grasshopper Warbler	<i>Locustella naevia</i>
Sedge Warbler	<i>Acrocephalus schoenobaenus</i>
Willow Warbler	<i>Phylloscopus trochilus</i>
Eurasian Jackdaw	<i>Corvus monedula</i>
Carrion Crow	<i>Corvus corone</i>
Common Raven	<i>Corvus corax</i>
Chaffinch	<i>Fringilla coelebs</i>
Lesser Redpoll	<i>Carduelis cabaret</i>
Reed Bunting	<i>Emberiza schoeniclus</i>