



BTO Research Report No. 602

**Third Year of Ornithological Surveys at
House of Water, East Ayrshire:
Breeding Season 2010 and
Winter Season 2010-11**

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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, former surface mine at House of Water in East Ayrshire in 2010-11. The principal interest was the re-diverted River Nith, which at *ca.* 3 km long is believed to be amongst the largest river diversion project in Europe. This is the third year the river and its immediate surrounds were surveyed and the second in which a wider restored area was included.
2. Four transect surveys were undertaken in the breeding season (April – June 2010) and four in the winter season (November 2010 – February 2011). 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 each of the breeding and winter seasons.
3. A total of 41 species was recorded within the study area during the eight survey visits. Thirty-six species were recorded in the breeding season, including 23 recorded as using the re-diverted river channel. Behaviour indicative of breeding was recorded for 27 species of which 14 were associated with the river channel. Twenty-two species were recorded in the winter survey visits of which five 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 2010-11. These were (1) Grey Heron seen in both summer and winter but not breeding, (2) Common Sandpiper with ten apparent territories along the river, (3) Sand Martin that have established a colony (actually within the surface mine) that included *ca.* 44 active burrows, (4) White-throated Dipper which was seen in both seasons with one apparent breeding territory, and (5) Goosander that was seen on the river in the breeding season. Other species seen on or immediately by the river were: Mallard (both seasons), Eurasian Teal (both seasons with one apparent territory away from the river), Eurasian Oystercatcher (3 apparent territories), Ringed Plover (3 apparent territories), Northern Lapwing (1 apparent territory), Common Snipe (both seasons with one apparent territory away from the river), , Eurasian Curlew (1 apparent territory), Common Redshank (1 apparent territory), Sky Lark (9 apparent territories), Meadow Pipit (both seasons, including 9 apparent territories), Pied Wagtail (2 apparent territories), Northern Wheatear (present in the breeding season), Common Grasshopper Warbler (5 apparent territories), Sedge Warbler (7 apparent territories) and Reed Bunting (9 apparent territories).
5. Principal changes since the first bird surveys in 2008 that are indicative of the development of the development of a riparian bird community are increases in the number of species using the river channel (11 in 2008-09, 19 in 2009-10 and 23 in 2010-11). Amongst these are increases in the number of apparently breeding Common Sandpiper (6 in 2008, 8 in 2009 and 10 in 2010), increases in the number of apparent territories of passerines associated with the river (Meadow Pipit (0, 7 and 9 respectively), Common Grasshopper Warbler (0, 2 and 5), Sedge Warbler (0, 3 and 7) and Reed Bunting (2, 7 and 9) and the first confirmed presence of breeding Sand martin in 2010. A decrease in breeding White-throated Dippers between 2009 and 2010 (from 2 to 1 apparent territory) and the absence of Grey Wagtails (present in 2009-10) *may* have been attributable to extreme winter weather in 2009-10. Neither of the latter two species were present in 2008.

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 nearly 3 km in length this is believed to be amongst the largest river restoration projects in Europe. This report describes and gives the results of surveys of breeding birds in 2010 and of birds present in winter 2010-11, the third successive season 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.

The development of vegetation and macro-invertebrate communities along the 3 km re-diverted section of the river are being monitored, following its restoration, by the School of Biological and Environmental Sciences, Stirling University. 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 2009-10 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 and 2009-10 seasons (Calladine & Thiel 2009, 2010), 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, shingle, soft mud and silt. Its course and nature aim to replicate the original section of the upper reaches of the River Nith prior to surface mining at the site (Halcrow Group Limited 2004). From this transect, an area of about 72 ha was covered. This included the river, restored (formerly surface mined) 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. During 2010, an area (*ca.* 20 ha) of formerly surveyed ground to the north of the river was included within the active surface mine and therefore became excluded from the surveyed area for the winter season.

From 2009, a more extensive area (including an additional 108 ha) has been surveyed. The additional areas were predominantly restored (formerly surface mined) 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 km² (after Brown & Shepherd 1993, Calladine *et al.* 2009).

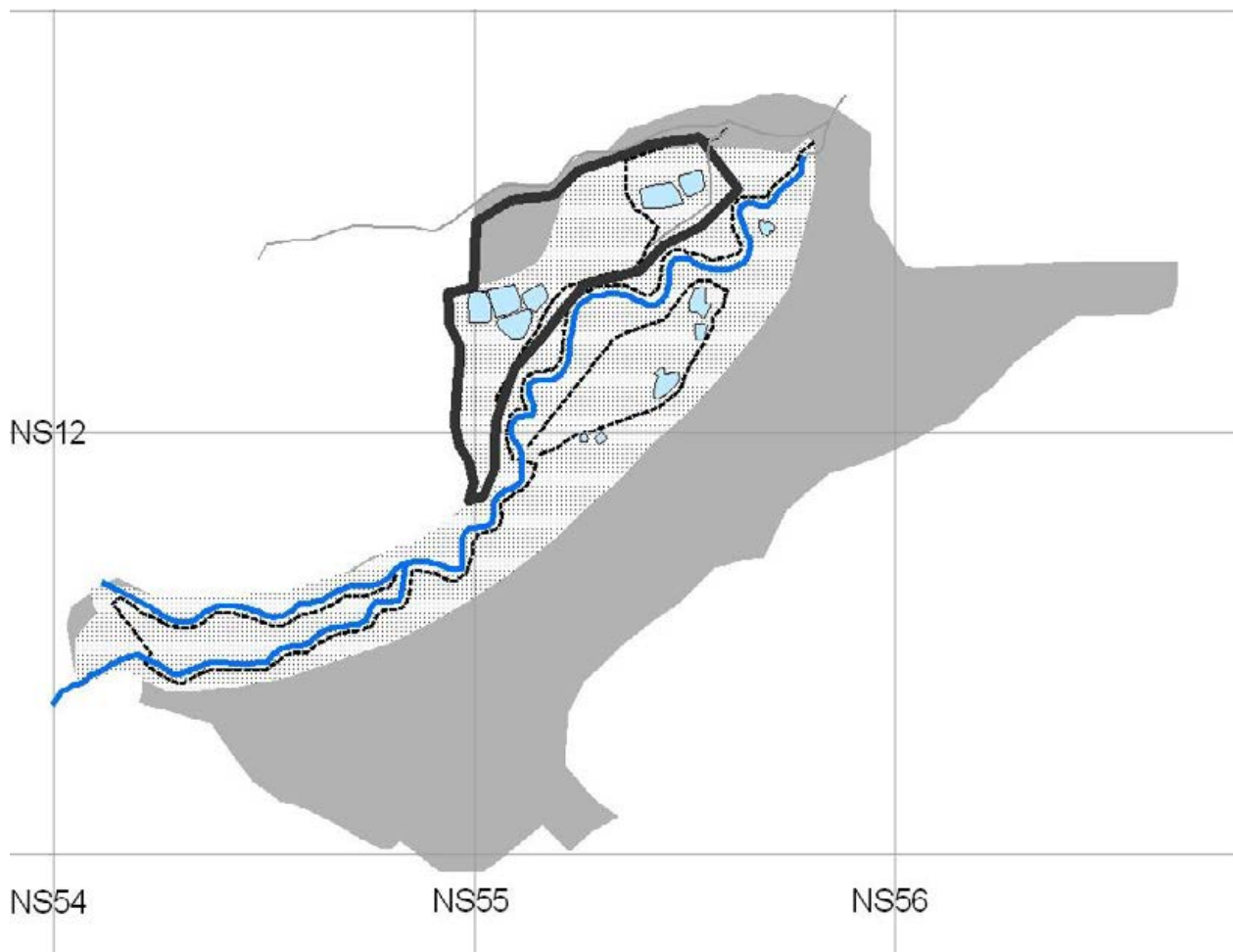


Figure 1 The House of Water study area and survey transects used in 2010-11. The solid shaded and stippled areas represent the complete study area (ca. 180 ha). The solid line represents the course of the re-diverted River Nith and the dotted lines the survey transects (ca. 6.1 km). The grid lines represent the 1-km divisions of the Ordnance Survey's national grid. The stippled area represents that approximate area that is surveyed from the transects (ca. 72 ha). The area delineated by the thick black line became included in the surface mine during 2010 and was therefore excluded from the winter surveys.

2.2 Breeding bird surveys

Four survey visits were carried out for breeding birds in 2010: on 16th April (Visit A); 11th May (Visit B); 26th May (Visit C) and 7th June (Visit D). A one-off visit was made on 17th May to count a Sand Martin colony on one of the walls of the operational House of Water surface mine adjacent to the study area. 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. Where this was not possible, 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 was assumed to be sufficient in this study 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). This approach is comparable to that which is widely used for breeding waders on moorland that uses just two survey visits (Brown & Shepherd 1993). Also, no correction factors have been employed in this study 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 the

priorities of this study 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 of bird population sizes should also be compatible with the most representative data that can be spatially referenced. Therefore we have chosen not to use correction factors that account for the possibility of some missed birds as the locations of those potentially missed birds would not be determinable.

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 ($n = 4$) and spatial coverage (walking within 100 m of all ground)) 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 individuals:

- a) were recorded on or in the water itself;
- b) were recorded on rocks or vegetated islets within the flowing river channel;
- c) 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) foraged in the air above the water and within 3 m of its surface.

2.3 Winter bird surveys

Four survey visits were undertaken in the winter of 2010-11: on 27th November (Visit A); 14th December (Visit B); 31st January (Visit C); and 26th February (Visit D). 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 only counts of birds seen on each survey visit are presented and no attempt is made at summarising of data for the winter season. As the principal aim was to record bird use of the re-diverted river, individuals were recorded within and away from the river channel separately. The same criteria as for including apparently non-breeding individuals using the river channel during the breeding season were used for the winter season (see the last paragraph of section 2.2).

3. RESULTS

A total of 41 species were recorded within the study area during the eight survey visits, four visits each in the breeding (2010) and winter (2010-11) seasons (Tables 1 and 2). Thirty-six species were recorded within the study area during the breeding season, which included 23 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). This compares to a total of 45 species in the 2009 and 2009-10 seasons, of which 19 were using the re-diverted river channel (Table 3). Eleven species were recorded using the river channel in the 2008 and 2008-09 seasons, the first year of surveying birds at the restored site (Calladine & Thiel 2009). Within that first year, the extensive restored area was not surveyed.

In 2010, territorial behaviour was recorded for 27 species compared to 25 in 2009 (Table 3). Within the river channel, 14 species were seen behaving as if holding territories in 2010 compared to 15 in 2009 (Tables 1 and 3). The distributions of the apparent territories in 2010 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.

Twenty-two species were recorded during the winter survey visits of which five were observed using the river channel (Table 2). This compares to 19 species recorded in winter 2009-10 and seven that were seen to be using the river channel (albeit during three rather than four survey visits). The locations of all species using the river channel during the three winter visits in 2010-11 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 2010 breeding season, one apparent territory (AT) of Eurasian Teal was on a pool to the south of the river (compared to no apparent territories in 2009 and one in 2008). There were no apparent territories of Mallard in 2010 (one in 2009 on the river and none in 2008), although birds were seen on the river and the pools to the south of the river. A Greater Canada Goose nest was found near to the river on visit A (Appendix 1) and three broods were seen on the settling lagoons to the north of the river. Further adults were seen around the wetlands to the north of the river (four apparent territories were located in both 2009 and 2008). Goosanders and Mute Swans were recorded on the river during the breeding season but no evidence of breeding was noted. Wildfowl were recorded along the full stretch of the re-diverted river in 2010-11, however the majority were found downstream of the haul road bridge.

3.2 Waders

Twenty-seven apparent territories of seven species of waders were recorded during the 2010 breeding season (Table 1), compared to nineteen apparent territories of eight species in 2009. Of these, 19 apparent territories of six species included the river channel (cf. 16 of six species in 2009 and 16 of five species in 2008).

The breeding populations of five wader species (as measured by the number of apparent territories) increased in 2010 compared to 2009: Common Sandpipers increased from 10 to 11 apparent territories; Ringed Plover (from 2 to 6 apparent territories); Eurasian Oystercatcher (from 3 to 5 apparent territories); Northern Lapwing (from 1 to 2); Common Snipe (from presence only to 1 apparent territory) (Table 3). Populations of Eurasian Curlew (1 apparent territory) and Common Redshank (1 apparent territory) were the same in both 2009 and 2010. There were no sightings of Dunlin in 2010 (1 apparent territory in 2009). As in 2009, 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). For comparisons of the river channel with 2008, see Table 3.

Two wader species were recorded during the winter surveys in 2010-11 (Ringed Plover and Common Snipe; Table 2). Ringed Plover was seen on the last survey visit (26th February) only, as was the case in winter 2009-10, and are likely to have been birds returning to their breeding areas.

3.3 Other species

Twenty-nine other species (i.e. those that are neither wildfowl nor waders) were recorded during the breeding and winter season survey visits combined (cf. 29 in 2009). Of these, 18 were thought likely to be breeding within the study area based on the observations of territorial behaviour (c.f. 14 in 2009). 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), the same as in 2009 and compared to 7 in 2008 (Table 3).

Notable developments since the 2008 breeding season were:

- i) The formation of a Sand Martin breeding colony (44 active nests observed) within the operation site in 2010. Six abandoned Sand Martin nest holes were on a bank of the river (which *could* have been present but missed during a previous year). Unusually, Sand Martins were not recorded as feeding over the river channel in 2010.
- ii) An increase in the number of Reed Buntings, from 16 (in 2009) to 20 (in 2010) apparent territories within the survey area, including an increase from 7 to 9 apparent territories associated with the river (cf. 2 in 2008);
- iii) An increase in the number of apparent territories of Sky Lark and Meadow Pipit associated with the river from none in 2008 to 4 and 9 respectively in 2010. However, overall numbers in the wider survey area were very similar in 2009 and 2010;
- iv) An increase in the number of apparent territories of Common Grasshopper Warbler associated with the river (including a change from none in 2008, 2 in 2009 and 5 in 2010) and Sedge Warbler, also associated with the river (from none in 2008, 5 in 2009 and 7 in 2010);
- v) Following the establishment of breeding White-throated Dippers in 2009 (with 2 apparent territories), this declined to 1 in 2010;
- vi) A decrease in the number of Winter Wrens in the wider survey area from 5 territories in 2009 to 1 in 2010.
- vii) Following the presence of Grey Wagtail in 2009, they were not recorded in 2010 (and were similarly not recorded in 2008).

In common with previous winter seasons, relatively few 'other' species were recorded during the winter survey visits in 2009-10. However flocks of Chaffinch and Goldfinch were recorded for the first time and Reed Buntings were recorded during three survey visits (c.f. only once in winter 2009-10).

Table 1 Species recorded during each of the four breeding season visits to the House of Water study area in 2010, 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 are not mutually exclusive in that the 'Apparent territories' numbers include those using the river channel.

| Species | Apparent territories | River channel | Visit A 16 Apr | Visit B 11 May | Visit C 26 May | Visit D 7 Jun |
|----------------------------|----------------------|---------------|-------------------|-------------------|-------------------|------------------|
| Mute Swan | 0 | Y | Y | Y | 0 | 0 |
| Greater Canada Goose | 3 | Y | Y | Y | Y | Y |
| Mallard | 0 | Y | Y | Y | 0 | 0 |
| Eurasian Teal | 1 | 0 | Y | Y | 0 | 0 |
| Goosander | 0 | Y | Y | Y | 0 | 0 |
| Grey Heron | 0 | Y | Y | Y | Y | 0 |
| Common Buzzard | 0 | 0 | 0 | Y | Y | Y |
| Eurasian Oystercatcher | 5 | 3 | Y | Y | Y | Y |
| Ringed Plover | 6 | 3 | Y | Y | Y | Y |
| Northern Lapwing | 2 | 1 | 0 | Y | 0 | 0 |
| Common Snipe | 1 | Y | Y | 0 | 0 | Y |
| Eurasian Curlew | 1 | 1 | Y | 0 | 0 | 0 |
| Common Redshank | 1 | 1 | 0 | Y | 0 | Y |
| Common Sandpiper | 11 | 10 | Y | Y | Y | Y |
| Black-headed Gull | 2 | 0 | Y | 0 | Y | 0 |
| Mew Gull | 1 | 0 | Y | Y | Y | Y |
| Lesser Black-backed Gull | 0 | 0 | 0 | Y | Y | Y |
| Common Wood Pigeon | 2 | 0 | 0 | 0 | Y | Y |
| Sky Lark | 41 | 9 | Y | Y | Y | Y |
| Sand Martin | 44 | Y | 0 | Y | Y | Y |
| Barn Swallow | 0 | 0 | 0 | Y | Y | 0 |
| Meadow Pipit | 32 | 9 | Y | Y | Y | Y |
| Pied Wagtail | 2 | 2 | Y | Y | Y | Y |
| White-throated Dipper | 1 | 1 | Y | 0 | 0 | 0 |
| Winter Wren | 1 | 0 | 0 | 0 | Y | Y |
| Whinchat | 3 | 2 | 0 | Y | Y | Y |
| Northern Wheatear | 2 | Y | Y | Y | Y | Y |
| Song Thrush | 1 | 0 | 0 | 0 | 0 | Y |
| Common Grasshopper Warbler | 8 | 5 | 0 | Y | Y | Y |
| Sedge Warbler | 21 | 7 | 0 | Y | Y | Y |
| Willow Warbler | 5 | 0 | 0 | Y | Y | Y |
| Eurasian Jackdaw | 0 | 0 | 0 | Y | 0 | 0 |
| Carrion Crow | 2 | Y | Y | Y | Y | Y |
| Common Raven | 0 | 0 | 0 | 0 | 0 | Y |
| Chaffinch | 8 | 0 | 0 | Y | Y | Y |
| Reed Bunting | 20 | 9 | Y | Y | Y | Y |

Table 2 The numbers of each species recorded during each of the four winter survey visits to the House of Water study area in 2010-11 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.

| Species | Visit A 27 Nov | | Visit B 14 Dec | | Visit C 31 Jan | | Visit D 26 Feb | |
|-----------------------|-------------------|------------------|-------------------|------------------|-------------------|------------------|-------------------|------------------|
| | Total | River channel | Total | River channel | Total | River channel | Total | River channel |
| Greater Canada Goose | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 0 |
| Mallard | 0 | 0 | 0 | 0 | 8 | 2 | 2 | 2 |
| Eurasian Teal | 28 | 26 | 8 | 8 | 8 | 5 | 1 | 0 |
| Grey Heron | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| Common Buzzard | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 0 |
| Common Kestrel | 1 - 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Ringed Plover | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| Common Snipe | 5 | 1 | 0 | 0 | 0 | 0 | 2 | 0 |
| Sky Lark | 0 | 0 | 0 | 0 | 1 | 0 | 33 | 0 |
| Meadow Pipit | 11 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| Pied Wagtail | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| White-throated Dipper | 4 | 4 | 4 | 4 | 3 | 3 | 0 | 0 |
| Winter Wren | 2 | 0 | 2 | 0 | 0 | 0 | 1 | 0 |
| Stonechat | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Fieldfare | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Carrion Crow | 6 | 0 | 9 | 0 | 21 | 0 | 8 | 0 |
| Common Raven | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Chaffinch | 0 | 0 | 48 | 0 | 0 | 0 | 0 | 0 |
| Goldfinch | 0 | 0 | 45 | 0 | 0 | 0 | 21 | 0 |
| Linnet | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Reed Bunting | 2 | 1 | 3 | 2 | 0 | 0 | 4 | 0 |

Table 3 Comparisons of the birds recorded within the whole study area between the 2009-10 and 2010-11 seasons and also those using the river channel during the three seasons (2008-09 to 2010-11). For the breeding seasons, the numbers of apparent territories identified is given; '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 (see Section 2.3). Note that no Visit B was undertaken in winter 2009-10.

| Species | BREEDING SEASON | | | | | WINTER | | | | |
|--------------------------|---------------------|------|---------------|------|------|---------------------|-------------|---------------|-------------|-------------|
| | Complete study area | | River Channel | | | Complete study area | | River channel | | |
| | 2009 | 2010 | 2008 | 2009 | 2010 | 2009 -10 | 2010 -11 | 2008 -09 | 2009 -10 | 2010 -11 |
| Mute Swan | P | P | 0 | 0 | 0 | A | | | | |
| Greater Canada Goose | 3 | 3 | 0 | 0 | 1 | D | D | | | |
| Eurasian Teal | 0 | 1 | 0 | 0 | 0 | ACD | ABCD | BCD | CD | ABC |
| Mallard | 1 | 0 | P | 1 | 0 | ACD | C | BCD | CD | C |
| Goosander | 0 | P | P | P | P | | | | | |
| Grey Heron | P | P | 0 | P | P | A D | D | A | D | |
| Common Buzzard | P | P | 0 | 0 | 0 | | BD | | | |
| Common Kestrel | 0 | 0 | 0 | 0 | 0 | C | AB | | | |
| Peregrine Falcon | 0 | 0 | 0 | 0 | 0 | | | | | |
| Eurasian Oystercatcher | 3 | 5 | 3 | 3 | 3 | | | | | |
| Ringed Plover | 2 | 6 | 2 | 2 | 3 | D | D | | | |
| Northern Lapwing | 1 | 2 | 3 | 0 | 1 | D | | | | |
| Dunlin | 1 | 0 | 0 | 1 | 0 | | | | | |
| Common Snipe | P | 1 | 0 | P | 0 | A | AD | BC | A | A |
| Jack Snipe | 0 | 0 | 0 | 0 | 0 | A | | | A | |
| Eurasian Curlew | 1 | 1 | 0 | 1 | 1 | | | | | |
| Common Redshank | 1 | 1 | 2 | 1 | 1 | | | | | |
| Common Sandpiper | 10 | 11 | 6 | 8 | 10 | | | | | |
| Black-headed Gull | 3 | 2 | P | 0 | 0 | | | | | |
| Mew Gull | 1 | 1 | 0 | 0 | 0 | | | | | |
| Lesser Black-backed Gull | P | P | 0 | 0 | P | | | | | |
| Herring Gull | 0 | 0 | 0 | 0 | 0 | | | | | |
| Great Black-backed Gull | 0 | 0 | 0 | 0 | 0 | | | | | |
| Common Wood Pigeon | P | 2 | 0 | 0 | 0 | | | | | |
| Common Cuckoo | 1 | 0 | 0 | 0 | 0 | | | | | |
| Sky Lark | 42 | 41 | 0 | 4 | 4 | C | CD | | | |
| Sand Martin | P | 44 | P | P | P | | | | | |
| Barn Swallow | P | P | 0 | P | P | | | | | |
| Meadow Pipit | 33 | 32 | 0 | 7 | 9 | AC | AD | AB | A | |
| Grey Wagtail | P | 0 | 0 | P | 0 | | | | | |
| White/Pied Wagtail | 2 | 2 | 1 | 2 | 2 | | D | B | | |
| White-throated Dipper | 2 | 1 | 0 | 2 | 1 | ACD | ABC | ABC | ACD | ABC |
| Winter Wren | 5 | 1 | 0 | 0 | 0 | A | ABD | | | |
| Whinchat | 2 | 3 | 0 | 0 | 0 | | | | | |
| Stonechat | P | 0 | 0 | 0 | 0 | A | D | | | |
| Northern Wheatear | 1 | 2 | 0 | 1 | 0 | | | | | |

Table 3 contd. Comparisons of the birds recorded within the whole study area between the 2009-10 and 2010-11 seasons and also those using the river channel during the three seasons (2008-09 to 2010-11). For the breeding seasons, the numbers of apparent territories identified is given; '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 (see Section 2.3). Note that no Visit B was undertaken in winter 2009-10.

| Species | BREEDING SEASON | | | | | WINTER | | | | |
|----------------------------|---------------------|------|---------------|------|------|---------------------|-------------|---------------|-------------|-------------|
| | Complete study area | | River Channel | | | Complete study area | | River channel | | |
| | 2009 | 2010 | 2008 | 2009 | 2010 | 2009 -10 | 2010 -11 | 2008 -09 | 2009 -10 | 2010 -11 |
| Common Blackbird | P | 0 | 0 | 0 | 0 | | | | | |
| Song Thrush | 1 | 1 | 0 | 0 | 0 | | | | | |
| Fieldfare | | | 0 | | | C | | | | |
| Common Grasshopper Warbler | 6 | 8 | 0 | 2 | 5 | | | | | |
| Sedge Warbler | 14 | 21 | 0 | 3 | 7 | | | | | |
| Willow Warbler | 5 | 5 | 0 | 0 | 0 | | | | | |
| Eurasian Jackdaw | 0 | P | 0 | 0 | P | | | | | |
| Carrion Crow | P | 2 | 0 | 0 | P | ACD | ABCD | | | |
| Common Raven | 0 | P | 0 | 0 | 0 | D | C | | | |
| Chaffinch | 9 | 8 | 0 | 0 | 0 | | BD | | | |
| Goldfinch | | | 0 | | | | BD | | | |
| Linnet | | | 0 | | | | B | | | |
| Lesser Redpoll | 0 | 0 | 0 | 0 | 0 | | | | | |
| Reed Bunting | 16 | 20 | 2 | 7 | 9 | | ABD | | | AB |

4 DISCUSSION

This third annual survey of the breeding and wintering birds at House of Water continues to measure the development of the bird communities within the restored, formerly mined, area with particular emphasis on the river and its immediate surrounds. The bird communities recorded during the surveys will have largely colonised the study area since 2004, when the re-diverted river channel was established. It should be noted, however, that a temporary diversion of the channel, which ran to the north and west of the original (and re-diverted) river course would 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 three seasons for which data are available (since 2008) provides strong support to suggest changing environmental conditions (through the development of the re-diverted river) and/or colonisation of the riparian habitats by birds that are additional to any initial displacement from the temporary diversion.

4.1 Piscivorous birds, waders and other riparian 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 using the river channel. 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 (e.g. through the construction of suitable holes or provision of nest boxes).

The most abundant breeding wader in the study area in 2010 and also one that was strongly associated with the river was Common Sandpiper. With ten apparent territories along *ca.* 3 km of river channels, this represents a progressive increase from the six apparent territories that were associated with the river channel in 2008 and eight in 2009. The breeding density in the study area is within the range of 0.13 - 4.67 pairs per km that have been found for established rivers in southern Scotland (Dougall & Yalden 2007). Given the comparatively narrow channel compared to some rivers (see Section 2.1), the actual breeding density per unit *area* of suitable riparian habitat *may* be within the higher range that could be expected.

The number of Ringed Plover territories along the river increased from two in 2008 and 2009 to three in 2010 while the number of Oystercatcher territories has remained the same at three. Three additional Ringed Plover and two Oystercatcher territories were located away from the river channel in 2010 and may be indicative of increasing populations expanding from the river, however some of the area occupied has subsequently been 'lost' through expansion of the active mining area.

Single territories of Northern Lapwing, Eurasian Curlew and Common Redshank in 2010 included the river channel. For Northern Lapwing and Common Redshank, this arguably represents declines since 2008 (Table 3), but it should be noted that numbers are small and the territories for these species may have been predominantly away from the river channel and be predominantly influenced by the adjacent industrial activities and also the natural development of vegetation in the restored areas.

Common Snipe were more numerous in the winter than the breeding season. There was, however, an apparent territory in the wetlands south of the river in 2010, as there was in 2008, though no territorial behaviour by Common snipe was recorded in 2009.

Three passerines typically associated with rivers are 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 2010 again with one active nest site found (under the haul road bridge near the centre of the re-diverted river) is an important indicator of a developing upland bird riparian bird community, although there was one less apparent territory than in 2009. Nest sites of White-throated Dippers include rock ledges, tree roots, 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). 2010 was the first year when Sand Martin nests were found in the study area. The presence of some unoccupied nest holes, however, does suggest that they could have been present in at least 2009 as well. Perhaps surprisingly, no Grey Wagtails were recorded in the 2010 breeding season nor the 2010-11 winter season, which follows their presence during the 2009 breeding season.

4.2 Other species

There was a general increase in the number of passerines (Common Grasshopper Warbler, Sedge Warbler, Meadow Pipit, and Reed Bunting) with breeding territories that included the river channel. In common with previous years, Eurasian Teal and Mallard were more numerous in the winter than in the breeding season. However, the likely presence of breeding Eurasian Teal in the pools south of the river is of note.

4.3 Potential causes of change

There have been some marked changes in the bird populations at House of Water during the three 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 with 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). Hydromorphological processes at House of Water will include bank erosion, the development of shingle beds and the development of vegetation and invertebrate fauna. General increases in birds that are riverine specialists since 2008, and indeed their colonisation of the site since 2004, indicate that these processes are indeed happening. The apparent movement or colonisation 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. In contrast the numbers of some resident and locally dispersive species such as White-throated Dipper and Grey Wagtail decreased. The 2009-10 winter (i.e. that which immediately preceded the breeding season reported here) was particularly harsh with prolonged and exceptionally cold periods. The potential influence of such conditions, through high winter mortality, on these species could have been factors contributing to their reduced breeding numbers or presence in the 2010 season.

Away from the river channel, changes in breeding birds will be associated with the natural development of vegetation on previously restored and/or disturbed ground, potential disturbance associated with the current proximate mining activities, weather and potentially other factors. Natural succession of vegetation is likely to be one of the important long-term factors influencing bird populations at the site. For some species, for example Common Sandpiper and Ringed Plover, extensive re-vegetating may reduce the area of habitat that is suitable for them. However, in contrast some other species (e.g. Sedge Warbler and Common Grasshopper Warbler) may increase. To ensure the diversity of species on the site (both obligate riparian species, i.e. those that occur only on rivers and more opportunist riparian species), the development of ephemeral shingle beds within the river channel is likely to become increasingly important at House of Water.

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 similar to the re-diverted River Nith at House of Water (Vaughan *et al.* 2007) and also the fact that the bird populations appear to be developing, 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 empirical quantitative 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 since 2008, 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. 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. Reed Bunting, Grasshopper Warbler and Sedge Warbler) are monitored adequately;

- d) Firmer plans for future integration with other biological and hydrological monitoring should be developed, notably with Stirling University staff.

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APPENDICES

Appendix 1 Distributions of apparent breeding territories at House of Water in 2010. Dots or dark shaded polygons denote single apparent territories. Polygons are the minimum convex polygons drawn around the plotted registrations are deemed to refer to the same territory and are presented for the breeding waders 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 and for Sand Martin the triangle refers to the location of the breeding colony.

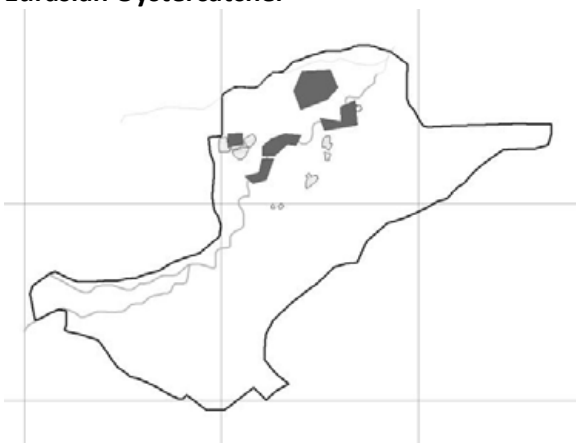
Greater Canada Goose



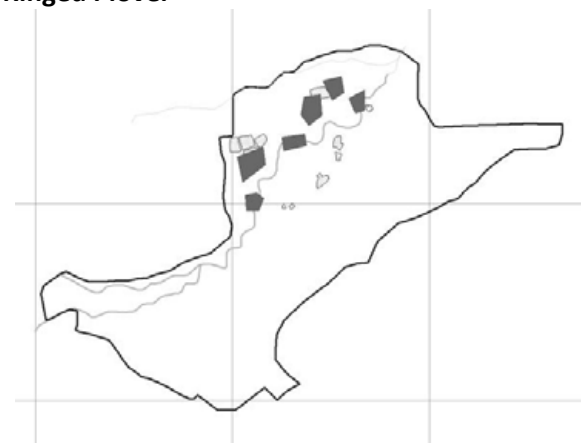
Eurasian Teal



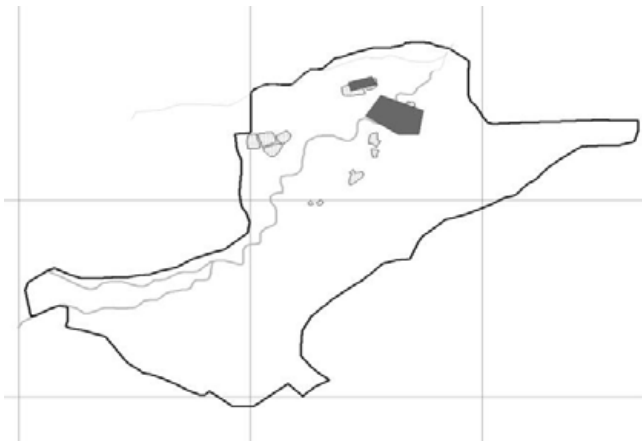
Eurasian Oystercatcher



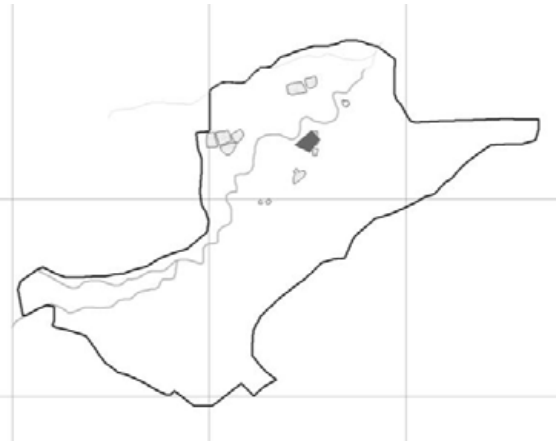
Ringed Plover



Lapwing



Common Snipe



Eurasian Curlew



Common Redshank



Common Sandpiper



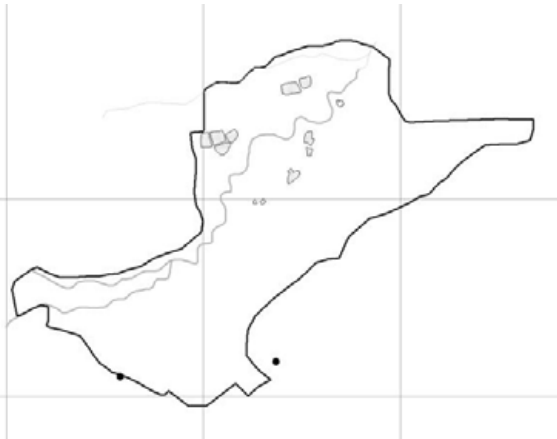
Black-headed Gull



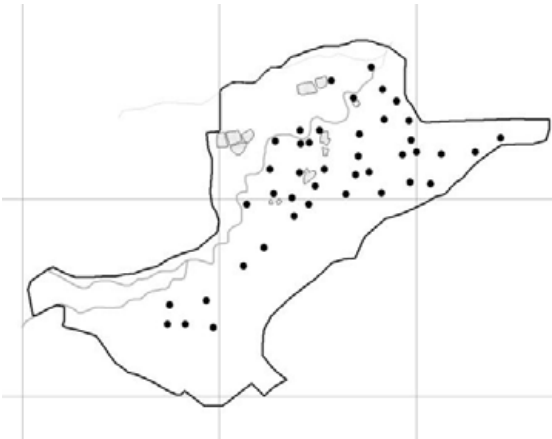
Mew Gull



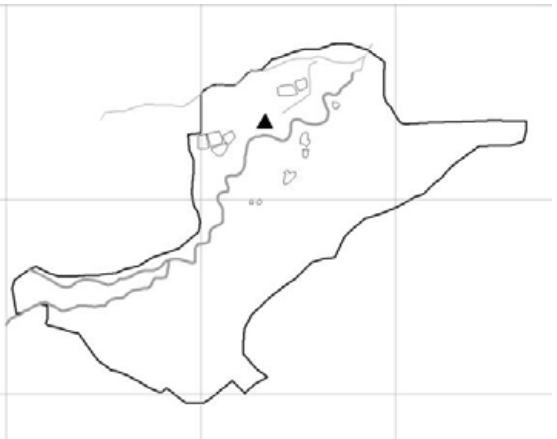
Common Wood Pigeon



Skylark



Sand Martin



Meadow Pipit



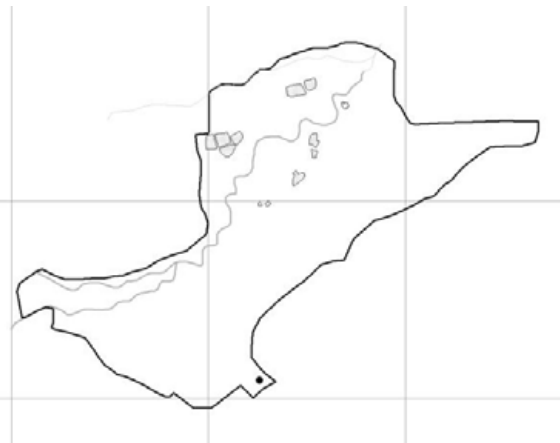
Pied Wagtail



White-throated Dipper



Winter Wren



Whinchat



Northern Wheatear



Song Thrush



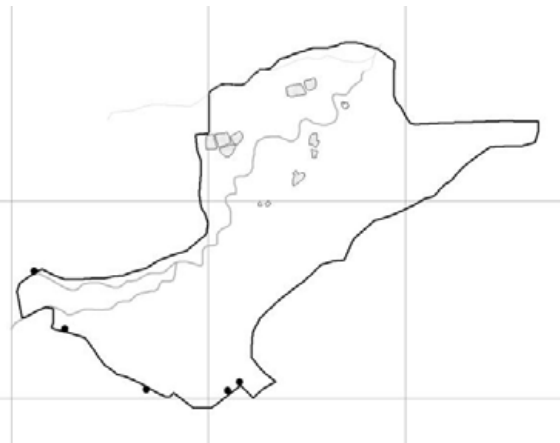
Common Grasshopper Warbler



Sedge Warbler



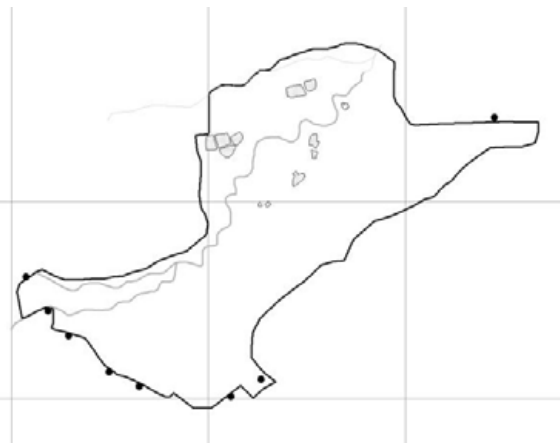
Willow Warbler



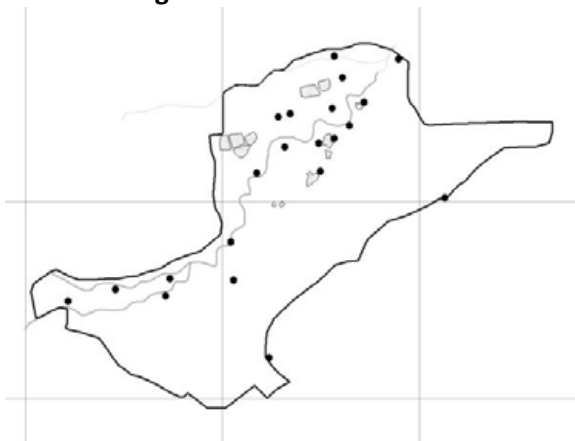
Carrion Crow



Chaffinch



Reed Bunting



Appendix 2 The locations of apparently non-breeding species using the river channel during all four survey visits April – June 2010. Dots denote locations where individuals were first detected on any one of the four visits.

Mute Swan



Mallard



Goosander



Grey Heron



Barn Swallow



Appendix 3 The locations of birds using the river channel during three survey visits in winter 2010-11. Dots denote locations where individuals were first detected on any one of the four visits.

Mallard



Eurasian Teal



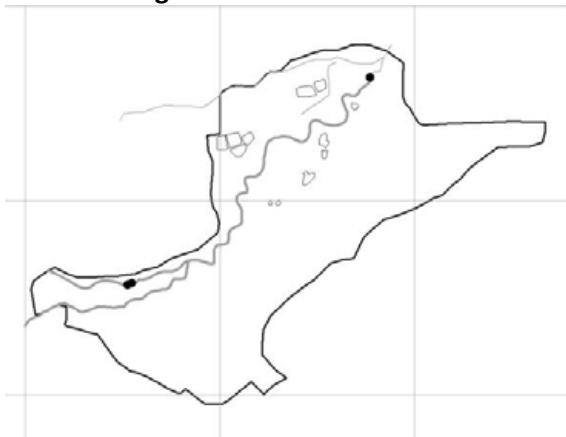
Common Snipe



White-throated Dipper



Reed Bunting



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> |