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An Assessment of the Effects of Arterial Drainage Maintenance on Birds Dependent on Riparian Habitats



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Foreword

This Ecological Assessment follows on from the strategic approach outlined in

“Series of Ecological Assessment on Arterial Drainage Maintenance No. 1: Screening of NATURA 2000 Sites for Impacts of Arterial Drainage Maintenance Operations.”

It examines the effects of statutory arterial drainage maintenance activities on birds dependent on riparian habitats, outlines measures to mitigate any negative impacts, and possible enhancement opportunities.

Environment Section

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Summary

1. This survey of the birds occurring along waterways in Ireland, carried out in 2006 and 2007, is a joint project of the National Parks and Wildlife Service, the Office of Public Works and Bird Watch Ireland. It aims to gather information on the distribution of waterways birds and to examine impacts of arterial drainage maintenance on bird communities.
2. This report focuses on the drainage maintenance assessment. Arterial drainage works are required to control flooding and bank erosion and improve river alignment and channels for navigation. These activities result in loss of habitats and increased disturbance to birds.
3. Visits were made to three Office of Public Works (OPW) managed channels where drainage maintenance work was carried out. Bird surveys were undertaken along 13 channels, most of which were at least partially managed within the past three years.
4. Along each waterway, observers covered ten 500 m sections, thus comprising a total of 5 km. Two visits were conducted during the breeding period. Observers recorded all birds seen or heard. Habitat details were also collated.
5. The surveyed channels were relatively homogenous, and located in low-lying areas surrounded by farmland (mostly improved grassland). The pace of maintenance work is relatively slow (roughly one kilometre stretches covered in a week and no more than five kilometres of a particular river managed in a year). Therefore, few of the channels surveyed had been entirely managed within a particular year.
6. Totals were calculated and compared between visits and habitats. A total of 72 bird species was recorded, including 14 riparian species, of which Mallard and Grey Heron were the most widespread, and Mallard and Sedge Warbler the most numerous. Greatest numbers were recorded during the early visit of 2007. Woodpigeon, Swallow, Wren, Robin, Blackbird, Song Thrush, Blue Tit, Rook and Chaffinch were present on all channels surveyed, and Rook, Golden Plover, Chaffinch, Wren and Woodpigeon were the most numerous overall.
7. Managed rivers have been shown to impact on bird communities through loss of feeding and/ or nesting habitats, and through disturbance. However, there was little evidence during the present work which suggested that drainage maintenance activities impact on birds. Species abundance and diversity varied widely, even between stretches covered within the same river system. It seems more likely that bird species distribution and abundance is more influenced by other factors, such as water flow and quality and the complexity of the adjacent bank habitats.
8. A public survey was undertaken seeking records of Kingfisher sightings over the past 10 years, since 1998. A questionnaire was drafted and circulated. Some 2,231 records at 1,017 locations throughout Ireland were received from 426 participants. They showed that Kingfisher distribution remains relatively widespread throughout lowland areas of Ireland, and throughout many OPW-managed channels.
9. The present arterial drainage maintenance regime is less aggressive and less damaging to waterways habitats than the engineering of the original schemes. A number of environmentally friendly measures are already implemented, and are beneficial to birds. These, and other ways in which managed channels may be enhanced for birds are discussed.

Introduction

Background

Ireland's waterways support a broad diversity of fauna, including a number of species of European significance. These include Kingfisher *Alcedo atthis* listed in Annex I of the EU Birds Directive, Freshwater Pearl Mussel *Margaritifera margaritifera*, White-clawed Crayfish *Austropotamobius pallipes* and Otter *Lutra lutra* and five fish species listed on Annex II of the Habitats Directive (O'Keeffe and Dromey 2004). Waterways are also used extensively by Dipper *Cinclus cinclus*, while bordering vegetation supports a range of other bird species, including Sedge Warbler *Acrocephalus schoenobaenus* and Reed Warbler *A. scirpaceus*.

Protection of waterways is fundamental to the success of these, and many other species, which depend on riparian habitats. To date, a number of Special Areas of Conservation (SACs) have been proposed for designation for several Annex II species listed above (Moorkens 2000, O'Keeffe and Dromey 2004). However, there is little information available on the current range of, and trends in, waterways bird species in Ireland.

Waterways in Ireland are continuously under threat due to a number of human activities, including:

- Drainage maintenance for flood control,
- Eutrophication caused by pollution or increased nutrients from agriculture, sewage, industry, forestry and dumping,
- Drainage of river beds or banks, siltation from forestry,
- Overfishing,
- Predation, particularly from American Mink *Mustela vison*, and
- Creation of dams or weirs.

Declines in many riverine species have been attributed to one or more of these threats (Moorkens 2000, Fitzsimons and Igoe 2004). A comparison of breeding bird atlases (1968-72, Sharrock 1976; 1988-91, Gibbons *et al.* 1996) suggests that there have been range declines in many waterways bird species in the 20 year period in between, particularly Little Grebe *Tachybaptus ruficollis*, Common Sandpiper *Actitis hypoleucos*, Kingfisher, Dipper and Sedge Warbler.

Arterial drainage maintenance

Arterial drainage works, or channelisation, is the group of engineering practices used to control flooding, drain wetlands, improve river channels for navigation, control stream-bank erosion and improve river alignment. Arterial drainage works along many Irish river catchments is the responsibility of the Engineering Service Section of the Office of Public Works (OPW). They are presently responsible for the maintenance of over 11,500km of channels, 700km of embankments and 18,500 bridges (OPW 1999). The original engineering work carried out between 1945 and 1995 (OPW 1999) involved dredging, deepening and straightening of river courses. There was significant removal of vegetation from banks, and banks were beveled to remove overhangs. These activities would have posed significant ecological consequences for the aquatic biota, and would have caused considerable damage to the adjacent terrestrial habitat, and would therefore have impacted on riparian birds. More recent drainage work along these channels is much less invasive, and most channels usually only require maintenance every four to seven years (OPW 1999).

Objectives

The main objectives of this work are:

1. To assess the types of OPW arterial drainage maintenance activities being carried out on river channels.
2. To evaluate the impacts of drainage maintenance activities on waterways birds.
3. To provide suggestions on how any potential impacts can be minimised.
4. To provide advice on additional measures which may enhance or facilitate birds using river corridor environments.

Methods

Field methods

In 2006, two visits were made to three OPW-managed arterial drainage sites. Observations were made of work being carried out, and in combination with discussions with the Foremen in each case, helped to evaluate potential effects of maintenance work on riparian birds.

In 2007, more detailed bird survey work was undertaken at a number of OPW-managed channels. Ideally, it was desirable that some channels selected for survey would undergo maintenance between the two survey visits. This would allow some comparison of pre- and post-maintenance bird distribution. However, such comparisons are limited by the relatively slow nature of the works, with only relatively short stretches (up to one kilometre) covered in a week. Thus, the channels selected were a combination of those scheduled for maintenance work in 2007 and those which were managed within the past three years.

Birds were recorded along 5km stretches of each selected channel, with each stretch split into ten 500m sections. Counts were carried out between 06:00 and 09:00 hours to coincide with maximum bird activity, but to avoid concentrated song activity at dawn.

Two visits were made to each waterway, the first between late March and mid May and the second between mid May and the end of June. This reflects the abundance of residents and early migrants, which tend to be more easily detected on the first visit, and later migrants, which are more abundant in the second visit.

All birds seen or heard were recorded within four distance bands, 0-5m, 5-10m, 10-25m and >25m. Birds in flight were recorded separately unless they were considered to be associating with the river habitat (e.g. swifts, swallows and martins) in which case they were recorded in the relevant distance band.

Habitat data collation

The survey work in 2006 (Thomas *et al.* 2006) showed that the standard habitat recording method was useful in a general context, but provided limited ability to describe waterways-specific characteristics. Thus, a new habitat recording form was designed for the 2007 survey. Habitats were recorded for each 500m section in three levels, the first collating information on the characteristics of the river itself, a second focussed on adjacent banks, and a third focussed on the general setting (see Appendix 1). Observers also noted whether or not the waterways were suitable for Kingfishers (i.e. slow-flowing, with perches available for fishing) and whether suitable Kingfisher-nesting banks (tall vertical banks with soft material into which they can dig their burrows) were present.

Where some of the channel sections underwent maintenance operations between visits, and habitat types were altered, that from the later visit was used to describe the given section.

Analyses of bird counts

Species totals over all distance bands (including birds in flight) were used to examine the distribution of all species. Totals were calculated for all riparian birds combined, as well as for each species, and compared between visits (early compared with late breeding visit). For other (non-riparian) species, similar totals were calculated and compared for the most widespread species. For the purpose of this report, species-specific analyses were concentrated mainly on waterways bird species, defined here by those species which are at least partially dependent on water and/ or adjacent riparian habitats (listed in Table 3 below).

An assessment of habitat-use by waterways birds was made by examining their presence or absence along each 500m section of each waterway covered in 2007. For this exercise, data from the additional 43 waterways surveyed as part of the main waterways bird survey in 2007 (Thomas *et al.* 2007), were included to increase the sample.

The density of each riparian bird species is presented as the total number of birds per kilometre, and was estimated by dividing the total number of birds by the total length of waterways surveyed. As the distributions of other, non-riparian, species are more widespread, and not dependent on waterways (hence non-linear), estimating their densities relies on more robust Distance Sampling techniques (Buckland *et al.* 2001). An assessment of the feasibility of calculating densities of non-riparian species using Distance Sampling was made as part of the main waterways birds survey (see Thomas *et al.* 2007 for further details).

Public survey of Kingfishers

Defining Kingfisher distribution is beyond the scope of the methodology outlined above. Therefore, as part of the 2007 work, a public survey was undertaken seeking information on the locations of any sightings of Kingfishers by members of the public over the past 10 years, since 1998.

Direct contact was made with the Central Fisheries Board, staff of the OPW arterial drainage programs, conservation staff of the National Parks and Wildlife Service, a number of angling, kayaking and other sporting groups associated with waterways, and volunteer observers associated with a number of BirdWatch Ireland surveys. A short article was placed in BirdWatch Ireland's magazine *Wings*, and was circulated as a press release. A questionnaire was drafted, posted on the BirdWatch Ireland website, and forwarded to anyone who responded to this call. Observers were asked to provide details of their sightings, in particular the date of the sighting, a description of the location and how many birds were seen. A copy of the survey questionnaire is presented in Appendix 2.

Additional Kingfisher records were obtained from other surveys such as the Countryside Bird Survey and the Irish Wetland Bird Survey, and from both the Cork Bird Report (Cronin *et al.* 2006) and the Irish East Coast Bird Report (Coombes and Murphy in prep.).

Kingfisher distribution during the breeding period is markedly different from other parts of the year, so data were divided into breeding (records between April and August) and non-breeding (all other months).

Results

Coverage

In total, 13 OPW channels were surveyed in 2007, including seven in the east (Counties Louth, Meath and Kildare), four in the west (Counties Galway and Mayo) and one each in Counties Roscommon and Westmeath (Table 1). Coverage was limited in some areas, and fewer 500m sections were covered, along rivers 1002 (total of 8 sections covered), 1005 (4 sections) and 1011 (8 sections), leaving a total of 120 sections covered overall.

The maintenance history of the channels surveyed is presented in Figure 1. Of these, the entire survey stretches of just three (1007, 1010 and 1011) were managed within the same year. All others were partially managed over a number of years. Most channels (11) were at least partially maintained within the past three years, with six channels partially (between 20% and 60%) maintained between bird visits in 2007. Channels 1001 and 1005 were managed more than three years ago, while 10% of channel 1012 has not been maintained in recent decades.

Table 1. OPW channels surveyed in 2007.

River	River name	Channel code	Start grid	End grid	Main county	Drainage scheme	SAC name
1001	Boyne	C1	N638403	N675442	Kildare	Boyne	
1002	Dee	C2(1)	N830858	N797874	Meath	Glyde and Dee	
1003	Brosna	C1(1)	N338365	N355394	Westmeath	Brosna	
1004	Dee	C2(1)	O066912	O086934	Louth	Glyde and Dee	
1005	Dee	C2/43	N794886	N796904	Louth	Glyde and Dee	
1006	Black	C4/21-3	M314623	M322579	Galway	Moy	
1007	Blackwater	C1(36)	N717489	N720450	Meath	Boyne	
1008	Grange	C3/9/1	M445469	M483490	Galway	Corrib Clare	000297 Lough Corrib
1009	Sinking	C3/35	M576616	M525621	Galway	Corrib Clare	000297 Lough Corrib
1010	Knightsbrook	C1/16	N803522	N828558	Meath	Boyne	
1011	Glyde/Lagan	C1(1)	N874964	N910991	Louth	Glyde and Dee	
1012	Lung	C1 & C1(14)	M619919	M651934	Roscommon	Boyle	
1013	Yellow	C1/30/7	M366835	M347877	Mayo	Moy	002298 River Moy

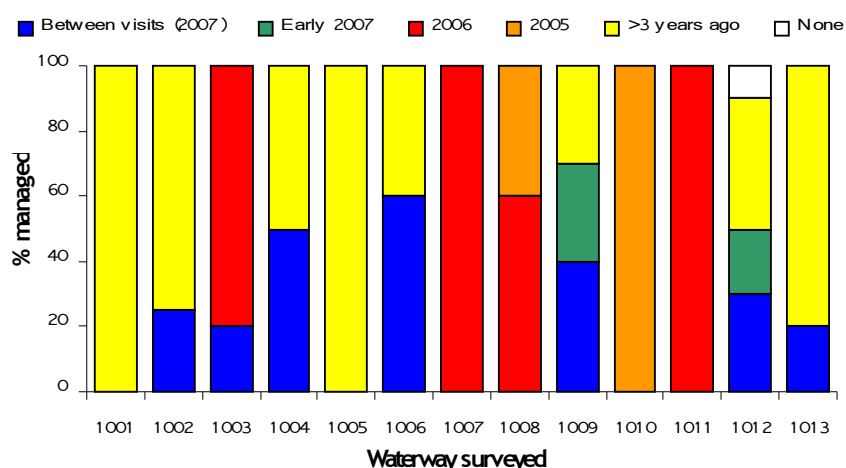


Figure 1. Maintenance history of the OPW channels surveyed, illustrating the timing of maintenance along each channel.

Habitat of waterways surveyed

All channels surveyed were relatively homogenous depositing lowland rivers, and all were least 3m wide, with the exception of one channel in County Galway (1006) which contained two narrower (stream) sections (Table 2). All channels were slow to medium flowing other than channel 1013, which was fast flowing. None of the channels contained small islands or had any nearby industrial activity. The majority channels (71% of 500m sections) had at least some emergent vegetation.

Most banks were 1-2m high and sloped (along 54% of sections) or over 2m high and sloped (43% of sections) (Table 2). Banks were largely vegetated (98% of sections). Bank tops were largely open with grassy/ herb layer (89% of sections) with many other sections (totaling 38%) dominated by mixed scrub and trees (Table 2). Bank-top vegetation was predominantly sparse (64% of sections).

All channels (over 95% of sections) were surrounded by improved grassland. Other habitat types recorded included arable land (15% of sections) and scrubland (10% of section) (Table 2).

Table 2. Habitat of channels surveyed.

Level	Charateristic	Total number of 500m sections (including %)		Total number of rivers (including %)	
Waterways					
1	Eroding /upland river or stream	0	(0.0)	0	(0.0)
	Depositing /lowland river or stream	120	(100.0)	13	(100.0)
2	Industrial activity	0	(0.0)	0	(0.0)
	Small islands	0	(0.0)	0	(0.0)
	Stream (less than 3m wide)	2	(1.7)	1	(7.7)
	River (more than 3m wide)	118	(98.3)	13	(100.0)
3	Slow medium running	110	(91.7)	12	(92.3)
	Fast-running	10	(8.3)	1	(7.7)
4	No emergent/fringe vegetation	35	(29.2)	8	(61.5)
	Some fringe vegetation (<2m wide &/or <2m linear length)	70	(58.3)	10	(76.9)
	Fringe vegetation (>2m wide & 2m linear length)	15	(12.5)	6	(46.2)
Bank					
1	Bank under 1m	9	(7.5)	7	(53.8)
	Bank 1-2m vertical	22	(18.3)	6	(46.2)
	Bank 1-2m sloped	65	(54.2)	10	(76.9)
	Bank over 2m vertical	11	(9.2)	3	(23.1)
	Bank over 2m sloped	52	(43.3)	10	(76.9)
2	Banks vegetated	117	(97.5)	13	(100.0)
	Banks unvegetated	3	(2.5)	1	(7.7)
3	Vegetated -riparian woodland	5	(4.2)	1	(7.7)
	Vegetated -scrub	6	(5.0)	4	(30.8)
	Vegetated -mixed scrub/trees	45	(37.5)	10	(76.9)
	Vegetated -open with grass/herb layer	107	(89.2)	13	(100.0)
4	Sparse (up to 50% vegetated)	77	(64.2)	11	(84.6)
	Dense (>50% vegetated)	35	(29.2)	7	(53.8)
Surrounding habitat					

1	Broad-leaved woodland	3 (2.5)	2 (15.4)
	Coniferous woodland	4 (3.3)	3 (23.1)
	Mixed woodland	8 (6.7)	3 (23.1)
	Scrub	12 (10.0)	6 (46.2)
	Heath/ bog	8 (6.7)	3 (23.1)
	Arable/ horticultural	18 (15.0)	4 (30.8)
	Improved grassland	115 (95.8)	13 (100.0)
	Semi-improved grassland	0 (0.0)	0 (0.0)
	Human sites (buildings, gardens, parks)	1 (0.8)	1 (7.7)

Riparian birds distribution and abundance

A total of 14 riparian bird species was recorded. Mallard was the most abundant and was recorded along all channels. Grey Heron, Grey Wagtail and Sedge Warbler were also relatively widespread, while Mallard and Sedge Warbler were most abundant (Table 3). Little Grebe, Coot and Dipper were among the least widespread and abundant species recorded.

Overall, more birds were recorded during the early, first visit, especially Cormorant and Teal, none of which were recorded during the later visit (Fig. 2). More Kingfishers and Sedge Warblers in particular were recorded during the second visit.

Table 3. Total number and density of riparian birds.

Species		Total rivers present	Peak count	Total birds	Density (birds/k m)
Little Grebe	<i>Tachybaptus ruficollis</i>	1	1	1	0.02
Cormorant	<i>Phalacrocorax carbo</i>	3	7	10	0.17
Grey Heron	<i>Ardea cinerea</i>	12	6	35	0.58
Mute Swan	<i>Cygnus olor</i>	8	4	25	0.42
Teal	<i>Anas crecca</i>	3	26	42	0.70
Mallard	<i>Anas platyrhynchos</i>	13	13	82	1.37
Moorhen	<i>Gallinula chloropus</i>	6	8	28	0.47
Coot	<i>Fulica atra</i>	1	1	1	0.02
Green Sandpiper	<i>Tringa ochropus</i>	1	3	3	0.05
Kingfisher	<i>Alcedo atthis</i>	7	9	29	0.48
Sand Martin	<i>Riparia riparia</i>	3	6	15	0.25
Grey Wagtail	<i>Motacilla cinerea</i>	10	4	23	0.38
Dipper	<i>Cinclus cinclus</i>	1	1	1	0.02
Sedge Warbler	<i>Acrocephalus schoenobaenus</i>	10	14	66	1.10

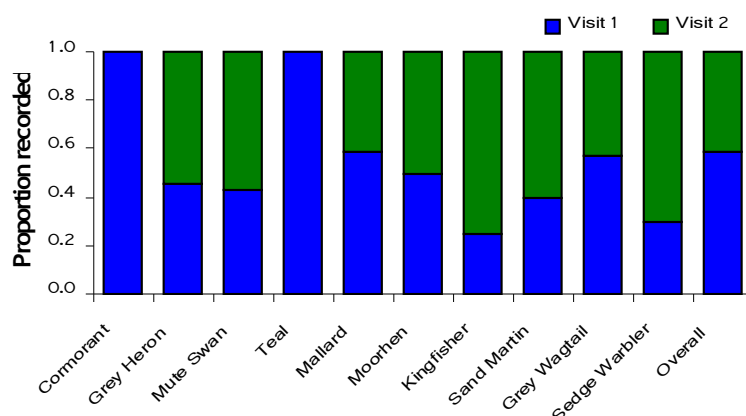


Figure 2. Comparison of the totals of selected riparian species recorded between visits.

The distribution and abundance of riparian birds varied considerably along the waterways surveyed. One stretch of the River Dee (channel 1004), situated near the coast in County Louth supported the highest numbers of riparian species and individuals, while another section, further upstream, of the same river (channel 1005), also in County Louth along with the Knightsbrook River in Meath (channel 1010) and the Black River in County Galway (channel 1006) supported the lowest number of species and individuals (Fig. 3).

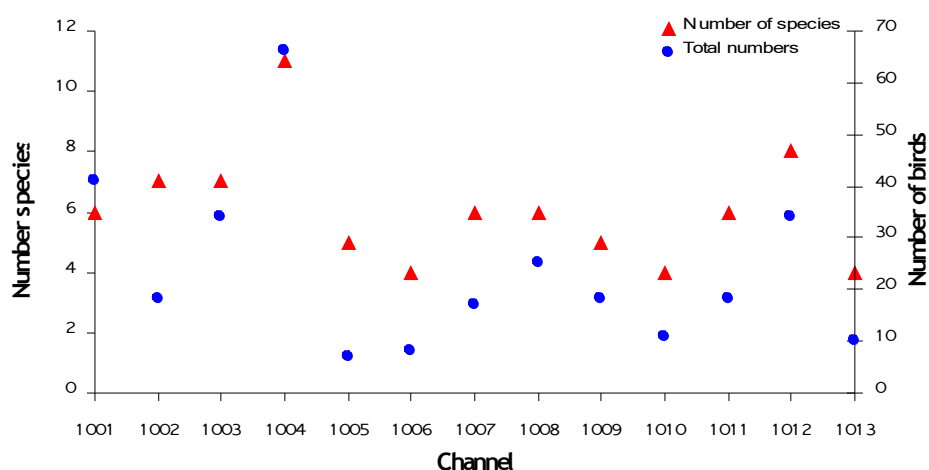


Figure 3. Number of riparian species (left axis) and individuals (right axis) occurring on each channel.

Habitats used by riparian birds

This assessment is based on information from a combination of the 13 OPW channels and a further 43 waterways covered as part of the main waterways birds survey in 2007 (Thomas *et al.* 2007). Most species were relatively widespread on a variety of habitats. Cormorant, Mute Swan, Moorhen and Kingfisher were present more lowland waterways (Table 4), while Common Sandpiper, Grey Wagtail and Dipper were seen in more upland areas.

Table 4. Mean altitudes (m) of 500m sections in which waterways species were present and absent.

	Present	Absent
Cormorant	50.9	78.8
Grey Heron	67.7	82.2
Mute Swan	50.0	79.1
Mallard	68.9	82.4
Moorhen	59.2	80.0
Common Sandpiper	102.5	76.1
Kingfisher	56.9	80.2
Sand Martin	80.0	76.4
Grey Wagtail	87.8	70.2
Dipper	99.9	71.2
Sedge Warbler	73.2	78.9

Other notable species-habitat relationships, where proportionally more sections supported more birds, are described below:

- Cormorant was widespread, though proportionally more were present on rivers with tall banks (greater than 2m high), and along rivers surrounded by broadleaved woodland, and also adjacent to human habitation.
- Grey Heron was relatively widespread, though proportionally more were recorded along sections of little or no fringe vegetation.
- Mute Swan was present on lowland waterways only, mostly slow to medium flowing, and with some fringe vegetation. It was present in proportionally more sections which were surrounded by arable farming or human habitation.
- Mallard was widespread, and present in almost 90% of sections which had islands. Proportionally more were recorded along rivers with a little or no fringe vegetation, and near human habitation.
- Moorhen were more prevalent along streams of slow to medium flow, with some fringe vegetation and higher banks. None were seen along sections surrounded by coniferous forestry or heathland.
- Common Sandpiper was present mostly on rivers larger than 3m wide, fast-flowing, with some or no fringe vegetation. Proportionally more were present along banks under 1m in height and unvegetated. None were seen along sections surrounded by scrubland, or arable land.
- Kingfisher was more prevalent on rivers greater than 3m wide, slow flowing and with some fringe vegetation. Proportionally more along banks over 2m in height, and vegetated. Fewer seen along waterways surrounded by scrub, heath and semi-improved grasslands and coniferous woodlands.

Kingfisher was recorded on 39% of 500m sections which were considered to contain both suitable banks and waterways, 28% of sections which comprised suitable banks and 27%

of sections which comprised suitable waterways (Table 5). It was present on a much smaller proportion of banks (6%) and waterways (1%) which were considered unsuitable.

Table 5. Presence and absence of Kingfisher on 500m sections where the suitability of the banks and/ or waterways was assessed.

		Number of 500m sections		
		Total	Present	Absent
Bank	Suitable	125	35	90
	Unsuitable	374	21	353
Waterway	Suitable	90	24	66
	Unsuitable	168	2	166
Bank & waterway	Suitable	28	11	17
	Unsuitable	136	1	135

- Sand Martin was present more on wider rivers, especially those with no fringe vegetation. Proportionally more were recorded along sections with vertical banks 1 to 2m in height, and those with unvegetated banks. Fewer were recorded in sections surrounded by woodland, heath or arable farming.
- Grey Wagtail was present along more faster flowing rivers, with no fringe vegetation. Proportionally more were recorded on waterways situated in woodland, especially broad-leaf. Few were present on waterways surrounded by arable farming.
- Dipper was mostly present on rivers greater than 3m wide, with faster flow and no fringe vegetation. Widespread in a variety of surrounding habitats, though proportionally fewer along waterways surrounded by arable farming.
- Sedge Warbler was present on a substantial number of sections with islands. It was mostly present on slow-flowing rivers, and those with some fringe vegetation.

Full details of the proportions of each habitat type supporting riparian species are presented in Appendix 3.

Public survey of Kingfisher

A total of 2,231 records at 1,017 locations throughout Ireland was received from 426 participants. Most sightings, from any one year, were reported from 2006 (Fig. 4a), and over 80% of records were of sightings made between 1998 and 2007 and were included in these analyses. Some 30% of records were from the breeding period (April to August inclusive, Fig. 4b).

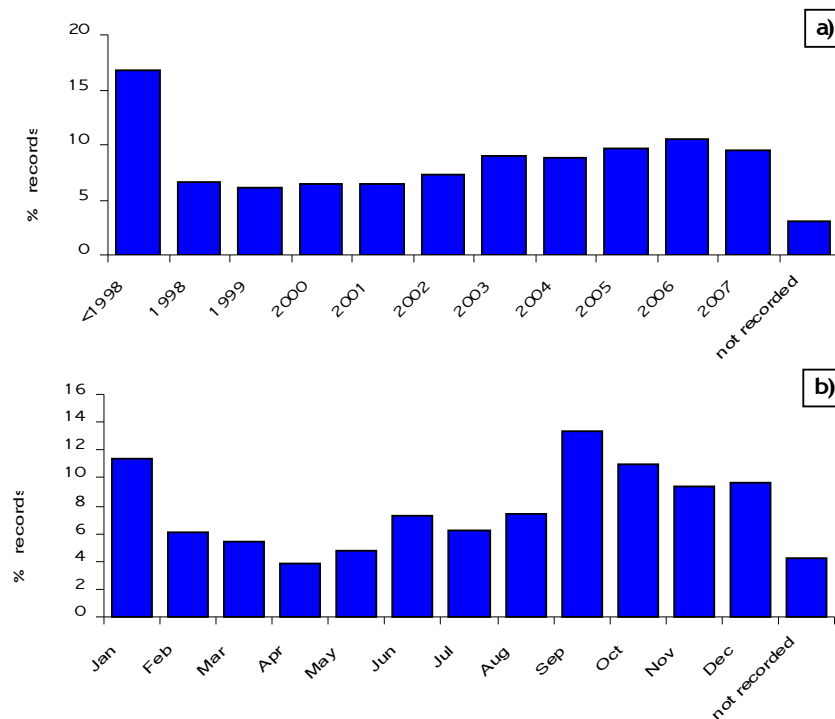


Figure 4. Year (a) and time of year (b) of Kingfisher records submitted.

These records have shown that Kingfisher is relatively widely distributed throughout the country and throughout the year, with particularly notable clusters along the coastline of Counties Dublin, Meath and Cork, and also in the north midlands (Fig. 5a, b). There was little notable difference between records during the breeding and non-breeding periods (Fig. 5a). Almost all sightings were located on low-lying waterways, between 10m and 160m altitude, with almost 50% of sightings around 10m altitude. A further 16 sightings were located in the Wicklow Mountains, and ranged between 200 and 230m elevation. Some 23% of sightings were situated within 61 SACs, while 15% of records were situated within 43 SPAs and 18% of records were within 1km of 32 OPW schemes (Fig. 5b). A full list of these SACs, SPAs and OPW schemes is presented in Appendix 4.

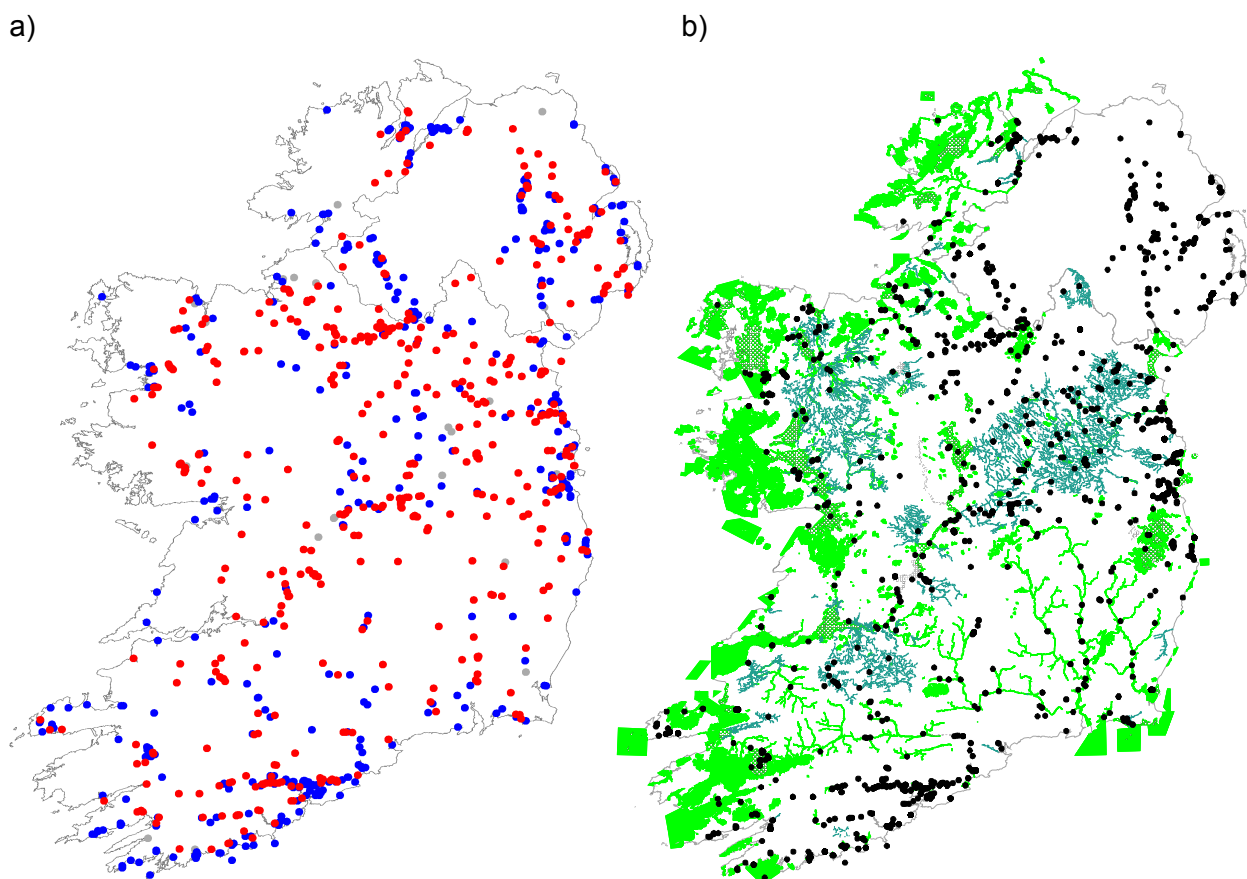


Figure 5. Kingfisher records received (a), divided into breeding (red dots), non-breeding (blue) and unknown time of year (grey), and (b) showing the distribution of all records and the SACs (green) and SPAs (red stippling) and OPW managed channels which support them.

Distribution and abundance of other bird species

A total of 58 other, mostly non-riparian, bird species was recorded. This includes Whooper Swan, which is to some extent riparian as it occurs along rivers, and at a number of other wetland sites. However, this is a wintering species, which migrates from Iceland. These birds (a flock of 22 birds and a single bird) were all recorded feeding on adjacent grasslands along one channel towards the end of March, prior to their return migration to Iceland. They are treated separately as this report is focussed on breeding birds.

Of the other, non-riparian, bird species, Woodpigeon, Swallow, Wren, Robin, Blackbird, Song Thrush, Blue Tit, Rook and Chaffinch were the most widespread, present along all of the waterways surveyed. Scarce species, with singles recorded on one river only, included Peregrine, Lapwing, Redshank, Herring Gull, Whitethroat, Spotted Flycatcher and Jay (Table 6).

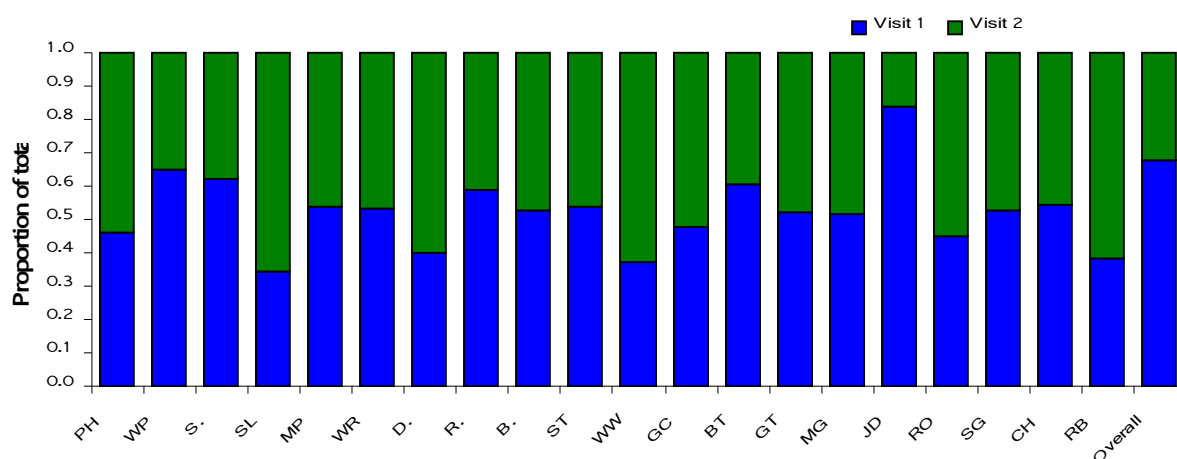
Rook, Golden Plover, Chaffinch, Wren and Woodpigeon were the most numerous species recorded, all of which were also relatively widespread, with the exception of Golden Plover, which occurred on only a few of the channels, but where one single count of 285 meant that this was among the most abundant species.

Table 6. Total number of non-riparian species and individuals recorded

Species		Number of rivers	Total number of individuals
Whooper Swan	<i>Cygnus cygnus</i>	1	23
Buzzard	<i>Buteo buteo</i>	1	2
Kestrel	<i>Falco tinnunculus</i>	3	3
Peregrine	<i>Falco peregrinus</i>	1	1
Pheasant	<i>Phasianus colchicus</i>	11	71
Golden Plover	<i>Pluvialis apricaria</i>	4	540
Lapwing	<i>Vanellus vanellus</i>	1	1
Snipe	<i>Gallinago gallinago</i>	9	23
Curlew	<i>Numenius arquata</i>	4	89
Redshank	<i>Tringa totanus</i>	1	1
Black-headed Gull	<i>Larus ridibundus</i>	1	4
Lesser Black-backed Gull	<i>Larus fuscus</i>	2	2
Herring Gull	<i>Larus argentatus</i>	1	1
Great Black-backed Gull	<i>Larus marinus</i>	1	3
Woodpigeon	<i>Columba palumbus</i>	13	358
Collared Dove	<i>Streptopelia decaocto</i>	2	3
Cuckoo	<i>Cuculus canorus</i>	2	3
Skylark	<i>Alauda arvensis</i>	9	73
Swallow	<i>Hirundo rustica</i>	13	134
Meadow Pipit	<i>Anthus pratensis</i>	12	219
Pied Wagtail	<i>Motacilla alba</i>	7	16
Wren	<i>Troglodytes troglodytes</i>	13	359
Duncock	<i>Prunella modularis</i>	10	50
Robin	<i>Erithacus rubecula</i>	13	341
Stonechat	<i>Saxicola torquata</i>	7	43
Blackbird	<i>Turdus merula</i>	13	312
Fieldfare	<i>Turdus pilaris</i>	3	148
Song Thrush	<i>Turdus philomelos</i>	13	73
Redwing	<i>Turdus iliacus</i>	4	35
Mistle Thrush	<i>Turdus viscivorus</i>	6	17
Grasshopper Warbler	<i>Locustella naevia</i>	2	4
Whitethroat	<i>Sylvia communis</i>	1	1
Blackcap	<i>Sylvia atricapilla</i>	5	6
Chiffchaff	<i>Phylloscopus collybita</i>	8	29
Willow Warbler	<i>Phylloscopus trochilus</i>	12	134
Goldcrest	<i>Regulus regulus</i>	11	101
Spotted Flycatcher	<i>Muscicapa striata</i>	1	1
Long-tailed Tit	<i>Aegithalos caudatus</i>	5	31
Coal Tit	<i>Parus ater</i>	9	43
Blue Tit	<i>Parus caeruleus</i>	13	167
Great Tit	<i>Parus major</i>	12	88
Treecreeper	<i>Certhia familiaris</i>	2	4
Jay	<i>Garrulus glandarius</i>	1	1
Magpie	<i>Pica pica</i>	12	108
Jackdaw	<i>Corvus monedula</i>	12	226
Rook	<i>Corvus frugilegus</i>	13	924
Hooded Crow	<i>Corvus corone cornix</i>	9	64
Starling	<i>Sturnus vulgaris</i>	11	118
House Sparrow	<i>Passer domesticus</i>	3	9
Tree Sparrow	<i>Passer montanus</i>	1	2
Chaffinch	<i>Fringilla coelebs</i>	13	426
Greenfinch	<i>Carduelis chloris</i>	8	21
Goldfinch	<i>Carduelis carduelis</i>	8	40
Linnet	<i>Carduelis cannabina</i>	6	42

Redpoll	<i>Carduelis cabaret</i>	7	31
Bullfinch	<i>Pyrrhula pyrrhula</i>	6	17
Yellowhammer	<i>Emberiza citrinella</i>	6	67
Reed Bunting	<i>Emberiza schoeniclus</i>	11	105

Overall, most birds were recorded during the early visit, and this pattern was consistent among a number of species, especially Jackdaw, Woodpigeon and Skylark (Fig. 6). Swallow, Dunnock, Willow Warbler, Rook and Reed Bunting were more abundant during the later visit.



PH = Pheasant, WP = Woodpigeon, S. = Skylark, SL = Swallow, MP = Meadow Pipit, WR = Wren, D. = Dunnock, R. = Robin, B. = Blackbird, ST = Song Thrush, WW = Willow Warbler, GC = Goldcrest, BT = Blue Tit, GT = Great Tit, MG = Magpie, JD = Jackdaw, RO = Rook, SG = Starling, CH = Chaffinch, RB = Reed Bunting.

Figure 6. Comparison of the totals of the 20 most widespread non-riparian species recorded between visits.

Like the riparian species, the distribution and abundance of non-riparian birds varied considerably between waterways, and the downstream stretch of the River Dee (channel 1004) in County Louth supported the highest numbers of species (36 species) and individuals (606) while the stretch further upstream (channel 1005) supported lowest numbers (94 birds of 16 species) (Fig. 7). Most other rivers were also relatively species-rich, although number of individuals varied widely (Fig. 7).

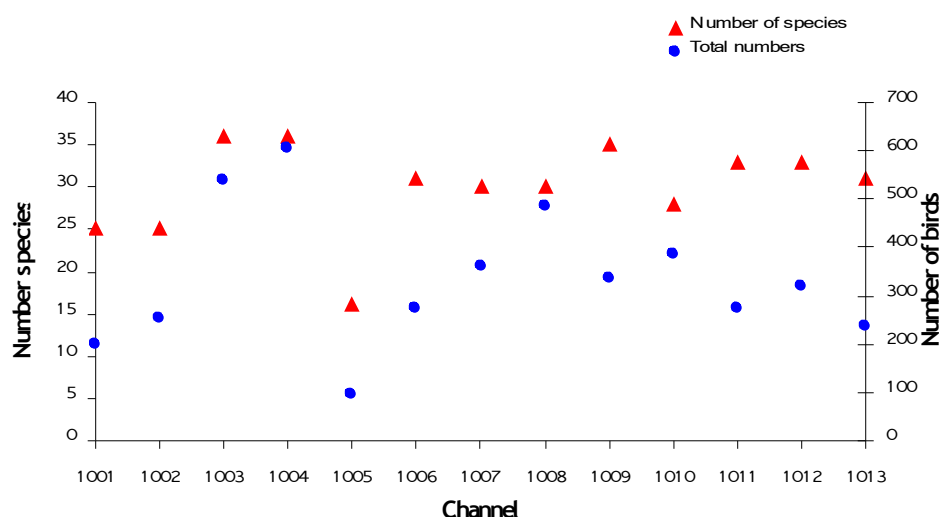


Figure 7. Number of non-riparian species (left axis) and individuals (right axis) occurring on each channel.

Observations on maintenance operations

Most maintenance operations are carried out along one bank only. In some cases, there appears to be very little visible difference in the channel before and after works have been carried out (Fig.

8 a & b), although there is some vegetation clearance required so that machines can pass along the river (e.g. Fig. 8b & i). Where there has been significant growth in reeds and other emergent vegetation, clearance is much more visible (Fig. 8c & d).

Visits to channels where operations were taking place in 2006 showed the removal of vegetation and silt using a hydraulic excavator. A hydraulic excavator was used to grab and remove dense reeds (Fig. 8c) and other vegetation in the channel. An increase in the rate of flow and an improvement in water clarity were immediately obvious where work had been carried out (Fig. 8d). There was little visible difference in this stretch in 2007 (Fig. 8e) other than some regrowth of the reedbeds.

Where maintenance operations took place a number of years ago, it appears in most cases that the habitat has regenerated (Fig. 8h & j)



Figure 8. A selection of pictures of channels surveyed in 2007 (a-j). In each case, the channel survey number, river name and maintenance history is given.

Discussion

Drainage maintenance and the selection of channels

River drainage maintenance work involves removal of silt and weeds from the bed. A considerable amount of bankside vegetation is also removed to allow the machinery to pass along the channels. OPW channels are maintained on an ongoing cyclical basis, most every four to seven years (OPW 1999). Maintenance is more frequent on channels which collect silt more rapidly and on which weed growth is more prolific, and less frequent on channels with a higher gradient and flow, which are less likely to suffer a build up of silt and vegetation. In this respect, some 90% of OPW maintenance is carried out on relatively narrow, low-lying channels. Work is conducted year round, although channels identified as particularly important for salmonid fish spawning by the Central and Regional Fisheries Boards are not worked on within the spawning period, which is typically October to April, although there is some regional variation in spawning times.

The channels selected for survey were among the wider of the OPW-managed channels, which are more likely to support a greater variety and number of riparian birds. These channels were relatively homogenous, low-lying and slow-running, and most were surrounded by farmland. These wider channels also silt up less, and do not need the same level or frequency of maintenance that the smaller channels require.

These waterways are markedly different from those surveyed as part of the main waterways birds survey (Thomas *et al.* 2007), which were randomly selected in an attempt at covering a representative sample of waterways in Ireland as a whole. Thus, the latter sample includes waterways which are much more varied and widely distributed, and most are not within OPW drainage schemes.

Kingfisher distribution

Kingfisher is listed in Annex I of the EU Birds Directive, thus there is an obligation to protect this species. The information gathered as part of the survey of public records of Kingfisher sightings has shown that Kingfisher remains very widespread in Ireland throughout the year, not just along waterways, but also around lakes, docks and canals. There appears to be little difference between the breeding and non-breeding distributions.

Boag (1982) described Kingfisher's choice of habitat as being limited by the amount of prey, and the availability of suitable nest sites. Slow-moving and shallow rivers or streams, with cover along the banks, are preferred. Kingfishers also show preference for lowland waterways (Morgan and Glue 1977). Both the public survey and the present survey of OPW-managed channels and other waterways supported this preference for lowland waterways, with almost 50% of sightings on waterways up to 10m altitude. Thus, many OPW-managed channels are suitable for Kingfisher, and roughly 400 of the public survey records were located on OPW drainage rivers (32 schemes), principally in the northeast, but also in parts of the west and southwest.

The present surveys showed that Kingfishers were present mostly along sections with steep and vegetated banks, over 2m in height. Vertical or overhanging banks are preferred for increased security from predation (Morgan and Glue 1977). They may use suboptimal banks in the absence of classic bare faces if other river features and food availability are good (Boag 1982). Kingfishers tend to nest close to waterways, and at the end of a burrow, which is easily tunnelled into, preferably of sandy soil (Boag 1982). It is easy for observers to overlook potential nesting sites, for example if these are inconspicuous, few in number, obscured by vegetation, or where the nest site is under the bank along which the observer is walking.

Impacts of drainage maintenance on riparian birds

Campbell (1988) showed that river engineering has a major effect on riparian habitats and breeding bird populations. Birds are affected through loss of nesting and/ or feeding habitat and disturbance. Managed rivers have been shown to support fewer species at lower densities than adjacent natural reaches (Brooker 1985). The recovery in habitat, and thereby the bird communities, can take many years (Raven 1986, Campbell 1988).

Removal of silt and emergent vegetation alters flow rate, which in turn affects the aquatic biota. Thus, bird communities are impoverished by a reduction in aquatic diversity. Riparian bird species, such as Mallard, Moorhen, Sedge Warbler and Reed Bunting, select emergent vegetation, and/ or adjacent tall and rank vegetation for nesting, and are especially vulnerable. Foraging Kingfishers may be affected if these works alter water quality and/or clarity. Also, Kingfishers will not return to nest in an area if there is ongoing disturbance near-by (Boag 1986).

Removal of shading bankside vegetation, for access by machinery, and regrading of banks causes substantial decrease in the availability of fringe and bush. This includes the removal of branches used as fishing perches by Kingfisher. This loss of this fringe vegetation can also lead to in-stream temperature changes (Brooker 1985), which potentially affects the aquatic flora and fauna. Additionally, the loss of adjacent, and in many cases linear, patches of trees, scrub and other such vegetation, along with the associated disturbance, is likely to have a substantial impact on other birds in the area, especially during the breeding period.

The present maintenance regime is much less aggressive and less damaging to waterways habitats than the engineering of the original schemes. The pace of the work is quite slow, with less than one kilometre covered in a week by the standard excavator, and less than 500m by the long-reach excavators which are used on the larger channels. Furthermore, it is seldom the case that more than five kilometres of a stretch is managed in a given year. Campbell (1988) showed that where works are localised, the decline in bird abundance is much less severe, largely because the damage to vegetation is more patchily distributed along the channel.

There was little evidence during the present survey to suggest that drainage maintenance activities impact on birds. Full descriptions of the distributions and habitat requirements of riparian birds are presented in Thomas *et al.* (2007). Most prefer low-lying areas, especially Cormorant, Mute Swan, Mallard, Moorhen and Kingfisher, and were recorded in higher densities along OPW-managed channels than during the main waterways birds survey (Thomas *et al.* 2007). It was surprising that Moorhen, which are highly adaptable, and are widely distributed throughout Ireland, occupying almost any type of freshwater habitat (Gibbons *et al.* 1993), were recorded on relatively few waterways (less than half of the number of rivers in which Mallard was recorded) during this survey, and also the main waterways bird survey. Moorhen is particularly sensitive to waterways management schemes. However, declines have been apparent for over 20 years (Gibbons *et al.* 1993), and have been attributed to land drainage and predation by Mink.

The densities of species preferring more upland waterways, such as Dipper, Common Sandpiper and Grey Wagtail were much lower. These riparian species are much less likely to be affected by drainage maintenance activities.

It may have been expected that waterways managed more than three years ago would support more birds and a greater diversity, especially when compared with those stretches managed more recently. However, there was no apparent relationship. Differences between site visits in the numbers of birds recorded was consistent with the main waterways survey (Thomas *et al.* 2007), and mostly related to the arrival and departure timing of migrant species, even along those waterways which were managed between visits. Furthermore, the 13 stretches which were covered supported similar numbers of riparian species and individuals (an average of 6 species/ 24 birds) compared with the waterways survey (5 species/ 24 birds) and slightly higher numbers of non-riparian species and individuals (30 species/ 335 individuals compared with 29 species/ 298 birds). It is likely that these differences reflect the broader variety of rivers surveyed as part of the waterways survey.

There was considerable variation within the same catchments and even within the same rivers; two stretches of the River Dee, in Counties Louth and Meath, supported highest and lowest numbers of bird species and individuals. It is likely that bird distribution and abundance is driven by some combination of other factors, particularly water depth, flow and quality and the complexity of adjacent riparian habitats.

This report focuses on assessing the impacts of arterial drainage maintenance activities on birds during the breeding period, when most riparian birds are constrained to particular stretches of waterways due to the available habitats, and/ or due to other inherent factors such as site fidelity.

Outside the breeding period, birds are generally more mobile, and arterial drainage maintenance activities would be expected to impact less on birds.

Recommendations

It appears that present OPW drainage maintenance practices pose relatively little impact on birds. The pace of maintenance is relatively slow and the stretches worked are short (most up to five kilometres a year). Furthermore, the frequency of maintenance, at roughly every four to seven year intervals, is relatively low. Such intervals are probably adequate enough for habitats to regenerate, and to become suitable for birds within a few years.

The RSPB/ NRA/ RSNC (1994) advocate measures which may be implemented to benefit riparian wildlife. A number of similar environmentally friendly measures have also been advocated by the OPW (OPW 2007) in order to comply with its commitments to the European Communities (Natural Habitat) Regulations 1997, and by the Central Fisheries Board aimed at minimising the impacts of arterial drainage maintenance on fish (King *et al.* 2002).

These measures are largely aimed at minimising damage to habitats and improving habitat quality through the construction of river features, and are particularly beneficial to birds, especially during the breeding season (April to August), when most birds are constrained to nesting areas.

Many of these measures are implemented by OPW as standard procedure, while others are carried out on a case by case basis, in consultation with the relevant foreman (OPW 2007). These include:

- The use of a modern mechanical fleet with specialised equipment such as long armed hydraulic excavators with weed cutting attachments and dredging buckets has facilitated more targeted excavation and vegetation removal.
- Leaving sections of channel and bankside vegetation (trees, scrub etc.) untouched if capacity is not affected, and removing branches to flood level using a secateurs (instead of an excavator). This serves to retain most of the habitats, including branches for foraging Kingfishers, and to minimise disturbance to nesting birds. A significant loss in bankside vegetation would decrease soil stability, which would result in increased sediment loads into the river system (Brooker 1985).
- Clearing vegetation from one bank only, preferably the bank with least vegetation, which allows many of the habitats to remain intact. Minimising the scraping of the working bank, and where possible, retention of stools, would speed up the regeneration of bush, scrub and reed vegetation.
- Sensitive removal of emergent and marginal vegetation. Typically, most Bulrush *Typha latifolia* and Water Celery *Apium graveolens*, which tend to block the channel flow, are removed. Bulrush is particularly favoured nesting habitat of both Sedge and Reed Warblers.
- The creation of riffles and pools and loosening of bed gravels to remove fine silts to accommodate fish spawning. This would also improve foraging conditions for birds feeding on aquatic invertebrates and/ or fish prey.
- Creation of a two-stage channel would serve to increase habitat diversity and growth of emergent vegetation which is required by some bird species, especially Moorhen and Sedge Warbler, for nesting and feeding.

Additional measures which may improve conditions for birds are detailed below:

- New riffles and pools can significantly improve the ecological interests of a river, especially plants, invertebrates and riffle-spawning fish, which in turn benefit foraging birds. BirdWatch Ireland encourages the continuous expansion of this type of river enhancement works.
- Marginal planting on berms with wildflower mix, or Willow *Salix* sp. (the latter on higher berms), would further improve habitat diversity for wildlife, especially birds.

- Retention of a strip of marginal and emergent vegetation would ensure that suitable nesting habitat is available to certain species without significantly reducing channel capacity. This would especially benefit Sedge Warbler and Reed Bunting, and also possibly Mallard and Moorhen on wider rivers.
- Where possible, additional seeding of banks would further enhance the regeneration process, especially where severe maintenance has taken place.
- Working from downstream up would improve the rate at which plants and animals can recolonise damaged areas.
- At least some marginal vegetation should be retained on suitable Kingfisher nesting banks. These are mostly vertical banks over one metre in height, composed of soft material into which they can dig their burrows. Occasionally, small nest holes may be visible if the bank has been used for nesting before (Fig. 9).

A



B



Figure 9. Examples of Kingfisher nesting banks seen along the (a) Oweniny River in County Mayo and (b) the Grange River in County in County Galway (arrows indicate nest holes). Note how vertical these banks are, and the presence of overhanging vegetation. Photos by C. Thomas.

- Nesting banks may be created by excavating a bare vertical section (using a hydraulic excavator) in areas where these banks are greater than one-metre in height and composed of a soft material.
- Bridges are considered to be important sites for wildlife (Smiddy and O'Halloran, 2004), especially bats and birds. Masonry bridges are generally more appealing than modern bridges because of the higher frequency of ledges, holes and crevices, and more varied vegetation which provide both shelter and food. These holes and open ledges are used as nesting and roosting sites by Dippers, Grey Wagtails and Pied Wagtails. Nests are usually located at least one metre above water level, and are often built in holes in the masonry joints or where stones have been eroded or are missing. Where possible, these features should be retained during bridge maintenance. Furthermore, when working during the spring and summer months, be particularly careful not to disturb nests.
- Wrens and other songbirds also often nest around bridges, especially where vegetation (mostly Ivy *Hedera* sp.) is available for cover. This associated vegetation also provides a diversity of invertebrates on which a wide variety of bird species will prey. Thus, efforts should be made to retain as much vegetation as possible during bridge repair works.

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References

- Boag, D. 1982. *The Kingfisher*. Blandford Press, Dorset.
- Brooker, M. P. 1985. The Ecological Effects of Channelization. *The Geographical Journal* 151, 63-69.
- Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers & L. Thomas. 2001. Introduction to Distance Sampling: Estimating Abundance of Biological Populations. Oxford University Press, Oxford.
- Campbell, L. H. 1988. The impact of river engineering on water birds on an English lowland river. *Bird Study* 35, 91-96.
- Coombes, R. H. & D. Murphy. *Irish East Coast Bird Report*. BirdWatch Ireland in prep.
- Cronin, C., C. Barton, H. Hussey & C. Carmody (eds). 2006. *Cork Bird Report 1996-2004*. Cork Bird Report Editorial Team, Cork.
- Fitzsimons, M. & F. Igoe. 2004. Freshwater fish conservation in the Irish republic: a review of pressures and legislation impacting on conservation efforts. *Biology and Environment* 104B, 17-32.
- Gibbons, D. W., J. B. Reid & R. A. Chapman. 1993. *The New Atlas of Breeding Birds in Britain and Ireland: 1988-1991*. T. & A. D. Poyser, London.
- King, J. J., T. Joyce, M. Collins, C. O' Donnell & V. Rhatigan. 2002. Mitigating for fish and habitat: Fisheries-Engineering interactions in Flood Relief Schemes in Ireland, 1996-2002. In O' Grady, M. F. (ed.) *Proceedings of the 13th International Salmonid Habitat Enhancement Workshop. Irish Freshwater Fisheries Ecology and Management Series No. 1*. Central Fisheries Board, Dublin, Ireland.
- Moorkens, E. A. 2000. Conservation Management of the Freshwater Pearl Mussel *Margaritifera margaritifera*. Part 2: Water Quality Requirements. Irish Wildlife Manuals, No. 9.
- Morgan R. & D. Glue. 1977. Breeding, mortality and movements of Kingfishers. *Bird Study* 24, 15-24.
- O'Keeffe, C. & M. Dromey. 2004. Designation of sites for fish under the EU habitats directive. *Biology and Environment* 104B, 103-105.
- OPW. 1999. *Arterial Drainage Maintenance Programme – Report on Measurement of Return of Investment*. Price Waterhouse Coopers & Ferguson McIlveen, Ireland.
- OPW. 2007. *Series of Ecological Assessments on Arterial Drainage Maintenance No. 1*. Environment Section, Galway.
- Raven, M. J. & D. G. Noble. 2006. *The Breeding Bird Survey 2005*. BTO Research Report 439. British Trust for Ornithology, Thetford.
- RSPB/ NRA/ RSNC. 1994. *The New Rivers and Wildlife Handbook*. RSPB, Sandy.
- Sharrock, J. T. R. 1976. *The Atlas of Breeding Birds in Britain and Ireland*. Poyser, Berkhamsted.

- Smiddy, P. & J. O'Halloran. 2004. The ecology of river bridges: their use by birds and mammals. Pp 83-97 In Davenport, J. & Davenport J. L. (eds) *The Effects of Human Transport on Ecosystems: cars and planes, boats and trains*. Royal Irish Academy, Dublin.
- Thomas, C., K. Finney, S. Farrell & O. Crowe. 2006. *Preliminary Results of a Survey of Waterways Birds in Ireland 2006 - 2007*. Unpublished BirdWatch Ireland Report to the National Parks and Wildlife Service and Office of Public Works. Newtownmountkennedy, Wicklow.
- Thomas, C., P. Troake, A. Karsch & O. Crowe. 2007. *Waterways Birds Survey 2006 & 2007*. Unpublished BirdWatch Ireland Report to the National Parks and Wildlife Service. Newtownmountkennedy, Wicklow.

Appendix 1. Habitat key used.

	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
A. PRIMARY - Waterway characteristics				
	1. Eroding /upland river or stream	1. Industrial activity	1. Slow medium running	1. No emergent/fringe vegetation
	2. Depositing /lowland river or stream	2. Small islands	2. Fast-running	2. Some fringe vegetation (<2m wide &/or <2m linear length)
	3. Canals	3. Stream (less than 3m wide)		3. Fringe vegetation (>2m wide & 2m linear length)
		4. River (more than 3m wide)		
B. SECONDARY - Bankside vegetation 5m either side of watercourse				
	1. Bank under 1m	1. Banks vegetated	1. Vegetated - riparian woodland	1. Sparse (up to 50% vegetated)
	2. Bank over 1-2m vertical	2. Banks unvegetated	2. Vegetated - scrub	2. Dense (>50% vegetated)
	3. Bank over 1-2m sloped	3. Top of banks vegetated	3. Vegetated - mixed scrub/trees	
	4. Bank over 2m vertical	4. Top of banks unvegetated	4. Vegetated - open with grass/herb layer	
	5. Bank over 2m sloped			
C. TERTIARY - Surrounding habitat				
	1. Woodland - Broadleaved			
	2. Woodland - Coniferous			
	3. Woodland - Mixed			
	4. Scrubland			
	5. Heathland/bog			
	6. Farmland - arable/horticultural			
	7. Farmland- improved grassland			
	8. Semi- improved grassland			
	9. Human (buildings, gardens, parks, roads, rubbish tips)			

Shaded cells indicate habitats for which definitions are provided below.

DEFINITIONS

LEVEL 1

A Natural watercourses, containing sections which are actively eroding, unstable & where there is little/ no deposition of fine sediment. Eroding conditions often associated with upland parts of rivers where gradients often steep, & water flow fast & turbulent. Other lowland rivers may also erode where there are waterfalls, rapids or weirs. Beds of eroding/upland rivers characterised by exposed bedrock & loose rock. Pebbles, gravel, coarse sand may accumulate. Fine sediments rarely deposited. Usually smaller & shallower than A2.

A Fine sediments deposited on river bed. Depositing conditions typical of lowland areas where gradients low and water flow is slow/ sluggish. Rivers usually larger & deeper than A1. Rivers erode their banks & meander across floodplains. Most have been modified to control water flow, facilitate navigation or prevent flooding/erosion. Include canalised/walled sections of rivers, natural watercourses that have been dredged/deepened & those with artificial earth banks. Vegetated islands, fringing reed beds, deep pools, backwaters, banks or mid-channel bars of gravel, sand or mud may be present. Substrate mainly fine alluvial/ peaty sediments. Vegetation may include floating and submerged aquatics, with fringing emergents in shallow water or overgrowing the banks.

C Dominated (>50%) cover of shrubs, stunted trees, brambles. Canopy height < 5m (4m in wetland areas). Frequently develops as a precursor to woodland & often found in inaccessible locations, or on abandoned/marginal farmland. In the absence of grazing/mowing, scrub can expand to replace grassland/heath. Trees included as components if their growth is stunted as a result of exposure, poor soils or waterlogging. Tall trees where present have a scattered distribution & do not form a distinct canopy. May include Hawthorn, Blackthorn, Gorse, Juniper, Bramble and erect or scrambling roses in addition to willows, small birches & stunted Hazel.

C Most open areas that are not farmland. Include areas covered in dense bracken and boggy marshy areas. > 25% cover of dwarf shrubs, (or mosses in some montane areas). Peat depths of < 0.5m indicative of heath. Trees/larger shrubs may be present but not abundant, with the exception of Western Gorse and Juniper (components of heath).

C Grassland that has been intensively fertilized, grazed or mown. Fairly uniform & species poor. Makes up a large proportion of Ireland's productive farmland. Also includes areas of amenity grassland that are improved/managed for recreation, amenity or sport.

C Fairly rough and shows at least medium species diversity. Most grasslands in Ireland have been modified/managed by grazing, mowing, fertiliser application or drainage. 'Semi-natural' grasslands may receive some inputs of fertiliser (organic or artificial), but are not intensively managed and have not recently been reseeded.

LEVEL 2

B Wet woodlands of river margins (gallery woodland) & low islands that are subject to frequent flooding, or where water levels fluctuate (e.g. from tidal movement in the lower reaches). Dominated by stands of willow. Alder occasionally present. Field layer characterised by broadleaved herbs- Nettle, Creeping Buttercup, Wood Dock, Meadowsweet, Wild Angelica, Hemlock Water-

dropwort & Hedge Bindweed. Reed Canary-grass also common. Indian Balsam locally abundant. Often an accumulation of river borne debris- dead vegetation & plastic, when water levels are low. Fine coating of grey mud on vegetation & tree bases that are regularly submerged & immersed.

B Banks of a mix of woodland and scrub, possibly trees with more open areas of scrubs. Also includes hedgerows that run along
4 river edge.

B Open areas with few trees or scrubs but that does have a vegetation layer.
5

Appendix 2. Kingfisher questionnaire.

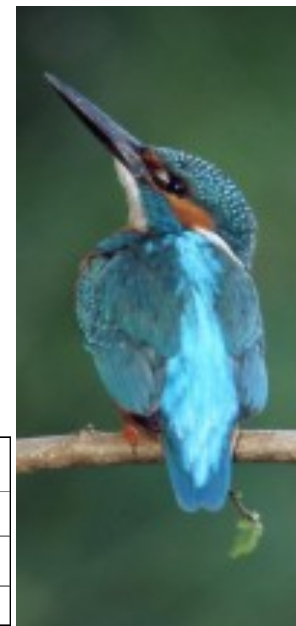
Have you seen this bird?

BirdWatch Ireland, the National Parks and Wildlife Service and the Office of Public Works are seeking records of Kingfisher sightings in Ireland over the last ten years. We are especially interested to hear from Fisheries Officers, Anglers and those who have knowledge of particular stretches of river.

We would be grateful for any details you can provide. Even records of stretches of river where no Kingfisher have been seen or just one-off Kingfisher records of river and year would be a great start. Any information on nest sites would be especially welcome.

Please complete the form below and return to Olivia Crowe at BirdWatch Ireland by email (ocrowe@birdwatchireland.ie), fax (01 2810997) or post (1 Springmount, Newtownmountkennedy, County Wicklow).

Thank you for your help



Name:
Address:
Phone:
Email:

Date	River	Location (e.g. between bridges X & Y)	Grid reference (e.g. N012450)	No. of Kingfisher	Additional notes



Appendix 3. Distribution of selected riparian bird species by habitat type.

The proportion of 500m sections of each habitat type supporting each species is given.

		Numb er of 500m sectio ns	Proportion of 500m sections										
			Cormor ant	Grey Hero n	Mute Swan	Mallard	Moorhen	Common Sandpiper	Kingfisher	Sand Martin	Grey Wagtail	Dipper	Sedge Warbler
Waterways	Eroding /upland river or stream	155	0.03	0.28	0.00	0.28	0.03	0.09	0.05	0.30	0.60	0.42	0.21
	Depositing /lowland river or stream	266	0.08	0.33	0.12	0.53	0.15	0.01	0.18	0.19	0.30	0.06	0.40
	Small islands	8	0.13	0.25	0.25	0.88	0.13	0.00	0.25	0.13	0.38	0.13	0.50
	Stream (less than 3m wide)	35	0.06	0.20	0.06	0.26	0.23	0.00	0.00	0.06	0.31	0.11	0.46
	River (more than 3m wide)	386	0.06	0.32	0.08	0.45	0.09	0.04	0.15	0.25	0.42	0.20	0.32
	Slow medium running	230	0.08	0.35	0.13	0.53	0.17	0.01	0.21	0.19	0.30	0.05	0.40
	Fast-running	191	0.04	0.27	0.01	0.32	0.02	0.07	0.04	0.29	0.54	0.37	0.24
	No emergent/fringe vegetation	237	0.06	0.31	0.02	0.38	0.05	0.05	0.11	0.28	0.54	0.32	0.21
	Some fringe vegetation (<2m wide &/or <2m linear length	159	0.04	0.26	0.11	0.43	0.14	0.02	0.15	0.14	0.24	0.04	0.39
	Fringe vegetation (>2m wide & 2m linear length)	25	0.01	0.02	0.01	0.03	0.01	0.00	0.00	0.01	0.01	0.00	0.04
Banks	Bank under 1m	130	0.05	0.30	0.06	0.43	0.08	0.07	0.09	0.22	0.49	0.19	0.37
	Bank over 1-2m vertical	106	0.04	0.31	0.05	0.50	0.12	0.04	0.11	0.40	0.43	0.17	0.46
	Bank over 1-2m sloped	223	0.06	0.30	0.08	0.40	0.13	0.03	0.11	0.23	0.38	0.22	0.33
	Bank over 2m vertical	32	0.13	0.28	0.03	0.41	0.13	0.00	0.25	0.16	0.38	0.25	0.09
	Bank over 2m sloped	120	0.06	0.32	0.08	0.43	0.04	0.04	0.17	0.18	0.48	0.18	0.20
	Banks vegetated	377	0.06	0.31	0.08	0.41	0.10	0.03	0.14	0.21	0.39	0.19	0.31
	Banks unvegetated	44	0.09	0.32	0.05	0.64	0.11	0.09	0.07	0.45	0.59	0.20	0.52
	Vegetated -riparian woodland	107	0.10	0.37	0.05	0.45	0.04	0.03	0.15	0.23	0.47	0.26	0.26
	Vegetated -scrub	22	0.05	0.27	0.09	0.64	0.09	0.09	0.09	0.36	0.45	0.32	0.55
	Vegetated -mixed scrub/trees	163	0.05	0.25	0.04	0.42	0.14	0.01	0.15	0.25	0.41	0.21	0.23
	Vegetated -open with grass/herb layer	361	0.06	0.34	0.09	0.44	0.10	0.04	0.14	0.26	0.43	0.17	0.35
	Sparse (up to 50% vegetated)	247	0.04	0.34	0.08	0.47	0.11	0.05	0.13	0.26	0.46	0.14	0.39
	Dense (>50% vegetated)	166	0.07	0.28	0.06	0.39	0.11	0.02	0.12	0.20	0.36	0.28	0.25

Surrounding habitat	Woodland -Broadleaved	32	0.16	0.41	0.09	0.34	0.13	0.06	0.19	0.16	0.63	0.28	0.34
	Woodland -Coniferous	34	0.03	0.32	0.06	0.38	0.00	0.09	0.09	0.15	0.50	0.32	0.15
	Woodland -Mixed	45	0.04	0.33	0.09	0.36	0.16	0.02	0.16	0.09	0.33	0.33	0.16
	Scrubland	42	0.07	0.33	0.02	0.45	0.07	0.00	0.00	0.24	0.38	0.24	0.45
	Heathland/bog	62	0.02	0.21	0.02	0.34	0.00	0.06	0.02	0.13	0.39	0.26	0.34
	Farmland -arable/horticultural	36	0.03	0.28	0.19	0.53	0.31	0.00	0.22	0.19	0.08	0.06	0.33
	Farmland- improved grassland	274	0.05	0.33	0.07	0.43	0.12	0.04	0.18	0.28	0.39	0.14	0.33
	Semi- improved grassland	86	0.09	0.34	0.08	0.47	0.08	0.02	0.05	0.21	0.42	0.26	0.49
	Human (buildings, gardens, parks,roads, rubbish tips)	17	0.24	0.59	0.12	0.71	0.12	0.06	0.18	0.29	0.71	0.29	0.18

Appendix 4. Designated sites in which Kingfishers were recorded, 1998-2007.

List of SACs, SPAs and OPW schemes in which Kingfishers were recorded present during the public survey.

SAC code	site name	SPA code	site name	OPW Scheme Name
7	Lough Oughter And Associated Loughs	400 1	Wexford Nature Reserve	Ballyteigue_Kilmore
14	Ballyallia Lake	400 6	Bull Island includes L.T.M.	Blanket Nook
32	Dromore Woods And Loughs	401 3	Drumcliff Bay	Bonet
90	Glengarriff Harbour And Woodland	401 5	Rogerstown	Boyle
91	Clonakilty Bay	401 6	Baldoyle	Boyne
93	Caha Mountains	402 0	Ballyteigue Burrow	Broadmeadow & Ward
101	Roaringwater Bay And Islands	402 4	Sandymount Strand/Tolka Estuary	Brosna
108	The Gearagh	402 5	Broadmeadow/Swords Estuary	Bunratty Rineanna
133	Donegal Bay (Murvagh)	402 6	Dundalk Bay	Corrib Clare
163	Lough Eske And Ardnamona Wood	402 7	Tramore Backstrand	Corrib Headford
199	Baldoyle Bay	402 8	Blackwater Estuary	Corrib Mask
205	Malahide Estuary	403 0	Cork Harbour	Deel
208	Rogerstown Estuary	403 1	Inner Galway Bay	Deele & Swillyburn
210	South Dublin Bay	403	Dungarvan Bay	Duleek (Nanny)

SAC code	site name	SPA code	site name	OPW Scheme Name		
216	River Shannon Callows	2				
		403	Bannow Bay	Dunmanway	Flood	Relief
		3		Scheme		
268	Galway Bay Complex	403	Killala Bay /Moy Estuary	Feale		
		6				
297	Lough Corrib	403	Killarney National Park	Glyde & Dee		
		8				
322	Rahasane Turlough	404	Ballyallia Lake Wildfowl	Hazelhatch (Shinkeen)		
		1	Sanctuary			
343	Castlemaine Harbour	404	Lough Corrib	Inny		
		2				
365	Killarney National Park, Macgillicuddy'S Reeks And Caragh River Catchment	404	Lough Derravaragh	Kilkenny Flood Relief		
		3				
440	Lough Ree	404	Lough Ennell	Killimore Carrigahorig		
		4				
455	Dundalk Bay	404	Lough Owel	Maigue		
		7				
458	Killala Bay/Moy Estuary	404	Lough Oughter	Maigue Outfall		
		9				
471	Brackloon Woods	405	Lough Arrow	Maine		
		0				
571	Charleville Wood	405	Lough Carra	Matt		
		1				
622	Ballysadare Bay	405	Lough Conn	Monaghan Blackwater		
		3				
627	Cummeen Strand/Drumcliff Bay (Sligo Bay)	405	Lough Cullin	Moy		
		4				
636	Templehouse And Cloonacleigha Loughs	405	Lough Derg (Shannon)	Mulkear Ballymackeogh		
		8				
671	Tramore Dunes And Backstrand	406	Lough Kinale and Derragh	Nenagh		
		1	Lough			
685	Lough Ennell	406	Lough Ree	Ouvane		
		4				
688	Lough Owel	406	Lough Sheelin	Ryewater		
		5				
696	Ballyteige Burrow	407	Lough Swilly	Skeoge Burnfoot		
		5				
697	Bannow Bay	407	Shannon Fergus Estuary			
		7				
733	Vale Of Clara (Rathdrum Wood)	408	Boyne Estuary			
		0				
781	Slaney River Valley	408	Kilcoole Marshes SPA			
		5				

SAC code	site name	SPA code	site name	OPW Scheme Name
1021	Carrowmore Point To SPANish Point And Islands	4086	Little Brosna Callows	
1040	Barley Cove To Ballyrisode Point	4089	Rahasane Turlough	
1058	Great Island Channel	4091	Stabannan -Braganstown	
1061	Kilkeran Lake And Castlefreke Dunes	4094	Blackwater Callows	
1090	Ballyness Bay	4095	Kilcoman Bog	
1230	Courtmacsherry Estuary	4096	Middle Shannon Callows	
1342	Cloonee And Inchiquin Loughs, Uragh Wood	4128	Broad Lough SPA	
1482	Clew Bay Complex	4140	Inch Lough	
1673	Lough Arrow			
1774	Lough Carra/Mask Complex			
1898	Unshin River			
1957	Boyne Coast And Estuary			
1976	Lough Gill			
2070	Tralee Bay And Magharees Peninsula, West To Cloghane			
2122	Wicklow Mountains			
2137	Lower River Suir			
2158	Kenmare River			
2162	River Barrow And River Nore			
2165	Lower River Shannon			
2170	Blackwater River (Cork/Waterford)			
2171	Bandon River			
224	Lough Derg, North-East Shore			

SAC code	site name	SPA code	site name	OPW Scheme Name
1				
224 9	The Murrough Wetlands			
228 7	Lough Swilly			
229 8	River Moy			
229 9	River Boyne And River Blackwater			