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Ecological Impact Assessment (EcIA) of the Effects of Statutory Arterial Drainage Maintenance Activities on Kingfisher *Alcedo atthis* and other riparian birds II

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Foreword

This Ecological Impact 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 impacts of statutory arterial drainage maintenance activities on Kingfisher (*Alcedo atthis*), outlines measures to mitigate any negative impacts, and possible enhancement opportunities.

Environment Section

An Assessment of the Effects of Arterial Drainage Maintenance on Kingfisher *Alcedo atthis* and other riparian birds II

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A report commissioned by the Office of public Works and prepared by BirdWatch Ireland

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Summary

1. This work was carried out as part of a joint project of the Office of Public Works, the National Parks & Wildlife Service and BirdWatch Ireland. It was designed to assess the potential impacts of arterial drainage maintenance works by OPW machines on the distribution and abundance of Kingfisher *Alcedo atthis* and other birds. One of the key objectives of the Arterial Drainage Works programme is to alleviate flooding from agricultural lands, urban areas, bogs and new plantation forestry.

2. In 2008, two river systems designated as Special Areas of Conservation (SAC), namely the River Boyne and River Blackwater SAC, a river which is managed by the Office of Public Works, and situated predominantly in County Meath, and the Blackwater SAC, an unmanaged river located in Counties Cork and Waterford, formed a basis for survey work. Observers aimed to cover the main SAC river stretches of both systems, as well as a number of its tributaries (both SAC and non-SAC). In 2009, some 21 OPW-managed channels across 7 rivers were selected for survey. It was intended that channels be surveyed before and after planned drainage works commissioned by the OPW.

3. In 2008, a maximum of 214km (comprising 451 sections) of six rivers on the Boyne system and 282km (593 sections) of six rivers on the Munster Blackwater system were covered through walked transects. Boat-based transects on the Munster Blackwater system were carried out along 128 km (247 sections) of rivers, including 100 km of the River Blackwater and 28 km of the River Bride. Two visits were made to each river system; early visits were made between 18 March and 15 May, while late visits were made between 16 May and 30 June. Additional early and late visits were made to the Boyne system in an attempt at evaluating whether or not a two-visit approach is adequate for surveying Kingfisher.

4. In 2009, lengths of OPW channels surveyed ranged from 400 – 2,400 metres. Up to 3 visits were made to each section, timings of which depended on when the machines were due to work the channels.

5. During both years, observers walked along one bank recording all waterways birds seen or heard, together with habitat information. Bird and habitat data were recorded in 500m sections to facilitate more refined assessments of the importance of the waterways surveyed. The work in 2008 was focussed on Kingfisher and other riparian bird species only, while in 2009 all birds were recorded. In 2009, the observer recorded all birds seen or heard, and in three distance bands which included the channel itself, up to 5 metres from the channel on either side, and greater than 5 metres from the channel to no greater than 100m from the channel where applicable. Habitat details were also collated for each survey section.

6. In 2008, 28 waterways bird species were recorded, including 27 on the Boyne system and 21 on the Munster Blackwater. Sand Martin *Riparia riparia* was the most abundant species on both systems. Mallard *Anas platyrhynchos* was also abundant and widespread. In 2009, a total of 67 bird species was recorded, including 18 riparian species and the Annex I listed Kingfisher. Several migrant species such as Sand Martin *Riparia riparia*, Swallow *Hirundo rustica*, House Martin *Delichon urbica*, and several warblers, most notably Sedge Warbler *Acrocephalus schoenobaenus*, Blackcap *Sylvia atricapilla* and Willow Warbler *Phylloscopus trochilus* were also recorded. A total of 23 species of conservation concern in Ireland were noted, including the red-listed Curlew *Numenius arquata*, Black-headed Gull *Chroicocephalus ridibundus* and Yellowhammer *Emberiza schoeninclus* and a further 20 species which are amber listed.

7. A total of 20 - 22 Kingfisher territories was estimated on the Boyne (density of 0.094 – 0.103 territories per kilometre) and 19 - 20 on the Munster Blackwater (0.067 – 0.071 territories/ kilometre) systems.

8. Overall densities of other riparian species in 2008 were similar on both systems, although there was considerable variation in the densities of several species between rivers. Grey Heron *Ardea cinerea*, Mallard, Sand Martin and Grey Wagtail *Motacilla cinerea* were recorded on all rivers, while Cormorant *Phalacrocorax carbo*, Little Egret *Egretta garzetta*, Moorhen *Gallinula chloropus*, Snipe *Gallinago gallinago*, Common Sandpiper *Actitus hypoleucos*, Dipper *Cinclus*

cinclus, Sedge Warbler *Acrocephalus schoenobaenus* and Reed Bunting *Emberiza schoeniclus* were more patchily distributed.

9. Among the waterways species recorded in 2009, Sedge Warbler, Mallard *Anas platyrhynchos* and Sand Martin were the most abundant. The aforementioned species, along with Snipe *Gallinago gallinago* and Grey Heron *Ardea cinerea* were the most widespread. Teal *Anas crecca*, Coot *Fulica atra*, Common Sandpiper *Actitis hypoleucos* and Kingfisher were relatively scarce, with small numbers recorded during the first visit only. Kingfishers were recorded on four occasions, all during first visits.

10. Results in 2008 showed that drainage maintenance activities on the Boyne system do not appear impact on waterways birds or their habitats at a wider scale. In 2009, there were minimal impacts of drainage maintenance work with respect to species richness along the river corridor. Most disturbances caused by the OPW works were short-lived.

11. Recommendations on the basis of this work and previous Waterways surveys (2006-07) are detailed in this report, and summarised as follows:

a) Continued monitoring of key waterways is required so that changes in riparian bird populations may be monitored.

b) OPW staff involved with operating or directing the machines on the channels should be able to recognise Kingfisher, suitable habitats, nest holes, as well as other riparian species.

c) Particular attention should be paid to minimise impacts of drainage works on Natura 2000 sites, especially from bank realignment and vegetation removal during the key months of the breeding season i.e. Apr-Jun.

d) Avoid the removal / bashing of bankside vegetation i.e. trees/hedgerow during the breeding season, unless the vegetation is restricting water flow.

e) Kingfishers tend to choose loamy banks on more slow-moving rivers. Artificial nest holes have been trialled with limited success, artificial nest boxes have had more success. Conservation efforts should concentrate on maintaining the existing character of our rivers (flow/ riverside vegetation & structure) and eliminate any potential harmful factors associated with drainage works such as increased run-off.

f) Existing measures in place as a result of protecting freshwater fish and lamprey populations should also positively impact on Kingfisher.

Introduction

Ireland's waterways support a broad diversity of fauna, including a number of species of European importance. These include the Kingfisher *Alcedo atthis*, listed in Annex I of the EU Birds Directive, the Freshwater Pearl Mussel *Margaritifera margaritifera*, the White-clawed Crayfish *Austropotamobius pallipes*, the 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 Dippers *Cinclus cinclus*, while bordering vegetation supports a range of other breeding migratory species, including Sedge Warbler *Acrocephalus schoenobaenus* and Reed Warbler *A. scirpaceus*.

Protection and appropriate management of waterways is fundamental to the success of these, and many other species that occupy riparian habitats. To date, a number of Special Areas of Conservation (SACs) have been proposed for designation for several of the 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 and in particular the impact of flood risk management on their abundance and/or distribution. The main reasons for this data deficiency have been a lack of resources and funding up to now and more practical difficulties inherent in studying our waterways species.

Waterways in Ireland are continuously under threat due to a number 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*,
- 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 *Actitus hypoleucos*, Kingfisher, Dipper and Sedge Warbler.

Arterial drainage works, or channelisation, is the umbrella 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, 730km of embankments and 18,500 bridges (OPW 2007). The original engineering work carried out between 1945 and 1995 (OPW 2007) 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 2007).

Objectives

The principal objectives of this project are:

- Carry out a review of published literature, which will highlight practical measures in place elsewhere for minimising impacts of drainage activities and enhancing conditions for Kingfishers on OPW-managed waterways.
- To examine the variation throughout river systems, as well as between rivers (SAC compared with non-SAC, managed compared with unmanaged), in the densities of Kingfisher and other waterways birds.

- Carry out survey work on OPW-managed waterways, to assess bird usage of the river corridor, and of the habitat immediately adjacent to the channel, and examine changes in bird habitats and bird numbers caused by drainage maintenance activities.
- To make recommendations for minimising impacts and enhancing habitats for Kingfishers and other migratory bird species.
- Look at best practice in internationally managed waterways.

Methods

The scientific names of most bird species are given in Appendix 1.

Coverage

In 2008, observers aimed to cover the main SAC river stretches of both systems, as well as a number of its tributaries (both SAC and non-SAC). The Boyne system is extensively managed by OPW; all of the rivers surveyed are part of the OPW arterial drainage maintenance scheme with the exception of the River Mattock. The Munster Blackwater system is not managed by OPW. Some three rivers were surveyed that were of the same name, thus these will be referred to as River Blackwater (Longwood) and River Blackwater (Kells) on the Boyne system and River Blackwater (Cork) on the main Munster Blackwater system.

A selection of OPW channels that were scheduled for maintenance work in spring/ summer 2009 were chosen for the 2009 survey. The specific channel stretch scheduled for maintenance formed the core of the stretch that was surveyed, with sections up and downstream also included. Thus, the length of each channel surveyed varied accordingly.

Very narrow streams (<1m wide) were excluded as they typically do not support significant proportions of waterways birds.

Bird recording

Observers walked along one bank recording all waterways birds seen or heard. Data were recorded in 500m sections (judged and measured by eye) to facilitate more refined assessments of the importance of the waterways surveyed. In 2009, three distance bands were used, within or along the river, up to 5 metres from the channel on either side and from 5 metres to 100m from the channel. The 5 metre band was used to attempt to capture any impacts on birds that may have been nesting along banks where management works were in operation. 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.

Most of the fieldwork in 2008 was carried out between 08:00 and 18:00; as most of the waterways species concerned are active throughout the day, this survey was not limited to the early morning hours required for surveys of most terrestrial breeding bird species. However, as the survey in 2009 was also focussed on examining the impacts of arterial drainage maintenance on terrestrial passerines, most of the counts were carried out during the early morning, between 06:00 and 09:00 hours, to coincide with the period of maximum bird activity, but to avoid concentrated song activity at dawn.

In 2008, a minimum of two visits were made to each river system. Early visits were made between 18 March and 15 May, while late visits were made between 16 May and 30 June, although inclement weather during late June disrupted coverage, and pushed the survey into early July.

It was intended that two visits be undertaken in 2009, one before and one after maintenance work was carried out (Fig. 1). This would allow some comparison of pre- and post-maintenance bird distributions. Most of the early (first visits) were made between late March and mid May, and later visits between mid May and early July. These periods coincide with 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.

In addition, a detectability code was assigned for each 500m section, which provided an indication of how accessible and visible each section of river was during each visit (except the first visit to the Boyne system). In this way, the detectability score described the accuracy of detections, and ranged between 1 (100% clear visibility of the section, and greatest accuracy of the counts) and 3 (a substantial proportion of the section was not visible, and birds may have been missed).

Bird recording – testing the methodology

Additional visits were made to the Boyne system in an attempt at evaluating whether or not a two-visit approach is adequate, especially in relation to the detectability of Kingfisher. Thus, some four visits were made overall to this system, two during the early breeding period and two late.

Additional survey work based on counts from a boat was trialled on the Munster Blackwater system. This boat work was carried out on the River Blackwater (Cork) and on the River Bride over a period of up to five days during each of the early (between 22 and 29 April) and late (between 19 and 25 June) survey periods, and in each period, within a few days of the walked transects.

An observer drifted downstream in a small inflatable, and kept a sharp watch for any birds. All birds seen or heard were recorded in 500m sections.

River properties

Habitat

Habitats were recorded during walked transects for each 500m section in three levels, the first aimed at collating information on the characteristics of the river itself, a second focussed on adjacent banks, and a third focussed on the general setting. Examples of habitat forms used in 2008 and 2009 are presented in Appendix 2 a & b respectively. 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.

Observers also noted whether or not the waterways were suitable for Kingfishers (i.e. slow-flowing, with perches available for fishing) (Fig. 2a) and whether suitable Kingfisher-nesting banks (tall vertical banks with soft material into which they can dig their burrows) were present (Fig. 2b). The proportion of sections supporting different habitats types is presented.

It was expected that changes in certain habitat types might be caused by maintenance activities. To this end, speed of flow, presence of riffles and pools, the extent of emergent vegetation, and the type and extent of bankside vegetation were compared between visits at channels which were maintained separately from those which were not.

Water quality

EPA water quality data (2000, unpublished) were extracted for monitoring stations located within the rivers surveyed in 2008. Minimum and maximum Q-values recorded on each river are presented.

A B

Figure 1 (a) Channel prior to maintenance (note emergent vegetation) and (b) post maintenance (river bank has been reworked by machines and emergent vegetation removed).

A B

Figure 2 (A) Section of the Bonet River (Co. Leitrim) where Kingfisher were recorded on survey (B) probable nest site on this river where Kingfisher were seen to occupy.

Analyses of bird counts

Species densities were estimated by dividing total counts by the length of river surveyed and are expressed as birds per kilometre. Densities were used to compare between visits and between rivers. In most cases, only those species considered to be the most widely distributed and abundant on each system were used to illustrate differences. For consistency in methods, comparisons made between rivers were based on counts made during walked transects only.

As a separate exercise, Kingfisher territories were identified and mapped in 2008. These were based predominantly on the distributions reported during the two early visits (two walked transects along the Boyne system and the walked transects combined with the boat-based surveys on the Blackwater). Kingfishers were considerably more widely distributed during the late visits (due to dispersing family groups), and it was decided not to include these records in selecting territories, with the exception of one territory which was defined on the Finisk River on the Blackwater (owing to it occurring at quite a distance from all other territories). The extent of these territories remains unknown, and would require more detailed behavioural observations.

In 2009, densities were estimated for each species on managed and unmanaged rivers during each count. Comparisons in densities were made between managed and unmanaged rivers, and between visit one and two; very few additional (third counts) were carried out. An assessment of the impacts of maintenance activities on birds nesting adjacent to rivers was made by examining differences in total numbers counted in the first distance band (0-5m) between visits and between managed and unmanaged channels.

Results

Coverage in 2008

A total of 1061 sections was covered overall. A maximum of 214km (comprising 451 sections) of six rivers on the Boyne system was covered (Fig. 3a, Table 1) through walked transects, 83% of which is part of the SAC. A maximum of 282km (593 sections) of six rivers on the Munster Blackwater system was covered through walked transects (Fig. 3b, Table 1), 85% of which is part of the SAC. The extent of coverage during visits remained relatively consistent, although access was prohibited along some stretches on some visits. A full description of coverage of the rivers surveyed is presented in Appendix 3.

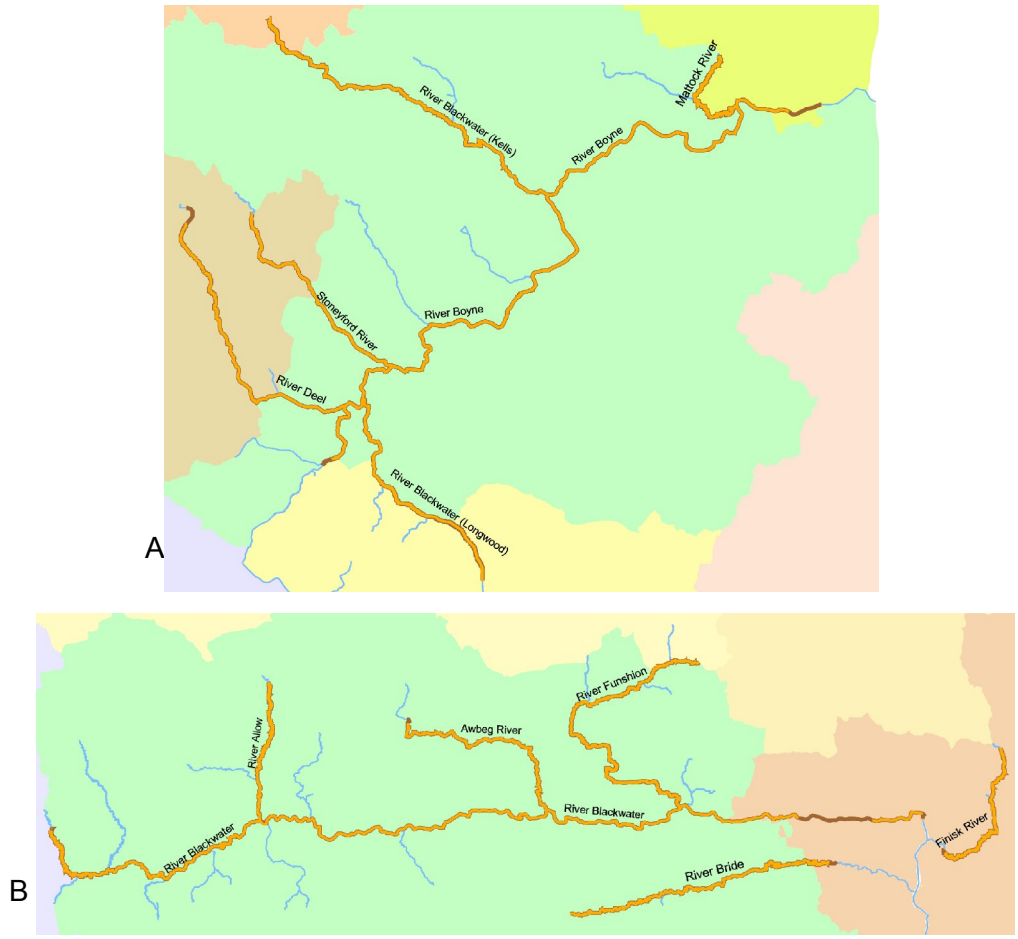

Figure 3. Coverage in 2008 of the Boyne (A) and Blackwater (B) systems, indicating the river sections covered during the early (brown) and late (orange) visits.

Table 1. Details of the rivers covered during each of the walked transect visits in 2008.

River system	Visit	River	Start date	End date	Start grid	End grid	Total length	Number sections
Boyne	Early 1	Boyne	20/03/2008	31/03/2008	O085752	N676444	80.1	178
		Blackwater (Kells)	25/03/2008	26/03/2008	N874680	N631834	45.8	82
		Blackwater (Longwood)	02/04/2008	02/04/2008	N712502	N816343	22.8	49
		Deel	27/03/2008	28/03/2008	N697497	N558668	31.1	67
		Mattock	03/04/2008	03/04/2008	O038756	O024799	12.7	28
		Stoneyford	04/04/2008	04/04/2008	N737530	N614663	21.2	47
		TOTAL	**20/03/2008**	**04/04/2008**			**213.8**	**451**
	Early 2	Boyne	07/04/2008	10/04/2008	O085752	N683448	67.0	170
		Blackwater (Kells)	12/04/2008	14/04/2008	N872681	N632835	45.8	83
		Blackwater (Longwood)	15/04/2008	16/04/2008	N712502	N816351	22.0	52
		Deel	10/04/2008	11/04/2008	N697496	N558668	31.1	66
		Mattock	16/04/2008	16/04/2008	O038756	O024799	12.7	29
		Stoneyford	14/04/2008	15/04/2008	N738530	N613666	21.2	48
		TOTAL	**07/04/2008**	**16/04/2008**			**199.8**	**448**
	Late 1	Boyne	13/05/2008	16/05/2008	O084752	N685448	76.2	161
		Blackwater (Kells)	20/05/2008	21/05/2008	N873683	N636824	45.8	77
		Blackwater (Longwood)	22/05/2008	22/05/2008	N712502	N816343	22.8	49
		Deel	17/05/2008	22/05/2008	N697496	N558655	29.2	60
		Mattock	23/05/2008	23/05/2008	O038757	O024800	12.7	29
		Stoneyford	16/05/2008	17/05/2008	N737530	N615662	21.2	44
		TOTAL	**13/05/2008**	**23/05/2008**			**208.0**	**420**
	Late 2	Boyne	26/05/2008	29/05/2008	O085752	N681447	76.2	165
		Blackwater (Kells)	02/06/2008	03/06/2008	N872681	N631834	45.8	79
		Blackwater (Longwood)	04/06/2008	05/06/2008	N714502	N816343	22.8	51
		Deel	30/05/2008	30/05/2008	N697496	N558655	29.2	60
		Mattock	05/06/2008	05/06/2008	O038756	O024799	12.7	28
		Stoneyford	03/06/2008	04/06/2008	N736531	N614663	21.2	46
		TOTAL	**26/05/2008**	**05/06/2008**			**208.0**	**429**
Blackwater	Early 1	Bride	23/04/2008	24/04/2008	X004943	W722888	43.3	93
		Blackwater (Cork)	25/04/2008	02/05/2008	X098990	W160979	127.0	262
		Finisk	06/05/2008	06/05/2008	X122957	S183067	21.7	45
		Funshion	29/04/2008	30/04/2008	R837003	R859157	41.2	90
		Allow	05/05/2008	05/05/2008	W385987	R393137	22.1	46
		Awbeg	07/05/2008	07/05/2008	W692999	R544094	27.1	57
		TOTAL	**23/04/2008**	**07/05/2008**			**282.3**	**593**
	Late 1	Bride	20/06/2008	22/06/2008	W998944	W719888	42.5	90
		Blackwater (Cork)	10/06/2008	19/06/2008	X099995	W161977	118.4	256
		Finisk	23/06/2008	24/06/2008	X123953	S184067	21.7	43
		Funshion	25/06/2008	29/06/2008	R837002	R859161	41.2	89
		Allow	02/07/2008	04/07/2008	W385989	R393137	22.1	42
		Awbeg	06/07/2008	08/07/2008	W693999	R544093	26.5	57
		TOTAL	**10/06/2008**	**08/07/2008**			**272.3**	**577**

Boat-based transects on the Munster Blackwater system were carried out along 128 km (247 sections) of rivers, including 100 km of the River Blackwater (Cork) and 28 km of the River Bride during both visits (Fig. 4). The River Blackwater transect began at Keale Bridge (W295935) and ended at Cappoquin (X100995), and was carried out over three days (day 1 from Keale Bridge to Mallow, day 2 from Mallow to Fermoy and day 3 from Fermoy to Cappoquin). The survey of the River Bride began at Rathcormack Bridge (W808906) and ended 0.5km downstream of Tallow Bridge (X004942).

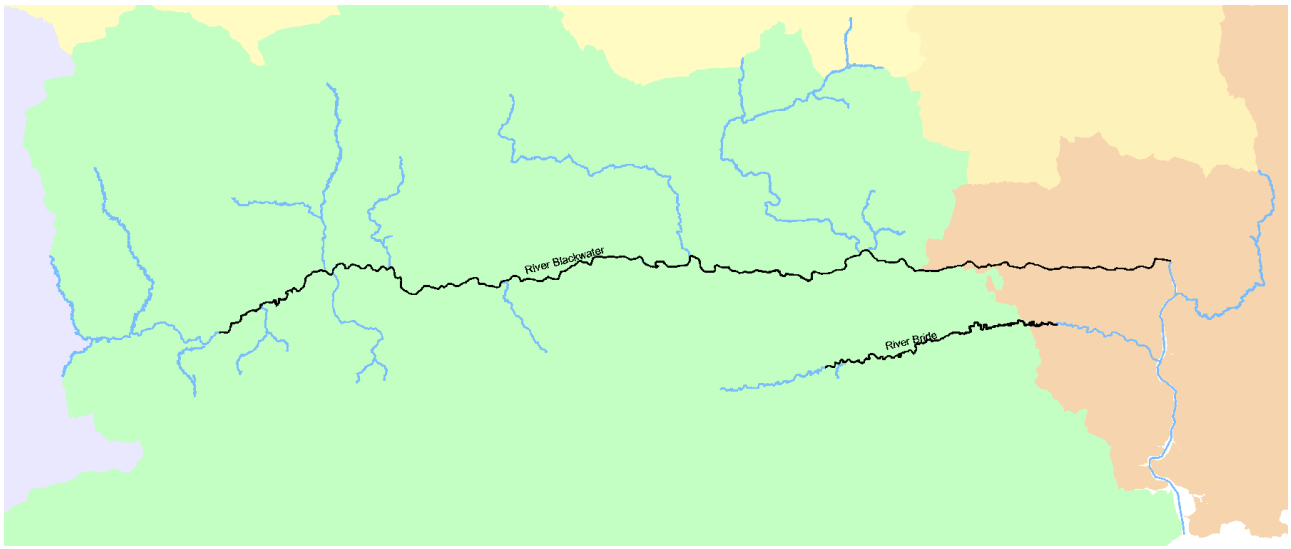

Figure 4. Area covered by boat, indicating the main river system (blue), and the river sections covered (black).

On parts of the river where the water was flat (and the current slow) the observer had to row the boat, sometimes vigorously. At such times the observer was facing away from the direction of travel. However, because birds generally called when they flew, it is not likely that birds were missed.

Inclement weather during late June disrupted coverage, and meant that two stretches of the Munster Blackwater system, namely the Awbeg and Allow Rivers were covered in early July (between 2 and 8 July).

Coverage in 2009

A total of 21 channels within seven river systems were surveyed (Fig. 5, Table 2), and most were visited twice. Some six channels were maintained between visits. Maintenance of remaining channels was delayed due to increased water-levels caused by a very wet summer (particularly in April and May).

Channel stretch ranged between 1 and 13 km, with the mean length of channel of 6.2 km. Overall, 128 km of channels were surveyed during the first visit, 80 km during the second and 10 during the third visit. Most channels were considered to be of favourable survey condition, with counts in relatively few sections (15% of sections overall) considered to be hampered by low detectability.

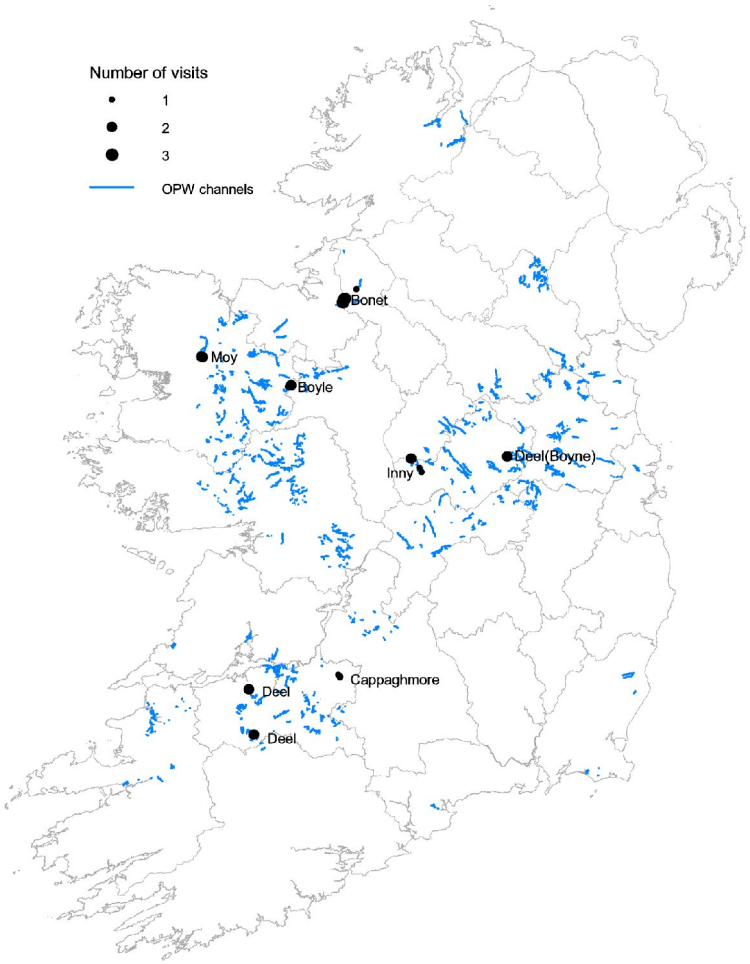

Figure 5. OPW channels surveyed in 2009 (black dots), illustrating the number of visits (size-scaled symbols), together with the extent of all OPW channels (blue lines).

Table 2. Details of the channels surveyed in 2009 and survey visits, and whether or not maintenance took place between visits.

River	Channel	Grid	Number of 500 m sections	Number of Visits	Maintenance*	Visit 1	Visit 2	Visit 3
Bonet	C1 (SectD)	G848338	24	1	0	19/06/09		
Bonet	C1/1/1	G798296	7	2	1	29/04/09	27/05/09	
Bonet	C1/1/2 (SectA)	G798296	7	2	1	28/04/09	28/05/09	
Bonet	C1/1/2 (SectB)	G791291	14	3	1	30/04/09	28/05/09	25/06/09
Bonet	C1/1/2 (SectC)	G785276	12	3	1	28/04/09	28/05/09	25/06/09
Bonet	C1/1	G797296	12	2	0	29/04/09	27/05/09	
Boyle	C1/24 (SectB)	M528882	5	1	0	05/06/09		
Boyle	C1/24 (SectA)	M544889	16	2	0	04/06/09	02/07/09	
Cappaghmore	C1/2	R773520	3	1	0	29/05/09		
Cappaghmore	C1/3	R764532	6	1	0	29/05/09		
Cappaghmore	C1/3/*	R766531	4	1	0	29/05/09		
Cappaghmore	C1/3/1	R765532	5	1	0	29/05/09		
Cappaghmore	C1/3/3	R772526	2	1	0	29/05/09		
Deel (Limerick)	C2	R346463	17	2	0	07/05/09	13/06/09	
Deel (Limerick)	C23/2	R369251	26	2	1	04/08/09	16/06/09	
Deel (Westmeath)	C1/37/15	N554554	19	2	0	22/05/09	25/06/09	
Inny	C2	N106545	19	2	1	25/04/09	21/05/09	
Inny	C7/2A	N143504	16	1	0	09/06/09		
Inny	C7/3	N155483	20	1	0	10/06/09		
Moy	C1/21/7/1	G129020	20	2	0	25/05/09	17/06/09	
Moy	C1/21/7/1/2	G122022	17	2	0	26/05/09	01/07/09	

* 1 = maintenance work took place between visits, 0 = no maintenance between visits.

There was considerable variation in the characteristics of the rivers and banks within rivers in 2008. Several examples are given below of rivers along the Boyne system (Figs 6-9), which illustrate some of this variation, and also which provide examples of where Kingfishers were found nesting in 2008.

Figure 6. Variation along the River Boyne (A - Slane N962738, B - Near Stoneyford Bridge N689474, C & D - Newgrange O027733, E - Bective N874613 and F - Trim N782566).

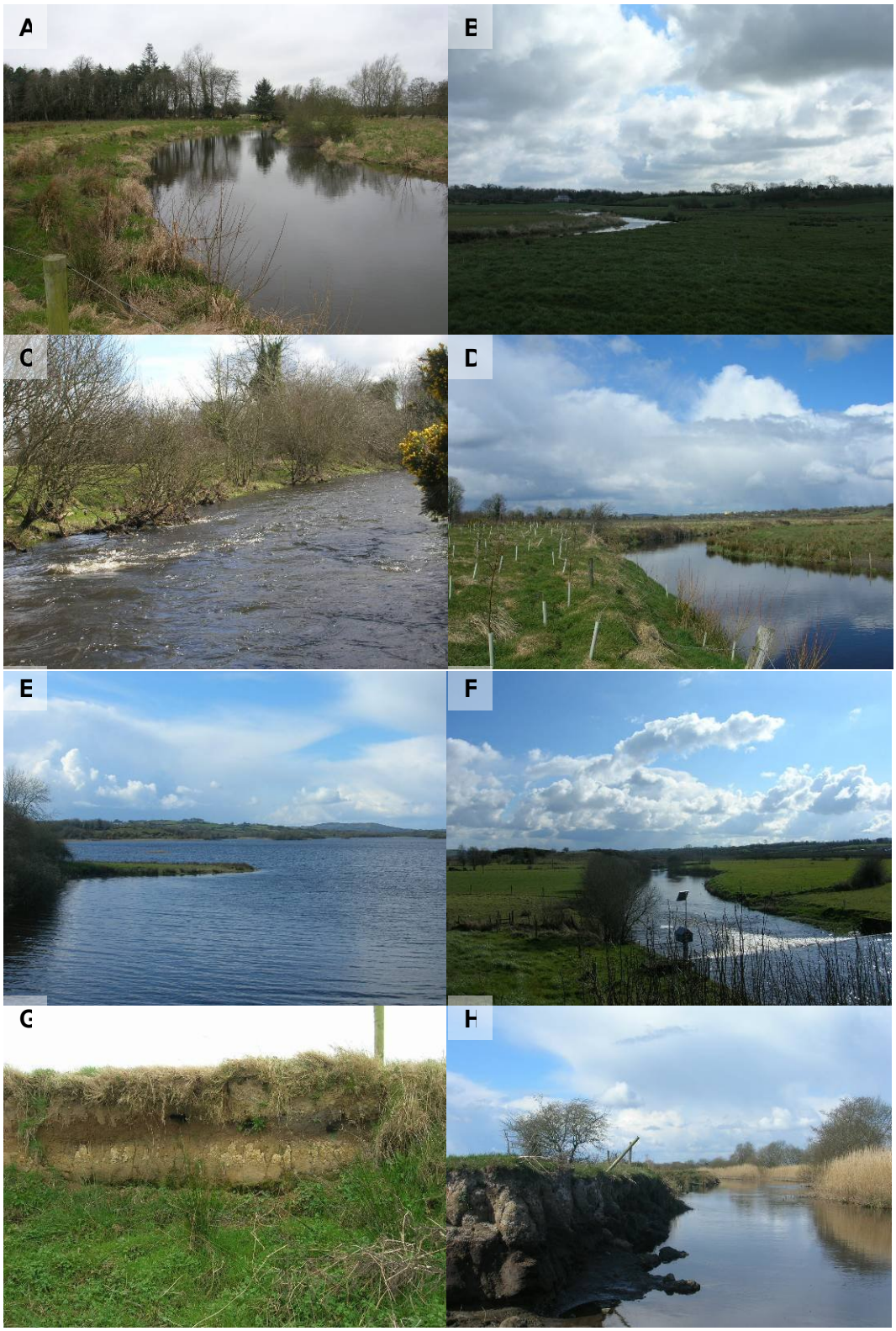

Figure 7. Variation along the River Blackwater (Kells) (A – Mullaghard N837704, B – Rahendrick N669793, C – O'Daly's Bridge N654803, D – Ballaghdarragh N637820, E & F – Lough Ramor N631835). Kingfisher nesting banks also illustrated at Mullaghard N837704 (G) & Ballaghdarragh N634825 (H)).

Figure 8. Variation along the River Deel (A & B - Downstream from Raharney N649502, C – Lough Analla on the River Deel N572616), and a Kingfisher nesting bank on the Stoneyford River (D – near Stoneyford Bridge N723536).

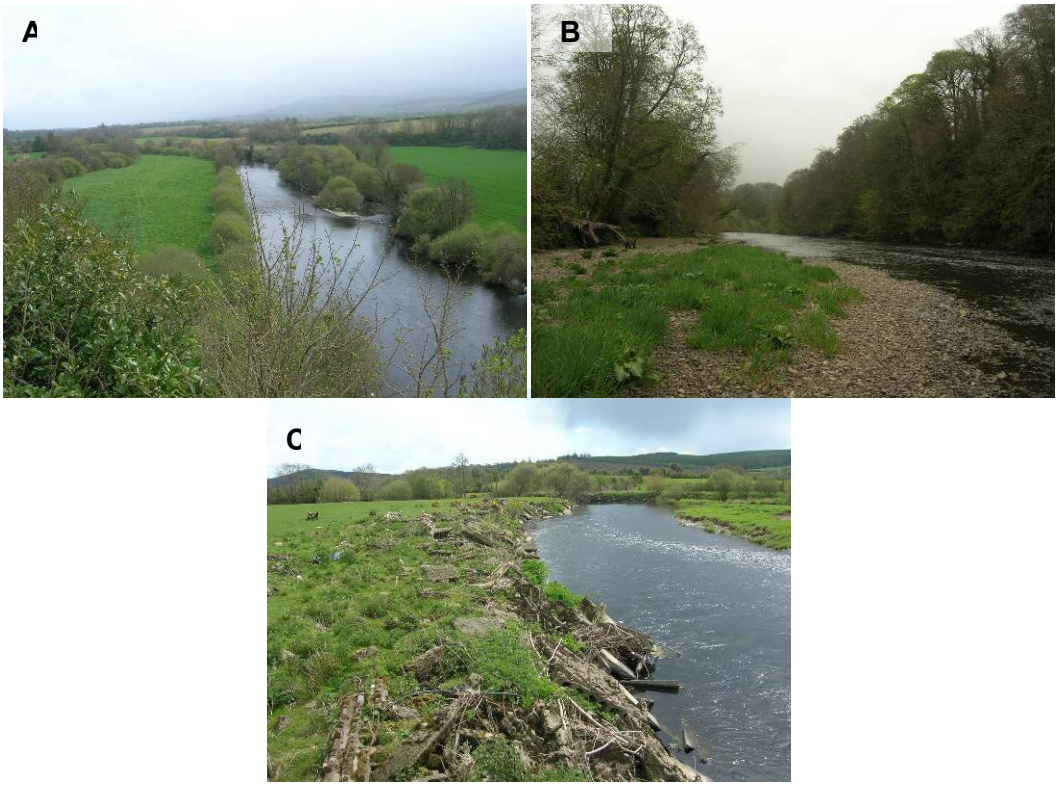

Figure 9. Variation along the River Blackwater (Cork) (A – between Mallow and Killavullen W618999, taken from the top of a Limestone cliff showing vegetation along the river corridor, B – near Mallow W571980 -C – bank reinforcement near Banteer W355972).

Habitat of rivers surveyed in 2008

All of the rivers covered as part of this survey were lowland depositing rivers (Table 3). Both the Blackwater and Boyne systems were predominantly slow to medium flowing and relatively wide rivers, although substantially more sections on the Munster Blackwater system were defined as medium and fast-flowing. Both systems had relatively few sections with riffles or pools. The Blackwater had proportionally less emergent vegetation than the Boyne, and fewer large sections of fringe vegetation, possibly because of faster flow.

Both the Blackwater and the Boyne systems comprised mostly banks under 2 metres in height, although the Blackwater had proportionally more vertical banks, and fewer banks over 2 metres in height than the Boyne. The banks of both systems were predominantly vegetated, with substantially more dense vegetation and more with riparian vegetation and less open grass/ herb layer on the Blackwater.

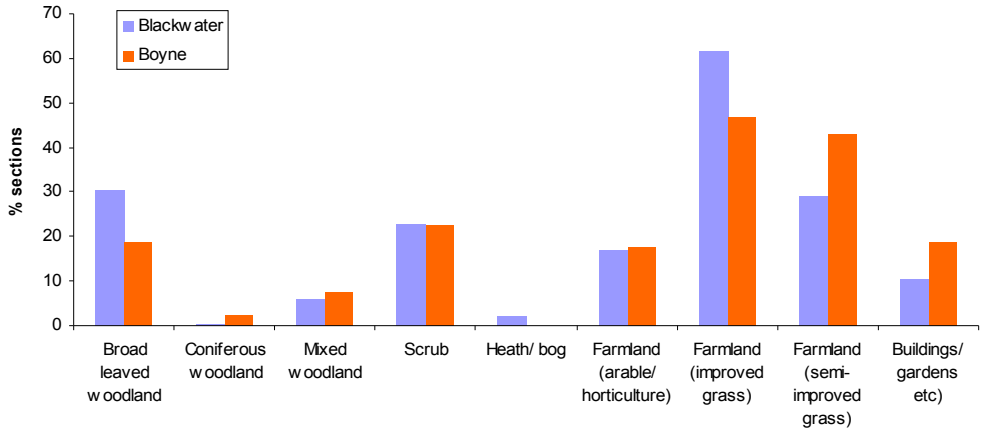

Figure 10. Occurrence of main habitat types in 2008 based on analysis of sections.

The stretches of rivers surveyed in both river systems were set predominantly in farmland areas (chiefly improved and semi-improved grassland) (Fig. 10).

The suitability of the rivers and the banks for Kingfishers was described for 600 sections on the Blackwater and 451 sections on the Boyne. The rivers were predominantly suitable on both systems (just 3% and 8% of the Blackwater and Boyne sections respectively were considered unsuitable). However, the Blackwater appeared to offer a greater abundance of suitable banks for nesting (42%) compared with the Boyne (15%).

The quality of all rivers surveyed in 2008 ranged between 3 (moderately polluted) and 4-5 (unpolluted) (Table 4). All of the rivers surveyed were at most 150m elevation (Table 4). The lowest lying rivers included the Rivers Bride and Finisk on the Munster Blackwater system, and the River Boyne and Mattock River on the Boyne system, while those at highest elevation included the Allow River on the Munster Blackwater system and the River Blackwater (Longwood) on the Boyne system.

Table 3. Characteristics of waterways and adjacent bank habitat types surveyed in 2008. The figures presented represent the number of sections, with percentage of sections in brackets.

	Level	Characteristic	Blackwater	Boyne
Waterways	1	Depositing /lowland river or stream	578 (100.0)	420 (100.0)
	2	Industrial activity	1 (0.2)	7 (1.7)
		Small islands	98 (17.0)	28 (6.7)
		Stream (less than 3m wide)	0	12 (2.9)
		River (more than 3m wide)	578 (100.0)	401 (95.5)
	3	Slow running	209 (36.2)	341 (81.2)
		Medium running	299 (51.7)	76 (18.1)
		Fast running	70 (12.1)	3 (0.7)
		Presence of riffles/ pools	80 (13.8)	69 (16.4)
	4	No emergent/fringe vegetation	184 (31.8)	88 (21.0)
		Some fringe vegetation (<2m wide &/or <2m linear length)	281 (48.6)	199 (47.4)
		Fringe vegetation (>2m wide & 2m linear length)	113 (19.6)	133 (31.7)
Bank	1	Bank under 1m	147 (25.4)	115 (27.4)
		Bank 1-2m vertical	131 (22.7)	30 (7.1)
		Bank 1-2m sloped	190 (32.9)	130 (31.0)
		Bank over 2m vertical	28 (4.8)	4 (1.0)
		Bank over 2m sloped	82 (14.2)	141 (33.6)
	2	Banks vegetated	574 (99.3)	413 (98.3)
		Banks unvegetated	3 (0.5)	2 (0.5)
		Top of banks vegetated	576 (99.7)	350 (88.3)
		Top of banks unvegetated	0	5 (1.2)
	3	Vegetated - riparian woodland	255 (44.1)	100 (23.8)
		Vegetated - scrub	103 (17.8)	49 (11.7)
		Vegetated - mixed scrub/trees	387 (67.0)	249 (59.3)
		Vegetated - open with grass/herb layer	353 (61.1)	398 (94.8)
	4	Sparse (up to 50% vegetated)	39 (6.7)	264 (62.9)
		Dense (>50% vegetated)	533 (92.2)	154 (36.7)

Table 4. Properties of the rivers surveyed, including SAC status, management, water quality and elevation (in metres).

System	River	SAC	OPW managed	Minimum water quality	Maximum water quality	Minimum elevation	Maximum elevation	Mean elevation
Blackwater	Allow	Y	N	3	4-5	70	140	104.0
	Awbeg	Y	N	3	4	30	90	63.3
	Blackwater (Cork)	Y	N	3	4-5	10	150	59.8
	Bride	Y	N	3	4	10	100	38.4
	Finisk	Y	N	4	4-5	10	100	42.6
	Funshion	N	N	3	4	30	110	57.8
	Blackwater (Kells)	Y	Y	3	4	30	100	61.6
	Blackwater (Longwood)	N	Y	3	4	70	80	73.6
Boyne	Boyne	Y	Y	3	4	10	70	42.0
	Deel	Y	Y	3-4	4	70	90	76.3
	Mattock	N	N	3	4	10	80	43.6
	Stoneyford	Y	Y	3-4	4	60	90	75.6

Habitat of channels surveyed in 2009

The majority of channels surveyed were depositing low-lying rivers or streams (90%, Table 5), and were relatively narrow (less than 3 metres wide). Most were medium or slow-flowing, and had little or no emergent vegetation. Few supported islands (11%) or riffles and pools (18%). Most banks were less than 2 metres in height, and were vegetated, predominantly with mixed scrub/ trees on the side that was not used by the machinery and with an open grassy layer on the side where machinery was operating. The large majority of channels were considered to be unsuitable for Kingfisher (66%) largely either due to lack of suitable nest sites (i.e. tall vertical loamy banks)

and/or absence of key channel characteristics preferred by Kingfishers. Most channels were located adjacent to semi-improved or improved grassland (Fig. 11).

Table 5. Details of the habitat characteristics of channels surveyed and adjacent banks (as assessed during visit 1).

Habitat	% sections
Depositing lowland river/ stream	90.2
Eroding/ upland river	7.8
River (>3m wide)	10.2
Stream (<3m wide)	74.5
Fast-flowing	9.4
Medium flow	45.9
Slow-running	40.0
Fringe vegetation (>2m wide & 2m linear length)	21.6
No emergent vegetation	38.0
Some fringe vegetation (<2m wide &/or <2m linear length	38.4
Bank >2m sloped	7.5
Bank >2m vertical	2.4
Bank 1-2m sloped	18.9
Bank 1-2m vertical	32.5
Bank under 1m	38.8
Banks unvegetated	2.7
Top of banks unvegetated	1.6
Top of banks vegetated	93.7
Mixed scrub/ trees	54.9
Open grass/ herb layer	23.9
Riparian woodland	18.0
Scrub	0.8
Dense vegetation	49.4
Sparse vegetation	47.5

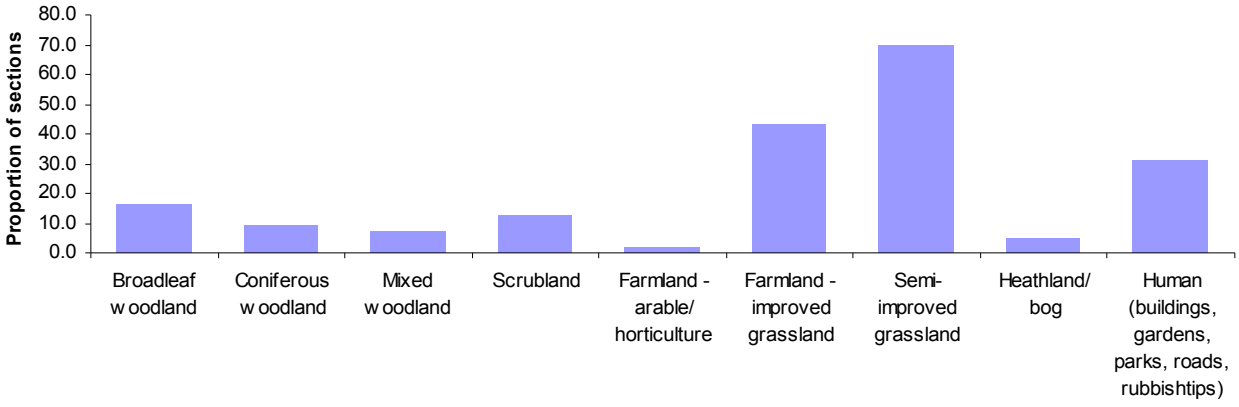

Figure 11. Main habitat setting of channels surveyed in 2009.

Change in channel habitats between visits in 2009

Habitats varied between visits along all channels (Figure 12a-d), although there were differences between managed and unmanaged channels in the nature of change which occurred. Given the heterogeneous physical characteristics of the channels surveyed, no clear pattern emerged in terms of differences in the flow rates of channels pre- and post-maintenance. During the first visit, most channels of both types (managed and unmanaged) were slow or medium-flowing, with relatively small proportion which were fast-flowing. By the second visit, there had been a decline in fast-flowing and an increase in the proportion of medium-flowing rivers on managed channels. The reverse was shown on unmanaged channels where there was a decline in the proportion of channels which were medium-flow, and an increase in those which were fast flowing or slow-flowing.

There were considerable differences between managed and unmanaged channels in the degree and extent of emergent vegetation before any maintenance activities took place, especially with much greater proportion of channels scheduled for maintenance supporting larger amounts of vegetation. However, by the second visit, these managed channels were more similar to those which were unmanaged. Most notably, there was a much greater increase in the proportions of channels with no emergent vegetation, and a decline in proportions with extensive emergent vegetation.

Most banks of managed and unmanaged channels were vegetated. Unmanaged channels supported more mixed scrub and trees, while managed channels supported a mix of mixed scrub and trees and open grass and herbs. There was very little difference between visits along managed and unmanaged channels, although a few notable differences included increased proportions of scrub/ trees along both. There was a decline in the proportion of banks supporting vegetation on managed channels and a substantial decline in those with riparian woodland. Along unmanaged channels, riparian vegetation was marginally more widespread during the second visits, while there was a decline in open grass/ herbs, probably due to the scrubbing up (hence increased scrub) during the summer months.

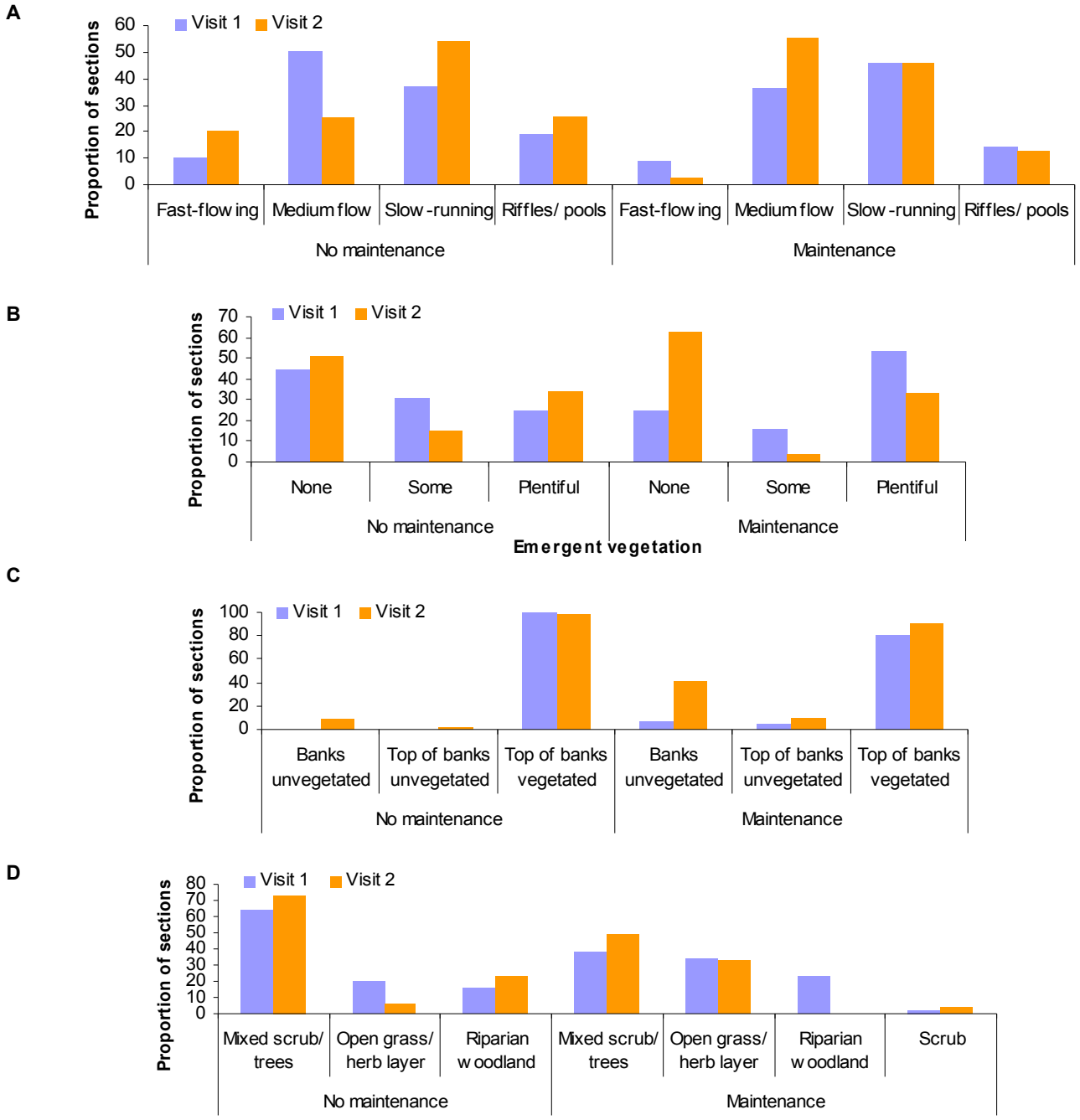

Figure 12 (A-D). Comparison of habitat types recorded during visits 1 & 2 at channels were no maintenance took place compared with channels where maintenance work was carried out.

Distribution of Kingfisher in 2008 & 2009

Kingfishers were recorded on all of the rivers surveyed in 2008, and full details are presented in Appendix 4, 5a & 5b). However, there was just one record on the Allow River on the Munster Blackwater system, and this was close to the confluence of the Allow River and the main River Blackwater (Cork). Kingfisher was recorded in greatest abundance throughout all rivers within the Boyne system, with highest densities recorded on the Stoneyford River (0.283 birds/ km). Highest densisites on the Munster Blackwater system were recorded on the River Bride (0.188 birds/km) (Fig. 13).

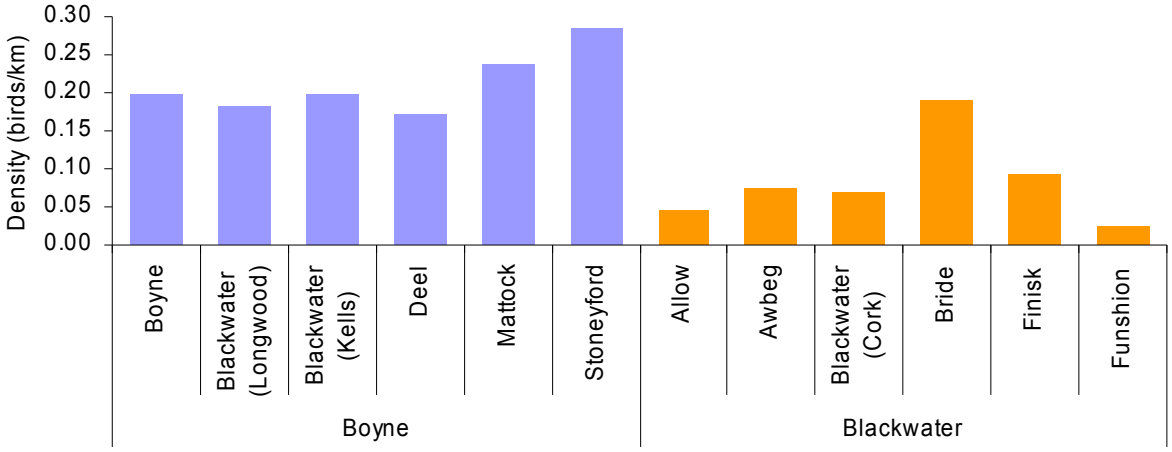

Figure 13. Densities of Kingfisher on the individual rivers surveyed as part of the Boyne (blue bars) and Blackwater (orange bars) systems.

Territory density between rivers was markedly variable, and ranged between 0 territories/ kilometre on the Allow River (Munster Blackwater system) (the individual recorded was subsumed within a territory on the Rover Blackwater) to 0.175 on the River Blackwater (Longwood) (Boyne system) (Fig. 14).

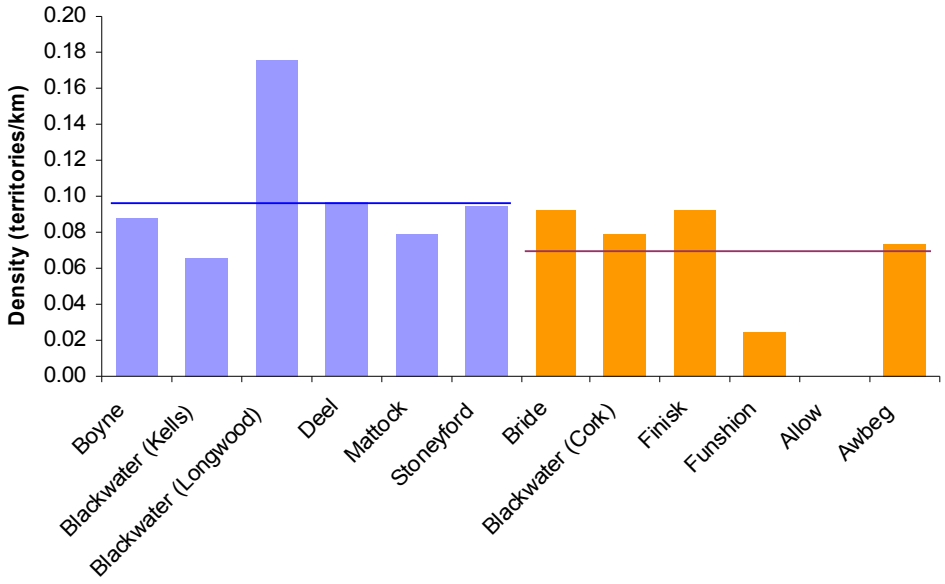

Figure 14. Kingfisher territory density on each of the rivers surveyed. Blue bars indicate rivers on the Boyne SAC system, while orange bars represent Blackwater rivers. Horizontal lines indicate the overall density on each system.

A total of 20 to 22 territories was estimated on the Boyne system and 19 to 20 on the Munster Blackwater systems (Fig 15). The figures presented below are based on minima, which are considered to be definite territories. It is possible that there are additional territories on the Mattock and the Deel Rivers on the Boyne system and on the River Bride on the Munster Blackwater system (Fig. 15). Thus, density was higher on the Boyne at 0.094 – 0.103 territories/ kilometre (or 1 territory every 10.7 – 9.7 kilometres) compared with 0.067 – 0.071 territories/ kilometre (or 1 territory every 14.9 – 14.1 kilometres) on the Blackwater (Fig. 15).

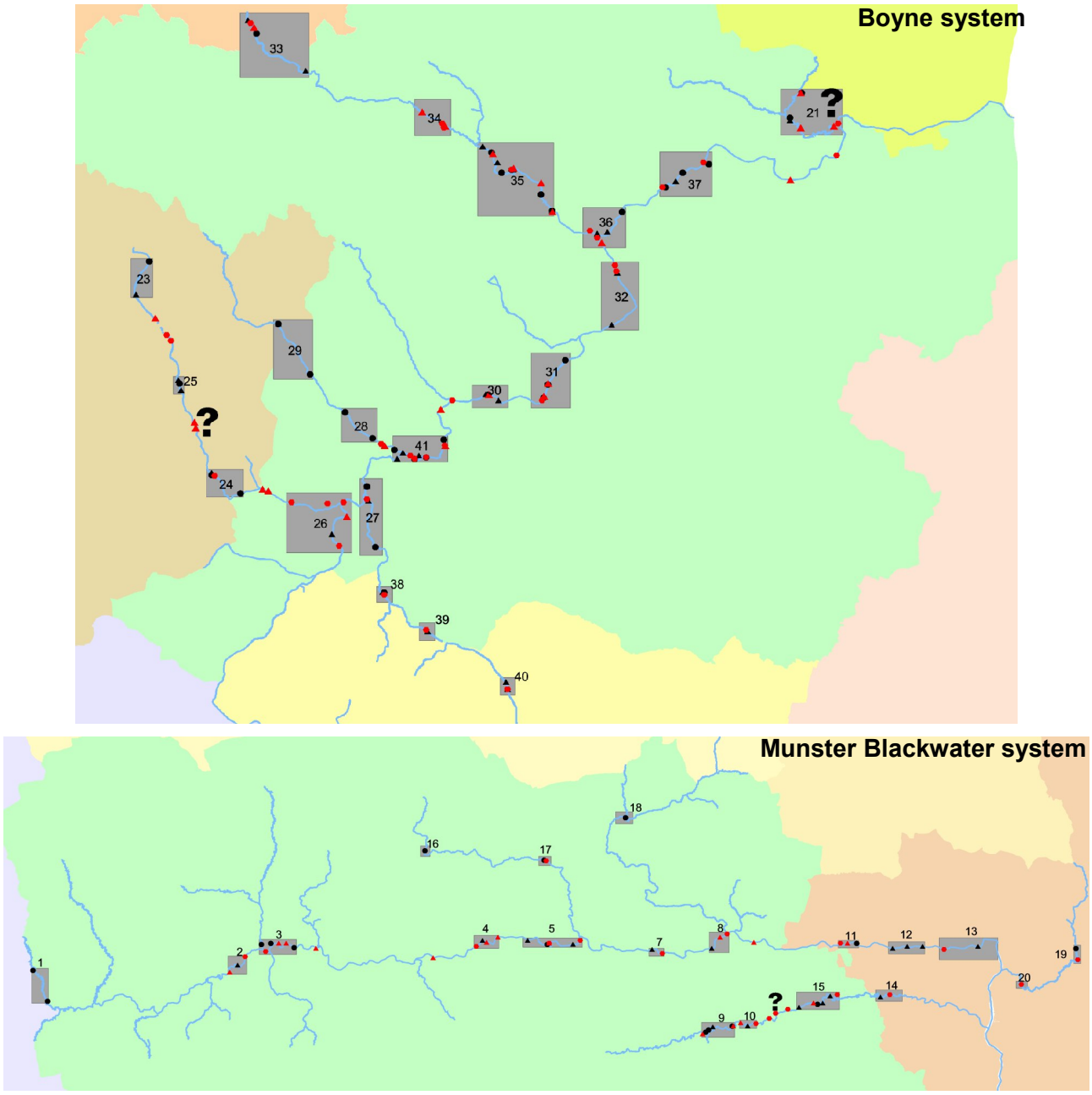

Figure 15. Kingfisher records during four visits, two early (black circles and triangles reflect the first and second (or boat-based) early visits) and two late (red circles and triangles). Kingfisher territories are shown by grey boxes, additional possible territories are indicated by a '?'.

While several rivers of the OPW catchments do support healthy numbers of Kingfisher, the specific channels which were subject to maintenance work in 2009 were considered to be unsuitable for Kingfisher. Most were relatively narrow, and located in higher altitudes, and banks were considered unsuitable for nesting. Kingfishers were recorded on just four occasions, all during the first visit. These were as follows:

- Deel(Boyne)_C1/37/15 - 22/05/2009
- Moy_C1/21/7/1/2 - 26/05/2009
- Bonet_C1(SectD) -19/06/2009
- Bonet_C1(SectD) -19/06/2009

Distribution and abundance of other birds

Density and distribution in 2008

Overall, 28 riparian bird species were recorded in 2008, including 27 on the Boyne system and 21 on the Blackwater. Further details are presented in Appendix 6. Sand Martin *Riparia riparia* was the most abundant, and was among the most widespread, species on both systems (Figure 16).

Mallard *Anas platyrhynchos* was also abundant and widespread. The densities of most species were relatively similar on both systems, although Moorhen *Gallinula chloropus* and Mute Swan *Cygnus olor* were prevalent on the Boyne system, while Grey Wagtail *Motacilla cinerea* was widespread on the Blackwater. Furthermore, Teal *A. crecca* and Snipe *Gallinago gallinago* were considerably more widespread on the Boyne than on the Blackwater, and Little Egret *Egretta garzetta* and Dipper were more widespread on the Blackwater.

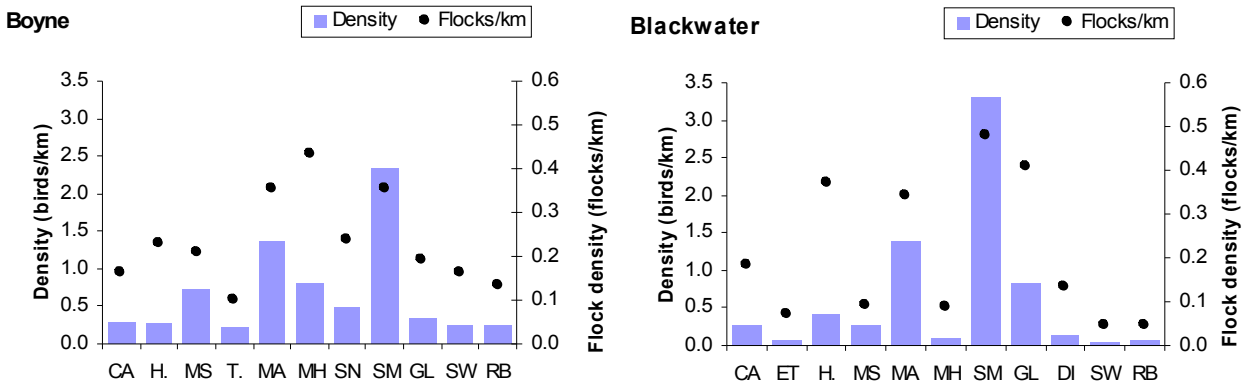

Figure 16. Maximum density of individuals and flocks/ groups of waterways birds (the most widespread species) on the Boyne and Munster Blackwater systems (CA = Cormorant, ET = Little Egret, H. = Grey Heron, MS = Mute Swan, T. = Teal, MA = Mallard, MH = Moorhen, SN = Snipe, SM = Sand Martin, GL = Grey Wagtail, DI = Dipper, SW = Sedge Warbler, RB = Reed Bunting).

There was considerable variation in the density of all species within the river systems (Fig. 17). Grey Heron *Ardea cinerea*, Mallard, Kingfisher, Sand Martin and Grey Wagtail were recorded on all rivers, while Cormorant *Phalacrocorax carbo*, Little Egret, Moorhen, Snipe, Common Sandpiper *Actitus hypoleucos*, Dipper, Sedge Warbler and Reed Bunting *Emberiza schoeniclus* were more patchily distributed. Particularly notable patterns in distribution include:

- Cormorant was particularly numerous on the larger rivers such as Rivers Blackwater (Cork) (0.417 birds/ km) and Bride (0.439 birds/ km) on the Munster Blackwater system and on the River Boyne (0.642 birds/ km), the latter where it appeared to be more abundant closer to the estuary near Drogheda. There were also occasional records along all tributaries surveyed.

- Little Egret was also more numerous along the main River Blackwater (Cork) (0.127 birds/ km) and River Bride, and also on the Finisk River (0.185 birds/ km). On the Boyne system, this species was found predominantly close to the estuary at Drogheda, with a few records some distance upstream on the River Blackwater (Kells).

- Grey Heron was widespread, and on the Boyne system was more numerous on rivers closer to the estuary, especially on Rivers Boyne (0.315 birds/ km), Mattock (0.473 birds/ km) and Blackwater (Kells) (0.349 birds/ km). On the Munster Blackwater system, this species was recorded in greatest densities closer to the main Rivers Blackwater (Cork) (0.566 birds/ km) and Bride (0.416 birds/ km).

- Mute Swan and Mallard were widely distributed on all rivers surveyed. Mute Swan was particularly abundant on the River Deel (1.200 birds/ km) (Boyne system) and on parts of the River Boyne itself (1.259 birds/ km), and was less numerous on the Munster Blackwater system, although recorded in greatest densities on the Awbeg River (0.491 birds/ km). Mallard was particularly numerous on the River Blackwater (Kells) (2.290 birds/ km) and the Mattock River (2.600 birds/ km) (Boyne system), and on the Rivers Blackwater (Cork) (1.488 birds/ km), Bride (1.848 birds/ km) and Funshion (1.944 birds/ km) (Munster Blackwater system)

- Moorhen, Snipe, Sedge Warbler and Reed Bunting all occurred in relatively low densities on rivers within the Munster Blackwater system. On the Boyne system, Moorhen was most numerous on Rivers Boyne (1.419 birds/ km) and Blackwater (Kells) (1.112 birds/ km), Snipe and Sedge Warbler on Rivers Blackwater (Kells) (0.938 and 0.502 birds/ km respectively) and Deel (0.804 and 0.446 birds/ km) and Reed Bunting on the River Deel (0.686 birds/ km).

- Common Sandpiper was recorded during the first visit only at two locations on the Munster Blackwater system and 11 locations on the Boyne.

- Sand Martin and Grey Wagtail were relatively widespread on all rivers surveyed. On the Munster Blackwater system, highest densities of both species were recorded on the River Blackwater (Cork) (4.874 and 1.106 birds/ km respectively) and the Funshion River (4.641 and 0.948 birds/ km respectively). On the Boyne system, Sand Martin density was greatest on Rivers Boyne and Deel (3.895 and 3.634 birds/ km respectively), while Grey Wagtail density was highest on the Mattock River (1.340 birds/ km).

- Dipper occurred in low densities on the Boyne system, where it was restricted mostly to the River Blackwater (Kells) (0.131 birds/ km), with occasional records on the Boyne. In contrast, this species was widespread, and recorded in relatively uniform densities, especially on the tributaries throughout the Munster Blackwater system (maximum density 0.277 on the Finisk River).

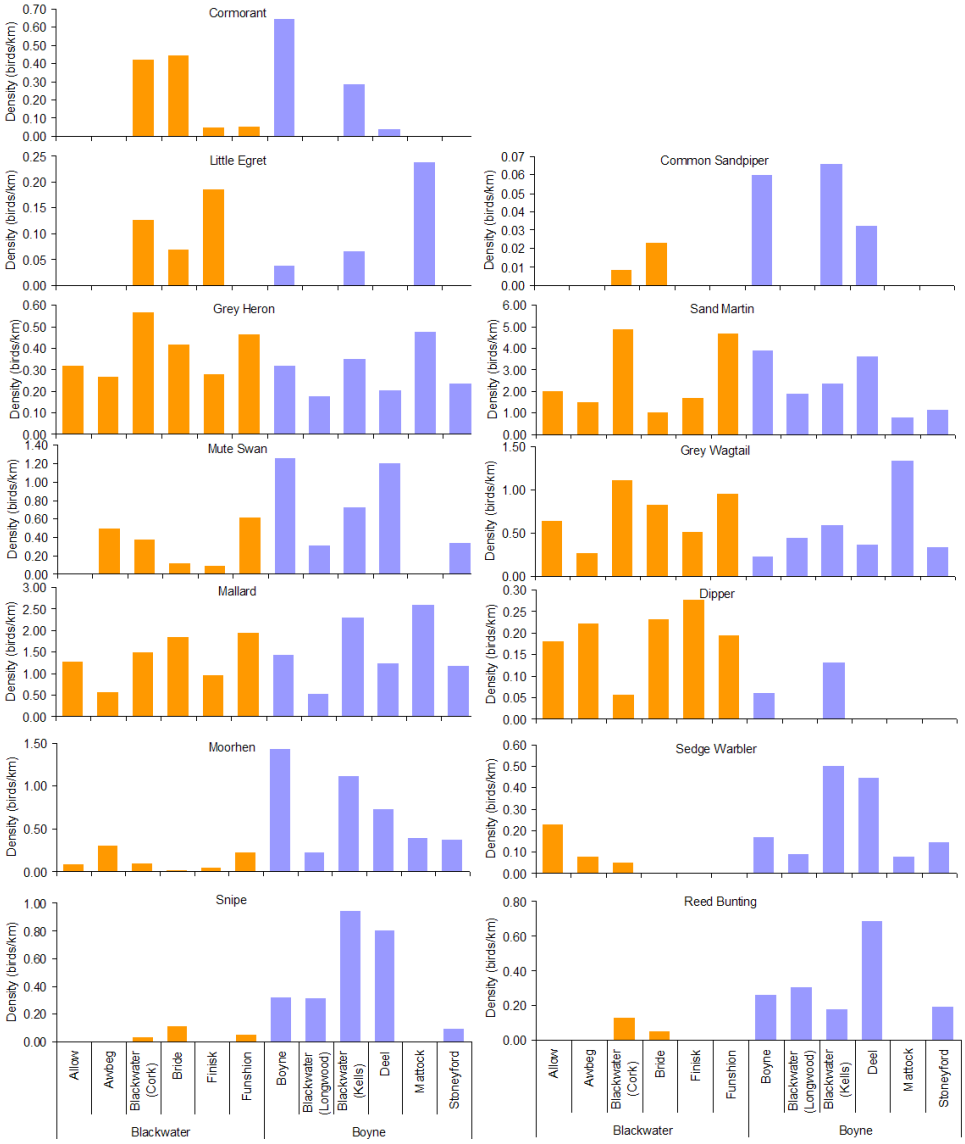

Figure 17. Densities of waterways birds on the individual rivers surveyed as part of the Boyne (blue bars) and Blackwater (orange bars) systems. Note that scales differ.

Total bird density and species richness 2009

Species richness ranged between 29 species on the Inny channels (visit 2) and 53 species on the Bonet (visit 1) (Table 6). Full detailes are presented in Appendix 7. Species richness declined between visits on the Bonet, Deel (Limerick) and Inny channels (all 3 channels where maintenance works took place) and increased on the Boyle, Deel (Westmeath) and Moy channels (channels where no maintenance occurred during the surey period). Total bird density ranged between 11.41 birds/kilometre on the Moy channels (largely surrounded by semi-improved farmland) (visit 1) and 23.90 on the Cappaghmore channels (lowland farmland) (visit 1) (Table 6). Increases in bird densities between visits were reported on the Bonet, Deel (Limerick), Deel (Westmeath) and Moy channels and a decline on the Boyle and Inny channels.

Table 6. Species richness and total bird density on each of the main channels surveyed.

	Species richness		**Density**	
	Visit 1	Visit 2	Visit 1	Visit 2
Bonet	53	43	14.73	17.16
Boyle	36	38	17.11	14.69
Cappaghmore	35	*	23.90	*
Deel (Limerick)	40	32	15.68	22.03
Deel (Westmeath)	31	34	17.11	23.37
Inny	43	29	22.11	13.70
Moy	35	38	11.41	14.66

* Note no second visit was paid to the channels at Cappaghmore due to delays in timings of when the machines went in.

A total of 67 bird species was recorded overall (Table 7), of which 18 are considered to be riparian and 23 of conservation concern in Ireland, including red-listed Curlew, Black-headed Gull and Yellowhammer and a further 20 which are amber listed species.

Among the waterways species, Sedge Warbler, Mallard and Sand Martin were the most abundant, while these species, along with Snipe and Grey Heron were the most widespread. Teal, Coot, and Common Sandpiper were relatively scarce, with small numbers recorded during the first visit only. Among other bird species, Starling, Chaffinch, Swallow, Wren and Rook were the most numerous, while Wren, Chaffinch, Blackbird, Willow Warbler and Robin were the most widespread.

Table 7. Summary bird species recorded in 2009.

Species	BoCCI*	Riparian species	Density (/km)			Peak count	% channels		
			1	2	3		1	2	3
Mute Swan	A	1	0.07	0.09	0	5	2.0	1.3	0.0
Teal	A	1	0.05	0	0	5	0.8	0.0	0.0
Mallard		1	0.4	0.14	0.42	14	7.5	3.8	10.5
Pheasant			0.2	0.2	0.21	1	10.2	10.0	10.5
Grey Heron		1	0.04	0.1	0	2	2.0	3.8	0.0
Sparrowhawk			0.02	0	0	1	0.8	0.0	0.0
Kestrel	A		0.02	0.03	0	1	1.2	1.3	0.0
Peregrine			0	0.01	0.11	1	0.0	0.6	5.3
Moorhen		1	0.02	0.05	0	1	1.2	2.5	0.0
Coot	A	1	0.01	0	0	1	0.4	0.0	0.0
Snipe	A	1	0.09	0.04	0	2	4.3	1.9	0.0
Curlew	R	1	0.02	0.13	0	8	0.4	1.3	0.0
Common Sandpiper	A	1	0.01	0	0	1	0.4	0.0	0.0
Black-headed Gull	R	1	0.01	0.13	0	8	0.4	1.3	0.0
Common Gull	A	1	0.02	0.06	0	2	0.4	3.1	0.0
Lesser Black-backed Gull	A	1	0.02	0.01	0.11	2	0.8	0.6	5.3
Woodpigeon			1.38	0.83	0.32	21	36.9	25.6	15.8
Collared Dove			0.01	0	0	1	0.4	0.0	0.0
Cuckoo			0.05	0.08	0.11	1	2.7	3.8	5.3
Swift	A		0.11	0.01	0	5	2.4	0.6	0.0
Kingfisher	A	1	0.03	0	0	1	1.6	0.0	0.0
Skylark	A		0.38	0.41	1.26	3	15.7	16.3	42.1
Sand Martin	A	1	0.24	0.2	0	9	3.9	5.6	0.0
Swallow	A		2.33	3.23	5.16	17	47.5	56.3	68.4
House Martin	A		0.13	0.14	0.11	8	2.0	2.5	5.3
Meadow Pipit			1.35	1.98	5.47	7	40.8	54.4	84.2
Grey Wagtail		1	0.09	0.05	0.21	2	3.5	2.5	10.5
Pied Wagtail			0.04	0.03	0	2	1.6	0.6	0.0
Dipper		1	0.03	0.01	0	2	1.2	0.6	0.0
Wren			2	2.85	3.26	9	65.9	76.9	84.2
Dunnock			0.67	0.61	1.05	3	27.8	27.5	47.4
Robin			2.12	1.8	1.79	4	67.5	62.5	57.9
Whinchat	A		0	0.01	0	1	0.0	0.6	0.0
Stonechat			0.11	0.09	0.21	6	2.7	3.1	5.3
Blackbird			2.33	2.28	2.21	6	69.8	69.4	63.2
Song Thrush			0.93	0.81	1.47	12	36.9	33.8	15.8
Mistle Thrush			0.32	0.35	0.74	7	13.3	14.4	5.3
Grasshopper Warbler	A		0.01	0.04	0.11	1	0.4	1.9	5.3
Sedge Warbler		1	0.41	0.54	1.05	4	11.0	18.1	36.8
Reed Warbler	A	1	0.02	0.04	0	1	1.2	1.9	0.0
Blackcap			0.27	0.28	0.32	2	13.3	13.1	10.5
Whitethroat			0.13	0.14	0	2	6.7	6.3	0.0
Chiffchaff			0.53	0.7	0.32	3	20.8	24.4	15.8
Willow Warbler			2.45	2.45	3.47	5	67.5	68.1	89.5
Goldcrest			0.83	1.19	0.63	4	26.3	35.0	15.8
Long-tailed Tit			0.2	0.75	0.53	8	5.5	11.9	5.3
Blue Tit			1.06	1.49	0.95	15	36.1	45.0	36.8
Great Tit			0.54	0.39	0.32	3	23.1	15.6	15.8
Coal Tit			1.03	1.3	0.84	8	33.3	40.0	26.3
Treecreeper			0.01	0	0	1	0.4	0.0	0.0
Jay			0.02	0	0	1	0.8	0.0	0.0
Magpie			0.32	0.68	0.11	3	13.3	24.4	5.3
Jackdaw			0.52	0.48	0.21	20	9.4	8.1	5.3
Rook			1.25	2.59	0.53	40	20.8	29.4	5.3
Hooded Crow			0.28	0.16	0	12	6.7	6.3	0.0
Raven			0.02	0.06	0	2	0.8	2.5	0.0
Starling	A		3.88	0.39	0	300	11.4	7.5	0.0
House Sparrow	A		0.12	0	0	9	2.0	0.0	0.0
Chaffinch			2.7	3.2	1.47	10	67.5	71.9	36.8
Greenfinch			0.27	0.25	0.42	4	9.0	9.4	21.1
Goldfinch			0.71	0.93	1.37	8	18.0	25.0	42.1
Siskin			0.01	0	0	1	0.4	0.0	0.0
Linnet	A		0.36	0.21	0.42	6	10.2	8.1	21.1
Redpoll			0.09	0.16	1.05	5	2.4	3.1	36.8
Bullfinch			0.2	0.35	0.95	2	9.0	15.0	31.6
Yellowhammer	R		0.02	0.01	0	1	0.8	0.6	0.0
Reed Bunting			0.35	0.55	1.37	3	14.5	20.0	52.6

* From Lynas *et al.* (2007). R – Red listed (dramatic decline in population or range in recent years/ breeding population has undergone large & widespread declines since 1800/ species of global conservation concern), A – Amber-listed (moderate decline in population or range in recent years/ breeding or wintering population localised or of internationally important numbers/ rare breeders/ unfavourable conservation status in Europe)

There was considerable variation in the densities of riparian species between managed and unmanaged channels and between visits. Densities of Mute Swan, Snipe, Sand Martin, Grey

Wagtail and Sedge Warbler were generally higher in unmanaged channels, while densities of Mallard and Grey Heron were lower. There was a substantial decline in Mallard and Snipe between visits both on managed and unmanaged channels, while an increase was shown in Grey Heron and Sedge Warbler (Fig. 19).

Figure 18. Adult Mute Swan approaching its nest on a channel of the Inny, Co. Westmeath. *Note extent of emergent vegetation in the channel.*

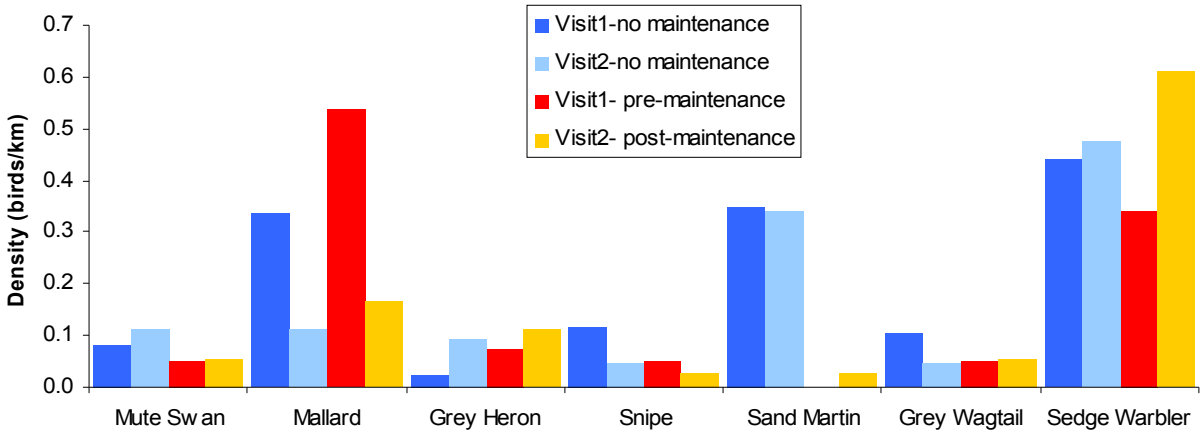

Figure 19. Density of a selection of riparian species in managed and unmanaged channels during first and second survey visits. Only species which were widely distributed are included.

There was generally little difference between managed and unmanaged channels in the densities of several common and widespread bird groups (Fig. 20A), even when totals were restricted to the channel and adjacent banks (Fig. 20B). However, there were considerable differences in several groups between visits (Fig. 20A). All groups showed increasing densities between visits on managed rivers, with the exception of Skylark, which showed a slight decline in density between visits. Taking out anomalies, such as a single large of flock of Starlings, potentially skewing results, there were increases in several species groups between visits on unmanaged rivers, with the exception of pigeons, songbirds, and in particular corvids.

When analyses were constrained to counts from the channel and adjacent banks (Fig. 20B), where most disturbance and loss of habitat was expected due to management activities, several groups were shown to decline slightly on managed channels, including pipits & wagtails, songbirds and warblers. Declines were also seen on unmanaged channels in songbirds, warblers and tits.

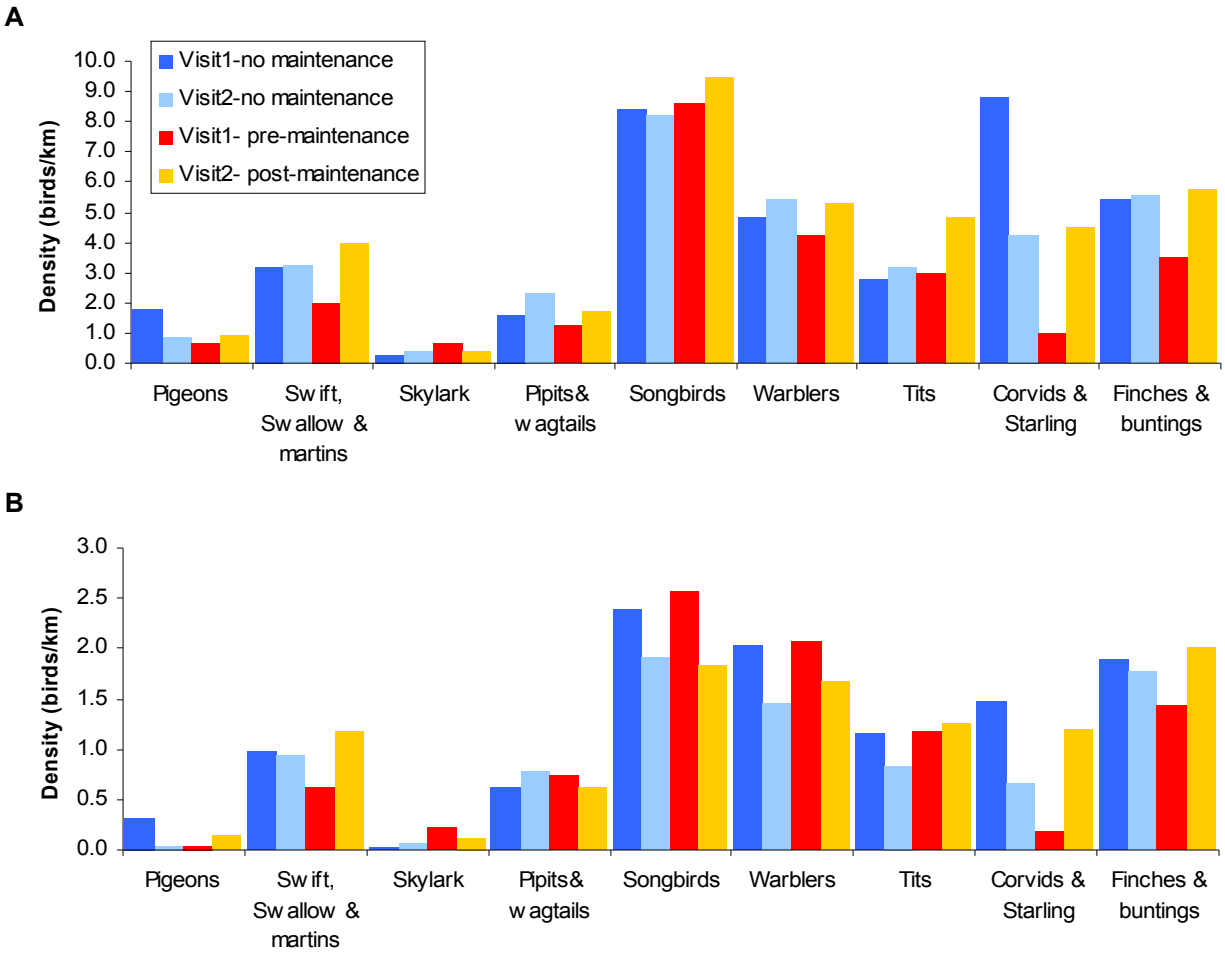

Figure 20 (A & B). Density of several bird groups overall (A) and within first distance band from the river (0-5m) (B) in managed and unmanaged channels during first and second survey visits.

Discussion

Distribution and abundance of Kingfisher

The Kingfisher is widely distributed as a breeding bird in Ireland and across Europe. The population has been estimated at less than 60,000 breeding pairs in Europe (Hagemeijer and Blair 1997) with 1,300 to 2,100 pairs in Ireland (Gibbons *et al.* 1993). It is regarded as sedentary, and shows some local movement to coastal areas in winter. They are widespread, and are present mainly lowland rivers, streams and other water bodies with shallow, slow-moving water (Morgan and Glue 1977) that contain thriving populations of small fish on which it feeds. They prefer stagnant waters, and strongly avoid rivers with scarce or very dense riparian vegetation. However, they do require trees and/or shrubs on the streams edges, which are used as perches for plunge diving (Peris and Rodriguez 1996). Vertical banks of fairly soft material are required for excavation of nesting burrows (Boag 1982). There is evidence to suggest that Kingfisher prefer banks with more loam than sand to nest in, differing to Sand Martins (Heneberg 2004). Nests ted to be located in banks where natural erosion is taking place as a result of the force of water in the channel. The first clutch is usually laid in April, but second broods are often in the nest at the end of July (Boag 1982).

Kingfisher is listed in Annex I of the EU Birds Directive, and therefore they are subject to specific protection measures. The Kingfisher remains very widespread in Ireland throughout the year, not just along waterways, but also around lakes, docks and canals and there appears to be little difference between the breeding and non-breeding distributions (Thomas and Crowe 2007).

Both the Boyne and Blackwater river systems were shown to offer a variety of riparian habitat types and to support a broad diversity of other waterways bird species. The Boyne system seemed to hold both a greater variety and greater numbers overall. The densities on both rivers were within

the range reported for various regions in Britain (Marchant and Hyde 1980). Densities were relatively stable throughout the four visits to the Boyne system. However, there was an increase shown between early and late visits to the Blackwater system, which probably reflects dispersal of young birds and/ or family groups.

At least eight sightings of Kingfishers on the Munster Blackwater system were made at points where there were small islands, and the bird usually flew along the smaller arm of the river (behind the island), perhaps illustrating a preference for smaller and more enclosed waterways. Some birds were seen flying up tributaries. It was felt that the numerous islands along the Munster Blackwater system in particular provided excellent habitat for Kingfishers, although few were seen during walked transects. It is probable that detection was hampered by poor visibility on the far side of these islands, which was further obscured by dense vegetation on these islands. In contrast, Kingfishers were regularly recorded on the Boyne system where islands were present, more often in the first visit as the vegetation was much lower and detection easier. On the Boyne system Kingfishers were observed flying out of grass on banks (often short grass) on numerous occasions. They were also observed to fly into fields for 150-200 metres and disappear out of view.

Kingfisher nests were found predominantly in clay banks (as opposed to sand). In this respect, they seem to last through the winters floods, and may be used year after year. Up to eight nest holes were reported in one small bank, but of course only one was used in 2008. While Kingfishers and Sand Martins both require steep banks for nesting, the two species were seldom seen nesting in the same areas during this survey. Sand Martins the most numerous species recorded using both systems during this survey, and were seen using more sandy cliffs, which were clear of vegetation.

Suitable nesting banks for Kingfishers were prevalent throughout most of the rivers surveyed, especially on the Munster Blackwater system. However, it was felt that perhaps an abundance of dense cover along the banks of the Munster Blackwater system may have deterred Kingfishers from some areas. Dense cover was much less prevalent on the Boyne system. Also, there were a number of relatively long stretches on the Munster Blackwater system where there were few suitable nesting banks available (maximum of up to 13 km stretch on the River Blackwater (Cork). However, it seems that Kingfishers do not appear to require long stretches of banks, and just 3 or 4 metres long is adequate. This means that even the stretches of rivers without suitable banks may not in fact be totally unsuitable. During this survey, Kingfishers were recorded only where the river was considered to be suitable. However, they were recorded on 50% of sections where banks were considered to be largely unsuitable.

There was evidence during the 2008 survey work which showed that Kingfishers are double brooded, which is consistent with other parts of their range (Boag 1982) and, with the second nest located up to 700 metres from the first. Active nests were identified by the fresh droppings and fresh fish bones, as well as by their smell (often with flies about the hole). Droppings at old holes, where dried from a previous year, were also still present.

Poor quality rivers are more likely to occur in lowlands, where there is greater industrial and agricultural activities and thus higher levels of pollution. During this survey, water quality in places was particularly poor, especially along some of the tributaries, although this is not reflected by the Q-values. Most notably the water in parts of Rivers Blackwater (Kells) and Blackwater (Longwood) and the Stoneyford River on the Boyne system and the Funshion River on the Munster Blackwater system was greyish coloured and with strong smelling water, and supported mats of vegetation. Numbers of most species were low on the Funshion, but appeared relatively normal elsewhere. It is likely such conditions would support relatively poor invertebrate communties and fish stocks. Furthermore, dense aquatic vegetation would undoubtedly render fishing difficult for the Kingfisher.

It is possible that mammalian predation may impact on bird numbers and/ or breeding success in some areas. Mink were seen on two occasions on the Munster Blackwater system.

The channels surveyed in 2009 were considered unsuitable, and did not support nesting Kingfishers.

Distribution and abundance of other waterways species

Dippers were considerably more prevalent on the tributaries of the Munster Blackwater system compared with the Boyne. They were also proportionally more numerous on medium and fast-flowing rivers, which were more abundant on the Munster Blackwater system; the Boyne system was predominated by slow-flowing rivers.

Common Sandpipers nest predominantly in upland areas where there is well-developed shingle, on low-gradient streams, feeding often on rough grassland and away from treed areas (Yalden 1986). They occurred in relatively low densities on both of the river systems surveyed.

Moorhens were much less abundant on the Blackwater than the Boyne system. This could be due to presence of mink. These were seen on two occasions during the survey. However, it is also possible that suitable Moorhen nesting habitat may be more limited on the Blackwater. Sedge Warbler and Reed Bunting densities were also considerably lower on the Blackwater. The Boyne system appeared to offer a greater abundance of fringe and emergent vegetation, especially rushes and reedbeds, which is required for nesting by these species. This is perhaps a little surprising given that the Boyne system is managed. However, the Munster Blackwater system is larger and faster flowing, which is not conducive to growth of emergent and fringe vegetation.

Rushton *et al.* (1994) showed that water quality affected all riparian species other than Kingfisher, especially in upland waterways. Common Sandpiper, Dipper and Grey Wagtail are especially vulnerable to the effects of water quality on their invertebrate food (Ormerod and Tyler 1991, Logie *et al.* 1996).

Designation of riparian SPAs

A survey of public records of Kingfisher was carried out in 2007 (Thomas *et al.* 2007), which showed that their distribution remains widespread. Thus, deriving a population estimate would be particularly difficult, and designating sites in the conventional manner (i.e. those which support 1% of the population) (Stroud *et al.* 2001, Biosphere Environmental Services 2004) is not considered to be a suitable approach. Given the close relationship, similar requirements and in some cases the reliance of Kingfishers and other waterways birds on other flora and fauna, it may be better to consider the suitability of rivers and catchments which have already afforded nature protection designation under the Habitats Directive for Kingfishers. In this respect, it is recommended that remaining lowlying SAC river systems are surveyed in a similar manner and territories defined. Thereafter, and with all the data compiled, decisions can be made on the most appropriate rivers which should be designated.

However, the extent of the SPA boundaries will need to be carefully reviewed, particularly of the adjacent bank/ terrestrial zone, which must safeguard Kingfisher from any polluting and disturbance issues in particular. Further detailed studies aimed at defining the 'terrestrial' requirements of Kingfishers are essential. Additionally, other waterways species would undoubtedly benefit from SPA designation, and in this respect, waterways bird species assemblages should be considered and described in any SPA citations, especially migratory species such as Common Sandpiper, Sand Martin and Sedge Warbler. It is also essential that designated areas continue to be monitored on a regular basis.

Threats to riparian bird communities

Channel maintenance

Drainage maintenance generally results in changes which affect in-stream and bankside ecology. Fish populations are particularly affected, especially by the loss of in-stream cover, and effects on invertebrate populations and aquatic vegetation are variable (Brooker 1985). Campbell (1988) showed that 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).

Historically, flood prevention measures and other river engineering had a major effect on both riparian habitats and breeding bird populations (Campbell 1988). Bed excavation, which was

commonly used in the past by the OPW drainage programme, has left a smooth bedrock base in some rivers which is not suitable for macro invertebrate fauna and provides few resting places for fish (O' Grady 2000). Accordingly, measures in place to enhance fish stocks such as the excavation of pools to provide natural resting places for Salmon, should also positively impact on Kingfisher populations.

It is likely that species requiring in-stream vegetation for nesting, such as Moorhen and Sedge Warbler, are more vulnerable to the direct affects of management, due to disturbance and loss of habitat. Faster flow may also result in loss of suitable habitat further downstream. It is known that Moorhens tend to prefer more heterogeneous unmanaged stretches of river than canalised managed stretches (Taylor 1984).

As suggested in previous reports (Thomas *et al.* 2007), the pace of present maintenance work in Ireland is relatively slow, and there are several measures in place which serve to protect, and even enhance fish habitats. It is considered that current management practices also benefit riparian bird communities, and that any impacts would be at a very local level.

The 2009 work was focused on assessing the impacts of arterial drainage maintenance activities on birds during the breeding season, 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, resident birds are more mobile, in general, and migrant species have returned to their wintering grounds. Consequently, arterial drainage maintenance activities would be expected to impact less on birds at this time.

The waterways selected for the 2009 survey were somewhat different from those surveyed previously 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. The sample in 2009 specifically characterised channels where remedial works were being carried out by OPW machines whereas, the latter sample (2006-07), included waterways which were much more varied and widely distributed, and most were not within OPW drainage schemes.

Seasonal changes were reported in the cover of vegetation, particularly the greening of tree canopies and increases in cover of scrub were also detected between first and second visits to channels. Such changes would be expected as vegetation grows through the summer months. Similarly, the extent of emergent vegetation increased on channels that were not subject to maintenance whereas emergent vegetation declined between visits on channels that were maintained, as expected. Emergent vegetation is an important nesting habitat for some species such as mallard and mute swans. While the removal of emergent vegetation by OPW machines could have adverse effects on these nesting species, channels are checked by operators prior to the machines going through to ensure that no obvious nests are destroyed. However, care needs to be taken as disturbance by machines could also lead to desertion by incubating adults.

Figure 21. Section of the channel on the Moy which was surveyed in the summer of 2009.

Note the canopy of broadleaf trees on both sides of the channel.

Figure 22. Section of the channel on the Boyle which was surveyed in the summer of 2009.

Note the plantation forestry on the left bank and the area of raised bog on the right bank.

The current pace of the maintenance is quite slow, with less than one kilometre covered in a week by the standard excavator, and 250-500m by the long-reach excavators which are only used on the larger channels. Furthermore, it is seldom the case that more than five kilometres of a stretch of a channel 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.

OPW channels are currently maintained on an ongoing cyclical basis, most every four to seven years (OPW 2007). 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.

River drainage maintenance work still involves removal of silt and emergent vegetation from the bed, thereby altering flow rates in worked channels, which in turn can affect the aquatic biota. 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 to such works. Kingfishers are visual foragers; they may be affected if these works alter water quality and/ or clarity. Also, Kingfishers will often not return to nest in an area if there is ongoing disturbance nearby (Boag 1982).

A considerable amount of bankside vegetation is removed during maintenance work to allow the machinery to pass along the channels. It is widely accepted that the removal of shading bankside vegetation, for access for machines (short or long arm diggers), and the regrading of banks causes a considerable reduction in the availability of fringe and bush vegetation. Some of these actions result in the removal of branches used as fishing perches by Kingfisher. 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.

Impact of maintenance works on birds utilising the river channels and adjoining riparian habitats

Species richness and bird densities were compared across visits at sites that were maintained during the survey period and at sites that were not. The latter sites served as a control to assess whether any changes were as a result of natural fluctuations in species richness across the breeding season or whether they were associated with the works themselves. In general, many resident species commence breeding earlier in the spring (Mar-Apr) before the arrival of summer migrants which usually do not commence breeding until late Apr-May and finish breeding later (Jul). Hence, resident species such as the Robin, Wren, tit and finch spp. tend to be more vocal earlier in the season with migrants (i.e. Willow Warblers, Chiff Chaffs, and Sedge Warblers) more vocal on later surveys, once they have arrived and have set up their breeding territories. On the three channels where maintenance occurred, the Bonet (Leitrim), the Inny (Westmeath) and the Deel (Limerick), species richness declined post maintenance whereas there were slight increases on second visits on those channels where no maintenance was carried out i.e. the Boyle (Roscommon), the Deel (Westmeath) and the Moy (Mayo). Given that maintenance works are likely to affect early resident breeders, these results were not unexpected. It is probable that many of the early breeding resident species utilising the river corridor and riparian habitat were affected by the works in terms of disturbance and the physical changes to the banks and bankside vegetation. Conversely, there was a trend for bird densities to increase post maintenance. This increase in bird densities is probably related to an increase in the numbers of juvenile birds later in the breeding season which would be expected.

Numbers of species recorded across the channels surveyed varied. Given that six separate channels on the Bonet were surveyed, it is not surprising that it had the highest number of species recorded. Some of the variation exhibited is also probably related to changes in land use and habitat make-up across channels. The Moy (Figure 21) has more deciduous woodland and semi-improved or unimproved farmland along its course whereas the Boyle (Figure 22) is surrounded largely by raised bog and coniferous plantation. Cappaghmore is surrounded by typical improved farmland and therefore it is not surprising that it had the fewest number of bird species (35 spp) recorded. By contrast, the Bonet which is typified by a combination of semi/unimproved farmland and broadleaf deciduous and coniferous woodland, had the greatest number of species recorded (57 spp). In terms of the species that were most abundant, there was some variation between rivers but in general resident species such as the wren, robin, blackbird and chaffinch were present

in the greatest numbers. Migrant species like the swallow and the willow warbler were also present on most channels in high densities.

No clear pattern emerged in terms of any negative association between either bird numbers or distribution and drainage maintenance activities. Given that bird species and numbers were seen to fluctuate on unmanaged as well as managed rivers this result is not surprising. Some species recorded declines on both managed and unmanaged channels between visits (i.e. Mallard) and others showed slight increases between visits (i.e. Sedge Warbler). Bird distribution and abundance can be affected by a combination of physical factors, including water depth, flow and quality and the complexity of adjacent riparian habitats. In addition, more biological constraints like the timings of breeding for resident and migratory species could have an effect. Many of our resident species commence breeding earlier than migratory species, which often do not arrive until April/May when residents have already bred. Interestingly, sand martins were largely found on channels where no maintenance was carried out. A wider subset of channels would need to be surveyed in order to see whether this difference was due to disturbance issues related to the maintenance works or whether this difference was an anomaly.

Recommendations

The recommendations below are specific to the requirements of breeding birds that utilise riparian corridors and do not take into account measures for aquatic plants, fish populations, invertebrates or otters. There is a direct conflict in terms of OPW Drainage management programme in terms of the timings of works on channels and the timing of the breeding season of our resident and migrant bird populations. While it is appreciated that drainage works often have to be carried out at these key times for bird populations, works should be directed towards channels that hold fewer target species i.e Kingfisher and restrict certain operations at particular times of the year. Activities such as tree felling/cutting, hedge cutting, marginal reed cutting, aquatic weed clearance and dredging/ work on margins would ideally be carried out outside the breeding season.

This study has shown some negative impacts on species diversity in channels where maintenance was carried out. Teasing out the significance of these impacts of OPW drainage maintenance practices is more difficult given the natural fluctuations in bird densities across the breeding season. Also, this study was limited in terms of both the number of study sites looked and the number of sites where maintenance work was actually completed prior to the study's completion. 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 to ameliorate any impacts on habitats which are then likely to become suitable within a few years for nesting birds.

The RSPB/ NRA/ RSNC (1994) advocated 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 have been 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 Best Practice Guidelines 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. Additional seeding of banks would further enhance this regeneration process, especially where severe maintenance has taken place.

- 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 which breed during late April through to the end of July.

- The creation of riffles and pools and loosening of bed gravels to remove fine silts to accommodate fish spawning. This improves foraging conditions for birds feeding on aquatic invertebrates and/ or fish prey.

- Creation of two-stage channels, where appropriate, 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.

- The retention of scrub on areas of bank that were formed by the spoil heap and bedrock removed from channels (Fig. 23), are important for breeding bird species, particularly finches such as Linnets *Carduelis cannabina* and Goldfinches *Carduelis carduelis*, along with Stonechats *Saxicola torquata*.

Figure 23. Note the broadleaf habitat on the right hand side of the channel and the created spoil heap to the left of the channel and fence posts which acts as an important habitat for finches in particular.

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. 24).

A B

Figure 24. Examples of Kingfisher nesting banks seen along the (a) Moy River in County Mayo and (b) the Bonet River in County Leitrim

- 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. *Care should be taken to ensure that the banks do not collapse when doing so.*

- Bridges are considered to be important sites for wildlife (Smiddy *et al.* 1996), 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.

Future Work

Appropriate Assessments

Kingfisher (Annex I Species) and other riparian migrant species should be listed on Appropriate Assessment Forms for those river catchments where they have been recorded during the present survey, and on previous Waterways surveys. It is strongly recommended that appropriate assessments should be undertaken at all designated sites where maintenance work is scheduled.

Nest Box / Artificial Nest Site Study

Future research commissioned by the OPW should include a pilot study to investigate the feasibility of creating suitable nest banks for Kingfisher and / providing artificial nest boxes. It is widely accepted that Kingfisher nesting density is limited by the availability of suitable banks for nesting (Peris *et al.* 1996).

- A manipulation study should be conducted prior to their breeding season and include the erection of artificial nest boxes and/or possible bank regarding by excavators in order to assess the possible impact such measures would have on Kingfisher numbers.
- As it is difficult to assess breeding success of Kingfishers at natural nest sites, artificial nest boxes (Fig. 25) would allow for potential monitoring of breeding success of Kingfishers on certain rivers.

Figure 25. Schwegler Kingfisher/ Sand Martin Nesting Tunnel

The vendors (Alana Ecology, www.alanecology.com) say that this tunnel (£91.95 incl V.A.T.) can '*provide a vital nesting opportunity where no suitable sites are available or where banks are too stony or have too many roots in them. The tunnel is made of lightweight concrete, regulating temperature and humidity and preventing condensation in the nesting chamber. A plastic mesh on the bottom protects it from rodents. Schwegler boxes have the highest occupation rates of all box types. They are carefully designed to mimic natural nest sites and provide a stable environment for chick rearing and winter roosting. They can be expected to last 25 years or more without maintenance*'. Boxes can also be constructed using information provided by Du Feu (2005) where implicit instructions (including dimensions) are given with respect to the construction, materials, maintenance and placement of nest boxes suitable for Kingfishers.

- Encourage the nesting of colonies of sand martins through identification of suitable natural sites i.e. sandy banks > 2m in height and possibly the creation of new banks where other have been damaged by previous works and the appropriate mitigation measures to ensure that any engineering works do not coincide with the nesting period of these migrants.

Survey methodology

There have been few other surveys which have compared boat and walked transects. However, one such study was carried out in Scotland on wintering birds along rivers (Cosgrove *et al.* 2004). They concluded that their counts from Canadian canoes were comparable with those from walked

transects, and implied that any disturbance caused, and also any risks of double counting, are similar between methods.

It is likely that future surveys of Kingfisher and other waterways birds will be carried out predominantly through walked transects. However, boat-based observations should be undertaken where possible (i.e. where rivers are sufficiently large). They are much less time-consuming (for example it took two observers roughly six days to cover the same area on foot that one observer covered by boat in four days). There are several other advantages of surveying from a boat. The observer has a clear view of the river ahead (unless rowing, in which case he/she has back to direction of travel), and a clear view of both banks, regardless of how dense the vegetation is. There are also no problems with accessibility, crops, cattle (bulls), landowners or fishery owners. However, there are also disadvantages, although some of these are not unique to surveying using a boat. Sufficiently large rivers are required, and calm weather is particularly essential. Birds that do not fly and sit tight on a branch or stump (i.e. if they sit on a leafy branch), that do not call, or only gave a single very weak call, that fly over banks 'around' the observer, with or without calling, or that go through vegetation to escape 'around' the observer could be easily missed. A Kingfisher's call is very distinctive, and when one flew ahead of the boat, it was often picked up first on call. However, occasionally Kingfishers did not call when flushed, or when taking flight, and some seen from the boat did not flush. This increases the likelihood of missing birds. However, by ensuring that rivers are visited twice, there is a good chance that birds will be picked up on either visit.

The inclusion of a detectability score proved to be a useful exercise. It showed that the degree of inaccuracy in late visit counts is likely to be higher than during early counts due to increased vegetation growth, and that detectability on the Boyne system was better than on the Munster Blackwater.

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Appendix 1. Bird species recorded during this project.

Mute Swan	*Cygnus olor*
Teal	*Anas crecca*
Mallard	*Anas platyrhynchos*
Pheasant	*Phasianus colchicus*
Grey Heron	*Ardea cinerea*
Sparrowhawk	*Accipiter nisus*
Kestrel	*Falco tinnunculus*
Peregrine	*Falco peregrinus*
Moorhen	*Gallinula chloropus*
Coot	*Fulica atra*
Snipe	*Gallinago gallinago*
Curlew	*Numenius arquata*
Common Sandpiper	*Actitis hypoleucos*
Black-headed Gull	*Chroicocephalus ridibundus*
Common Gull	*Larus canus*
Lesser Black-backed Gull	*Larus fuscus*
Woodpigeon	*Columba palumbus*
Collared Dove	*Streptopelia decaocto*
Cuckoo	*Cuculus canorus*
Swift	*Apus apus*
Kingfisher	*Alcedo atthis*
Skylark	*Alauda arvensis*
Sand Martin	*Riparia riparia*
Swallow	*Hirundo rustica*
House Martin	*Delichon urbica*
Meadow Pipit	*Anthus pratensis*
Grey Wagtail	*Motacilla cinerea*
Pied Wagtail	*Motacilla alba*
Dipper	*Cinclus cinclus*
Wren	*Troglodytes troglodytes*
Dunnock	*Prunella modularis*
Robin	*Erithacus rubecula*
Whinchat	*Saxicola rubetra*
Stonechat	*Saxicola torquata*
Blackbird	*Turdus merula*
Song Thrush	*Turdus philomelos*
Mistle Thrush	*Turdus viscivorus*
Grasshopper Warbler	*Locustella naevia*
Sedge Warbler	*Acrocephalus schoenobaenus*
Reed Warbler	*Acrocephalus scirpaceus*
Blackcap	*Sylvia atricapilla*
Whitethroat	*Sylvia communis*
Chiffchaff	*Phylloscopus collybita*
Willow Warbler	*Phylloscopus trochilus*
Goldcrest	*Regulus regulus*
Long-tailed Tit	*Aegithalos caudatus*
Blue Tit	*Cyanistes caeruleus*
Great Tit	*Parus major*
Coal Tit	*Periparus ater*
Treecreeper	*Certhia familiaris*
Jay	*Garrulus glandarius*
Magpie	*Pica pica*
Jackdaw	*Corvus monedula*
Rook	*Corvus frugilegus*
Hooded Crow	*Corvus corone cornix*
Raven	*Corvus corax*
Starling	*Sturnus vulgaris*
House Sparrow	*Passer domesticus*
Chaffinch	*Fringilla coelebs*
Greenfinch	*Carduelis chloris*
Goldfinch	*Carduelis carduelis*
Siskin	*Carduelis spinus*
Linnet	*Carduelis cannabina*
Redpoll	*Carduelis flammea*
Bullfinch	*Pyrrhula pyrrhula*
Yellowhammer	*Emberiza citrinella*
Reed Bunting	*Emberiza schoeniclus*

Appendix 2a. Habitat coding scheme used in 2008.

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
A. PRIMARY - Waterway characteristics			
1. Eroding /upland river or stream	**1.** Industrial activity	**1.** Slow running	**1.** No emergent/fringe vegetation
2. Depositing /lowland river or stream	**2.** Small islands	**2.** Medium flow	**2.** Some fringe vegetation (<2m wide &/or <2m linear length
3. Canals	**3.** Stream (less than 3m wide)	**3.** Fast-running	**3.** Fringe vegetation (>2m wide & 2m linear length)
	4. River (more than 3m wide)	**4.** Presence of riffles/pools	
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.

Appendix 2b. Habitat key used in 2009.

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)			

Appendix 3. Coverage descriptions of rivers in 2008.

Boyne System:

River Boyne: The lower sections of the river were tidal below Grove Island, or had tidal backwash below O034734. The sections between Brú na Boyne and Navan were relatively open and easy to walk along. There were areas of woodland immediately below Slane, while from Slane to Navan there was managed woodland in a high proportion of the sections. The area between Navan and Ballinteer Bridge was more difficult to survey due to the terrain. The remainder of the Boyne was easy to survey with the exception of the complex habitat between Bective Bridge and the mouth of the Knightsbrook River. Upstream of Trim, the river had high banks and was easy to walk and observe Kingfisher movements. It was open for the majority of sections with pockets of woodland or scrubland.

River Blackwater (Kells): The lower sections of the Blackwater were situated, in or close to Navan town, at the confluence of the River Boyne. The first three kilometres of the river were industrial and were difficult to survey, but Kingfishers were seen in places. The river upstream to Headford Bridge had some excellent bank habitats, especially just above Donaghpatrick Bridge. The river up to Carnaross was quick flowing and shallow with a more riffle areas. The river approaching Lough Ramor had variable habitat types. The area just above Carnaross had quick flowing areas while the river became deeper with steeper banks within kilometres of the lake. Also the soil was a mixture of drained peatland and sandy banks close to the lake.

River Deel: The first two kilometres (near the confluence with the River Boyne) were very fast flowing. Further upstream, the river gradually became a canalised, especially between Clondalee Bridge and Inan Bridge. The banks were very steep due to drainage works (the land in the 1970s was wetland and is now pasture). The river from Inan Bridge to Ballynacor Bridge was open and easy to survey as it had been drained as well. Above Ballynacor Bridge there was a lot of wetland and conifer forestry.

River Stoneyford: The lower sections were open and had steep vertical mud banks. The middle reaches from Cloghbrack to the N51 were dominated by pastureland with the feeder streams flowing into the river originating from bogland. The upper reaches became narrower and were highly polluted with agricultural waste (farm plastic & inputs like slurry / fertiliser) and possibly also due to over-flowing septic tanks.

River Blackwater (Longwood): The lower sections, close to the Boyne confluence, were open and had a high level of mixed farmland including arable cropland (barley and carrots), grassland and horse studs. The middle sections were open with very little cover along the banks. Sheep and cattle grazed the banks bare. The banks were very deep, due to extensive drainage along the course of the river. The river was heavily drained beyond Johnstown Bridge. The soil was predominantly drained peat land, and the water in the upper sections was considerably peaty also.

Mattock River: This river was relatively small compared with the other rivers in the Boyne System. It was relatively shallow and narrow, and had a considerable amount of riffle, pool and glide habitats. The lower stages, near the confluence with the Boyne, were wooded as were the sections upstream (i.e. those immediately downstream of Wood Mill Bridge). Increased levels of mixed (arable) agriculture were seen approaching Mattock Bridge until the confluence of the Delvin River. The river was shallow and easy to cross with numerous meanders along its course. This gave rise to some pool systems particularly in the middle reaches of the area surveyed. This also gave rise to a high proportion of banks with steep sides lacking any vegetation covering their vertical elevation from the river. Fishermen there were collecting minnow from the river, and small trout could be seen in the pools. Some sections, extending approximately 2 kilometres above Mattock Bridge had alterations to the bank and in-stream habitats, probably to improve spawning beds etc. The river was highly silted due to the ability of livestock, particularly dairy cows above Wood Mill Bridge, and sheep / horses downstream of this bridge, to access the river. There was little or no fencing along the river banks to block access to drinking areas. Deer were also seen using the river.

Munster Blackwater system

River Blackwater (Cork): The area above Rathmore was difficult to survey due to bank vegetation (especially in some areas approaching Ballydesmond). The tributaries in particular supported abundant suitable habitat for Kingfisher. The river was very shallow in some parts. There were areas of woodland, and some of the banks had a thick corridor of trees. However in some places the river had shingle banks that could be walked for a few hundred metres. Between Keale Bridge and Ballymaquirk Bridge the river was deeper and had some excellent bank habitats. From Ballymaquirk Bridge to Longfield's Bridge the river also had some very suitable Kingfisher habitat. Some of the banks were protected by concrete that was dumped at meanders by farmers e.g. at W356971. The river was difficult to survey between Longfield's Bridge and Mallow Bridge due to dense bank vegetation. The area between Mallow and Fermoy had numerous limestone cliffs along both banks. Around these cliffs were large areas of woodland/ scrub which made surveying difficult. The banks were also heavily vegetated. This was especially true between Mallow and Kilavullen. Below Fermoy there were some cliffs also, but these dissipated heading towards Ballyduff Lower. The bank from 10 kilometres above Ballyduff to two kilometres above Lismore was easy to walk along. There were a number of islands along the course of the river that may provide excellent habitat for Kingfishers.

River Bride: This river was very difficult to survey in parts. The lower sections, below Bridebridge, had a lot of weed. This may have been due to the possible inefficiency of the Sewage Treatment Plant at Rathcormack. The banks were well wooded in some sections, while the land was mixed with high levels of arable land above Conna Bridge. Above Rathcormack Bridge, the river became less wide, with increased river velocity, while the density of the vegetation along the bank increased, possibly due to the field boundary changes. Woodland density increased above the intersection of the M8 motorway and the river.

River Allow: The lower sections had a high proportion of wooded areas on its banks. There was some evidence of pollutant where the river entered the Blackwater. Above Kanturk, the river narrowed, and the woodland became less dense, leaving more open farmland with a dense layer of trees (mainly Willow) along the banks. These often covered the river and would have impeded any birds trying to fly up and down the river. In the upper stretches, the landscape became more open with some meanders providing some bank habitats for potential nest sites.

River Awbeg: The lower reaches around Castletownroche had steep valleys and were heavily wooded. The area downstream of Doneraile (close to Doneraile Wildlife Park) was also heavily wooded. The areas between Doneraile and Buttevant, and two kilometres above and below Cahermee Bridge, were extremely difficult to survey from the banks (due to dense woodland). The banks were very low and the area had flooded woodland on both banks. There were also a lot of aquatic plants choking the channel just above the bridge, probably due to slow flow conditions. This extensive growth was possibly due to some biological/ chemical unbalance in the system. The river approaching Buttevant had some excellent Kingisher habitat. There was some weed in the river near Castle Bridge and there was access to the river for horses.

River Finisk: The lower and middle sections of the river had areas of mixed arable farming. The upper stretches had a more 'V' shaped valley profile and were narrow. The river was not very deep, and after Modelligo bridge was more upland in nature. The predominant land use was mixed cattle/ dairy above Finisk Bridge while below that there was some arable land use present. Above Mountain Castle Bridge, the road impeded surveying as the terrain slope of the river increased. The river had excellent water quality.

River Funshion: The lower sections of the river, and the area approaching Glanworth, were wooded and difficult to survey from the banks. There was also an odour in parts that may have come from the sewage treatment plant at Glanworth. The area above Glanworth was more open and easier to survey. The river between Killee Bridge and Ballyaghaderg Bridge had some outflow pipes form a factory (animal processing plant) entering the river. The upper sections of the river above Ballyaghaderg Bridge were impacted by some pollution (possibly agricultural but may have been petroleum based from road works constructing the M8 motorway between Cashel & Mitchelstown). The land was not as productive or intensively managed as the area downstream of Ballyaghaderg Bridge.

Appendix 4. Further details of the Kingfishers located during survey work in 2008.

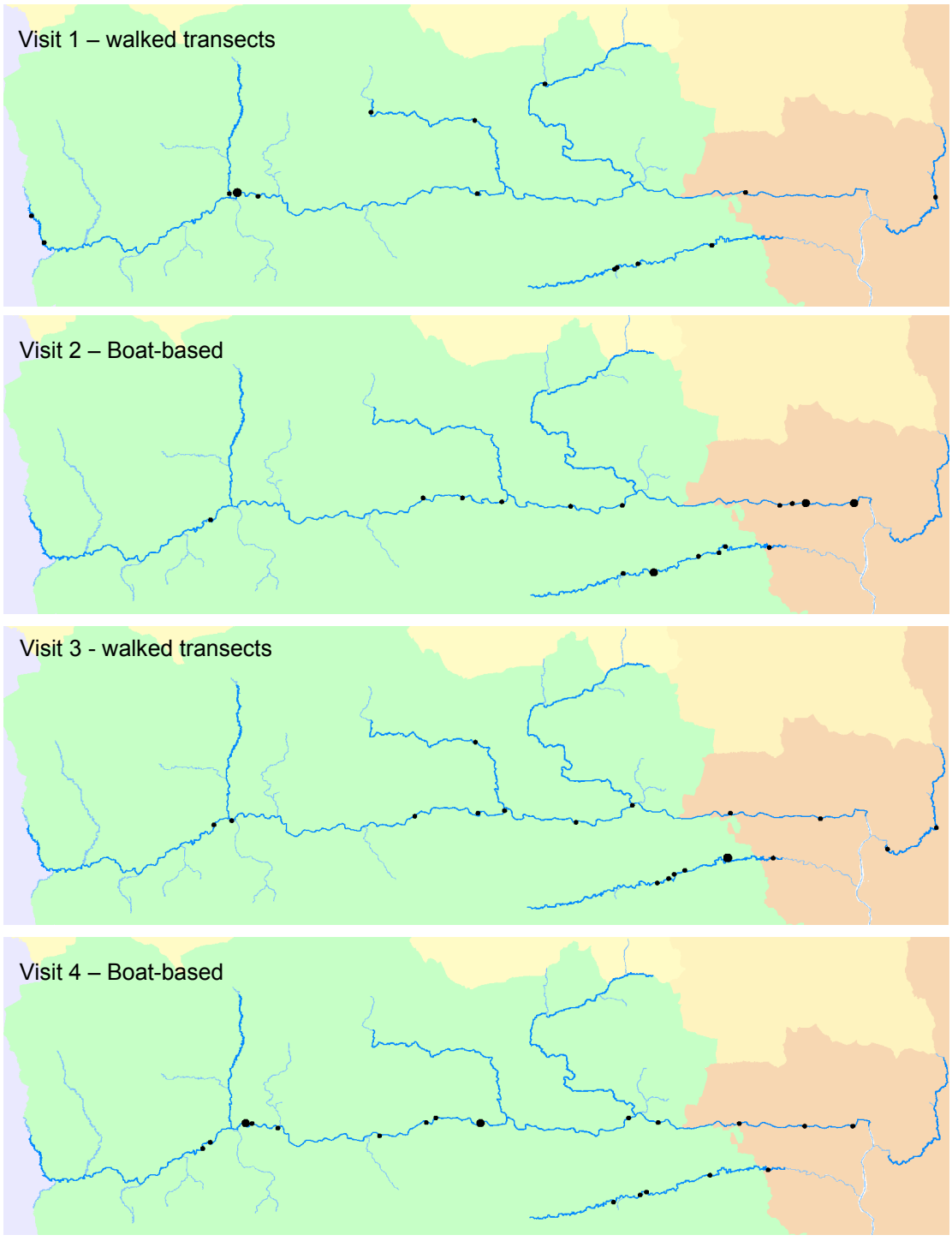
Early (E1 and E2) and late (L1 and L2) visit counts are presented. The grid references provided indicate the start point of the 500m section surveyed in which a Kingfisher was recorded. E2 and L2 denote the second set of walked transects on the Boyne and the boat-based transects on the Blackwater conducted in each of the early and late periods.

Blackwater						Boyne						Boyne					
River	Grid	E1	E2	L1	L2	River	Grid	E1	E2	L1	L2	River	Grid	E1	E2	L1	L2
Allow	W384992	1				Blackwater[2]	N631828		1			Deel	N554639		1		
Awbeg	R543083	1				Blackwater[2]	N633826			1		Deel	N563663	1			
Awbeg	R659074	1				Blackwater[2]	N635823				1	Deel	N567623				1
Awbeg	R661073			1		Blackwater[2]	N637819	1				Deel	N575611			1	
Blackwater[1]	W162967	1				Blackwater[2]	N671793		1			Deel	N578607			1	
Blackwater[1]	W176937	1				Blackwater[2]	N751765				1	Deel	N583580		1		
Blackwater[1]	W353965				1	Blackwater[2]	N765757			1		Deel	N584578	2			
Blackwater[1]	W361972		1		1	Blackwater[2]	N766754			1		Deel	N585573		1		
Blackwater[1]	W368980			1		Blackwater[2]	N767755				1	Deel	N594551				1
Blackwater[1]	W388985			1		Blackwater[2]	N793741		1			Deel	N595547				1
Blackwater[1]	W393993	2				Blackwater[2]	N799737	2				Deel	N606515	1			
Blackwater[1]	W401993				2	Blackwater[2]	N800736				1	Deel	N606516		1		
Blackwater[1]	W408993				1	Blackwater[2]	N803730		1			Deel	N608514			1	
Blackwater[1]	W416989	1				Blackwater[2]	N806723	1				Deel	N626502	1			
Blackwater[1]	W437988				1	Blackwater[2]	N813725	1		1		Deel	N641505				1
Blackwater[1]	W551979				1	Blackwater[2]	N814725		1			Deel	N645504				1
Blackwater[1]	W593990			1		Blackwater[2]	N814726				2	Deel	N661496			1	
Blackwater[1]	W599996		1			Blackwater[2]	N833708	1				Deel	N697496			1	
Blackwater[1]	W603994				1	Blackwater[2]	N833716				1	Mattock	O005759		1		
Blackwater[1]	W614999				1	Blackwater[2]	N841696				2	Mattock	O005761	1			
Blackwater[1]	W643996		1			Blackwater[2]	N841697	1	1			Mattock	O012754				1
Blackwater[1]	W662992	1				Blackwater[2]	N867683			2		Mattock	O012778				1
Blackwater[1]	W664993			1	2	Blackwater[2]	N872681		1			Mattock	O013778	1			
Blackwater[1]	W687992		1			Blackwater[3]	N713498			1		Mattock	O035755				1
Blackwater[1]	W694996			1		Blackwater[3]	N719465	1				Mattock	O038757			1	
Blackwater[1]	W764987		1			Blackwater[3]	N724434		1			Stoneyford	N652619	1	1		
Blackwater[1]	W774983			1		Blackwater[3]	N725432			1		Stoneyford	N674584	1			
Blackwater[1]	W822988		1			Blackwater[3]	N725434	1				Stoneyford	N698558	2			
Blackwater[1]	W830999				1	Blackwater[3]	N754408			1		Stoneyford	N717540	1			
Blackwater[1]	W863994				1	Blackwater[3]	N755407		1			Stoneyford	N723536			1	
Blackwater[1]	W947993			1		Blackwater[3]	N809372		1			Stoneyford	N725535				2
Blackwater[1]	W954993				1	Blackwater[3]	N810367		1	1		Stoneyford	N732532	1			
Blackwater[1]	W963993	1				Boyne	N686495			1		Stoneyford	N738530		1		
Blackwater[1]	W998988		1			Boyne	N689474		2								
Blackwater[1]	X012990		1			Boyne	N694466			1							
Blackwater[1]	X027990		2		1	Boyne	N699486				1						
Blackwater[1]	X048987			1		Boyne	N713507	1	1								
Blackwater[1]	X081990		2		1	Boyne	N714497		1								
Bride	W813905				1	Boyne	N734526		1								
Bride	W816907	1				Boyne	N743528			1							
Bride	W819909	1				Boyne	N746526	2		1							
Bride	W823912		1			Boyne	N749528		1								
Bride	W842913	1				Boyne	N754527	1		1							
Bride	W843913				1	Boyne	N764560				1						
Bride	W850916				1	Boyne	N766539	1									
Bride	W857913		2			Boyne	N767535			1	1						
Bride	W865915			1		Boyne	N772566			1							
Bride	W878920			1		Boyne	N795570		1								
Bride	W884925			1		Boyne	N797570	1			1						
Bride	W896929			1		Boyne	N804566		1								
Bride	W907931		1			Boyne	N834566			1							
Bride	W921935				1	Boyne	N835568	1									
Bride	W925934	1				Boyne	N835569				5						
Bride	W930935		1			Boyne	N838577	1									
Bride	W937942		1			Boyne	N838578				1						
Bride	W944943			3		Boyne	N850594	1									
Bride	W986941		1		1	Boyne	N872678			2							
Bride	W995943			1		Boyne	N875675				1						
Finisk	X123953			1		Boyne	N879682		1								
Finisk	X176988	1				Boyne	N882618		1								
Finisk	X178977			1		Boyne	N884659			1							
Funshion	R738115	1				Boyne	N885655			1							
Funshion	R837002			1		Boyne	N886654		1								
						Boyne	N889696	1									
						Boyne	N917713			1							
						Boyne	N919713	1									
						Boyne	N926717		1								
						Boyne	N931723	1									
						Boyne	N945730			1							
						Boyne	N949729	1									
						Boyne	O005718				1						
						Boyne	O037735			1							

Blackwater[1] = River Blackwater (Cork), Blackwater[2] = River Blackwater (Kells), Blackwater[3] = River Blackwater (Longwood)

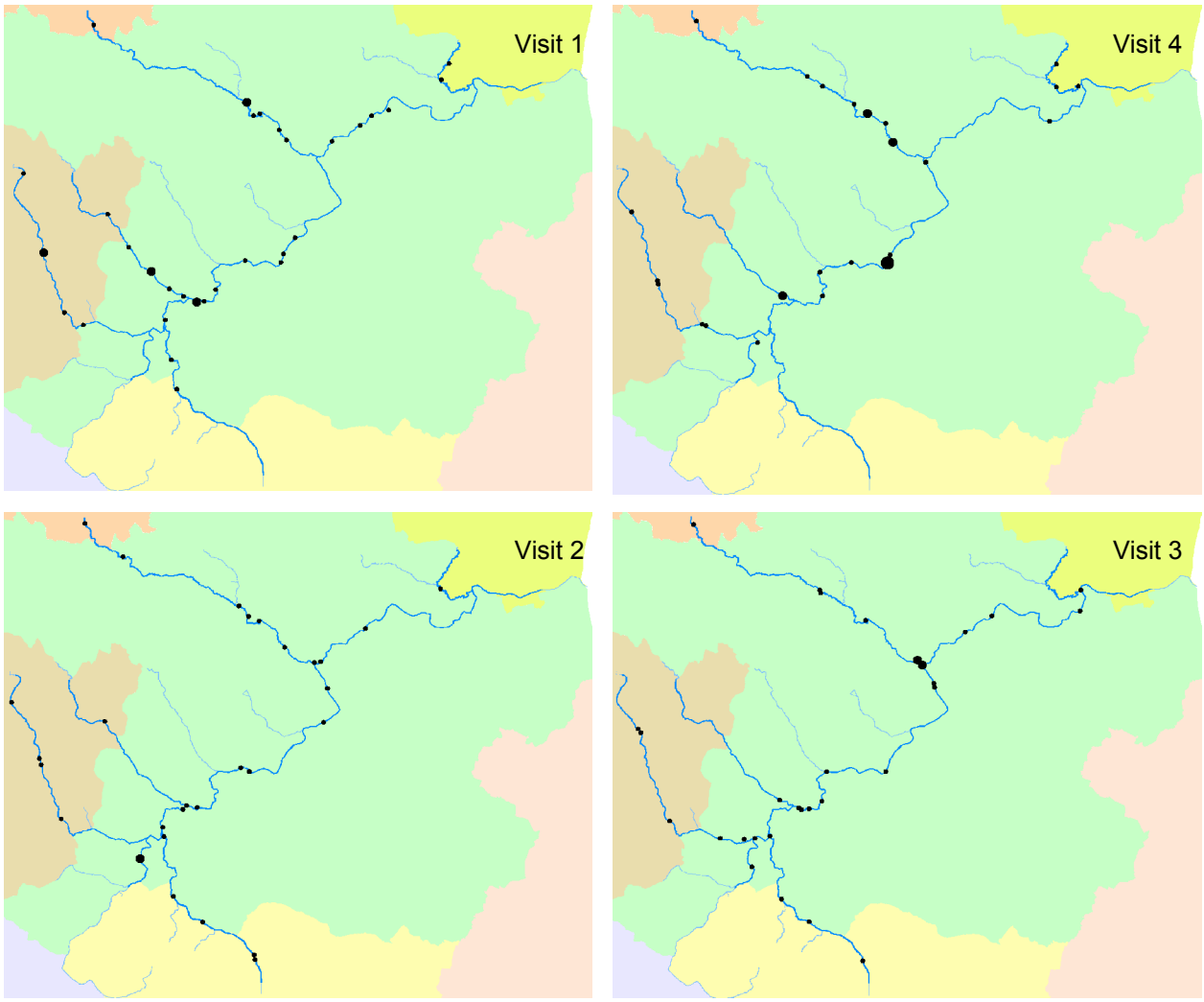
Appendix 5a. Distribution of Kingfishers during early and late visits on the Munster Blackwater.

Data are based on observations from land and by boat. Circle size reflects numbers seen (maximum = 5 birds).



Appendix 5b. Distribution of Kingfishers during early and late visits on the Boyne system.

Data are based on observations from land and by boat. Circle size reflects numbers seen (maximum = 5 birds).



Appendix 6. Maximum density of waterways birds in 2008.

Numbers of flocks/ groups are presented in brackets.

Blackwater

species		Allow	Awbeg	Blackwater (Cork)	Bride	Finisk	Funshion
Little Grebe	*Tachybaptus ruficollis*			0.008 (1)		0.046 (1)	0.024 (1)
Cormorant	*Phalacrocorax carbo*			0.417 (37)	0.439 (12)	0.046 (1)	0.049 (2)
Little Egret	*Egretta garzetta*			0.127 (13)	0.069 (3)	0.185 (4)	
Grey Heron	*Ardea cinerea*	0.317 (7)	0.264 (7)	0.566 (59)	0.416 (18)	0.277 (6)	0.462 (16)
Mute Swan	*Cygnus olor*		0.491 (7)	0.370 (21)	0.118 (2)	0.092 (1)	0.607 (6)
Whooper Swan	*C. cygnus*			0.024 (1)			
Teal	*Anas crecca*			0.008 (1)			
Mallard	*A. platyrhynchos*	1.269 (9)	0.553 (5)	1.488 (62)	1.848 (28)	0.969 (5)	1.944 (18)
Tufted Duck	*A. fuligula*		0.038 (1)				
Coot	*Fulica atra*					0.046 (1)	
Moorhen	*Gallinula chloropus*	0.091 (2)	0.295 (8)	0.094 (9)	0.024 (1)	0.046 (1)	0.219 (6)
Snipe	*Gallinago gallinago*			0.031 (3)	0.115 (4)		0.049 (1)
Green Sandpiper	*Tringa ochropus*			0.008 (1)	0.024 (1)		
Common Sandpiper	*Actitus hypoleucos*			0.008 (1)	0.023 (1)		
Black-headed Gull	*Larus ridibundus*			0.211 (7)			
Kingfisher	*Alcedo atthis*	0.045 (1)	0.074 (2)	0.068 (8)	0.188 (6)	0.092 (2)	0.024 (1)
Sand Martin	*Riparia riparia*	1.994 (9)	1.472 (6)	4.874 (72)	1.016 (14)	1.708 (5)	4.641 (24)
Grey Wagtail	*Motacilla cinerea*	0.635 (10)	0.264 (4)	1.106 (63)	0.824 (19)	0.508 (7)	0.948 (16)
Dipper	*Cinclus cinclus*	0.181 (4)	0.221 (5)	0.055 (7)	0.231 (9)	0.277 (6)	0.194 (7)
Sedge Warbler	*Acrocephalus schoenobaenus*	0.227 (5)	0.076 (2)	0.051 (6)			
Reed Bunting	*Emberiza schoeniclus*			0.127 (10)	0.047 (2)		

Boyne

species		Blackwater (Kells)	Blackwater (Longwood)	Boyne	Deel	Mattock	Stoneyford
Great Crested Grebe	*Podiceps cristatus*				0.069 (1)		
Little Grebe	*Tachybaptus ruficollis*	0.022 (1)		0.052 (3)			
Cormorant	*Phalacrocorax carbo*	0.284 (6)		0.642 (28)	0.034 (1)		
Little Egret	*Egretta garzetta*	0.065 (2)		0.037 (3)		0.236 (2)	
Grey Heron	*Ardea cinerea*	0.349 (12)	0.175 (4)	0.315 (22)	0.206 (5)	0.473 (5)	0.236 (5)
Mute Swan	*Cygnus olor*	0.720 (9)	0.307 (4)	1.259 (26)	1.200 (13)		0.330 (1)
Whooper Swan	*Cygnus cygnus*	0.109 (3)		0.100 (1)	0.064 (1)		
Teal	*Anas crecca*	0.458 (8)	0.307 (3)	0.164 (6)	0.225 (4)		
Mallard	*A. platyrhynchos*	2.29 (21)	0.526 (6)	1.43 (45)	1.234 (9)	2.600 (8)	1.179 (7)
Coot	*Fulica atra*	0.174 (3)		0.015 (1)	0.064 (1)		
Moorhen	*Gallinula chloropus*	1.112 (26)	0.219 (5)	1.419 (48)	0.720 (13)	0.394 (4)	0.377 (7)
Water Rail	*Rallus aquaticus*				0.064 (2)		
Golden Plover	*P. apricaria*	4.362 (1)	2.632 (1)				3.066 (1)
Lapwing	*Vanellus vanellus*	0.087 (1)		0.012 (1)	0.069 (1)	0.079 (1)	0.047 (1)
Snipe	*Gallinago gallinago*	0.938 (21)	0.307 (4)	0.314 (15)	0.804 (9)		0.094 (2)
Curlew	*Numenius arquata*			0.012 (1)			
Green Sandpiper	*Tringa ochropus*	0.174 (5)	0.045 (1)	0.037 (2)	0.096 (3)		
Common Sandpiper	*Actitus hypoleucos*	0.065 (2)		0.06 (4)	0.032 (1)		
Black-headed Gull	*Larus ridibundus*	0.174 (5)		0.325 (5)	0.034 (1)		1.321 (1)
Herring Gull	*Larus argentatus*	0.022 (1)	0.044 (1)	0.249 (2)			
Great Black-backed Gull	*Larus marinus*			0.412 (1)			
Kingfisher	*Alcedo atthis*	0.196 (7)	0.182 (4)	0.197 (14)	0.171 (5)	0.236 (3)	0.283 (5)
Sand Martin	*Riparia riparia*	2.334 (15)	1.886 (11)	3.895 (47)	3.634 (15)	0.788 (3)	1.132 (4)
Grey Wagtail	*Motacilla cinerea*	0.589 (15)	0.439 (6)	0.225 (13)	0.354 (7)	1.340 (9)	0.330 (3)
Dipper	*Cinclus cinclus*	0.131 (6)		0.060 (3)			
Sedge Warbler	*Acrocephalus schoenobaenus*	0.502 (15)	0.088 (1)	0.170 (7)	0.446 (7)	0.079 (1)	0.142 (3)
Reed Bunting	*Emberiza schoeniclus*	0.174 (5)	0.307 (2)	0.262 (11)	0.686 (9)		0.189 (2)

Appendix 7. Maximum densities of birds occurring on OPW channels surveyed in 2009.

Note that species which occurred in the highest numbers in each river are highlighted in bold type. Kingfisher records are highlighted in red.

1. Bonet

species	C1(SectD)	C1/1	C1/1/1	C1/1/2SectA	C1/1/2SectB	C1/1/2SectC
Mute Swan	1.57					
Mallard	0.78		1.57	2.50	42.11	6.27
Pheasant	1.57	1.57	2.50	3.14	10.53	10.53
Grey Heron	0.78				0.78	
Kestrel				1.25		
Peregrine					10.53	1.25
Snipe			0.78		1.25	
Common Sandpiper	0.78					
Lesser Black-backed Gull				0.78	10.53	
Woodpigeon	10.98	4.71	2.50	9.41	21.05	10.53
Collared Dove		0.78				
Cuckoo		1.25	1.25	2.50	10.53	0.78
Swift	3.14					1.25
Kingfisher	**1.57**					
Skylark		0.78	1.57		63.16	63.16
Sand Martin	14.90				1.25	
Swallow	**18.82**	**7.50**	**17.50**	**18.75**	**273.68**	**242.11**
House Martin		6.25	6.25	3.92		10.53
Meadow Pipit	**9.41**		**5.49**	**5.49**	**242.11**	**305.26**
Grey Wagtail	3.92				21.05	
Pied Wagtail	1.57		0.78			
Dipper	1.57			0.78		1.25
Wren	**21.18**	**11.25**	**8.75**	**10.00**	**231.58**	**94.74**
Dunnock	3.92	3.75	1.57	7.84	52.63	52.63
Robin	**10.20**	**11.25**	**8.75**	**21.18**	**136.84**	**42.11**
Stonechat					2.50	21.05
Blackbird	**18.82**	**8.75**	**11.25**	**16.25**	**178.95**	**42.11**
Song Thrush	**3.92**	**6.25**	**5.00**	**11.76**	**136.84**	**10.53**
Mistle Thrush		2.35	5.00	3.14	73.68	
Grasshopper Warbler					10.53	
Sedge Warbler	3.14		2.50		31.58	73.68
Reed Warbler						1.25
Blackcap	1.57	3.14	0.78	3.92	31.58	0.78
Whitethroat	0.78	1.25			2.50	2.50
Chiffchaff		1.25	1.57	1.25	31.58	
Willow Warbler	**16.47**	**11.25**	**11.25**	**16.47**	**252.63**	**94.74**
Goldcrest	7.84	8.75	5.00	1.25	63.16	
Long-tailed Tit	3.14		1.25		3.75	52.63
Blue Tit	3.14	10.20	8.75	10.00	84.21	10.53
Great Tit	3.14	7.06	4.71	8.75	21.05	10.53
Coal Tit	0.78	11.25	13.75	12.55	63.16	21.05
Jay		0.78				
Magpie	0.78	1.25		3.75	10.53	0.78
Jackdaw	0.78			1.25	25.00	
Rook	9.41		0.78	15.00	52.63	1.25
Hooded Crow	2.35			1.25		
Starling	10.20		3.75	6.25	1.25	0.78
House Sparrow				1.57		
Chaffinch	**25.10**	**27.50**	**18.75**	**31.25**	**115.79**	**31.58**
Greenfinch		0.78	1.25	5.49	42.11	3.75
Goldfinch	**9.41**	**12.50**	**3.75**	**3.75**	**115.79**	**21.05**
Siskin	0.78					
Linnet	0.78		1.57		10.53	31.58
Redpoll	9.41				84.21	21.05

Bullfinch	1.57	0.78	1.25	1.57	94.74	1.25
Yellowhammer						1.57
Reed Bunting	3.14			2.50	73.68	63.16

2. Boyle

species	C1/24(SectB)	C1/24SectA
Mute Swan	1.57	6.25
Teal		5.49
Mallard		14.12
Pheasant	0.78	
Grey Heron		2.50
Kestrel		1.25
Moorhen		3.75
Snipe	1.57	5.49
Curlew		12.50
Black-headed Gull		12.50
Common Gull		1.25
Lesser Black-backed Gull	1.57	1.25
Woodpigeon	0.78	
Cuckoo		0.78
Swift	0.78	
Skylark		12.50
Sand Martin		18.75
Swallow	11.76	11.76
House Martin	8.63	
Meadow Pipit	**3.92**	**37.50**
Wren	**6.27**	**32.50**
Dunnock	0.78	1.57
Robin	2.35	3.75
Stonechat		1.25
Blackbird	6.27	10.00
Song Thrush		1.25
Mistle Thrush	2.35	2.50
Grasshopper Warbler		2.50
Sedge Warbler	**3.14**	**21.25**
Reed Warbler	1.57	1.25
Whitethroat	0.78	3.14
Willow Warbler	**8.63**	**22.75**
Goldcrest	2.35	7.50
Long-tailed Tit		0.78
Blue Tit		6.25
Great Tit		0.78
Coal Tit		8.75
Jackdaw	1.57	
Rook	2.35	1.57
Hooded Crow		1.25
Starling		6.25
Chaffinch		10.98
Greenfinch		2.50
Goldfinch		5.00
Linnet	1.57	2.50
Redpoll		7.50
Bullfinch		2.50
Reed Bunting	**1.57**	**23.75**

3. Cappaghmore

species	C1/2	C1/3	C1/3/*	c1/3/1	c1/3/3
Mallard		2.35			
Pheasant		2.35	0.78		
Grey Heron				0.78	
Kestrel				0.78	
Woodpigeon	**1.57**	**25.88**	**6.27**	**12.55**	**5.49**
Swift	0.78			1.57	
Swallow	**7.06**	**7.06**	**0.78**	**6.27**	**7.84**
Meadow Pipit		7.06	1.57	3.14	
Wren	**3.92**	**7.84**	**4.71**	**6.27**	**1.57**
Dunnock	3.14	0.78		2.35	0.78
Robin	**4.71**	**9.41**	**7.06**	**7.06**	**2.35**
Stonechat				4.71	0.78
Blackbird	**7.84**	**15.69**	**4.71**	**8.63**	**4.71**
Song Thrush		2.35	1.57	3.14	2.35
Mistle Thrush		0.78			
Sedge Warbler				0.78	
Blackcap				0.78	
Whitethroat				1.57	
Chiffchaff	1.57			0.78	
Willow Warbler	**1.57**	**2.35**	**1.57**	**5.49**	**3.14**
Goldcrest	1.57	3.14	2.35	3.14	
Blue Tit	1.57	3.92	1.57	3.14	0.78
Great Tit	1.57	0.78	1.57	0.78	
Coal Tit	1.57	7.84	3.92	0.78	0.78
Magpie	1.57	0.78	0.78	2.35	
Rook	0.78	5.49	0.78	0.78	
Raven	0.78				
Starling	0.78	16.47			1.57
House Sparrow	0.78				
Chaffinch	**3.14**	**18.82**	**10.98**	**7.84**	**5.49**
Greenfinch			0.78		
Goldfinch		0.78	0.78	2.35	
Linnet	0.78				0.78
Bullfinch		0.78	0.78	0.78	0.78
Reed Bunting		0.78	0.78		2.35

4. Deel

species	C2	C23/2
Mallard		5.49
Pheasant		1.57
Grey Heron		1.25
Kestrel	0.78	
Coot	0.78	
Curlew		1.57
Common Gull		3.75
Woodpigeon	11.76	22.50
Skylark		8.75
Swallow	**16.25**	**82.50**
Meadow Pipit	5.00	13.75
Grey Wagtail	1.57	2.50
Wren	**26.25**	**70.00**
Dunnock	3.75	13.75
Robin	15.69	27.50
Stonechat		2.50
Blackbird	**25.00**	**52.50**
Song Thrush	7.06	18.75
Mistle Thrush	5.00	3.75
Sedge Warbler		2.35
Blackcap	5.49	2.50
Whitethroat	3.92	
Chiffchaff	**18.75**	**33.75**
Willow Warbler	**21.25**	**21.25**
Goldcrest	**18.75**	**31.25**
Long-tailed Tit	13.75	27.50
Blue Tit	**13.75**	**51.25**
Great Tit	7.06	12.50
Coal Tit	**17.25**	**31.25**
Treecreeper	0.78	
Jay	0.78	
Magpie	11.25	21.25
Jackdaw	18.04	12.50
Rook	**27.45**	**81.25**
Hooded Crow	10.98	
Raven		2.50
Starling	0.78	3.75
Chaffinch	**30.59**	**71.25**
Greenfinch	6.27	3.92
Goldfinch	4.71	5.49
Linnet	2.35	3.14
Bullfinch	4.71	10.00

5. Deel (Boyne)

species	C1/37/15
Pheasant	7.50
Sparrowhawk	0.78
Kestrel	0.78
Moorhen	1.25
Woodpigeon	28.75
Kingfisher	**0.78**
Swallow	**37.50**
Meadow Pipit	**33.75**
Wren	**42.50**
Dunnock	17.50
Robin	**32.50**
Whinchat	1.25
Blackbird	18.75
Song Thrush	17.50
Mistle Thrush	4.71
Sedge Warbler	3.75
Blackcap	11.25
Chiffchaff	7.50
Willow Warbler	**35.00**
Goldcrest	16.25
Long-tailed Tit	20.00
Blue Tit	7.84
Great Tit	2.50
Coal Tit	10.00
Magpie	16.25
Jackdaw	8.63
Rook	**105.00**
Hooded Crow	3.75
Raven	1.57
Starling	3.75
House Sparrow	1.57
Chaffinch	**32.50**
Goldfinch	13.75
Linnet	1.25
Redpoll	1.25
Bullfinch	8.75
Yellowhammer	1.25
Reed Bunting	5.00

6. Inny

species	C2	C7/2A	C7/3
Mute Swan	2.50		
Mallard	1.57		
Pheasant	3.75	0.78	0.78
Grey Heron	3.75		
Sparrowhawk			0.78
Moorhen	1.57		
Snipe	0.78		
Black-headed Gull	0.78		
Woodpigeon	6.27	7.06	13.33
Swift			4.71
Skylark	10.98	2.35	5.49
Swallow	26.25	24.31	13.33
House Martin	1.25		
Meadow Pipit	**13.75**	**5.49**	**14.90**
Grey Wagtail			1.57
Pied Wagtail			1.57
Wren	**8.63**	**10.98**	**35.29**
Dunnock	3.75	3.14	8.63
Robin	**10.20**	**7.84**	**14.12**
Blackbird	**11.25**	**17.25**	**29.80**
Song Thrush	8.75	7.84	7.06
Mistle Thrush	1.57	1.57	2.35
Grasshopper Warbler	1.25		
Sedge Warbler	5.00		
Reed Warbler	1.25		
Blackcap		1.57	0.78
Whitethroat	1.57		0.78
Chiffchaff	4.71	3.14	2.35
Willow Warbler	**25.10**	**15.69**	**21.18**
Goldcrest	**3.75**	**20.39**	**16.47**
Long-tailed Tit	1.25	3.92	5.49
Blue Tit	**5.49**	**10.98**	**9.41**
Great Tit	0.78	2.35	2.35
Coal Tit	3.14	3.92	3.14
Magpie	0.78	1.57	3.14
Jackdaw			4.71
Rook		**5.49**	**16.47**
Hooded Crow	2.50		6.27
Starling		**327.84**	**20.39**
House Sparrow		0.78	7.06
Chaffinch	**16.25**	**14.90**	**17.25**
Greenfinch	1.25	2.35	1.57
Goldfinch	8.75	5.49	6.27
Linnet	3.75	9.41	5.49
Bullfinch		0.78	2.35
Reed Bunting	3.14	1.57	0.78

7. Moy

species	C1/21/7/1	C1/21/7/1/2
Mallard	3.14	5.00
Grey Heron	1.25	1.25
Snipe	0.78	
Common Gull	1.57	1.25
Woodpigeon	8.63	6.27
Cuckoo	1.25	0.78
Kingfisher		**0.78**
Skylark	3.75	6.25
Sand Martin		2.35
Swallow	**50.00**	**33.75**
Meadow Pipit	**17.50**	**28.75**
Grey Wagtail	1.25	
Pied Wagtail		2.50
Wren	**26.25**	**36.25**
Dunnock	3.75	2.50
Robin	11.25	20.00
Stonechat		0.78
Blackbird	**26.25**	**13.75**
Song Thrush	3.14	2.50
Mistle Thrush	1.25	1.25
Sedge Warbler	1.25	2.35
Blackcap	2.50	3.75
Whitethroat	2.50	
Willow Warbler	**37.50**	**20.39**
Goldcrest	15.00	8.75
Long-tailed Tit	5.00	2.50
Blue Tit	**10.00**	**17.50**
Great Tit	1.57	8.75
Coal Tit	11.25	8.75
Magpie	6.25	7.50
Jackdaw		**16.47**
Rook	1.25	13.75
Hooded Crow	2.50	5.00
Raven		2.50
Starling		13.75
Chaffinch	**26.25**	**36.25**
Greenfinch	3.75	3.75
Goldfinch	**5.00**	**17.50**
Linnet	10.00	2.50
Redpoll		7.50
Bullfinch	1.25	6.25
Reed Bunting	1.57	3.75