Assessment of the distribution and abundance of Kingfisher *Alcedo atthis* and other riparian birds on six SAC river systems in Ireland



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Summary

- Six river systems, namely the Barrow, Blackwater (Munster region), Boyne, Clare, Moy and Nore, all designated as Special Areas of Conservation (SAC) formed the basis for this survey.
- Observers aimed to cover all the main channels along with all tributaries feeding into the main system (both SAC and non SAC). Three visits were made to each system between 15 March – 1 Jun 2010.
- In addition, two smaller systems, the Gill (Co. Leitrim) and the Ilen (Co. Cork) were surveyed by NPWS Conservation Rangers.
- Most fieldwork was carried out between 08:00 and 18:00, and all waterways bird species seen or heard were recorded. Observations by boat or on foot involved collecting birds and habitat data every 500m.
- Grid references of the locations of any Kingfishers seen or heard were noted as were the locations of any nest holes deemed active, inactive or unknown.
- A maximum length of 941 km divided into 2,004 sections was covered across the eight river systems. The Blackwater (Munster) system surveyed was the longest river system surveyed (265 sections totalling 218km) while the Ilen in Cork was the shortest in total length surveyed (25 sections totalling 12km). The average length of river system surveyed was just less than 119km.
- A total of 25 waterways bird species were recorded, with the highest total of 21 species on both the Blackwater (Munster) and Boyne systems. Sand Martin *Riparia riparia* was the most abundant species on both systems, with Mallard *Anas platyrhynchos* also plentiful.
- Vertical nesting banks of 1-2m in height were more common on sections with Kingfishers, as expected and overall the proportion of banks on sections with Kingfishers was greater, in particular banks greater than 10m in length.
- A total of 16 – 22 territories were identified on the Nore (densities of 0.10-0.14 territories/km) and 15-19 territories on the Boyne (densities of 0.09-0.12 territories/km). On the Moy and Clare systems densities ranged from 0.11-0.12 territories/ km to 0.07-.0.08 territories/km respectively. Lowest densities were recorded on the Barrow (0.04-0.08 territories/km) and Blackwater (Munster) systems (0.05 territories/km).
- The territories identified using both boat and walked transect methodologies along the six chosen river systems surveyed in 2010 will inform the Special Protection Area designation process, with regards to Kingfisher (*Alcedo atthis*).
- Supplementary information on other waterways species, in particular the location of breeding colonies of Sand Martin, should also prove useful.

Introduction

One of the most important features of Ireland's waterways is the biodiversity that they support, and many are designated under the Birds * and Habitats Directives** (i.e. Special Protection Areas and Special Areas of Conservation) and the Wildlife Act 2000 (Natural Heritage Areas). A number of species of European significance occur on our waterways including the Kingfisher *Alcedo atthis,* listed on Annex I of the EU Birds Directive, Freshwater Pearl Mussel *Margaritifera margaritifera*, White-clawed Crayfish *Austropotamobius pallipes* and Otter *Lutra lutra* along with five fish species listed on Annex II of the Habitats Directive (O'Keeffe and Dromey 2004). Waterways are also used extensively by riparian birds including the Dipper *Cinclus cinclus* and Grey Wagtail *Motacilla cinerea*, while bordering vegetation and habitat supports a range of other bird species, including Sedge Warbler *Acrocephalus schoenobaenus* and Reed Bunting *Emberiza schoeniclus*.

Protection of waterways is fundamental to the success of the above species, and many other flora and fauna that depend on riparian habitats. There are huge pressures on Ireland's Waterways which include arterial drainage works, recreational activities, alien species, peat extraction, gravel extraction, pollution including increased nutrients from agriculture, industry, forestry (including the impact of siltation), illegal dumping, drainage of river beds or banks, overfishing, predation (particularly from American Mink *Mustela vison*) and creation of dams or weirs.

To date, a number of Special Areas of Conservation (SACs) have been proposed for designation under the EU Habitats Directive for several Annex II species listed previously (Moorkens 2000, O'Keeffe and Dromey 2004). Historically there has been very little information available on the current range of, and trends in, waterways bird species in Ireland. No sites in Ireland have been formally designated for waterways species, despite the legal requirements for some species i.e. the Annex I listed Kingfisher. This issue was raised in the European Court of Justice ruling against Ireland (December 2007).

Between 2006 and 2008, joint projects of the National Parks and Wildlife Service, the Office of Public Works and BirdWatch Ireland on waterways birds were carried out. These surveys were focussed on investigating the most appropriate methodology for surveying waterways birds, gathering information on their distribution (particularly with respect to habitat characteristics), compiling records of Kingfisher held by the public, comparing results with previous national surveys (breeding atlases), and evaluating the impacts of statutory arterial drainage maintenance activities on waterways birds. The results of this work are presented in Thomas *et al*. (2007) and Crowe *et al.* (2008).

The principal objective of this survey in 2010 was to quantify the distribution and densities of Kingfisher and other waterways birds throughout six SAC river systems. These SAC river systems were selected for survey as they are:

1. SACs with defined boundaries
2. large enough to support high numbers of Kingfisher, and
3. reasonably widespread, and represent a geographical spread across the country.

Methods

The scientific names of all riparian species recorded are presented in Table 3a, and of all other species where first mentioned in the text.

Study location

Initially six river complexes, hereafter referred to as river systems, which were known to support Kingfisher, were selected for survey. These river systems are:

- The River Boyne and River Blackwater (SAC code 2229), situated predominantly in County Meath, and partially in neighbouring counties, is hereafter referred to as the Boyne system.
- The Blackwater (SAC code 2170), located in Counties Cork and Waterford, hereafter referred to as the Munster Blackwater system.
- The River Moy (SAC code 2298) is situated predominantly in Co. Mayo although parts are in west Sligo and north Roscommon.

- The River Clare (SAC code 297), included under the designation for the Lough Corrib candidate SAC, located in County Galway.
- The River Barrow (SAC code 2162), flows through seven counties Offaly, Kildare, Laois, Carlow, Kilkenny, Wexford and Waterford.
- The River Nore (SAC code 2162), flows through Tipperary, Laois and Kilkenny before joining the River Barrow.

Additional data were supplied by NPWS Conservation Rangers for two additional systems, namely:

- The Gill System (The Bonet River in Leitrim) (SAC Code 001976).
- The Ilen (Cork) (undesignated).

Coverage

Rivers were surveyed either on foot or by boat depending on a number of factors including, accessibility and terrain, ease of navigation, surveyor availability, water levels and time constraints. The upper sections of the rivers were usually walked as the rivers in these sections tended to be narrower and shallower and would have been more difficult to navigate by boat. Where possible river sections that were surveyed on foot were repeated on foot, and those covered by boat were repeated by boat. A variety of boat types were used, including rubber dinghy (Munster Blackwater and Bride, single person), Canadian canoe (River Moy, Nore and Barrow, two people) or double kayak (River Boyne and Barrow, two people). On the Gill system, two single kayaks were used.

Observers aimed to cover the main SAC river stretches of all systems, as well as a number of their tributaries. Two of the rivers surveyed were of the same name, namely the River Blackwater (Kells) on the Boyne system and River Blackwater in Cork. These are hereafter referred to as the Blackwater (Boyne) and the Munster Blackwater respectively.

Field methods

In general breeding bird survey methodology requires a minimum of two bird count visits (Bibby 2000) which are carried out during early and late periods of the breeding season, to increase the chances of detection of early and late migrant species, and to improve estimates of resident species. Most breeding bird surveys which employ transect methodology are based on two visits, one in each of these periods (Coombes *et al*. 2006, Raven & Noble 2006, Thomas *et al*. 2007). This methodology was applied during previous riparian bird surveys whereby two visits were made to each river system between March and June.

It was intended that three visits be undertaken in 2010, between 15 March and 11 April, 12 April and 6 May and 7 May and 1 June, to maximise the chance of recording Kingfisher, and to improve the definition of Kingfisher territories. Poor weather conditions during the early part of the survey meant that several survey days were lost in visit 1, which prolonged this and subsequent visits marginally.

The same standard transect survey methodology used in 2008 (Crowe *et al*. 2008) was used. Rivers were divided into 500m sections during the first visit, and were closely followed in subsequent visits, making data comparable between visits. Sections on most rivers were defined using hand held GPS units (Garmin GPS model 60cx usually showing an accuracy of less than 15m). A waypoint (a ten figure grid reference) was recorded at the start and end of each transect.

The 500m sections surveyed during the boat-based survey of the Munster Blackwater were determined prior to this year's survey. Each (six figure) grid reference was calculated from the Discovery Series Ordnance Survey maps (accurate to 100m). Since the rivers concerned (Blackwater and Bride) run west to east (with occasional meanders north and south), the boat survey was conducted from west to east in order to avail of the current. A Garmin GPS mounted on the stern of the boat was used to establish these reference points in 2010.

Due to the density of the vegetation or the steepness of the terrain it was not always possible to access the river on foot. Thus, it was occasionally necessary to omit sections or parts of sections, and deviations from defined start and end waypoints had to be made. Usually these were short stretches, and discrepancies were small. In addition, in order to avoid overlapping sections, the

final section of a survey period was often cut short (i.e. less than 500m) as one surveyor finished where another started.

Most fieldwork was carried out between 08:00 and 18:00. Observers recorded all waterways bird species seen or heard while walking along banks (foot-based survey) or while paddling downstream (boat-based survey).

Grid references (10 digit) of the locations of Kingfishers seen or heard were recorded, and likewise for the location of all possible nest holes. Nest holes were categorised as active when Kingfisher activity was reported near the hole and/ or fresh droppings were present at the entrances. Most grid references were taken either from the bank or from the centre of the river opposite the bird, nest or bank feature being reported on. Observers also recorded habitats and pressures and threats using standard dataforms. Examples of these forms are presented in Appendix 1a & b.

A detectability code was assigned for each section during walked transects, which provided an indication of how accessible and visible each section of river was during each visit. 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).

Figure 1. Illustrations of methods used in 2010, including bird foot and boat-based survey work (Canadian canoe bottom left, and double kayak bottom right).
Photos by Jackie Hunt, Ruth Gaj McKeever and Laura McNaghten.

River properties

Habitat

Habitats were recorded for each 500m section. Information on the characteristics of the river, of adjacent banks, and of surrounding habitats was recorded. Observers also noted whether or not the waterways were suitable for Kingfishers (i.e. slow-flowing, with perches available for fishing, see Fig. 2) and whether suitable Kingfisher nesting banks (tall vertical banks with soft material into which they can dig their burrows) were present. The extent of suitable nesting banks was defined for each section as 1 (less than 10m of suitable bank), 2 (10-100m of suitable bank) or 3 (more than 100m of suitable bank).

Figure 2. Suitable nesting bank with a well used perch on the River Nore.
Photo by Ruth Gaj McKeever.

Pressures and threats

Information on possible pressures and threats to the watercourse were also recorded and were based on a comprehensive list drafted for the purpose of Article 17 reporting under the EU Habitats Directive. This list was tailored to account for likely pressures and threats occurring along waterways, some of which may impact on birds, and an example of the form used is presented in Appendix 1b. Pressures and threats were recorded for all sections in at least one visit.

Potential sources of bias

There was some variation in the pressure and threats recorded in sections of rivers covered by boat and on foot as different views were afforded by each method. Likewise habitat data may also vary in those sections of river covered by boat and on foot as surrounding habitat may not always have been clearly seen from the boat with steep banks often obscuring views. Moreover, boat-based observers were better able to view both banks, and would have an improved probability of finding nest holes. The estimation of bank sizes was subjective as the boat afforded different views than surveying on foot on the bank. In some cases, there was also variation in tidal sections of river as a result of the various times that sections were surveyed (e.g. high/low tide) with, some differences in estimates of river vegetation as a result. Despite these methodological differences, it was expected that the probability of detecting Kingfisher would have been improved by the three-visit approach, and that any impacts on the estimation of territories would have been negligible.

Some habitat data varied between walked sections on different visits as there may have been more than two habitats existing in equal proportions thus assumptions as to which habitat was dominant may have differed between visits.

Recommendations for future boat based surveys of riparian birds are outlined in detail in Appendix 4. It is hoped these recommendations will prove invaluable to future boat-based survey work.

Analyses

Proportions of total sections were calculated to illustrate differences in detectability, habitats, pressures and threats between river systems.

The relative abundance of all waterways species was calculated by dividing total counts across all sections in each river and in each visit by the length of river surveyed, and are expressed as birds per kilometre. This measure of relative abundance was used to compare between visits, rivers and river systems. In most cases, only those species considered to be the most widely distributed and abundant on each system were used to illustrate differences.

The number of Kingfisher territories on each river and river system was estimated from the distribution of sightings and nest locations along rivers, and the individual sightings of Kingfishers on all three visits. This process involved examining areas of overlap in sightings and nests and categorising such areas as probable or possible territories. Probable territories were assigned to areas where Kingfishers were seen during earlier visits 1 and 2, and where active nests were identified. Kingfishers were considerably more widely distributed during the last (third) visits, presumably due to dispersing family groups, and it was decided not to include these records in selecting territories. Possible territories were identified by clusters of sightings where no active nest holes were found. Surveyors of these rivers were consulted to ensure that plotted locations of territories were correct. Defining the true extent of territories would require tagging and tracking of individuals, which was beyond the scope of this work.

Results

Coverage

A total of 2,004 sections were covered overall, including 1,870, 1,904 and 1,853 sections during visits 1, 2 and 3 respectively, comprising 919km, 941km and 926km. The extent of coverage is illustrated in Figure 3. While most systems were covered predominantly on foot (Table 1), boats (rubber dinghy, Canadian canoe and/ or double kayak) were used to cover the main river in each system other than the Clare system which was covered entirely on foot. Of the main six river systems covered, the total lengths of river covered ranged between 105 km and 209 sections (maximum covered, visit 3) on the Moy and 218 km and 437 sections on the Munster Blackwater. Full descriptions of coverage of the specific rivers within these systems are given in Appendix 2, while further details about coverage of these rivers are tabulated in Appendix 3.

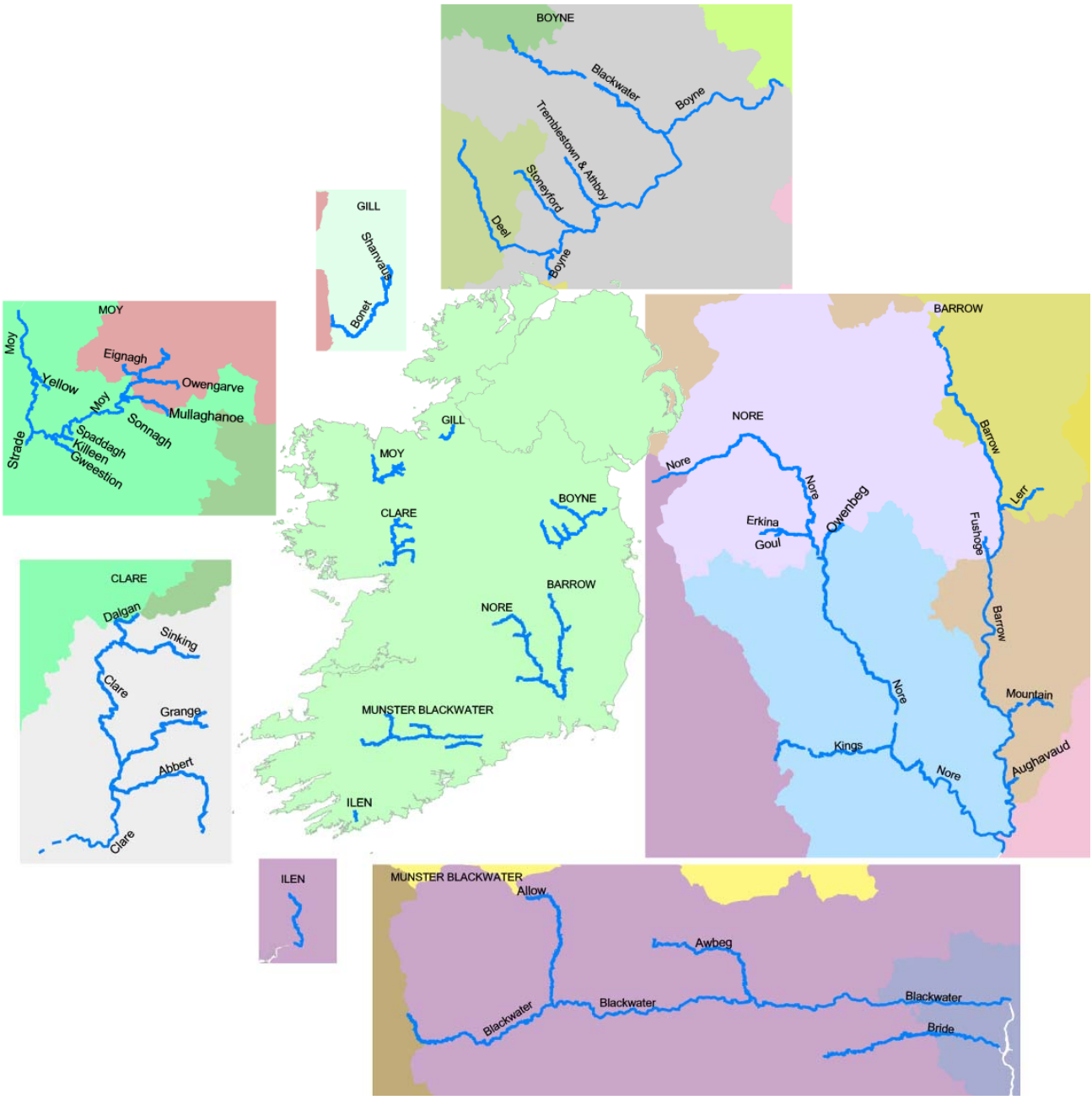


Figure 3. Coverage in 2010 of all eight river systems: Barrow and Nore (Co. Kilkenny & Co. Laois) Blackwater and Ilen (Co. Cork), Boyne (Meath), Clare (Co. Galway), Moy (Co. Mayo) and Gill (Co. Leitrim).

Table 1. Details of coverage during three visits to eight river systems in 2010.
Refer to Appendix 3 for further details specific to the rivers surveyed.

Visit	System	Start date	End date	Number sections	Total length	% Walked	% Dinghy	% Canadian canoe	% Kayak
1	Barrow	23/03/2010	15/04/2010	261	132.6	86.9			13.1
2	Barrow	26/04/2010	07/05/2010	265	134.6	65.1		34.9	
3	Barrow	24/05/2010	01/06/2010	263	133.4	81.5		18.5	
1	Blackwater	15/03/2010	24/03/2010	443	217.4	40.9	59.1		
2	Blackwater	12/04/2010	16/04/2010	437	218.3	36.3	63.7		
3	Blackwater	10/05/2010	17/05/2010	435	217.7	36.1	63.9		
1	Boyne	27/03/2010	03/04/2010	307	155.0	53.4			46.6
2	Boyne	19/04/2010	25/04/2010	308	155.6	53.6			46.4
3	Boyne	17/05/2010	25/05/2010	315	159.0	54.6			45.4
1	Clare	26/03/2010	02/04/2010	294	135.5	100.0			
2	Clare	19/04/2010	28/04/2010	286	131.6	100.0			
3	Clare	13/05/2010	19/05/2010	258	117.8	100.0			
1	Moy	23/03/2010	07/04/2010	208	104.1	37.7		62.3	
2	Moy	28/04/2010	04/05/2010	205	103.6	37.4		62.6	
3	Moy	20/05/2010	30/05/2010	209	104.6	38.0		62.0	
1	Nore	08/04/2010	16/04/2010	277	135.5	100.0			
2	Nore	04/05/2010	10/05/2010	326	159.4	50.8		30.9	18.3
3	Nore	26/05/2010	28/05/2010	296	156.1	51.2		31.3	17.5
1	Gill	15/03/2010	14/04/2010	55	26.9	100.0			
2	Gill	04/05/2010	07/05/2010	55	26.9	54.2			45.8
3	Gill	24/05/2010	31/05/2010	55	26.9	68.9			31.1
1	Ilen	23/03/2010	23/03/2010	25	12.2		100.0		
2	Ilen	29/04/2010	29/04/2010	22	10.6		100.0		
3	Ilen	20/05/2010	20/05/2010	22	10.6		100.0		

Detectability

The vast majority of the sections surveyed on all systems were assigned a detectability score of 1, and thus had good visibility (Fig. 4). The Gill was walked during visit one which resulted in higher proportions of sections that were considered to be poor detectability.

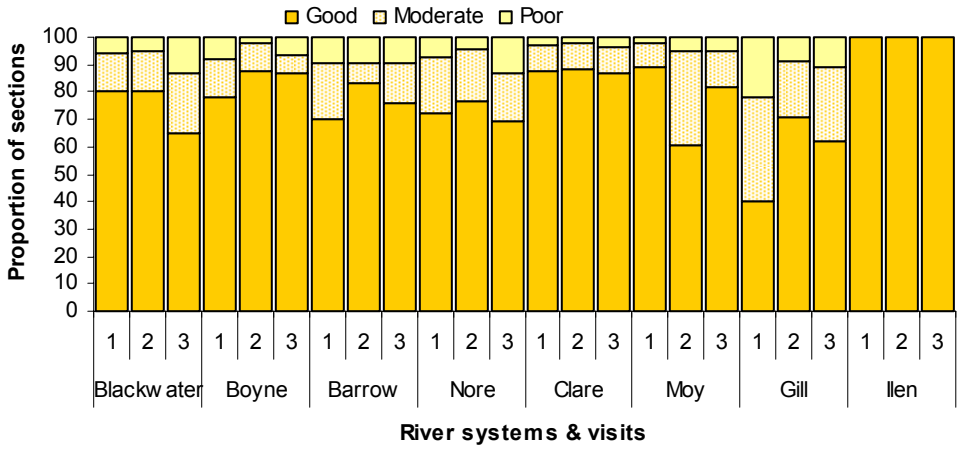


Figure 4. Detectability estimates derived from sections of those systems surveyed.

Habitat, pressures & threats

Riverine Habitats

With the exception of the Ilen, all of the rivers covered as part of this survey were considered to be lowland depositing rivers for the vast majority of sections surveyed (Table 2a). The majority of the Ilen (approximately 60%) was considered to be 'eroding upland river'. The section of river surveyed is intermediate in character between the eroding upland and depositing lowland; while it is lowland and partly meandering across a floodplain, the river bed is mostly stones and bedrock rather than fine sediment.

The speed of water flow was variable on all river systems surveyed. All of the rivers had fast flowing sections but the majority of sections were classified as medium or slow flowing.

Riffles and pools were recorded on all river systems and the percentage of stretches with riffles/pools varied between 21% (on the Clare) and 64% (on the Ilen and Gill). Small Islands were also present on all systems surveyed except the Ilen. The Barrow, Blackwater and Gill systems all had proportionally more islands. The Barrow, Boyne, Clare, Moy, Gill and Nore had emergent vegetation in the majority of sections surveyed, while the Blackwater and the Ilen had no emergent vegetation in the majority of sections surveyed.

Table 2a. Habitat characteristics of the rivers surveyed. For each characteristic, the percentages of sections reported in each system during visit 1 are given.

	Habitat characteristic	Blackwater	Boyne	Barrow	Nore	Clare	Moy	Gill	Ilen
RIVERS	Canal			1.9					
	Depositing lowland river/ stream	77.7	96.7	88.1	76.4	85.2	88.3	90.9	36.0
	Eroding/ upland river	22.1	3.3	10.0	23.6	14.8	11.7	9.1	64.0
	Industrial activity	2.0	5.9	5.8	3.3		0.5	5.5	12.0
	Small islands	23.3	13.7	24.2	17.0	5.2	2.9	25.5	
	River (>3m wide)	99.1	96.4	88.8	96.7	97.6	99.0	94.5	100.0
	Stream (<3m wide)	0.5	3.9	11.2	3.0	2.1	1.0	9.1	
	Fast-flowing	17.8	12.7	22.3	25.1	26.1	27.2	12.7	
	Medium flow	47.2	44.4	44.2	45.8	45.4	20.9	18.2	64.0
	Slow-running	38.6	43.1	34.6	29.5	28.5	51.0	70.9	36.0
	Riffles/ pools	56.7	35.3	33.5	40.2	21.0	35.4	63.6	64.0
	Fringe vegetation (>2m wide & 2m linear length)	28.2	22.2	38.8	24.7	41.6	27.2	9.1	
	No emergent vegetation	60.5	11.8	20.0	24.0	29.2	36.9	38.2	88.0
	Some fringe vegetation (<2m wide &/or <2m linear length)	9.7	65.7	41.2	50.6	27.8	35.4	52.7	12.0
BANKS	Bank >2m sloped	2.9	30.4	17.3	3.0	19.6	34.5	1.8	
	Bank >2m vertical	1.6	5.6	1.5	3.3	4.5	1.0	7.3	24.0
	Bank 1-2m sloped	58.7	22.5	10.4	28.8	47.8	36.9	20.0	
	Bank 1-2m vertical	15.3	10.5	7.3	35.8	9.6	8.3	29.1	64.0
	Bank under 1m	20.8	31.0	63.5	28.4	17.9	15.5	41.8	
	Banks unvegetated	15.6	11.1	13.1	27.3	4.5	20.4	80.0	
	Banks vegetated	83.7	88.9	86.9	72.7	95.9	93.2	21.8	88.0
	Top of banks unvegetated	18.1	1.0	1.5	1.8			5.5	
	Top of banks vegetated	81.0	99.0	98.5	96.3	99.7	46.6	87.3	88.0
	Mixed scrub/ trees	56.0	45.8	43.1	58.7	8.2	31.6	20.0	
	Open grass/ herb layer	76.7	95.1	85.0	84.1	94.8	79.6	54.5	88.0
	Riparian woodland	41.8	23.2	46.5	26.9	1.7	42.2	34.5	88.0
	Scrub	11.5	10.8	5.8	10.7	16.8	18.0	30.9	
	Dense vegetation	64.1	94.1	98.1	91.9	96.6	61.2	50.9	88.0
	Sparse vegetation	35.4	2.3	1.9	2.2		37.4	49.1	
SURROUNDING	Broadleaf woodland	37.7	19.3	18.1	16.2	4.8	4.9	10.9	
	Coniferous woodland	3.6	1.6	2.7	0.4	2.7	12.1	16.4	
	Farmland - arable/ horticulture	11.3	12.4	18.1	5.5	1.4			
	Farmland - improved grassland	62.1	69.3	54.2	87.1	50.9	36.4	45.5	84.0
	Heathland/ bog	0.5	2.6	0.8	3.7	4.8			
	Human (buildings, gardens, parks, roads, rubbishtips)	15.1	17.0	29.6	20.3	1.0	20.9	9.1	16.0
	Mixed woodland	5.0	8.8	22.3	10.3	1.4	4.4	5.5	
	Scrubland	18.3	10.1	13.5	6.3	22.7	20.9		
	Semi-improved grassland	27.3	48.7	30.8	25.5	61.2	57.8	49.1	

Table 2b. Pressures and threats identified. For each characteristic, the percentages of sections reported in each system during visit 1 are given.

Code	Activity	Blackwater	Boyne	Barrow	Nore	Clare	Moy	Gill	Ilen
A04	Grazing	60.6	46.8	50.2	72.2	52.1	46.4	73.7	
A04.01.01	Intensive cattle grazing	57.3	49.0	15.0	36.1	14.3	2.6	23.7	95.5
A04.01.02	Intensive sheep grazing	0.7	27.1	11.9	4.0	18.2	2.6	21.1	
A04.01.03	Intensive horse grazing	3.0	7.4	5.1	7.6	9.3			
A04.01.04	Intensive goat grazing	0.2	1.9			0.7			
A04.01.05	Intensive mixed animal grazing	1.4	11.6	4.3	0.7	16.4	17.2		
C01.01.01	Sand and gravel quarries	0.2	4.5	3.2	0.3	0.4			
D01.01	Paths, tracks, cycling tracks	18.9	47.4	79.1	38.7	21.1	34.9	2.6	
D01.02	Roads, motorways	23.5	41.9	59.3	46.4	23.9	19.3	26.3	
D01.03	Car parks and parking areas	2.8	13.5	33.6	18.5	2.9	7.8		
D01.05	Bridge, viaduct	17.0	28.1	28.5	28.1	32.1	19.3	28.9	
E02	Industrial or commercial areas	3.3	10.6	16.2	12.6	1.8	1.6	2.6	4.5
G01.01.01	Motorized nautical sports		1.3	28.1	1.7	0.4	2.6		
G01.01.02	Non-motorized nautical sports	4.2	29.0	2.8	8.9	18.6	35.9		
G05.01	Human trampling, overuse	4.2	15.5	36.4	14.6	2.5	5.7		
H01.05	Pollution due to agricultural/ forestry	11.0	56.5	9.9	16.2	35.4	14.6		
H01.08	Pollution due to household sewage/ waste waters	8.6	2.6	8.7	3.6	2.9	1.6	2.6	4.5
J02.03.01	Large scale water deviation	2.6	1.6	24.5	2.6	1.1			
J02.05.02	Modifying structures of inland water courses	5.4	16.5	27.7	8.9	4.6	21.9		4.5
J02.06	Water abstractions from surface waters	1.6							
J02.10	Management aquatic/ bank vegetation for drainage	6.8	34.2	47.8	34.4	50.4	4.7		
J02.11.02	Dykes & flooding defense in inland water systems	1.4	5.8	10.3	3.3	3.2		26.3	
J03.01	Reduction or loss of specific habitat features	2.6	14.8	24.5	7.0		6.8		
J03.03	Reduction, lack or prevention of erosion	12.8	12.3	15.4	6.3	6.1	21.4		
K01.01	Erosion	17.0	4.8	1.6	18.5	15.7	37.0	23.7	
K01.02	Silting up	13.8	7.4	22.1	2.6		5.2		

Bank Habitats

There was a lot of variation in bank height along the river systems surveyed. Most banks on the Barrow system were under 1 metre, while the banks on the Boyne, Gill, Moy and Nore were heterogeneous with much variation across the categories assessed (Table 2a). The vast majority of the banks on the Blackwater and the Clare were 1-2 metres and sloped. The banks of all systems were predominantly vegetated except on the Gill where the vertical banks were mostly unvegetated. The 'open grass/ herb layer' was by far the most dominant bankside habitat, and was prevalent on all river systems surveyed.

Figure 5. Selection of habitats, including (from left to right) riparian vegetation along the Mountain River, scrub lining one bank of the upper River Blackwater (Boyne) and low sloping banks surrounded by improved grassland on the upper Barrow.
(photos by Ruth Gaj McKeever)

Surrounding Habitats

Improved and semi-improved grassland habitats were the most common habitats identified as surrounding all river systems surveyed (Table 2a). Arable farmland was the predominant habitat on at least 10% of sections along the Barrow, Boyne and Blackwater. More than 15% of sections of most systems were classified as 'Human', i.e. buildings, gardens, parks, roads and/ or rubbish tips etc. Conifer plantation was most abundant on the Moy and on the Gill (Table 2a), while broadleaf woodland (Fig. 5) was a very abundant habitat along some river systems (on the Blackwater, the Boyne, the Barrow and the Nore) and was completely absent from others (i.e. the Ilen).

Pressures & Threats

Grazing pressure was evident on all of the rivers shown. Intensive cattle grazing (Fig. 6) was the most common type of grazing and was particularly common on the Blackwater, the Nore, the Boyne and the Ilen. Sheep grazing was the next most common grazing type and was common on the Boyne, the Clare, the Gill and the Barrow (Table 2b).

Figure 6. Use of rivers as drinking areas for livestock. The first image illustrates creation of a drinking area for cattle along the River Moy.
(photos by Jackie Hunt & Laura McNaghten)

Pressures and threats associated with transport such as paths/tracks, roads/motorways, bridge/viaduct and car parks appeared to be the most commonly encountered threats to the river

systems. Industrial and commercial activity was recorded on at least 10% of sections on the Barrow, Boyne and Nore.

Motorised nautical sports were prevalent on the Barrow with almost 30% of sections being subject to disturbance of this kind, and largely absent from all of the other river systems. Non-motorised nautical sports were fairly common on the Moy, Boyne and Clare systems. (e.g. 36% of sections on the Moy were affected by this, and was mostly related to fishing.

Pollution due to agriculture and forestry was prevalent, especially on the Boyne and the Clare systems (Table 2b). Pollution due to household sewage and waste waters was most prevalent on the Barrow and Munster Blackwater.

Management for drainage was very common on the Nore, Barrow and Boyne systems. Water deviation was encountered in very few sections, with the exception of the Barrow where water deviation was encountered on 25% of sections surveyed. Modifying structures of watercourses were present along most of the river systems and were common along the Barrow, the Boyne and the Moy. Erosion and erosion prevention were also common on the river systems, particularly on the Moy.

Riparian bird distribution & abundance

A total of 25 waterways bird species were recorded across all systems. The highest total for any system was 21 waterways bird species for both the Blackwater and Boyne systems, 19 species on the Clare System, 18 on both the Barrow and the Nore systems and 17 species on the Moy (Table 3a). Fewer species were recorded on the shorter additional systems, with nine species recorded on the Ilen and 11 species on the Gill (Table 3b).

Of the main river systems surveyed, some 12 species were recorded on all systems. Mean totals (per kilometre) are illustrated in Figure 7. Not surprisingly, numbers of most species per kilometre varied across river systems. Mean Kingfisher abundance ranged between 0.12 birds/km on the Munster Blackwater system and 0.54 birds/km on the Ilen (Table 3a & b), although this result on the Ilen should be treated with caution as the length of river covered was very short (12.2km) compared with the main river systems surveyed.

Sand Martin was the most abundant species recorded on almost all systems. On the Clare system, a mean of 5.9 birds per kilometre was recorded, which was largely influenced by high counts at several colonies along the Grange River during the third visit. The locations of several nesting colonies of Sand Martins were located on the Moy system (Fig. 8). However, Sand Martin was entirely absent from the Ilen, possibly because the stretch surveyed was predominantly eroding and located further upland than most of the other rivers surveyed. Mallard was also relatively abundant on all systems. Reed Bunting was especially numerous on the Moy system owing to a relatively high count of four birds recorded during the second visit on the Sonnagh River, of which only a short stretch was surveyed (1.3km). Black-headed Gull counts along several River Barrow sections were also high during the first visit.

Dipper and Common Sandpiper were present on almost all systems, and mostly on the fast moving tributaries in higher altitudes. Dipper abundance was highest on the Ilen, Blackwater and the Gill systems (Tables 3a & b). Common Sandpipers were recorded in higher numbers on the Ilen and the Moy, with none recorded on the Barrow. The presence of Green Sandpiper on almost all systems was quite remarkable while the absence of Mute Swan from the Moy system was surprising.

Table 3a. Peak and mean relative abundance over all 500m sections of waterways birds on each river system, together with the proportion of sections within each in which each species was recorded.

species		Overall abundance	Boyne			Blackwater			Barrow			Nore			Clare			Moy		
			Peak	Mean	%	Peak	Mean	%	Peak	Mean	%	Peak	Mean	%	Peak	Mean	%	Peak	Mean	%
Mute Swan	*Cygnus olor*	0.303	0.98	0.47	25.9	1.00	0.29	10.9	1.13	0.59	22.8	0.89	0.27	9.6	0.58	0.31	15.8			
Whooper Swan	*Cygnus cygnus*	0.126	0.26	0.16	0.6	0.45	0.45	0.6	0.24	0.24	0.4				1.14	1.14	0.7	0.17	0.17	1.0
Greylag Goose	*Anser anser*	0.002				0.04	0.04	0.2	0.01	0.01	0.4									
Teal	*Anas crecca*	0.644	1.38	0.68	7.6	2.71	0.53	11.5	6.92	2.50	2.2	0.12	0.08	2.4	3.05	1.05	18.9	0.81	0.41	8.2
Mallard	*Anas platyrhynchos*	1.612	1.95	0.89	47.2	3.29	1.53	61.1	1.66	0.74	38.6	1.96	1.02	33.9	5.71	1.18	40.2	4.01	1.38	61.4
Great Crested Grebe	*Podiceps cristatus*	0.002	0.07	0.07	0.9															
Little Grebe	*Tachybaptus ruficollis*	0.003	0.03	0.03	0.3										0.04	0.04	0.3			
Cormorant	*Phalacrocorax carbo*	0.180	0.58	0.20	13.3	0.59	0.15	10.7	0.16	0.09	9.7	0.25	0.10	4.3	0.52	0.25	7.9	0.77	0.42	2.9
Grey Heron	*Ardea cinerea*	0.334	0.37	0.18	22.2	0.86	0.37	39.3	1.15	0.40	39.7	0.60	0.29	24.5	0.27	0.14	13.7	0.62	0.24	15.5
Little Egret	*Egretta garzetta*	0.029	0.03	0.03	0.9	0.24	0.08	4.3	0.69	0.20	4.5	0.11	0.06	3.2						
Water Rail	*Rallus aquaticus*	0.002				0.02	0.02	0.2												
Moorhen	*Gallinula chloropus*	0.228	0.67	0.32	27.8	0.50	0.16	10.0	0.69	0.26	15.4	0.27	0.11	7.2	0.51	0.16	12.4	0.64	0.19	3.9
Coot	*Fulica atra*	0.013	0.12	0.09	1.3	0.01	0.01	0.2	0.02	0.02	0.7	0.06	0.05	1.3	0.14	0.08	1.4	0.19	0.19	0.5
Common Sandpiper	*Actitis hypoleucos*	0.041	0.12	0.08	3.5	0.03	0.02	1.1				0.11	0.04	1.3	0.19	0.14	1.7	0.32	0.20	10.1
Green Sandpiper	*Tringa ochropus*	0.050	0.15	0.09	2.8	0.16	0.12	5.3				0.13	0.10	2.7	0.25	0.10	3.4	0.02	0.02	0.5
Black-headed Gull	*Chroicocephalus ridibundus*	0.062	0.17	0.14	1.6	0.03	0.02	0.4	2.15	0.59	7.1	0.03	0.03	0.5	0.04	0.04	0.3	0.09	0.06	1.9
Common Gull	*Larus canus*	0.004																0.06	0.06	1.4
Herring Gull	*Larus argentatus*	0.018	0.06	0.06	0.3				0.14	0.09	2.2	0.02	0.01	0.5	0.10	0.10	0.7			
Kingfisher	*Alcedo atthis*	0.150	0.55	0.24	27.2	0.24	0.12	7.7	0.38	0.18	12.7	0.40	0.19	16.8	0.24	0.15	12.4	0.89	0.31	22.7
Sand Martin	*Riparia riparia*	5.107	5.81	2.46	32.3	9.94	3.13	9.6	12.23	3.76	47.9	9.34	4.24	38.9	17.26	5.91	44.3	8.14	2.27	40.1
Grey Wagtail	*Motacilla cinerea*	0.175	0.35	0.16	7.9	0.35	0.24	17.5	0.45	0.24	9.7	1.31	0.33	14.7	0.10	0.05	2.4	0.42	0.18	4.8
Dipper	*Cinclus cinclus*	0.134	0.10	0.06	3.8	0.97	0.33	20.7	1.15	0.33	7.5	0.40	0.20	13.1	0.25	0.17	2.7	0.84	0.34	13.5
Sedge Warbler	*Acrocephalus schoenobaenus*	0.170	0.31	0.22	6.3	0.55	0.18	4.9	0.38	0.26	16.1	0.75	0.22	4.5	0.68	0.33	8.2	0.39	0.19	4.8
Reed Warbler	*Acrocephalus scirpaceus*	0.003				0.08	0.08	0.4												
Reed Bunting	*Emberiza schoeniclus*	0.139	0.47	0.17	11.1	0.23	0.08	6.2	1.15	0.41	13.9	0.67	0.24	9.6	0.38	0.19	10.0	3.07	1.60	1.4

Table 3b. Peak and mean relative abundance of waterways birds on the Ilen and Gill systems, together with the proportion of sections within each in which species were recorded.

	Ilen			Gill		
species	Peak	Mean	%	Peak	Mean	%
Mute Swan	0.57	0.37	12.0	0.20	0.12	12.7
Mallard	2.46	1.80	72.0	1.58	0.93	61.8
Cormorant	0.25	0.15	20.0	0.08	0.06	5.5
Grey Heron	0.09	0.09	8.0	0.12	0.10	12.7
Little Egret	0.16	0.13	12.0			
Common Sandpiper	0.25	0.25	8.0	0.08	0.08	1.8
Kingfisher	0.57	0.54	44.0	0.16	0.11	16.4
Sand Martin				1.99	1.58	34.5
Grey Wagtail	0.19	0.19	4.0	0.91	0.35	18.2
Dipper	0.74	0.44	28.0	0.45	0.31	27.3
Sedge Warbler				0.91	0.40	12.7
Reed Bunting				0.12	0.08	10.9

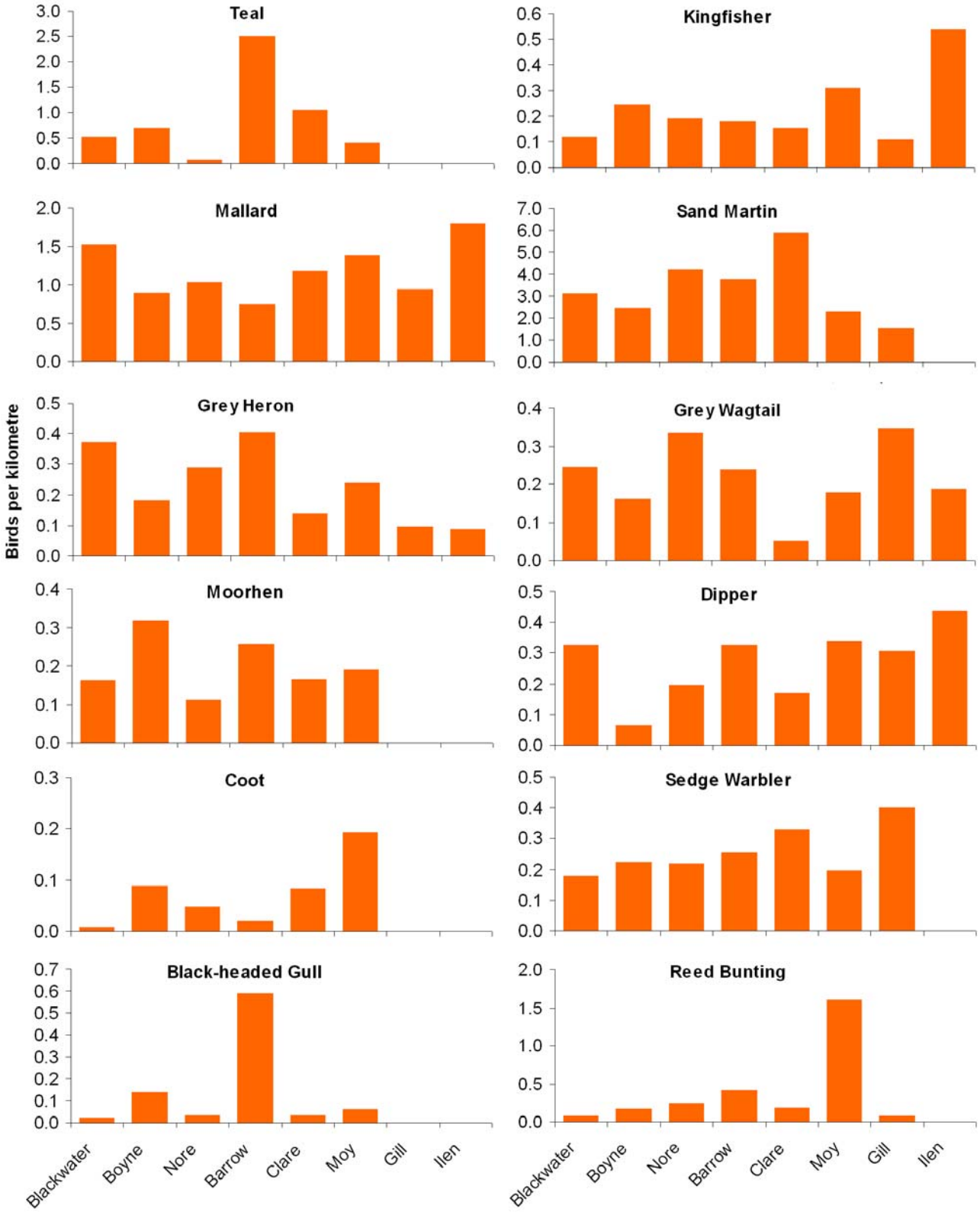


Figure 7. Mean relative abundance of a selection of widely distributed waterways bird species on each river system. Note that scales differ.

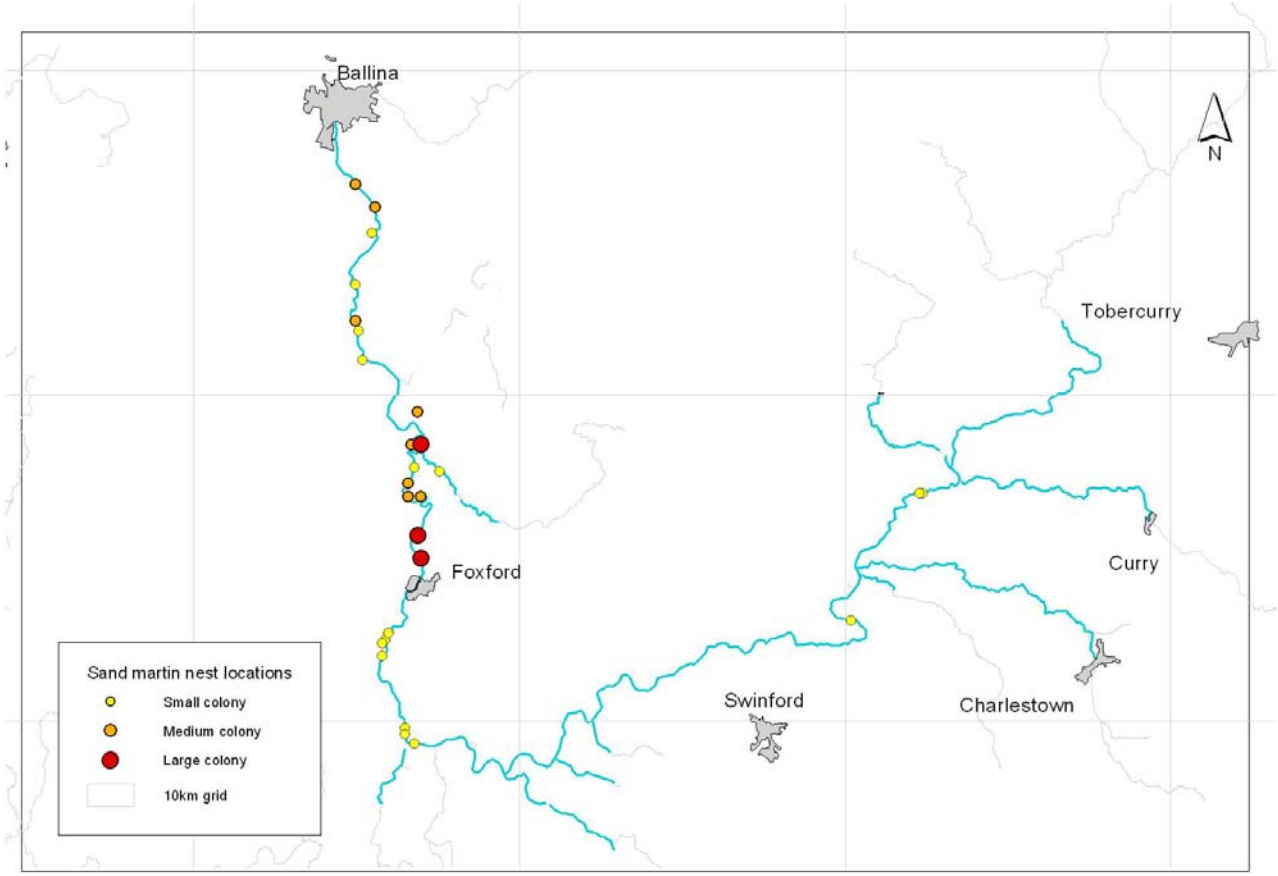


Figure 8. Locations of nesting Sand Martin colonies on the Moy system.
Small refers to colonies less than 10 birds, medium 10-50 birds and large >50 birds.

Kingfisher distribution within river systems

Relative abundance

Kingfishers were recorded on all river systems surveyed, although there was much variation within river systems and between visits (Fig. 9). The rivers consistently supporting highest numbers per kilometre included the River Bride (Munster Blackwater), the River Boyne and the Tremblestown/ Athboy River (Boyne), the River Barrow on the Barrow system, (although relative abundance was higher on other rivers they were less consistently reported between visits), River Nore (Nore), Strade, Mullaghanoe and Moy Rivers (Moy), and the Abbert, Sinking and Clare Rivers (Clare). Kingfishers were entirely absent from the Allow River (Munster Blackwater), the Mountain River (Barrow), Erkina and Goul Rivers (Nore), the Einagh, Killeen, Sonnagh and Spaddagh Rivers (Moy) and the Dalgan River (Clare system).

Relative abundance was consistently high on all three visits of the Ilen system, and was low on the Gill system. As the lengths of rivers surveyed within these systems were much smaller than the other systems assigned for this work, caution is urged with respect to overall numbers per kilometre presented for each, and how these compare with the other much larger systems surveyed.

Between visits, numbers were shown to increase from the first visit to a peak on the third visit on all tributaries of the Boyne system, except the Blackwater and Tremblestown/ Athboy. In contrast, numbers were shown to decline between visits on the Munster Blackwater and the Nore systems. There were no consistent patterns between visits in the numbers recorded on other systems (Fig. 9).

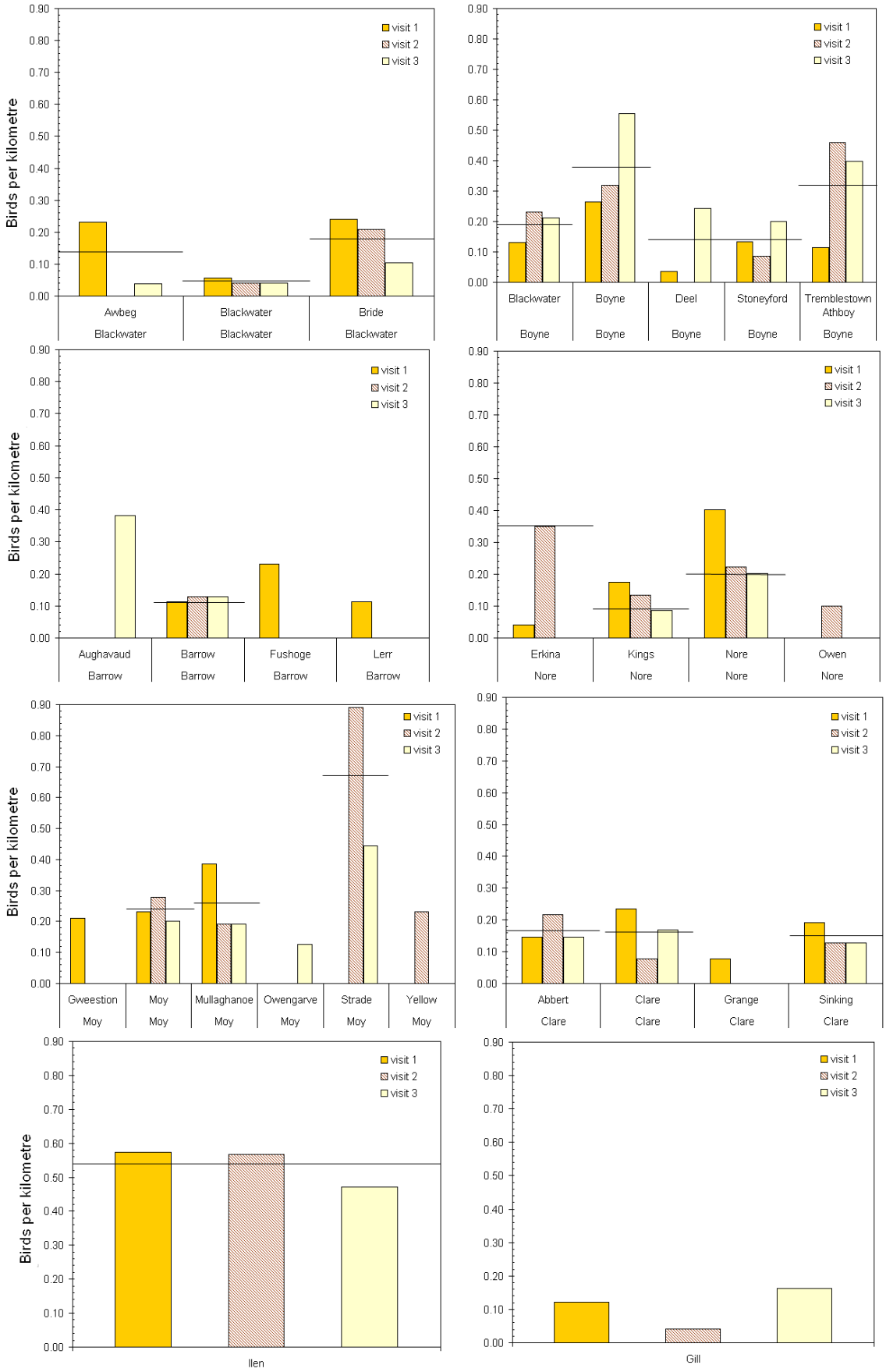


Figure 9. Relative abundance of Kingfisher on each of the river systems surveyed are given. Horizontal lines indicate the overall (mean) abundance on each river of each system. Missing bars indicate only one visit where birds were recorded.

Territories

Territories were estimated based on registrations of birds and birds' activities and nest holes seen, primarily on the first two visits. Examples of some nest holes located on this survey are given in Fig. 10 below.

Figure 10. Selection of Kingfisher nest sites recorded in 2010, illustrating nest locations on the River Moy (A) and Barrow (B), a nest hole with well-used perch on the River Nore near Ballyragget (C), and opportunistic nest holes on man-made excavation on the River Barrow (D) and an access point for livestock on the River Barrow (E).
(Photos by Charlie Horan, Jackie Hunt, Sean Pierce and Ruth Gaj McKeever)

A total of 100 Kingfisher territories were estimated overall, with the greatest number recorded on the Nore system (Table 4). Excluding the two shorter river systems surveyed, the highest totals of 0.14 and 0.12 birds per kilometre were estimated on the Nore and Boyne systems respectively, while lowest totals of 0.05 and 0.07 birds per kilometre were estimated on the Munster Blackwater and the Clare systems. Sightings, nests and estimated territories are illustrated in Figure 11 a-h.

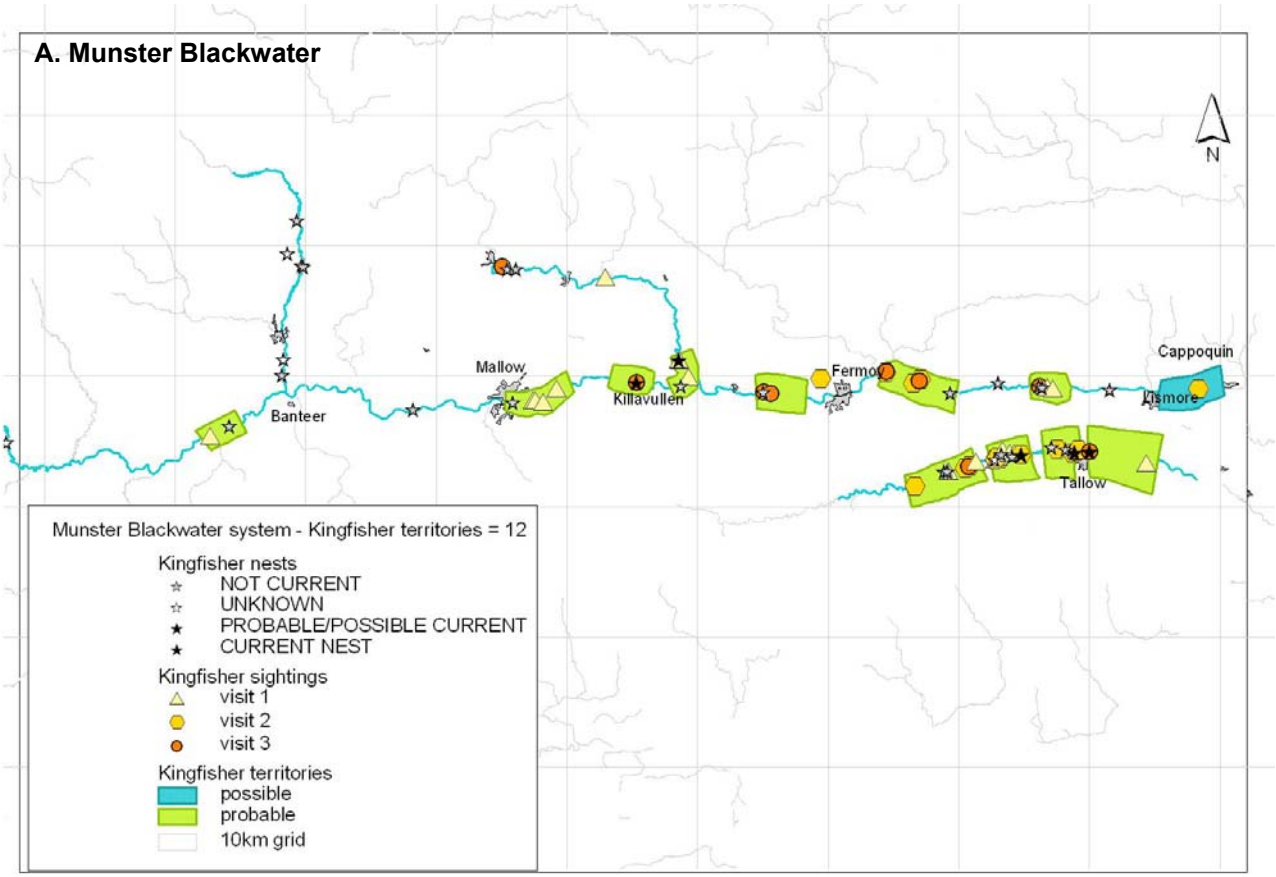
The Nore system had the highest numbers of active nests (0.14/km) followed by the Moy (0.12/km) and Boyne (0.11/km) systems. The relative abundances on the Barrow, Clare and Munster Blackwater were 0.10/km, 0.04/km and 0.03/km respectively.

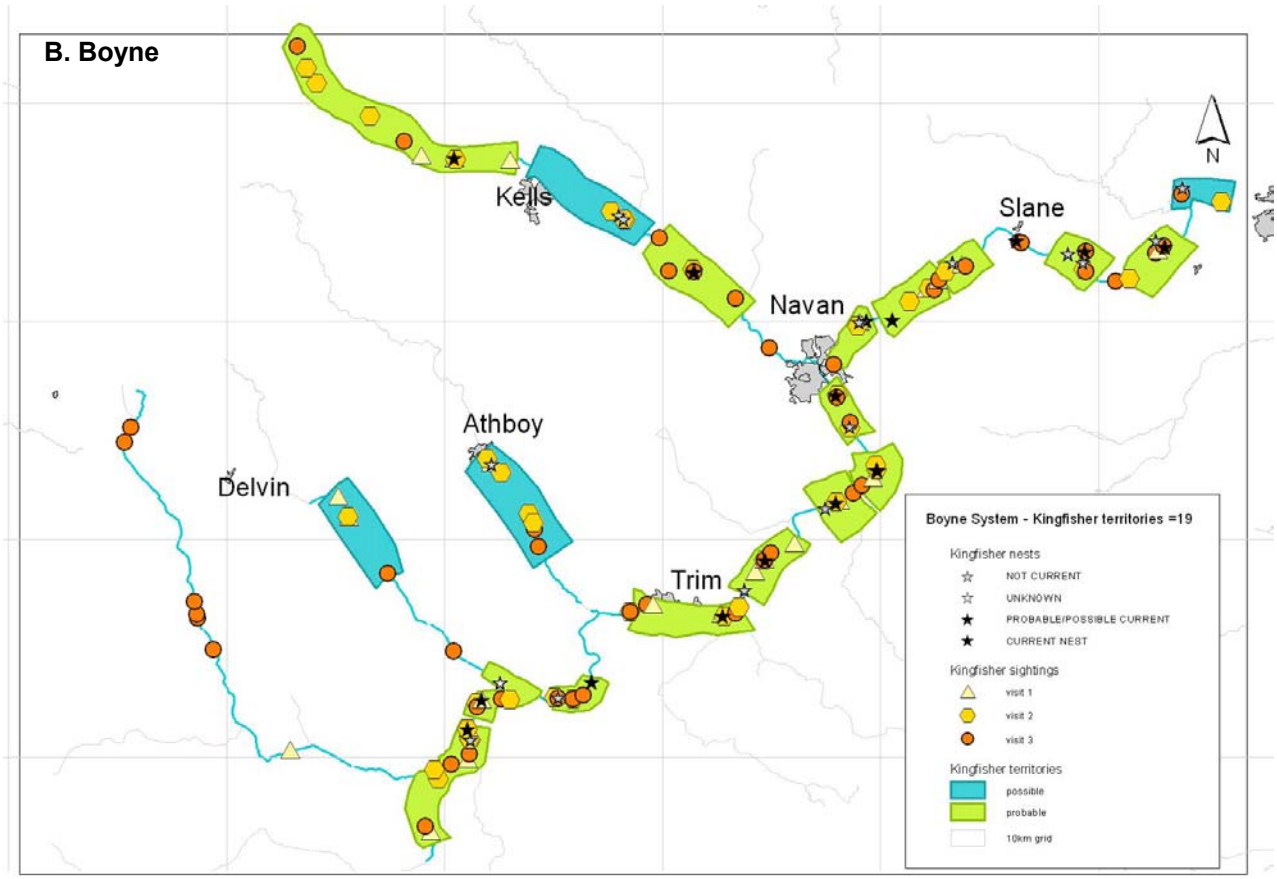
Table 4. Number and relative abundance of Kingfisher territories on each of the surveyed river systems.

System	Probable	Possible	Total	Territories per km	Total number per km
Munster Blackwater	11	1	12	0.05	0.12
Boyne	15	4	19	0.12	0.24
Barrow	6	5	11	0.08	0.18
Nore	16	6	22	0.14	0.19
Clare	10	0	10	0.07	0.15
Moy	9	3	12	0.11	0.31
Gill	4	0	4	0.15	0.11
Ilen	4	0	4	0.33	0.54

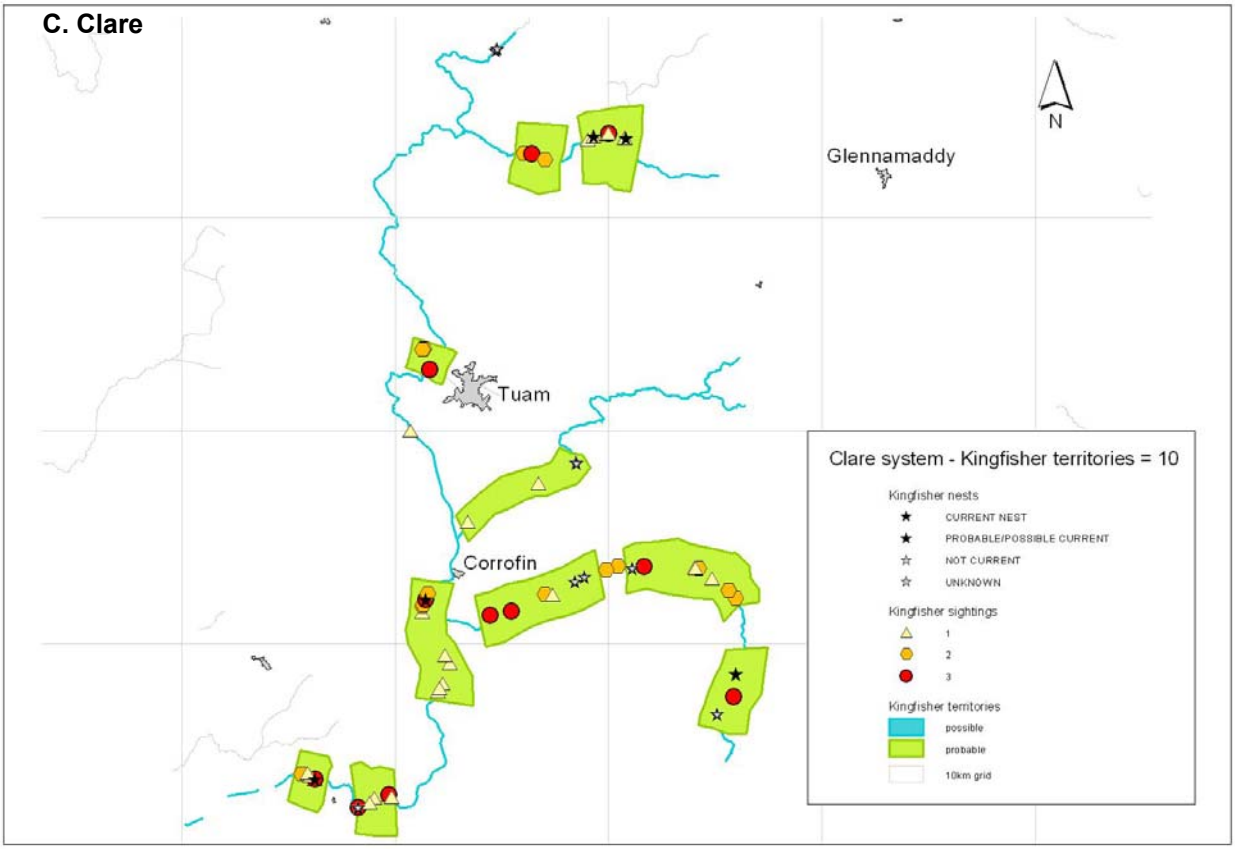
Comparisons between 2008 and 2010 in the location of territories estimated on the Boyne (Fig. 12) and Munster Blackwater (Fig. 13) systems show that there has been some consistency in the areas used, but that there has been slight displacement of birds in parts, most notably:

- Boyne system: the absence of territories from the River Deel in 2010, and increased abundance of territories further downstream, beyond the confluence with the River Blackwater. A total of 20 – 22 territories was estimated in 2008, which equates to 0.09 – 0.10 territories per kilometre.
- Munster Blackwater system: the absence of territories on the Awbeg River. A total of 19 – 20 territories was estimated in 2008, which equates to 0.06 – 0.07 territories per kilometre.

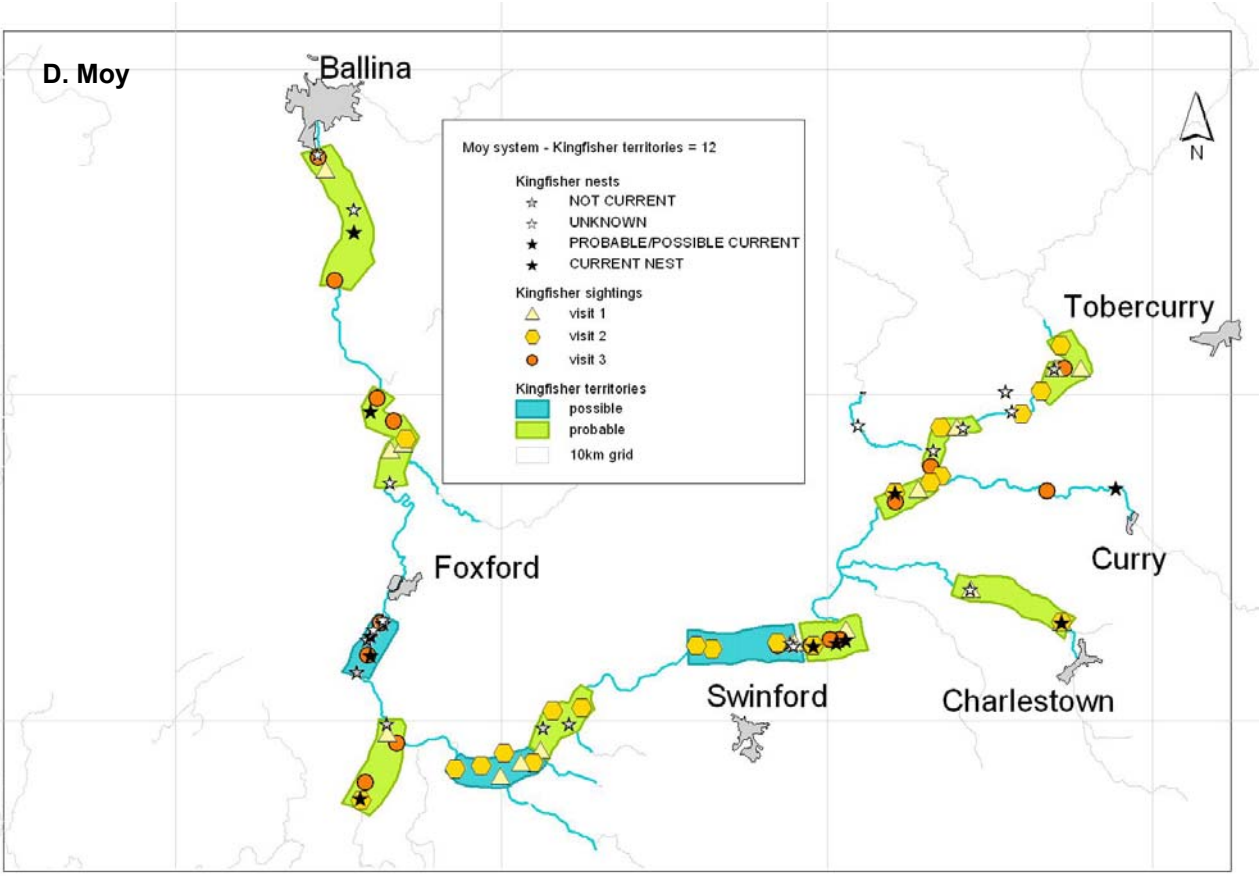

A. Munster Blackwater
N
Mallow
Killavullen
Fermoy
Cappoquin
Lismore
Banteer
Tallow
Munster Blackwater system - Kingfisher territories = 12
Kingfisher nests
NOT CURRENT
UNKNOWN
PROBABLE/POSSIBLE CURRENT
CURRENT NEST
Kingfisher sightings
visit 1
visit 2
visit 3
Kingfisher territories
possible
probable
10km grid

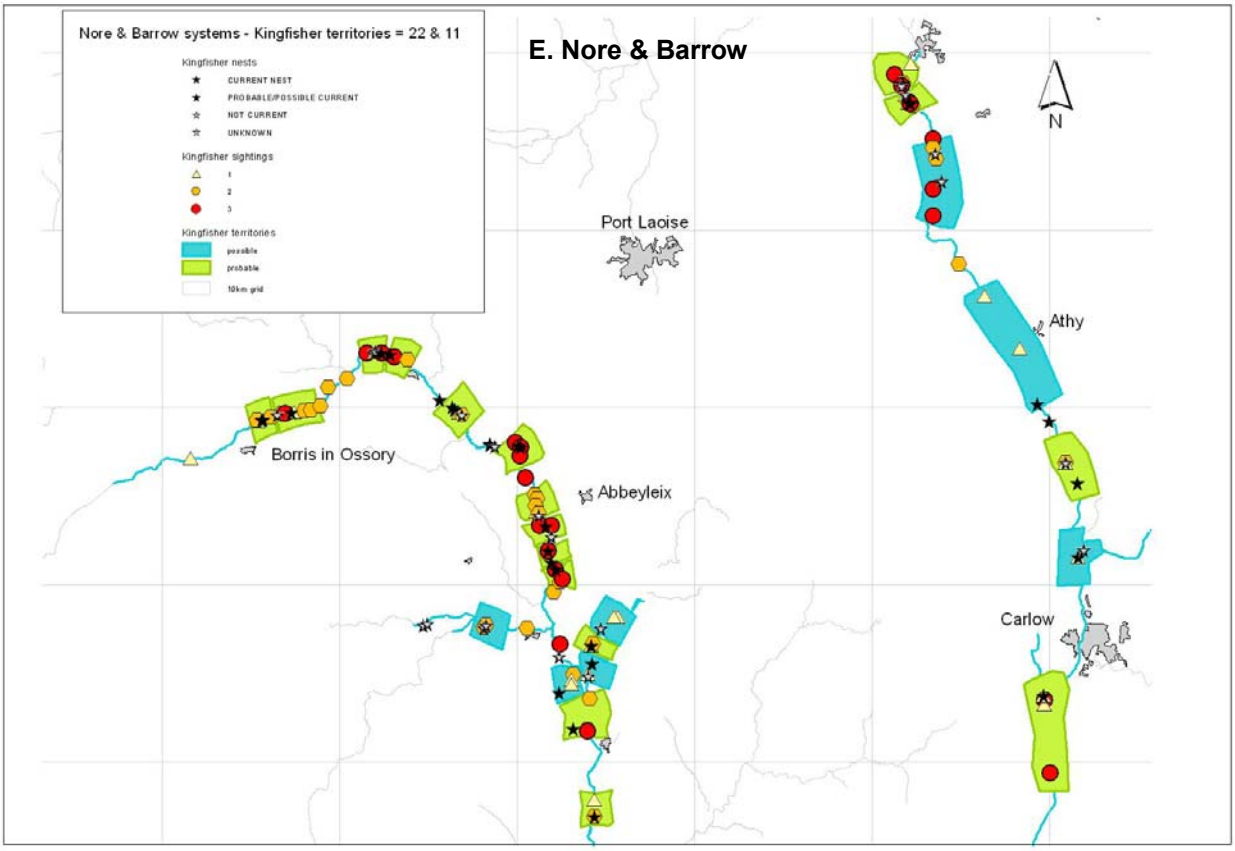

B. Boyne
N
Kells
Slane
Navan
Athboy
Delvin
Trim
Boyne System - Kingfisher territories =19
Kingfisher nests
NOT CURRENT
UNKNOWN
PROBABLE/POSSIBLE CURRENT
CURRENT NEST
Kingfisher sightings
visit 1
visit 2
visit 3
Kingfisher territories
possible
probable
10km grid

C. Clare

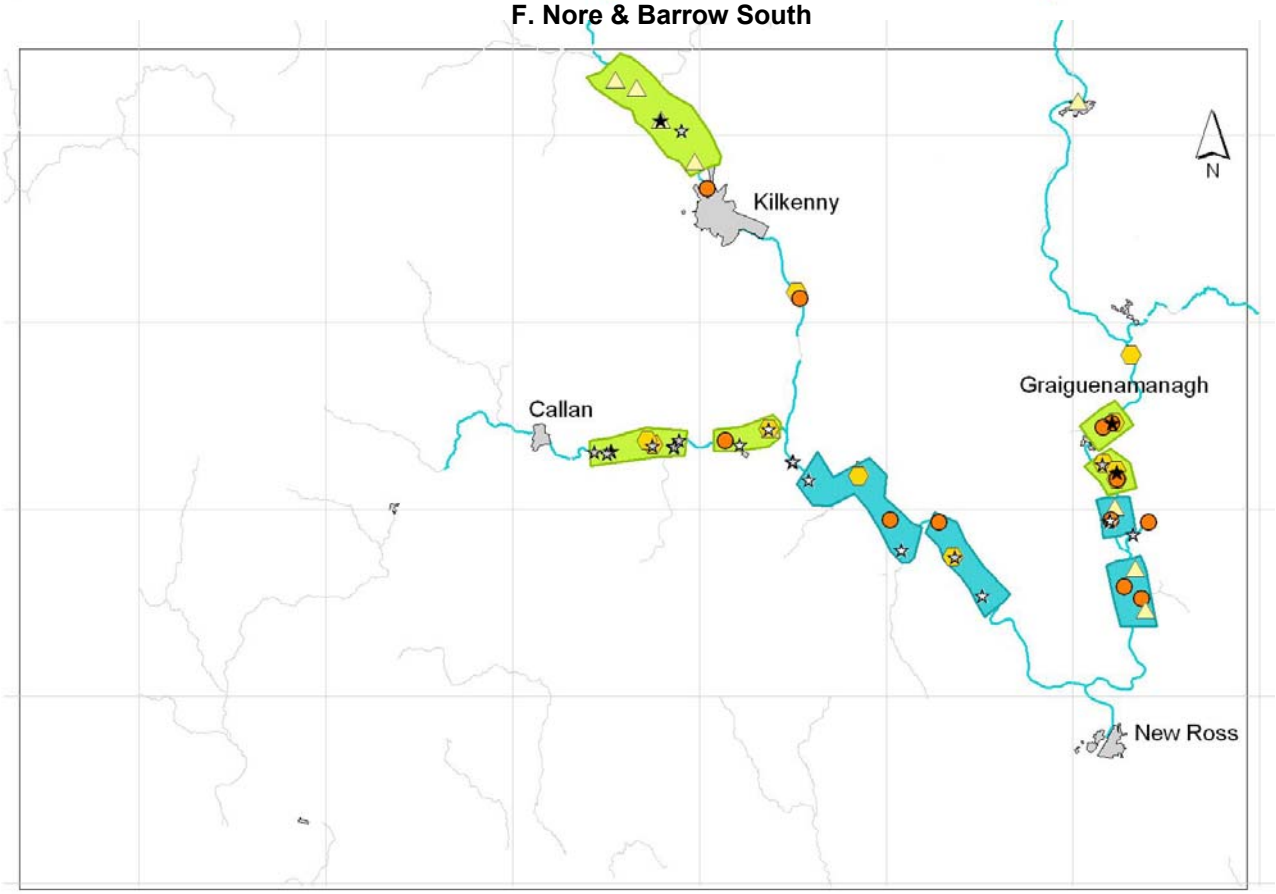

N
Glennamaddy
Tuam
Corrofin
Clare system - Kingfisher territories = 10
Kingfisher nests
CURRENT NEST
PROBABLE/POSSIBLE CURRENT
NOT CURRENT
UNKNOWN
Kingfisher sightings
1
2
3
Kingfisher territories
possible
probable
10km grid

D. Moy


Ballina
N
Moy system - Kingfisher territories = 12
Kingfisher nests
NOT CURRENT
UNKNOWN
PROBABLE/POSSIBLE CURRENT
CURRENT NEST
Kingfisher sightings
visit 1
visit 2
visit 3
Kingfisher territories
possible
probable
10km grid
Tobercurry
Foxford
Curry
Swinford
Charlestown



F. Nore & Barrow South



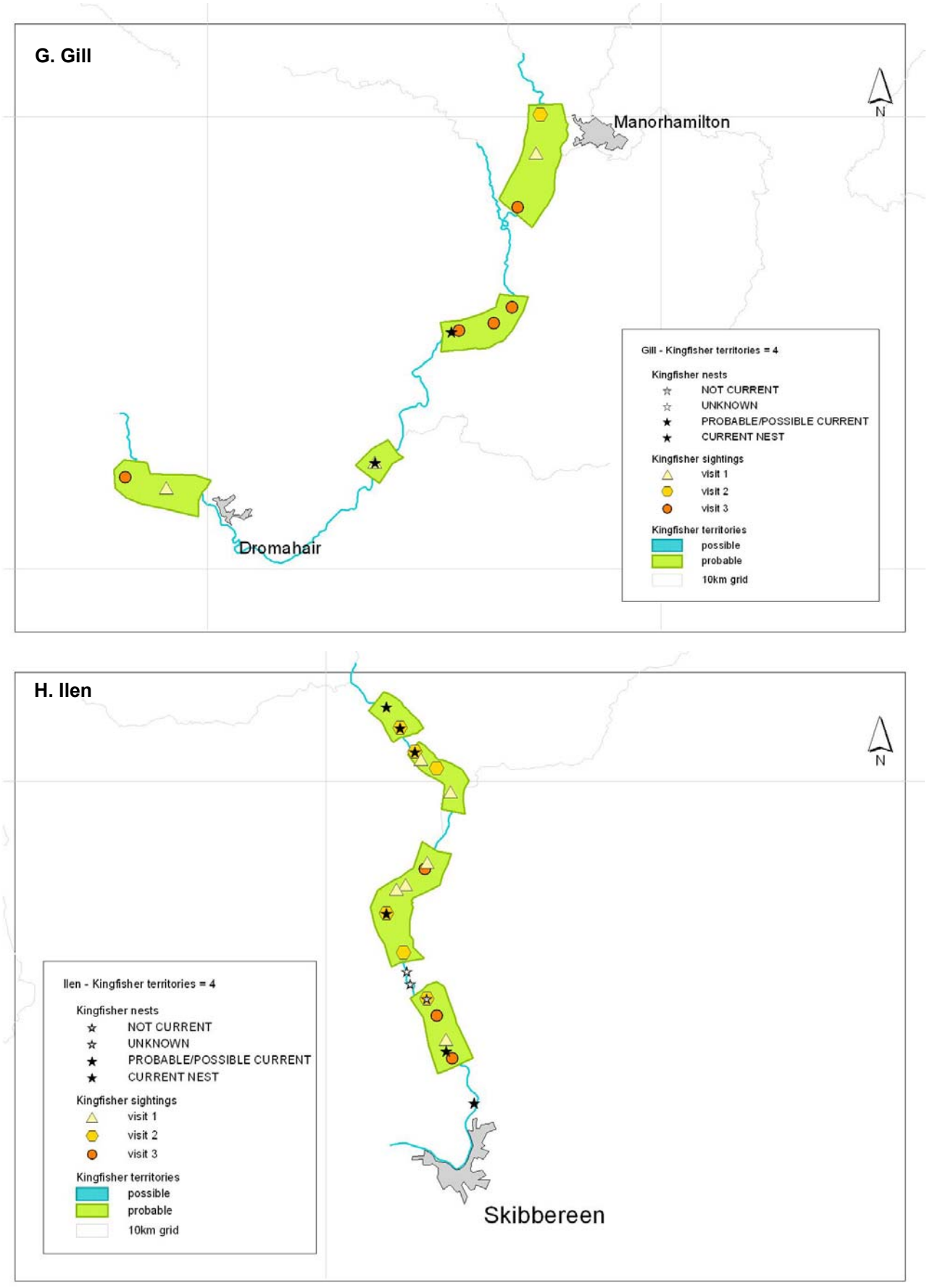


Figure 11. Locations of Kingfisher sightings during the 3 visits and their nests on (A) the Munster Blackwater, (B) Boyne, (C) Clare, (D) Moy, (E & F) Nore & Blackwater, (G) Gill and (H) Ilen river systems.

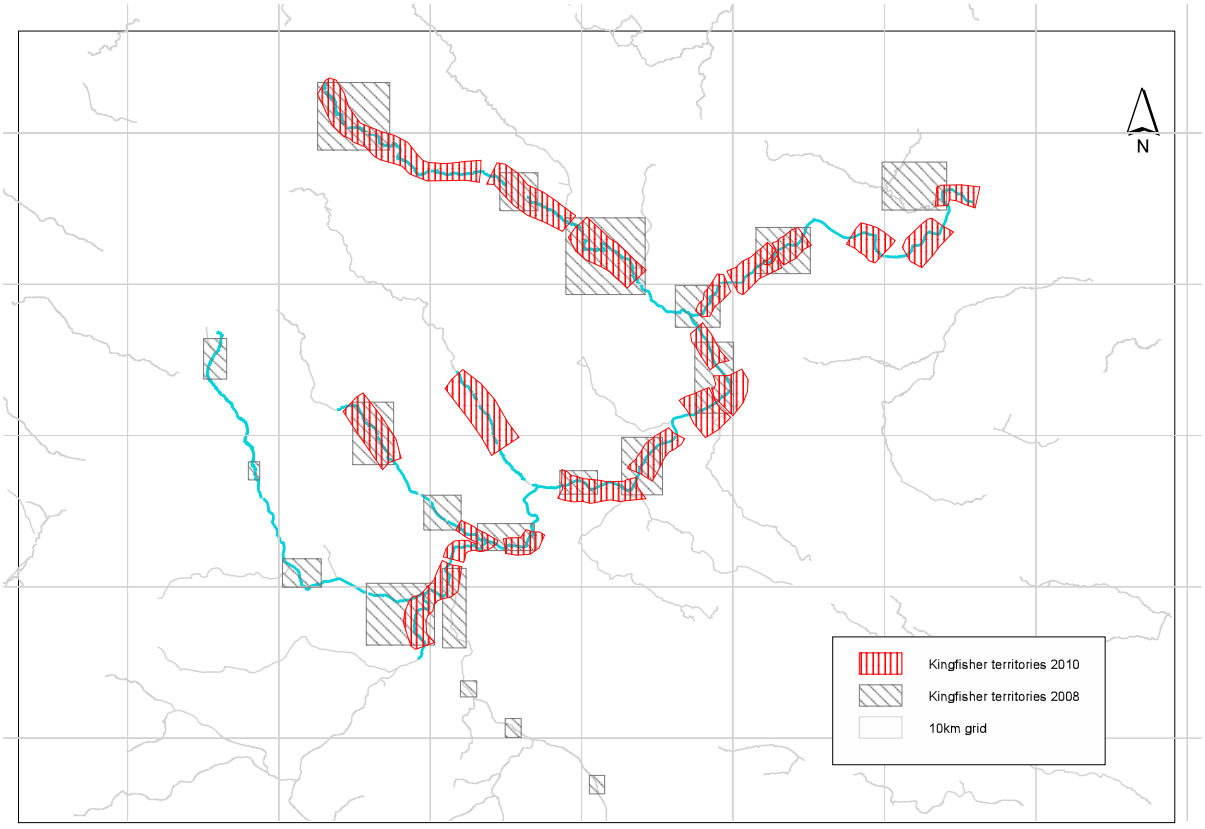


Figure 12. Comparison of territory locations on the Boyne system between 2008 and 2010.

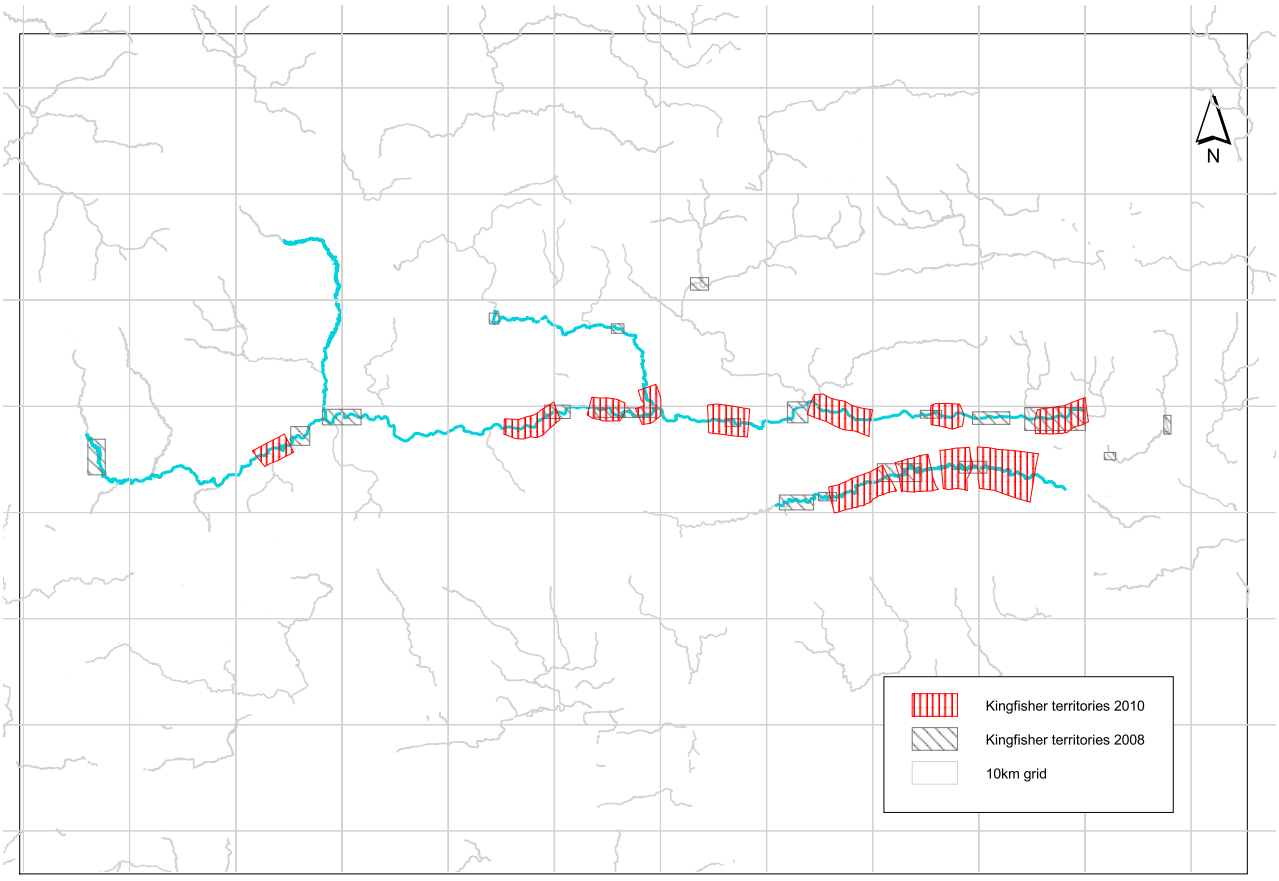


Figure 13. Comparison of territory locations on the Munster Blackwater system between 2008 and 2010.

Habitats

For the majority of habitat characteristics, no obvious differences were noted between the sections surveyed as a whole and those where Kingfishers were present. Kingfishers were seen in slightly higher proportions of rivers which were slow flowing (Fig. 14). Other minor differences were noted from the 'emergent vegetation' category and the 'bank height/slope/vertical category'. There appeared to be a slight preference for banks of at least 1-2 metres high and for vertical banks. Similarly a slight preference for 'some emergent/ fringing vegetation' is evident (Fig. 14).

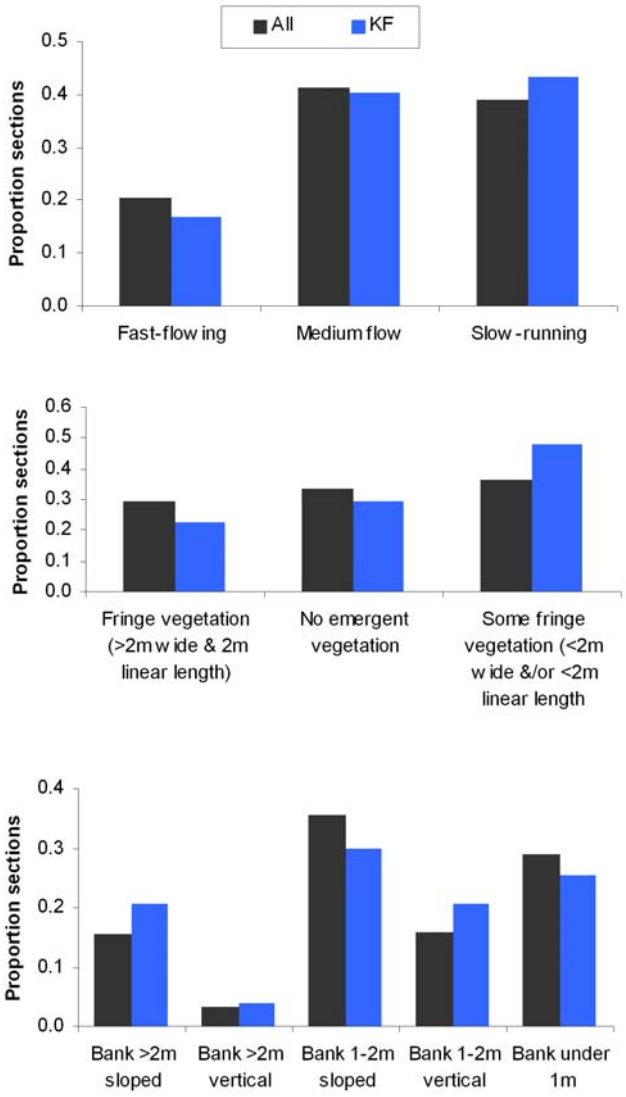


Figure 14. Habitats of sections overall (black bars) compared with those where Kingfishers were seen (blue bars).

Bank & River suitability

The vast majority of the sections of rivers surveyed were considered to be suitable for Kingfisher (Fig. 15). The Ilen had the largest proportion of sections that were considered unsuitable at 16%. The availability of suitable banks was much more variable (Fig. 15). The Ilen, Gill, Nore and Clare systems seemed to support proportionately more suitable banks. Across all rivers, the proportion of banks that were suitable for nesting was higher in sections where Kingfishers were seen.

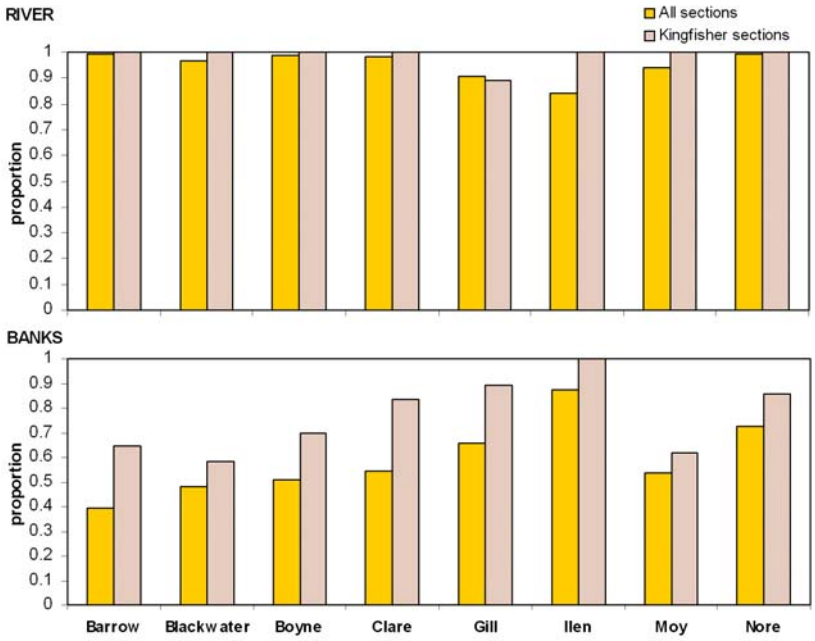


Figure 15. Proportion of sections on each system surveyed comprising suitable Kingfisher rivers and banks, illustrating a comparison between all sections with those where Kingfisher was seen.

Within sections where suitable banks were identified, most banks were relatively short (less than 10m of suitable bank available), and relatively few were more than 100m in length (Fig. 16). The proportion of suitable banks of lengths greater than 100m was higher on sections with Kingfisher when compared with bank extent overall.

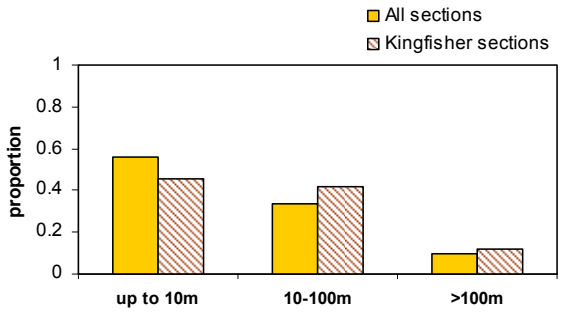


Figure 16. Extent of suitable banks within sections over all systems, illustrating a comparison between all sections with those where Kingfisher was seen.

Predators

Potential predators of riparian birds recorded during survey work included Brown Rat *Rattus norvegicus*, Fox *Vulpes vulpes*, American Mink *Neovison vison*, Otter *Lutra lutra* and Irish Stoat *Mustela erminea hibernicus*. Some 30 records were submitted, and were predominated by American Mink and Otter (Table 5). Most were reported on the Blackwater system. Some examples of possible predation attempts are illustrated in Figure 17.

Table 5. Observations made on possible predators of riparian birds. The total number of records is given.

	River	Brown Rat	Fox	American Mink	Otter	Stoat
Boyne	Blackwater			1		
	Boyne				1	
	Deel			1		
Blackwater	Allow		1			
	Blackwater			3	2	1
	Bride			4	1	
Barrow	Barrow	1			3	
	Lerr			1		
Nore	Erkina			2		
	Nore			1	1	
Moy	Moy				2	
Clare	Abbert			1	1	
	Clare			1		
Ilen	Ilen				1	

Figure 17. Examples of possible predation attempts on waterways birds, illustrating American Mink scrapes around a Kingfisher nest hole on the Ilen (top photo, by Declan O'Donnell) and signs of Otter at a Sand Martin colony (bottom photo, by Jackie Hunt).

Discussion

Distribution of Kingfisher territories

A wide range of riparian habitats and bird species were recorded across all the river systems surveyed. Given the severity of last winter's cold spell, with temperatures well below freezing for many weeks, it is reassuring that Kingfishers were widespread across all of the systems surveyed, albeit not every tributary contained Kingfisher territories. One of the most limiting factors with regards the presence or absence of Kingfishers is the availability of suitable nesting banks (Boag 1982). Most of the rivers surveyed were shown to support at least some suitable Kingfisher banks. This factor, along with surrounding waterways habitats, has probably largely influenced the number of territories occupied by Kingfishers on the different river systems.

Kingfisher territories were assigned after an examination of areas of overlap of sightings of birds on visit 1 and visit 2 and the locations of any active or presumed active nests. By the time visit 3 was being carried out (7 May – 1 June), some juveniles were likely to have fledged, and were possibly persisting in parental territories. This might help explain the increases seen on some rivers of the Boyne system over time. Eventually these young are evicted by their parents (Boag 1982), who often produce a second brood. Subsequently, the majority do not disperse very far and will try to keep a low profile to avoid being driven further away by breeding adults. These birds most likely contributed towards the sightings recorded on tributaries feeding into the main channels that had little or no sightings on visit 1 and visit 2.

Distribution of Kingfishers across the six main systems surveyed in 2010

The relative abundances reported are akin to those previously reported in Ireland (Crowe *et al.* 2008) and for various regions in Britain (Marchant & Hyde 1980). The total number of active nests per kilometre across the rivers varied considerably, and was in line with the abundance of territories. Suitable nesting banks were more prevalent on the Nore than any of the remaining five systems, and the Nore also supported the highest totals of active nests per kilometre. These factors probably explain why it had the highest territory abundance. By contrast, the vast majority of the River Barrow had banks under one metre in height, which may explain why it had much fewer Kingfisher territories than the neighbouring Nore. The apparent proximity of Kingfisher territories on the Barrow may be related to the shortage of suitable nesting banks elsewhere on the system.

As the vast majority of the banks on the Munster Blackwater and the Clare were 1-2 metres and sloped, they were possibly less suitable for nesting Kingfishers. However, nesting banks may not be the only limiting factor in determining Kingfisher presence or absence. The Boyne, which also had reasonably high numbers of Kingfisher territories per kilometre, had fewer suitable banks than some rivers with lower numbers. Obviously other factors such as water quality, availability of suitable perches and adequate fish populations are also important in the overall suitability of river systems for Kingfisher. Boat-based observersalso remarked on the difficulty in locating nest holes on the Boyne. This was because of substantial overhanging vegetation and/ or trees obstructing the observers' view in parts, and highlights the importance of spending time assessing bank suitability.

Comparison of territories per kilometre in 2010 with those reported in 2008 (Crowe *et al*. 2008) on the Boyne and Munster Blackwater systems indicate that the relative abundance of territories on the Boyne has remained unchanged, but that there has been a slight decline on the Munster Blackwater, from 0.06-0.07 in 2008 to 0.05 during the present work. This may have been due to differences in survey area (more rivers were surveyed in 2008). However, territory estimation in 2010 was greatly improved due to the availability of data on nest locations, and the determination of territories in 2010 was possibly more stringent.

The Ilen and Gill systems were also surveyed in 2010, but given that the total length of river surveyed across these systems was much shorter, the totals presented (per kilometre) can not be

directly compared with the larger systems mentioned above. The Ilen had the greater percentage of suitable nesting banks and higher numbers of active nests per kilometre compared to the Gill.

Bankside and surrounding habitats

The results of the habitat assessments show that the river systems surveyed meandered through landscapes fabricated by a mixture of farmland (mainly improved grassland), coniferous forestry, broadleaved woodland and scrub. Bankside habitats were largely 'open grass/herb layer'. Looking at finer scale bankside properties, there was a slight preference by Kingfishers for banks of at least 1-2 metres high, vertical banks and for 'some fringing vegetation'. It may be that birds avoid sections with too much aquatic vegetation which could obscure their view of fish from perches with such proliferation of vegetation also possibly indicating eutrophication. However, some fringe and emergent vegetation is important as it can provide suitable perches and some security for fish to hide from predators. Also some fringe vegetation is important for controlling temperature of the water which can prove vital for macroinvertebrates and fish (O' Grady 2000). The Gill was the only system where banks were mostly unvegetated which may in part be related to the arterial drainage works carried out by the Office of Public Works on the Bonet River (Gill system).

Pressures and threats

Disturbance factors could also impact on numbers of breeding pairs, as Kingfishers will often not nest in an area if there is ongoing disturbance nearby (Boag 1982). Pressures were examined in terms of percentage occurrence across the systems surveyed. Grazing was universal in terms of its occurrence across all systems with a little variation between systems. The Barrow, which had amongst the lowest numbers of Kingfishers per kilometre had the highest percentage of 'paths & tracks', 'roads' and 'human trampling' which may suggest that such disturbances could be having a negative effect on populations there. However, anecdotal reports from local fishermen indicated that fish numbers on this river are low, which is why there is a fishing ban on the river. Given the nature of this survey work, any assumptions on the severity of these threats would be tenuous given the amount of time actually spent on any one section of the rivers during the survey period.

Abundance and distribution of other waterways bird species

As expected, the colonial nesting Sand Martin was the most numerous species recorded. Given their preferences for nesting banks it is not surprising that their breeding distribution probably reflects suitability of waterways for Kingfisher as well. In terms of nesting Sand Martin colonies, it is perhaps surprising that the greatest number of nests was actually recorded on the Moy. It is likely that either nesting banks for Sand Martins went undetected and/or they were nesting away from the main channels surveyed.

The relative abundance of Dipper was highest on the Ilen and the Munster Blackwater, supporting a southerly bias in their abundance. This result compares well with that of the previous survey of the Blackwater in 2008 which also had reasonably high numbers of Dippers per kilometre. The preference of Dippers for faster flowing rivers and streams (Ormerod and Tyler 1991) has been previously documented. During the current work, Dippers were found on the faster flowing stretches of the rivers surveyed, usually where stones and rocks were protruding above the water level in the rivers.

As there are no known records of Green Sandpipers breeding in Ireland (Hutchinson 1989), and winter numbers are low, it is surprising that so many were recorded on this survey. These records most likely reflect birds on passage, although the lack of ringing recoveries in Ireland indicates that there is no proof of the origins of these birds. However, given the timing, it is possible that these birds are from the population wintering on Continental Europe and heading northbound to their breeding grounds in Scandinavia (Wernham *et al.* 2002). It is probable that Green Sandpipers have been under recorded here in the past, as they are very cryptic.

Common Sandpipers exhibited a westerly bias with numbers (per kilometre) greatest on the Moy and Clare systems, which is in line with their preference for more upland stoney rivers during the breeding season (Sharrock, 1976, Gibbons *et al*. 1993, Wernham *et al.* 2002).

Recommendations for future monitoring, and protection of the Kingfisher

Compiled databases of Kingfisher sightings in recent years (both Breeding and Wintering Atlas records 2007-2010 & Public Sightings Survey in 2007) suggest that Kingfishers are widely distributed in Ireland. Estimating the national population on the basis of these sightings and those from previous waterways reports (Crowe *et al.* 2008) would prove very difficult. Based on the recommendations of the previous report (Crowe *et al.* 2008) and consultation with the NPWS, it was determined that a better option would be to assess the suitability of rivers and catchments that have already been afforded nature protection designation under the Habitats Directive for Kingfisher, in particular the low lying SAC river systems. As a consequence six river systems were chosen at the outset of this year's survey and were covered using methodologies tried and tested on the previous survey in 2008.

All six river systems surveyed provided suitable habitat for Kingfisher, with the relative abundance of territories ranging between 0.05/km and 0.14/km over all systems. The additional two smaller rivers surveyed also supported high numbers of Kingfisher (per kilometre) albeit they were also the shortest of the rivers surveyed. The Ilen is the only river surveyed that is not part of the Natura 2000 network.

Future monitoring of waterways birds should adopt the methodology used in 2010. Three visits between mid-March and end of May are of considerable benefit, especially for Kingfisher, which is reportedly an early nester (Boag 1982). The majority of nests are laid at the end of March and into early April, which means that the first brood of chicks can be fledged by the end of April. Boat-based surveys are by far the most efficient. They also improve detectability of birds and nest holes. Canadian canoe, rubber dinghy and double kayak all proved to be suitable, although the latter is faster, and two experienced observers are necessary. Improvements that would be valuable to future monitoring would include a more standardised approach to habitat recording with ideally the same observers covering the same stretches of river through the season. Another recommendation would be a workshop that includes all observers on habitat identification and classification prior to the season commencing.

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In this photo (Some of the members of the field team): *James Roberts, Ruth Gaj McKeever & Laura McNaghten*

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Appendices

Appendix 1a. Habitat key & recording form.

	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)			

500m			PRIMARY						SECONDARY						TERTIARY		Kingfisher river		Detectability
Section	Time start	Grid start	1	2A	2B	3A	3B	4	1	2A	2B	3A	3B	4	1A	1B	River	Banks	(1-3)

Appendix 1b. Pressures and threats key.

Date: _____ **Observer:** _____

River: _____

		500m section:																					
Agriculture	A04	grazing																					
	A04.01.01	intensive cattle grazing																					
	A04.01.02	intensive sheep grazing																					
	A04.01.03	intensive horse grazing																					
	A04.01.04	intensive goat grazing																					
	A04.01.05	intensive mixed animal grazing																					
	C01.01.01	sand and gravel quarries																					
Transport/ corridors	D01.01	paths, tracks, cycling tracks																					
	D01.02	roads, motorways																					
	D01.03	car parks and parking areas																					
	D01.05	bridge, viaduct																					
	E02	Industrial or commercial areas																					
Human	G01.01.01	motorized nautical sports																					
	G01.01.02	non-motorized nautical sports																					
	G05.01	Human trampling, overuse																					
	H01.05	Pollution due to agricultural/ forestry																					
	H01.08	Pollution due to household sewage/ waste waters																					
Natural system modification	J02.03.01	large scale water deviation																					
	J02.05.02	modifying structures of inland water courses																					
	J02.06	Water abstractions from surface waters																					
	J02.10	management aquatic/ bank vegetation for drainage																					
	J02.11.02	dykes & flooding defense in inland water systems																					
	J03.01	reduction or loss of specific habitat features																					
	J03.03	reduction, lack or prevention of erosion																					
	K01.01	Erosion																					
	K01.02	Silting up																					

Appendix 2. River coverage descriptions

The Boyne System

River Boyne

The survey of the River Boyne was completed by boat during all three surveys therefore no major access problems due to terrain etc were encountered. There were, however a number of difficult weirs to pass which were quite frequent from Navan to Boyne Bridge. The Boyne from the Boyne Aqueduct to Trim was mostly improved agricultural land which was being grazed by cattle and sheep at the time of the survey. The livestock had frequent access to the river and were considered to be a possible source of pollution. The banks in this section were steeply sloped which made viewing the surrounding landscape difficult. These steep banks could be the result of management for flood defence at some time in the past. No suitable nesting sites were observed until Trim where there was a congregation of islands and riffles which appeared to provide suitable habitat. The Boyne from Trim to Navan became quite frequently interspersed with deciduous and mixed woodland and a number of small islands were recorded sporadically. The banks coming into Navan town were considered to be ideal for Kingfisher with riparian vegetation and unvegetated vertical banks. Several feeder streams were also noted in this area; these streams may be utilised by Kingfisher. The Boyne from Navan to Boyne Bridge became even more forested and the number of islands and backwaters doubled. These conditions were considered good for Kingfisher but were likely to reduce Kingfisher detectability. Kingfishers were regularly encountered on the River Boyne.

River Blackwater (Kells)

The River Blackwater converges with the main channel of the River Boyne in Navan. The lower stretches of the river are within the urban fringe of Navan and were difficult to survey due to access and development. Upstream of Navan the habitat was mainly agricultural and to the south of Mullaghard there was a young mixed plantation on the east bank of the river. From Donaghpatrick Bridge to Headford Bridge the river was easy to survey with stiles over fences and bridges over ditches. Some excellent banks for Kingfisher were identified to the south of Bloomsbury Bridge. A golf course was situated to the south of Headford Bridge and extended until just south of Maudlin Bridge. There was no access to the river in this location due to the presence of high stone walls and gates surrounding the course. North of Maudlin Bridge the river widened and sluices were present in the watercourse. North of Pottlereagh the river was surrounded by scrub before opening out into farmland and was easier to survey on the east side. To the south of Lough Ramor many drainage ditches intersected the river and the surrounding habitats were predominantly scrubland and coniferous woodland. The River Blackwater is principally surrounded by improved grassland and scrub. The quantity of scrub increased in the upper sections. Cattle and sheep grazing was quite intensive in places and river banks were sometimes grazed bare. Livestock had access to the river in several places along the course of the river. The lower sections of the river had mixed farmland including arable cropland, grassland and horse studs. Kingfishers were encountered in several locations on the River Blackwater.

River Deel

The lower stretches of the Deel until Ballynacor Bridge were dominated by improved agricultural grassland although a plantation was present on the north side of the river east of Clondalee Bridge. A large sand pit and quarry was present between Inan Bridge and Grange Beg. There was no buffer zone between the quarry site and the river and the top of the river banks have been covered in gravel in the vicinity of this pit/quarry. The habitats in the upper Deel were a mixture of grassland, wetland and mixed and coniferous forest. From Ballynacor Bridge to Mooretown Bridge the river was surrounded by deciduous woodland. Further upstream the river widens out into a series of small lakes with marginal reeds and marshland. The survey of the upper Deel proved quite slow and laborious as the forested section was interspersed with frequent steep sided drainage ditches and feeder streams. Some bank reinforcement was noted just north of Drumcree. The upper Deel was very clean and clear with many trout. The OPW were carrying out in-steam drainage maintenance works on the Deel during the third visit. Kingfishers were recorded once in the lower stretches of the river during visit one and on several occasions on visit three.

Stoneyford River

The banks of the Stoneyford River were mainly vegetated, sloped and approximately 2m high. The Stoneyford was more accessible on the east bank for the most part, as there were stiles present and ditches were more easily crossed. The surrounding habitat was predominantly improved agricultural land with patches of forest and arable fields. The middle reaches from Cloghbrack to the N51 were dominated by pastureland with many feeder streams flowing into the river originating from bogland. Intensive cattle grazing was common along the river, especially between Shanco Bridge and Earls Bridge where the cattle were

observed walking in the river. The upper Stoneyford becomes quite narrow and fast flowing in parts, with a dense cover of scrub and trees. Kingfisher was recorded on this river during all three survey periods.

Tremblestown/ Athboy River

The Tremblestown/Athboy River was easily walked from Athboy to the confluence with the River Boyne. The surrounding habitat was a mixture of improved agricultural land and arable. The river was predominantly slow flowing with some good banks for Kingfisher nesting. Bird life was quite prolific along this river and it appeared, for the most, to be relatively unpolluted. Kingfishers were recorded on this river during all three visits.

The Barrow

River Barrow

The River Barrow was easily walked from Carlow to St. Mullins as the well maintained Barrow Way follows its course the majority of the distance. This section of the river was dominated by mixed woodland and improved and semi improved grassland. Canalised sections and long weirs were present in several places along the river. The upper section of the Barrow between Monasterevin and Athy was not easily accessible due to flooding during the first visit. During the second and third visits the flood water had receded and more of the river was accessible. Heavily forested areas were present just south of Monasterevin and to the north of Dunrally Bridge, and as a result the density of these forested areas made access to the river more difficult. Some sections of the Barrow had large long islands running along the middle of river for about 200m which obscured the view of the opposite bank, and some birds or nest holes may have been missed. The river was being dredged 2km south of Athy during the second visit. The lower section of the Barrow, south of St. Mullins, is in a steep valley with a dense mixture of deciduous and coniferous woodland and can only be accessed by boat. This section is tidal and surveys were subject to tides. Kingfishers were encountered frequently along the River Barrow.

Lerr River

The Lerr River was surveyed on foot between the N9 and its confluence with the main channel of the River Barrow. The Lerr River was surrounded by arable and agricultural habitat for most of its course. Upstream of Lerr Bridge a section of dense scrub-like vegetation and an area of mixed woodland were encountered. Between Ballaghmoon Bridge and Doyle's Bridge at Castledermot the dense bankside vegetation often overgrew the river. The river was difficult to access near Castledermot due to housing and industry in the vicinity of the river. Further upstream the new M9 crosses over the river at Halfmiletown. Again the river was very overgrown in this area. The upper sections of the Lerr River were fast flowing with very little bank suitable for Kingfisher. Kingfishers were recorded once on this stretch of river during the first survey.

Fushoge River

The Fushoge River is situated to the east of Carlow town and was surveyed on foot. The Fushoge River was surrounded by agricultural fields and farmland which was densely stocked with cattle. The banks of the river were, for the most part, heavily vegetated with scrub and trees. The river narrowed at its northernmost sections and appeared to be polluted. Household pollution (from adjacent houses at Springhill Bridge) and agricultural pollution (from drainage ditches carrying agricultural waste from improved grasslands into the river) appeared to be the main sources of pollution in the area. The upper sections of this river were considered to be upland eroding river. Kingfishers were recorded once during the three surveys just upstream of the rivers confluence with the River Barrow.

River Mountain

The River Mountain was surveyed on foot and was considered to be an upland eroding river. The lower stretches of the river were surrounded by mixed broadleaf and coniferous woodland between Borris and the rivers confluence with the River Barrow. A mixture of Oak, Maple and Conifer sp. were recorded in this woodland. Dense stands of Rhododendron and Cherry Laurel had invaded the woodland and were particularly prolific on the northern bank of the river. A footpath was present along this section of the river. Upstream of the viaduct in Borris the river was surrounded by agricultural fields and woodland. Dense scrub and trees along the river bank were also evident. Further upstream the river became increasingly difficult to survey due to dense mixed woodland and young deciduous plantation along the banks in the Ballinamona area. The river was very fast flowing during the first survey and few species of interest were recorded. By the second and third visit the water level had gone down and the flow had lessened providing good habitat for Dippers. In the upper section of the Mountain from Rathanna the river was very narrow (<1m), had a very low water level and little or no banks. No Kingfishers were recorded on this river, although Dipper and Treecreeper were common.

Aughavaud River

A small section of the Aughavaud River was surveyed on foot. The Aughavaud River was a fast flowing stream with often steep and heavily vegetated banks. The banks of the river were often reinforced with stones. The river was densely wooded from St Mullins to where the river joins the Barrow, however the trees along one bank had been recently cut down. From St Mullins to Glynn the river was surrounded by dense woodland. A Kingfisher was recorded in the northernmost section during the third visit. Despite this the river was considered to be unsuitable for Kingfisher for most of its course but suitable for Dipper and Grey Wagtail.

Munster Blackwater system

River Blackwater

The upper section of the River Blackwater between Lisheen Bridge and Keale Bridge was surveyed on foot; the lower section until about 1km upsteam of Cappoquin was surveyed by boat. The section between Lisheen Bridge and Rathmore was dominated by a mixture of agricultual grassland, wet grassland and coniferous plantation. Some very degraded peatland habitats were also present and broadleaf woodland and scrub were common throughout. The banks along this section varied between 1 and 3 metres, and several stretches of bank appeared to be ideal as Kingfisher nesting habitat. Between Rathmore and Charles's Bridge the habitats surrounding the river were more improved and dominated by agricultural farmland. Some scrub and trees were present along the banks of the river. The banks along this section were not considered ideal for Kingfisher nesting as they were highly vegetated and rock armouring of the banks was common. The stretch of river immediately downstream of Charles's Bridge was surrounded by some broadleaf woodland and wet grassland, before opening out into improved farmland downstream. The walked section of the River Blackwater was considered to be upland eroding river. Despite this, the habitat was considered suitable for Kingfisher especially the area above Rathmore. No Kingfishers were recorded on the walked section of the River Blackwater (upstream of Keale Bridge).

Several dams and weirs occur on the Blackwater, and water abstraction takes place. Rock armouring is a common practice on some parts of the river, particularly upstream of Mallow and downstream of Fermoy and at a few locations on the Bride.

Refer to Crowe *et al*. (2008) for further details on the Munster Blackwater.

River Bride

The River Bride was surveyed by boat between Rathcormack Bridge and Tallow Bridge on all three surveys. The final section between Tallow Bridge and Camphire Bridge was surveyed on foot during the first survey and surveyed by boat for the second and third surveys.

Invasion of Giant Hogweed *Heracleum mantegazzianum* was worst in upstream sections. Downstream of Tallow Bridge the Bride is tidal, the vast majority of which was extremely inaccessible and dominated by dense riparian woodland. The banks were shallow and sloping, composed of soft mud and were considered to be unsuitable as nesting habitat for Kingfisher. This section was originally carried out on foot but was repeated by boat due to accessibility. This section of the river was considered to be depositing lowland river and would be ideal fishing habitat for Kingfisher.

Further details on the River Bride are presented in Crowe *et al*. (2008).

River Allow

A high proportion of broadleaf plantation and some stretches of native woodland were present on the eastern side of the river on the lower sections of the river to the south of Kanturk. The western side consisted largely of improved agricultural farmland. Above Kanturk, the river narrowed, and the woodland became less dense, leaving more open farmland with a dense layer of trees (mainly Willow and Alder) along the banks. These often covered the river and may have impeded the flight of birds up and down the river. To the north of Walsh's Cross the terrain became difficult to survey due to large sections of young conifer plantations, uneven ground and some sections of dense scrub that impeded progress. The meandering river along with recently eroded banks appeared to provide suitable nest habitats for Kingfishers. Some evidence of pollution was evident along the river and in several locations scrap cars were seen in the river; these cars were thought to have been used in an attempt at bank reinforcement. In several locations old Freshwater Pearl Mussel shells were recorded on bank sides, usually in the vicinity of silted up areas. These shells were thought to have been deposited during a recent heavy flooding event. No Kingfishers were recorded on this river during any of the survey periods despite the fact that several stretches of good habitat were recorded.

Awbeg River

The Awbeg River was surveyed on foot between Buttevant and its confluence with the River Blackwater. The river was densely wooded in places and broadleaf woodland as well as broadleaf plantation were common throughout. The course of the river had been much altered in the past and several weirs and mill races were recorded along the river, e.g east of Buttevant, west of Doneraile and at Castletownroche. These weirs and millraces appeared to change the natural gradient of the river increasing the flow of water in the local area. These conditions were ideal for Dipper and Dipper were often recorded in the vicinity of these features. The river valley was steep in places and these valleys were usually associated with mature woodland. Agricultural grassland, marshy grassland and arable land dominated the wider area along this river. The banks of the majority of the sections surveyed were quite shallow and considered unsuitable to support Kingfisher nesting habitat. The river itself had many suitable stretches of slow flowing water with ample perches for fishing. Invasive exotic species such as bamboo, rhododendron and western skunk cabbage were prolific in several locations along the river.

The Clare System

River Clare

The River Clare was surveyed on foot from where the Sinking River and the Dalgan River merge a few kilometres upstream of Milltown to where the Clare flows into the Corrib. The lower section of the Clare near the Corrib was very difficult to survey due to the abundance of drainage channels that flow into the river. These channels were wide and deep and impossible to cross or to divert around. For this reason this section of the river was not resurveyed during survey two and three. The habitats surrounding the river in this area were mainly wet grassland and improved agricultural grassland, with some obvious remnants of bog habitat. The river was very wide and slow flowing in this area and would have been suitable fishing habitat for Kingfisher. The banks in this area were very shallow and composed of peat and were not considered suitable as Kingfisher nesting habitat. Upstream, the river banks become taller and some excellent banks for Kingfisher were recorded in the last kilometre, between Claregalway and Lackagh Bridge. Upstream to Tuam the surrounding habitats were predominately agricultural and have been much improved. Some areas of cutover and intact bog were present in the wider area. A waste transfer station was present adjacent to the river approaching Ballygaddy Bridge on the outskirts of Tuam, this station was considered to be a source of pollution for the River Clare. The habitats upstream between Tuam and where the Dalgan and Sinking converge were similar to those downstream of Tuam i.e. mainly agricultural land that has been much drained and improved and wet grassland with occasional scrub. Kingfishers were encountered frequently along the River Clare especially between Claregalway and Tuam.

Abbert River

The Abbert River between its confluence with the river Clare and where it meets the R347 was surrounded by agricultural farmland that had been much improved. The majority of the river downstream of Abbey was slow flowing and was considered to be depositing lowland river. Upstream of the R347 the river channel has been much altered at the site of an old mill and millrace at Brooklodge. A weir was also present in the river at this location. This area was surrounded by broadleaf woodland, although many non-native species were present within the woodland. Another old mill and millrace was present at Chapelfield were the river splits briefly in two before re-converging. Upstream of Chapelfield the river was surrounded by improved agricultural habitats. Broadleaf and coniferous plantations were also present adjacent to the river. Some good banks suitable for Kingfisher as well as slow flowing stretches ideal for fishing were present at this location. The Abbert River has been extensively managed for drainage in the past and a lot of material has been excavated and stockpiled parallel to the river. These banks of dredged material have often become overgrown with gorse scrub, occasionally obscuring the view of the river. As you walk further upstream more peatland habitats such as bog are encountered along the river. Agricultural farmland and coniferous plantations were also abundant. Kingfishers were recorded on the Abbert River during all three visits.

Grange River

The Grange River was surveyed on foot and was surrounded by agricultural farmland for most of its course. Conifer plantation, scrub, cutover bog and other degraded peatland habitats were also encountered adjacent to the river. The lower stretches of the river were mainly slow flowing and were considered to be depositing lowland river while the upper sections were considered to be eroding upland river. The banks in the vast majority of sections were not considered to be suitable to support Kingfisher nesting. Kingfisher was recorded twice on the lower sections of the river.

Sinking River

The lower parts of the Sinking River were surrounded by agricultural habitats, which had been heavily grazed in areas by cattle and ponies. The banks in this area of the river were tall, sloped and well vegetated. Between Ardcloon and Dunmore several stretches of suitable banks for Kingfisher nesting were noted. The

lower parts of the river downstream of Dunmore were slow flowing and considered to be depositing lowland river. The upper stretches of the river pass through several peatland habitats and less improved habitats. Further upstream the river branches into two channels and becomes more typical of an eroding upland river, with fast flowing sections and riffle zones. Kingfishers were recorded on the river in several locations and on all visits.

Dalgan River

The Dalgan River was surrounded by agricultural habitats that had been extensively drained with deep ditches intersecting the river. The soil in this area was peat based; it was evident that this habitat had been peatland at some time in the past. Several areas of wetter habitats, such as wet grassland, less improved habitats and flooded fields were present on the upper sections of the Dalgan. These habitats were hot spots for waders and Golden Plover, Lapwing and Curlew were recorded in these areas. The banks of the river were mainly composed of peat and were thus not considered suitable in the vast majority of sections surveyed. No Kingfishers were recorded on the Dalgan River during any of the three visits.

The Moy System

River Moy

The River Moy was surveyed using a Canadian Canoe. Light paddling was always necessary and strong paddling was often required as the northerly winds were against us. On the last survey trip water levels were exceptionally low and walking with the canoe was necessary, or scraping over the rocks. The survey began at Annagh Bridge just west of Tobercurry, Co. Sligo. The upper section of the river has many riffle areas, interspersed with stretches of slow moving water. River banks were generally low in the upper section, with some steep mud banks. Most of the banks supported a healthy strip of wet woodland vegetation and human impacts were not obvious. The low water levels on the last visit meant that stretches of stagnant and strongly smelling water did occur. The mid section of the river flowed from near Swinford across to Foxford. This section had faster moving water and a number of rapid sections. Slow moving stretches were also present and there were good stretches of steep bank habitat and generally good coverage of riparian vegetation, with overhanging trees. This stretch has been heavily modified for fishing purposes, with narrows created in the river channel and boulders and logs placed along river banks to prevent erosion. A number of cattle drinking areas, constructed using large boulders, were present or under construction. The lower section of the Moy, stretched from Foxford to Ballina. Aside from the rapids at Foxford this section was slow moving with deeper water, which was not particularly clear. The banks were sandy, steep in places and many had Sand Martin colonies. As in the middle section many banks were enforced with logs or boulders to prevent erosion. Riparian habitat in the lower section has largely been cleared to allow fishermen to view up and down the river and to prevent their lines being caught. This meant that overhanging trees were limited to a few stretches only. Kingfisher numbers were lowest in this section, but did occur in the wooded stretches. This section of river was heavily littered, with overhanging trees and branches adorned with silage wrap and plastic of all kinds. A great number of soccer balls were also noted. A purple shrimp was found in the river, perhaps a new invasive but then discovered to be fishing bait. However, two definite invasives, the Zebra Mussel *Dreissena polymorpha* and American Mink *Mustela vison* were both found on the river. Shells of the Freshwater Pearl Mussel *Margaritifera margaritifera* were regularly seen in the upper and mid river sections. Otter and Pine Martin were also seen. Kingfishers were observed in most river sections, as were nest holes. The holes were distinctive in their shape and were found on both sand and clay banks and on low or high banks, with overhanging vegetation or not. There was evidence of hole widening by predators at Sand Martin colonies, but not at Kingfisher nest sites. The river also supported breeding Dipper, Common Sandpiper, Grey Wagtail and Mallard, which were all seen with young on the last visit.

Yellow River

The Yellow River flows through an area of agricultural land, which has been extensively drained and improved. The whole area was probably bog in the past and there are large areas of cutover bog in the wider area. The river was surveyed on foot and many steep banked drainage ditches discharged to the river. Some small areas of scrub and broadleaf woodland were noted along the course of the river. The banks of the river were steep and well vegetated for the most part. The only Kingfisher was recorded during visit two, near the confluence with the main channel of the River Moy.

Strade River

A small section of the Strade River was surveyed on foot between Strade and the confluence of the river Moy. This section of the river flowed through farmland which had been improved by extensive drainage. Several deep drainage ditches were present adjacent to the river, especially in the northernmost sections. The water level was occasionally higher than the banks of these ditches during the first visit and adjacent land was flooded in some areas. The banks of the southern sections surveyed were considered to be

suitable for Kingfisher in places and a Kingfisher and a Kingfisher nest site were observed in this area. The banks downstream were densel vegetated and shallow in places and were not considered to be suitable for Kingfisher.

Gweestion River

The Gweestion River is a moderate to fast flowing river which was surrounded by agricultural habitats. This river was wide especially in the lower section and was in spate during the first survey period. Some scrub and woodland are present along its course and bankside vegetation is dense in places. A Kingfisher was recorded close to the rivers confluence with the River Moy during the first visit.

Kileen River

The Kileen River was surrounded by improved and semi-improved agricultural habitats. The river was considered to be an eroding upland river of moderate flow with an abundance of riffles. The banks of the river varied between 1 and 5 metres and were generally sloping and well vegetated; thus these banks were considered to be unsuitable as Kingfisher nesting habitat. No Kingfishers were recorded on this river.

Spaddagh River

The Spaddagh River was medium to fast flowing and was considered to be an eroding upland river. The majority of the river was surrounded by dense scrub and trees and access to the river bank was difficult. The adjacent land was used for agriculture and a mixture of rank and improved grasslands were evident in the surrounding area. For the most part the banks were shallow, but were considered to be marginally suitable for Kingfisher. No Kingfishers were recorded on this river.

Sonnagh River

A short stretch of the Sonnagh River was surveyed on foot between Gorteen Bridge and the rivers confluence with the River Moy. The banks of the river were tall, sloped and vegetated for the majority of the section surveyed. The water in the river was of moderate flow and the river was considered to be an upland eroding river. Kingfishers were not recorded on this river during any of the three visits. The surrounding habitats were mainly agricultural fields with scrub and treelines. A lot of Willow was noted along the river banks.

Mullaghanoe River

The banks of the Mullaghanoe River were steep and sloped especially where the river meets the River Moy. The majority of the land adjacent to the river has been somewhat improved and is managed for agricultural purposes. In the vicinity of Cloonfinish extensive drainage works have taken place on adjacent land and deep drainage ditches run perpendicular to the river. These ditches were very overgrown with scrub and trees and made access to the river very difficult. Some bands of conifer plantation were present immediately adjacent to the river along its course. Sewage works on the outskirts of Charlestown appeared to be pumping sewage into the river. Kingfishers were recorded on all of the visits on the eastern section of this river.

Eignagh River

The Eignagh River was surveyed between Aclare and the rivers confluence with the Moy. The upper sections of the river near Aclare were difficult to survey due to dense scrub and housing adjacent to the river. Continuing downstream, access becomes easier and a mixture of agricultural land and degraded peatland habitats are present in the vicinity of the river. Some patches of broadleaf woodland are also present along the river. No Kingfishers were recorded on the section of the Eignagh River surveyed.

Owengarve River

The last stretch of the Owengarve River before its confluence with the River Moy was surrounded by coniferous plantation, broadleaf woodland and scrub. Access in this area was difficult. A lot of peatland habitats, predominantly cutover bog, were present in the wider area. Upstream, the habitat was more open and less wooded, although mixed scrub and trees were still present along the watercourse. Very large conifer plantations and some broadleaf woodland were noted immediately adjacent to the river further upstream. On the outskirts of Curry pollution from a sewage plant was observed. Kingfishers were recorded once during the three visits upstream of Dawros Bridge.

<u>The Nore</u>

The River Nore

In visit one, the Nore was surveyed on foot from Nore Bridge at Timoney to approximately 3km west of Thomastown and from Brownsbarn Bridge south to Inistioge. A large section was not covered from Thomastown to Brownsbarn Bridge and from Inistioge to the River Barrow due to access and time constraints. In visit two the Nore was walked from Ballyragget to Thomastown and covered by boat from Quakers Bridge, west of Borris in Ossory, to Ballyragget and from Thomastown to the confluence with the Barrow River. The top section of the Nore, from Nore Bridge to Quakers Bridge, was walked as the river is too difficult for a boat to navigate. The boat work was undertaken in the second and third visits to allow field work to be carried out in the allotted time and to cover those areas that were inaccessible during the first visit. In visit three, survey work followed the same pattern as in visit two but the boat work was extended to include the section from Ballylinch Bridge to Thomastown. This section was included in order to view some potentially good Kingfisher banks that were not clearly visible on previous visits.

For the most part the River Nore was surrounded by improved agricultural habitats, although scrub, broadleaf woodland and coniferous plantation were common adjacent to the river corridor. In several areas along the course of the river more mature native woodlands were observed. The river flows through some peatland habitat at the uppermost sections surveyed in the vicinity of Nore Bridge. From Nore Bridge to Quakers Bridge the river was narrow and some sections were surrounded by dense scrub and woodland. Some very good Kingfisher nesting banks were observed between Quakers Bridge and Ballyragget. This area was difficult to access in places due to the density of the vegetation.

The lower sections of the Nore from Inistioge to where the river flows into the Barrow were extremely difficult to access due to the steep wooded valley that surrounds the river. The woodland was a mixture of broadleaf and coniferous trees and an abundance of rhododendron were growing on the water edge. In addition the river was very wide at this location and it would be easy to miss birds perched on the other side of the river. This section of the river was influenced by the tide and a lot of soft mud had been deposited in the lower sections.

Erkina/Goul River

The upstream sections of the Erkina River were surrounded by improved and highly managed habitats. The fields surrounding the river appeared to have been extensively drained in the past. Little or no scrub or trees which could provide possible perches for Kingfisher were observed in this area. In addition the banks in this area appeared to be unsuitable for Kingfisher due to a peaty soil composition. The middle section surveyed consisted of a large area of dense broadleaf woodland. Further downstream the river flows through the built up area of Durrow, (where some houses had gardens backing onto the river) before joining the River Nore. Very little riparian bird life was seen on the surveyed sections of the Erkina River. Kingfishers were recorded on this river at three locations during visit two.

Owenbeg River

The Owenbeg River was often fast flowing, with a significant proportion of unvegetated vertical bank that therefore provided good nesting potential for Kingfishers. The river bank was bordered with scrub and trees which occasionally blocked the view of the river. The river was surrounded by improved agricultural fields with well maintained field boundaries (hedges). Some wooded areas were observed especially in areas where steep banks surrounded the river such as at Loughill Bridge. Surrounding land use was mainly agricultural and cattle were frequently observed grazing along the river. Occasionally livestock had access to the river, which was considered to be a source of pollution. The last kilometre of the river heading towards Loughill bridge was very overgrown with dense deciduous woodland. Kingfishers were sighted at several locations on the river during the first two survey periods.

Kings River

The Kings River from Kyleaduhir Bridge to Callan was accessible, for the most part, as it passed through areas of open farmland. These agricultural areas had been much improved (slurry spreading and seeding) and some areas had been extensively drained. Access to the river was difficult at Kyleadohir forest, which is a large area of woodland on the uppermost section of the river surveyed. The banks along these uppermost sections were heavily vegetated and the river was often overgrown with bank vegetation. Some fast flowing sections were noted in this upper section of the river. The south side of the river was very built up in the town of Callan and access to the river was impeded. Immediately downstream of Callan, a wastewater treatment plant was discharging waste water into the river. Approximately one kilometre downstream of Callan the river splits in two at the site of an old mill race. The southern section of the river was surveyed during the first visit and the river at this location was very stagnant and slow flowing. The area surrounding the river was surrounded by wet woodland which was in flood during the first visit. Access to the river was difficult and a small section was skipped in this area due to the density of the surrounding Willow and some human habitation. Further downstream towards Kells and beyond, the habitats open up and are predominantly agricultural, with some areas of wet grassland and broadleaf woodland. The banks of the river appeared to be suitable for Kingfishers in this area, although they were often quite low. A second disused mill and mill

race was present approximately half way between Kells and Callan. Kingfishers were encountered on several occasions on the lower section of the river near its confluence with the River Nore.

Gill System – Bonet and Shanvaus rivers

The Gill system comprises of Loughs Gill, Doon & Glenade, and Rivers Garavogue, Bonet, Owenmore & Shanvaus. It is an SAC for White Clawed Crayfish, Otter, Salmon; Brook, River & Sea Lamprey, as well as the habitats of alluvial wet woodlands, old oak woodlands and natural eutrophic lakes. The section covered for this survey was from rivers from just north of Manorhamilton (Bonet and Shanvaus) to where the river enters Lough Gill. Flood relief works are carried out on the Bonet annually by the OPW. Works consist of Silt/vegetation management, aquatic vegetation cutting, bank protection (including rock armouring and wooden flood defences), Tree & shrub trimming, and bridge structure repair/replace.

The top sections of both rivers are fast flowing and run through native woodland/scrub before changing into a meandering slow flowing river with steep open unfenced banks which are grazed by sheep. Two territories were located along this stretch. Further along the banks become lower and rockier, and surrounding habitat becomes mainly ungrazed, rushy, scrubby pasture and in some places closed in on both sides with coniferous and native woodland. One of the few places along this stretch with suitable habitat and banks was where the 3rd territory was located, beside some old flood defence works. The Kingfisher was seen to perch on the flood defence posts in the 1st visit and on the 3rd visit a nest hole was evident in the bank behind the flood defences. Many of the wooden flood defences on the river are now quite old, standing 1-2 metres from the bank, allowing the bank's continued use by Kingfishers.

A further stretch passes through intensive improved grassland and cattle grazing before passing through an unsuitable section in the town of Dromahair, which is dominated by waterfalls, rapids and very rocky sections. Between Dromahair and Lough Gill there was a couple of kilometres of suitable meandering river with good perches and banks and the 4th Kingfisher territory was located here, near a regularly used fishing pool. Finally as the river discharges into Lough Gill the low banks were dominated by alluvial forest.

Appendix 3. Further details on river coverage in 2010.

River	visit	Start date	End date	Number sections	Total length	% Walked	% Dinghy	% Canadian canoe	% Kayak
Barrow									
Aughavaud	1	24/03/2010	09/04/2010	7	2.6	100.0			
Aughavaud	2	30/04/2010	30/04/2010	6	2.2	100.0			
Aughavaud	3	25/05/2010	25/05/2010	7	2.6	100.0			
Barrow	1	06/04/2010	15/04/2010	202	107.0	83.7		16.3	
Barrow	2	28/04/2010	07/05/2010	207	109.4	57.1			42.9
Barrow	3	25/05/2010	01/06/2010	206	108.7	77.3			22.7
Fushoge	1	23/03/2010	23/03/2010	10	4.3	100.0			
Fushoge	2	27/04/2010	27/04/2010	10	4.3	100.0			
Fushoge	3	24/05/2010	24/05/2010	10	4.3	100.0			
Lerr	1	25/03/2010	25/03/2010	19	8.8	100.0			
Lerr	2	26/04/2010	27/04/2010	19	8.8	100.0			
Lerr	3	24/05/2010	24/05/2010	17	7.9	100.0			
Mountain	1	24/03/2010	24/03/2010	23	9.8	100.0			
Mountain	2	28/04/2010	28/04/2010	23	9.8	100.0			
Mountain	3	31/05/2010	31/05/2010	23	9.8	100.0			
Blackwater									
Allow	1	15/03/2010	17/03/2010	61	29.3	100.0			
Allow	2	12/04/2010	14/04/2010	61	29.7	100.0			
Allow	3	10/05/2010	11/05/2010	62	29.8	100.0			
Awbeg	1	17/03/2010	24/03/2010	61	25.9	100.0			
Awbeg	2	14/04/2010	15/04/2010	60	25.5	100.0			
Awbeg	3	12/05/2010	13/05/2010	60	25.5	100.0			
Blackwater	1	15/03/2010	24/03/2010	245	124.6	19.2	80.8		
Blackwater	2	12/04/2010	16/04/2010	245	124.7	19.3	80.7		
Blackwater	3	10/05/2010	12/05/2010	242	124.0	18.8	81.2		
Bride	1	22/03/2010	23/03/2010	76	37.6	26.3	73.7		
Bride	2	15/04/2010	15/04/2010	71	38.4		100.0		
Bride	3	13/05/2010	17/05/2010	71	38.4		100.0		
Boyne									
Blackwater	1	29/03/2010	03/04/2010	55	30.5	100.0			
Blackwater	2	19/04/2010	20/04/2010	63	34.5	100.0			
Blackwater	3	20/05/2010	25/05/2010	60	33.0	100.0			
Boyne	1	27/03/2010	29/03/2010	151	72.2			100.0	
Boyne	2	24/04/2010	25/04/2010	151	72.2			100.0	
Boyne	3	21/05/2010	22/05/2010	151	72.2			100.0	
Deel	1	27/03/2010	31/03/2010	56	28.7	100.0			
Deel	2	22/04/2010	23/04/2010	56	28.7	100.0			
Deel	3	19/05/2010	20/05/2010	56	28.7	100.0			
Stoneyford	1	31/03/2010	01/04/2010	29	15.0	100.0			
Stoneyford	2	21/04/2010	21/04/2010	22	11.5	100.0			
Stoneyford	3	18/05/2010	18/05/2010	29	15.0	100.0			
Tremblestown & Athboy	1	01/04/2010	01/04/2010	16	8.7	100.0			
Tremblestown & Athboy	2	20/04/2010	20/04/2010	16	8.7	100.0			
Tremblestown & Athboy	3	17/05/2010	17/05/2010	19	10.1	100.0			
Clare									
Abbert	1	29/03/2010	29/03/2010	58	27.6	100.0			
Abbert	2	20/04/2010	20/04/2010	58	27.6	100.0			
Abbert	3	14/05/2010	19/05/2010	58	27.6	100.0			
Clare	1	26/03/2010	30/03/2010	117	55.4	100.0			
Clare	2	19/04/2010	28/04/2010	110	52.0	100.0			
Clare	3	13/05/2010	17/05/2010	88	41.3	100.0			
Dalgan	1	31/03/2010	31/03/2010	23	10.9	100.0			
Dalgan	2	27/04/2010	27/04/2010	22	10.4	100.0			
Dalgan	3	17/05/2010	17/05/2010	16	7.4	100.0			
Grange	1	01/04/2010	01/04/2010	58	25.8	100.0			
Grange	2	23/04/2010	28/04/2010	58	25.8	100.0			
Grange	3	18/05/2010	18/05/2010	58	25.8	100.0			
Sinking	1	02/04/2010	02/04/2010	38	15.8	100.0			

Sinking	2	28/04/2010	28/04/2010	38	15.8	100.0			
Sinking	3	19/05/2010	19/05/2010	38	15.8	100.0			
Gill									
Bonet	1	15/03/2010	14/04/2010	50	24.7	100.0			
Bonet	2	04/05/2010	07/05/2010	50	24.7	50.1		49.9	
Bonet	3	24/05/2010	31/05/2010	50	24.7	66.1		33.9	
Shanvaus	1	15/03/2010	15/03/2010	5	2.2	100.0			
Shanvaus	2	04/05/2010	04/05/2010	5	2.2	100.0			
Shanvaus	3	30/05/2010	30/05/2010	5	2.2	100.0			
Ilen									
Ilen	1	23/03/2010	23/03/2010	25	12.2		100.0		
Ilen	2	29/04/2010	29/04/2010	22	10.6		100.0		
Ilen	3	20/05/2010	20/05/2010	22	10.6		100.0		
Moy									
Eignagh	1	06/04/2010	06/04/2010	11	4.9	100.0			
Eignagh	2	04/05/2010	04/05/2010	11	4.9	100.0			
Eignagh	3	20/05/2010	20/05/2010	11	4.9	100.0			
Gweestion	1	06/04/2010	06/04/2010	12	4.8	100.0			
Gweestion	2	28/04/2010	29/04/2010	9	4.3	100.0			
Gweestion	3	20/05/2010	20/05/2010	12	4.8	100.0			
Killeen	1	05/04/2010	05/04/2010	5	2.2	100.0			
Killeen	2	28/04/2010	28/04/2010	5	2.2	100.0			
Killeen	3	20/05/2010	20/05/2010	5	2.2	100.0			
Moy	1	23/03/2010	27/03/2010	119	64.9				100.0
Moy	2	01/05/2010	03/05/2010	119	64.9				100.0
Moy	3	28/05/2010	30/05/2010	119	64.9				100.0
Mullaghanoe	1	07/04/2010	07/04/2010	22	10.4	100.0			
Mullaghanoe	2	30/04/2010	30/04/2010	22	10.4	100.0			
Mullaghanoe	3	21/05/2010	21/05/2010	22	10.4	100.0			
Owengarve	1	07/04/2010	07/04/2010	16	7.9	100.0			
Owengarve	2	04/05/2010	04/05/2010	16	7.9	100.0			
Owengarve	3	21/05/2010	21/05/2010	16	7.9	100.0			
Sonnagh	1	07/04/2010	07/04/2010	3	1.3	100.0			
Sonnagh	2	30/04/2010	30/04/2010	3	1.3	100.0			
Sonnagh	3	21/05/2010	21/05/2010	3	1.3	100.0			
Spaddagh	1	05/04/2010	05/04/2010	3	1.2	100.0			
Spaddagh	2	29/04/2010	29/04/2010	3	1.2	100.0			
Spaddagh	3	20/05/2010	20/05/2010	3	1.2	100.0			
Strade	1	06/04/2010	06/04/2010	5	2.2	100.0			
Strade	2	28/04/2010	28/04/2010	5	2.2	100.0			
Strade	3	20/05/2010	20/05/2010	5	2.2	100.0			
Yellow	1	06/04/2010	06/04/2010	12	4.3	100.0			
Yellow	2	28/04/2010	29/04/2010	12	4.3	100.0			
Yellow	3	20/05/2010	20/05/2010	13	4.8	100.0			
Nore									
Erkina	1	14/04/2010	14/04/2010	20	9.0	100.0			
Erkina	2	05/05/2010	06/05/2010	19	8.5	100.0			
Erkina	3	27/05/2010	27/05/2010	18	8.0	100.0			
Goul	1	14/04/2010	14/04/2010	3	1.5	100.0			
Goul	2	05/05/2010	05/05/2010	3	1.5	100.0			
Goul	3	28/05/2010	28/05/2010	3	1.5	100.0			
Kings	1	09/04/2010	09/04/2010	54	23.9	100.0			
Kings	2	05/05/2010	07/05/2010	51	22.4	100.0			
Kings	3	26/05/2010	28/05/2010	49	22.9	100.0			
Nore	1	08/04/2010	16/04/2010	183	91.1	100.0			
Nore	2	04/05/2010	10/05/2010	236	117.0	33.0		24.9	42.1
Nore	3	26/05/2010	28/05/2010	209	113.7	32.9		24.1	43.0
Owenbeg	1	09/04/2010	14/04/2010	17	9.9	100.0			
Owenbeg	2	06/05/2010	06/05/2010	17	9.9	100.0			
Owenbeg	3	28/05/2010	28/05/2010	17	9.9	100.0			

Appendix 4. Recommendations for future boat-based surveys of riparian birds

Surveying using boats proved extremely valuable and useful in covering large stretches of river and is ideal for surveying riparian birds. The main drawback of this method is that it is less effective at detection of birds in surrounding fields, which may often hold riparian bird species and others of note. However, this shortcoming is offset by the fact that boat work is vital in giving exact locations of Kingfisher nests, and it provides a better opportunity to view Kingfisher behaviour such as fishing, feeding, mating etc.

Boat Surveying: difficulties and solutions

1. Demands on surveyors differ between boat surveys and those on foot. For example, the speed of work is much greater by boat (recording every few minutes) which can be demanding and lead to observer fatigue.
2. Boat Surveys place physical demands on surveyors. The use of upper body strength for paddling and the necessity of long stints of time in the boat can lead to cramping and back problems. To minimise the affects of such work on the bird surveyor who may not be accustomed with boat work, it is important that regular breaks are taken for stretching and rest. Ideally legs should be stretched frequently whilst in the boat and a supportive chair or cushion should be provided in Canadian canoes. Furthermore, it is essential to have a 'buddy' in the boat with adequate bird knowledge, to count birds that may be missed while the 'main' surveyor is taking notes, (which can happen quite frequently due to the speed at which the boat can progress along the survey route). Such measures would alleviate the pressure on the surveyor and benefit data collection and data quality.
3. Risks for surveyors on rivers differ to those on land. Travelling by boat; there are weirs, strong riffles, trees that have fallen into the river, fast approaching overhanging branches and a greater exposure to the elements (water, wind and sun). Prior to taking part in any boat surveys, members of the field team need to be informed as to how to deal with these risks while in the water and they should be alerted to any approaching obstacles by their canoeing partner in good time, to allow time to prepare and secure notes. For health and safety reasons a life jacket should always be worn and for protection against the elements some form of wet suit is desirable as it protects against the constant drip from rowing (particularly the case with kayaks). Sun block should be applied regularly (particularly in summer months) and a cap and/or sunglasses should always be worn. The latter is not only important for health reasons but also for recording, as visibility can be impaired by the glare off the water.
4. There are differing factors affecting the surveyors recording on boats. Visibility is affected to a greater degree by weather conditions rather than vegetation cover and the ability to accurately detect tertiary habitat is reduced, as banks often obscure views of surrounding habitat (e.g. upper sections of Boyne). In addition, both banks can be recorded which may leave discrepancies between visits depending on which bank is observed to greater degree. Importantly, notes taken on a boat are prone to greater water damage. To minimise the discrepancies between surveying techniques weather should be included in the detectability bracket. The boat could be slowed down, if the surveyor is unsure of bankside vegetation and surrounding habitat, or the surveyor could alight, if possible, from the boat and gain a good vantage point. However as the latter solution is time consuming and largely impractical the best approach is to combine general knowledge of the area with what can be viewed from the boat.
5. In the case of bank recording the most dominant feature (e.g. bank size, direction and vegetation) between both banks should be taken and recorded. Also, notes taken on a boat are prone to greater water damage. Thus, it is very beneficial to have a weather writer to protect notes (and/or use waterproof paper) and when recording is finished it is important to keep notes off the floor of the boat where water often gathers. It is advisable for the surveyor to keep notes on their lap when not in use and to put them under the spray deck if in a kayak when going over a weir. Also, to protect equipment (e.g. gps, reference books, binoculars) in use while on the boat, it is useful to either store them in a watertight bag or barrel or keep them in the pocket of the life jacket.
6. Use double kayaks, rather than Canadian canoes, on rivers with many weirs as they are more easily navigated by the surveyor (and field notes stand a greater chance of surviving undamaged). As kayaks are faster than Canadian canoes, greater coverage can be achieved in a shorter amount of time which is essential given the usual time constraints for surveying rivers.
7. Canadian canoes are recommended when going shorter distances on easier stretches of river and when the boating partner has little bird knowledge, as the surveyor is more likely to pick up birds by song, since Canadian canoes can be slightly quieter when paddling.