

# BANDON FLOOD RELIEF SCHEME

## FISH STOCK ASSESSMENT



Version: 1<sup>st</sup> November 2011 (Final)



Tait Business Centre, Dominic Street, Limerick City, Ireland.  
t. +353 61 419477, f. +353 61 414315  
e. [info@ecofact.ie](mailto:info@ecofact.ie)  
w. [www.ecofact.ie](http://www.ecofact.ie)

## SUMMARY

A fish stock assessment was undertaken on the Lower River Bandon during September 2011. The purpose of this assessment was to provide baseline data to inform the design of a flood alleviation scheme being designed for the town. A total of 12 sites were investigated in the study area which stretch from above Bandon weir to Innishannon. Two of the sites were located upstream of the proposed scheme area and were used as reference sites, five of the sites were located within the area likely to be directly affected by the proposed scheme, while four sites were located downstream of the proposed works area and could be indirectly affected by any instream works. Some of the works area was being affected by dredging works which were being undertaken in the River by Cork County Council during 2011. Similar work had been undertaken in the river by Cork County Council during 2010 and previously by other bodies. The current study was affected by slightly elevated water levels and the fact that dredging works were ongoing in the river at the time of the assessment.

A total of eight fish species occur in the study area. The most common species recorded was Atlantic salmon *Salmo salar*, followed by minnow *Phoxinus phoxinus*. The other fish species recorded were River lamprey *Lampetra fluviatilis*, Brook lamprey *Lampetra planeri*, three-spined stickleback *Gasterosteus aculeatus*, stone loach *Barbatula barbatula*, European eel *Anguilla anguilla* and flounder *Platichthys flesus*. The lower River Bandon has exceptional juvenile salmon populations. The current survey has confirmed that salmon spawn throughout the lower river. This is an SAC quality River for this species. The lower River Bandon is less important in relation to trout populations. This is to some degree to do with habitats; however competition from the large salmon populations may also be a factor. Adult sea trout and salmon were observed throughout the lower river during the current survey. The lower River Bandon also has exceptional juvenile lamprey populations. Both River lampreys and Brook lampreys are thought to be present. River lampreys are only present in the River Bandon downstream of Bandon weir. No lampreys were recorded in the area which had been affected by the 2010/2011 dredging, but were present at all other sites investigated. Indeed, some of highest densities of river lampreys ever recorded in Ireland were recorded during the current survey. This is an SAC quality river for River lamprey also, a species listed under Annex II and V of the EU Habitats Directive. Sea lampreys are absent from the River Bandon. Eels, an endangered species globally, are common in the study area.

The current survey was undertaken in advance of any designs for the proposed scheme being available, so no impact assessment or mitigation measure section is included in this report. It is clear however that any scheme on this river has the potential to significantly affected both salmon and lampreys population. It is thought that river lampreys cannot pass Bandon Weir at present so would be particular vulnerable impacts from a flood scheme. Even if no dredging works are proposed construction of river walls or other modifications would directly affect the habitats that juvenile lampreys use. Dredging can have even more devastating effects, as silt deposits that lampreys use for their extended juvenile life cycle phase would be removed and would be difficult to mitigate for this habitat loss. Sedimentation from instream works could affected both salmonid and lamprey reproduction in the river by affecting areas where these species spawn. If works were undertaken during the lamprey (April to July) or salmon (October to May) close seasons the works could have a devastating effect on these species.

A range of mitigation responses are available however. Careful project design to minimise instream works is certainly recommended. It is clear that water management should be looked into at a catchment wide level. Works should be timed to avoid times when fish are spawning in the river and juvenile lamprey population will need to be moved out of the way prior to works. Habitat restoration could be undertaken in relation and provision of lamprey passage through the Bandon weir could be included as an enhancement / rehabilitation measure.

## TABLE OF CONTENTS

<b>1.</b>	<b>INTRODUCTION .....</b>	<b>5</b>
<b>2.</b>	<b>METHODOLOGY .....</b>	<b>6</b>
2.1	SURVEY SITES AND METHODS .....	6
2.2	LIMITATIONS OF THE SURVEY .....	8
<b>3.</b>	<b>RESULTS .....</b>	<b>18</b>
3.1	SURVEY SITES .....	20
3.1.1	Site 1 .....	20
3.1.2	Site 2 .....	21
3.1.3	Site 3 .....	22
3.1.4	Site 4 .....	24
3.1.5	Site 5 .....	25
3.1.6	Site 6 .....	26
3.1.7	Site 7 .....	27
3.1.8	Site 8 .....	27
3.1.9	Site 9 .....	28
3.1.10	Site 10 .....	30
3.1.11	Site 11 .....	31
3.1.12	Site 12 .....	32
<b>4.</b>	<b>DISCUSSION .....</b>	<b>54</b>
	<b>REFERENCES .....</b>	<b>56</b>



## 1. INTRODUCTION

A flood alleviation scheme for the River Bandon at Bandon town is currently being designed. During consultation with Inland Fisheries Ireland (IFI) at the early design stage of this scheme a fish stock assessment was requested by Inland Fisheries Ireland (Dr. Patrick Buck, 2 February 2011). Ecofact Environmental Consultants Ltd. were commissioned by Ryan Hanley Consulting Engineers to undertake this survey during late August 2011. Survey work and sampling was undertaken on the 15<sup>th</sup> and 16<sup>th</sup> September and on the 22<sup>nd</sup> and 23<sup>rd</sup> September 2011. With water levels, seasonal constraints and other factors, these were the only windows available for this survey following issuing of the Section 14 license. The survey was completed and a full description of the fish stocks present in the River Bandon from Inishannon to the weir and Bandon is presented in this report.

According to Inland Fisheries Ireland the Bandon River is one of the premier salmonid fisheries in the South West Region of Ireland. A fish counter located on the weir/fish pass in Bandon records the upward movement of salmon and sea trout; however this is a partial count only and salmonids can also pass directly over the weir at this location. According to IFI during 2010 a total of 3,791 fish were recorded passing through the counter, and IFI estimates that in 2010 a total of approximately 6318 fish (adult salmon and sea trout) moved upstream over the weir in Bandon. They point out however that this figure does not take into account returning fish which spawned in the main channel downstream of the weir or in any of the tributaries which enter the main channel downstream of the weir e.g. Bridewell and Brinny Rivers. With respect to catch statistics the average annual angling catch for the years 2003-2006 was 517 fish (salmon and sea trout > 40cm) per year for the Bandon system (Source IFI). For 2010 an angling quota of 350 fish and a draft net quota of 61 fish applied for the Bandon River.

According to IFI the River Bandon between Baxter's Bridge and Innishannon Bridge (where the river becomes tidal) can be categorised as being all salmonid spawning, nursery or angling waters. IFI also noted that in addition to salmonids, freshwater pearl mussel, lamprey and eels have been recorded within the constraints study area.

The current survey and assessment was undertaken in the absence of any design information / proposal regarding the proposed flood alleviation scheme.

IFI have recommended that "the current assessment of flooding events in Bandon must be a catchment wide process assessing the impact of changes in drainage, development and land use patterns and practices on the response of flows in the Bandon River to rainfall events". Likewise, they have recommended that "the potential solutions should consider the catchment in its entirety and not focus solely on the small area set out in the constraints study". It is noted that the current study has been limited to assessing the River Bandon between Inishannon and Bandon weir only; with two reference sites upstream of here also selected.

## 2. METHODOLOGY

### 2.1 Survey sites and methods

A total of 12 sites were examined as part of the current fish stock assessment. Four locations on the River Bandon were examined downstream of the proposed flood relief scheme near Inishannon. The River Bandon was surveyed at six locations within the stretch directly affected by the proposed flood relief scheme. Two locations were surveyed upstream of the proposed scheme; one on the Bandon River and another on the Bridewell River, a tributary of the Bandon River. The locations of the study sites are given in Table 1 and are also shown in Figures 1-9. The fish stock assessment involved electrical fishing, sweep sampling and snorkeling.

The survey was carried out under authorisation from the Department of Communication, Energy and Natural Resources under Section 14 of the Fisheries Act (1980). Electrical fishing specifically for salmonids was carried out at each site following the methodology outlined in the manual "*Methods for the Water Framework Directive - Electric fishing in wadable reaches*" by CFB (2008). Portable electrical fishing units (Smith Root-LR 24 Model) were used during the assessment. At sites for the assessment of juvenile salmonids, fishing was carried out continuously for 20 minutes at each site and captured fish were collected into a container of river water. Fish species other than salmon and trout were also recorded in this component of the survey. Following completion of the fishing, the dimensions and physical habitat characteristics of the site were recorded.

Electrical fishing for European eel was also carried out at each location by focusing on rocky substrate. During this survey, an area of 5m<sup>2</sup> (ca. 2.2m X 2.2m) was examined semi-quantitatively.

Quantitative electrical fishing for juvenile lampreys was carried out at each location. An area of 3m<sup>2</sup> was examined at each location. This was achieved by placing a netted frame enclosing an area of 1m<sup>2</sup> at each of three sub-sites at each survey location. Electrical fishing within the enclosure followed methodology outlined in O'Connor (2004). Lampreys were measured to the nearest millimetre (Standard Length), weighted to the nearest 0.1g and identified using the keys given in Gardiner (2003). Larvae of the two *Lampetra* species which occur in Ireland (*L. planeri* and *L. fluvialitis*) are impossible to separate by external examination. However, as transformation proceeds, the different development trajectories of the two species become apparent and identification is possible based on size of transforming individual and physical characteristics.

During the electrical fishing surveys, an assistant held an insulated dip net for collecting fish that failed to be captured by the operator.

Sweep sampling was undertaken along the margins of the river at each site. A dip net (mesh size 1mm; 40 cm x 40 cm frame, handle length 182 cm) was submerged and quickly swept through the water and aquatic/emergent vegetation, each sweep lasting 2-3 seconds. A total of 20 sweeps at random locations along the river was carried out at each site.

**Table 1** Locations of the survey sites and the fish surveys carried out at each site.

Site	Location	NOS Grid Reference	Fish surveys carried out					Snorkelling
			Salmonid semi-quantitative electrical fishing	Juvenile lamprey quantitative electrical fishing	Eel semi-quantitative electrical fishing	Sweep netting		
1	Bandon River immediately downstream of N71 Inishannon Bridge, ca. 6km downstream of Bandon	W54094 57047	✓	✓	✓	✓	✓	
2	Bandon River ca. 200m downstream of the River Brinny confluence, ca. 5.2km downstream of Bandon	W53279 57497	✓	✓	✓	✓	✓	
3	Bandon River adjacent to car parking area at Ardnaclug. Ca. 4.8km downstream of Bandon	W53013 57189	✓	✓	✓	✓	✓	
4	Bandon River ca. 4km downstream of Bandon	W52340 57676	✓	✓	✓	✓	✓	
5	Bandon River ca. 3.2km downstream of Bandon	W51604 57006	✓	✓	✓	✓	✓	
6	Bandon River ca. 2.5km downstream of Bandon	W51455 56702	✓	✓	✓	✓	✓	
7	Bandon River ca. 2km downstream of Bandon	W50964 56241	✓	✓	✓	✓	✓	
8	Bandon River ca.1km downstream of Bandon	W50280 55600	✓	✓	✓	✓	✓	
9	Bandon River immediately downstream of Bandon Bridge	W48961 55104	✓	✓	✓	✓	✓	
10	Bandon River downstream of the weir in Bandon	W49015 55095	✓	✓	✓	✓		
11	Bandon River ca. 2km upstream of Bandon	W47068 54739	✓	✓	✓	✓	✓	
12	Bridewell River approximately 2km upstream of the Bandon River confluence	W47651 53743	✓	✓	✓	✓	✓	

Captured fish for each survey type were anaesthetised after individual surveys using a solution of 2-phenoxyethanol. All captured fish were identified and measured to the nearest mm using a measuring board. Subsequent to this the fish were allowed to recover in a container of river water. All fish were released alive and spread evenly over the sampling area. Results of the investigations are presented using Catch per Unit Effort (CPUE) indices; fish number/m<sup>2</sup> and fish number/minute.

At each site, a reach of river was also surveyed by snorkeling, a reach being defined as 'a section of stream at least twenty times longer than its average channel width that maintains homogenous channel morphology, flow, and physical, chemical and biological characteristics' (Flosi and Reynolds, 1994). During this assessment an attempt was made to record all fish species seen. This survey mainly targeted adult fish (i.e. adult salmon and sea trout). However, conditions were generally suboptimal for this type of assessment due to elevated water levels and ongoing dredging works on the river (see below).

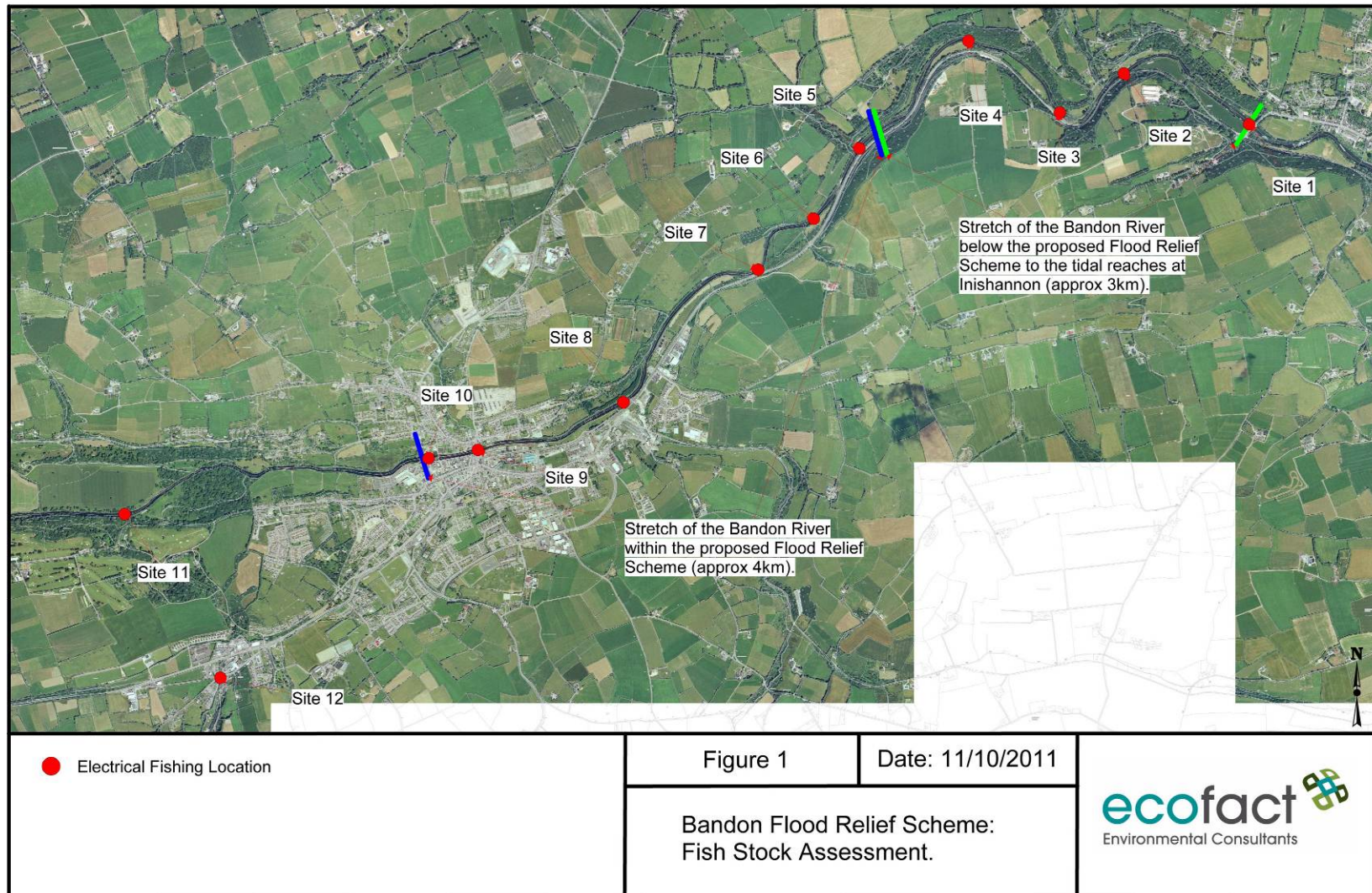
## **2.2 Limitations of the survey**

Advance survey work was carried out on the 4<sup>th</sup> to 5<sup>th</sup> September to select sites for the subsequent survey. River levels were low and ideal for survey work at this time. The license to undertake the survey was unfortunately not in place at this time, and the River Bandon went into flood shortly after this. Actual survey work and sampling was undertaken on the 15<sup>th</sup> and 16<sup>th</sup> September and on the 22<sup>nd</sup> and 23<sup>rd</sup> September 2011. With water levels, seasonal constraints and ongoing river dredging works, these were the only windows available for this survey. It is noted that water levels on the 15<sup>th</sup> September and 22<sup>nd</sup> September were higher than normal. Water levels on the following days (17<sup>th</sup> and 23<sup>rd</sup> September) were slightly lower, but still considered elevated. Water clarity was good on all survey dates with the exception of the 22<sup>nd</sup> September when work had to be abandoned due to deterioration in water visibility. This was caused by dredging works in Bandon. Turbidity levels were still slightly elevated on the 23<sup>rd</sup> September.

The current survey was commissioned as a fish stock assessment only. The habitat survey has been presented elsewhere and no quantitative assessment of habitats has been made in the current report. No project proposal was available for consideration at the time of preparing the current report. Therefore the current document is a description of the baseline receiving environment in terms of fish and lamprey populations only. It is noted that the habitats and fish populations of the study area may have already been significantly affected by the extensive dredging work that took place during 2010- and which was ongoing during the current survey.

The juvenile salmonid survey was by its nature, semi-quantitative. Attempts were made to close off the areas selected for salmonid electrical fishing using heavy duty fine mesh stop nets. These nets were set up to enclose the area but these could not be stabilised due to the slightly elevated water levels experienced at the time of the survey. The boundary of the surveyed area at each location therefore was chosen to comprise of a bank of the river, and where possible other features that limited fish from swimming from the survey area were utilised as boundaries (e.g. exposed rock, high gradient riffles in the channel). However, this approach is likely to have lowered catch efficiency for salmonids. However, this will not have affected the overall evaluation of the fish populations in the study area. Snorkeling work was also affected by the environmental constraints discussed above, but extensive qualitative snorkeling surveys were completed. Surveys for lampreys were completed successfully with all areas successfully enclosed at each site using a mesh box.

## Bandon Flood Relief Scheme: Fish Stock Assessment



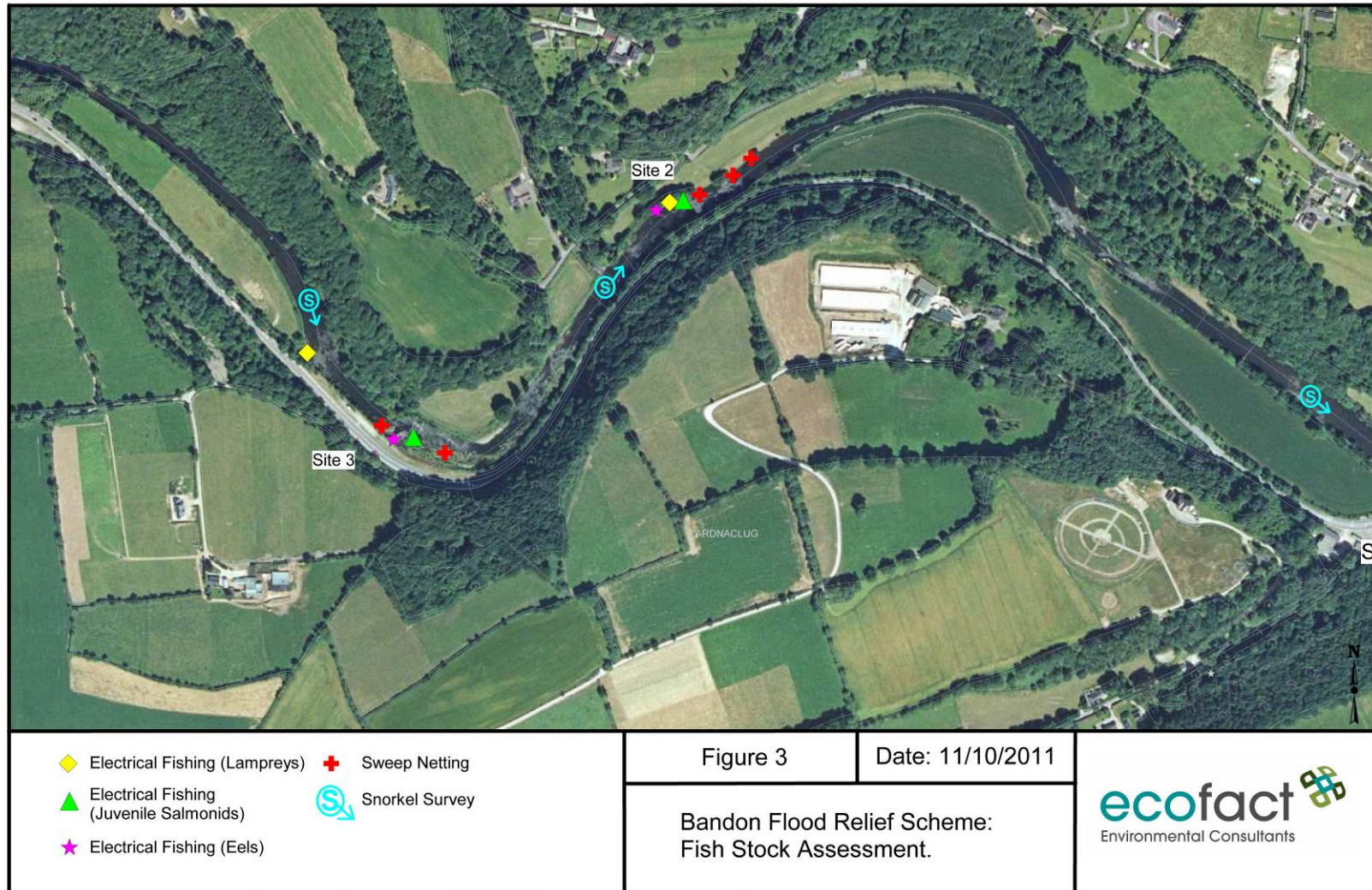


## Bandon Flood Relief Scheme: Fish Stock Assessment (Site 1)



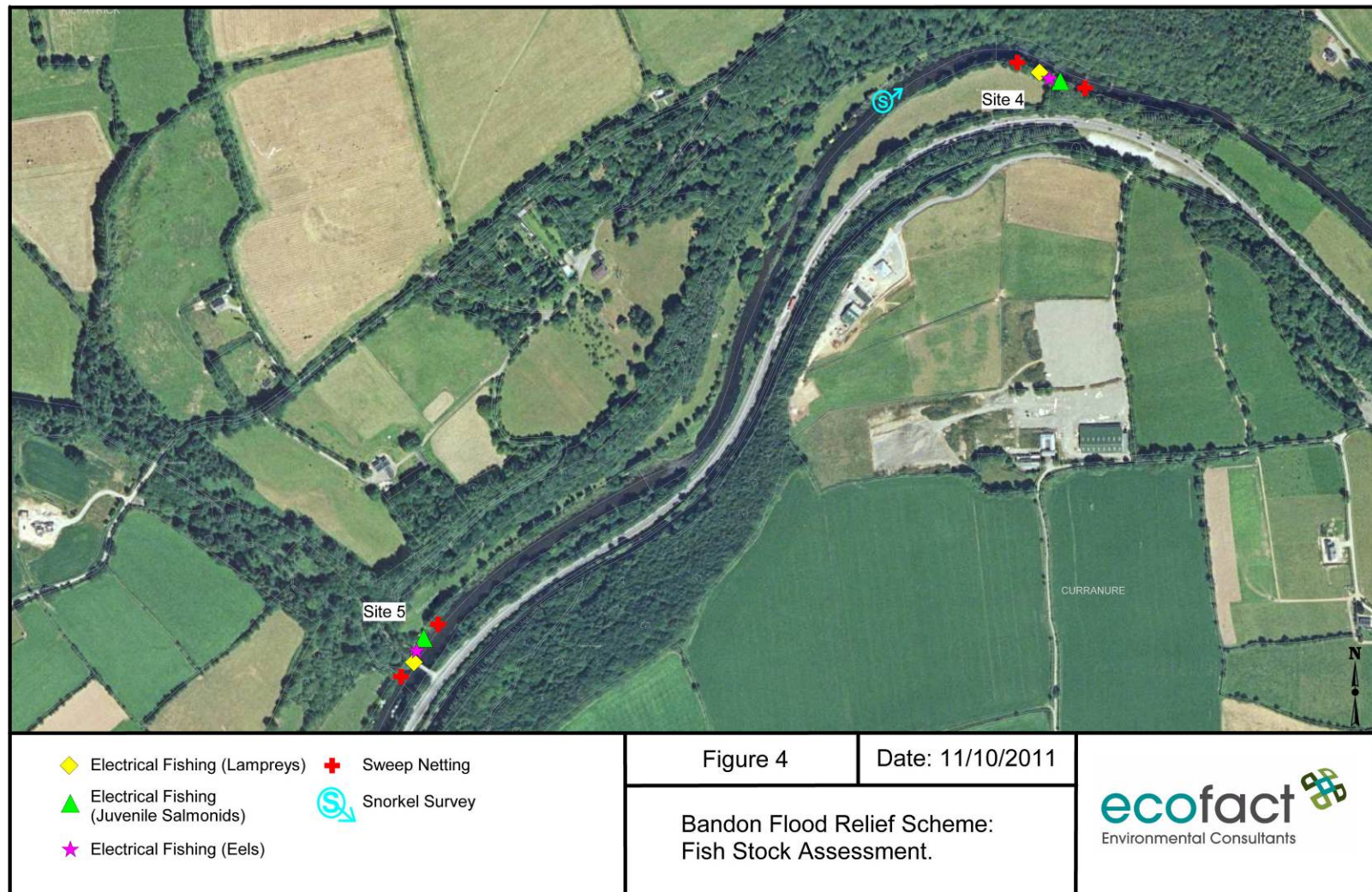


## Bandon Flood Relief Scheme: Fish Stock Assessment (Sites 2 and 3)



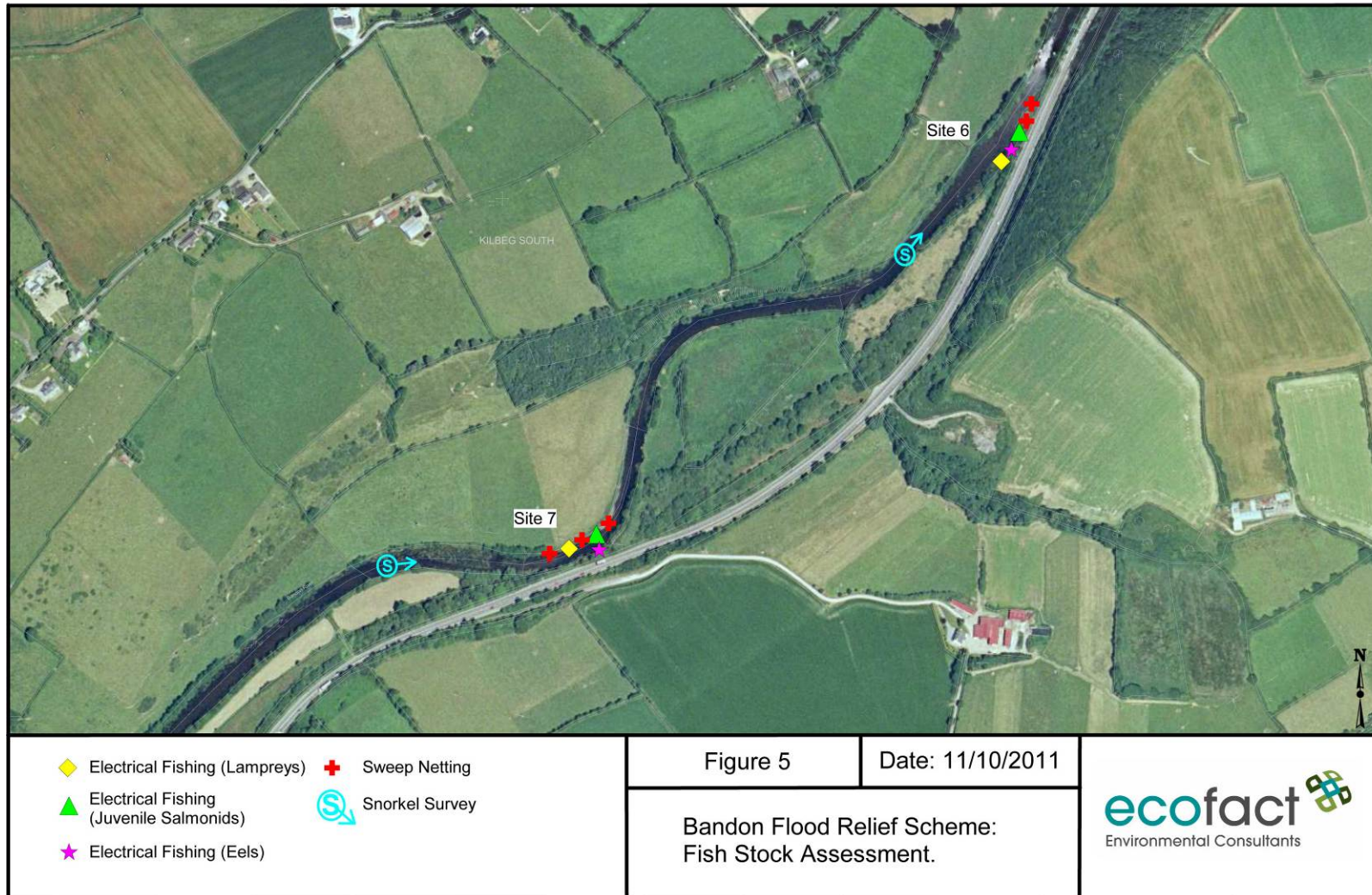


## Bandon Flood Relief Scheme: Fish Stock Assessment (Sites 4 and 5)



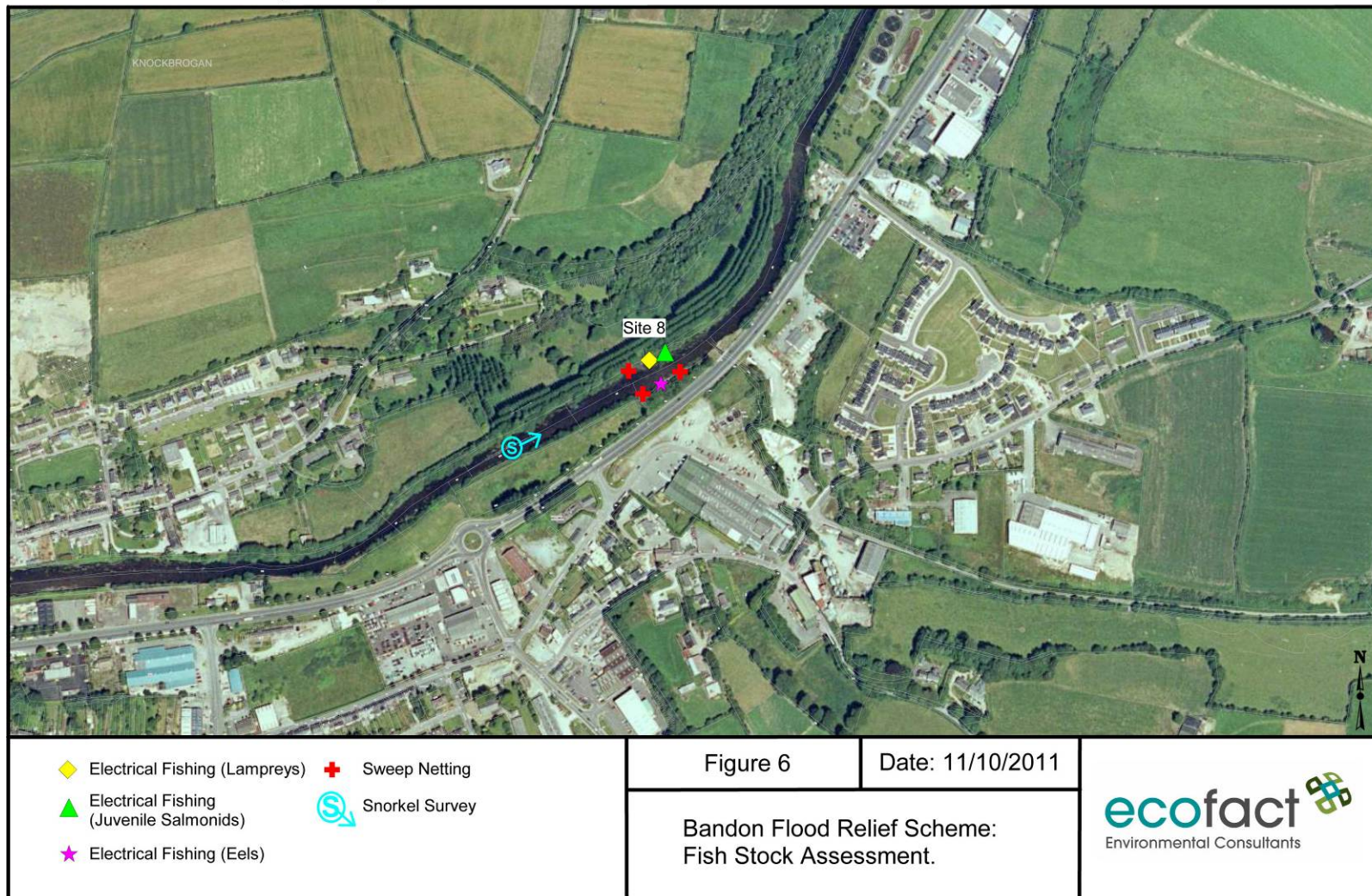


## Bandon Flood Relief Scheme: Fish Stock Assessment (Sites 6 and 7)





## Bandon Flood Relief Scheme: Fish Stock Assessment (Site 8)



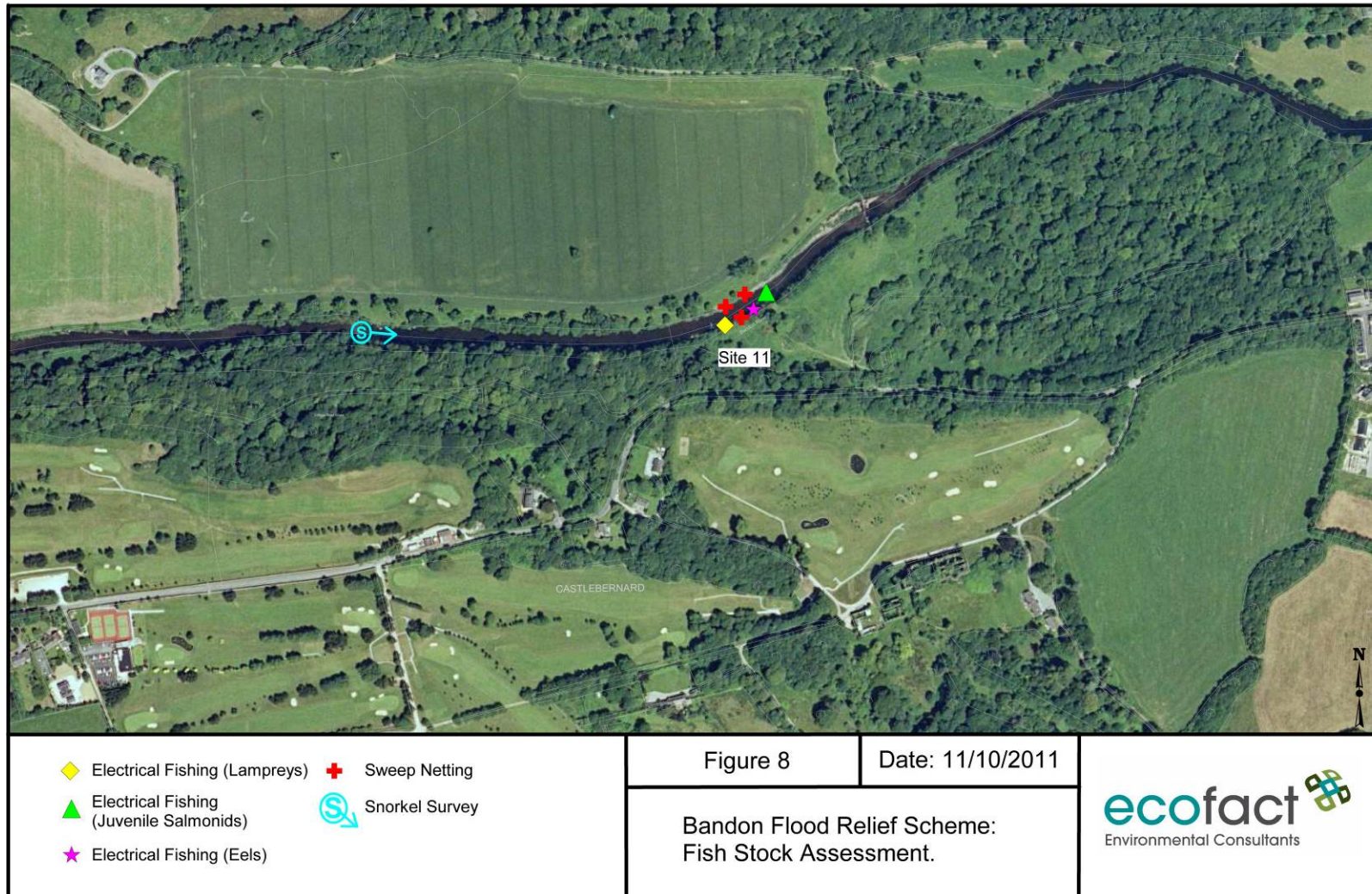


## Bandon Flood Relief Scheme: Fish Stock Assessment (Sites 9 and 10)



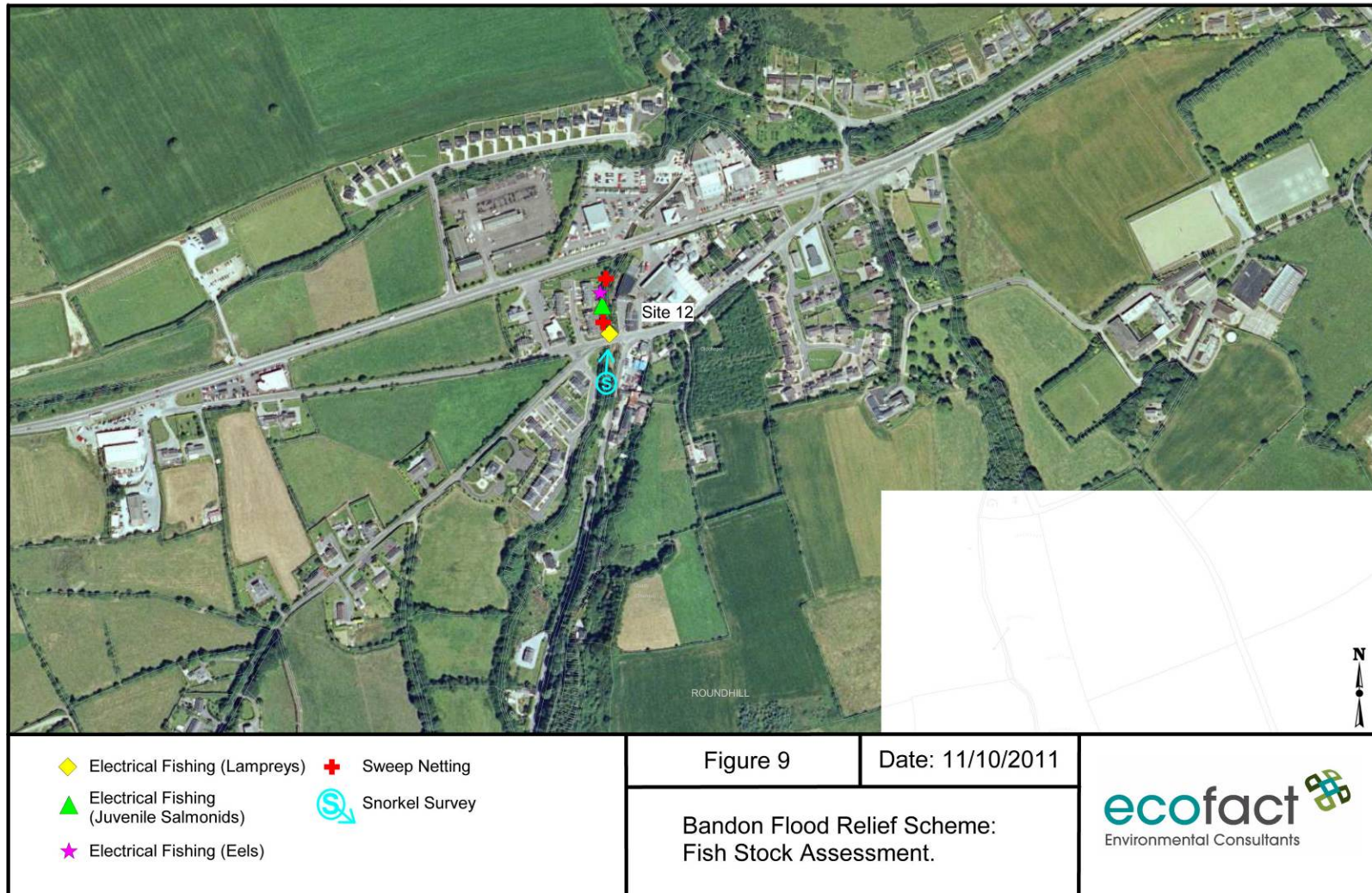


## Bandon Flood Relief Scheme: Fish Stock Assessment (Site 11)



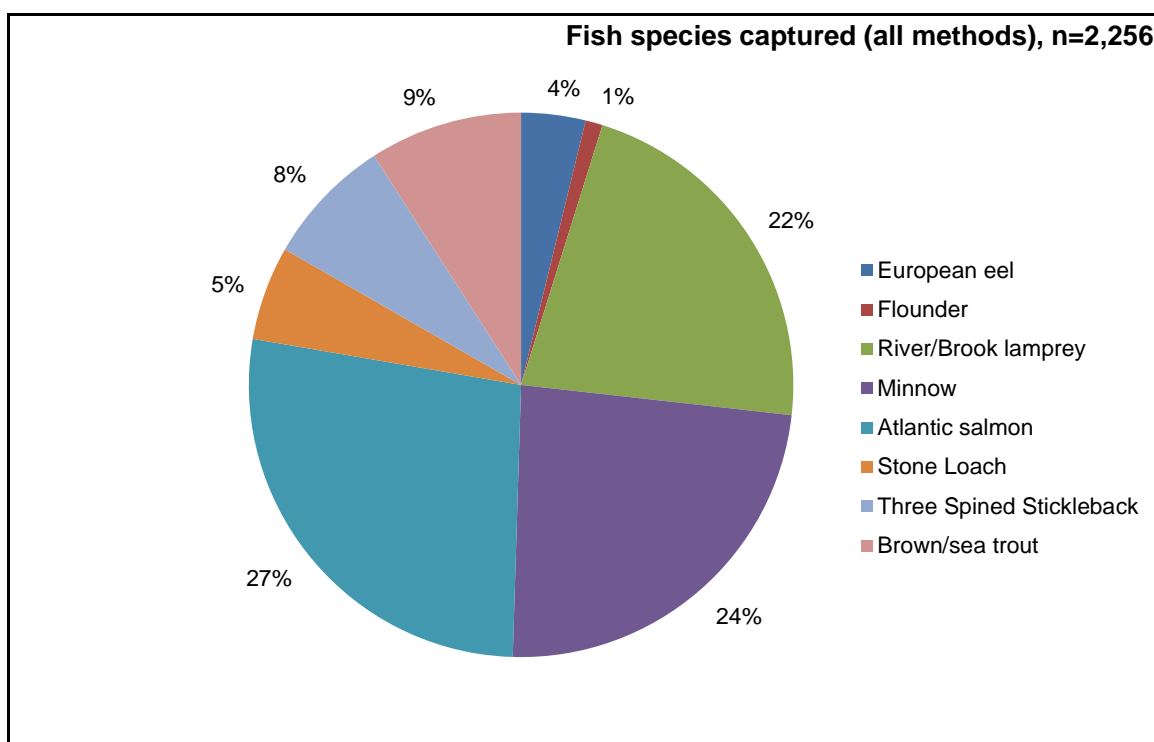


## Bandon Flood Relief Scheme: Fish Stock Assessment (Site 12)



### 3. RESULTS

Over the 12 sites surveyed a total of 1,605m<sup>2</sup> of habitat was surveyed for juvenile salmonids; 60m<sup>2</sup> was surveyed for European eel; while a total of 36m<sup>2</sup> of suitable habitat was surveyed for lamprey. The current survey also included 240 sweep net samples within the study area. The survey resulted in the capture of 2,256 fish in total, comprising eight species. The most common species recorded was Atlantic salmon *Salmo salar*, followed by minnow *Phoxinus phoxinus*. Additional fish species recorded include three-spined stickleback *Gasterosteus aculeatus*, stone loach *Barbatula barbatula*, European eel *Anguilla anguilla* and flounder *Platichthys flesus*. The relative abundance of all species recorded during the current survey is shown in Figure 10.



**Figure 10** Fish species compositor (all methods combined) for the September 2011 fish stock assessment on the Bandon River.

A total of 495 juvenile lamprey were recorded, with both river lamprey *Lampetra fluviatilis* and brook lamprey *L. planeri* populations present. Based on the examination of transformers, it is confirmed that the population of juvenile lampreys downstream of Bandon weir includes (and may be dominated by) River lampreys. Bandon weir has been identified as being an impassable barrier to lampreys, and the lampreys upstream of this weir are identified as brook lampreys. This is corroborated with evidence collected during the examination of transforming lampreys in this area. No sea lamprey were recorded during the current survey, and it is confirmed that this species is absent from the River Bandon. Brown trout *Salmo trutta* (n=205) were recorded throughout the study area, with sea trout also recorded during the snorkel surveys. Brown trout numbers were found to be very low in the lower reaches of the Bandon to Inishannon, with numbers increasing upstream to Bandon town and upstream of Bandon weir. This may be due to competition by the Atlantic salmon population which dominates this stretch of the river. Adult salmon and sea trout were observed throughout the study area during September 2011.

This stretch of the river is identified as a significant and highly productive stretch for Atlantic salmon within the study area. The densities of juvenile lampreys recorded were considered to be exceptional, and amongst the highest ever recorded in Ireland. No lampreys were recorded in the stretch of river affected by dredging in 2010/2011.

Atlantic salmon, River lampreys and Brook lampreys are listed under Annex II of the EU Habitats Directive. The lower River Bandon is considered to be a Special Area of Conservation (SAC) quality river in relation to these species; although it is acknowledged that it does not hold this designation. The lower river also provides significant habitats for the European eel which has been listed as 'Critically endangered' and is now 'Red Listed' according to the recently published 'Red List No. 5: Amphibians, Reptiles & Freshwater Fish' (King *et al.*, 2011).

The results of the September 2011 study are outlined in detail below and in the following table and Figures. Table 2 presents the physical characteristics of the 12 juvenile salmonid survey sites assessed using electrical fishing during September 2011, while Table 3 presents the overall catch results from the 12 juvenile salmonid survey sites assessed using electrical fishing during September 2011. Table 4 gives the physical characteristics of the 12 European eel survey sites assessed while the overall catch results from the 12 eel survey sites assessed is provided in table 5. The physical characteristics of the 36 juvenile lamprey survey sites assessed at 12 stations is presented in Table 6, while Table 7 gives the overall catch results from the 12 juvenile lamprey survey stations. Table 8 presents the length (cm) descriptive statistics for 595 juvenile Atlantic salmon captured at the 12 study sites., with similar adat given for 187 juvenile Brown/sea trout in Table 9. The length (cm) descriptive statistics for 86 European eels captured at the 12 study sites are provided in Table 10. Table 11 gives the length (cm) descriptive statistics for 490 juvenile River/Brook lampreys *Lampetra sp.* captured at the 12 study sites. Table 12 and 13 give similar data for minnow and stone loach.

In Figure 11 the density (no. per m<sup>2</sup>) of juvenile Atlantic salmon *salmo salar*, Brown/sea, and River/Brook lampreys at the 12 sites investigated is presented. Figure 12 illustrates the variation of juvenile Brook/River lampreys density recorded between sites. The abundance index (catch per minute) of juvenile Atlantic salmon, Brown/sea at the 12 sites investigated is shown in Figure 13. Figure 14 gives the length percentage frequency distribution of juvenile Atlantic salmon captured at all sites (top), and at sites 1-4 (indirectly affected by proposed works, Sites 5-10 (directly affected by proposed works, and at Sites 11-12 (reference sites). In Figure 15 the length percentage frequency distribution of trout from the all sites combined, the River Bridewell and River Bandon sites. Figure 16 shows the length percentage frequency distribution of 88 European eel captured during the survey while Figure 17 and 18 present similar results for three-spined stickleback, minnow and stone loach. In Figure 20 the length percentage frequency distribution of juvenile Brook/River lampreys captured at all sites, and at sites 1-4 (potentially indirectly affected by proposed works, Sites 5-10 (potentially directly affected by proposed works, and at Sites 11-12 (reference sites) is given. Figure 21 shows the variation mean length (+/- 95% C.I.) of juvenile Brook/River lampreys recorded. Length weight relationships for trout, salmon and lampreys are presented in Figures 21, 22 and 23 respectively.

Table 14 gives the results of the snorkel survey carried out in the Bandon River during September 2011 and fisheries evaluation. Note: the snorkel survey at each location was carried out in the downstream direction. This routine is reflected in the 'results' column where each reach is

described from upstream to downstream. Table 15 presents the results of the sweep netting (20 sweeps per site). The results from the individual sites are outlined below.

### **3.1 Survey sites**

#### **3.1.1 Site 1**

This site was located on the Bandon River downstream of the N71 Road Bridge at Inishannon (Inishannon Bridge). This site was located approximately 3km downstream of any potential in-stream works. This part of the river is influenced by the tide and its banks are lined with trees which overhang the river to varying degree. The wetted width of the channel was approximately 20m. The river to 100 meters downstream of the bridge is generally fairly shallow with glide flow dominating. The substrate was dominated by rock and cobble.

Salmonid electrical fishing was carried out along the margin of the right bank of the river in riffle/glide habitat. This site was located ca. 40m downstream of Inishannon Bridge. This area comprised a band of approximately 4.5m wide parallel to the bank and 19 meters long. There was a narrow band of depositing habitat along the right bank of the river within the study site. Surveying for lampreys was carried out approximately 80 meters downstream of Inishannon Bridge where depositing habitat was more extensive. The survey site was in a shaded shallow part of the river where the mean depth was ca. 40cm. Sweep netting was performed from just downstream of the bridge to ca. 80 meters downstream. The snorkel survey began approximately 200m upstream of the bridge and was completed approximately 150 meters downstream of the bridge.

During the salmonid electrical fishing, an area of approximately 85m<sup>2</sup> was surveyed. A total of 28 juvenile salmon were recorded at this location. The recorded density of juvenile salmon was 0.28/m<sup>2</sup> or 1.4/minute. The vast majority of the juvenile salmon recorded were O+ group fish. It is noted that electrical fishing efficiency was affected by the size of the river at this location as it would be in any large river. Electrical fishing was also impaired by higher than normal water levels. It is considered that catch efficiency for 1+ salmon in particular was affected by these factors. Nonetheless, the large number of juvenile salmonids that were caught (and seen) during the survey confirms that this is an important spawning and nursery area for Atlantic salmon. During the snorkel survey several adult salmon were seen in the pool immediately downstream of the bridge and also in deep water approximately 100m downstream of the Bridge. The snorkel survey confirmed the presence of significant numbers of juvenile salmon and the domination of this species over brown trout in this part of the river. Only two brown trout were recorded during the salmonid electrical fishing. This corresponds to a density of brown trout of less than 0.1/m<sup>2</sup>. One trout was captured while sweep netting. During the snorkel survey adult sea trout were seen in the pool immediately downstream of the bridge and also in sluggish water approximately 100m downstream of the Bridge.

Despite higher than normal water levels, electrical efficiency for lamprey was not affected, and an 1m<sup>2</sup> box enclosure was used successfully at this site. A total of 136 brook/river lamprey were recorded in the 3m<sup>2</sup> surveyed. The corresponding density of lampreys was 45/m<sup>2</sup>. This is considered an exceptionally density of lampreys, and is near the high end of the scale of



densities recorded for lampreys in Ireland. Four of the lampreys were transformers, and though to be River Lamprey *Lampetra fluviatilis*.

Surveying for European eel was carried out over an area of 5m<sup>2</sup> at a location approximately 10 meters downstream of the bridge. The substrate was ca. 75% rock and ca. 40cm deep. A total of 2 eels were recorded. A total of 4 eel were recorded during the salmonid survey and 2 during the lamprey survey. A total of 17 flounder were recorded at this location. Minnow (n=4), stone loach (n=3), three-spined stickleback (n=4) and stone loach (n=3) were also recorded at this location.

This part of the River Bandon is considered an important area for all life stages of the Annex II listed Atlantic salmon. The current survey has confirmed that this area is an important spawning and nursery area for this species. The pools along this part of the river are also used by resting adult salmonids. This is also an important angling area, and was being actively fished for salmon at the time of the survey. This stretch of river is considered to be an exceptional (SAC quality) spawning and nursery area for river lampreys (and probably brook lampreys). The deposited substrate along the verge of the river was considered optimal habitat for burrowing juvenile lampreys. This part of the river is considered important for all life stages of lampreys. There is an abundance of lampreys spawning habitat in this part of the river. Eels were recorded in a variety of different substrates. The classification of the European eel as 'Critically Endangered' is a reflection of its significant International decline (King *et al.*, 2011). The significant numbers of small flounder recorded highlights the importance of the lower reaches of the river as a nursery for this species. Overall, the part of the river supports a variety of native fish species including salmon, river lamprey and brook lamprey which are protected species (listed under Annex II of the European Habitats Directive) and European eel which is now regarded as endangered.

### 3.1.2 Site 2

This site was located on the left side of the Bandon River ca. 200m downstream of the River Brinny confluence. The location of this site is approximately 2km downstream of any potential in-stream works. This site was accessed from the local road to the north of the River Bandon. This part of the river is combination of riffle glide and pool sequences. The river had a wetted width of approximately 15 meters. This part of the river is relatively narrow and deep. Surveying for salmonids was carried out in a high gradient riffled area of strong flow. The mean depth of the area surveyed was ca. 40 cm with a maximum depth of 50cm. The substrate was mostly of rock (ca. 60%).

An area of approximately 27 meters along the left bank X 5 meters wide was examined during the salmonid electrical fishing assessment. The 3m<sup>2</sup> area surveyed for lampreys was directly adjacent to the left bank. This area was heavily shaded by trees. There was no flow apparent at this location. The substrate was a mixture of rock and silt. Lamprey habitats like this are common along this part of the river. The eel survey was carried out approximately 1 meter from the left bank. The mean depth of the surveyed area (5m<sup>2</sup>) was ca. 25cm. The substrate consisted of ca. 80% rock and ca. 20% cobble that had a light coat of silt. This site was surveyed on the morning of the 22<sup>nd</sup> September during bright conditions. A slightly tainted colour on the river water was noted upon arriving at the site but this was only barely discernible. Suspended solids levels increased steadily from arrival at the site. By the time the electrical fishing survey of the site was

completed, turbidity levels had increased dramatically and the survey had to be abandoned. This suspended solids pollution was being caused by dredging works in the river upstream at Bandon.

A total of 60 juvenile salmon were recorded during the salmonid electrical fishing assessment. The recorded density of juvenile salmon was ca.  $0.45/\text{m}^2$  (3 fish minute). The bulk of the juvenile salmon at this location were 0+ group fish. An area of approximately  $135\text{m}^2$  was surveyed. This figure represents an index of the density of salmon in this part of the river. The true numbers of fish are considered to be considerably greater. It is noted that catch success was reduced by the extent of rock, fast flowing water and shade in this part of the river. In addition, water clarity deteriorated during the electrical fishing survey due to the dredging works ongoing upstream. During the snorkel survey, the deep pools along the stretch were found to be used by resting adult salmon as expected. A total of 9 juvenile trout were recorded at this location. Eight of these fish were recorded during the salmonid survey and 1 while sweep sampling. Four of these fish were 0+ trout. The recorded density of trout was approximately  $0.05/\text{m}^2$ .

Lampreys were surveyed in a  $3\text{m}^2$  area along the left margin of the river. A total of 25 juvenile brook/river lampreys were recorded from the surveyed area, corresponding to a density of ca.  $8/\text{m}^2$ . This density is deemed high in the context of a fast flowing part of the river. There are numerous pockets of lamprey habitat along this stretch of river, and overall lamprey production here is likely to be significant.

This part of the river contains a large proportion of rock. A total of 20 eel were recorded; 12 during the salmonid electrical fishing, 5 during the eel survey ( $1\text{fish}/\text{m}^2$ ), 2 during the lamprey survey and one while sweep sampling. The eel electrical fishing site comprised approximately 80% rock and 20% cobble substrate and had a mean depth of approximately 25cm. This part of the river has good physical diversity and is therefore thought an important area for minnow, stone loach and three-spined stickleback also which were abundant in the sweep net samples.

The substantial juvenile salmon population at this site confirms the importance of the lower Bandon River as a spawning and nursery area for this Annex II species. The surveyed stretch was deemed appropriate for salmonid spawning as it contained gravel substrate along areas where glide occurred at the end of pools. In addition, this part of the river is an important salmonid nursery with ample riffled areas and plenty of cover for juvenile salmonids. This part of the river also has deep pools considered important holding areas for adult salmon and sea trout. This stretch of the river is also an important amenity with respect to angling. The large proportion of rock, including bedrock in this part of the river is thought to be the reason for the reduced density of juvenile lampreys at this site. However, this is also an important area for lampreys with both river and brook lampreys thought to be present. Spawning habitat for both species was present locally. This part of the river also contained good eel habitats, and eels were common here.

### 3.1.3 Site 3

This site was located on the right side of the Bandon River adjacent to N71 Road car parking area at Ardnaclog (ca. 4.8km downstream of Bandon). This site was located approximately 1.5km downstream any potential in-stream works. One short stretch of river at the downstream end of the car parking area had relatively high gradient and a large proportion of the habitat was riffled here. Where this riffled habitat occurred, the substrate was dominated by rock, including bedrock.

Some rocky outcrops were present. It was apparent from vegetation on these rocks that water levels at the time of the survey were higher than normal. The wetted width of the river at this location was approximately 23m. This stretch contained a long deep pool along most of the car parking area. Mature trees lined the left bank of the river along this stretch of the river.

The salmonid electrical fishing site was carried out in the riffled habitat at the downstream end of the car parking area along the right side of the channel. The mean and maximum depth of the fished area was 25cm and 50cm respectively. The substrate consisted of rock (ca. 60%), cobble (ca. 20%) and gravel (ca. 20%). The lamprey survey was carried out at the downstream end of the pool immediately upstream of the car parking area. The surveyed area had a mean depth of less than 30cm and the substrate was ca.80% finely deposited sand and silt. The eel survey was carried out in sluggish water next to the salmonid electrical fishing site. The mean depth was 20cm. Rock accounted for most of the bed material at ca. 60% cover. The remainder was cobble (ca. 30%), gravel (ca. 5%) and fine (ca. 5%).

An area of approximately 63m<sup>2</sup> was examined while electrical fishing for salmonids. A total of 28 juvenile salmon were captured during this survey (ca. 0.5/m<sup>2</sup>, 3/minute). The amount of large rock at the survey site coupled with fast flow reduced electrical fishing efficiency. Many small fish were not captured as they could not be retrieved from under rocks. During snorkeling, the density of salmon encountered was thought to significantly exceed the density recorded during electrical fishing. It was concluded that this is an exceptional spawning and nursery area for Atlantic salmon. Only one trout, a juvenile was recorded at this site. While snorkeling the stretch of river along the car park, adult sea trout were seen in the deeper parts of the pool.

A total of 45 juvenile river/brook lampreys were recorded from the 3m<sup>2</sup> area examined. This represents a lamprey density of 15/m<sup>2</sup>, which is considered to be a very high density. Eight of these fish were at transformer stage. Six of these were less than 9cm long and it was concluded based on their transformation size and physical characteristics that they were all River lampreys. The substrate was deemed to offer ideal nursery habitats for juvenile lampreys, and with ample spawning habitats nearby.

This part of the river had good physical diversity and therefore provided a variety of habitats for fish. The amount of rock in the river at this location was considered important with respect to fish refuges. Indeed, 12 eel were recorded at this location. Six of these fish were recorded during the salmonid survey, 4 during the eel survey and 2 while surveying for lamprey. As per the eel survey, the density of eel in the survey area was 1.2/m<sup>2</sup>. The importance of this location for a variety of fish species was underlined by the amounts of other fish species recorded, including three-spined stickleback, stone loach, minnow, and flounder.

This part of the river was deemed ideal for the early life stages of salmon. Along with the extensive riffled habitat that occurs at this location, rocks, instream vegetation, bankside shade and instream debris all contribute to the value of this river stretch in providing cover for young fish. This fast flowing part of the river is more suited to the early life stages of salmon than trout. The margins of this stretch of the river next to pool/sluggish habitat is considered to provide optimal conditions with regard to supporting juvenile lampreys - the substrate is soft and likely to be protected from scouring out during flood conditions. This part of the river was deemed very important with respect to eel production and for a range of other fish species.

### 3.1.4 Site 4

This site was located on the Bandon River ca. 4km downstream of Bandon. This location was located approximately 0.8km downstream of any potential in-stream works. It is noted that this site was the nearest site downstream of the proposed scheme. This site was accessed from the car parking area at Curranure. Surveying was carried out from the right side of the river. It was evident from old foundations in the river that a bridge once crossed the river at this location. This part of the river had deep pools connected by short riffles and glide as it flows through a wooded corridor. It is noted that walking along this section of the river was not possible due to the rugged terrain along both sides of the channel. This limited the electrical fishing options in terms of areas available for specific surveys. The substrate along this part of the river comprised approximately 20% rock, 50% cobble and 30% gravel.

The salmonid electrical fishing site was located on a side channel of the river adjacent to the right bank. The area examined was a combination of riffle and glide where the mean depth was ca. 30cm. This area was enclosed on the right side by the right bank and on the left side by an outcrop of loose boulders that once formed the foundation of the bridge. The upstream and downstream ends of the fished area were marked by shallow riffled habitat. This location on the river had little/no depositing areas; electrical fishing for lampreys was carried out in pool habitat adjacent to the riffle at the upstream end of the stretch below the old bridge crossing point. At this site the substrate was an even mix of cobble, gravel and fine material. The mean depth was approximately 40cm.

This site was examined on the 23<sup>rd</sup> of September, the day following the instream works on the river in Bandon. Significant siltation of the substrate was recorded at this location and walking on the substrate resulted in a silt plume downstream. High levels of siltation like this on gravels used by salmon for spawning can significantly affect production. As this type of works also took place during 2010 and previously (but not just at Site 4) the possibility that fisheries production on this stretch has already been suppressed cannot be dismissed. Water clarity was deemed to be still impacted slightly by the works carried out the preceding day. The 5m<sup>2</sup> area surveyed for eel was located 5-10m upstream of the old bridge structure. This site had a mean depth of ca. 20cm. The substrate in this area consisted of approximately 50% rock, 40% cobble and 10% fine material. It is noted that the larger substrate at this location (rock and cobble) was more angular than in other parts of the river. This material probably derived from deconstruction of the bridge in the past.

A total of 82 juvenile salmon were recorded at this site in a surveyed area of ca. 120m<sup>2</sup>. This corresponds to a density index of ca. 0.6 juvenile salmon/m<sup>2</sup> or 4/minute. The vast majority of the salmon were considered to be 0+ fish, but 1+ fish were also present. The natural barriers around the survey site helped prevent fish dispersing from the area during sampling, but catch efficiency for older age groups was probably lower. Two juvenile salmon were also recorded while electrical fishing for lampreys. Only one brown trout, a juvenile 8.4cm long, was recorded at this location. During snorkeling, the long pools upstream and downstream of the electrical fishing site were found to hold both adult salmon and sea trout. In the 3m<sup>2</sup> area examined for lampreys, a total of 6 juvenile river/brook lampreys *Lampetra* sp. were recorded. It is noted that 50% of these fish were recorded from the 1m<sup>2</sup> area that contained the least amount of rock. The recorded density of lampreys (2/m<sup>2</sup>) was low but the substrate examined was not suitable for lampreys. Three eel were recorded during the specific eel survey, representing a density of 0.6 eels/m<sup>2</sup>. Two eel were

recorded in the salmonid electrical fishing survey. A total of 27 minnow and 25 stone loach were recorded at this location.

This part of the river was deemed to contain excellent spawning, nursery and holding habitat for Atlantic salmon. The dominance of juvenile salmon shows that this part of the river is an important spawning and nursery area for salmon. This part of the river is used to lesser degree by brown /sea trout. The pools along this part of the river are considered important for holding adult salmon and sea trout. Mature trees occurred along both sides of the channel and provided dappled shade. The shade provided by bankside trees along this stretch is considered to add to the quality of these pools as resting areas for adult fish. This part of the river however is generally unsuitable for juvenile lampreys which require soft substrate into which they can burrow. Some patches of deposited sand/silt are likely to occur along this part of the river as in other stretches. This stretch does provide potential spawning habitat for lamprey however. This is also an important stretch for eel, stone loach and minnow.

### 3.1.5 Site 5

This site was located in the vicinity of a bridge over the Bandon River ca. 3.2km downstream of Bandon. This bridge links the N71 Road at Curranure to a local road to the north side of the River Bandon. Sampling was carried out from the left bank of the river under the bridge and downstream of same. This site is within the stretch of river that would be directly affected by potential in-stream works. This part of the river had a wetted width of approximately 22 meters. Electrical fishing for salmonids was carried out along the left bank of the river immediately downstream of the bridge. This area comprised glide and pool habitat only. Surveying for lampreys was carried out under north end of the bridge adjacent to the left bank in substrate consisting mostly of silt. Surveying for eel was undertaken over a 5m<sup>2</sup> area immediately downstream of the bridge. The substrate comprised ca. 60% rock and 30% cobble at a depth of ca. 60cm.

A total of 5 juvenile salmon were recorded during the juvenile salmonid survey at this location, and densities of salmonids were low. The low densities recorded were mainly due to the low gradient habitat at this location, which is not ideal for juvenile salmonids. It is noted that water levels and turbidity were elevated during the survey. The salmon captured were 0+ group fish, confirming that this stretch is also used as a nursery area for salmon, despite sub-optimal habitats. Adult salmon and sea trout were seen in the long pools upstream and downstream of the bridge while snorkeling. A total of 5 juvenile trout were recorded at this location. Conditions are however ideal for lampreys, and a total of 78 (26 per m<sup>2</sup>) juvenile lampreys (including 1 transformer) were recorded in depositing substrate in the area of 3m<sup>2</sup> surveyed. The bulk of the lampreys were recorded in soft substrate that was covered with leaf litter. The most commonly recorded fish at this location was minnow. Only 2 eel were recorded in the 5m<sup>2</sup> area examined. The habitat examined was a mixture of rock and silt, and was deemed suitable for this species. Stone loach, three-spined stickleback and minnow were also recorded at this site.

This stretch of the river was sluggish and deemed suboptimal for spawning and the early life stages of salmonids given the lack of riffled habitat. Deeper areas along this part of the river are important holding areas for adult salmon and adult sea trout. This stretch of the river is however though to support vast numbers of juvenile lampreys given that depositing areas occur all along

both sides off the channel. A considerable quantity of leaf litter was recorded along the margins of this part of the river indicating the depositing nature of this reach.

### 3.1.6 Site 6

This site was located on the Bandon River ca. 2.5km downstream of Bandon, within the footprint of potential in-stream works. This part of the river is relatively open with only short treelines on the left and right banks. This part of the river had a wetted width of approximately 23 meters. Electrical fishing for salmonids was carried out along the right bank of the river. The salmonid electrical fishing site comprised a strip of ca. 4m wide parallel to the bank and ca. 44m long. The mean depth of the fished area was ca. 45cm. The substrate was mostly cobble and gravel. A large proportion of the substrate (ca. 90%) was covered with floating river vegetation. These physical characteristics were representative of the river at this point. The area surveyed for lampreys was adjacent to the right bank of the river in a location shaded by trees and riparian vegetation. The water depth was approximately 25cm. The substrate comprised a mix of silt, sand and gravel with finer materials towards the bank. The eel electrical fishing survey was carried out directly adjacent to the right bank of the river. The substrate was mostly of cobble (ca. 65%) with ca. 30% rock. The mean depth of the surveyed area was ca. 20cm.

The area surveyed for salmonids was approximately 176m<sup>2</sup>. A total of 45 juvenile salmon were recorded at this site. The presence of this instream vegetation greatly reduced electrical fishing efficiency and the true density of salmon is thought to be considerably higher, and juvenile salmon were seen to be abundant in this area during the snorkeling survey. This part of the river was found to be relatively shallow and no adult salmon were recorded during the snorkel survey. A total of 12 trout were recorded at this site. Some adult sea trout were also seen in the pool upstream of the electrical fishing site. A total of 47 juvenile lampreys were recorded at this site including one transformer, equivalent to a density of 16 lampreys/m<sup>2</sup>. The concentration of lampreys recorded at this site was considered high. Areas of finely deposited silt near the bank were found to hold most of lampreys. Patches of such habitat were recorded sporadically along this part of the channel. Eel, stone loach, three-spined stickleback and minnow were also recorded at this site. European eel (n=15) were most frequently recorded during the salmonid survey (n=11). These fish were using the cover of cobble and vegetation in the surveyed area and were mostly around 11cm long. It is probable that there were as many more eel that were undetected during the salmonid survey. Only 1 eel was recorded in a 5m<sup>2</sup> area that was specifically aimed at finding eel. Three eel were recorded while electrical fishing for lampreys, this areas having some branches under which the eel occurred. Minnow (n=12) and three-spined stickleback (n=8) were recorded mostly by sweep netting. Two stone loach were recorded during the lamprey electrical fishing exercise. Flounder were also seen during the snorkel survey of this site, although this species was not recorded during the other assessments.

This part of the river is considered to be a very important (SAC quality) nursery area for salmonids. Salmon are the dominant species here. This part of the river is probably too shallow to hold adult salmon as it does not have pools sufficiently deep. The deeper parts of this stretch however are used by adult sea trout. The results from the lamprey survey show that this part of the river is exceptionally important for juvenile lampreys. This part of the river also has extensive areas of suitable lamprey spawning habitat. Eels are also common along this stretch.

### 3.1.7 Site 7

This site was located on the Bandon River ca. 2km downstream of Bandon, within the area directly affected by potential in-stream works. This part of the river had a wetted width of approximately 13 meters and was characterised by deep pools linked by riffle/glide sequences. Electrical fishing for salmonids was carried out away from the thalweg in shallower water near the edge of the river (left side). The salmonid electrical fishing site had a mean depth of ca. 30cm. The substrate comprised rock (10%), gravel (40%), gravel (40%) and fine (10%). Flow in the areas fished would be best described a fast glide. The lamprey electrical fishing sites were located on the left bank of the river along the base of emergent vegetation. An area of ca. 5m<sup>2</sup> at the end of a pool was inspected for eel. This area comprised mostly large rocky substrate and had a mean depth of ca. 60cm. Site 7 was examined on the 23<sup>rd</sup> September following the instream works in Bandon.

An area of approximately 120m<sup>2</sup> was fished for salmonids. In total, 21 juvenile salmon were recorded at this site. It is noted that turbidity levels were high due to the previous days dredging works. The actual density of salmon at this location would far exceed the density recorded. Some of the pools along this part of the river were in excess of 2 meters deep. The pool immediately upstream and the pool immediately downstream of the electrical fishing site were found to hold adult salmon during the snorkel survey. Two juvenile trout were recorded during the salmonid survey. Adult sea trout and brown trout were recorded in the pool immediately upstream and downstream of electrical fishing site during the snorkeling assessment.

A total of 10 juvenile lampreys were recorded at this site (including 2 transformers). The corresponding lamprey density was 3/m<sup>2</sup>. The substrate was generally hard as it comprised mostly cobble and gravel substrate. This substrate had some embedded silt. It was noted that the depth of silt at this location was only 2-3cm. The substrate at this spot was mostly of angular rock and the mean depth was ca. 70cm. A total of 4 eel were recorded in this area. Two eel were recorded during the electrical fishing for salmonids. One juvenile flounder was recorded at the edge of the river while surveying for lampreys. A total of 27 minnow were captured at this location, mostly by sweep sampling. Stone loach was very common at this site.

This part of the River Bandon has all the attributes of a good salmon river and having excellent holding pools, nursery areas and spawning habitat. This part of the river is one of the main angling reaches of the lower River Bandon. This part of the river has fairly high gradient and the general lack of depositing areas provide only suboptimal conditions for juvenile lampreys; however significant lamprey populations do still occur. This part of the river is considered an important spawning area for lampreys however. This stretch is also important for eel and minnow.

### 3.1.8 Site 8

This site was located on the Bandon River ca. 1km downstream of Bandon. This part of the river is within the area that would be directly affected by potential in-stream works. The wetted width of the river at this point was approximately 25m. The salmonid electrical fishing site was located on the left side of the river alongside the bank. A length of river along the left bank of the channel of approximately 28m long and 7m wide was surveyed for salmonids. The mean depth of the salmonid electrical fishing survey site was approximately 35cm. The maximum depth of this area

was 30cm. The substrate was a combination of rock (ca. 10%), cobble (ca. 40%), gravel (ca. 35%) and fine (ca. 15%). This site was surveyed on the 23<sup>rd</sup> September and a considerable amount of silt had accumulated on the substrate, as a result of the upstream dredging works. Straw from bales used as a 'silt barrier' for these works had also drifted down as far as this site. Water levels had dropped slightly from the previous day, but were still slightly elevated.

The juvenile lamprey survey was carried out on the left bank of the river. Electrical fishing for eel was carried out adjacent to the right bank of the river in a 5m<sup>2</sup> area of rock and cobble substrate. The mean depth of this area was ca. 30cm and flow was typically glide. This site was shaded from mature bankside trees. This site was selected as it contained more rocks than other parts of this part of the river. Approximately 50% of the substrate comprised rock with the remainder of roughly equal amounts of cobble and gravel. The mean depth of the surveyed area was ca. 20cm.

An area of ca. 196m<sup>2</sup> was examined during the salmonid electrical fishing survey. A total of 56 juvenile salmon were recorded at this location. All these fish with the exception of 7 were captured from the area surveyed for salmonids, the remainder being captured while electrical fishing for lampreys. The density of salmon in the salmonid survey site was 0.25/m<sup>2</sup> or 2.8/minute. A total of 4 juvenile trout were recorded during the salmonid electrical fishing survey. Two of these fish were 0+ group fish and two were in the 1+ cohort. The recorded density of trout was 0.02/m<sup>2</sup> or 0.02/minute. During the snorkel survey, the centre of the channel was examined. These riffled parts of the stretch of the river were considered to support a significant population of juvenile salmonids. The riffled areas were found to be of far greater importance to juvenile salmonids than marginal water that was usually sluggish.

A total of 103 juvenile lampreys were recorded in the area of 3m<sup>2</sup> investigated, corresponding to a mean density of ca. 34 lampreys/m<sup>2</sup>. This density of lampreys was considered remarkably high, and is of national significance. The maximum density (43 lampreys/m<sup>2</sup>) was in a 1m<sup>2</sup> area that contained approximately 50% leaf litter and woody debris as well as some instream vegetation. In the other two areas each of 1m<sup>2</sup>, the lamprey density was 30/m<sup>2</sup>. These areas contained 30% and 0% organic debris in that order. Two eel were recorded in the 5m<sup>2</sup> surveyed. Minnow (n=15) and stone loach (n=5) were also recorded at this site during electrical fishing. Flounder was recorded sporadically during the snorkel survey, mostly near the sides of the river.

This stretch of river is an exceptional spawning and nursery area for both Atlantic salmon and river/brook lampreys. Two large potential salmonid spawning areas were identified at the end of the two long stretches upstream and downstream of the salmonid electrical fishing location. The substrates in these areas were heavily silted as a result of the previous days dredging works. There was little/no pool habitat along this reach and no adult salmon or sea trout were recorded during the snorkel survey. Even though this stretch of the river does support eel, this part of the river has relatively poor habitat for this species. This is thought to result from the uniform nature of the substrate which has little or no rock.

### 3.1.9 Site 9

This site was located on the Bandon River immediately downstream of Bandon Bridge. This site was located approximately 400m downstream of the weir in Bandon. The weir in Bandon is at the



upstream end of potential in-stream works. The river at Bandon Bridge had a wetted width of approximately 30m and has been highly modified. There is an ill-defined thalweg since the bed of the river has been flattened due to recent dredging works. The riverbed is homogenous with respect to substrate composition (mostly gravel) and profile. There was no pool habitat. The right bank of the river is a steep embankment reinforced with limestone boulders. The left bank is also steep and of varied composition; boulders, amenity grassland and scrub. Buildings occur less than 5 meters back from the river on the left side of the channel. Surveying at this location was carried out on 15<sup>th</sup> September. Instream works that were carried out in 2010 are thought to have reduced the morphological complexity of an already modified river. Further excavation of this part of the river was carried out on the 22<sup>nd</sup> September 2011. This work is thought to have further reduced the quality of fish habitats in the area.

The salmonid electrical fishing survey area was located approximately 10m downstream of Bandon Bridge. It comprised the riffled area immediately downstream of a small island below the third arch of the bridge. The mean depth of the fished area was ca. 35cm. The rock cobble gravel fine fraction of the substrate was 5%, 15%, 60% and 20% respectively. Extensive searching for suitable lamprey habitat was carried out in this area, but depositing areas likely to contain juvenile lampreys could not be found. It was clear that this stretch of the river has been significantly affected by the dredging that occurred here during September 2010, with juvenile lamprey habitats (and associated lamprey populations) removed. This area was surveyed prior to the dredging work that took place during September 2011.

The areas examined for lampreys were located immediately downstream of the pillars of the bridge, the most likely habitat to support lampreys in this part of the river. These areas had substrates of fine gravel and sand, and were the only areas that would have approximated juvenile lamprey habitats in this part of the river. Electrical fishing for eel was carried out under the centre eye of the bridge where rocky substrate occurred. The mean depth of this area was ca. 50cm.

An area of approximately 150m<sup>2</sup> was inspected for salmonids by electrical fishing. In total, 39 juvenile salmon were recorded at this location, corresponding to a juvenile salmon density of 0.26/m<sup>2</sup>, or 1.95/minute. All but one of these fish were captured while electrical fishing, a single fish being caught while sweep netting. The density of juvenile salmon at this site was considered low, considering that the area examined represented the best habitat for juvenile salmonids in this part of the river. In addition, electrical fishing efficiency was deemed greater than most other locations given the ease at which electrical fishing could be carried out. A total of 10 trout were recorded during the salmonid electrical fishing survey along with 2 additional fish during sweep netting. All these fish were considered to be 0+ group fish. The density of brown trout in the salmonid survey area was ca. 0.06/m<sup>2</sup> or 0.5/minute. No adult salmon or sea trout were seen during the snorkel survey of this part of the river. Small numbers of adult brown trout were recorded during this survey.

No lampreys were recorded at this location, the only site where this group was absent. The lack of any depositing habitat was considered unusual, and it was concluded at the time that this area had been severely affected by the dredging work undertaken here during 2010. Dredging works were observed during 2011 and there was no attempt being made to provide any mitigation for lampreys. Only one eel was recorded in the 5m<sup>2</sup> area examined specifically for eel. The most

common fish at this site was minnow with 153 recorded collectively (130 electrical fishing for salmonids and 23 sweep netting). Three stone loach were recorded while sweep netting. A total of 53 three-spined stickleback were recorded at this site during the following surveys; salmonid electrical fishing (n=11), eel electrical fishing (n=32) and sweep netting (n=10).

The lack of instream physical diversity reduces the value of this part of the river for juvenile and adult salmonids. The low number of salmon was most likely due to the suboptimal habitat present. This was brought about due to the lack of rock substrate or other features that would provide cover for young fish. This stretch of the river has been degraded to the extent that it does not have any supporting habitat for juvenile lampreys. The substrate was the finest in the vicinity of the bridge but even this was considered too compacted for juvenile lampreys. The disproportionately large amount of minnow and three-spined stickleback at this site is indicative of the impacted ecology of this site.

### *3.1.10 Site 10*

This site was located on the left side of the Bandon River downstream of the weir in Bandon. This site is at the upper end of any potential in-stream works. This part of the river is enclosed on both sides by the wall/embankment or other artificial structures but the river channel itself is in a semi-natural state. There is a hydro-electric generating station located to the north of the weir. The intake is located above the weir and the tailrace discharges back to the main river. Much of the substrate along this part of the river is bedrock which protrudes from the river. The river was running clear and was considered to be at higher than normal level when surveyed in mid September.

Electrical fishing for salmonids was carried out on a left side of the river immediately downstream of the weir (next to the wall of the hydro scheme). The right side of the fished area was a rocky outcrop while the left side was a stone wall that forms part of the hydroelectric station tail race. The length of the fished area was ca. 27m and the mean width was ca. 6.5m. The mean and maximum depths at this site were 30cm and 75cm respectively. Surveying for lampreys was carried out adjacent to the wall on the left side of the river, a distance of ca. 40m downstream of the weir. The area surveyed was depositing in nature. Surveying for eel was carried out adjacent to the outflow from the tailrace of the hydro-station. This area of 5m<sup>2</sup> was approximately 60cm deep and the substrate was mostly rock and cobble. A snorkel survey was not carried out at this location for health and safety reasons.

An area of ca. 175m<sup>2</sup> was surveyed for salmonids. A total of 113 juvenile salmon were recorded at this site. Most of these fish were in the 0+ age cohort. The corresponding density of salmon was 0.65/m<sup>2</sup> or 5.6/minute. It is noted that difficulty in performing electrical fishing at this location was experienced as fast currents quickly carried away stunned fish and conditions underfoot were slippery. The strength of the current also caused difficulty for the assistant in maneuvering the dip net. These factors reduced the efficiency of the electrical fishing at this site; however catches were still considered to be exceptional. A total of 19 juvenile trout were recorded during the salmonid electrical fishing survey (density 0.1/m<sup>2</sup> or ca. 1/minute).

A total of 5 lampreys were recorded in the surveyed area of 3m<sup>2</sup> at this site. All of these fish were recorded from an area of 1m<sup>2</sup> where the mean depth was 20cm. The substrate at this location

comprised ca. 10% gravel and ca. 90% fine material. The two other sub-sites examined for lampreys were shallower and contained less fine substrate. A total of 9 eels were captured at this location. Three of these fish were recorded in the shallow areas where electrical fishing for lampreys was undertaken. The remainder of the eels captured came from the salmonid fishing survey site ( $n=6$ ). Eel were not recorded in the  $5\text{m}^2$  area specifically examined for this species. Three-spined stickleback ( $n=18$ ), stone loach ( $n=1$ ), minnow ( $n=61$ ) and eel ( $n=3$ ) were also recorded at this location. The bulk of the minnow and three-spined stickleback were recorded during sweep netting. The density of juvenile salmon and trout at this location suggest this part of the river is an extremely important salmonid nursery area.

Owing to the high gradient of the river downstream of the weir, there is little depositing habitat in this part of the river. The numbers of juvenile lampreys was considered low at this site but this was directly related to the lack of depositing areas. The hydroelectric station at this location affects water levels at a local scale. When operating, less water flows over the weir with the effect of lowering levels in the riffled habitat downstream of the weir. These fluctuations are considered to have effects on fish in this area.

### *3.1.11 Site 11*

This site was located on the right bank of the Bandon River ca. 2km upstream of Bandon. This location was approximately 1.7km upstream of any proposed in-stream works. This part of the river had a wetted width of approximately 15 meters. This reach of the river has some bends and deep pools were recorded in such places. Flow along this part of the river was a combination of riffle-glide-pool sequences with depth varying considerably along the channel.

The salmonid electrical fishing site was located on the right side of the river adjacent to the right bank. The area fished had a mean depth of ca. 25cm with a maximum depth of 75cm. The substrate was typical of the river in general and consisted of ca. 10% rock, 60% cobble, 25% gravel and 5% fine matter. The lamprey electrical fishing site was at the verge of a deep pool. Here, sluggish flow and bankside scrub resulted in a large deposition of sand and silt. This location was the focus of the lamprey survey. Surveying for eel was carried out at the downstream end of a deep pool. The mean depth of the area fished was ca. 70cm. the substrate comprised ca. 50% rock, 30% cobble and 20% gravel. An area of approximately  $120\text{m}^2$  was surveyed at the salmonid site.

A total of 77 juvenile salmon were recorded in the area. The vast majority of these fish were 0+ group fish. The corresponding density of juvenile salmon was ca  $0.65/\text{m}^2$  or 3.9/minute. This density was considered high given that water levels were higher than normal during the survey. These conditions reduced the catch efficiency. A total of 17 brown trout were caught during the electrical fishing carried out at this site (density of  $0.14/\text{m}^2$  or 0.85/minute). All but one of these trout were considered 0+ group fish. As for other locations, the numbers of older group fish such as 1+ fish in the study site were probably as high. During the snorkel survey, adult salmon, sea trout and brown trout were seen in the pools along the stretch examined.

A total of 25 lampreys were recorded at this site; 24 juveniles and 1 transformer. The corresponding density was ca.  $8.3/\text{m}^2$ . Two eels were recorded in the surveyed area of  $5\text{m}^2$ , equating to a density of  $0.4/\text{m}^2$ . Two more eel were caught while electrical fishing for salmonids.

Stone loach (n=2), three-spined stickleback (n=11) and minnow (n=23) were also recorded at this location.

This stretch of the river is a very important area of salmonid production. It has valuable spawning, nursery and holding habitat for both salmon and trout. There was relatively more trout in this part of the river than downstream of the weir in Bandon. This may indicate the increasing importance of the river for trout with distance upstream. The pools and associated sluggish waters in pools along this stretch have silt deposits along their margins. These areas are likely to be used by lampreys to the same degree of the survey site. This part of the river is most likely dominated by brook lamprey *Lampetra planeri*, as it is unlikely that lampreys are able to pass the weir at Bandon. It is an important fluvial habitat area for all life stages of this species. This site would not be affected by the proposed flood scheme but was included in the current survey as a reference site.

### 3.1.12 Site 12

This site was located on the Bridewell River approximately 2km upstream of the Bandon River confluence. The site was located along the stretch of the river downstream of a local road bridge that links the N71 to the R602. The Bridewell River at this location had a wetted width of approximately 3 meters. The stretch surveyed was typical of the river and was heavily shaded by mature trees. The deepest part of the river was a pool of ca. 75cm deep. It is noted that there was only one location where a pool of this size occurred (approximately 20m downstream of the bridge). Substrate along the surveyed reach consisted of ca 10% rock, 40% cobble, 40% gravel and 10% fine.

The salmonid electrical fishing site was located from approximately 50 meters downstream of the bridge to ca. 20 meters downstream of the bridge, the upstream end at the deep pool described above. The mean depth of the surveyed stretch of the river was approximately 15cm. Electrical fishing for lampreys was carried out in a side channel of the river immediately downstream of the bridge. This area was depositing and the substrate was mostly silt. Electrical fishing for eel was carried out ca. 15 meters downstream of the bridge in substrate similar to the salmonid electrical fishing location. An area of ca. 159m<sup>2</sup> as surveyed during the salmonid survey.

A total of 57 juvenile salmon were recorded, equivalent to a density of 0.36/m<sup>2</sup>, or 2.85/minute. Most of the salmon were in the 0+ cohort but a significant proportion of juvenile salmon were in the 1+ age category. A total of 97 juvenile trout were recorded during the electrical fishing (density of 0.6/m<sup>2</sup>, 4.8/minute). Again, most of these fish were 0+ group fish but a large proportion were a year older (1+). A greater proportion of older fish were captured at this location as fish congregated in the pool at the upstream end of the survey site and could easily be caught in this small river. Lampreys were also present at this site. This site would not be affected by the proposed flood scheme but was included in the current survey as a reference site.

**Table 2** Physical characteristics of the 12 juvenile salmonid survey sites assessed using electrical fishing during September 2011.

Site	1	2	3	4	5	6	7	8	9	10	11	12
Mean Depth (cm)	35	40	25	30	45	20	30	20	35	30	25	15
Max Depth (cm)	50	65	50	40	70	30	50	30	80	75	60	75
Rock (%)	15	60	60	20	10	5	10	10	5	25	10	10
Cobble (%)	50	30	20	50	40	50	40	40	15	40	60	40
Gravel (%)	30	10	20	30	35	40	40	35	60	30	25	40
Fine (%)	5	0	0	0	15	5	10	15	20	5	5	10
Instream veg(%)	5	0	0	0	0	90	5	0	0	0	5	0
Shade (%)	0	0	0	0	0	10	0	0	0	0	5	70
Conductivity	213	223	228	227	223	229	230	226	219	236	212	216
Riffle (%)	50	45	50	60	0	80	40	30	80	90	50	55
Glide (%)	40	50	45	40	50	20	60	60	20	5	50	35
Pool (%)	10	5	5	0	50	0	0	10	0	5	0	10

**Table 3** Overall catch results from the 12 juvenile salmonid survey sites assessed using electrical fishing during September 2011.

Site	1	2	3	4	5	6	7	8	9	10	11	12
Length fished (m)	19	27	14	24	15	44	30	28	6	27	6	53
Width Fished (m)	4.5	5	4.5	5	7	4	4	7	25	6.5	20	3
Area fished (m2)	85.5	135	63	120	105	176	120	196	150	175.5	120	159
Time fished (minutes)	20	20	20	20	20	20	20	20	20	20	20	20
Salmon (n)	24	60	28	82	3	45	21	49	38	111	77	57
Trout (n)	2	8	1	1	1	12	2	4	10	17	32	97
Salmon/m2	0.28	0.44	0.44	0.68	0.03	0.26	0.18	0.25	0.25	0.63	0.64	0.36
Trout/m2	0.02	0.06	0.02	0.01	0.01	0.07	0.02	0.02	0.07	0.10	0.27	0.61
Salmon/min	1.2	3	1.4	4.1	0.15	2.25	1.05	2.45	1.9	5.55	3.85	2.85
Trout/min	0.1	0.4	0.05	0.05	0.05	0.6	0.1	0.2	0.5	0.85	1.6	4.85
Eel (n)	4	12	6	2	0	11	2	0	0	6	2	0
Minnow (n)	0	0	18	0	101	0	0	15	130	1	0	0
Stone loach (n)	1	1	15	24	3	16	29	4	2	0	4	0
Flounder (n)	6	0	5	0	0	0	0	0	0	0	0	0

**Table 4** Physical characteristics of the 12 European eel survey sites assessed using electrical fishing during September 2011.

Site	1	2	3	4	5	6	7	8	9	10	11	12
Rock (%)	75	80	60	50	60	30	80	50	60	55	50	10
Cobble (%)	20	20	30	40	30	65	15	25	30	40	30	40
Gravel (%)	5	0	10	10	5	5	5	25	10	5	20	40
Fine (%)	5	0	0	0	5	0	0	0	0	0	0	10
Mean depth (cm)	40	25	20	15	60	20	60	20	50	60	70	30

**Table 5** Overall catch results from the 12 eel survey sites assessed using electrical fishing during September 2011.

Site Number	Area fished (m2)	Species recorded	Number	Catch per m2
1	5	Eel	2	0.4
		Flounder	2	0.4
		Salmon	4	0.8
		Stone Loach	1	0.2
2	5	Eel	5	1
		Lamprey	2	0.4
		Stone Loach	1	0.2
		Trout	1	0.2
3	5	Eel	4	0.8
		Salmon	1	0.2
		Stone Loach	1	0.2
		Three Spined Stickleback	1	0.2
4	5	Eel	3	0.6
		Salmon	2	0.4
5	5	Eel	2	0.4
		Lamprey	1	0.2
		Minnow	10	2
		Stone Loach	2	0.4
		Trout	1	0.2
6	5	Eel	1	0.2
		Stone Loach	1	0.2
7	5	Eel	4	0.8
8	5	Eel	2	0.4
		Salmon	7	1.4
		Stone Loach	1	0.2
9	5	Eel	1	0.2
		Three Spined Stickleback	32	6.4
10	5	Minnow	17	3.4
		Salmon	2	0.4
		Trout	1	0.2
11	5	Eel	2	0.4
		Stone Loach	2	0.4
12	5	Eel	1	0.2
		Trout	4	0.8

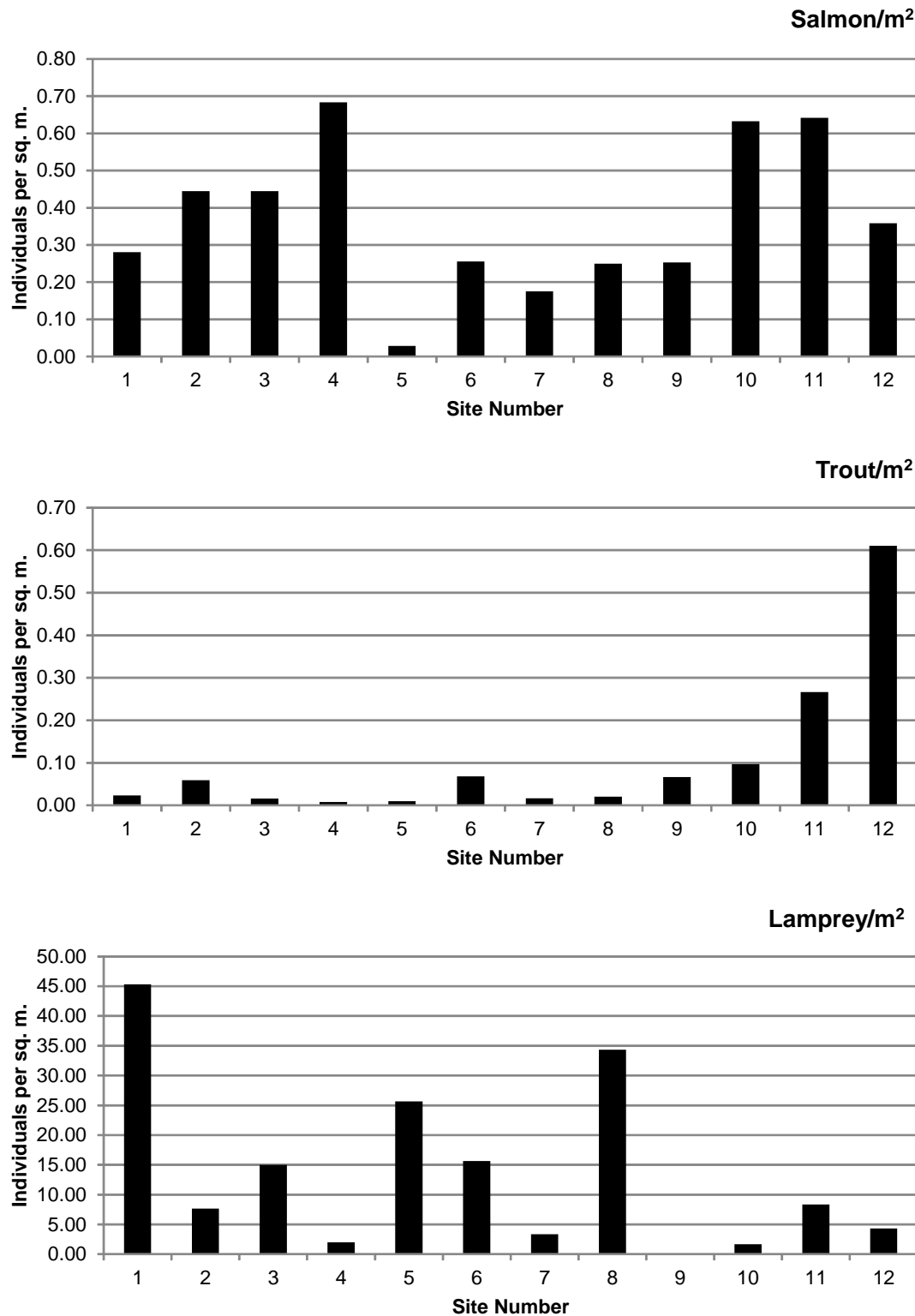
**Table 6** Physical characteristics of the 36 juvenile lamprey survey sites assessed at 12 stations using electrical fishing during September 2011.

Site	Sub Site	Depth (cm)	Rock (%)	Cobble (%)	Gravel (%)	Fine (%)	Organic debris cover (%)	Shade (%)
1	A	15	0	0	20	80	40	20
	B	20	0	0	10	90	25	20
	C	20	0	0	10	90	60	20
2	A	25	10	20	20	50	30	30
	B	20	0	30	10	70	70	30
	C	25	20	30	10	40	60	30
3	A	25	0	10	20	70	50	30
	B	25	0	20	10	70	30	30
	C	20	0	0	20	80	40	30
4	A	40	15	30	25	30	5	0
	B	40	10	30	30	30	20	0
	C	30	20	20	30	30	10	0
5	A	30	10	0	20	70	50	50
	B	40	0	0	30	70	20	50
	C	30	0	0	10	90	50	50
6	A	25	0	0	10	90	30	20
	B	35	10	0	0	90	40	20
	C	30	0	0	0	100	20	20
7	A	30	10	10	40	40	10	10
	B	30	0	10	50	40	5	10
	C	30	0	20	50	30	20	10
8	A	20	0	0	0	100	0	0
	B	30	0	0	0	100	50	10
	C	20	0	0	0	100	30	10
9	A	20	0	10	70	20	0	0
	B	20	0	5	75	20	0	0
	C	40	10	20	60	10	10	80
10	A	12	25	0	0	75	10	0
	B	15	25	0	0	75	10	0
	C	20	0	0	10	90	0	0
11	A	40	0	0	60	40	30	0
	B	30	0	0	60	40	50	0
	C	20	0	0	60	40	10	0
12	A	10	0	0	0	100	25	0
	B	12	0	0	0	100	10	0
	C	20	0	0	0	100	25	0

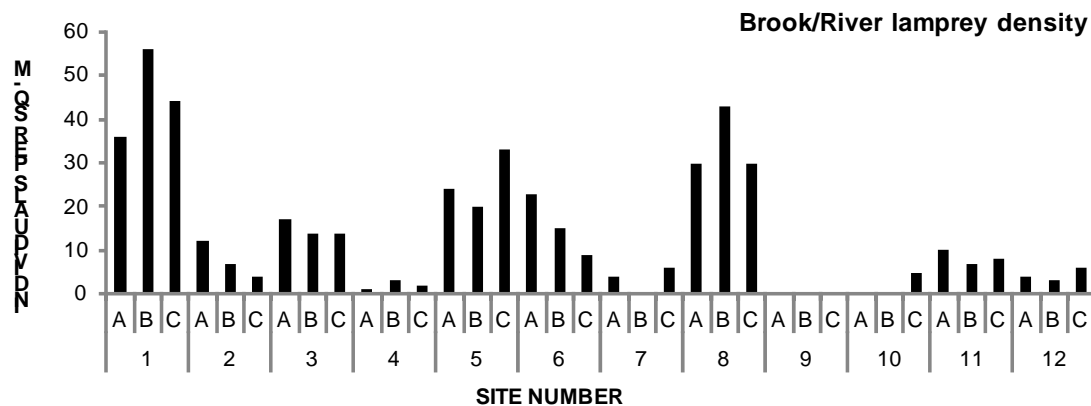
**Table 7** Overall catch results from the 12 juvenile lamprey survey stations assessed using electrical fishing during September 2011.

Site number	Number of 1 m2 sub-sites	Fishing time (minutes)	Species recorded	Number	Catch per m2
1	3	6	Eel	2	0.67
			Flounder	2	0.67
			Lamprey	136	45.33
			Minnow	4	1.33
			River Lamprey	1	0.33
2	3	6	Eel	2	0.67
			Lamprey	23	7.67
3	3	6	Eel	2	0.67
			Lamprey	45	15.00
4	3	6	Lamprey	6	2.00
			Minnow	2	0.67
5	3	6	Lamprey	77	25.67
			Minnow	5	1.67
6	3	6	Eel	3	1.00
			Lamprey	47	15.67
			Minnow	1	0.33
			River Lamprey	1	0.33
			Stone Loach	2	0.67
			Three-Spined Stickleback	1	0.33
7	3	6	Flounder	1	0.33
			Lamprey	10	3.33
			Minnow	9	3.00
8	3	6	Lamprey	103	34.33
9	3	6	Eel	1	0.33
10	3	6	Eel	3	1.00
			Lamprey	5	1.67
			Minnow	1	0.33
			Stone Loach	1	0.33
11	3	6	Lamprey	25	8.33
			Minnow	16	5.33
			Three-Spined Stickleback	4	1.33
12	3	6	Lamprey	13	4.33

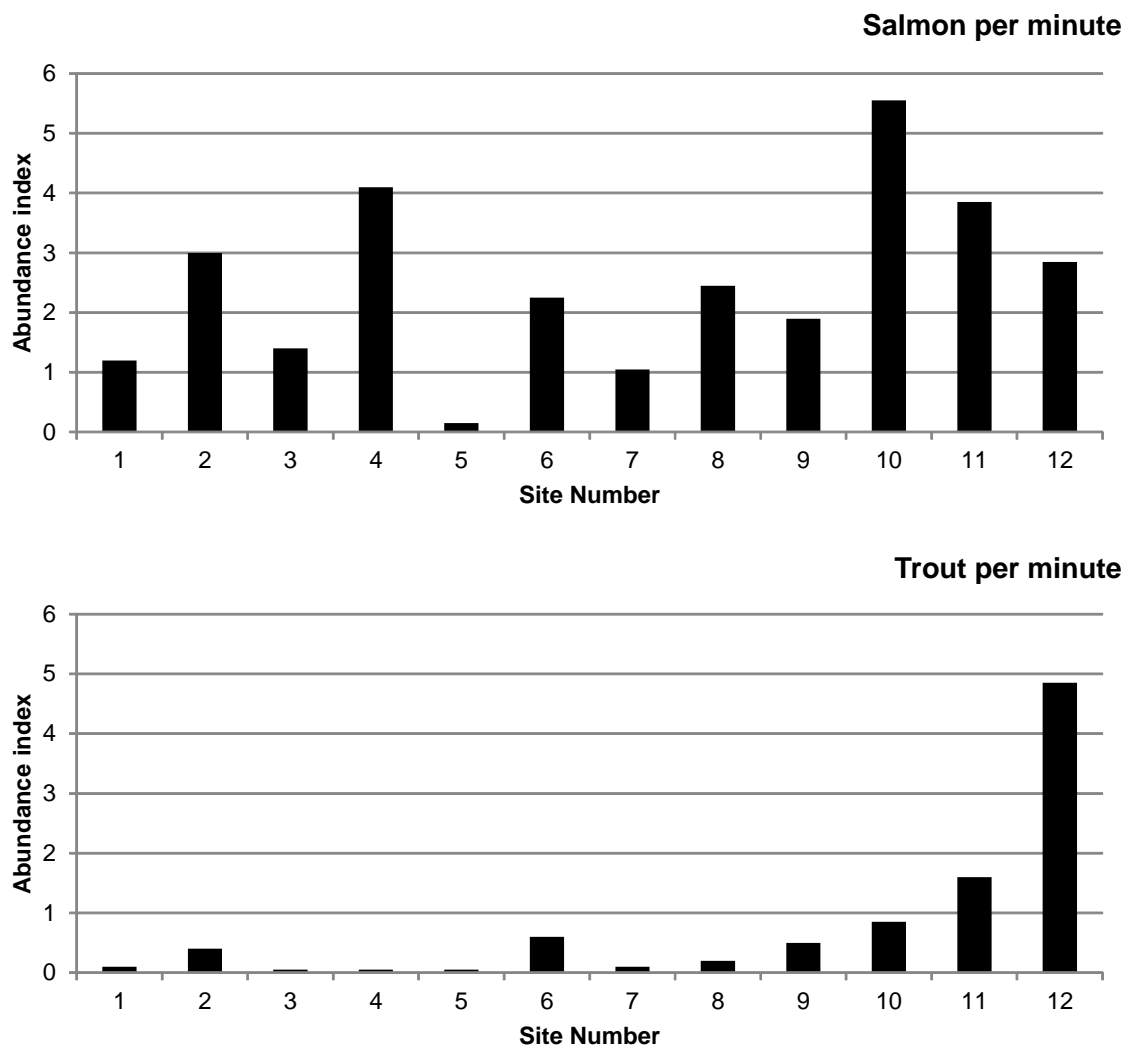




**Figure 11** Density (no. per m<sup>2</sup>) of juvenile Atlantic salmon *salmo salar*, Brown/sea *Salmo trutta*, and River/Brook lampreys *Lampetra* sp. at the 12 sites investigated during September 2011. Note densities are based on catch per area and are a semi-quantitative index of abundance only.



**Figure 12** Variation of juvenile Brook/River lampreys *Lampetra sp.* density recorded between sites. Site 9 affected by dredging in 2010.



**Figure 13** Abundance index (catch per minute) of juvenile Atlantic salmon *salmo salar* and Brown/sea *Salmo trutta* at the 12 sites investigated during September 2011.

**Table 8** Length (cm) descriptive statistics for 595 juvenile Atlantic salmon *Salmo salar* captured at the 12 study sites investigated using electrical fishing during September 2011.

Site	N	Mean	Min	Max	St. Dev.	Variance	95% C.I.
1	24	7.41	5.90	12.30	1.35	1.83	0.54
2	60	8.38	5.80	13.30	2.15	4.63	0.54
3	28	8.71	5.70	13.70	1.85	3.42	0.68
4	82	7.52	5.30	12.70	1.49	2.23	0.32
5	3	6.70	5.30	7.80	1.28	1.63	1.44
6	45	8.88	6.80	14.10	1.56	2.43	0.46
7	21	6.45	3.90	9.50	1.32	1.74	0.56
8	49	8.73	6.20	13.70	1.74	3.02	0.49
9	38	7.49	5.40	10.00	1.13	1.29	0.36
10	111	6.58	4.70	12.80	1.48	2.19	0.28
11	77	7.05	5.30	13.80	1.46	2.13	0.33
12	57	8.28	5.30	12.70	2.22	4.92	0.58

**Table 9** Length (cm) descriptive statistics for 187 juvenile Brown/sea trout *Salmo trutta* captured at the 12 study sites investigated using electrical fishing during September 2011.

Site	N	Mean	Min	Max	St. Dev.	Variance	95% C.I.
1	2	7.95	7.90	8.00	0.07	0.00	0.10
2	8	9.36	5.10	16.10	4.09	16.76	2.84
3	1	8.40	8.40	8.40			
4	1	5.90	5.90	5.90			
5	1	5.40	5.40	5.40			
6	12	9.40	6.50	15.80	2.93	8.56	1.66
7	2	6.90	6.60	7.20	0.42	0.18	0.59
8	4	9.75	7.60	12.00	2.27	5.16	2.23
9	10	6.76	5.20	7.80	0.82	0.67	0.51
10	17	6.53	4.90	10.80	1.46	2.14	0.70
11	32	7.08	5.40	11.20	1.48	2.18	0.51
12	97	10.72	5.10	20.30	4.72	22.29	0.94

**Table 10** Length (cm) descriptive statistics for 86 European eels *Anguilla anguilla* captured at the 12 study sites (salmonid surveys, eel survey, and sweep netting) investigated using electrical fishing during September 2011.

Site number	Species	N	Mean	Min	Max	St. Dev.	Variance	95% C.I.
1	Eel	8	15.44	8.10	28.50	7.96	63.39	5.52
2	Eel	20	21.47	7.80	42.00	10.47	109.68	4.59
3	Eel	12	11.68	8.60	16.40	2.45	6.00	1.39
4	Eel	5	13.20	9.00	18.00	3.56	12.68	3.12
5	Eel	2	29.05	27.50	30.60	2.19	4.81	3.04
6	Eel	15	13.65	9.20	18.80	3.21	10.28	1.62
7	Eel	6	9.37	8.00	11.00	1.08	1.16	0.86
8	Eel	2	16.30	15.20	17.40	1.56	2.42	2.16
9	Eel	2	10.10	9.20	11.00	1.27	1.62	1.76
10	Eel	9	10.48	7.90	12.90	1.92	3.70	1.26
11	Eel	4	15.28	10.70	20.10	4.26	18.12	4.17
12	Eel	1	24.00	24.00	24.00			

**Table 11** Length (cm) descriptive statistics for 490 juvenile River/Brook lampreys *Lampetra* sp. captured at the 12 study sites investigated using electrical fishing during September 2011.

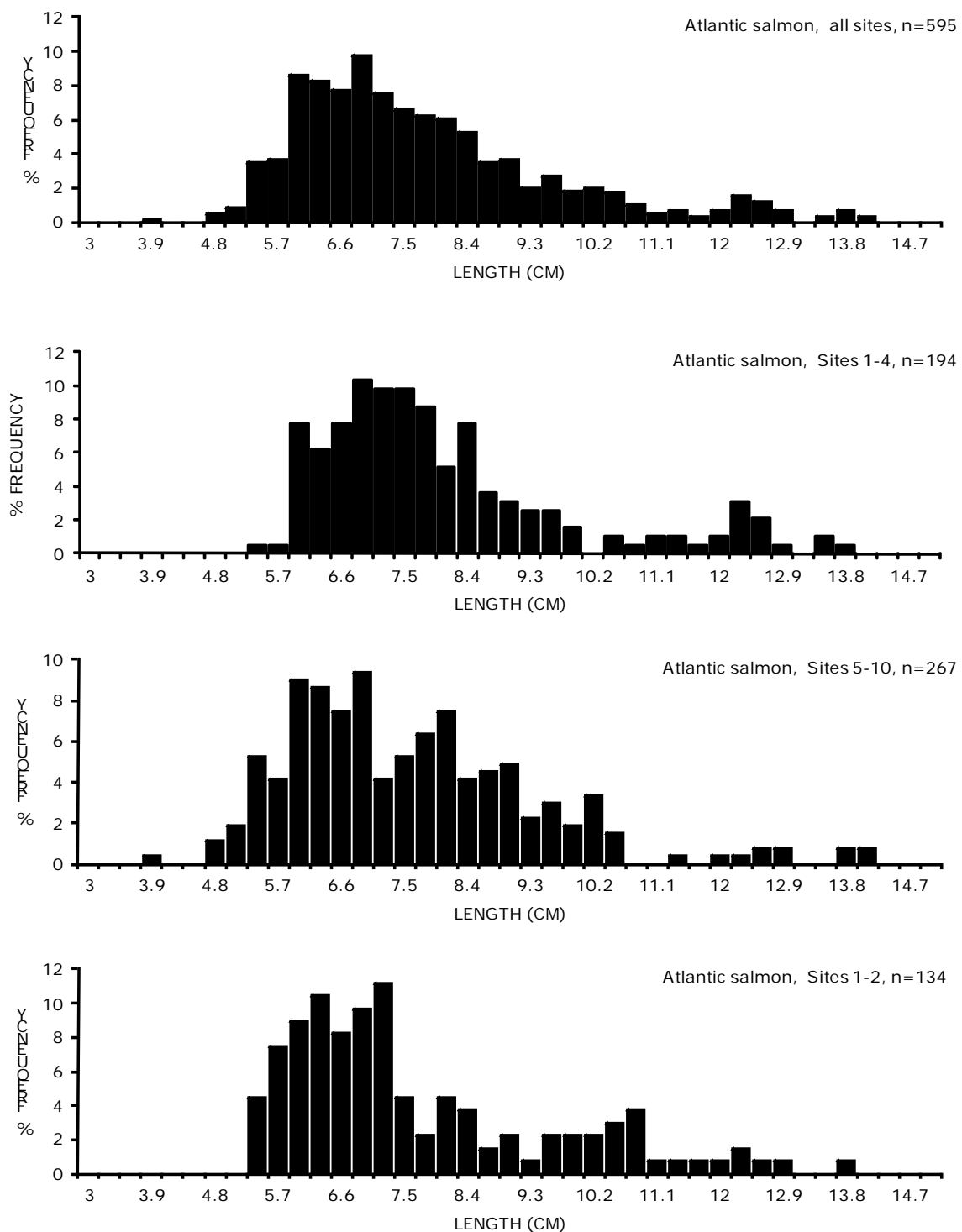
Site	Sub-site	N	Mean	Min	Max	St. Dev.	Variance	95% C.I.
1	A	36	7.63	4.50	10.30	1.62	2.64	0.53
	B	56	7.44	4.00	10.60	2.19	4.81	0.57
	C	44	7.32	4.00	10.60	2.12	4.51	0.63
2	A	12	5.58	3.60	7.70	1.42	2.00	0.80
	B	7	6.01	4.40	7.80	1.55	2.40	1.15
	C	4	5.10	4.10	6.90	1.30	1.69	1.27
3	A	17	7.16	3.70	9.60	1.81	3.26	0.86
	B	14	7.31	4.50	9.50	1.74	3.04	0.91
	C	14	7.51	4.20	10.20	1.79	3.21	0.94
4	A	1	8.20	8.20	8.20			
	B	3	6.87	6.10	7.70	0.80	0.64	0.91
	C	2	9.00	8.20	9.80	1.13	1.28	1.57
5	A	24	6.87	2.30	12.40	2.47	6.10	0.99
	B	20	6.80	2.20	9.20	1.97	3.88	0.86
	C	33	5.97	2.20	10.10	2.51	6.32	0.86
6	A	23	6.77	4.70	10.00	1.42	2.03	0.58
	B	15	6.11	4.10	10.20	1.77	3.14	0.90
	C	9	6.44	5.40	8.40	0.96	0.92	0.63
7	A	4	8.90	7.20	10.20	1.31	1.72	1.29
	C	6	7.65	5.60	11.00	1.82	3.30	1.45
8	A	30	6.18	3.60	10.00	1.64	2.69	0.59
	B	43	6.59	2.80	12.40	2.07	4.29	0.62
	C	30	6.88	3.10	10.20	1.62	2.61	0.58
10	C	5	8.62	7.40	11.20	1.51	2.27	1.32
11	A	10	6.76	4.90	9.60	1.71	2.93	1.06
	B	7	5.93	5.20	6.60	0.48	0.23	0.35
	C	8	7.11	5.00	10.30	1.82	3.31	1.26
12	A	4	12.00	10.00	13.90	1.62	2.62	1.59
	B	3	12.53	8.10	16.00	4.04	16.30	4.57
	C	6	11.43	7.10	14.60	2.72	7.41	2.18

**Table 12** Length (cm) descriptive statistics for 265 minnow *Phoxinus phoxinus* at the 12 study sites investigated using electrical fishing during September 2011.

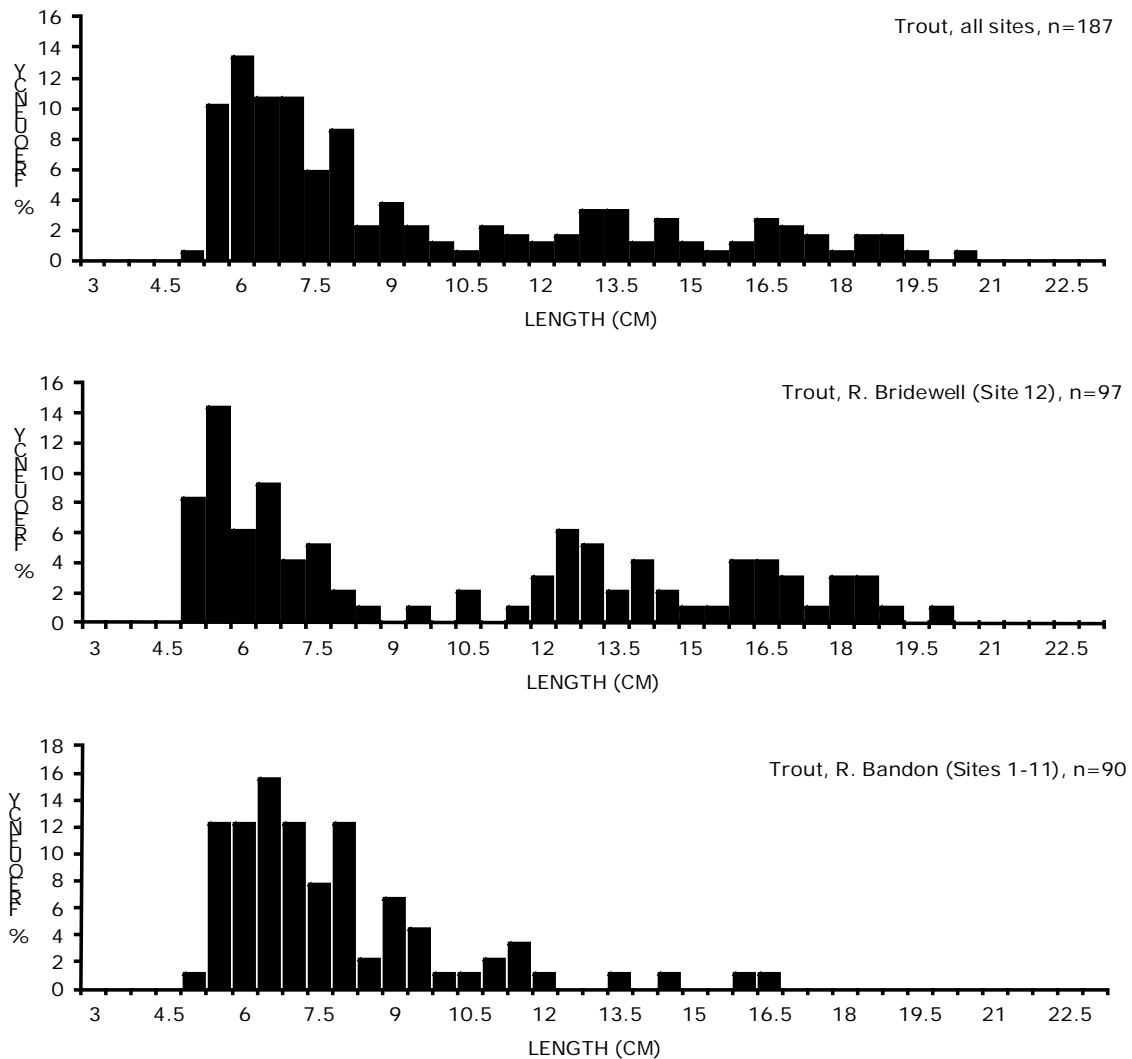
Site	Species	N	Mean	Min	Max	St. Dev.	Variance	95% C.I.
3	Minnow	18	5.55	2.70	6.90	1.18	1.38	0.54
5	Minnow	101	3.24	3.00	3.60	0.18	0.03	0.03
8	Minnow	15	6.11	2.80	8.20	1.58	2.51	0.80
9	Minnow	130	4.10	3.00	6.20	1.27	1.60	0.22
10	Minnow	1	5.40	5.40	5.40			

**Table 13** Length (cm) descriptive statistics for 99 stone loach *Barbatula barbatula* captured at the 12 study sites investigated using electrical fishing during September 2011.

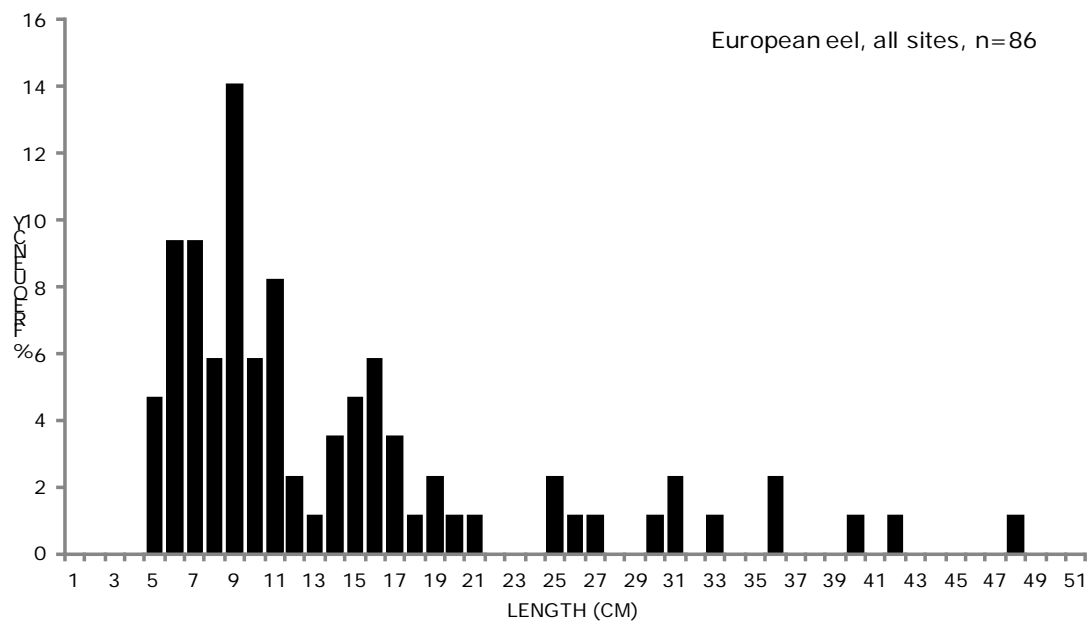
Site	Species	N	Mean	Min	Max	St. Dev.	Variance	95% C.I.
1	Stone Loach	1	10.50	10.50	10.50			
2	Stone Loach	1	8.80	8.80	8.80			
3	Stone Loach	15	9.96	8.80	10.70	0.51	0.26	0.26
4	Stone Loach	24	6.27	3.90	8.00	1.37	1.89	0.55
5	Stone Loach	3	9.07	8.90	9.20	0.15	0.02	0.17
6	Stone Loach	16	8.86	4.10	11.00	2.63	6.94	1.29
7	Stone Loach	29	4.86	4.00	11.00	1.28	1.64	0.47
8	Stone Loach	4	9.35	8.30	10.10	0.76	0.58	0.74
9	Stone Loach	2	8.25	8.00	8.50	0.35	0.13	0.49
11	Stone Loach	4	8.65	8.30	9.00	0.31	0.10	0.30



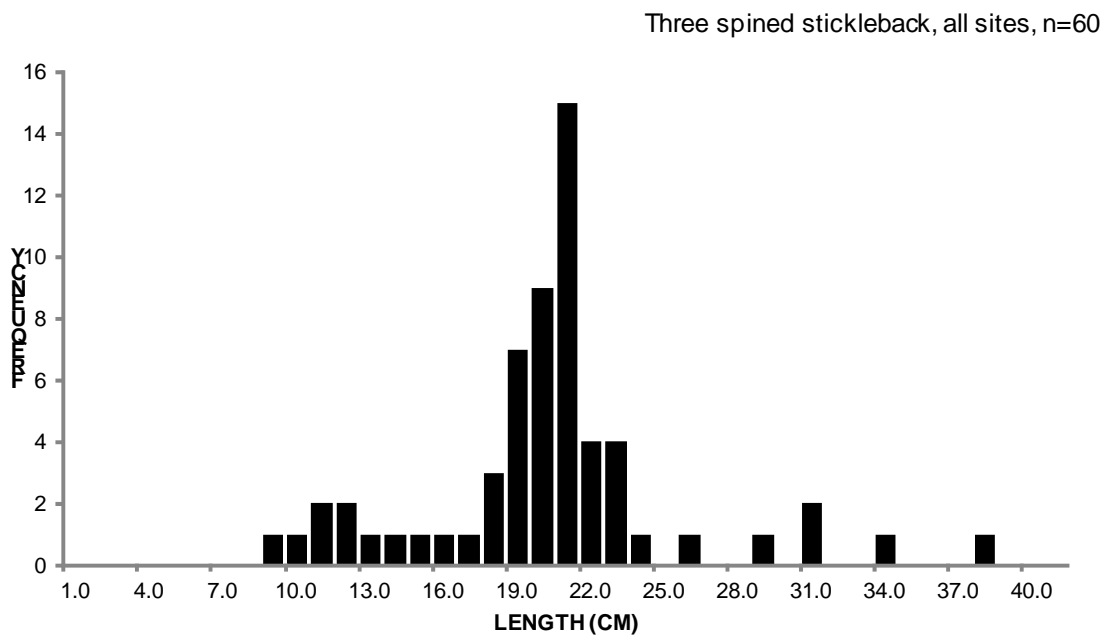
**Figure 14** Length percentage frequency distribution of juvenile Atlantic salmon *salmo salar* captured at all sites (top), and at sites 1-4 (indirectly affected by proposed works, Sites 5-10 (directly affected by proposed works, and at Sites 11-12 (reference sites).



**Figure 15** Length percentage frequency distribution of brown trout captured at all sites (top), and in the River Bridewell (Sites 12), and River Bandon (Sites 1-11).

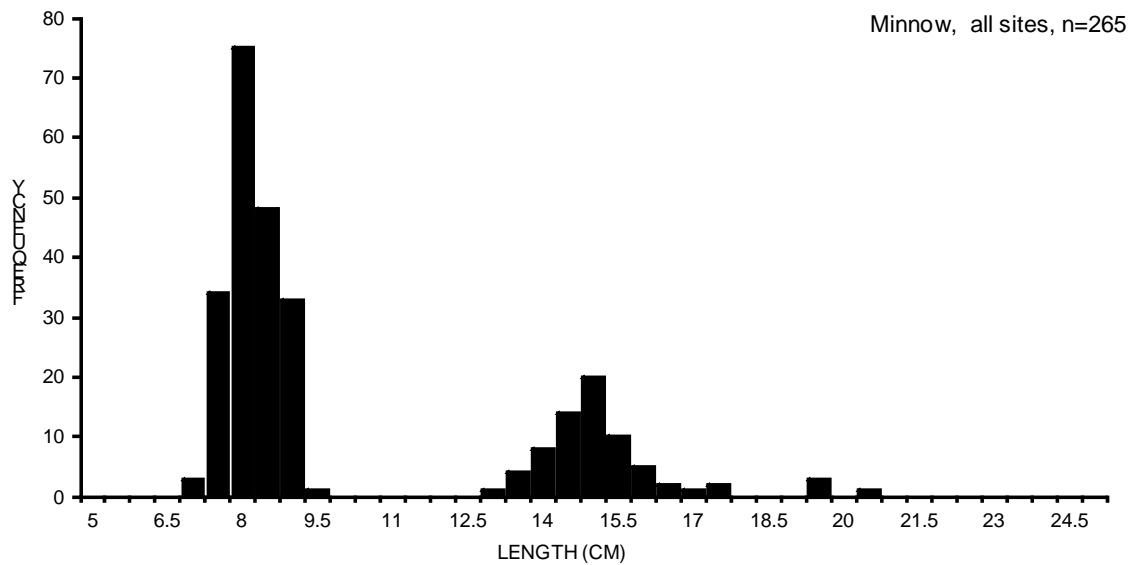


**Figure 16** Length percentage frequency distribution of 88 European eel *Anguilla anguilla* captured at the 12 sites investigated during September 2011.

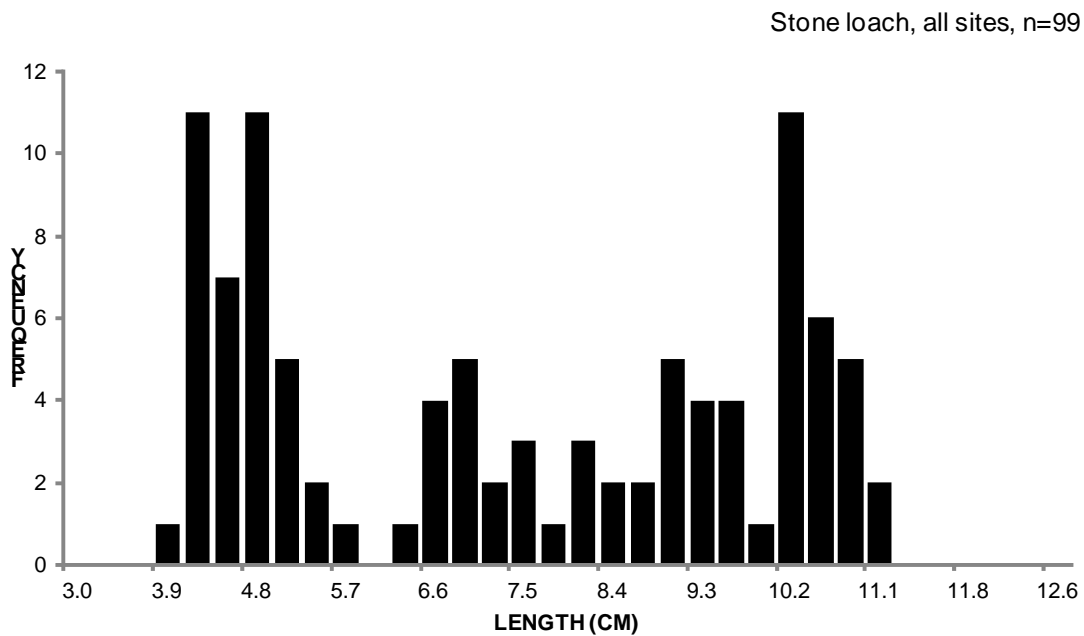


**Figure 17** Length frequency distribution of 60 Three spined sticklebacks *Gasterosteus aculeatus* captured at the 12 sites investigated during September 2011.

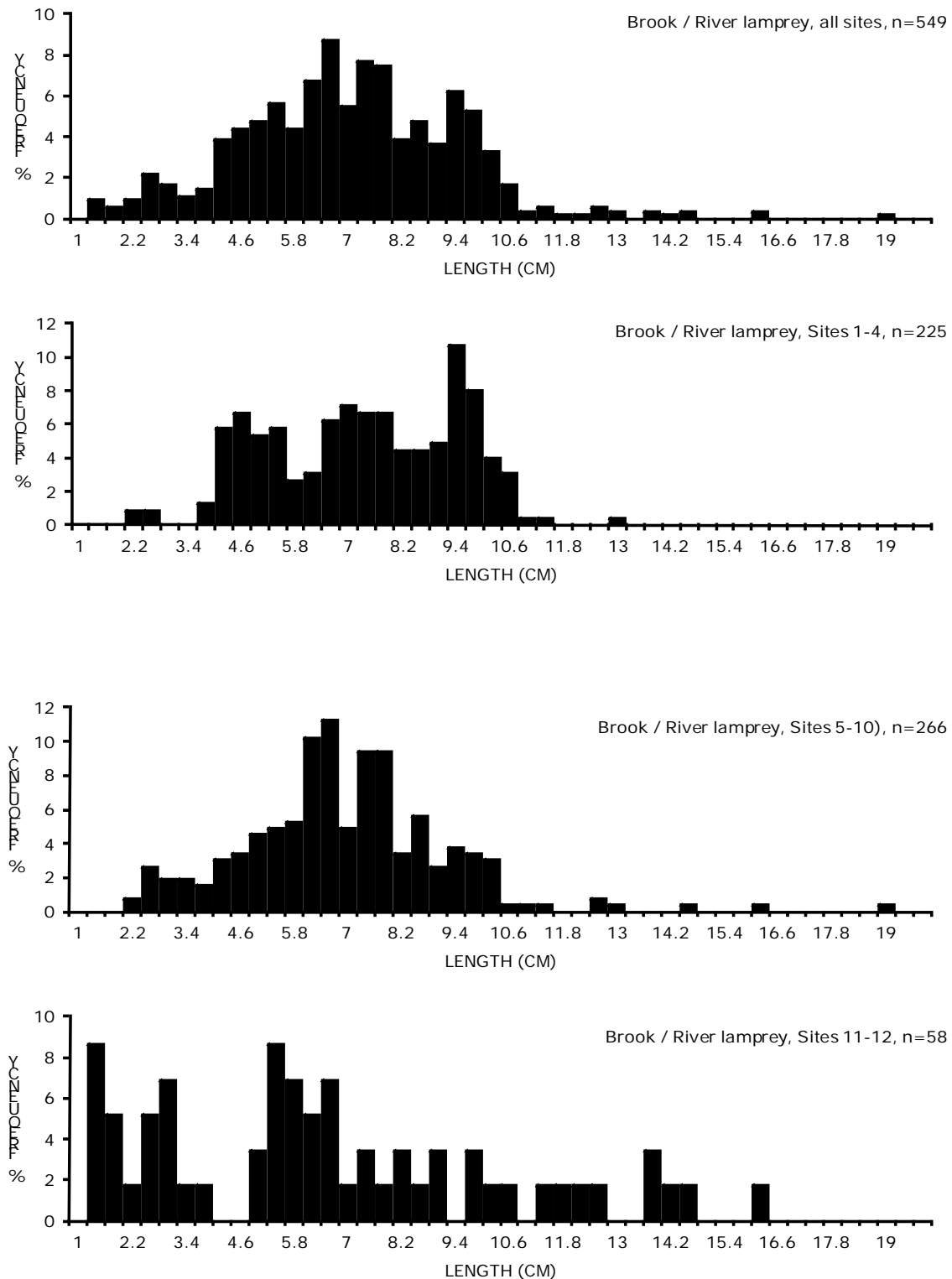




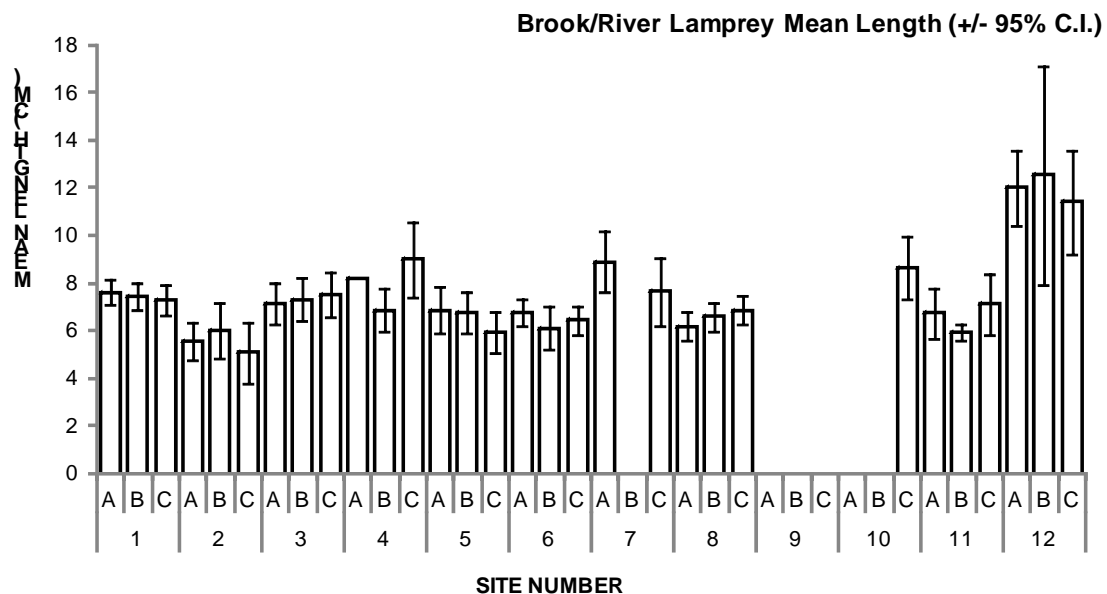
**Figure 18** Length percentage frequency distribution of 265 Minnow *Phoxinus phoxinus* captured at the 12 sites investigated during September 2011.



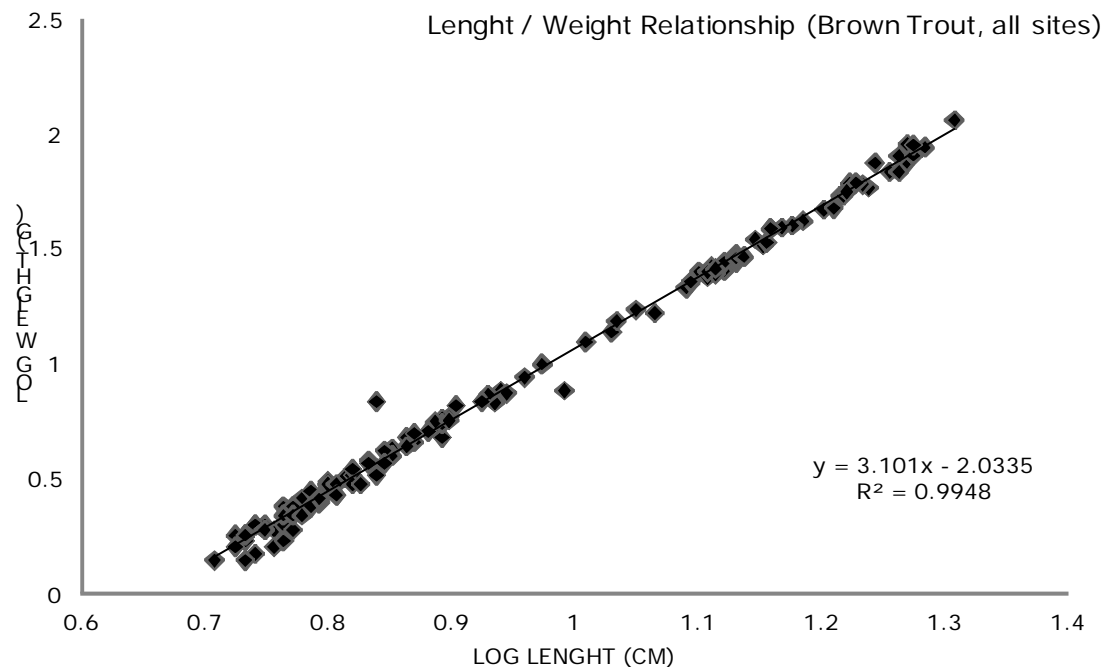
**Figure 19** Length percentage frequency distribution of stone loach captured at the 12 sites investigated during September 2011.



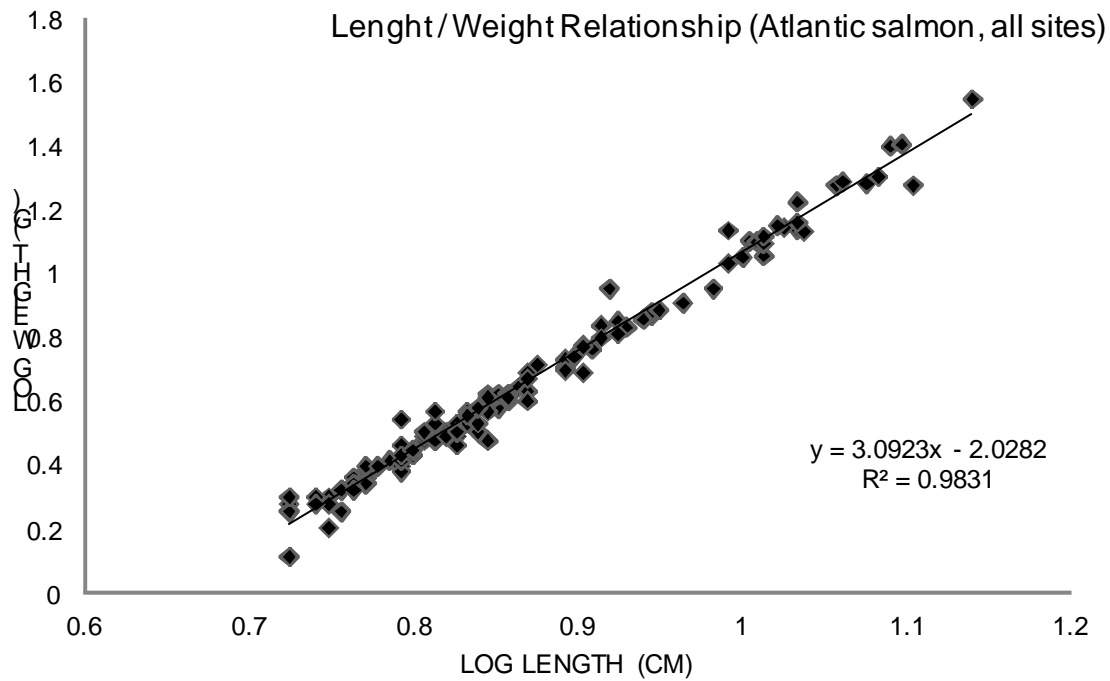
**Figure 20** Length percentage frequency distribution of juvenile Brook/River lampreys *Lampetra* sp. captured at all sites (top), and at sites 1-4 (indirectly affected by proposed works, Sites 5-10 (directly affected by proposed works, and at Sites 11-12 (reference sites). Note no lampreys were recorded at Site 9 which had been affected by dredging in 2010.



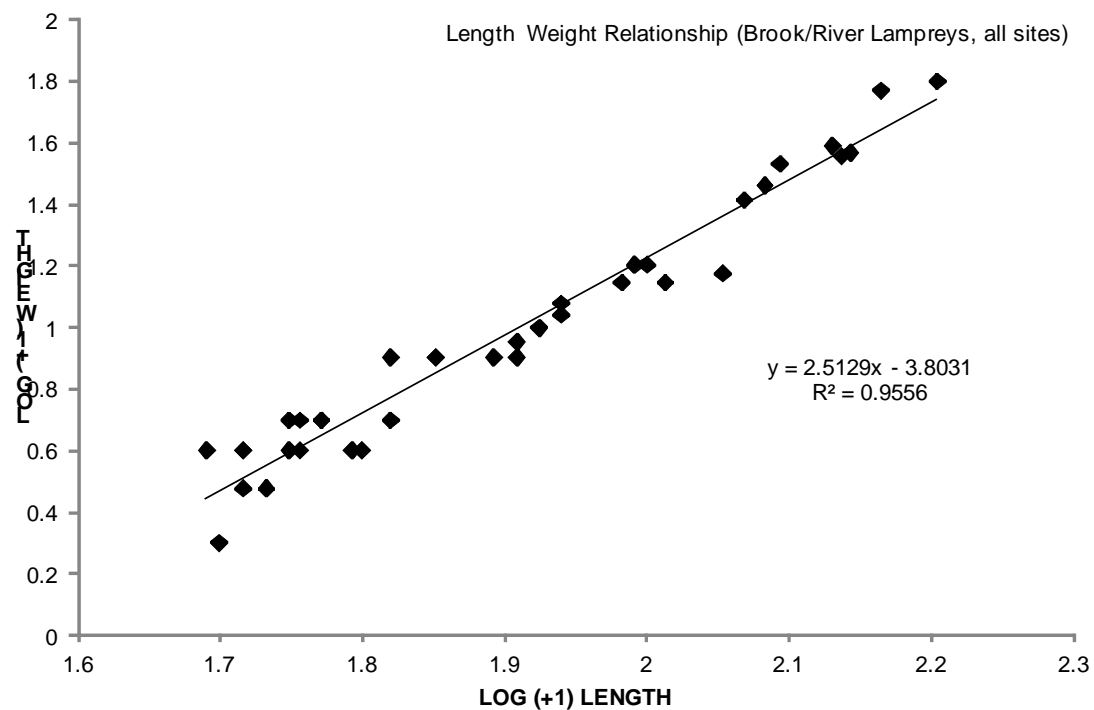
**Figure 21** Variation of juvenile Brook/River lampreys *Lampetra* sp. mean length (+/- 95% C.I.) recorded between sites. Site 9 affected by dredging in 2010.



**Figure 22** Length weight relationship of brown trout (all sites).



**Figure 23** Length weight relationship of Atlantic salmon (all sites).



**Figure 23** Length weight relationship of Brook/River lampreys (all sites).

**Table 14** Summary of results of the snorkel survey carried out in the Bandon River during September 2011 and fisheries evaluation. Note: the snorkel survey at each location was carried out in the downstream direction. This routine is reflected in the 'results' column where each reach is described from upstream to downstream.

Survey location	site	Survey conditions and results	Fish species recorded during snorkelling survey								Evaluation	
			Adult Salmon	Juvenile Salmon	Adult Brown Trout	Adult Sea Trout	Juvenile Trout	Minnow	Stone loach	Flounder		Three-spined Stickleback
1	A channel length of ca. 400 meters surveyed - 200m upstream of Inishannon Bridge to 150m downstream of same.	Good visibility despite elevated water levels at the time of the survey. Shallow riffled areas (ca. 40cm deep) at upstream end of site change to glide/pool habitat upstream of bridge. Deep pool ca. 2.5m deep immediately downstream of bridge. Shallow riffled habitat ca. 50m downstream of bridge gradually deepens to ca. 2 meters. Substrate dominated by cobble and gravel with some rock in pools. Depositing areas along verges of river. Juvenile salmon abundant in riffled areas and less frequent in slower flowing parts. Adult salmon (n=1) and sea trout (n=2) seen in the pool immediately downstream of the bridge. Adult salmon (n=2) and sea trout (n=2) seen and in the pool ca.150m downstream of bridge. Numerous flounder also recorded as well as shoals of minnow.	●	●	●	●	●	●		●	Significant numbers of juvenile salmon occurred along this reach. Important stretch for a number of fish species. Important spawning, nursery and holding area for salmon. Important holding area for sea trout. Important nursery stretch for flounder.	
2	Surveyed stretch of ca. 250m, beginning at the River Brinny confluence.	Water levels elevated, visibility suboptimal at the beginning of survey. Visibility deteriorated during the survey due to upstream dredging works at the time of the survey. Relatively high gradient long riffled stretch with pools to depths of 2m hold adult brown trout, sea trout and juvenile salmonids, mostly salmon. One adult salmon and 3 sea trout recorded here where river narrows and was deepest. Pool at downstream end of survey area likely to have held more adult salmon and sea trout than observed – visibility poor at this time.	●	●	●			●			●	Very good salmonid population with juvenile salmon, adult sea trout and adult salmon. Important stretch for all sizes of fish probably owing to good habitat variation.
3	Channel length of ca. 200m surveyed adjacent to car parking area at Ardnaclog. Ca. 4.8km downstream of Bandon	Water levels at the time of the survey were significantly higher than normal but water clarity was good. This stretch was generally no more than 1m deep. Cobble gravel substrate in slower flowing areas contained good stocks of juvenile salmon. Minnow and flounder also recorded in slower flowing areas. Profile of river bed highly varied in lower end of stretch with rocky substrate and riffles providing optimal conditions in terms of cover for young fish. Adult sea trout (n=3) were seen in the deeper parts of this stretch. Stone loach recorded in the shallow riffles.		●	●	●	●	●	●	●	●	Juvenile salmon dominant fish with high densities occurring. An exceptional nursery area for Atlantic salmon.
4	Channel length of ca. 400m surveyed ca. 4km downstream of Bandon	Water levels elevated and visibility slightly impaired by suspended solids. Significant siltation of the substrate along the surveyed stretch. Adult brown trout and numerous juvenile salmon in riffled stretches. Deep shaded pools to minimum depth of 2m along this reach were holding adult salmon (n=2) and sea trout (n=3), these fish recorded at the sides of the channel.	●	●		●		●				Important spawning, nursery and holding area for salmonids. Riffles of particular importance to juvenile salmon.

Survey location	site	Survey conditions and results	Fish species recorded during snorkelling survey								Evaluation	
			Adult Salmon	Juvenile Salmon	Adult Brown Trout	Sea Trout	Juvenile Trout	Minnow	Stone loach	Flounder		Three-spined Stickleback
5	Ca. 3.2km downstream of Bandon Channel length of ca. 300 meters surveyed - 150m upstream of bridge to 200m downstream of same.	Water levels elevated, visibility good. Upstream end of reach a shallow riffle across the width of the river. This area had a substrate of mostly cobble with floating river vegetation and significant numbers of juvenile salmon here. One adult salmon and 3 sea trout seen alongside right bank of river in glide / pool habitat upstream of bridge (maximum depth of ca. 1.5m). One salmon and one sea trout in the long pool downstream of the bridge. Juvenile salmon and trout seen sporadically along the slower flowing sections. Shoals of minnow at various locations along right side of river.	•	•	•	•	•	•			•	Good pool habitat for resting adult salmonids. Suboptimal nursery habitat yet it supports a significant amount of juvenile salmonids.
6	Stretch of ca. 250m surveyed ca. 2.5km downstream of Bandon.	Water levels elevated, visibility reduced as a result of instream works the previous day. Straight river channel with rock/cobble/gravel substrate. Wide riffled stretch with a mean depth of ca. 30cm with dense cover of floating river vegetation. Juvenile salmon were abundant in this area with adult brown trout and stone loach also recorded. Numerous juvenile salmon, 3 adult sea trout and 3 adult brown recorded in deeper areas. Minnow and flounder were also recorded throughout the surveyed reach.		•	•	•		•	•	•	•	High value stretch for salmonids, especially at the early life stages. Particularly important for young salmon where floating river vegetation occurs – this provides excellent cover for fish.
7	Stretch of ca. 300 meters surveyed.	Water levels elevated, visibility reduced as a result of instream works the previous day. It is noted that the substrate and submerged vegetation had a coat of silt. Relatively deep reach with a mean depth of ca. 1m. A total of 7 adult sea trout and 8 adult brown trout were recorded in the pools along this reach. Juvenile salmon recorded in all areas but most juvenile salmonids found close to rock cover in riffled areas.	•	•	•	•	•	•			•	Important holding pools for adult salmon and sea trout. Excellent nursery habitat for salmonids and spawning also.
8	Stretch of ca. 350m surveyed	Water levels elevated, visibility reduced as a result of instream works the previous day. Adult brown trout (n=6) and several juvenile salmonids recorded in pool of maximum depth of ca. 1m. Cobble dominated reach of river, generally shallow with a mean depth of ca. 0.6m supporting an abundance of juvenile salmon. Fast flowing riffles at the centre of the channel most important for salmonids. Three adult brown trout recorded in pool at the downstream end of the reach. Flounder recorded sporadically along the reach.		•	•		•	•			•	All parts of the river used by young salmonids but riffled areas of greatest value to juvenile salmonids. Suboptimal pool habitat for holding adult salmon (insufficiently deep).
9	Survey extended from	Water levels elevated, good visibility. Four adult brown trout in the short pool (to ca. 1.3m deep) just downstream of		•	•		•			•		Reach of most importance to juvenile

Survey location	site	Survey conditions and results	Fish species recorded during snorkelling survey								Evaluation
			Adult Salmon	Juvenile Salmon	Brown Trout	Sea Trout	Juvenile Trout	Minnow	Stone loach	Flounder	
Bandon Bridge to ca. 400m downstream.		Bandon Bridge. Combination of riffle and glide habitat downstream of here with juvenile salmonids dispersed across the channel. Salmon greatly outnumbering trout being recorded mostly near the centre of the channel. This stretch within the town had a mean depth of ca. 45cm. The substrate in the stretch was mostly of gravel with more cobble occurring with distance downstream. Flounder also recorded.									salmon. Degraded substrate mostly unsuitable for salmonid spawning. Too shallow to be of importance to adult salmon and little cover for juvenile salmonids.
11 Stretch of ca. 400m surveyed		Water levels elevated, good visibility. Varied substrate composition of bed of river and varied depth provide niches for all sizes of salmonids. Three adult salmon and 8 adult sea trout were seen in the pools along the surveyed reach which had a maximum depth of ca. 2 meters. Juvenile salmon and trout abundant in the shallower riffled areas. Shoals of minnow at the verges of pools usually amongst submerged branches of trees.	•	•	•	•	•	•			Very good holding pools for adult salmonids and excellent salmonid nursery.
12 Stretch of ca. 100, beginning ca. 50m upstream of the local road bridge that links the N71 to the R602.		Water level slightly elevated, good water clarity but visibility impaired by degree of shade. Mainly riffled reach with a mean depth of ca. 20cm. Cobble/gravel substrate dominated and supported numerous juvenile salmon and brown trout in roughly equal abundance. Small pools to ca. 30cm intermittent along the reach, these pools occupied predominantly by older age group juvenile salmonids. 0 group fish recorded in shallows less than 5cm deep.		•	•						Important nursery stream for trout and salmon. Reach too small to hold adult salmon and sea trout during normal flows but used by these fish for spawning.

**Table 15** Results of the sweep netting (20 sweeps per site) carried out in the Bandon River during September 2011.

Survey site location	Survey results	Fish species recorded and number							Evaluation
		flounder	3-spined stickleback	minnow	stone loach	trout	salmon	eel	
1 Sampled a stretch of ca. 25 meters immediately downstream of Inishannon Bridge along the right bank.	Four fish species were recorded among vegetation and submerged branches. Flounder were the most commonly recorded fish followed by 3-spined stickleback and then stone loach.	7	3		1				Submerged bankside vegetation provides good cover for fish. Important nursery area for flounder.
2 Surveyed stretch of ca. 30m, along the left bank of the river. Survey area ca. 150m downstream of River Brinny confluence.	Three-spined stickleback caught among rocks along the shallow verges of the river. European eel (n=1) also recorded here.		20					1	Very important part of the river for eel probably owing to the amount of rock present. Good cover for small fish such as three-spined stickleback at this site.
3 Sweeping carried out adjacent to car parking area at Ardnaclug ca. 4.8km downstream of Bandon (right side of river).	Three-spined stickleback recorded in riffled areas. Minnow recorded in glide/pool habitat.		10	2					Rock provides good habitat for three-spined stickleback. Slow flowing shallow areas good nursery areas for minnow.
4 Sampled pool habitat along right side of river to 20m upstream and 20m downstream of old bridge foundation ca. 4km downstream of Bandon.	Minnows caught mostly at the verge of the river where depth was ca. 34-40cm and light could penetrate.			25					Exposed pools along river are an important habitat for minnow.
5 Sluggish stretchy along left bank of river surveyed upstream and downstream of bridge ca. 3.2km downstream of Bandon.	Three-spined stickleback and minnow abundant along vegetated bank. Stone loach as well as juvenile salmon and trout also caught in these areas.		24	45	9	3	2		Undercut banks and submerged part of emergent aquatic plants along bankside are important habitats for fish, including juvenile salmonids.
6 Stretch of ca. 20m along right bank surveyed alongside N71 ca. 2.5km downstream of Bandon.	Three-spined stickleback and minnow recorded in riffled stretch ca. 10-20cm deep.		7	11					Margins of river provide good cover for three-spined stickleback and minnow.
7 Stretch of ca. 60 meters surveyed ca. 2km downstream of Bandon.	Three-spined stickleback and minnow recorded in pool verges ca. 40cm deep.		8	15					As above
8 Stretch of ca. 20m surveyed ca. 1km downstream of Bandon on both sides of the river.	Three-spined stickleback, minnow and trout recorded. Three-spined stickleback caught mostly in shallow rocky areas. Shoal of minnow and trout near deadwood on left side of channel. Only small proportion of fish were caught.		12	20		1			Any instream physical diversity such as fallen trees deemed to increase the value of fish habitat, providing extra cover for fish.
9 Sweep netting carried out on both sides of the river ca. 50m downstream of Bandon Bridge.	Three-spined stickleback and minnow most common fish species recorded. Three-spined stickleback caught mostly near rock armouring. Minnow, stone loach, trout and		10	23	3	2	1		This is an important part of the river for juvenile salmonids and other small fish. The relatively large numbers of fish caught here are expected to be related



Survey site location	Survey results	Fish species recorded and number							Evaluation
		flounder	3-spined stickleback	minnow	stone loach	trout	salmon	eel	
	salmon caught near vegetated margins. Little physical diversity along this part of the channel.								to the lack of cover for fish as opposed to larger densities of fish.
<b>10</b> Stretch of ca. 40m surveyed along the left bank of the river downstream hydro station tailrace weir.	Shoals of minnow in sluggish water downstream of tailrace. Three-spined stickleback found mostly in floating grass habitat. Trout also recorded among grass.		18	42		1			Slow flowing parts of the river including glide and pool habitat important for minnow and three-spined stickleback. These areas also provide cover for young salmonids where vegetation occurs.
<b>11</b> Stretch of ca. 40m surveyed on both sides of the river ca. 2km upstream of Bandon.	Three-spined stickleback, minnow and stone loach found in submerged bankside vegetation and submerged branches of willow trees. Difficult to penetrate into willow branches – only a small proportion of minnows captured.		9	9	2				Submerged plants and branches of trees provide excellent cover for minnows and three-spined stickleback.
<b>12</b> Stretch of ca. 50m surveyed downstream from the local road bridge that links the N71 to the R602. Both sides of river surveyed.	0+ group brown trout recorded in riffles.					4			Important spawning and nursery stream for trout.

## 4. DISCUSSION

The lower River Bandon has exceptional juvenile salmon populations. The current survey has confirmed that salmon spawn throughout the lower river. This is an SAC quality River for this species. The lower River Bandon is less important in relation to trout populations. This may to some degree be related to habitats; however competition from the large salmon populations may also be a factor. Adult sea trout and salmon were observed throughout the lower river during the current survey, and the study area is a nationally important salmonid angling area.

The lower River Bandon also has exception juvenile lamprey populations. The current survey was undertaken during September, which is about a month too early for that recommended for rivers which contain both *Lampetra* species (Gardiner, 2003). However, it was concluded that many of the transformers recorded during the current survey were *L. fluvialitis*. All of these transformers lampreys were less than 11cm and in the size range reported for *L. fluvialitis* (Gardiner, 2003). One almost fully transformed individual identified as being River lamprey *Lampetra fluviatilis*. It is considered, based on the geographically location, that most of the population here probably are *L. fluvialitis* (rather than *L. planeri*). However, both of these Annex II species are almost certainly present. There was a good size range of juvenile lampreys present at this site, with several age classes ranging from young of the year to transformers. This is considered to be an exceptional (SAC quality) spawning and nursery area for river lampreys (and probably brook lampreys). Sea lamprey was confirmed absent.

It is noted that river lampreys and brook lampreys are often grouped together and assessed in terms of conservation status as if they were one species (i.e. NPWS, 2008; King *et al*, 2011). This is understandable due to the difficulties with separating these species. However, although it is difficult, it is not impossible to separate them and a national survey of river lamprey populations is recommended. River lampreys are generally confined to the lower reaches of river, and in most Irish situations where they occur that are confined below weirs and other obstacles. It is clear that because of this they have a much more restricted distribution than *L. planeri* and also almost certainly more vulnerable. They are particularly vulnerable to instream works (including flood schemes and drainage works) due to their non-mobile extended juvenile life cycle phase, and spring-summer spawning seasons.

The current survey was undertaken in advance of any designs for the proposed scheme being available, so no impact assessment or mitigation measure section is included in this report. It is clear however that any scheme on this river has the potential to significantly affected both salmon and lampreys population. It is thought that river lampreys cannot pass Bandon Weir at present so would be particularly vulnerable to the impacts from a flood scheme. Even if no dredging works are proposed construction of river walls or other modifications could directly affect the habitats that juvenile lampreys use. Sedimentation from instream works could affected both salmonid and lamprey reproduction in the river by affecting areas where these species spawn.

The existing weir at Bandon presents an obstacle to River lamprey upstream migration. The available spawning and juvenile silt bed habitats downstream of this weir are therefore of increased importance in the context of the Bandon River catchment. Impacts affecting this stretch of the river below the weir would have the potential to result in direct and indirect adverse impacts

on this Annex II species. It is also noteworthy that juvenile salmonid stocks below the weir are dominated by salmon. Therefore the weir may also act as a partial barrier to this species.

A range of mitigation responses are available however. Careful project design to minimise instream works is certainly recommended. However, construction of river walls should also be considered to be instream works with the potential to significantly affect lamprey populations which are often found at the margins of rivers. Works should be timed to avoid times when fish are spawning in the river and juvenile lamprey population will need to be moved out of the way prior to works. Habitat restoration could be undertaken in relation and provision of lamprey passage through the Bandon weir could be included as an enhancement / rehabilitation measure.

## REFERENCES

Flosi, G, and Reynolds, F. L. (1994) California salmonid stream habitat restoration manual. California Department of Fish and Game, Technical Report, Sacramento.

Gardiner, R (2003). Identifying Lamprey. A Field Key for Sea, River and Brook Lamprey. Conserving Natura 2000 Rivers Conservation Techniques Series No. 4. English Nature, Peterborough.

Johnson, D. H., Shrier, B. M., O'Neal, J. S., knutzen, J. A., Augerot, X. (2007) Salmonid Field Protocols Handbook: techniques for assessing status and trends in salmon and trout populations. American Fisheries Society, Bethesda, Maryland.

King, J.L., Marnell, F., Kingston, N., Rosell, R., Boylan, P., Caffrey, J.M., FitzPatrick, Ú., Gargan, P.G., Kelly, F.L., O'Grady, M.F., Poole, R., Roche, W.K. & Cassidy, D. (2011) Ireland Red List No. 5: Amphibians, Reptiles & Freshwater Fish. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.

NPWS (2008). The Status of EU Protected Habitats and Species in Ireland. National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin.

O'Connor W. (2004) A survey of juvenile lamprey populations in the River Moy catchment. *Irish Wildlife Manuals*, No. 15. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland.

Slaney, P. A. and Martin, A. D (1987) Accuracy of underwater census of trout populations in a large stream in British Columbia. *North American Journal of Fisheries Management* 7:117-122.

## PLATES

### Methodology



**Plate 1** Juvenile salmonid electrical fishing survey location at Site 10 in Bandon town. Salmonid electrical locations were chosen on riffled parts of the river.



**Plate 2** Electrical fishing for juvenile lampreys at Site 10. Sites for juvenile lampreys were located in depositing parts of the river in areas where the substrate was dominated by soft substrates.





**Plate 3** One of three electrical fishing locations selected for the lamprey survey at Site 9. This 1m<sup>2</sup> frame which was fitted with fine mesh was used at three sub-sites at each site.



**Plate 4** Electrical fishing with the portable electrical fishing unit (Smith Root-LR 24 backpack) on the Bridewell River. Electrical conductivity within the study area was typically low at around 220µS/cm. This machine automatically adjusts the power output according to conductivity and water depth, therefore providing a standardized sampling effort.





**Plate 5** Electrical fishing for European eel among submerged rock habitat at Site 10.



**Plate 6** Sweep netting for fish along the margins of the River Bandon at Site 7. Sweep netting at each location consisted of 20 sweeps of a dip net through aquatic vegetation.





**Plate 7** Sweep netting at Site 1. A total of 20 sweeps were carried out at each site at random locations along the bank of the river.



**Plate 8** Snorkel survey being carried out in riffled habitat in the River Bandon at Site 2.

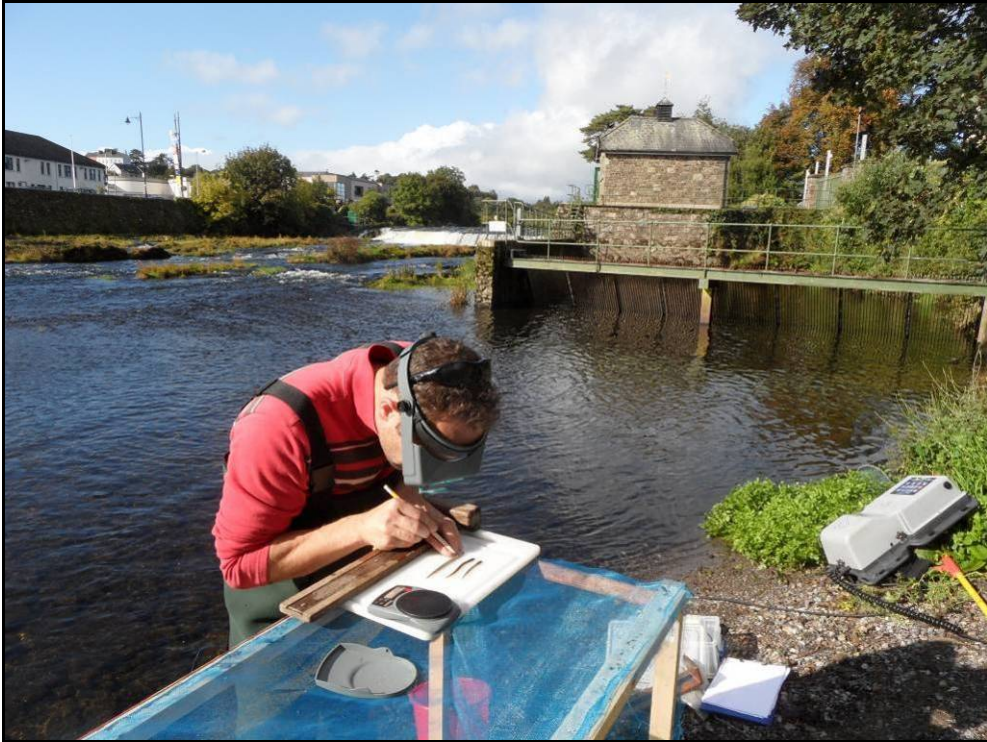




**Plate 9** Snorkeling in the Bandon River at Site 7. Adult salmon were located in this pool and also in the next pool downstream.



**Plate 10** Snorkeling at Site 11, the uppermost site on the Bandon River. This surveyed confirmed that this part of the river is an important area for both juvenile and adult salmon and trout.



**Plate 11** Identification of juvenile lampreys captured at Site 10. This procedure involved counting trunk myomeres, assessing oral hood and caudal fin pigmentation and length measurement.

#### **Fish survey results**



**Plate 12** Salmonid parr (top) were recorded at all survey sites.





**Plate 13** Juvenile salmon from the River Bandon below the weir in Bandon (Site 10). Salmon were the most common fish recorded in the current survey.



**Plate 14** Salmon parr *Salmo trutta* recorded while snorkeling at Site 7. Siltation of the substrate is evident in this picture. This was the result of the instream works that were carried out in the river in Bandon town.



**Plate 15** Brown trout *Salmo trutta* (top two) and Atlantic salmon *Salmo trutta* (four fish below) from Site 12 on the Bridewell River. This watercourse is more important as a producer of brown trout than salmon.



**Plate 16** Brown trout *Salmo trutta*.





**Plate 17** Fish recorded at Site 1 included flounder *Platyichthys flesus*, three-spined stickleback *Gasterosteus aculeatus*, brown trout *Salmo trutta* and stone loach *Barbatula barbatula*.



**Plate 18** Flounder, minnow and stone loach were among the fish recorded at Site 7. The lower reach of the River Bandon is a particularly important nursery area for flounder. The upper limit of this species is probably at the weir in Bandon.



**Plate 19** Shoal of minnow *Phoxinus phoxinus* in the Bandon River at Site 7. Minnows occur throughout the River Bandon within the study area, in particular along the margins of the river.



**Plate 20** Minnow was the most frequently recorded fish during the sweep netting.





**Plate 21** Three-spined stickleback *Gasterosteus aculeatus* occurs along the vegetated margins of the Bandon River.



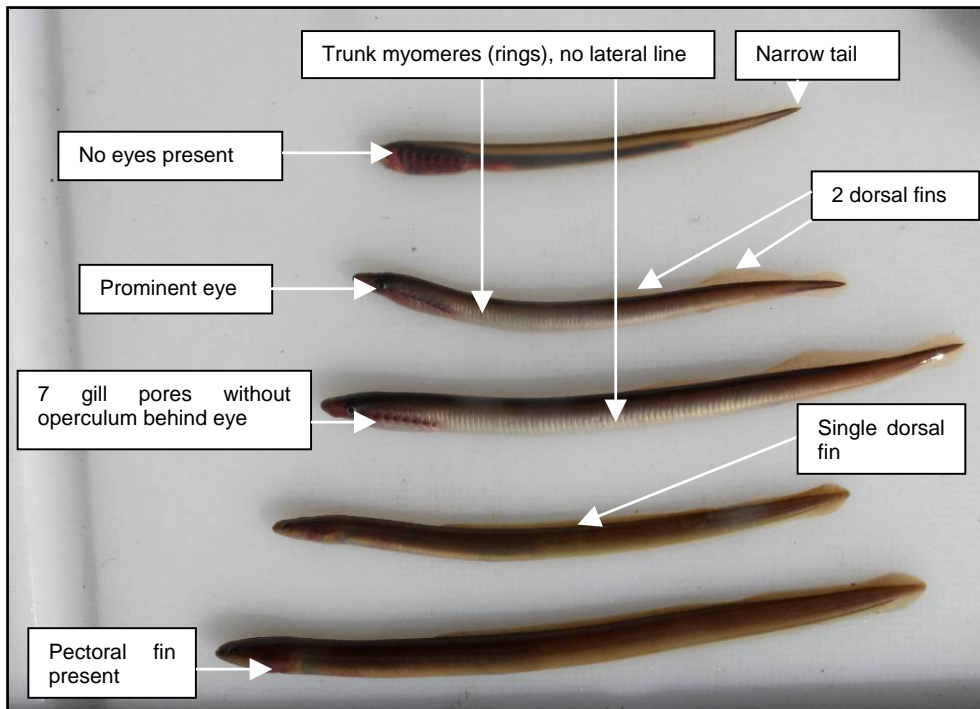
**Plate 22** European eel *Anguilla anguilla* recorded from Site 2. European eel is a fish species in International decline and has recently been declared an endangered species. The lower reaches of the river are of importance for this species.



**Plate 23** Stone loach *Barbatula barbatula*.



**Plate 24** Sample of fish recorded from Site 10; brook/river lamprey (top two) and European eel (bottom two).



**Plate 25** Juvenile lamprey (top), transformer lampreys (2<sup>nd</sup> and 3<sup>rd</sup> from top) and European eel (4<sup>th</sup> and 5<sup>th</sup> from top). The captions indicate some differences between lamprey and eel. A primary difference between lamprey and eel is that lampreys do not possess a jaw. Eels are more similar to salmon than lampreys!



**Plate 26** Lampreys recorded from Site 3; top: confirmed river lamprey and below river/brook lamprey. Both the river and brook lamprey are protected under European law being listed on Annex II of the E.U Habitats Directive.





**Plate 27** Juvenile lampreys recorded at Site 5 from within the proposed flood relief scheme. The variety of age classes recorded in the Bandon River indicates the vitality of the river with respect to reproducing lampreys.



**Plate 28** Juvenile river/brook lamprey *Lampetra* sp. exiting its burrow. Most of the juvenile lamprey habitat used by lampreys at this life stage occurs along the edges of the river and are very susceptible to dredging works.



**Plate 29** Underwater image of the margin of the River Bandon at Site 4.



**Plate 30** Weir on the River Bandon in Bandon town. This point on the river is thought to be the upper limit for river lamprey (and flounder). This structure could also be a difficult obstacle for European eel to pass.





**Plate 31** River Bandon at the time of the survey was higher than normal.



**Plate 32** Fish pass at the weir in Bandon. This picture was taken in early September when water levels were low.



## Survey sites



**Plate 33** Site 1 on the River Bandon at Inishannon Bridge, ca. 3km downstream of the proposed works. This is a very important part of the river for all life stages of salmon.



**Plate 34** Site 4 was located approximately 0.8km downstream of the proposed flood relief scheme.



**Plate 35** Site 2 on the River Bandon approximately 1km upstream of Inishannon Bridge (ca. 2km downstream of the proposed works).



**Plate 36** Site 5 from the Bridge at Curranure. This sluggish stretch of the River Bandon is an important reach for juvenile lampreys.



**Plate 37** Site 3 on the River Bandon was located approximately 1.5km downstream of the proposed works.

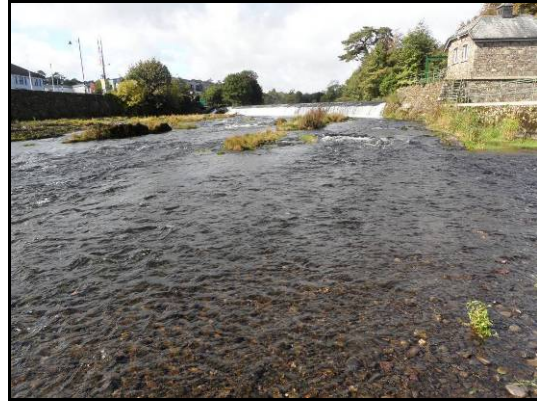


**Plate 38** Site 6 on the Bandon River. This part of the river is an important area for salmon, eel and lamprey and is within the stretch where the flood relief scheme is proposed.





**Plate 39** Site 7 was located within the stretch of the River Bandon that would be affected by the proposed scheme. This area is important for all life stages of salmon, including holding adult fish.



**Plate 40** Site 10 on the Bandon River below the weir in the Bandon. This riffled part of the river is at the upper end of the proposed flood relief scheme and is an important nursery area for salmon.



**Plate 41** Site 8 on the Bandon River was located approximately 1 km downstream of the bridge in Bandon within the proposed flood relief scheme.



**Plate 42** Site 11 on the Bandon River upstream of the proposed flood relief scheme.



**Plate 43** Bandon River in Bandon at the R589 Bridge (Site 9). Instream works that previously took place along this stretch have diminished the fisheries value of this area.



**Plate 44** Site 12 on the Bridewell River. This tributary of the Bandon joins the Bandon River upstream of the proposed flood relief scheme.





**Plate 45** Deposited silt such as this provides optimal burrowing habitat for juvenile lampreys. Such areas in the lower River Bandon are deemed especially important for river lampreys given that this species is probably restricted to the river downstream of Bandon. .



**Plate 46** Lamprey electrical fishing location at Site 3.





**Plate 47** Lamprey electrical fishing location at Site 8. A total of 103 river/brook lampreys were recorded in 3m<sup>2</sup> of the silt bed shown above. This type of depositing habitat shown occurs at various locations along this part of the river and is likely to hold similar densities of lampreys.



**Plate 48** Optimal habitat for juvenile lampreys occurs at various locations along the verge of the River Bandon. Such habitat is more common along depositing reaches. Shown above is substrate consisting of fine sand and silt at the edge of the river at Site 4.





**Plate 49** Salmonid electrical fishing location at Site 7.



**Plate 50** Underwater view of the substrate at Site 7. This combination of rock and cobble in a fast flowing area provides ideal nursery conditions for young salmon and trout.





**Plate 51** Substrate in the River Bandon in a glide flow feature upstream of the instream works (photo taken on 23<sup>rd</sup> September 2011).



**Plate 52** View of substrate in the River Bandon in a riffled area upstream of the instream works (photo taken on 23<sup>rd</sup> September 2011).





**Plate 53** Instream works that were taking place on the Bandon River on 22<sup>nd</sup> September 2011.



**Plate 54** Instream works that were taking place on the Bandon River on 22<sup>nd</sup> September 2011.



**Plate 55** Ineffective silt control measures being used downstream of the instream works on the River Bandon. Straw bales can be seen floating downstream in the background. The bales have also been topped with silt, which inevitably was also washed downstream.



**Plate 56** Siltation on the River Bandon downstream of the instream works within Bandon Town (photo taken on 23<sup>rd</sup> September 2011).





**Plate 57** Siltation on the River Bandon downstream of the instream works within Bandon Town (photo taken on 23<sup>rd</sup> September 2011).



**Plate 58** Plume of silt caused by walking in the River Bandon approximately 1km downstream of the works, illustrating high level of siltation in this area in advance of salmonid spawning season. It is clear from this photo the level of suspended solids pollution experience by section of the river downstream of the instream works. As works also took place during September 2010 it is clear that such works could have affected salmonid production in this stretch and therefore the results of the current survey.





**Plate 59** Confluence of the River Brinny with the River Bandon approximately 5.5km downstream of the instream works in Bandon. It is clear from this photo the level of suspended solids pollution experience by section of the river downstream of the instream works.



**Plate 60** River Bandon at Inishannon Bridge in the evening of the 22<sup>nd</sup> of September, also showing suspended solids pollution.