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## Freshwater pearl mussel survey of Northern 2011.

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# Freshwater pearl mussel survey of Northern Ireland 2011



**Research and Development Series 10/XX**  
**A report commissioned by the Northern Ireland Environment Agency**

## **Freshwater pearl mussel survey of Northern Ireland 2011**

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The opinions expressed in this report do not necessarily reflect the current opinion or policy of the Northern Ireland Environment Agency.

## EXECUTIVE SUMMARY

1. The freshwater pearl mussel *Margaritifera margaritifera* is Ireland's only globally 'Endangered' species and the EU Habitats Directive requires the designation of Special Conservation Areas (SACs) or Areas of Special Scientific Interest (ASSIs) for its protection. The species has undergone dramatic declines throughout its range including in Northern Ireland.
2. Freshwater pearl mussels are extant in six rivers in Northern Ireland. The Ballinderry, Owenkillew and Swanlinbar are currently designated as SACs, the Tempo is currently designated as an ASSI whilst the Owenreagh and Waterfoot are proposed ASSIs.
3. Initial condition assessments for the three SAC rivers were carried out by Killeen (2007) and populations were found to be in "Unfavourable declining" condition.
4. The current survey reassessed the condition assessment of the three SAC rivers and conducted the first baseline assessments of the three ASSI and proposed ASSI rivers.
5. A total of 12,947 freshwater pearl mussels were recorded on SAC designated rivers (Ballinderry, Owenkillew and Swanlinbar). Whilst there was a +4.1% increase in the numbers of mussels recorded, there was no significant temporal trend in abundance and populations judged to be stable since the previous survey. Nevertheless, water quality and other factors resulted in an overall condition assessment for 2011 judged to be "Unfavourable no change".
6. A total of 9,032 freshwater pearl mussels were recorded on the ASSI and proposed ASSI rivers (Tempo, Owenreagh and Waterfoot). The current survey discovered a substantial population (8,195 mussels) on the Owenreagh which represents the population data for this river. Numbers declined by -17.9% on the Tempo river. The Waterfoot had also been surveyed previously; however, there were difficulties in direct comparisons of individual river sections between the current survey and previous surveys. Water quality and other factors resulted in an overall condition assessment for 2011 judged to be "Unfavourable" for the Owenreagh and "Unfavourable declining" the Tempo and Waterfoot.
7. Overall, a total of 21,979 freshwater pearl mussels were recorded on six rivers throughout Northern Ireland.

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## INTRODUCTION

The freshwater pearl mussel *Margaritifera margaritifera* is Ireland's only globally 'Endangered' species (IUCN 1996). It is protected under Appendix II of the Bern Convention and listed under Annex II and V of the EU Habitats Directive (92/43/EEC) i.e. a species whose conservation requires the designation of sites at which it occurs, such as Special Conservation Areas (SACs) or Areas of Special Scientific Interest (ASSIs). Exploitation such as taking specimens from the wild prohibited except under licence.

The species has undergone dramatic declines throughout its range (Hastie & Cosgrove, 2001), including throughout the British Isles (Cosgrove *et al.*, 2000). The stronghold for the species in Great Britain is Scotland where there are 21 sites designated with the freshwater pearl mussel as the named feature (Anon 2011).

The species was once common on many rivers in Northern Ireland (Kerney 1999). However, recent surveys have identified small beds of *M. margaritifera* in only a few river systems where they form small, senescent populations (Killeen, 2007). Declines have been such that it has been estimated that the species may be totally extinct in Northern Ireland by 2098 (Wilson 2011a). Consequently, the freshwater pearl mussel is the named feature in three rivers designated as SACs: namely the Ballinderry, Owenkillew and Swanlinbar and one river as an ASSI: namely the Tempo (Fig. 1) whilst two rivers as currently proposed as future ASSIs: namely the Owenreagh and Waterfoot. Designated sites are subject to regularly monitoring whilst baseline data are required for proposed sites.

Initial condition assessments for the SAC rivers were carried out by Killeen (2007). Total counts were conducted and the status of all sites was found to be "unfavourable declining".

The aim of the current survey was to reassess the present condition of freshwater pearl mussel populations on the 3 SAC rivers and conduct the first baseline conservation assessments for the 3 ASSI or proposed ASSI rivers (for which some previous data are available).



**Fig. 1** Those rivers with extant freshwater pearl mussel populations currently designated as SACs are the **a)** Ballinderry, **b)** Owenkillew and **c)** Swanlinbar whilst the **d)** Tempo is currently an ASSI and the **e)** Owenreagh and **f)** Waterfoot are proposed ASSIs.

## METHODS

### Total counts

Mussels occur in discrete beds (sub-populations) within defined stretches or sections of each river. Killeen (2007) identified and surveyed mussel beds on the three SAC designated rivers whilst Preston *et al.* (2006) previously surveyed remnant populations on the Tempo ASSI and Waterfoot proposed ASSI. There has been no previous survey of the Owenreagh proposed ASSI.

We returned to the same mussel beds surveyed by Preston *et al.* (2006) and Killeen (2007) and repeated an identical survey during early 2011. No previous data existed for the Owenreagh. However, Wilson (2011) conducted a low resolution survey of the occurrence of mussels on the Owenreagh at sites separated by 500m along the length of their range during 2009 (unpublished data). These data were used to

identify the stretches of Owenreagh on which mussel beds were known to occur and thereafter identical methods to those used on the other rivers.

Each mussel bed was surveyed using a standard bathoscope (perspex-bottomed viewing bucket) in water shallow enough for wading (maximum of 1.2m). Absolute counts of mussels were conducted within each sub-population and their locations recorded using a handheld GPS. Maps of discrete river sections were created to show the location of each survey section at a scale of 1:10,000 using ArcGIS 10 (ESRI, California, USA).

Any dead shells found on the river banks were collected. The size structure of each populations was estimated by measuring the total length (mm) of all dead shells and plotting their frequency distribution. The substrate type and presence of filamentous algae within each section of river was also recorded. For substrate, the river bottom was disturbed by kicking to a depth of 10cm and observing whether a silt 'plume' was produced (Killeen 2007).

For SAC rivers only, the total numbers of mussels enumerated during the current survey were compared directly with those from Killeen (2007) to ascertain if there was any significant temporal trend using a Wilcoxon signed rank test for matched paired (a non-parametric test for small sample sizes).

## **Water chemistry**

Water chemistry data were obtained from NIEA Water Management Unit for all six sites. Datasets covered the period January 2007 to March 2011. As in the previous assessment carried out by Killeen (2007) datasets were obtained for orthophosphate, nitrate, suspended solids and BOD levels only. These parameters are thought to be detrimental to the recruitment of mussels (Bauer, 1988). However, it is now believed that the target levels set by Bauer (1998) may be too high for effective recruitment in Ireland (Moorkens, 2006). Mean values were calculated and variance in the time-series for each of the four parameters was plotted. Indicative threshold target values were taken from Moorkens (2006) as in Table 1.



**Table 1** Threshold values for four water chemistry parameters necessary for freshwater pearl mussel recruitment.

| <b>Parameter</b> | <b>Bauer (1988)</b><br>mg/l | <b>Moorkens (2006)</b><br>mg/l |
|------------------|-----------------------------|--------------------------------|
| Orthophosphate   | 0.03                        | 0.005                          |
| Nitrate          | 0.50                        | 0.125                          |
| Suspended Solids | <10.00                      | <10.000                        |
| BOD              | <1.40                       | <1.400                         |

## Conservation Assessments

We assessed the current conservation status of each river using the JNCC Common Standards Monitoring categories (Table 2) defining each by the same criteria used by Young *et al.* (2003) and Killeen (2007) presenting the results in a Favourable Condition Table or FCT (Table 3).

**Table 2** Conservation Assessment for freshwater pearl mussel following the JNCC Common Standards Monitoring categories.

| <b>Favourable</b> | <b>Unfavourable</b>                         |
|-------------------|---|
| Maintained        | Declining                                   |
| Recovered         | No change                                   |
|                   | Recovering                                  |
|                   | Partially destroyed (habitats)              |
|                   | Totally destroyed (habitats)/lost from site |

**Table 3** Favourable Condition Table (FCT) criteria used to assess the conservation status of the freshwater pearl mussel (extracted from Killeen 2007).

| Attribute                        | Target   | Notes   |
|----------------------------------|--|---|
| <b>Mussels</b>                   |  |   |
| Density                          | Potentially suitable habitat at capacity (least 10 mussels/m <sup>2</sup> ). | Target in UK protocol (Young <i>et al.</i> 2003) is 10 mussels/m <sup>2</sup> in favourable habitat.  |
| Numbers of live individuals      | No recent decline  | Based on comparative results from the most recent surveys.  |
| Numbers of dead                  | <1% of population  | 1% considered to be indicative of natural losses. Age of dead shells can be used to provide information if loss level is otherwise in doubt – if all dead shells are fresh this would indicate a more serious problem than scattered disintegrating shells of various ages.               |
| Age structure                    | At least 20% of population ≤65mm   | Target in UK protocol (Young <i>et al.</i> 2003).   |
| Age structure 2                  | At least some mussels ≤30mm  | Target in UK protocol (Young <i>et al.</i> 2003).   |
| <b>Water Quality</b>             |  |   |
| Orthophosphate                   | 0.005mg/l (<0.030)   | The target level given in the FCT based upon Bauer (1988) is <0.030mg/l, but recent evidence from Ireland (Moorkens, 2006) found that the highest median levels associated with effectively recruiting populations are 0.005mg/l.   |
| Nitrate                          | 0.125mg/l (<0.500)   | No target given in FCT. Bauer (1988) gives <0.500mg/l, but Moorkens (2006) found that the highest median levels associated with effectively recruiting populations are 0.125mg/l.   |
| Suspended Solids                 | <10mg/l  | Suspended solids should be rare rather than chronic and attributable to natural conditions.   |
| BOD                              | <1.40mg/l  | No target given in FCT but Bauer (1988) gives <1.40mg/l.  |
| <b>Substrate Condition</b>       |  |   |
| <b>Siltation</b>                 | No plumes of silt when substrate kicked to 10cm deep                         | A 'plume' is an obvious flush of silt, produced when stones are lifted from the substrate or submerged vegetation is disturbed, such that visibility of the river bed is momentarily obscured.  |
| <b>Redox measurements</b>        | <20% loss in redox value at 5cm depth  | Based on work by Geist <i>et al.</i> (in prep). Results from a recent survey of the River Ehen in Cumbria (Killeen 2006) show that young mussels and juveniles were present only in the most highly oxygenated riffle areas where the loss in redox value was less than 20% at 5cm depth. |
| <b>Filamentous algae</b>         | None (<5% cover)   | Target in UK protocol Young <i>et al.</i> 2003). Any filamentous algae should be wispy and ephemeral.   |
| <b>Adjacent Land Use Issues</b>  | No damaging activities   | Damaging activities are those considered to contribute more suspended solids and/or nutrients than would be expected in functioning mussel habitats.  |
| <b>Evidence of pearl fishing</b> | None   | Based upon evidence (i.e. opened shells caches on banks) or information from locals.  |

## RESULTS

### Populations in SAC rivers

A total of 12,947 freshwater pearl mussels were recorded on SAC designated rivers (Ballinderry, Owenkillev and Swanlinbar). All sections of each river had been surveyed previously during either 2004 (NIEA 2004) or 2007 (Killeen 2007) with the exception of Point transect A5 on the Owenkillev. Thus, excluding this section the total number of mussels observed on SAC rivers during 2011 was 12,727 compared to 12,229 during the previous survey. Whilst this represented a +4.1% increase in the numbers of mussels observed, there was no significant difference between the surveys (Wilcoxon signed rank test for matched pairs = 0.019,  $p=0.984$ ).

### Populations in ASSI or proposed ASSI rivers

A total of 9,032 freshwater pearl mussels were recorded on the Tempo ASSI and Owenreagh and Waterfoot proposed ASSIs. Most notably, 8,195 mussels of these mussels were recorded on the Owenreagh proposed ASSI representing the first baseline survey of this river. The number of live mussels observed on the Tempo ASSI declined by -17.9% from 525 during 2009 (Wilson 2011) to 431 during 2011. The Waterfoot proposed ASSI had also been surveyed previously, however, there were difficulties in direct comparisons of individual river sections between the current survey (where the area surveyed was known) and previous surveys (Preston *et al.* 2007; Wilson 2011) where the area surveyed was not well reported.

### Conservation status

A total of 21,979 freshwater pearl mussels were recorded on six rivers throughout Northern Ireland. There was no evidence for any temporal trend in abundance on SAC designated rivers suggesting populations have remained stable since 2004/09. Water quality criteria failed in the majority of cases and the current condition assessment of all SACs was judged as “Unfavourable no change”. The status of the Tempo ASSI and Waterfoot proposed ASSI was determined as “Unfavourable declining” due to poor water quality and an apparent reduction in mussel numbers

whilst the Owenreagh proposed ASSI was determined as “Unfavourable” as no assessment of temporal change could be made.

### Ballinderry SAC

A total of 3 sections were surveyed on the Ballinderry SAC (Fig. 2). A total of 846 live mussels were observed (Table 4). This represents a -14.5% decrease on the 989 mussels observed in the previous survey during 2007 (Killeen 2007). For detailed maps of each section and summary tables see Appendix 1.

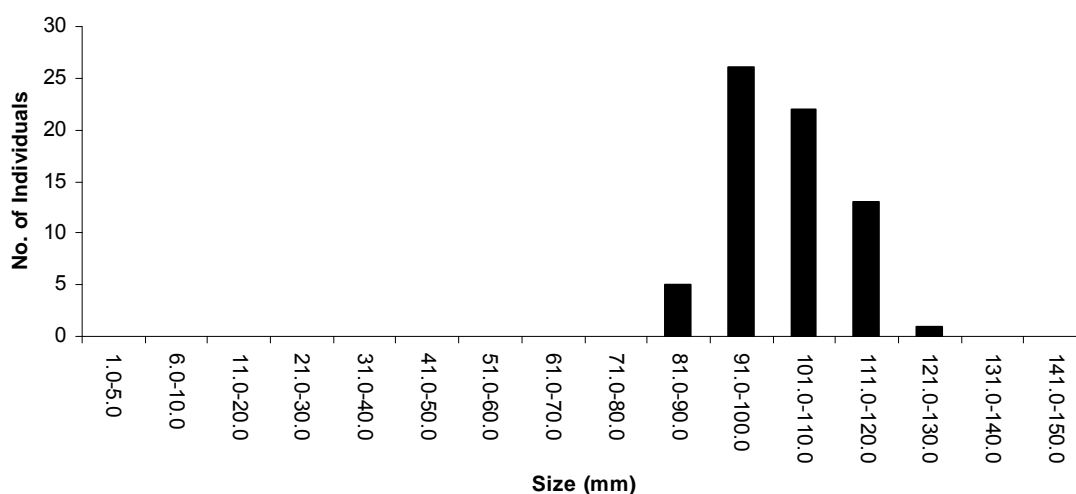


**Fig. 2** Survey sections on the Ballinderry SAC numbered to be consistent with Killeen (2009).

**Table 4** Total numbers of live mussels recorded in each section of the Ballinderry SAC during the previous and current studies.

| Section      | Location                              | No. of mussels |            |
|--------------|---------------------------------------|----------------|------------|
|              |                                       | 2007           | 2011       |
| 16           | Downstream of Corkhill Bridge         | 643            | 550        |
| 17           | Downstream of Wellbrook Beetling Mill | 113            | 106        |
| 20           | To Kildress House                     |                |            |
| 21           | To u/s Auglish Bridge                 |                |            |
| 22           | To Auglish Bridge                     |                |            |
| <b>Total</b> |                                       | <b>989</b>     | <b>846</b> |

A total of 67 dead shells were collected. No mussels <65mm were recorded and the frequency distribution of shell size suggested that the population was composed predominately of aged adults (Fig. 3). Several moribund and living mussels were found on the margins of the river (<30mm water depth) in Section 16 (downstream of Corkhill Bridge) and it was suspected that these mussels had been washed out during a preceding period of heavy flow during January 2011. These individuals were moved into deeper water.



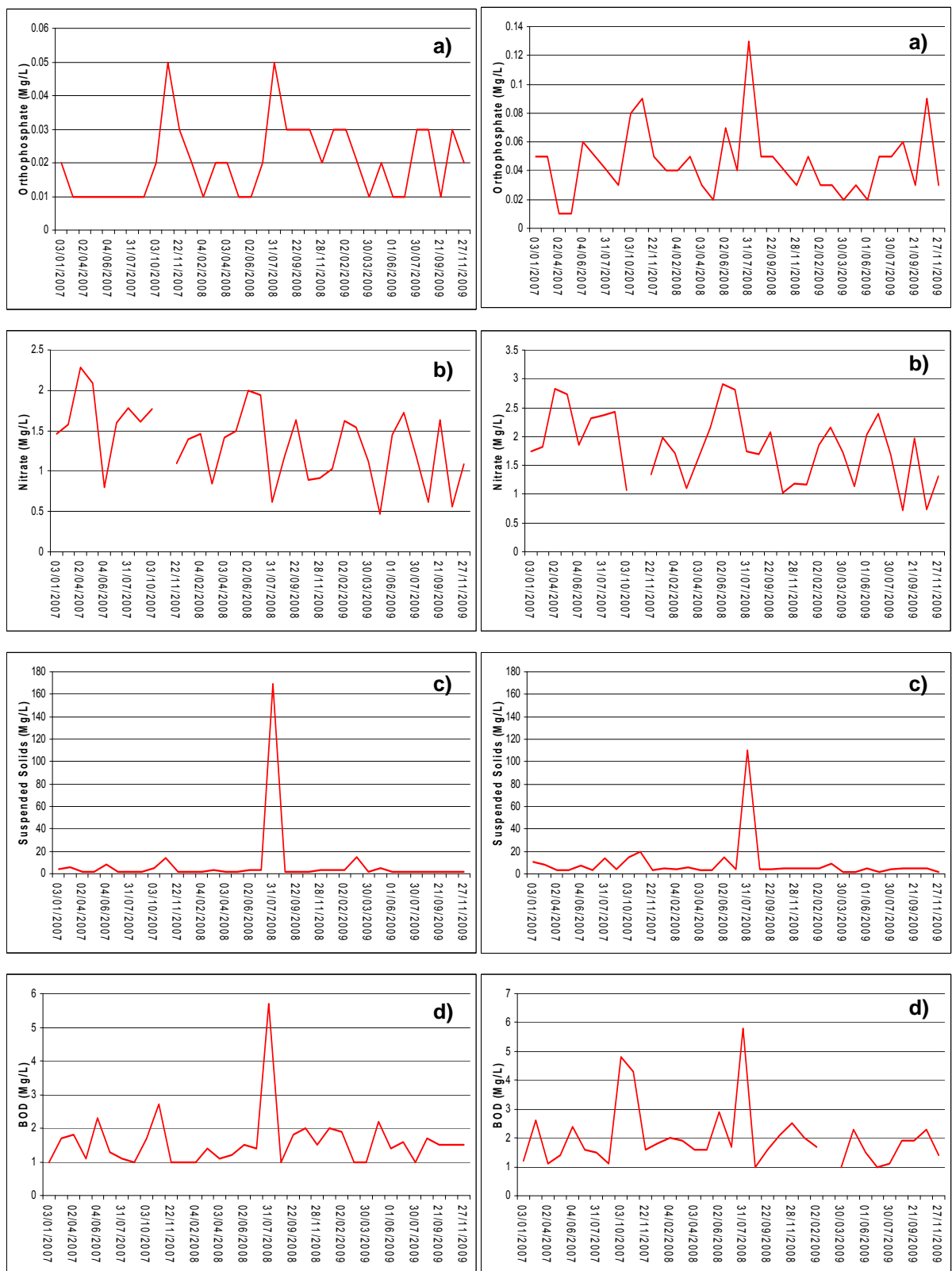
**Fig 3** Frequency distribution of shell size (derived from dead shells collected) found on the Ballinderry SAC.

Water chemistry was assessed at two sampling stations at i) Corkhill Bridge (H734793) and ii) King's Bridge (H812765) covering the length of river inhabited by mussels for the period of January 2007 to March 2011 (Fig. 4). Orthophosphate levels ranged from 0.01 to 0.13mg/l (mean = 0.04). Nitrate levels ranged from 0.47 to 2.91mg/l (mean = 1.58). Levels of suspended solids were generally below 10mg/l but rose above this level on a number of occasions, most notably up to a maximum of 169mg/l and 110mg/l at both sites respectively during July 2008. BOD ranged from 1-5.8mg/l (mean = 1.79).

A conservation assessment using criteria from Table 3 suggested that the population on the Ballinderry SAC is currently "Unfavourable no change" (Table 5).

**i) Corkhill Bridge**

**ii) King's Bridge**



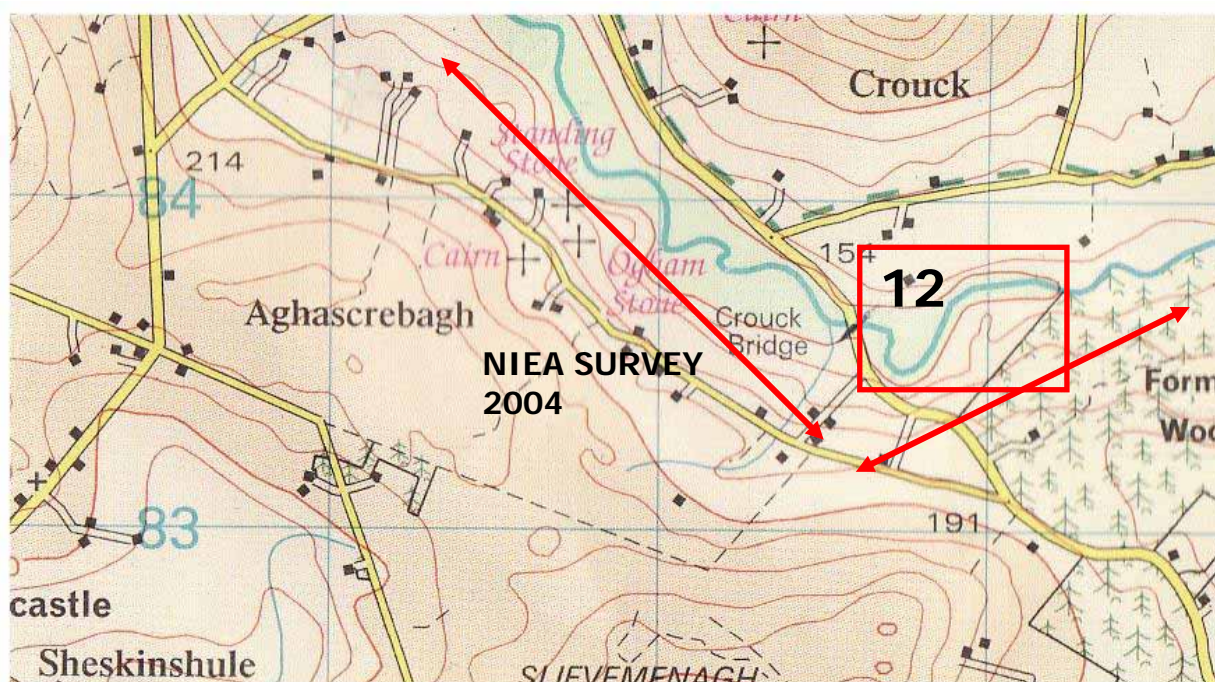
**Fig 4** Variance in (a) orthophosphate, (b) nitrate, (c) suspended solids and (d) biological oxygen demand from January 2007 to March 2010 at i) Corkhill Bridge and ii) King's Bridge (data obtain from the NIEA Water Management Unit).

**Table 5** Conservation Assessment for the Ballinderry SAC freshwater pearl mussel population.

| Attribute                           | Target  | Actual   | Pass/Fail    |
|-------------------------------------|---|--|--------------|
| <b>Mussels</b>                      |   |  |              |
| Density                             | Potentially suitable habitat at capacity (or at least 10 mussels/m <sup>2</sup> ) | Patchy distribution. Many areas of suitable substrate with no mussels.                     | Fail         |
| Number of live individuals          | No decline since most recent survey   | -14.5% decrease in numbers since previous assessment ( 2007)                               | Fail         |
| Numbers of dead shells              | <1% of population   | 67 dead : 846 alive (8% dead)  | Fail         |
| Age structure 1                     | At least 20% of population ≤65mm  | None   | Fail         |
| Age structure 2                     | At least some mussels ≤ 30mm  | None   | Fail         |
| <b>Water Quality (2007-2010)</b>    |   |  |              |
| Orthophosphate                      | 0.005mg/l (<0.03)   | 0.04mg/l (range: 0.01-0.13)  | Fail         |
| Nitrate                             | 0.125mg/l (<0.5)  | 1.58mg/l (range 0.47-2.91)   | Fail         |
| Suspended Solids                    | <10mg/l   | Generally <10mg/l (max= 169)   | Pass         |
| BOD                                 | <1.4mg/l  | 1.79mg/l (range 1-5.8)   | Fail         |
| <b>Substrate Condition</b>          |   |  |              |
| Siltation                           | No plumes of silt when substrate kicked to 10cm depth                             | 100% of samples plumed   | Fail         |
| Redox measurements                  | Measurements <20% loss in redox value at 5cm depth                                | Not assessed   | Unknown      |
| <b>Macrophytes</b>                  |   | <i>Ranunculus</i> in places  | Not assessed |
| <b>Filamentous algae</b>            | None (<5% cover)  | Generally <10% but greater cover further downstream  | Fail         |
| <b>Adjacent Land Use Issues</b>     |   | Cattle poaching, bank erosion, severe scarring of the river bed and banks by winter floods | Fail         |
| <b>Evidence of pearl fishing</b>    | None  | No exploitation evident  | Pass         |
| <b>OVERALL CONDITION: No change</b> |   |  |              |

## Owenkillew SAC

One section was surveyed on the Owenkillew SAC (Fig. 5) in addition to 21 point transects and 4 line transects previously surveyed by Killeen (2007) and NIEA (2004) respectively. A total of 8,474 live mussels were observed (Table 6). This represents a +6.4% increase on the 7,931 mussels observed during previous surveys. For detailed maps of each section and summary tables see Appendix 1.



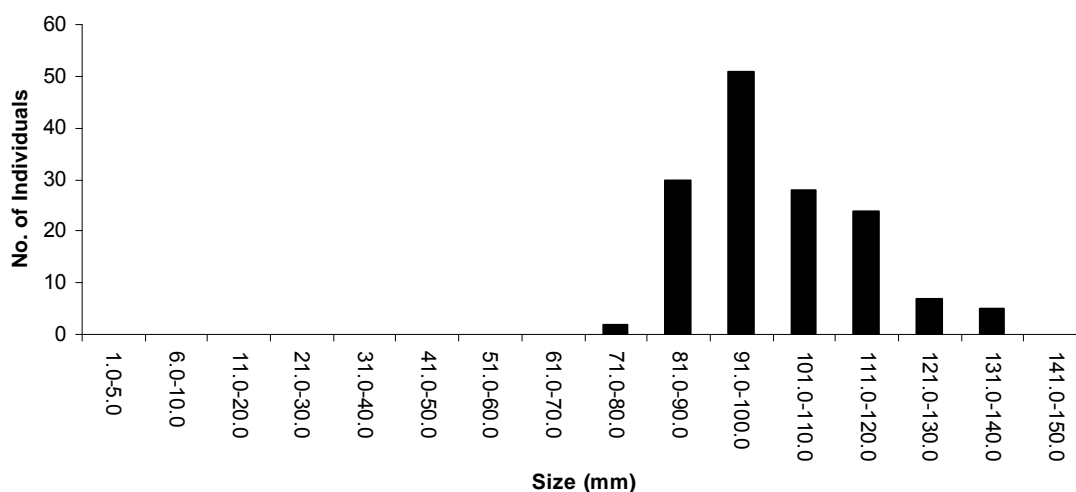
**Fig. 5** Survey sections on the Owenkillew SAC numbered to be consistent with Killeen (2009) with red arrows indicating the extent of points and transects previously surveyed by NIEA (2004).

**Table 6** Total numbers of live mussels recorded in each section of the Owenkillew SAC during the previous and current studies.

| ID           | Description               | No. of mussels |      |              |
|--------------|---------------------------|----------------|------|--------------|
|              |                           | 2004           | 2007 | 2011         |
| 12           | Upstream of Crouck Bridge |                | 824  | 2,391        |
| Points       | 21 points transects       | 6,380          |      | 5,467        |
| Transects    | 4 x 50m line transects    | 727            |      | 616          |
| <b>Total</b> |                           | <b>7,931</b>   |      | <b>8,474</b> |



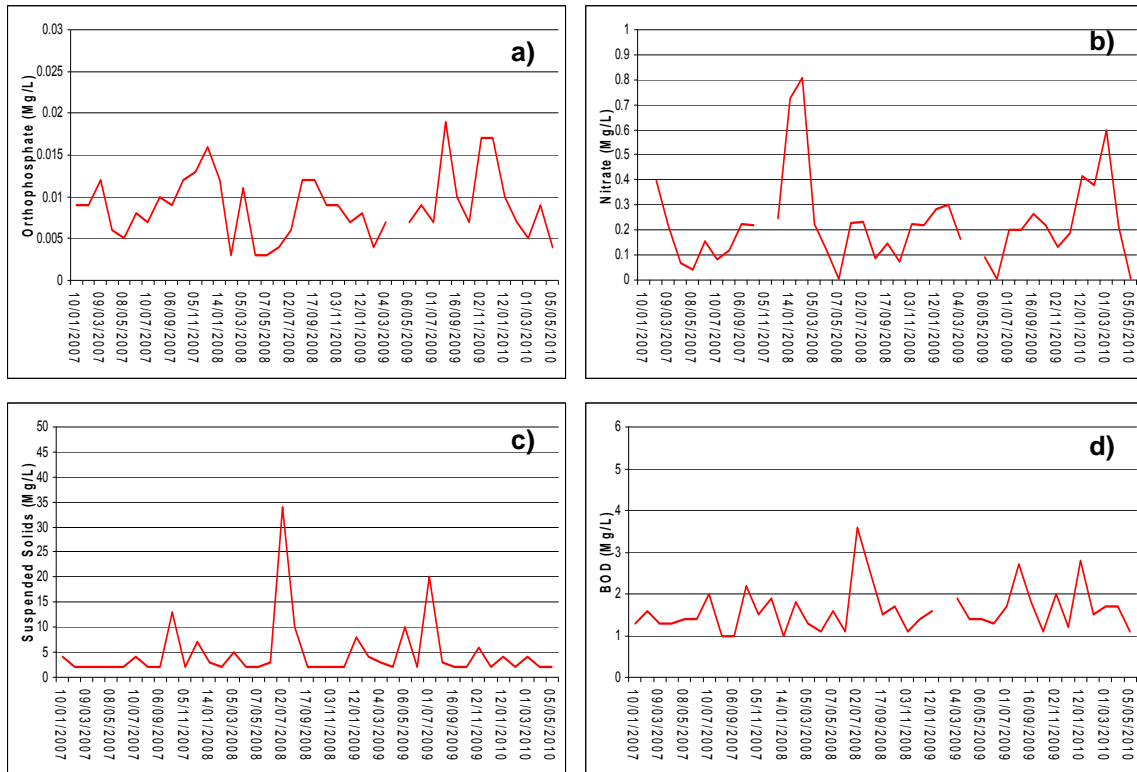
A total of 147 dead shells were collected. No mussels <65mm were recorded and the frequency distribution of shell size suggested that the population was composed predominately of aged adults (Fig. 6). Nevertheless, several juvenile mussels including one estimated to be <5 years old were identified by NIEA staff during an 'emergency response' in late March 2011 (Tony Waterman pers. comms.). This may suggest that some recruitment has occurred during the past 5-10 years.



**Fig 6** Frequency distribution of shell size (derived from dead shells collected) found on the Owenkillew SAC.

Water chemistry was assessed at Monanameal Bridge (H614848) which was downstream of the pearl mussel population for the period of January 2007 - March 2011 (Fig. 7). Orthophosphate levels ranged from 0.003 to 0.02mg/l (mean = 0.009). Nitrate levels ranged from 0.003 to 0.806mg/l (mean = 0.22). Levels of suspended solids were generally below 10mg/l but rose above this level on a number of occasions, most notably up to a maximum of 34mg/l during July 2008. BOD ranged from 1-3.6mg/l (mean = 1.61).

A conservation assessment using criteria from Table 3 suggests that the population on the Owenkillew SAC is currently "Unfavourable no change" (Table 7).



**Fig 7** (a) Variance in (a) orthophosphate, (b) nitrate, (c) suspended solids and (d) biological oxygen demand from January 2007 to March 2010 (data obtain from the NIEA Water Management Unit).

**Table 7** Conservation Assessment for the Owenkillew SAC freshwater pearl mussel population.

| Attribute                           | Target  | Actual  | Pass/Fail    |
|-------------------------------------|---|---|--------------|
| <b>Mussels</b>                      |   |   |              |
| Density                             | Potentially suitable habitat at capacity (or at least 10 mussels/m <sup>2</sup> ) | Some dense beds but large areas of suitable substrate devoid of mussels         | Fail         |
| Number of live individuals          | No decline since most recent survey   | +6.4% increase in numbers since previous survey (NIEA 2004; Killeen 2007)       | Pass         |
| Numbers of dead shells              | <1% of population   | 147 dead : 5467 alive (2.7%)  | Fail         |
| Age structure 1                     | At least 20% of population ≤65mm  | Several individuals thought to be <5-10 years old found by NIEA (2011)          | Fail         |
| Age structure 2                     | At least some mussels ≤ 30mm  | None  | Fail         |
| <b>Water Quality (2007-2010)</b>    |   |   |              |
| Orthophosphate                      | 0.005mg/l (<0.030)  | 0.009mg/l (range 0.003-0.020)   | Fail         |
| Nitrate                             | 0.125mg/l (<0.500)  | 0.22mg/l (0.003-0.806)  | Fail         |
| Suspended Solids                    | <10mg/l   | Generally <10mg/l (max = 34)  | Pass         |
| BOD                                 | <1.40mg/l   | 1.61mg/l (1.00-3.60)  | Fail         |
| <b>Substrate Condition</b>          |   |   |              |
| Siltation                           | No plumes of silt when substrate kicked to 10cm depth                             | Some plumes of silt present especially in slow water                            | Fail         |
| Redox measurements                  | Measurements <20% loss in redox value at 5cm depth                                | Not assessed  | Unknown      |
| <b>Macrophytes</b>                  |   | <i>Ranunculus</i> in places   | Not assessed |
| <b>Filamentous algae</b>            | None (<5% cover)  | Present but <5%   | Pass         |
| <b>Adjacent Land Use Issues</b>     |   | Cattle poaching, severe bank erosion due to winter floods & coniferous forestry | Fail         |
| <b>Evidence of pearl fishing</b>    | None  | No exploitation evident   | Pass         |
| <b>OVERALL CONDITION: No change</b> |   |   |              |

## Swanlinbar SAC

A total of 4 sections were surveyed on the Swanlinbar SAC (Fig. 8). A total of 3,627 live mussels were observed (Table 8). This represents a +8.8% increase on the 3,309 mussels observed in the previous survey during 2007 (Killeen 2007). For detailed maps of each section and summary tables see Appendix 1.

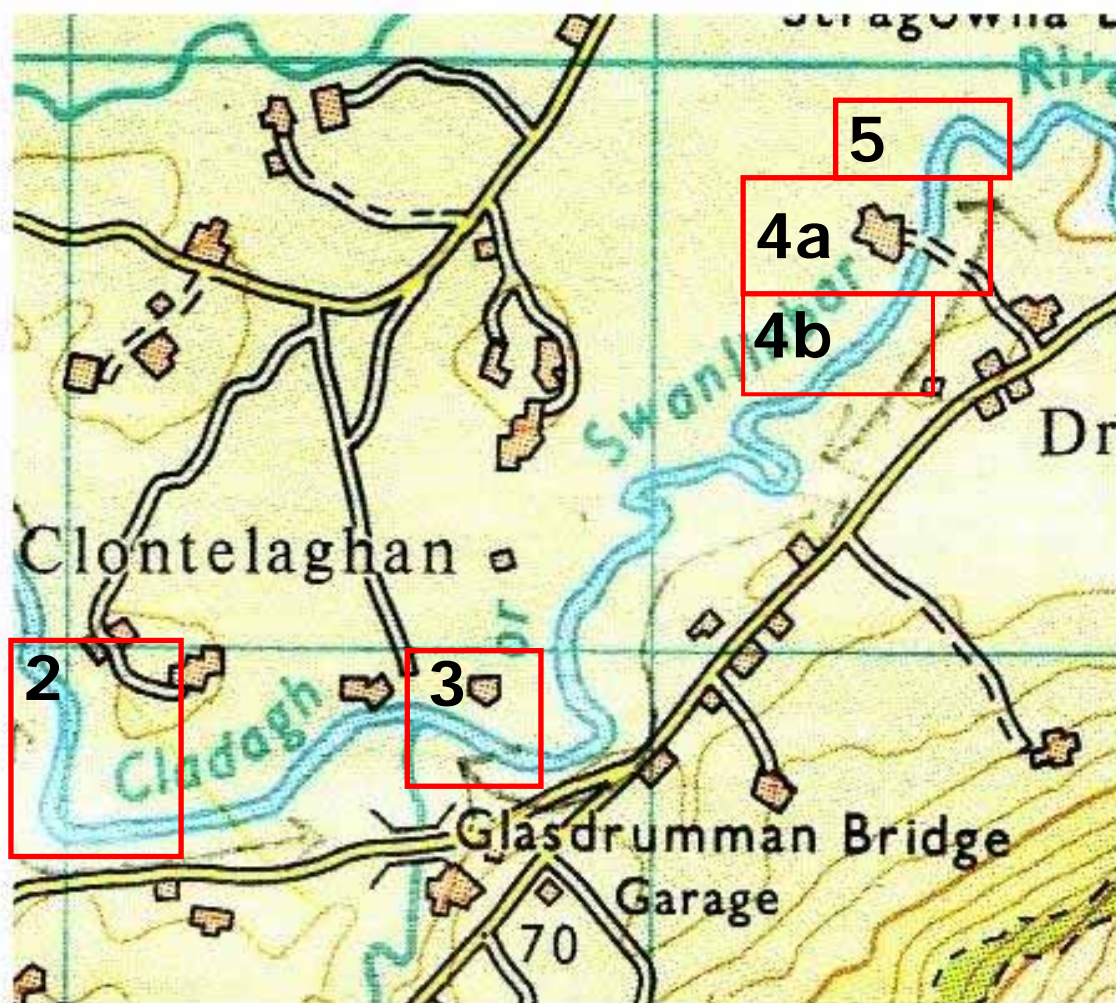
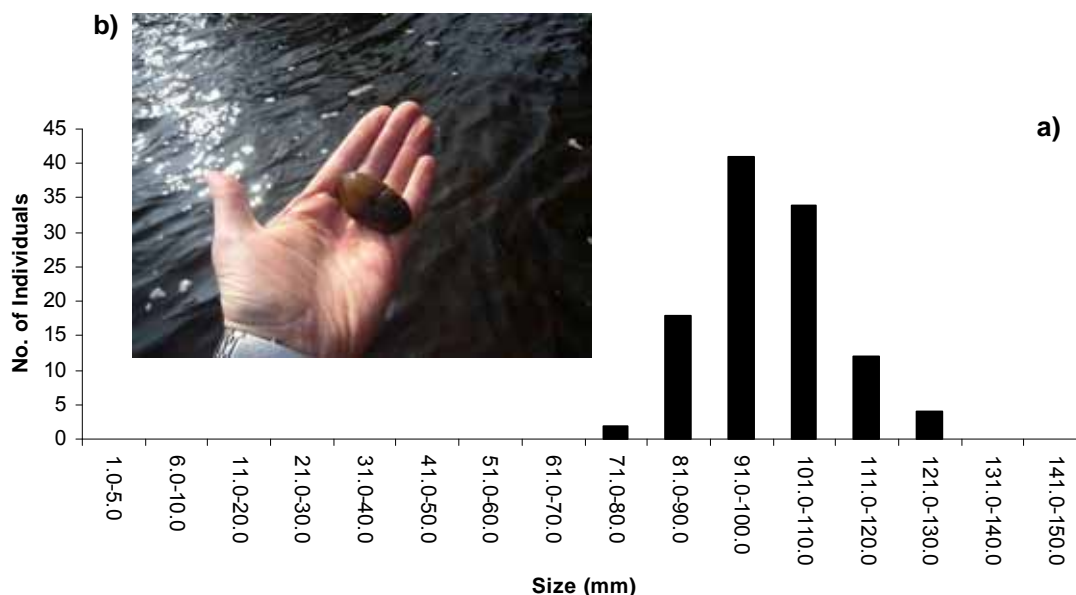


Fig. 8 Survey sections on the Swanlinbar numbered to be consistent with Killeen (2009).

**Table 8** Total numbers of live mussels recorded in each section of the Swanlinbar SAC during the previous and current studies.

| Section      | Location                                       | No. of mussels |              |
|--------------|--|----------------|--------------|
|              |  | 2007           | 2011         |
| 2            | Upstream of Glasdrumman Bridge                 | 1,112          | 1,396        |
| 3            | Downstream of Glasdrumman Bridge               | 53             | 84           |
| 4a           | Around the Ulster Way bridge at Drumroosk      | 1,065          | 1,128        |
| 4b           | Upstream of the Ulster Way bridge at Drumroosk | 684            | 644          |
| 5            | Downstream of Stragowna Bridge                 | 395            | 375          |
| <b>Total</b> |  | <b>3,309</b>   | <b>3,627</b> |

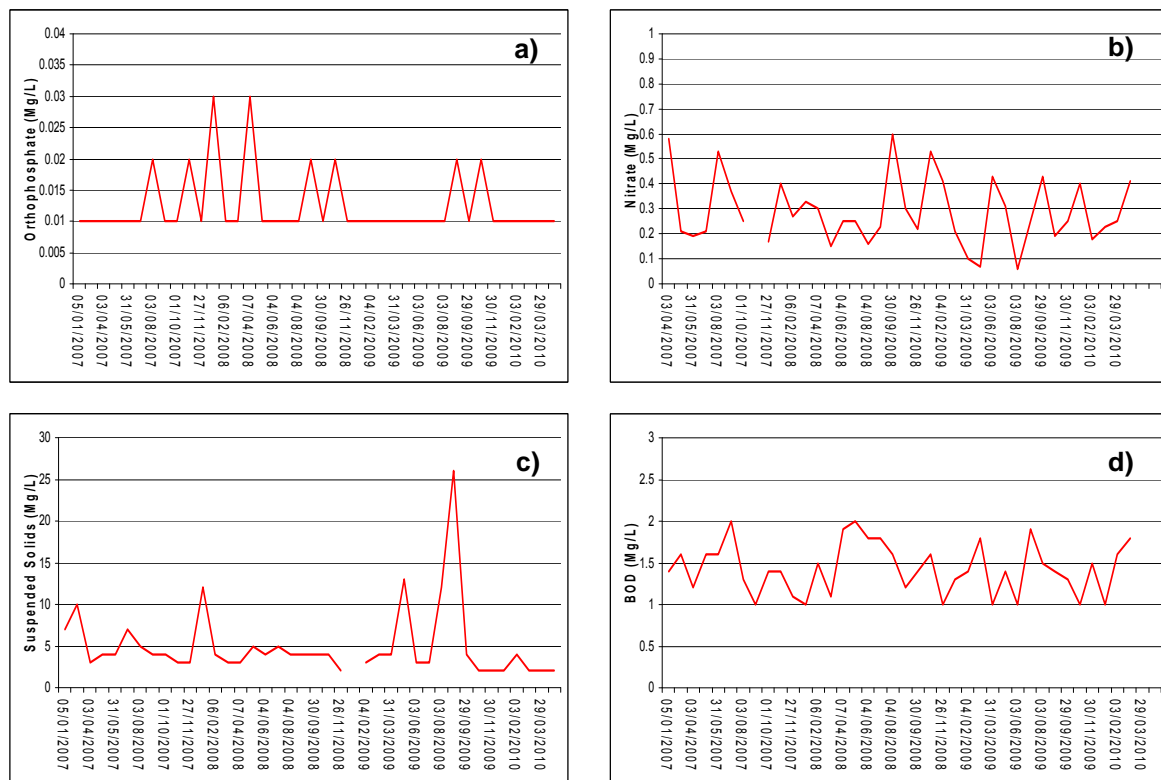
A total of 111 dead shells were collected. No mussels <65mm were recorded and the frequency distribution of shell size suggested that the population was composed predominately of aged adults (Fig. 9a). Nevertheless, a juvenile mussel (50mm in length) was found in loose gravel substrate and was estimated at approximately 10 years old (Fig. 9b).



**Fig 9 (a)** Frequency distribution of shell size (derived from dead shells collected) and **(b)** a juvenile mussel estimated to be approx. 10 years old found on the Swanlinbar SAC.

Water chemistry was assessed at Thompson's Bridge (H253313) which was c. 3km downstream of the pearl mussel population for the period of January 2007 - March 2011 (Fig. 10). Orthophosphate levels ranged from 0.01 to 0.03mg/l (mean = 0.01) and were lower than those recorded during the previous monitoring period of 1999 to 2006 (Killeen 2007). Nitrate levels ranged from 0.06 to 0.60mg/l (mean = 0.29) and were similar to those recorded during the previous monitoring period (Killeen 2007). Levels of suspended solids were generally below 10mg/l but rose above this level on four occasions up to a maximum of 26mg/l during late 2009. BOD ranged from 1-2mg/l (mean = 1.43) and was lower than levels recorded previously (Killeen, 2007).

A conservation assessment using criteria from Table 3 suggests that the population on the Swanlinbar SAC is currently "Unfavourable no change" (Table 9).



**Fig 10** (a) Variance in (a) orthophosphate, (b) nitrate, (c) suspended solids and (d) biological oxygen demand from January 2007 to March 2010 (data obtain from the NIEA Water Management Unit).

**Table 9** Conservation Assessment for the Swanlinbar SAC freshwater pearl mussel population.

| Attribute                        | Target   | Actual  | Pass/Fail                          |
|----------------------------------|--|---|------------------------------------|
| <b>Mussels</b>                   |  |   |                                    |
| Density                          | Potentially suitable habitat at capacity (or at least 10 mussel/m <sup>2</sup> ) | Mussels widespread but density very low except in the most suitable riffles | Fail                               |
| Number of live individuals       | No decline since most recent survey  | +8.8% increase in numbers since previous assessment (2007)                  | Pass                               |
| Numbers of dead shells           | <1% of population  | 111 dead : 3,627 live (3.4% dead)   | Fail                               |
| Age structure 1                  | At least 20% of population ≤65mm   | Only one live individual at 50mm  | Fail                               |
| Age structure 2                  | At least some mussels ≤30mm  | None  | Fail                               |
| <b>Water Quality (2007-2010)</b> |  |   |                                    |
| Orthophosphate                   | 0.005mg/l (<0.03)  | 0.01mg/l (range: 0.01-0.03)   | Fail                               |
| Nitrate                          | 0.125mg/l (<0.5)   | 0.29mg/l (range: 0.06-0.60)   | Fail                               |
| Suspended solids                 | <10mg/l  | Generally <10mg/l (max = 26)  | Pass                               |
| BOD                              | <1.4mg/l   | 1.43mg/l (range: 1-2)   | Fail                               |
| <b>Substrate Condition</b>       |  |   |                                    |
| Siltation                        | No plumes of silt when substrate kicked to 10cm depth                            | 40% of samples plumed   | Fail                               |
| Redox measurements               | Measurements <20% loss in redox value at 5cm depth                               | Not assessed  | Unknown                            |
| <b>Macrophytes</b>               |  | <i>Ranunculus</i> in places, plus occasional <i>Myriophyllum</i>            | Not assessed                       |
| <b>Filamentous algae</b>         | None (<5% cover)   | Present in all section but generally <10%                                   | Fail                               |
| <b>Adjacent Land Use Issues</b>  |  | Cattle poaching, bank erosion and coniferous forestry (in ROI)              | Fail                               |
| <b>Evidence of pearl fishing</b> | None   | No exploitation evident   | Pass                               |
|                                  |  |   | <b>OVERALL CONDITION</b> No change |

## Tempo ASSI

A total of 3 sections were surveyed on the Tempo non-SAC (Fig. 11). A total of 431 live mussels were observed (Table 10). This represents a -17.9% decrease on the 525 mussels observed in the last previous survey during 2009 (Wilson 2011). A total of 26 dead shells observed. For detailed maps of each section and summary tables see Appendix 1.



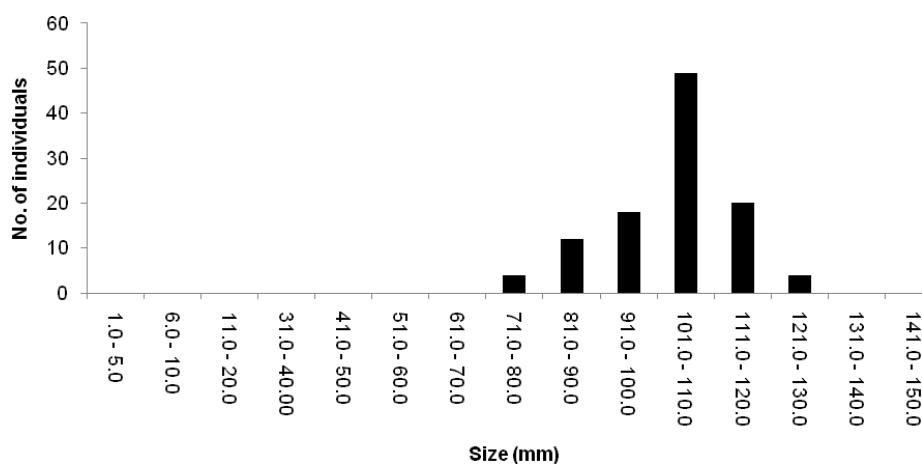
Fig. 11 Survey sections on the Tempo surveyed for comparison with Wilson (2011).

Table 10 Total numbers of live mussels recorded in each section of the Tempo non-SAC in previous and the current survey.

| Sections     | Location                     | Central Grid Reference | No. of mussels |            |            |
|--------------|------------------------------|------------------------|----------------|------------|------------|
|              |                              |                        | 2006*          | 2009†      | 2011       |
| 1 / D* / E†  | Upstream of A4 road bridge   | H 3420 3925            | 100            | 181        | 125        |
| 2 / G* / I†  | At Old Coach Road ford       | H 3395 3975            | 200            | 169        | 162        |
| 3 / P* / R†  | Upstream of Drumglone Bridge | H 3355 4275            | 170            | 175        | 144        |
| <b>Total</b> |                              |                        | <b>470</b>     | <b>525</b> | <b>431</b> |



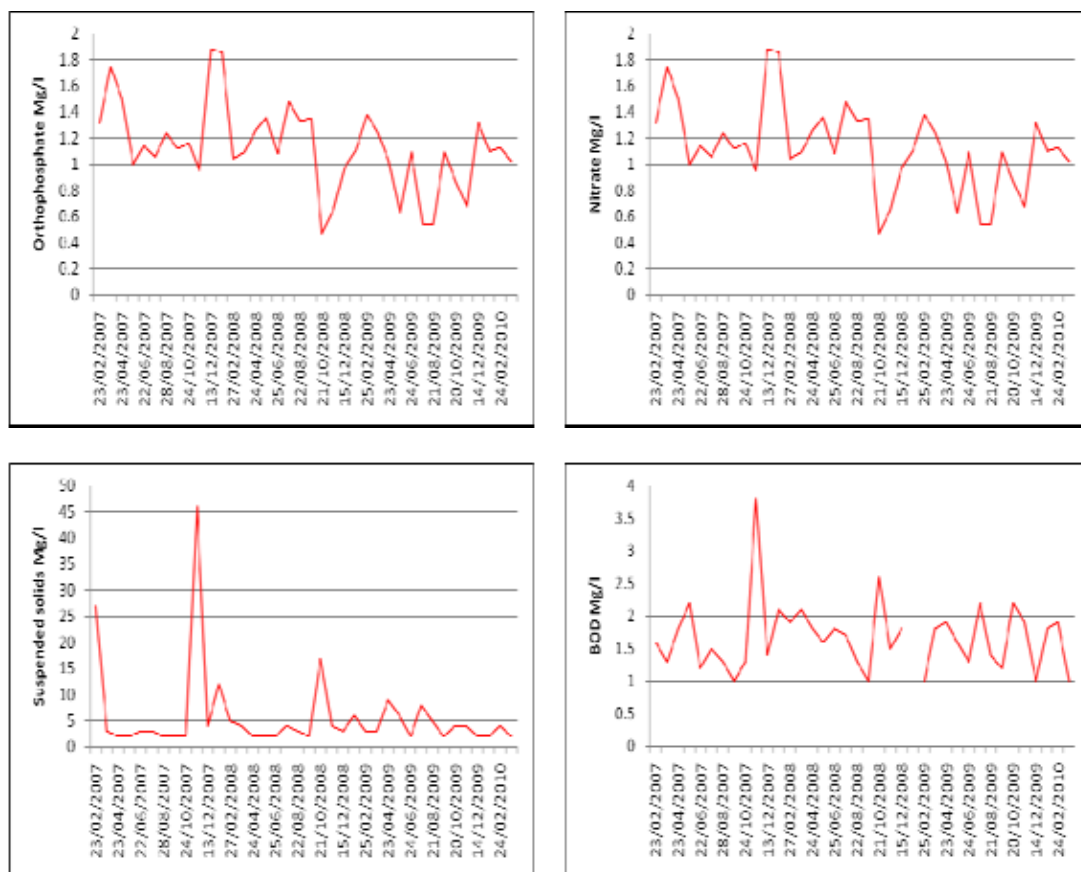
A total of 26 dead shells were collected and added to a larger sample of 105 dead shells previously collected by NIEA (provided courtesy of Tony Waterman) to assess age structure. The frequency distribution of shell size (n = 131) suggested that the population was composed predominately of aged adults (Fig. 15).



**Fig 15** Frequency distribution of shell size (derived from dead shells collected) at the Tempo ASSI.

Water chemistry was assessed at the A4 Road Bridge (H342392) for the period of January 2007 - March 2011 (Fig. 12). Orthophosphate levels ranged from 0.01 to 0.08mg/l (mean = 0.01). Nitrate levels ranged from 0.47 to 1.88mg/l (mean = 1.13). Levels of suspended solids were generally below 10mg/l but rose above this level on four occasions up to a maximum of 46mg/l during Nov 2007. BOD ranged from 1.00-3.80mg/l (mean = 1.67).

A Conservation Assessment using criteria from Table 3 suggested that the population on the Tempo ASSI is currently in “Unfavourable declining” condition (Table 11).



**Fig 12** (a) Variance in (a) orthophosphate, (b) nitrate, (c) suspended solids and (d) biological oxygen demand from January 2007 to March 2010 (data obtain from the NIEA Water Management Unit).

**Table 11** Conservation Assessment for the Tempo ASSI freshwater pearl mussel population.

| Attribute                                       | Target   | Actual  | Pass/Fail    |
|---|--|---|--------------|
| <b>Mussels</b>                                  |  |   |              |
| Density   | Potentially suitable habitat at capacity (or at least 10 mussel/m <sup>2</sup> ) | Three small beds; densities generally ≤0.5 mussels/m <sup>2</sup>                                       | Fail         |
| Number of live individuals                      | No decline since most recent survey  | -17.9% decrease in numbers since previous assessment (2009)   | Fail         |
| Numbers of dead shells                          | <1% of population  | 26 dead : 431 live (6.0% dead)  | Fail         |
| Age structure 1                                 | At least 20% of population ≤65mm   | None  | Fail         |
| Age structure 2                                 | At least some mussels ≤30mm  | None  | Fail         |
| <b>Water Quality (2007-2010)</b>                |  |   |              |
| Orthophosphate                                  | 0.005mg/l (<0.03)  | 0.01mg/l (range: 0.01-0.08)   | Fail         |
| Nitrate   | 0.125mg/l (<0.5)   | 1.13mg/l (range: 0.47-1.88)   | Fail         |
| Suspended solids                                | <10mg/l  | Generally <10mg/l (max = 46)  | Pass         |
| BOD   | <1.4mg/l   | 1.67mg/l (range: 1.00-3.80)   | Fail         |
| <b>Substrate Condition</b>                      |  |   |              |
| Siltation                                       | No plumes of silt when substrate kicked to 10cm depth                            | Plumes at all 3 sites assessed; 2 excessive   | Fail         |
| Redox measurements                              | Measurements <20% loss in redox value at 5cm depth                               | Not assessed  | Unknown      |
| <b>Macrophytes</b>                              |  |   |              |
|   |  | None  | Not assessed |
| <b>Filamentous algae</b>                        | None (<5% cover)   | Present in all section between 10-20%   | Fail         |
| <b>Adjacent Land Use Issues</b>                 |  |   |              |
|   |  | Poor fencing, cattle poaching and crossing (including broken shells) and fallen tree creating siltation | Fail         |
| <b>Evidence of pearl fishing</b>                | None   | No exploitation evident   | Pass         |
| <b>OVERALL CONDITION</b> Unfavourable declining |  |   |              |

## Owenreagh proposed ASSI

A total of 15 sections were surveyed on the Owenreagh proposed ASSI (Fig. 13). A total of 8,195 live mussels were observed (Table 12). This was the first survey of the Owenreagh and the data are to be taken as the baseline survey. A total of 59 dead shells observed. For detailed maps of each section and summary tables see Appendix 1.

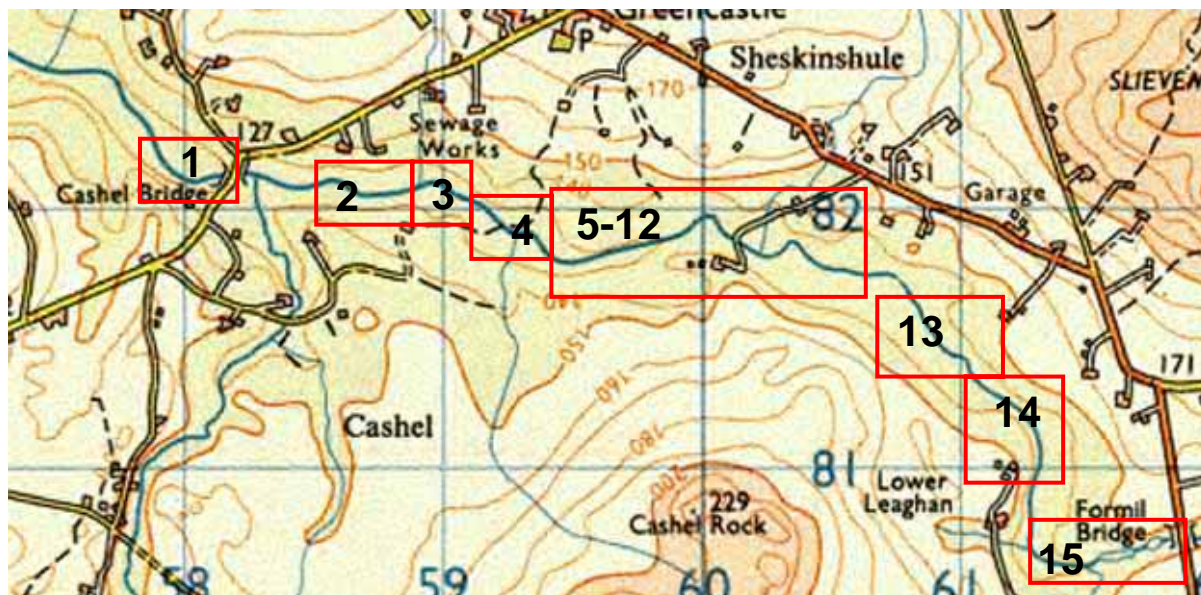
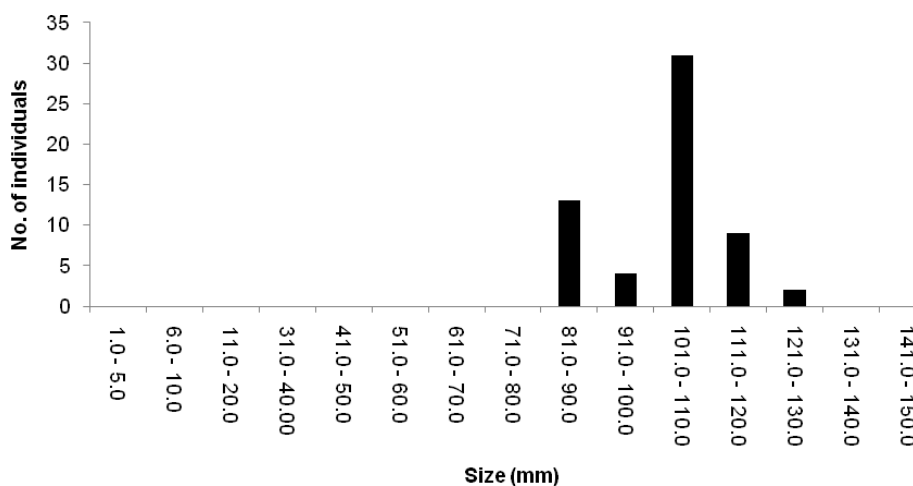


Fig. 13 Sections on the Owenreagh proposed ASSI surveyed as a baseline during 2011.

**Table 12** Total numbers of live mussels recorded in each section of the Owenreagh proposed ASSI during 2011.

| Section      | Central Grid Reference | No. of mussels<br>2011 |
|--------------|------------------------|------------------------|
| 1            | H 5793 8216            | 2                      |
| 2            | H 5875 8205            | 0                      |
| 3            | H 5896 8209            | 50                     |
| 4            | H 5933 8191            | 773                    |
| 5            | H 5955 8180            | 926                    |
| 6            | H 5965 8183            | 1,007                  |
| 7            | H 5979 8186            | 10                     |
| 8            | H 6002 8191            | 364                    |
| 9            | H 6027 8181            | 601                    |
| 10           | H 6041 8182            | 1,676                  |
| 11           | H 6052 8176            | 1,100                  |
| 12           | H 6058 8175            | 1,100                  |
| 13           | H 6089 8155            | 353                    |
| 14           | H 6130 8116            | 233                    |
| 15           | H 6166 8067            | 0                      |
| <b>Total</b> |                        | <b>8,195</b>           |

A total of 59 dead shells were collected during the current survey and these were used to assess age structure. The frequency distribution of shell size suggested that the population was composed predominately of aged adults (Fig. 14).



**Fig 14** Frequency distribution of shell size (derived from dead shells) at the Owenreagh proposed ASSI.

Water chemistry was assessed at Drumlea Bridge (H535859) for the period of January 2007 - March 2011 (Fig. 15). Orthophosphate levels ranged from 0.01 to 0.06mg/l (mean = 0.01). Nitrate levels ranged from 0.05 to 0.75mg/l (mean = 0.43). Levels of suspended solids were generally below 10mg/l but rose above this level on three occasions up to a maximum of 54mg/l during July 2008. BOD ranged from 1.00-4.30mg/l (mean = 1.65).

A conservation assessment using criteria from Table 3 suggested that the population on the Owenreagh proposed ASSI is currently in “Unfavourable” condition. However, as this was the first baseline survey it was impossible to assess if the condition was declining. We therefore judged this assessment as “Unfavourable no change” (Table 13).



**Fig 15 (a)** Variance in (a) orthophosphate, (b) nitrate, (c) suspended solids and (d) biological oxygen demand from January 2007 to March 2010 (data obtain from the NIEA Water Management Unit).

**Table 13** Conservation Assessment for the Owenreagh proposed ASSI freshwater pearl mussel population.

| Attribute                             | Target   | Actual  | Pass/Fail    |
|---------------------------------------|--|---|--------------|
| <b>Mussels</b>                        |  |   |              |
| Density                               | Potentially suitable habitat at capacity (or at least 10 mussel/m <sup>2</sup> ) | Large numbers of beds throughout surveyed sections often with high numbers but densities were ≤5.5 mussel/m <sup>2</sup>                          | Fail         |
| Number of live individuals            | No decline since most recent survey  | First baseline survey; no previous data   | Not assessed |
| Numbers of dead shells                | <1% of population  | 59 dead : 8,195 live (0.72% dead)   | Pass         |
| Age structure 1                       | At least 20% of population ≤65mm   | None  | Fail         |
| Age structure 2                       | At least some mussels ≤30mm  | None  | Fail         |
| <b>Water Quality (2007-2010)</b>      |  |   |              |
| Orthophosphate                        | 0.005mg/l (<0.03)  | 0.01mg/l (range: 0.01-0.06)   | Fail         |
| Nitrate                               | 0.125mg/l (<0.5)   | 0.43mg/l (range: 0.05-0.75)   | Fail         |
| Suspended solids                      | <10mg/l  | Generally <10mg/l (max = 54)  | Pass         |
| BOD                                   | <1.4mg/l   | 1.65mg/l (range: 1.00-4.30)   | Fail         |
| <b>Substrate Condition</b>            |  |   |              |
| Siltation                             | No plumes of silt when substrate kicked to 10cm depth                            | Sediment largely boulders, cobbles and coarse grain sand. No plumes reported.   | Pass         |
| Redox measurements                    | Measurements <20% loss in redox value at 5cm depth                               | Not assessed  | Unknown      |
| <b>Macrophytes</b>                    |  |   |              |
|                                       |  | <i>Ranunculus</i> beds common and widespread  | Not assessed |
| <b>Filamentous algae</b>              | None (<5% cover)   | Where present generally <10%  | Fail         |
| <b>Adjacent Land Use Issues</b>       |  |   |              |
|                                       |  | Waste Water Treatment Works (WWTW) nearby, dredging present, excavations previously made, cattle poaching and crossing and poor fencing in places | Fail         |
| <b>Evidence of pearl fishing</b>      | None   | No exploitation evident   | Pass         |
| <b>OVERALL CONDITION Unfavourable</b> |  |   |              |

## Waterfoot proposed ASSI

A total of 3 sections were surveyed on the Waterfoot proposed ASSI (Fig. 16). A total of 406 live mussels were observed (Table 14). Previous surveys were not directly comparable as the area surveyed was poorly reported (Table 14). No dead shells observed. For detailed maps of each section and summary tables see Appendix 1.

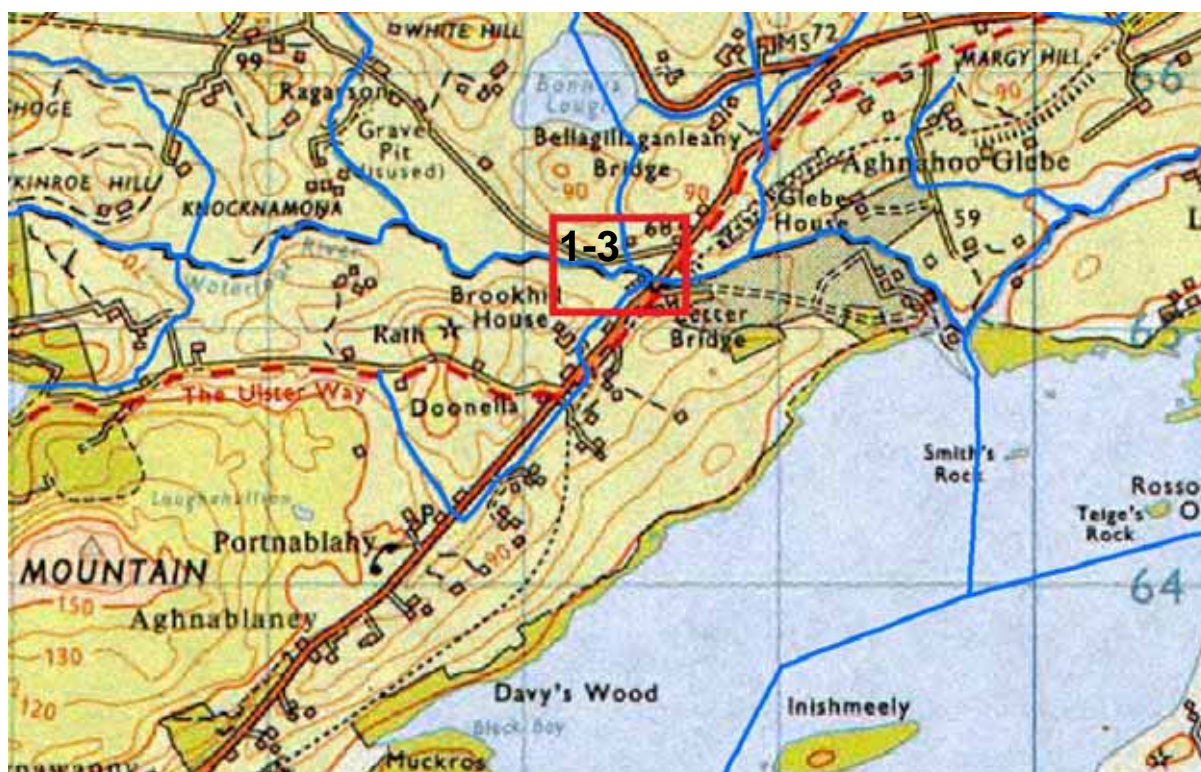


Fig. 16 Survey sections on the Waterfoot surveyed for comparison with Preston (2006).

**Table 14** Total numbers of live mussels recorded in each section of the Waterfoot non-SAC in previous and the current survey.

| Sections     | Locations                      | Central<br>Grid Reference | 2006*                               |                                      | 2009†                          |                                      | 2011                            |                                      |
|--------------|--------------------------------|---------------------------|-------------------------------------|--------------------------------------|--------------------------------|--------------------------------------|---------------------------------|--------------------------------------|
|              |                                |                           | # mussels<br>(area surveyed)        | Density<br>(mussels/m <sup>2</sup> ) | # mussels<br>(area surveyed)   | Density<br>(mussels/m <sup>2</sup> ) | # mussels<br>(area surveyed)    | Density<br>(mussels/m <sup>2</sup> ) |
| 1            | Upstream of Letter Bridge      | H085652                   | 225 (unknown)                       | -                                    | 64 (106m <sup>2</sup> )        | 0.60                                 | 107                             | -                                    |
| 2            | 150m upstream of Letter Bridge | H084652                   | 550 (unknown)                       | -                                    | -                              | -                                    | 183                             | -                                    |
| 3            | 250m upstream of Letter Bridge | H083653                   | 490 (unknown)                       | -                                    | 14 (140m <sup>2</sup> )        | 0.10                                 | 116                             | -                                    |
| <b>Total</b> |                                |                           | <b>1,265</b> (4,000m <sup>2</sup> ) | <b>0.32</b>                          | <b>78</b> (246m <sup>2</sup> ) | <b>0.32</b>                          | <b>406</b> (680m <sup>2</sup> ) | <b>0.60</b>                          |

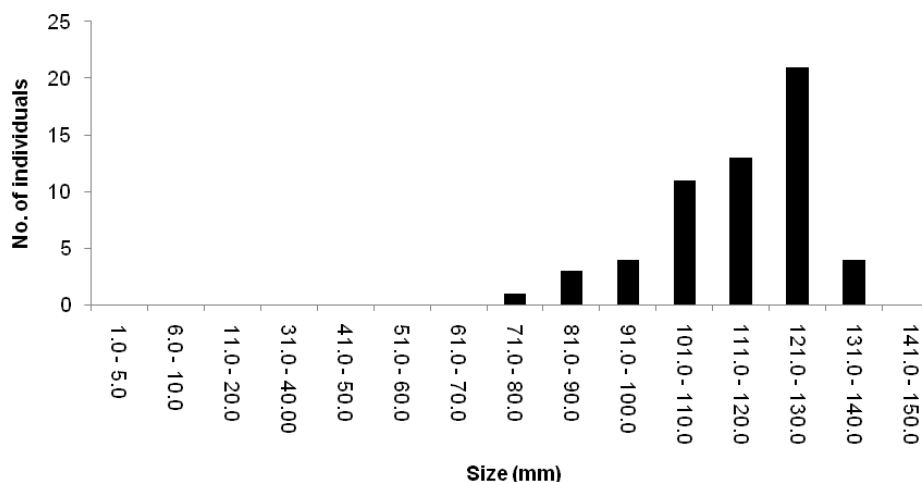
NB: The areas covered are not comparable between surveyed and in some cases are unknown. However, reported estimates of density may be comparable.

\* Preston (2006) - Area covered in each section was unreported, however, total count was from an area 1,000m x 4m = 4,000m<sup>2</sup>.

† Wilson (2011) – Only mussel density reported. Area (m<sup>2</sup>) was back calculated. Dimensions of bed unreported.



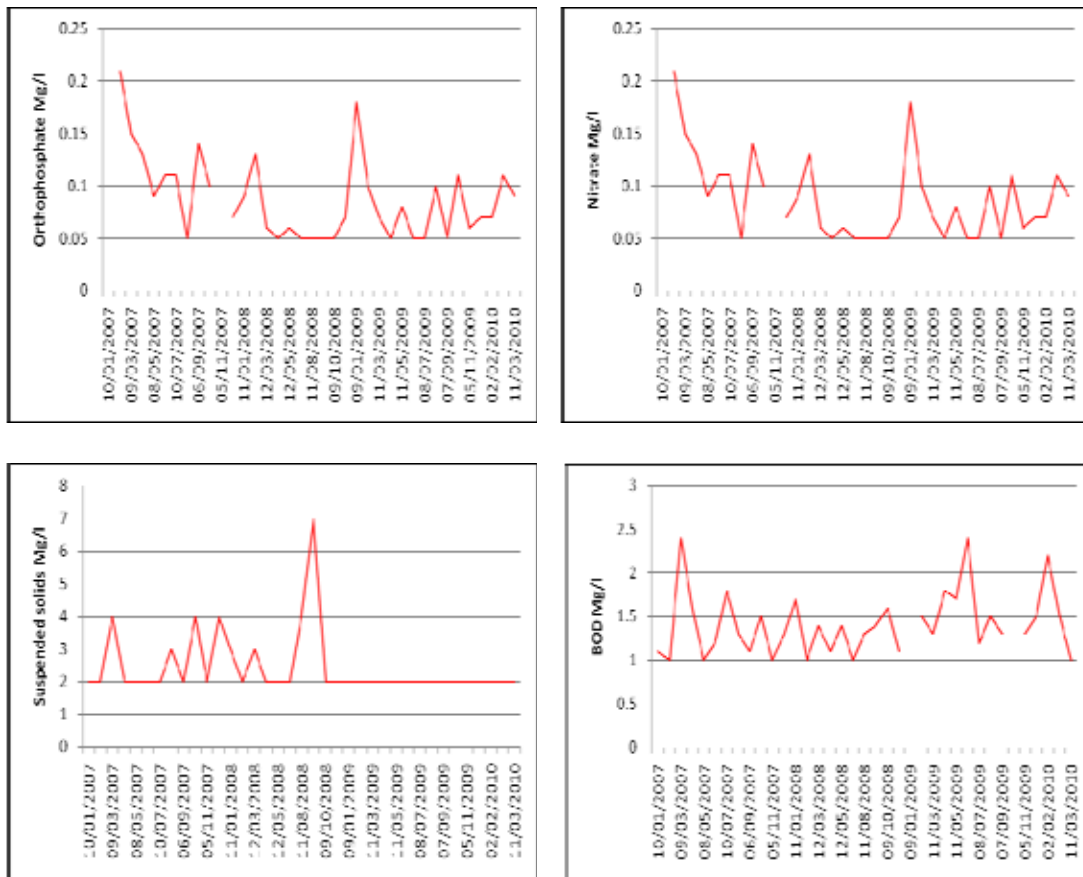
No dead shells were recovered during the current survey. However, a sample of 57 dead shells previously collected by NIEA (provided courtesy of Tony Waterman) was used to assess age structure. The frequency distribution of shell size suggested that the population was composed predominately of aged adults (Fig. 17).



**Fig 17** Frequency distribution of shell size (derived from dead shells collected) at the Waterfoot proposed ASSI.

Water chemistry was assessed at Letter Bridge (H085652) for the period of January 2007 - March 2011 (Fig. 18). Orthophosphate levels ranged from 0.01 to 0.02mg/l (mean = 0.01). Nitrate levels ranged from 0.05 to 0.21mg/l (mean = 0.09). Levels of suspended solids were consistently below 10mg/l and never rose above a maximum of 7mg/l during September 2008. BOD ranged from 1.00-2.40mg/l (mean = 1.41).

A Conservation Assessment using criteria from Table 3 suggests that the population on the Waterfoot proposed ASSI is currently “Unfavourable declining” (Table 15).



**Fig 18 (a)** Variance in **(a)** orthophosphate, **(b)** nitrate, **(c)** suspended solids and **(d)** biological oxygen demand from January 2007 to March 2010 (data obtain from the NIEA Water Management Unit).

**Table 15** Conservation Assessment for the Waterfoot proposed ASSI freshwater pearl mussel population.

| Attribute                                       | Target   | Actual  | Pass/Fail    |
|---|--|---|--------------|
| <b>Mussels</b>                                  |  |   |              |
| Density   | Potentially suitable habitat at capacity (or at least 10 mussel/m <sup>2</sup> ) | Mussels at 3 sections but densities ≤0.60 mussel/m <sup>2</sup>   | Fail         |
| Number of live individuals                      | No decline since most recent survey  | Temporal comparisons are difficult due to varying methodologies but general evidence for decline since 2006 | Fail         |
| Numbers of dead shells                          | <1% of population  | 0 dead : 406 live (0.0% dead)   | Pass         |
| Age structure 1                                 | At least 20% of population ≤65mm   | None  | Fail         |
| Age structure 2                                 | At least some mussels ≤30mm  | None  | Fail         |
| <b>Water Quality (2007-2010)</b>                |  |   |              |
| Orthophosphate                                  | 0.005mg/l (<0.03)  | 0.01mg/l (range: 0.01-0.02)   | Fail         |
| Nitrate   | 0.125mg/l (<0.5)   | 0.09mg/l (range: 0.05-0.21)   | Pass         |
| Suspended solids                                | <10mg/l  | Consistently <10mg/l (max = 7)  | Pass         |
| BOD   | <1.4mg/l   | 1.41mg/l (range: 1.00-2.30)   | Fail         |
| <b>Substrate Condition</b>                      |  |   |              |
| Siltation                                       | No plumes of silt when substrate kicked to 10cm depth                            | No plumes at any section  | Pass         |
| Redox measurements                              | Measurements <20% loss in redox value at 5cm depth                               | Not assessed  | Unknown      |
| <b>Macrophytes</b>                              |  | None  | Not assessed |
| <b>Filamentous algae</b>                        | None (<5% cover)   | Present in all section but <10%   | Fail         |
| <b>Adjacent Land Use Issues</b>                 |  | None  | Pass         |
| <b>Evidence of pearl fishing</b>                | None   | No exploitation evident   | Pass         |
| <b>OVERALL CONDITION</b> Unfavourable declining |  |   |              |

## **DISCUSSION**

A total of 12,947 freshwater pearl mussels were recorded on SAC designated rivers (Ballinderry, Owenkillew and Swanlinbar). Whilst there was a +4.1% increase in the numbers of mussels recorded, there was no significant temporal trend in abundance within designated sites and populations were judged to be stable since previous surveys during 2004/06.

Nevertheless, for all SAC rivers mean values for orthophosphate, nitrate and BOD resulted in attributes failing the current condition assessment. Only values for suspended solids passed the assessment. Overall, the current assessment was determined as “Unfavourable no change” as populations had remained stable but water chemistry conditions, whilst improved from the previous condition assessment (Killeen 2006), were still above maximum threshold values.

A total of 9,032 freshwater pearl mussels were recorded on ASSI and proposed ASSI rivers (Tempo, Owenreagh and Waterfoot). The current survey discovered a substantial population (8,195 mussels) on the Owenreagh and represented the first baseline data for this river. Numbers declined by -17.9% on the Tempo river. The Waterfoot had also been surveyed previously, however, there were difficulties in direct comparisons of individual river sections between the current survey and previous surveys. Overall, the current assessment was determined as “Unfavourable declining” on the Tempo ASSI and Waterfoot proposed ASSI and “Unfavourable” on the Owenreagh proposed ASSI as water chemistry conditions were still above maximum threshold values.

Overall, a total of 21,979 freshwater pearl mussels were recorded on six rivers throughout Northern Ireland.

## **ACKNOWLEDGEMENTS**

This project was funded by the Northern Ireland Environment Agency (NIEA) via the Natural Heritage Research Partnership (NHRP) with *Quercus*, Queen's University Belfast. Many thanks to Tony Waterman and John Early who acted as joint NIEA Client Officers. Thanks also to Frank Mitchell, Mark Horton and Steven Ewbank for assistance in the field. We are also grateful to Dr. Conor Wilson who provided data for mussel occurrence on the Owenreagh non-SAC rivers during 2009.

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## **APPENDIX I – Individual site maps and data summaries**

Individual maps for specific sections of each river surveyed and summary tables for results, including the total counts of mussels in each bed during the previous and current survey are provided overleaf.

## Ballinderry SAC – Section #16



|   |  |  |
|---|--|--|
| <b>Location:</b>  | Downstream of Corkhill Bridge                      |  |
| <b>Start Point GPS:</b> H74218 78781  | <b>Start Point Features:</b> Island in mid-channel |  |
| <b>End Point GPS:</b> H73704 79129  | <b>End Point Features:</b>                         |  |
| <b>Approximate distance (m):</b> 470m   |  |  |
| <b>Presence of fine sediments:</b> Layer of fine sediment over substrate along margins of the channel. Silt plumes produced when substrate disturbed. |  |  |
| <b>Filamentous algae:</b> <10%  |  |  |
| <b>Total No. Live Mussels Counted 2011:</b> 550   |  |  |
| <b>No. of dead shells 2011:</b> 21  |  |  |
| <b>Issues/Comments:</b> Some poaching of the banks by livestock.  |  |  |

**Ballinderry SAC - Section #16** Comparison of mussel counts during 2007 and 2011 within specific mussel beds known as section sub-units within Killeen (2007).

| Section Unit | Limits  | No. of mussels |            |
|--------------|---|----------------|------------|
|              |   | 2007           | 2011       |
| A            | Start point near confluence at H74218 78781 to upstream end of island at H74158 78848     | 155            | 156        |
| B            | Upstream of old Mill race H73949 78971 for 20 metres                                      | 127            | 121        |
| u/s of B     |   | -              | 104        |
| C1           | From 10m downstream of fence at H73835 79015 to end of tree line at H73793 79122          | 226            | 169        |
| C2           | Section continues alongside of island (u/s end at H73704 79129) to cascade c. 25m beyond. | 135            |            |
| <b>TOTAL</b> |   | <b>643</b>     | <b>550</b> |



### Ballinderry SAC – Section #17



|   |   |  |
|---|---|--|
| <b>Location:</b>  | Downstream of Wellbrook Beetling Mill                     |  |
| <b>Start Point GPS:</b> H75130 79230  | <b>Start Point Features:</b> Cascade                      |  |
| <b>End Point GPS:</b> H73704 79129  | <b>End Point Features:</b> Wellbrook Beetling Mill Bridge |  |
| <b>Approximate distance (m):</b> 140m   |   |  |
| <b>Presence of fine sediments:</b> Layer of fine sediment over substrate throughout. Silt plumes produced when substrate disturbed. |   |  |
| <b>Filamentous algae:</b> <10%  |   |  |
| <b>Total No. Live Mussels Counted 2011:</b> 106   |   |  |
| <b>No. of dead shells 2011:</b> 11  |   |  |
| <b>Issues/Comments:</b> Some stock access to banks and channel.   |   |  |

**Ballinderry SAC - Section #17** Comparison of mussel counts during 2007 and 2011 within specific mussel beds known as section sub-units within Killeen (2007).

| Section Unit                  | Limits | No. of mussels |            |
|-------------------------------|--------|----------------|------------|
|                               |        | 2007           | 2011       |
| <b>TOTAL</b> (entire Section) |        | <b>113</b>     | <b>106</b> |

## Ballinderry SAC – Sections #20-22



|  |  |  |
|--|--|--|
| <b>Location:</b>   | Upstream of Aughlish Bridge to the bridge.                               |  |
| <b>Start Point GPS:</b> H78703 78195   | <b>Start Point Features:</b> d/s end of concrete plinth beneath Aughlish |  |
| <b>End Point GPS:</b> H77521 78450   | <b>End Point Features:</b> Riffle below Kildress House                   |  |
| <b>Approximate distance (m):</b> 470m  |  |  |
| <b>Presence of fine sediments:</b> Layer of silt over substrate throughout especially in slower reaches. Silt plumes produced on disturbance of the substrate. |  |  |
| <b>Filamentous algae:</b> <10%   |  |  |
| <b>Total No. Live Mussels Counted 2011:</b> 190  |  |  |
| <b>No. of dead shells 2011:</b> 35   |  |  |
| <b>Issues/Comments:</b> Greater levels of silt throughout. Stock access a particular problem and erosion of banks due to livestock poaching.                   |  |  |

**Ballinderry SAC - Section #20-22** Comparison of mussel counts during 2007 and 2011 within specific mussel beds known as section sub-units within Killeen (2007).

| Section Unit | Limits   | No. of mussels |            |
|--------------|--|----------------|------------|
|              |  | 2007           | 2011       |
| A            | From start point to weir at H78693 78197       | 10             | 5          |
| B            | To next weir at H78689 78202                   | 2              | 4          |
| C            | To riffle at H78651 78237                      | 16             | 21         |
| D            | To large boulders at H78616 78253              | 41             | 27         |
| E            | To weir/rocks at H78522 78238                  | 0              | 0          |
| F            | To bedrock weir by gravel pit at H78100 78240  | 109            | 82         |
| G            | To fisherman's hut at H77751 78360             | 28             | 30         |
| H            | To dead tree on north bank at H77712 78355     | 13             | 7          |
| I            | To end of woodland at H77655 78368             | 10             | 13         |
| J            | To riffle below Kildress House at H77521 78450 | 4              | 1          |
| <b>TOTAL</b> |  | <b>233</b>     | <b>190</b> |

### Owenkillew SAC – Section #12



|   |  |  |
|---|--|--|
| <b>Location:</b>  | Upstream of Crouck Bridge.                 |  |
| <b>Start Point GPS:</b> H62595 83641  | <b>Start Point Features:</b> Crouck Bridge |  |
| <b>End Point GPS:</b> H63198 83647  | <b>End Point Features:</b> Field boundary  |  |
| <b>Approximate distance (m):</b> 800m - discontinuous   |  |  |
| <b>Presence of fine sediments:</b> Some silt present especially in slower water. Some plumes of silt when substrate disturbed but quickly dispersed.  |  |  |
| <b>Filamentous algae:</b> <5%   |  |  |
| <b>Total No. Live Mussels Counted 2011:</b> 2391  |  |  |
| <b>No. of dead shells 2011:</b> 142   |  |  |
| <b>Issues/Comments:</b> Poaching of the bank by livestock and severe erosion by recent floods. Lack of bankside fencing due to collapse of banks by flooding. Stranding of a large number of mussels washed down by recent flood events along the channel margins. Several mussels in <10cm depth of water and in danger of drying out. |  |  |

**Owenkillew SAC - Section #12** Comparison of mussel counts during 2007 and 2011 within specific mussel beds known as section sub-units within Killeen (2007).

| Section Unit | Limits  | No. of mussels |             |
|--------------|---|----------------|-------------|
|              |   | 2007           | 2011        |
| A            | Under Crouck Bridge   | 39             | 59          |
| B            | U/s end of Crouck Bridge to willow on N bank at H62623 83645  | 32             | 43          |
| C            | To sycamore on N bank at H62628 83641   | 6              | 2           |
| D            | To sycamore trunk + willow at H62659 83626  | 7              | 5           |
| E            | To willow at H62677 83615 (last tree on north bank)   | 7              | 4           |
| F            | To large dark boulder on N bank at H62706 83603   | 3              | 5           |
|              | Gap   |                |             |
| G            | From willow on S bank at H62787 83509   | 24             | 412         |
| H            | To the upstream willow of 2 willows on S bank. The deep ditch immediately above the willow is at H62815 83543 | 18             |             |
| I            | To top of riffle at H62826 83557  | 10             |             |
| J            | To barbed wire fence on S bank at H62846 83592  | 53             | 71          |
| K            | To deep ditch and barbed wire fence on S bank at H62875 83680   | 17             | 62          |
|              | Gap   |                |             |
| L            | Downstream tip of boulder at H63104 83777 to H63112 83776   | 408            | 1728        |
| M            | Upstream to field boundary at H63198 83749  | 200+           |             |
| <b>TOTAL</b> |   | <b>824+</b>    | <b>2391</b> |

### Owenkillew SAC – Multiple mussel beds at point transects



**Owenkillew SAC – Multiple mussel beds at points** Comparison of mussel counts during 2004 and 2011 at specific points.

| Bed No.      | Central Grid Ref. | Bed Length (m) | No. of mussels |             |
|--------------|-------------------|----------------|----------------|-------------|
|              |                   |                | 2004           | 2011        |
| A1           | H61458466         | 10             | 87             | 5           |
| A2           | H61428469         | 25             | 100            | 42          |
| A3           | H61448463         | 15             | 100            | 19          |
| A4           | H62038391         | 30             | 210            | 170         |
| A5           | H62188388         | 30             | ?              | 220         |
| A6           | H62338357         | 20             | 368            | 412         |
| A7           | H63048376         | 45             | 952            | 741         |
| A8           | H63108377         | 20             | 1101           | 987         |
| A9           | H63288376         | 66             | 1536           | 1081        |
| A10          | H63338376         | 20             | 172            | 168         |
| A11          | H63418381         | 50             | 1027           | 842         |
| A12          | H63518380         | 70             | 264            | 243         |
| A13          | H63568384         | 10             | 240            | 198         |
| B1           | H6260 8365        | -              | 15             | 59          |
| B2           | H6288 8369        | -              | 42             | 71          |
| B3           | H6289 8371        | -              | 38             | 29          |
| B4           | H6296 8375        | -              | 15             | 33          |
| B5           | H6315 8377        | -              | 18             | 15          |
| B6           | H6317 8377        | -              | 26             | 45          |
| B7           | H6318 8376        | -              | 41             | 26          |
| B8           | H6322 8374        | -              | 28             | 61          |
| <b>TOTAL</b> |                   |                | <b>6380</b>    | <b>5467</b> |

### Owenkillew SAC – Multiple mussel beds at line transects



**Owenkillew SAC – Multiple mussel beds at transects** Comparison of mussel counts during 2004 and 2011 at 1x50m transects previously surveyed by NIEA.

| Transect No. | D/S Grid ref | U/S Grid ref | No. Mussels<br>2004 | No. Mussels<br>2011 |
|--------------|--------------|--------------|---------------------|---------------------|
| T1           | IH61498461   | H61538458    | 205                 | 189                 |
| T2           | IH61708438   | H61718432    | 451                 | 374                 |
| T3           | IH62888369   | H62918373    | 10                  | 21                  |
| T4           | IH63388382   | H63368381    | 61                  | 32                  |
| <b>Total</b> |              |              | <b>727</b>          | <b>616</b>          |

## Swanlinbar SAC – Section #2



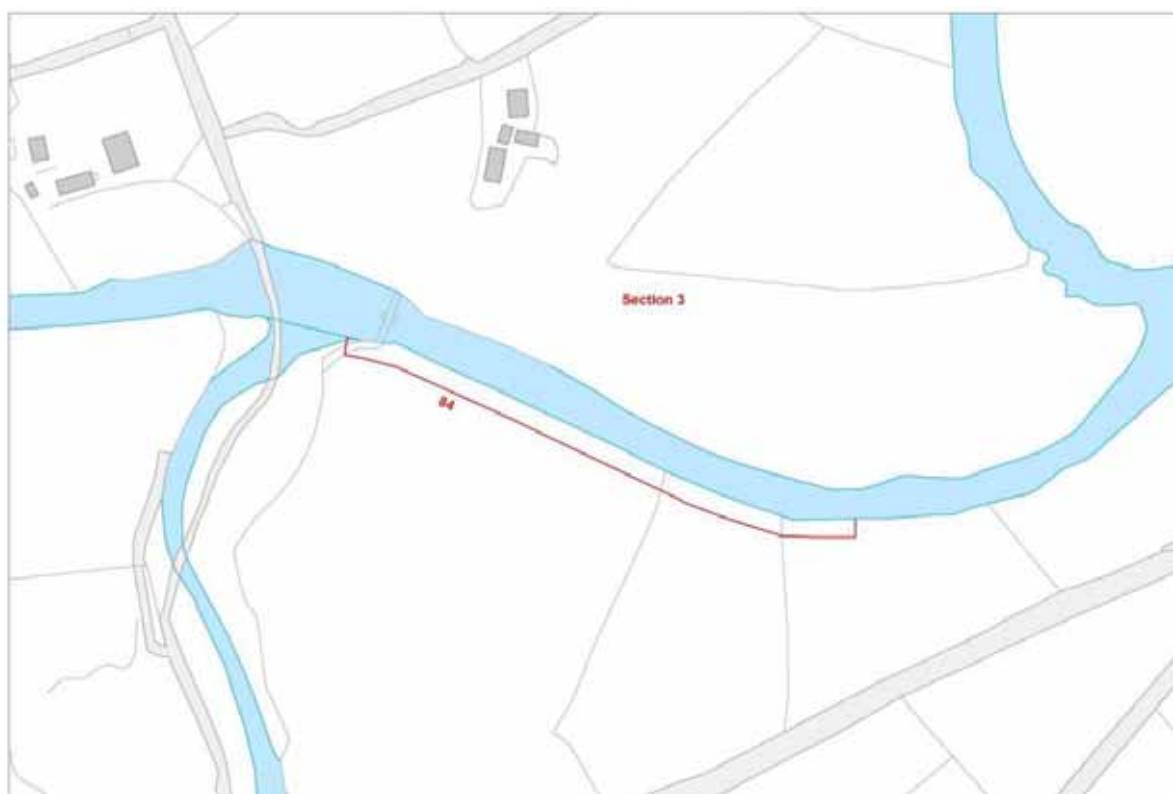
|   |  |  |
|---|--|--|
| <b>Location:</b>  | Upstream of Glasdrumman Bridge                                 |  |
| <b>Start Point GPS:</b> H22144 28697  | <b>Start Point Features:</b> Ford                              |  |
| <b>End Point GPS:</b> H22017 28848  | <b>End Point Features:</b> Field boundary on north (east) bank |  |
| <b>Approximate distance (m):</b> 450  |  |  |
| <b>Presence of fine sediments:</b> None   |  |  |
| <b>Filamentous algae:</b> Less than 10% cover overall   |  |  |
| <b>Total No. Live Mussels Counted 2011:</b> 1,396   |  |  |
| <b>No. of dead shells 2011:</b> 41  |  |  |
| <b>Issues/Comments:</b><br>Stock access and vehicle access at ford where mussels are known to be present immediately upstream. Use of tar to paint wooden footbridge. Area known to have been fished for pearl mussel in the distant past (land owner pers. comm.). |  |  |

**Swanlinbar SAC - Section #2** Comparison of mussel counts during 2007 and 2011 within specific mussel beds known as section sub-units within Killeen (2007).

| Section sub-unit | Limits   | No. of mussels   |                  |                  |                  |
|------------------|--|------------------|------------------|------------------|------------------|
|                  |  | 2007             |                  | 2011             |                  |
|                  |  | N <sup>1/2</sup> | S <sup>1/2</sup> | N <sup>1/2</sup> | S <sup>1/2</sup> |
| A                | Ford to stepping stones at H22113 28688                | 0                | 58               | 0                | 45               |
| B                | Stepping stones to footbridge at H22083 28688          | 3                | 57               | 68               | 37               |
| C                | To tree leaning into river at H22066 28687             | 54               | 0                | 61               | 0                |
| D                | To field boundary (on S side) at H22035 28681          | 29               | 64               | 45               | 88               |
| E                | To field boundary and gate (on S side) at H21989 28714 | 16               | 32               | 8                | 51               |
| F                | To big ash on north bank at H21998 28747               | 52               | 0                | 63               | 0                |
| G                | To opposite field boundary                             | 37               | 0                | 21               | 0                |
| H                | To alder tree on north bank                            | 42               | 0                | 40               | 0                |
| I                | To double-trunked ash (on N side) at H21994 28757      | 29               | 391              | 143              | 391              |
| J                | To field boundary (on N side) at H22007 28788          | 13               | 32               | 18               | 56               |
| K                | To field boundary (on N side) at H22017 28848          | 141              | 62               | 203              | 58               |
| <b>TOTAL</b>     |  | <b>1,112</b>     |                  | <b>1,396</b>     |                  |



### Swanlinbar SAC – Section #3



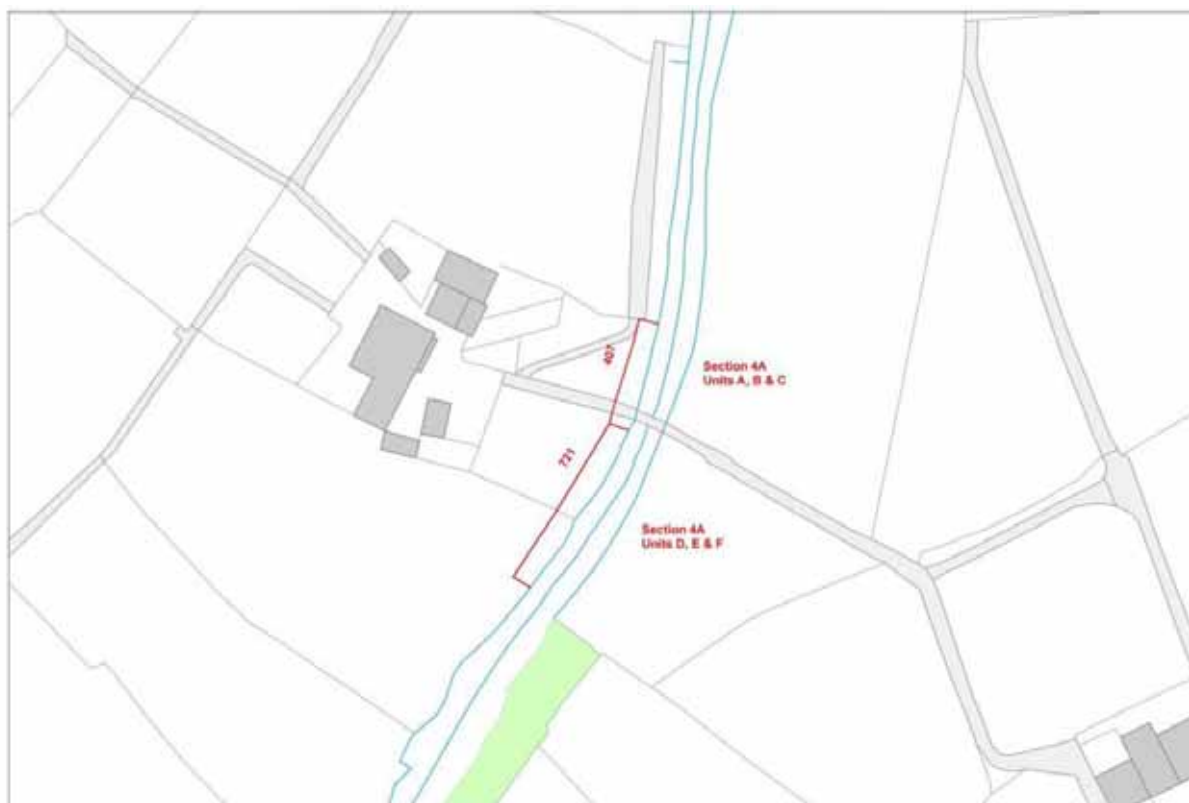
#### Summary table

|  |   |  |
|--|---|--|
| <b>Location:</b>   | Downstream of Glassdrumman Bridge                     |  |
| <b>Start Point GPS:</b> H22810 28813   | <b>Start Point Features:</b> Hazel tree on south bank |  |
| <b>End Point GPS:</b> H73704 79129   | <b>End Point Features:</b> Owengarr River confluence  |  |
| <b>Approximate distance (m):</b> 300   |   |  |
| <b>Presence of fine sediments:</b> Few fines observed  |   |  |
| <b>Filamentous algae:</b> Less than 10% cover overall  |   |  |
| <b>Total No. Live Mussels Counted 2011:</b> 84   |   |  |
| <b>No. of dead shells 2011:</b> 6  |   |  |
| <b>Issues/Comments:</b><br>Channel substrate clean and very little silt or filamentous algae present. Some stock access from eroded banks. |   |  |

**Swanlinbar SAC - Section #3** Comparison of mussel counts during 2007 and 2011 within specific mussel beds known as section sub-units within Killeen (2007).

| Section Unit | Limits                                       | No. of mussels |           |
|--------------|--|----------------|-----------|
|              |  | 2007           | 2011      |
| A            | Hazel tree to field boundary at H22752 28828 | 0              | 6         |
| B            | To sycamore at H22694 28861                  | 41             | 57        |
| C            | To old footbridge at H22652 28872            | 12             | 19        |
| D            | To Owengarr confluence                       | 0              | 2         |
| <b>TOTAL</b> |  | <b>53</b>      | <b>84</b> |

## Swanlinbar SAC – Section #4a



|   |  |  |
|---|--|--|
| <b>Location:</b>  | Upstream and downstream of the Ulster Way bridge at Drumroosk    |  |
| <b>Start Point GPS:</b>   | <b>Start Point Features:</b> Field boundary downstream of bridge |  |
| <b>End Point GPS:</b> H23403 29551  | <b>End Point Features:</b> Stepping Stones                       |  |
| <b>Approximate distance (m):</b> 300  |  |  |
| <b>Presence of fine sediments:</b> Few fines observed   |  |  |
| <b>Filamentous algae:</b> Less than 10% cover overall   |  |  |
| <b>Total No. Live Mussels Counted 2011:</b> 726   |  |  |
| <b>No. of dead shells 2011:</b> 32  |  |  |
| <b>Issues/Comments:</b><br>Channel substrate clean and very little silt or filamentous algae present. |  |  |

**Swanlinbar SAC - Section #4a** Comparison of mussel counts during 2007 and 2011 within specific mussel beds known as section sub-units within Killeen (2007).

| Section Unit | Limits   | No. of mussels |              |
|--------------|--|----------------|--------------|
|              |  | 2007           | 2011         |
| A & B        | Field boundary at H23473 29820 to centre point of riffle at H23464 29785 | 369            | 402          |
| C            | Riffle to bridge at H23467 29669   | 0              | 5            |
| D            | From bridge to top of riffle   | 45             | 177          |
| E            | To field boundary on south side  | 84             | 89           |
| F            | To stepping stones at H23403 29551 567                                   | 567            | 455          |
| <b>TOTAL</b> |  | <b>1,065</b>   | <b>1,128</b> |

## Swanlinbar SAC – Section #4b



|  |   |  |
|--|---|--|
| <b>Location:</b>   | Upstream and downstream of the Ulster Way Bridge at Drumroosk |  |
| <b>Start Point GPS:</b> H23403 29551   | <b>Start Point Features:</b> Steeping stones                  |  |
| <b>End Point GPS:</b> H23280 29474   | <b>End Point Features:</b> Field boundary                     |  |
| <b>Approximate distance (m):</b> 300   |   |  |
| <b>Presence of fine sediments:</b> Few fines observed except in slower sections of water.                |   |  |
| <b>Filamentous algae:</b> Less than 15% cover overall  |   |  |
| <b>Total No. Live Mussels Counted 2011:</b> 644  |   |  |
| <b>No. of dead shells 2011:</b> 18   |   |  |
| <b>Issues/Comments:</b><br>Channel substrate mostly clean with little silt or filamentous algae present. |   |  |

**Swanlinbar SAC - Section #4b** Comparison of mussel counts during 2007 and 2011 within specific mussel beds known as section sub-units within Killeen (2007).

| Section Unit | Limits                                    | No. of mussels |            |
|--------------|---|----------------|------------|
|              |   | 2007           | 2011       |
| A            | Immediately upstream of steeping stones   | 12             | 10         |
| B            | To sycamore on north bank at H23369 29551 | 30             | 41         |
| C            | To next sycamore on north bank            | 6              | 10         |
| D            | To field boundary at H23356 29540         | 63             | 50         |
| E            | To field boundary at H23356 29540         | 101            | 85         |
| F            | To large ash at H23312 29510              | 184            | 169        |
| G            | To large ash at H23312 29510              | 63             | 76         |
| H            | To drain at H23298 29503                  | 80             | 105        |
| I            | To field boundary at H23280 29474         | 145            | 98         |
| <b>TOTAL</b> |   | <b>684</b>     | <b>644</b> |

### Swanlinbar SAC – Section #5

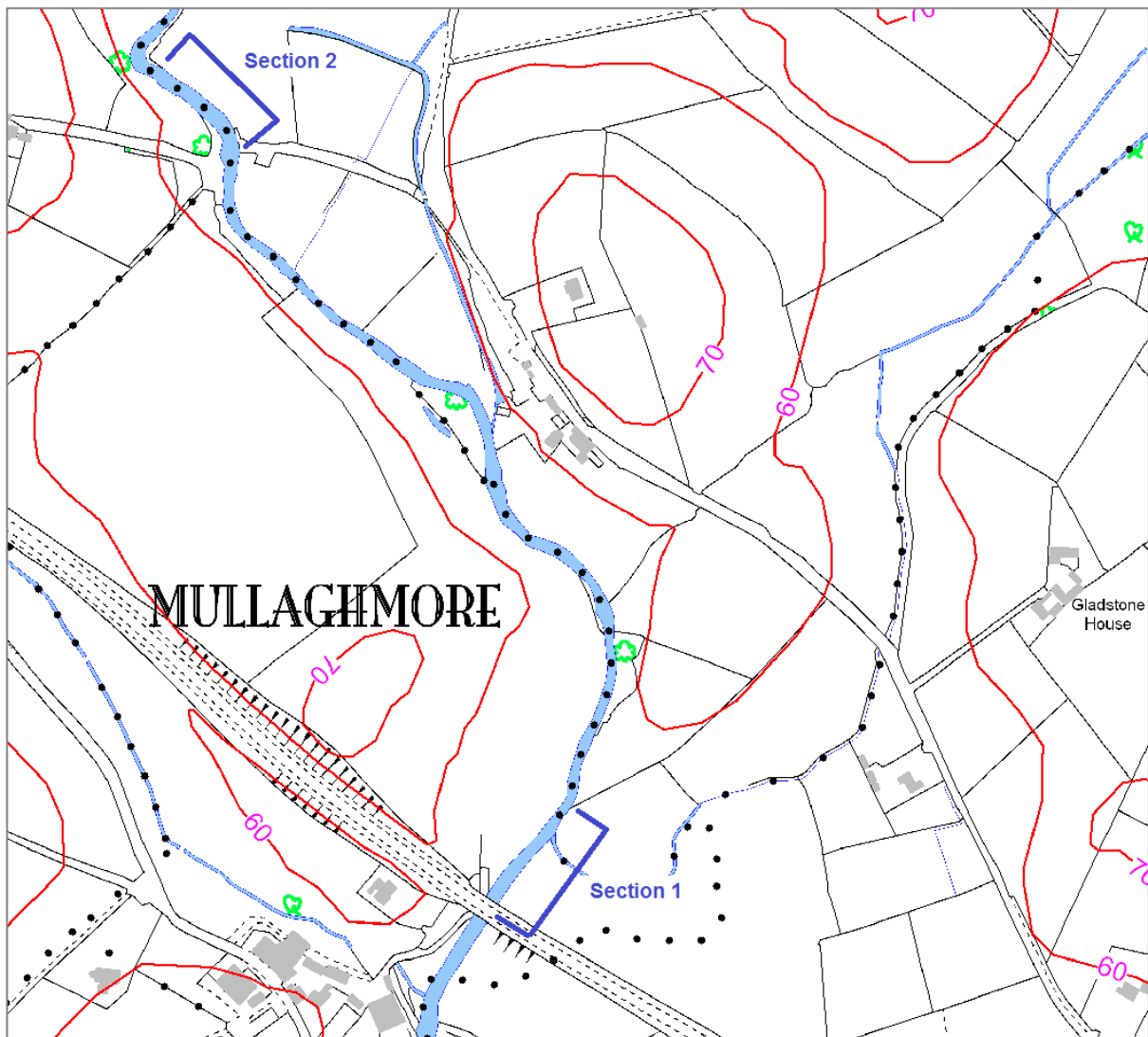


|  |  |  |
|--|--|--|
| <b>Location:</b>   | Downstream of Stragowna Bridge   |  |
| <b>Start Point GPS:</b> H23862 30631   | <b>Start Point Features:</b> Field boundary on south bank just below downstream end of narrow island |  |
| <b>End Point GPS:</b> H24043 30675   | <b>End Point Features:</b> Large alder on south bank   |  |
| <b>Approximate distance (m):</b> approx 300  |  |  |
| <b>Presence of fine sediments:</b> Fines observed in slower sections of water.   |  |  |
| <b>Filamentous algae:</b> Some filamentous algae present in slower sections of river.  |  |  |
| <b>Total No. Live Mussels Counted 2011:</b> 375  |  |  |
| <b>No. of dead shells 2011:</b> 14   |  |  |
| <b>Issues/Comments:</b><br>Channel substrate silty with some filamentous algae present. Cattle trampling of banks severe in areas and access to the channel. |  |  |

**Swanlinbar SAC - Section #5** Comparison of mussel counts during 2007 and 2011 within specific mussel beds known as section sub-units within Killeen (2007).

| Section Unit | Limits   | No. of mussels |    |            |    |
|--------------|--|----------------|----|------------|----|
|              |  | 2007           |    | 2011       |    |
|              |  | N½             | S½ | N½         | S½ |
| A            | Boundary hedge on bend on south bank at H23862 30631 to alder tree on south bank | 7              | 10 | 15         | 11 |
| B            | To alder tree on south bank  | 39             | 0  | 25         | 0  |
| C            | To ash and alder on south bank   | 20             | 0  | 31         | 0  |
| D            | To old hawthorn at H23900 30634  | 24             | 0  | 5          | 0  |
| E            | To large, old willow (2 trunks) on south bank                                    | 0              | 57 | 0          | 69 |
| F            | To next willow on south bank   | 0              | 34 | 0          | 21 |
| G            | To hawthorn on south bank mid-channel  | 20             |    | 14         |    |
| H            | To large sycamore on north bank  | 55             | 0  | 52         | 2  |
| I            | To willow on north bank  | 0              | 6  | 2          | 9  |
| J            | Bend section   | 5              | 66 | 1          | 71 |
| K            | Bend to single hawthorn on north bank  | 0              | 36 | 0          | 28 |
| L            | To large alder on south bank at H24043 30675                                     | 0              | 16 | 2          | 17 |
| <b>TOTAL</b> |  | <b>395</b>     |    | <b>375</b> |    |

### Tempo ASSI – Sections #1-2



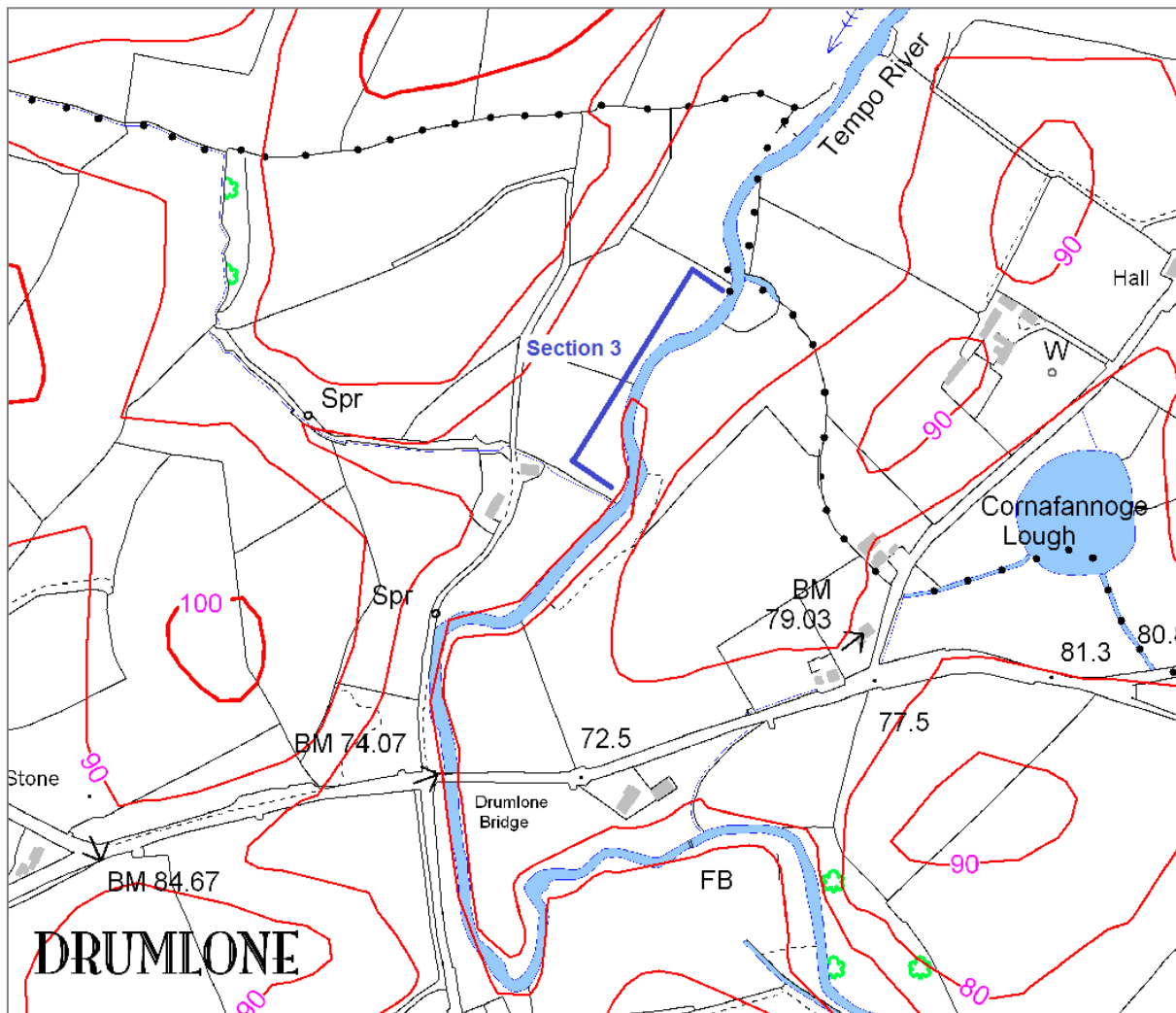
### Tempo ASSI – Sections #1

|   |                |  |
|---|----------------|--|
| <b>Location:</b>  | A4 Road Bridge |  |
| <b>Start Point GPS:</b>   | H 3420 3925    | <b>Start Point Features:</b> 5m downstream of A4 road bridge |
| <b>End Point GPS:</b>   |                | <b>End Point Features:</b> Confluence of drain               |
| <b>Approximate distance (m):</b> 80m  |                |  |
| <b>Presence of fine sediments:</b> Excessive plume from bed   |                |  |
| <b>Filamentous algae:</b> 20%   |                |  |
| <b>Total No. Live Mussels Counted 2011:</b> 125   |                |  |
| <b>No. of dead shells 2011:</b> 14  |                |  |
| <b>Issues/Comments:</b> Very poor fences along both banks. Cattle cross river at the mouth of the drain. Four broken shells found – probably the result of cattle trampling |                |  |

**Tempo ASSI – Sections #2**

|  |  |  |
|--|--|--|
| <b>Location:</b>   | Old Coach Road ford  |  |
| <b>Start Point GPS:</b> H 3395 3975  | <b>Start Point Features:</b> 10m downstream of Old Coach Road ford     |  |
| <b>End Point GPS:</b>  | <b>End Point Features:</b> Riffle upstream of large alder on left bank |  |
| <b>Approximate distance (m):</b> 80m   |  |  |
| <b>Presence of fine sediments:</b> Excessive silt plume  |  |  |
| <b>Filamentous algae:</b> 20%  |  |  |
| <b>Total No. Live Mussels Counted 2011:</b> 162  |  |  |
| <b>No. of dead shells 2011:</b> 6  |  |  |
| <b>Issues/Comments:</b> River is tree-lined and well fenced on both banks. Fallen tree should be removed as floods are scouring the river bed and exposing underlying clay. This will be causing further siltation downstream. |  |  |

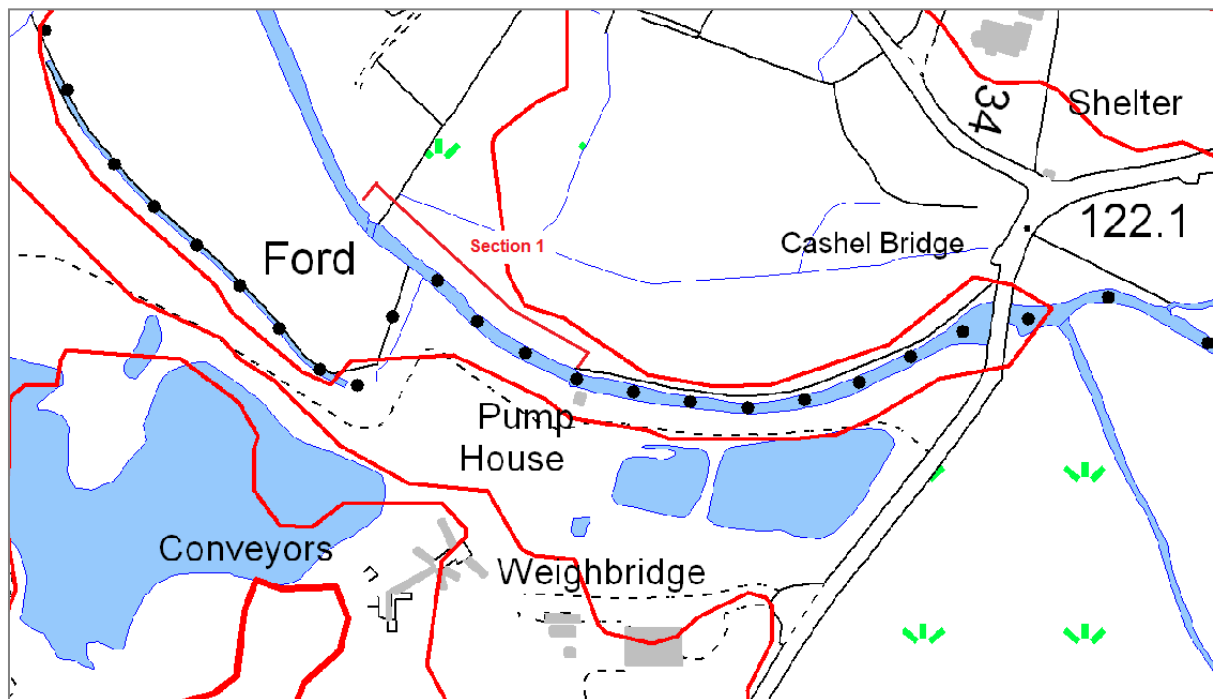
### Tempo ASSI – Sections #3



|   |                             |   |
|---|-----------------------------|---|
| <b>Location:</b>  | Upstream of Drumlone Bridge |   |
| <b>Start Point GPS:</b>   | H 335 4275                  | <b>Start Point Features:</b> Tributary entering from right bank |
| <b>End Point GPS:</b>   |                             | <b>End Point Features:</b> Fallen willows on right bank         |
| <b>Approximate distance (m):</b> 80m  |                             |   |
| <b>Presence of fine sediments:</b> Small plume from bed   |                             |   |
| <b>Filamentous algae:</b> <10%  |                             |   |
| <b>Total No. Live Mussels Counted 2011:</b> 144   |                             |   |
| <b>No. of dead shells 2011:</b> 6   |                             |   |
| <b>Issues/Comments:</b> Right bank unfenced where there is a dairy cow paddock. Left bank well fenced |                             |   |

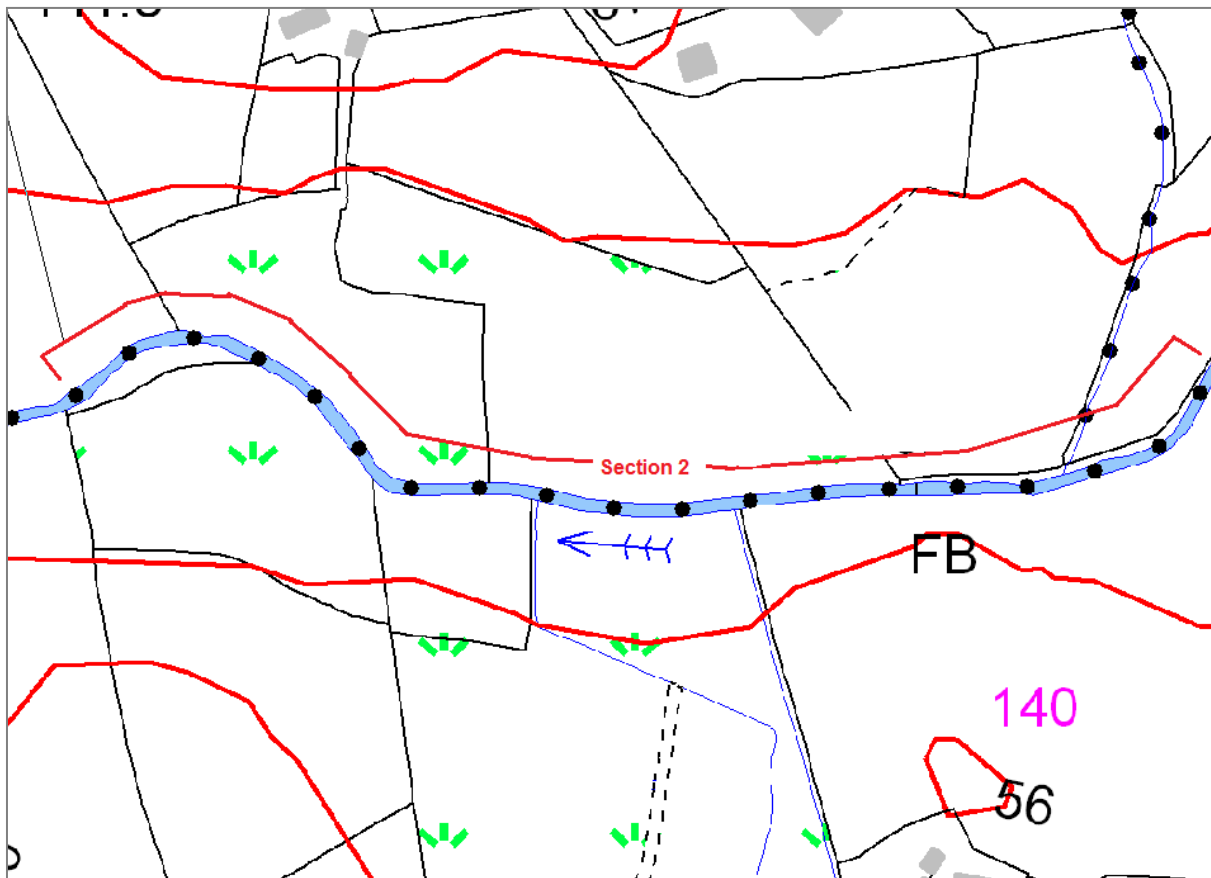


### Owenreagh proposed ASSI – Section #1



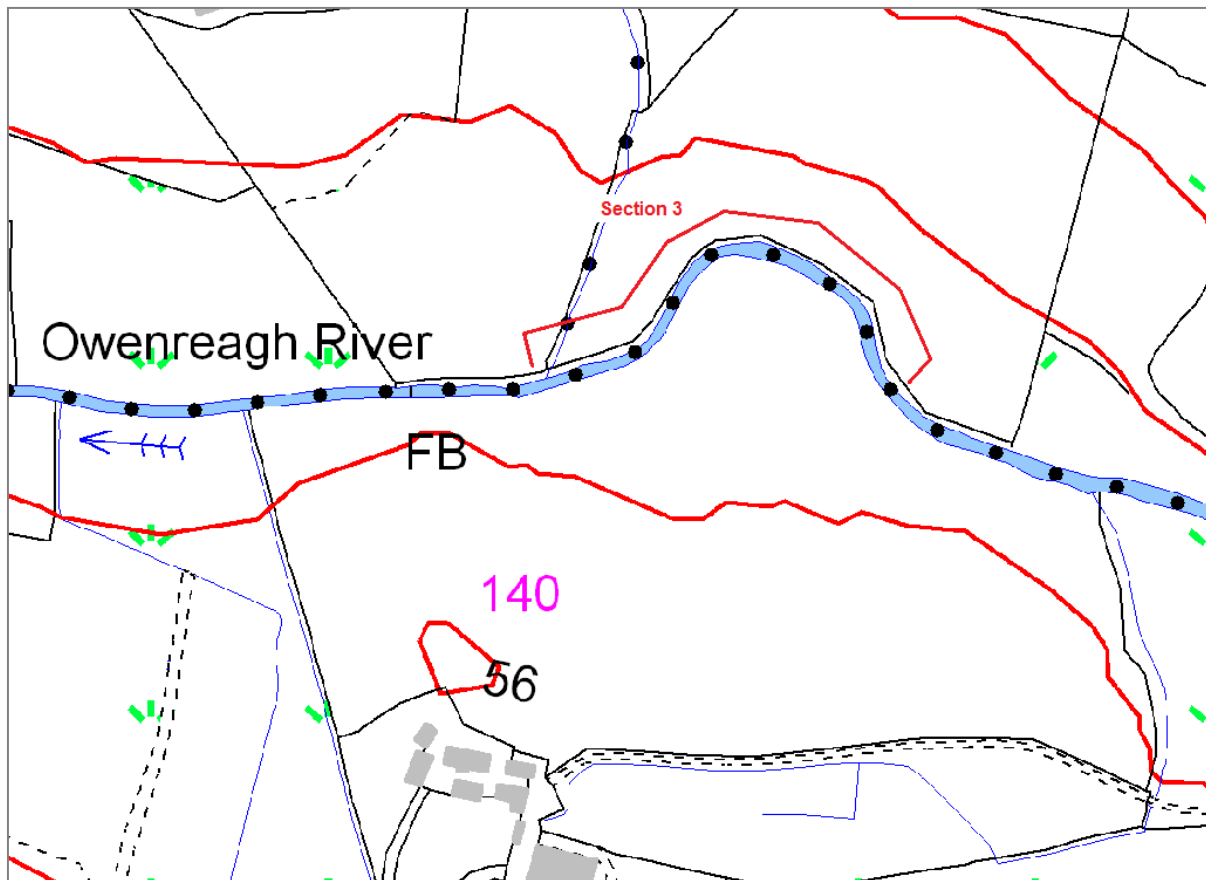
|   |  |
|---|--|
| <b>Location:</b>  |  |
| <b>Start Point GPS:</b> H5800 8210  | <b>Start Point Features:</b> Upstream from pump house          |
| <b>End Point GPS:</b> H5791 8218  | <b>End Point Features:</b> Downstream from ford                |
| <b>Approximate distance (m):</b> 120m   |  |
| <b>Presence of fine sediments:</b> Cobble, boulder and coarse sand  |  |
| <b>Filamentous algae:</b> 0   |  |
| <b>Total no. live mussels during 2011:</b> 2  | <b>Estimated mussels density:</b> 0.003 mussels/m <sup>2</sup> |
| <b>No. of dead shells 2011:</b> 0   |  |
| <b>Issues/Comments:</b> Sparse <i>Ranunculus</i> . Substrate looks suitable for mussels. No signs of pressure from the adjacent quarry. Good density of 0+ salmon observed below spawning ford. |  |

Owenreagh proposed ASSI – Section #2



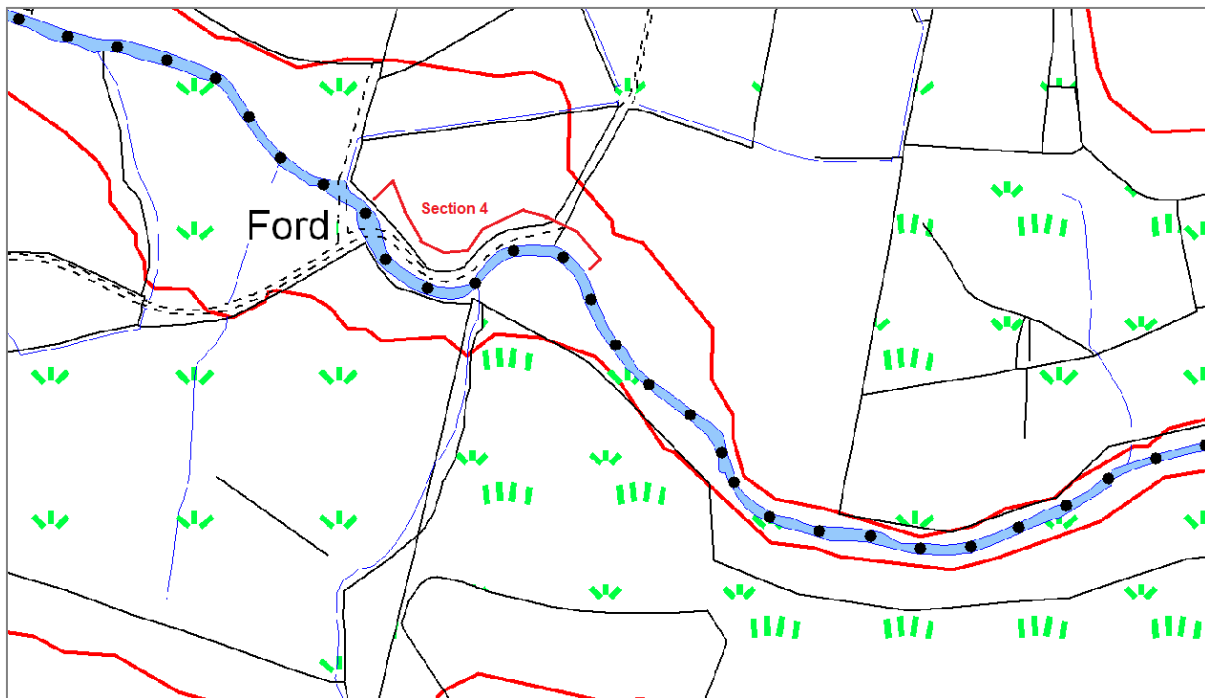
|   |  |
|---|--|
| <b>Location:</b>  |  |
| <b>Start Point GPS:</b> H5892 8209  | <b>Start Point Features:</b>                               |
| <b>End Point GPS:</b> H5851 8209  | <b>End Point Features:</b>                                 |
| <b>Approximate distance (m):</b> 200m   |  |
| <b>Presence of fine sediments:</b> Cobble, boulder, bedrock and sand  |  |
| <b>Filamentous algae:</b> 10%   |  |
| <b>Total no. live mussels during 2011:</b> 0  | <b>Estimated mussels density:</b> 0 mussels/m <sup>2</sup> |
| <b>No. of dead shells 2011:</b> 3   |  |
| <b>Issues/Comments:</b> Bedrock has been dredged along this stretch. Greencastle WWTW discharges into a tributary just upstream of this site. |  |

### Owenreagh proposed ASSI – Section #3



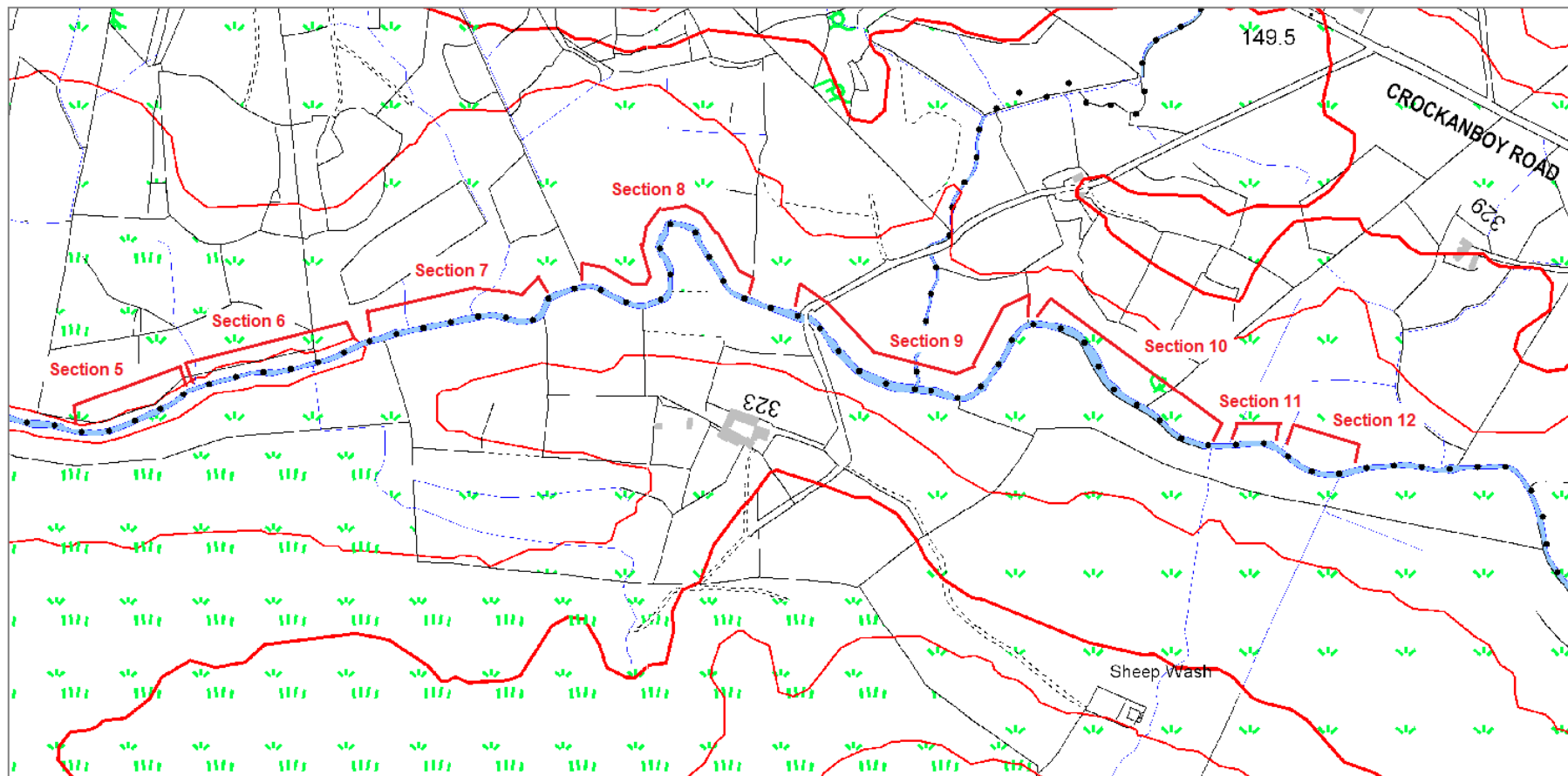
|   |   |
|---|---|
| <b>Location:</b>  |   |
| <b>Start Point GPS:</b> H5901 8205  | <b>Start Point Features:</b> Upstream of boulders in main channel |
| <b>End Point GPS:</b> H5886 8205  | <b>End Point Features:</b> Downstream of confluence with burn     |
| <b>Approximate distance (m):</b> 50m  |   |
| <b>Presence of fine sediments:</b> Cobble, boulder and sand   |   |
| <b>Filamentous algae:</b> None recorded   |   |
| <b>Total no. live mussels during 2011:</b> 50   | <b>Estimated mussels density:</b> 0.25 mussels/m <sup>2</sup>     |
| <b>No. of dead shells 2011:</b> 0   |   |
| <b>Issues/Comments:</b> <i>Ranunculus</i> present. Mussels are dense along right (north) bank. The influence of the WWTW appears to have affected the mussel population downstream of the receiving burn. |   |

### Owenreagh proposed ASSI – Section #4



|  |  |
|--|--|
| <b>Location:</b>   |  |
| <b>Start Point GPS:</b> H5933 8188   | <b>Start Point Features:</b>   |
| <b>End Point GPS:</b> H5922 8193   | <b>End Point Features:</b> Ford  |
| <b>Approximate distance (m):</b> 90m   |  |
| <b>Presence of fine sediments:</b> Cobble, boulder and coarse grain  |  |
| <b>Filamentous algae:</b> None recorded  |  |
| <b>Total no. live mussels during 2011:</b> 773   | <b>Estimated mussels density:</b> 2.17 mussels/m <sup>2</sup><br>(10.0 mussels/m <sup>2</sup> in <i>Ranunculus</i> beds) |
| <b>No. of dead shells 2011:</b> 2  |  |
| <b>Issues/Comments:</b> 573 in channel and 200 estimated in <i>Ranunculus</i> bed. Repaired fence along left bank. New fence on right bank at D/S end. No fence along much of right bank. Some excavation of the river bed here recently. No dead mussels observed in spoil. |  |

### Owenreagh proposed ASSI – Sections #5-12



## Owenreagh proposed ASSI – Sections #5

|  |  |  |
|--|--|--|
| <b>Location:</b>   |  |  |
| <b>Start Point GPS:</b> H5958 8181   | <b>Start Point Features:</b> Upstream from large patch of weed                 |  |
| <b>End Point GPS:</b> H5948 8177   | <b>End Point Features:</b> At stone wall on northern bank downstream of willow |  |
| <b>Approximate distance (m):</b> 100m  |  |  |
| <b>Presence of fine sediments:</b> Cobble, coarse grain sand & boulders  |  |  |
| <b>Filamentous algae:</b> None recorded  |  |  |
| <b>Total no. live mussels during 2011:</b> 926   | <b>Estimated mussels density:</b> 3.33 mussels/m <sup>2</sup>                  |  |
| <b>No. of dead shells 2011:</b> 3  |  |  |
| <b>Issues/Comments:</b> <i>Ranunculus</i> present. This stretch has been allowed to close in to its natural 3 metre width since the fences were erected. |  |  |

## Owenreagh proposed ASSI – Sections #6

|  |   |  |
|--|---|--|
| <b>Location:</b>   |   |  |
| <b>Start Point GPS:</b> H5974 8185   | <b>Start Point Features:</b> Riffle section                   |  |
| <b>End Point GPS:</b> H5959 8181   | <b>End Point Features:</b> Downstream of deep pool            |  |
| <b>Approximate distance (m):</b> 175m  |   |  |
| <b>Presence of fine sediments:</b> Cobble, coarse grain sand   |   |  |
| <b>Filamentous algae:</b> None recorded  |   |  |
| <b>Total no. live mussels during 2011:</b> 1007  | <b>Estimated mussels density:</b> 3.33 mussels/m <sup>2</sup> |  |
| <b>No. of dead shells 2011:</b> 4  |   |  |
| <b>Issues/Comments:</b> <i>Ranunculus</i> present. Buffer strips grow sedge grass, banks are stable and mussels are most dense on right (north) side of the channel. Good fences set 10 metres from river bank along both sides. |   |  |

## Owenreagh proposed ASSI – Sections #7

|  |  |  |
|--|--|--|
| <b>Location:</b>   |  |  |
| <b>Start Point GPS:</b> H5991 8189   | <b>Start Point Features:</b> Upstream of pool                  |  |
| <b>End Point GPS:</b> H5975 8185   | <b>End Point Features:</b> Downstream of pool                  |  |
| <b>Approximate distance (m):</b> 220m  |  |  |
| <b>Presence of fine sediments:</b> Boulder, cobble and bedrock   |  |  |
| <b>Filamentous algae:</b> None recorded  |  |  |
| <b>Total no. live mussels during 2011:</b> 10  | <b>Estimated mussels density:</b> 0.015 mussels/m <sup>2</sup> |  |
| <b>No. of dead shells 2011:</b> 4  |  |  |
| <b>Issues/Comments:</b> Mussel beds are absent here as bedrock predominates. Repaired fence ends on left side at pole across the river. No fence upstream. Poor fence on right bank. |  |  |

## Owenreagh proposed ASSI – Sections #8

|   |  |  |
|---|--|--|
| <b>Location:</b>  |  |  |
| <b>Start Point GPS:</b> H6008 8189  | <b>Start Point Features:</b> Downstream of bridge              |  |
| <b>End Point GPS:</b> H5994 8190  | <b>End Point Features:</b> Large expanse of bedrock            |  |
| <b>Approximate distance (m):</b> 600m   |  |  |
| <b>Presence of fine sediments:</b> Boulder, bedrock, cobble and sand  |  |  |
| <b>Filamentous algae:</b> None recorded   |  |  |
| <b>Total no. live mussels during 2011:</b> 364  | <b>Estimated mussels density:</b> 0.152 mussels/m <sup>2</sup> |  |
| <b>No. of dead shells 2011:</b> 7   |  |  |
| <b>Issues/Comments:</b> <i>Ranunculus</i> present. Mussel beds re-occur upstream around the right side of a bend. Substrate has been removed from this pool {at some pines}. No shells observed in spoil. |  |  |

## Owenreagh proposed ASSI – Sections #9

|  |  |  |
|--|--|--|
| <b>Location:</b>   |  |  |
| <b>Start Point GPS:</b> H6034 8187   | <b>Start Point Features:</b> Upstream of bend in channel     |  |
| <b>End Point GPS:</b> H6013 8188   | <b>End Point Features:</b> Bridge                            |  |
| <b>Approximate distance (m):</b> 300m  |  |  |
| <b>Presence of fine sediments:</b> Boulder, cobble, bedrock and sand   |  |  |
| <b>Filamentous algae:</b> None recorded  |  |  |
| <b>Total no. live mussels during 2011:</b> 601   | <b>Estimated mussels density:</b> 0.5 mussels/m <sup>2</sup> |  |
| <b>No. of dead shells 2011:</b> 4  |  |  |
| <b>Issues/Comments:</b> The fence on the right bank from the bridge up to the burn is poor. Fences are good on the left bank and on the right bank upstream of burn. Mussel beds are dense upstream of the bedrock within stretches 8 & 9. |  |  |

## Owenreagh proposed ASSI – Sections #10

|   |   |  |
|---|---|--|
| <b>Location:</b>  |   |  |
| <b>Start Point GPS:</b> H6050 8176  | <b>Start Point Features:</b>                                  |  |
| <b>End Point GPS:</b> H6035 8187  | <b>End Point Features:</b>                                    |  |
| <b>Approximate distance (m):</b> 180m   |   |  |
| <b>Presence of fine sediments:</b> Cobble and coarse sand   |   |  |
| <b>Filamentous algae:</b> None recorded   |   |  |
| <b>Total no. live mussels during 2011:</b> 1,676  | <b>Estimated mussels density:</b> 5.55 mussels/m <sup>2</sup> |  |
| <b>No. of dead shells 2011:</b> 6   |   |  |
| <b>Issues/Comments:</b> <i>Ranunculus</i> present. Good fence along left bank. Very poor fence on right bank at upstream end where improved grassland starts. This stretch holds the most dense mussel colonies in the Owenreagh. Hand searching revealed that there as many mussels in the <i>Ranunculus</i> beds as between them. |   |  |

## Owenreagh proposed ASSI – Sections #11

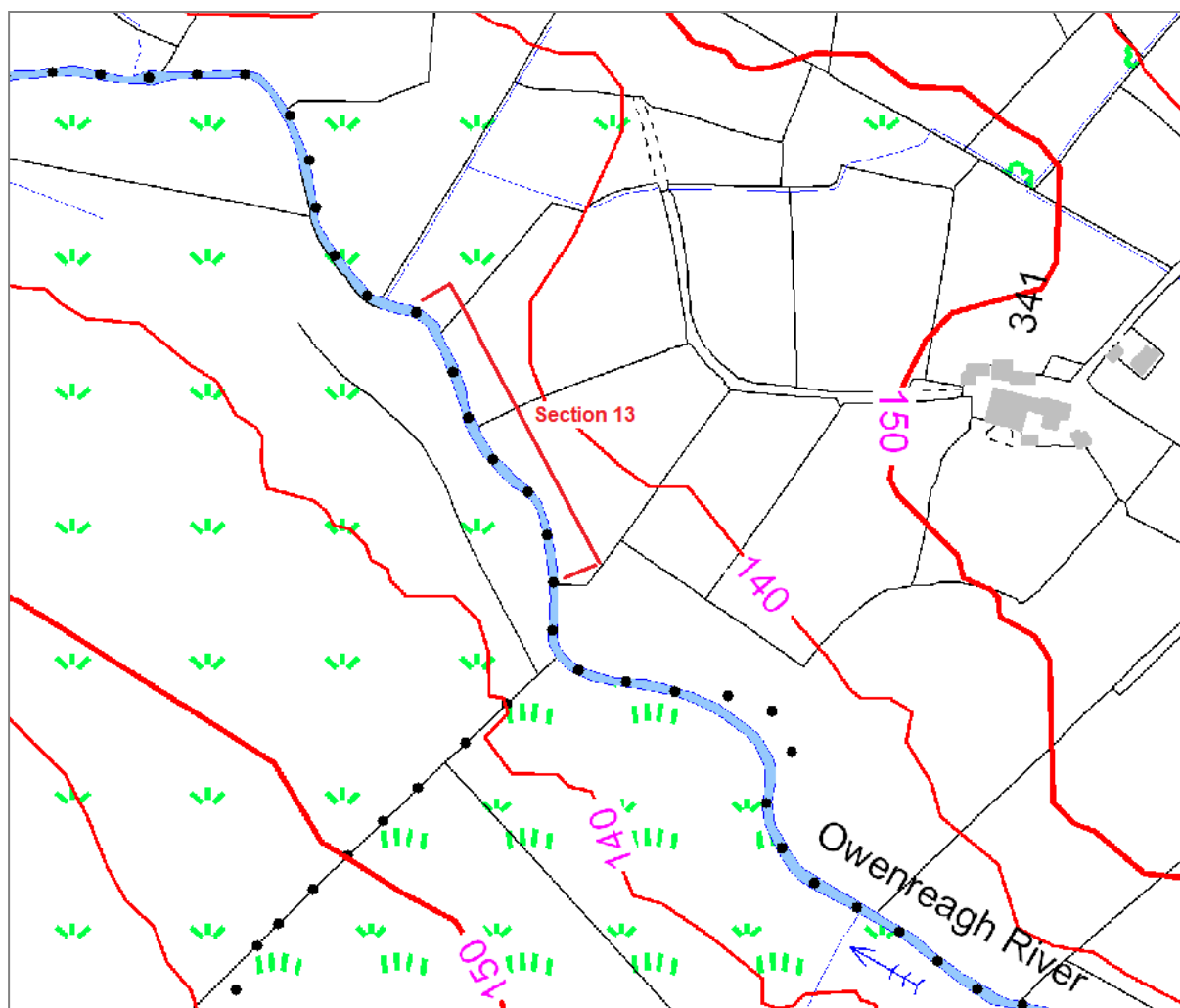
|   |  |  |
|---|--|--|
| <b>Location:</b>  |  |  |
| <b>Start Point GPS:</b> H6056 8176  | <b>Start Point Features:</b>                                 |  |
| <b>End Point GPS:</b> H6049 8176  | <b>End Point Features:</b>                                   |  |
| <b>Approximate distance (m):</b> 55m  |  |  |
| <b>Presence of fine sediments:</b> Small cobble and coarse sand   |  |  |
| <b>Filamentous algae:</b> None recorded   |  |  |
| <b>Total no. live mussels during 2011:</b> 1,100  | <b>Estimated mussels density:</b> 5.0 mussels/m <sup>2</sup> |  |
| <b>No. of dead shells 2011:</b> 3   |  |  |
| <b>Issues/Comments:</b> <i>Ranunculus</i> present. Hand searching in the <i>Ranunculus</i> beds located c.50% of the mussels in this stretch. No fence along right bank. Poor fence along left. |  |  |

## Owenreagh proposed ASSI – Sections #12

|  |   |  |
|--|---|--|
| <b>Location:</b>   | Downstream of fence crossing channel                          |  |
| <b>Start Point GPS:</b> H6060 8173   | <b>Start Point Features:</b> Upstream of the 3 Sycamore trees |  |
| <b>End Point GPS:</b> H6055 8176   | <b>End Point Features:</b> Downstream of ash tree             |  |
| <b>Approximate distance (m):</b> 70m   |   |  |
| <b>Presence of fine sediments:</b> Small cobble and coarse grain sand  |   |  |
| <b>Filamentous algae:</b> None recorded  |   |  |
| <b>Total no. live mussels during 2011:</b> 1,100   | <b>Estimated mussels density:</b> 4.0 mussels/m <sup>2</sup>  |  |
| <b>No. of dead shells 2011:</b> 12   |   |  |
| <b>Issues/Comments:</b> <i>Ranunculus</i> present. > 50% of mussels were found in sand under <i>Ranunculus</i> . |   |  |

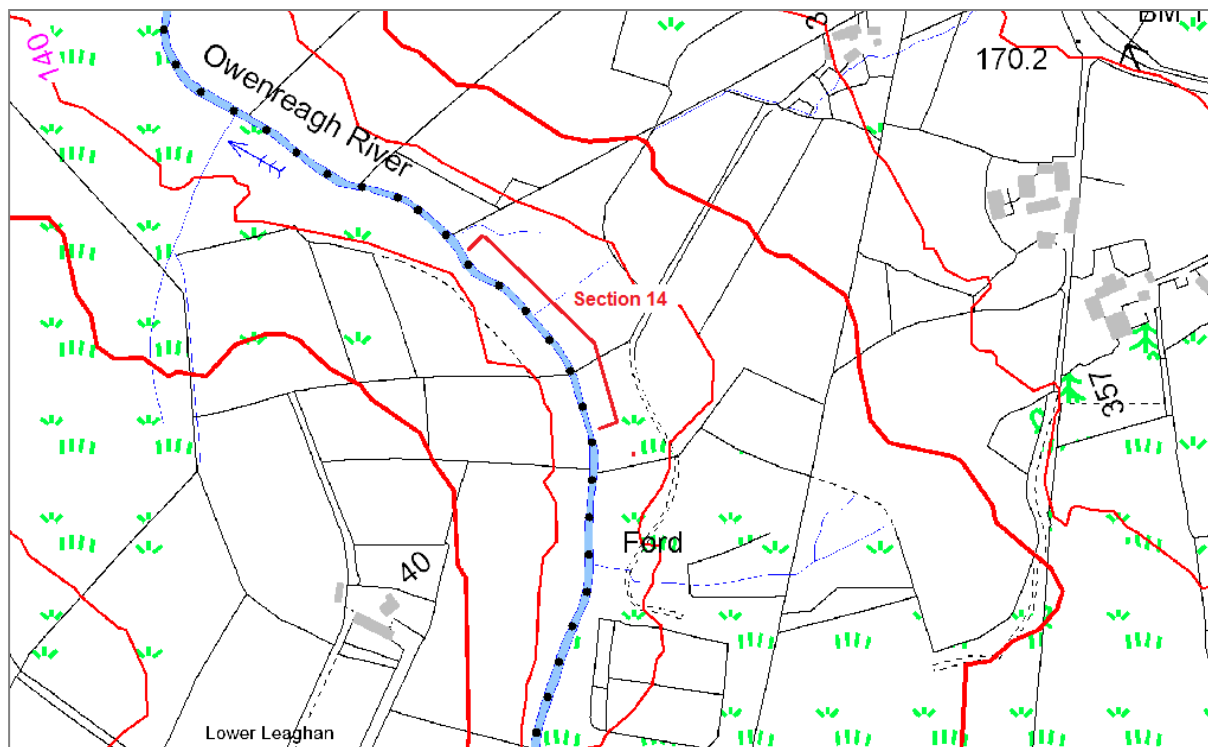


## Owenreagh proposed ASSI – Section #13



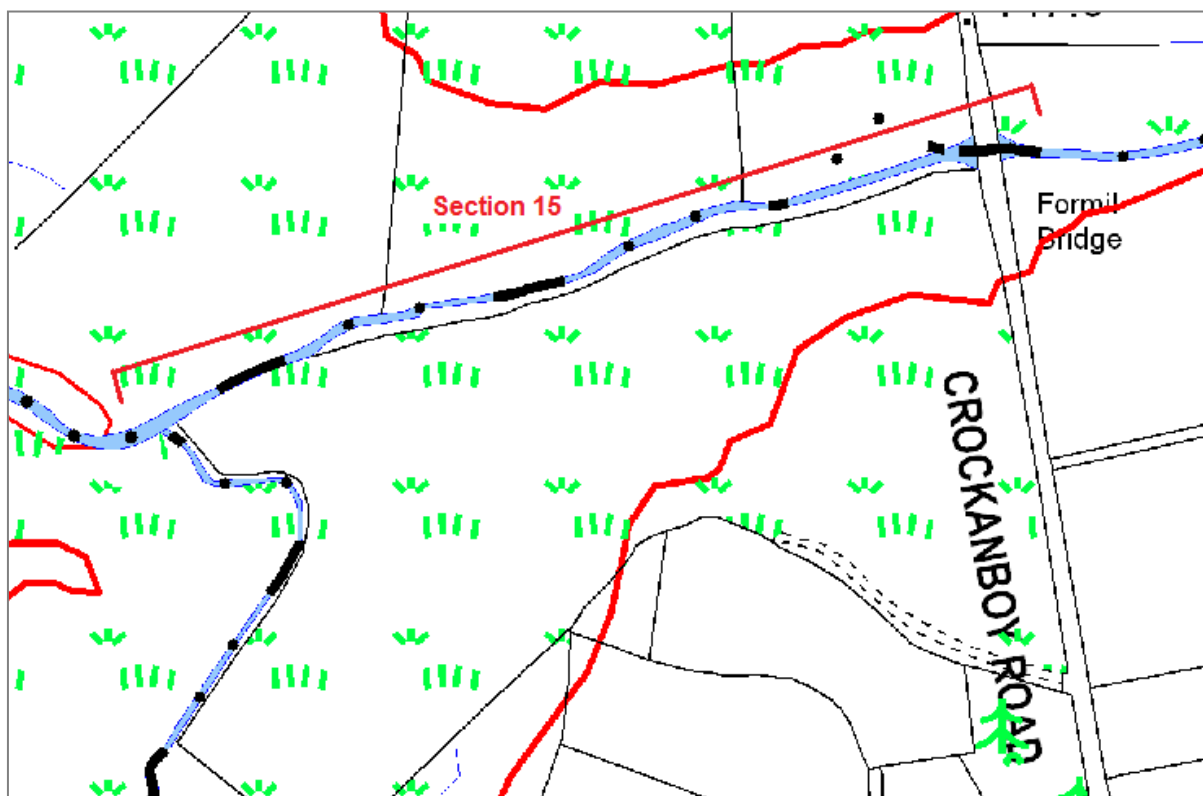
|   |   |  |
|---|---|--|
| <b>Location:</b>  | Downstream of fence crossing channel  |  |
| <b>Start Point GPS:</b> H6092 8147  | <b>Start Point Features:</b> Downstream of fence crossing channel and upstream from weed growth |  |
| <b>End Point GPS:</b> H6086 8162  | <b>End Point Features:</b> Bend in the river channel  |  |
| <b>Approximate distance (m):</b> 150m   |   |  |
| <b>Presence of fine sediments:</b> Small cobble and coarse grain sand   |   |  |
| <b>Filamentous algae:</b> None recorded   |   |  |
| <b>Total no. live mussels during 2011:</b> 353  | <b>Estimated mussels density:</b> 0.59 mussels/m <sup>2</sup>                                   |  |
| <b>No. of dead shells 2011:</b> 4   |   |  |
| <b>Issues/Comments:</b> Cattle can access the river from right bank. Two broken shells were found, probably the result of cattle access. No fence along right side. Repaired fence on left. |   |  |

### Owenreagh proposed ASSI – Section #14



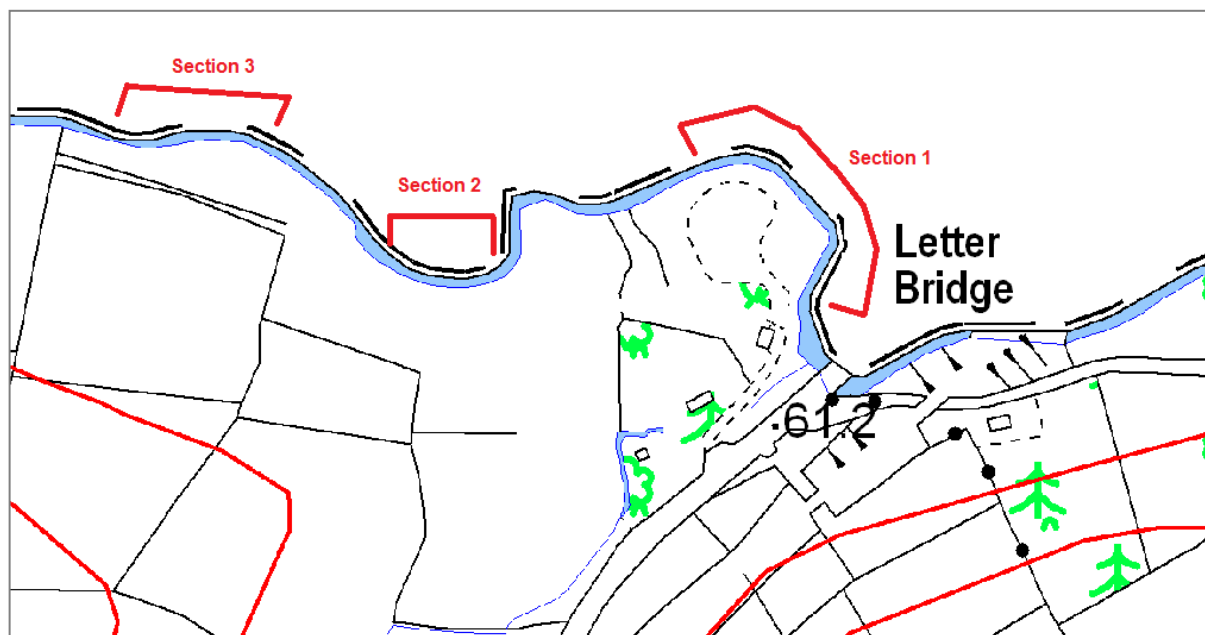
|   |  |  |
|---|--|--|
| <b>Location:</b>  | Downstream of ford   |  |
| <b>Start Point GPS:</b> H6132 8109  | <b>Start Point Features:</b> Site of old foot bridge at end of lane    |  |
| <b>End Point GPS:</b> H6123 8121  | <b>End Point Features:</b> Fence across channel downstream of ash tree |  |
| <b>Approximate distance (m):</b> 140m   |  |  |
| <b>Presence of fine sediments:</b> Largely cobble, boulder and sand   |  |  |
| <b>Filamentous algae:</b> None recorded   |  |  |
| <b>Total no. live mussels during 2011:</b> 233  | <b>Estimated mussels density:</b> 0.417 mussels/m <sup>2</sup>         |  |
| <b>No. of dead shells 2011:</b> 7   |  |  |
| <b>Issues/Comments:</b> <i>Ranunculus</i> present. No fences upstream of land on right bank. Fence downstream on right bank. No fence downstream of land on left bank. Fence on left bank upstream of lane. |  |  |

### Owenreagh proposed ASSI – Section #15



|   |   |  |
|---|---|--|
| <b>Location:</b>  | Downstream of Formil Bridge   |  |
| <b>Start Point GPS:</b> H6186 8072  | <b>Start Point Features:</b> Formil Bridge  |  |
| <b>End Point GPS:</b> H6150 3806  | <b>End Point Features:</b> Pine trees downstream of the confluence with the tributary |  |
| <b>Approximate distance (m):</b> 320m   |   |  |
| <b>Presence of fine sediments:</b> Largely boulders, cobble, coarse grain sand and bedrock  |   |  |
| <b>Filamentous algae:</b> None recorded   |   |  |
| <b>Total no. live mussels during 2011:</b> 0  | <b>Estimated mussels density:</b> 0 mussels/m <sup>2</sup>                            |  |
| <b>No. of dead shells 2011:</b> 0   |   |  |
| <b>Issues/Comments:</b> An elderly lady who lives upstream of Formil Bridge said she remembers mussels there but not any more. This is probable as no mussels were found in Stretch 15. No fence on right bank. |   |  |

### Waterfoot proposed ASSI – Sections #1-3



### Waterfoot non-SAC – Sections #1

|  |  |  |
|--|--|--|
| <b>Location:</b>                                     | Upstream of Letter Bridge                                |  |
| <b>Start Point GPS:</b> H0848 6517                   | <b>Start Point Features:</b> Letter Bridge               |  |
| <b>End Point GPS:</b> H0843 6522                     | <b>End Point Features:</b> Drain flowing in on left bank |  |
| <b>Approximate distance (m):</b> 60m                 |  |  |
| <b>Presence of fine sediments:</b> No plume from bed |  |  |
| <b>Filamentous algae:</b> <10%                       |  |  |
| <b>Total No. Live Mussels Counted 2011:</b> 107      |  |  |
| <b>No. of dead shells 2011:</b> 0                    |  |  |
| <b>Issues/Comments:</b> None                         |  |  |

### Waterfoot proposed ASSI – Sections #2

|  |  |  |
|--|--|--|
| <b>Location:</b>                                     | 150m upstream of Letter Bridge                                   |  |
| <b>Start Point GPS:</b> H0834 6518                   | <b>Start Point Features:</b> 10m downstream of large fallen tree |  |
| <b>End Point GPS:</b> H0830 6519                     | <b>End Point Features:</b> Riffle at bend                        |  |
| <b>Approximate distance (m):</b> 60m                 |  |  |
| <b>Presence of fine sediments:</b> No plume from bed |  |  |
| <b>Filamentous algae:</b> <10%                       |  |  |
| <b>Total No. Live Mussels Counted 2011:</b> 183      |  |  |
| <b>No. of dead shells 2011:</b> 0                    |  |  |
| <b>Issues/Comments:</b> None                         |  |  |

### Waterfoot proposed ASSI – Sections #3

|  |  |  |
|--|--|--|
| <b>Location:</b>                                     | 250m upstream of Letter Bridge   |  |
| <b>Start Point GPS:</b> H0824 6523                   | <b>Start Point Features:</b> Riffle downstream of start of native woodland |  |
| <b>End Point GPS:</b> H0819 6523                     | <b>End Point Features:</b> 10m upstream of old fallen tree                 |  |
| <b>Approximate distance (m):</b> 50m                 |  |  |
| <b>Presence of fine sediments:</b> No plume from bed |  |  |
| <b>Filamentous algae:</b> <10%                       |  |  |
| <b>Total No. Live Mussels Counted 2011:</b> 116      |  |  |
| <b>No. of dead shells 2011:</b> 0                    |  |  |
| <b>Issues/Comments:</b> See sketch map               |  |  |

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Our aim is to protect, conserve and promote the natural and built environment for the benefit of present and future generations.