

SURVEY OF THE  
DISTRIBUTION OF FRESH-  
WATER PEARL MUSSELS  
*Margaritifera margaritifera* L.  
IN NORTHERN IRELAND

Report to the Environment and Heritage Service

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## 1 SUMMARY

*Margaritifera margaritifera* is listed as vulnerable in the 1990 IUCN Red List of Threatened Animals (Young, 1991) and is included in Annex III of the 1979 Berne Convention of European Wildlife and Natural Habitats which requires that their exploitation be subject to a management plan. Annexes II and V of the EU Habitats and Species Directive (1991) respectively provide protection of the habitat of *M. margaritifera* and require member states to regulate its exploitation.

This report presents the results of a survey of the freshwater pearl mussel in Northern Ireland. Out of a total of 73 sites surveyed, 20 sites have been identified as harbouring live mussels. Densities of mussels varied between 0.02 m<sup>-2</sup> and 2.26 m<sup>-2</sup>. Estimated population size at sites ranged between <10 to 1120 individuals. The highest densities of mussels were recorded at site 52 on the Swanlinbar River (Grid Ref. H235 298), site 29 on the Broughderg Burn (Grid Ref. H626 837) and site 4 on the Ballinderry River (Grid Ref. H748 792). It is recommended that these sites are designated as ASSIs.

The main causes for the disappearance of *M. margaritifera* throughout its range are: water pollution; habitat disturbance; overfishing and decreasing abundance of host fish. Threats to *M. margaritifera* in Northern Ireland include deteriorating water quality, pearl fishing and habitat disturbance such as gravel removal and the creation of cattle wades.

Possible methods of restoration and conservation of pearl mussels include: protection of the remaining populations; reintroduction of adult specimens; semi-artificial propagation under natural conditions; and artificial culture. Although other methods may become feasible in future, the only realistic option in Northern Ireland at present is the protection of key populations. The efficacy of such an approach, which is dependent on effective legislation, can only be assessed by careful monitoring. In this context, detailed baseline data were collected for the sites with the highest densities (above) and at site 42 on the Colebrooke River (Grid Ref. H325 387) where there is possibly a hard-water form of *M. margaritifera*. These four sites are the locations where *M. margaritifera* has the most likely chance of survival and should be monitored annually in future.

The database on mussel distribution could be expanded very effectively, at little cost, by circulating an information request form through the channel of local groups such as anglers and by a full Province-wide survey every five years.



## 2 INTRODUCTION

*Margaritifera margaritifera* is listed as vulnerable in the 1990 IUCN Red List of Threatened Animals (Young, 1991) and is included in Annex III of the 1979 Berne Convention of European Wildlife and Natural Habitats which requires that their exploitation be subject to a management plan (Woodward, 1994). Annexes II and V of the EU Habitats and Species Directive (1991) respectively provide protection of the habitat of *M. margaritifera* and require member states to regulate its exploitation. In Great Britain, it is an offence to kill or injure freshwater mussels except under licence or in exceptional circumstances. In the Republic of Ireland, legislation protects freshwater pearl mussels and their habitat and a licence is required to handle mussels. However, in Northern Ireland, the Wildlife (Northern Ireland) Order, 1985, simply makes it illegal to trade in live or dead specimens and even this legislation may not apply to by-products of mussels, such as pearls (Allen, *pers comm.*).

*M. margaritifera* occurred in great numbers in rivers in Northern Ireland according to historical accounts collated by Mackie and Roberts (1995). A survey of the main rivers in Northern Ireland (Mackie and Roberts, 1995) showed that *M. margaritifera* no longer occurs at many of its former localities and where it does occur, populations are small. The survey (Mackie and Roberts, 1995) included only rivers which were greater than 8 m in width. Since then, several new sites, four of which were on rivers less than 8 m in width, have been found to harbour freshwater pearl mussels (Allen, *pers. comm.*; Mackie, 1995).

The present survey was carried out to evaluate the distribution and status of freshwater pearl mussels in rivers of less than 8 m in width in Northern Ireland in the light of the recent observations above. An additional aim was to evaluate changes which may have taken place at sites found to harbour *M. margaritifera* in the most recent surveys by examining these sites again. Specific aims were to:

- map the distribution of freshwater pearl mussels in Northern Ireland
- describe the status of existing populations of pearl mussels in Northern Ireland
- make recommendations on the conservation of freshwater pearl mussels in Northern Ireland, including the identification of sites meriting ASSI designation to protect the species
- draw up a monitoring programme for freshwater pearl mussels in Northern Ireland and carry out any baseline monitoring required over and above the initial survey work

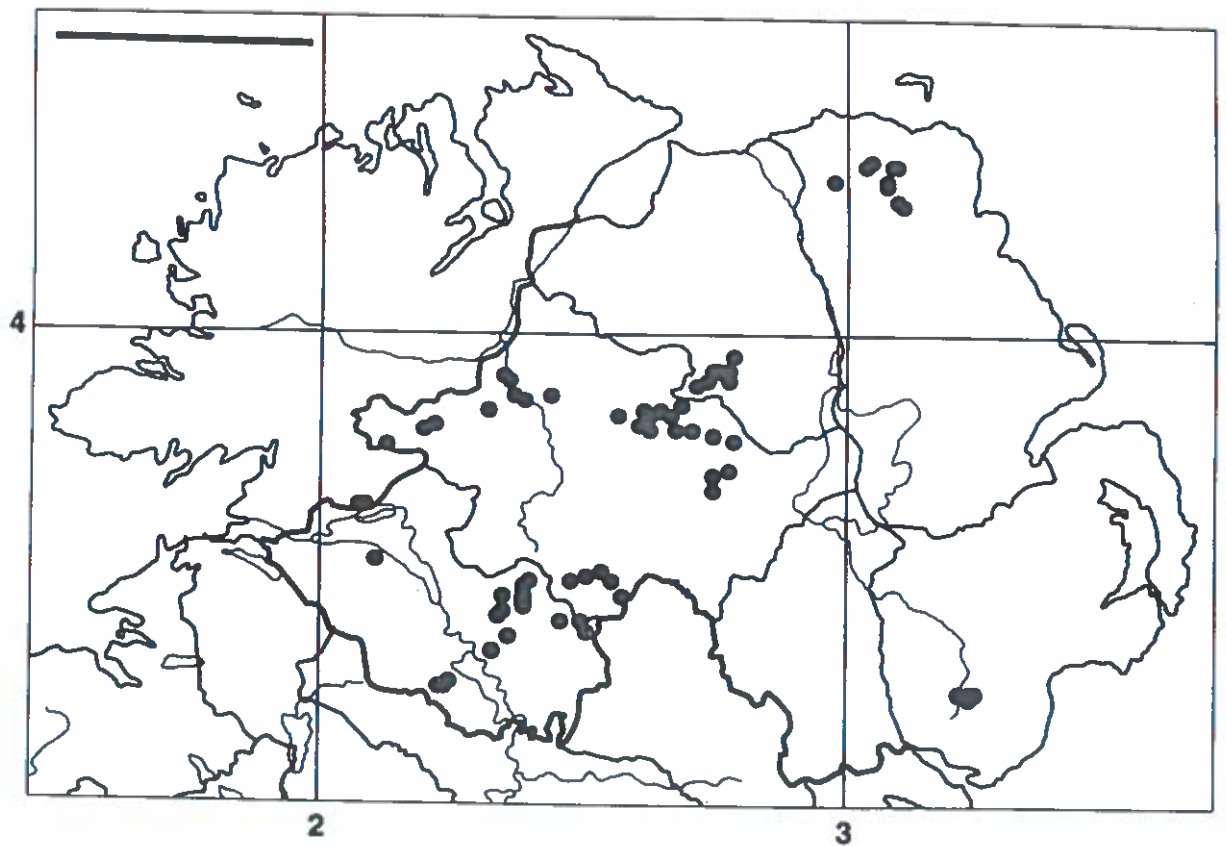


Figure 1. Distribution of the 73 sites in Northern Ireland surveyed for *M. margaritifera* during the present study (1996). Scale bar on upper left = 40 km.



## 3 METHODS

### 3.1 Initial survey

#### 3.1.1 Catchment selection

All catchments from which *M. margaritifera* has been previously recorded were surveyed. Rivers which have not been surveyed before were identified from a map study. These include rivers and streams between 2 and 8m in channel width. Fieldwork was divided into manageable work loads according to the major river catchments and concentrated on the Foyle catchment in the north-west, the L. Erne catchment in the south-west, and selected rivers in the north-east and south-east (Appendix I).

#### 3.1.2 Site selection

A total of 73 sites from all the major catchments in Northern Ireland were surveyed for *M. margaritifera* between July and September 1996 (Appendix I, Figure 1). Sites on rivers that had been identified in previous reports (Mackie, 1995; Mackie and Roberts, 1995) as having mussels were surveyed to provide a comparison between the present and previous status of the population. Other potential sites were chosen from a map study to ensure adequate coverage of all rivers likely to harbour freshwater pearl mussels (Figure 1). With the permission of the Environment and Heritage Service, distribution and abundance data on *M. margaritifera*, obtained during the present survey, were lodged with the Centre for Environmental Data and Recording (CEDaR) at the Ulster Museum on the understanding that the data would be subject to the strictest confidentiality.

#### 3.1.3 Sampling strategy within sites

The methodology recommended by Young (1995a, 1995b) for surveying and monitoring Scottish populations of freshwater pearl mussels was adopted as it was felt that physical conditions in Scottish rivers were similar to those in Northern Ireland and that it is desirable to have comparable datasets from countries where *M. margaritifera* exists by means of the use of standard techniques.

For adult mussels, a general assessment of the site and the substratum type was made by walking the bank. This also allowed a quick search for empty shells. Searching for mussels in the river bed began where the substratum was considered suitable for pearl mussels, usually a mixture of cobble and sand or gravel. A perspex bottomed box was used to view the river bed in water shallow enough for wading in. Searching proceeded in an upstream direction so that

disturbed sediment did not reduce visibility. Particular attention was paid to the lee of cobbles and boulders. In the absence of mussels, searching continued for 2 man-hours within a 500m radius before a negative result was reported. Where mussels were located, a single transect 50m long by 1m wide was placed across the mussel bed, searched and all mussels counted within this transect. A sample of up to 50 mussels was measured for shell length. At 10 and 30 m on the 50 m survey transect for adults, a 1 X 1 m quadrat was searched for juvenile mussels (shell less than 30 mm in length) by removing large stones and debris and examining the exposed sand and gravel.

#### **3.1.4 Biological water quality**

Kick samples for other macroinvertebrates were taken at 57 sites. Three replicates, each taken over a period of three minutes, were collected. Macroinvertebrates were identified to family level and Biological Monitoring Working Party (BMWP) scores and Average Score Per Taxon (ASPT) values were calculated for each site.

#### **3.1.5 Additional recording**

The following data were recorded on the data sheet (Appendix II):

Site name and six figure Grid Reference

Date and name of surveyors

Time of survey, brief details of prevailing weather conditions

Approximate width and depth of river (Appendix III)

Approximate description of substratum type (Appendix IV)

Unusual features within the river

Human disturbance

Bankside vegetation character and Land use [River Habitat Survey (Environment Agency, 1996) categories]

### **3.2 Baseline monitoring**

#### **3.2.1 Site selection**

Following the initial survey, four sites were chosen for the purpose of monitoring freshwater pearl mussels in Northern Ireland (Appendix V). The selection of these sites follows the recommendations of Young (1995a) for monitoring freshwater pearl mussels in Scotland. Young (1995a) recommends that sites are (i) spread geographically throughout the mussel's range and (ii) are representative of a range of different states and conditions to include rivers

of different sizes, rivers used regularly by pearl fishermen and those where juveniles have been reported.

Sites were chosen to include those with the highest densities recorded in the present survey and represent a range of water hardness conditions. For example, some of the highest densities of mussels in Northern Ireland are found at the Swanlinbar (Plate 1A, B) and Broughderg Burn sites. At the Colebrooke site, *M. margaritifera* occurs with *Anodonta* sp. and *Austropotamobius pallipes*. The possibility of juveniles occurring at the Broughderg Burn site has been raised by Mackie (1995) and mussels between 41 and 55 mm were found during the present study at the Swanlinbar site. The Colebrooke and Swanlinbar sites have been fished in the past and the latter site has been fished as recently as 1995. Finally, large and small rivers are represented by the chosen sites.

The Northern Ireland recommended monitoring sites are as follows:

River	Grid Reference	Location name	Survey Ref. No.
A. Ballinderry R.	H748 792	Wellbrook Mill	4
B. Broughderg Burn	H626 837	Crouck Br.	29
C. Swanlinbar R.	H235 298	nr. Drumroosk	52
D. Colebrooke R.	H352 387	nr. Maguiresbridge	42

### 3.2.2 Sampling strategy

The methodology adopted follows that recommended by Young (1995a) for monitoring freshwater pearl mussels in Scotland (section 3.1.3 above).

For adult mussels, at each site, up to five 50 X 1 m transects were made beginning a suitable distance from an identifiable marker point such as a bridge. The orientation of the river banks was determined by facing downstream and labelling the banks left and right respectively. This convention was adopted for all recommended monitoring sites. The transects were arranged across the width of the river such that the area of substratum beside at least one bank was sampled. Transects were also arranged around the central part of the river as far as was practical. A perspex bottomed box was used to view the river bed in water shallow enough for wading in. Searching proceeded in an upstream direction so that disturbed sediment did not reduce visibility. The number of adult mussels occurring in each quadrat was recorded. The presence of juvenile mussels was investigated at 10 and 30 m on the 50 m transect as described in section 3.1.3 above.

### **3.2.3 Site description**

A sketch map was made of each site detailing the co-ordinates of the transects (Appendix V). For future reference, photographs were taken at three sites, at a point close to the first transect, to include the marker point and a 1 X 1 m quadrat for scale (Appendix VIA-C). Site 42 was not photographed during the present survey.

### **3.2.4 Additional recording**

The following data were recorded on the data sheet (Appendix VII):

Name of river

Six figure Grid Reference of monitoring site

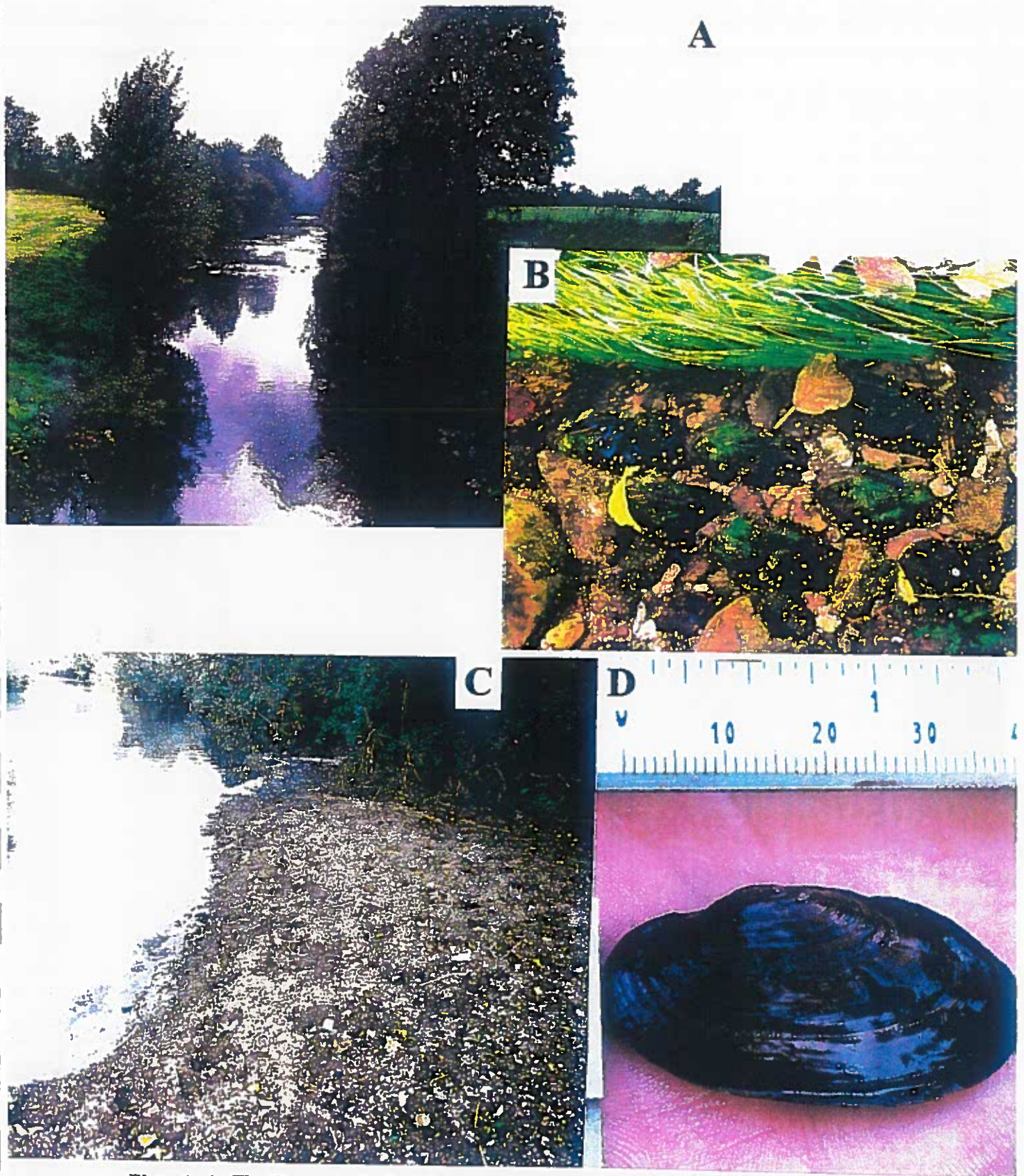
Identity of marker point

Co-ordinates of transect 1 with reference to marker point

Prevailing weather conditions

Number of mussels in each transect

Sketch Map of site and Photograph



**Plate 1.** A. The Drumroosk site (site no. 52, Grid Ref. H235 298) on the Swanlinar R. where the highest densities of mussels were found during the present survey, B. a section of the river bed at the Drumroosk site in which a cluster of mussels is visible, C. evidence of cattle wading in the shallow water at the Stragowna Br. site (site no. 53, Grid Ref. H242 302) on the Swanlinbar R. where many shells were found, D. a young mussel found at the Drumroosk site, this individual is about 40 mm long.



## 4 RESULTS

### 4.1 Initial Survey

#### 4.1.1 Previous records and current distribution of *M. margaritifera* in Northern Ireland.

Previous records of the distribution of *M. margaritifera* in Northern Ireland are reported in Roberts and Mackie (1993) which outlines historical data and describes a comprehensive survey of larger rivers, carried out between 1990 and 1991 (Figure 2). The results of the present survey are shown in Figure 3. Living freshwater pearl mussels were found in 8 river systems at 20 of the 73 sites surveyed between July and September 1996.

Records of live mussels have increased over the past few years as a result of greater sampling effort in the field. The current distribution of *M. margaritifera* in Northern Ireland is restricted to the Foyle, Ballinderry and L. Erne catchments. Comparing Figures 2 and 3, the number of records of live *M. margaritifera* have increased for the region between L. Neagh and the Foyle and for the L. Erne catchment. Records of live *M. margaritifera* from the main Foyle channel have decreased since Roberts and Mackie's (1993) report. For example, of 6 sites on the Strule/Mourne river which were found to contain living mussels during the previous survey, only two sites were confirmed to have living mussels during the 1996 survey.

#### 4.1.2 Status of *M. margaritifera*

Mean mussel density and estimated population size for each site are given in Table 1. The highest densities of mussels are from sites on the Swanlinbar R. in the L. Erne catchment. At most sites, mussel densities were below  $1 \text{ m}^{-2}$ , except for the Drumroosk site on the Swanlinbar and the Wellbrook site on the Ballinderry (Table 1). At the Crouck Br. site on the Broughderg Burn, mean mussel density was  $0.74 \text{ m}^{-2}$ . Figure 4 shows the number of mussels in 50 X 1 m transects at each site. Clearly, the Swanlinbar sites are the most significant in terms of abundance in Northern Ireland. Other important sites are found in the eastern part of the Foyle catchment (Figure 4).

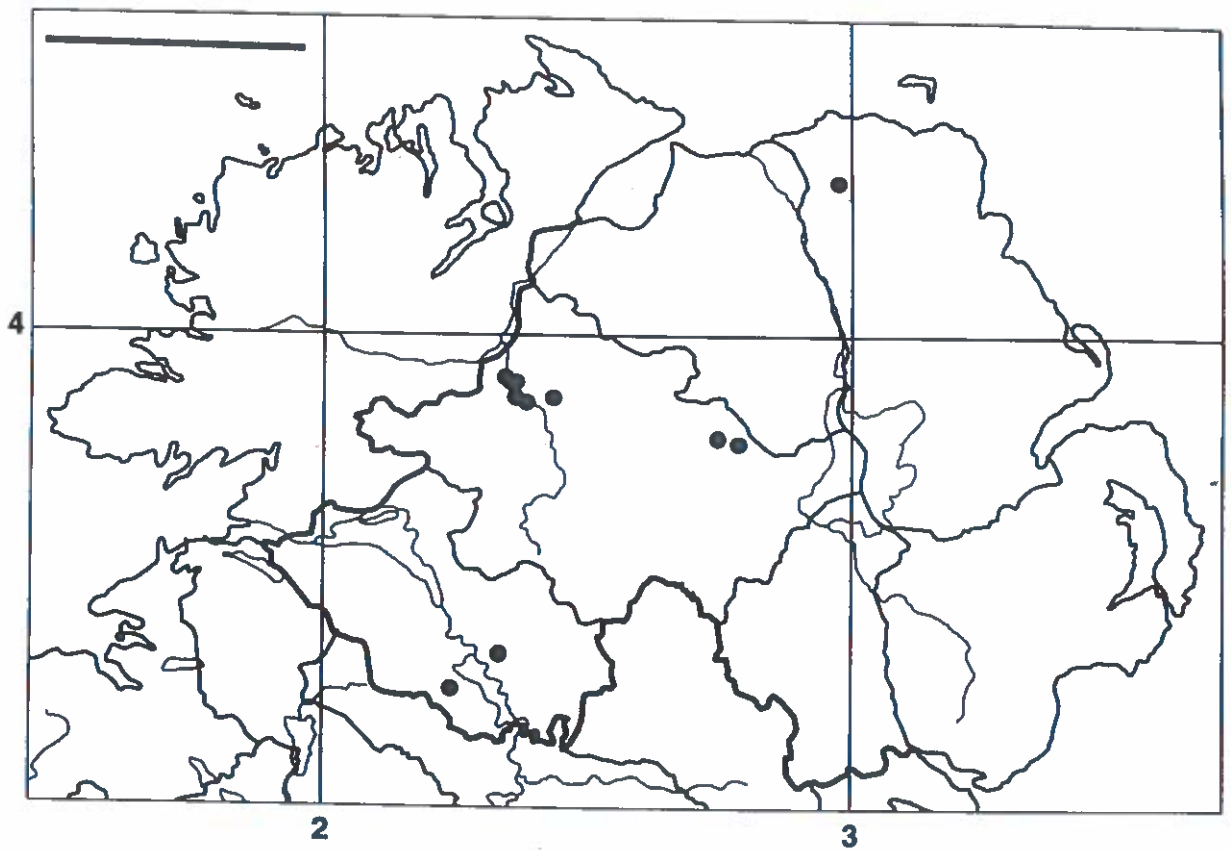


Figure 2. Records of live *M. margaritifera* in Northern Ireland from sites surveyed between 1990-1991 (Mackie, 1992) mapped as six figure Grid References. Scale bar on upper left = 40 km.

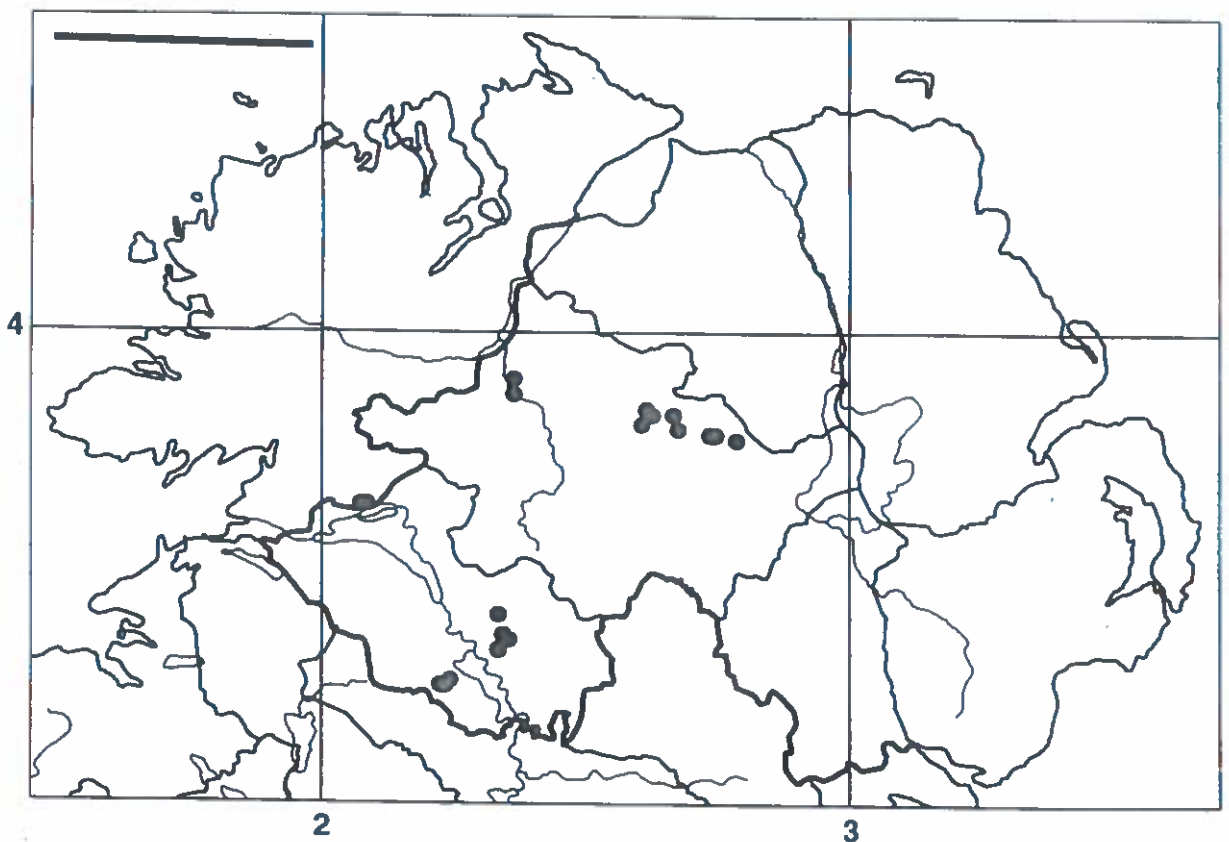


Figure 3. Sites found to contain living *M. margaritifera* during the present study (1996) mapped as six figure Grid References. Scale bar on upper left = 40 km.



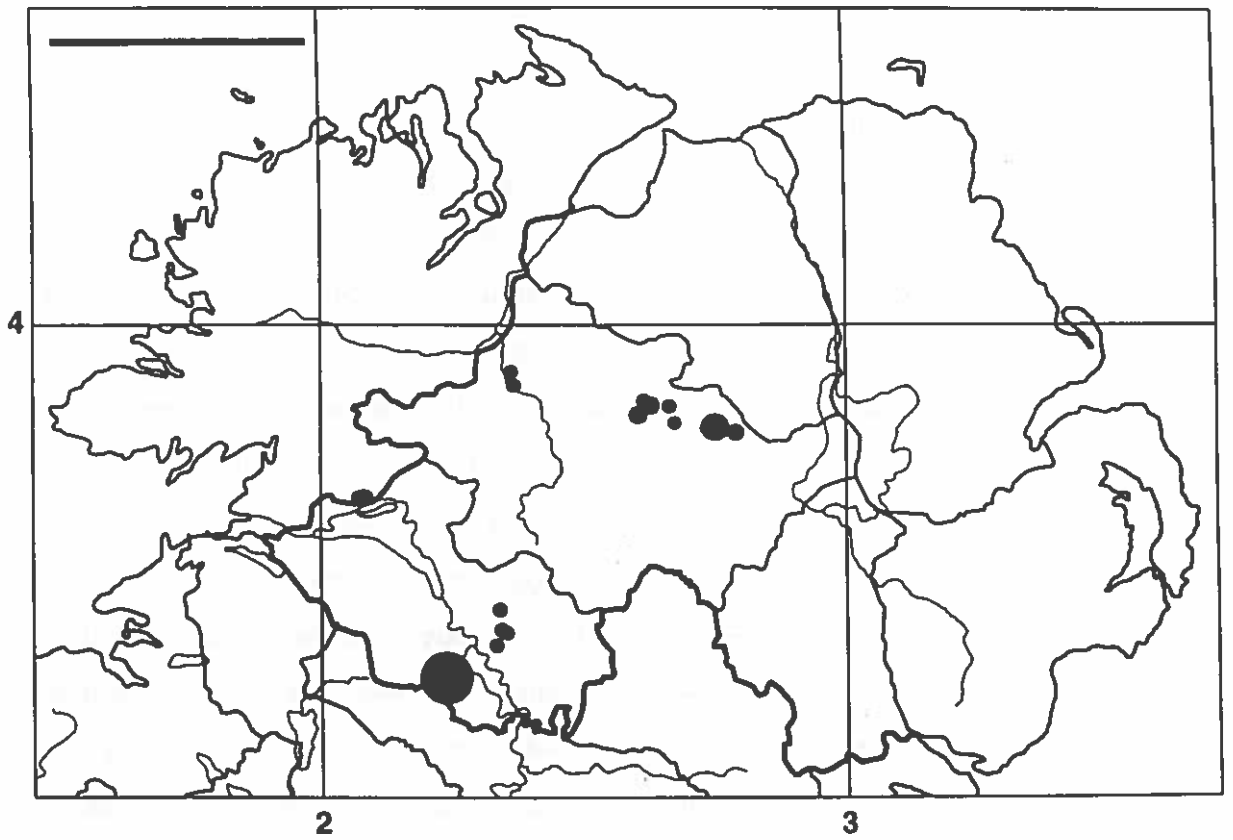


Figure 4. Sites found to contain living *M. margaritifera* during the present study (1996) mapped as six figure Grid References. The diameter of the circle represents the number of mussels found in a 50 X 1 m transect at each site. The diameter of the largest circle (bottom left of map) represents 113 individuals. Scale bar on upper left = 40 km.

Values of mean length of mussels from each site are listed in Table 2. Mean length tends to be greater among mussels from sites on rivers from the Foyle catchment (Mourne, Broughderg Burn, Owenreagh) and the Ballinderry R. than among mussels from sites on rivers from the L. Erne catchment (Tempo, Swanlinbar, Waterfoot and Colebrooke). However, the number of mussels measured was low at many sites.

The distribution of shell lengths of living mussels and empty shells in mussel rivers in Northern Ireland are given in Figure 5a-h. In the Mourne, Colebrooke and Tempo rivers, few living mussels were found and therefore it was not possible to construct a useful mussel size frequency distribution in these rivers. However, in the Ballinderry, Broughderg Burn, Owenreagh, Waterfoot and Swanlinbar rivers, sufficient numbers of living mussels were found. No mussels smaller than 40 mm in length were found during the present study. A single mussel of 40 mm was found at the Drumroosk site on the Swanlinbar River. Numbers of empty shells found at each site are listed in Table 2. Large numbers of empty shells were found at the Stragowna Br. site on the Swanlinbar R., a site where there is evidence of cattle wading in the river (Plate 1C), at the Ballindarragh Br. site on the Colebrooke and at the Killashanbally site on the Tempo River. Elsewhere numbers of empty shells were less than 15 at each site. Greater numbers of empty shells than those of living mussels occur in most size classes of mussel in the Colebrooke, Tempo and Swanlinbar rivers (Figure 5e, f and h).

#### 4.1.3 Habitat

Habitat data relating to the physical characteristics of each site are listed in Appendices III and IV. This information is intended to be descriptive and complementary to the results of the mussel survey and will not be discussed further.

#### 4.1.4 Biological Water Quality

BMWP water quality scores, related ASPT values and the number of invertebrate families found in kick samples at 57 sites, including all mussel sites, are listed in Table 3. At mussel sites, BMWP scores vary between 42 and 96 whereas at non-mussel sites, scores vary between 33 and 130. ASPT values range from 3.81 to 6.00 at mussel sites, whereas values at non-mussel sites vary between 4.6 and 6.5. ASPT values are of greater use than BMWP scores when comparing biological water quality at sites because ASPT values take into account variation in sample size. With BMWP scores, the larger the sample, the greater the score. Ideally, biological scores should be independent of sample size.

ASPT values were below 5.5 at 17 out of 57 sites. Significantly, ASPT values at all the sites, including mussel sites, on the Strule/Mourne river were below 5.5. Similarly on several other mussel rivers, including the Ballinderry, Owenreagh, Colebrooke and Waterfoot, ASPT values were below 5.5 at some sites. On the Ballinderry R., the smallest ASPT value occurred at the only site where mussels were not found (Table 3). In contrast, on the Owenreagh and Colebrooke rivers, ASPT values were greater at sites where no mussels were found than at sites where they did occur (Table 3). All sites on the Waterfoot R. contained mussels but at one site, near Knocknamona, the ASPT value of 4.5 was lower than those at the other two sites (Table 3). ASPT values were greater than 5.5 at all sites on the Broughderg Burn, Tempo and Swanlinbar rivers. ASPT values at mussel and non-mussel sites were highest on the Broughderg Burn. On the Tempo and Swanlinbar rivers ASPT were very similar and lower than those on the Broughderg Burn.

**Table 1. Mean mussel density and estimated population size at sites in Northern Ireland**

<b>River</b>	<b>Grid Ref.</b>	<b>Location</b>	<b>Density±s.e. (nos. m<sup>-2</sup>)</b>	<b>Population (nos. individuals)</b>
Ballinderry	H672 803	Teebane Br.	N/A	<10
	H735 793	Corkhill Br.	0.02±0.02	<10
	H748 792	Wellbrook Mill	1.02±0.49	500
	H788 782	Auglish Br.	0.46±0.15	290
Broughderg B.	H662 835	Evishessan Br.	N/A	<10
	H626 837	Crouck Br.	0.74±0.14	300
	H613 847	Monameal	0.02±0.02	<10
Owenreagh	H601 819	opp. Cashel Rock	0.44±0.14	120
Tempo	H338 432	opp. Glundeas Hill	0.02±0.02	<10
	H342 392	Killashanbally	0.04±0.02	20
Mourne	H368 879	Strule/Derg confl.	0.02±0.02	20
	H363 904	Victoria Br. 2	N/A	<10
Swanlinbar	H220 299	nr. Clontelaghan	0.56±0.21	300
	H235 298	nr. Drumroosk	2.26±0.52	1120
	H242 302	Stragowna Br.	0.3±0.09	140
Waterfoot	H073 654	nr. Knocknamona	0.08±0.08	10
	H081 653	nr. Brookhill Hse.	0.37±0.12	120
	H085 652	Letter Br.	0.14±0.06	40
Colebrooke	H352 387	nr. Maguiresbridge	0.16±0.07	140
	H333 362	Ballindarragh Br.	N/A	<10

Table 2. Mean length of shell of live mussels (n = number live mussels measured) and number of empty shells found at sites in Northern Ireland

River	Grid Ref.	Location	Mean Length±s.e. (mm)	n	No. empty shells
Ballinderry	H672 803	Teebane Br.	112±7.6	3	0
	H735 793	Corkhill Br.	103.2±3.6	4	1
	H748 792	Wellbrook Mill	102.4±1.6	51	2
	H788 782	Auglish Br.	96.9±2.0	30	14
Broughderg B.	H662 835	Evishessan Br.	113±14.9	2	1
	H626 837	Crouck Br.	106±1.52	51	0
	H613 847	Monameal	101.66±4.9	3	11
Owenreagh	H601 819	opp. Cashel Rock	112.2±1.4	31	0
Tempo	H338 432	opp. Glundeas Hill	102±8.9	2	3
	H342 392	Killashanbally	83.0±4.0	3	41
Mourne	H368 879	Strule/Derg confl.	115.5±1.2	4	5
	H363 904	Victoria Br. 2	N/A	1	4
Swanlinbar	H220 299	nr. Clontelaghan	98.8±1.8	49	6
	H235 298	nr. Drumroosk	95.5±1.9	50	13
	H242 302	Stragowna Br.	87.8±1.5	34	116
Waterfoot	H073 654	nr. Knocknamona	82.7±1.8	19	0
	H081 653	nr. Brookhill Hse.	83.6±2.09	50	4
	H085 652	Letter Br.	79.2±6.1	9	8
Colebrooke	H352 387	nr. Maguiresbridge	106±2.14	15	5
	H333 362	Ballindarragh Br.	115	2	84

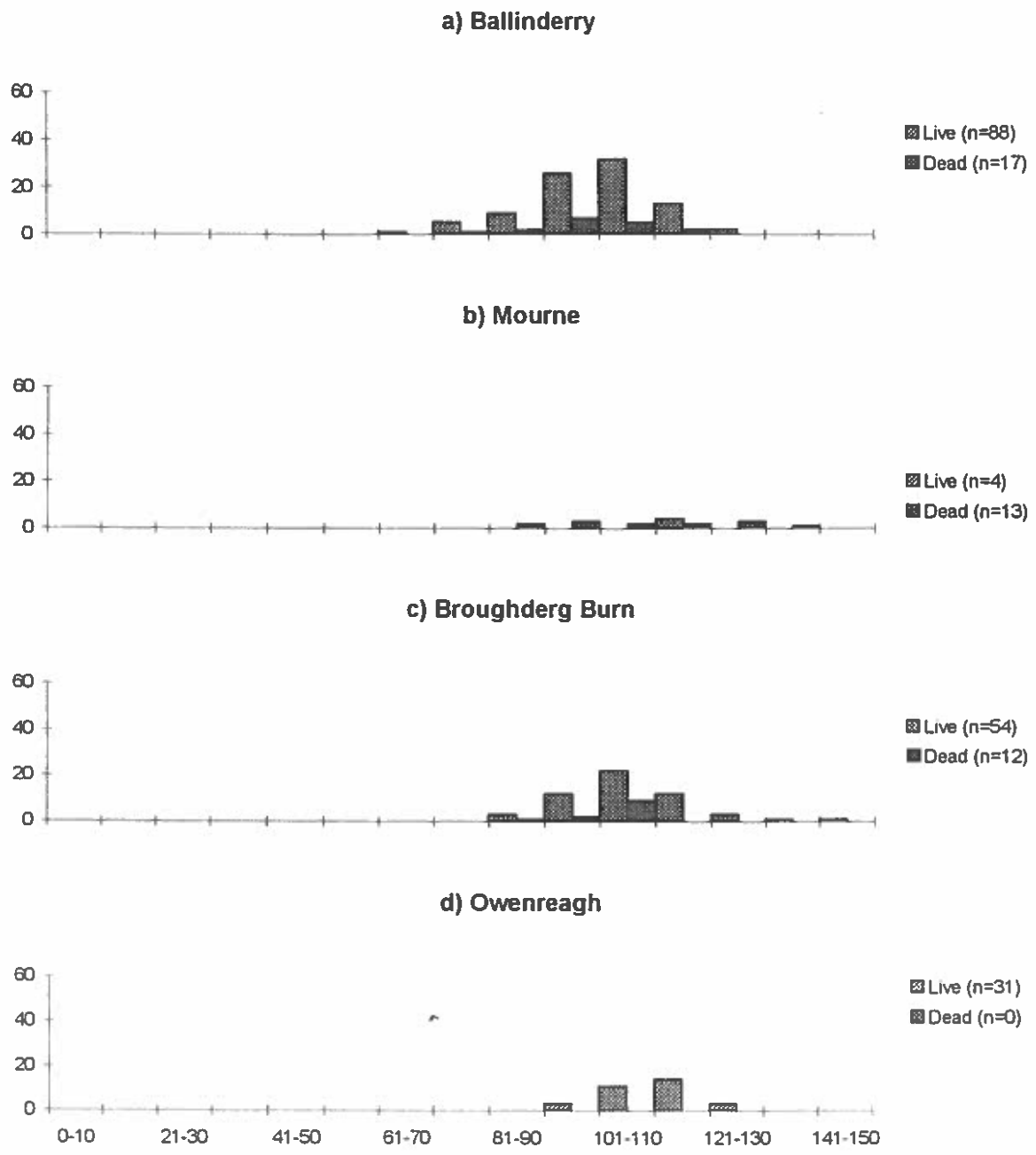


Figure 5a-d. Frequency distribution of shell lengths of living and dead mussels in rivers in Northern Ireland (n refers to the number of individuals measured).

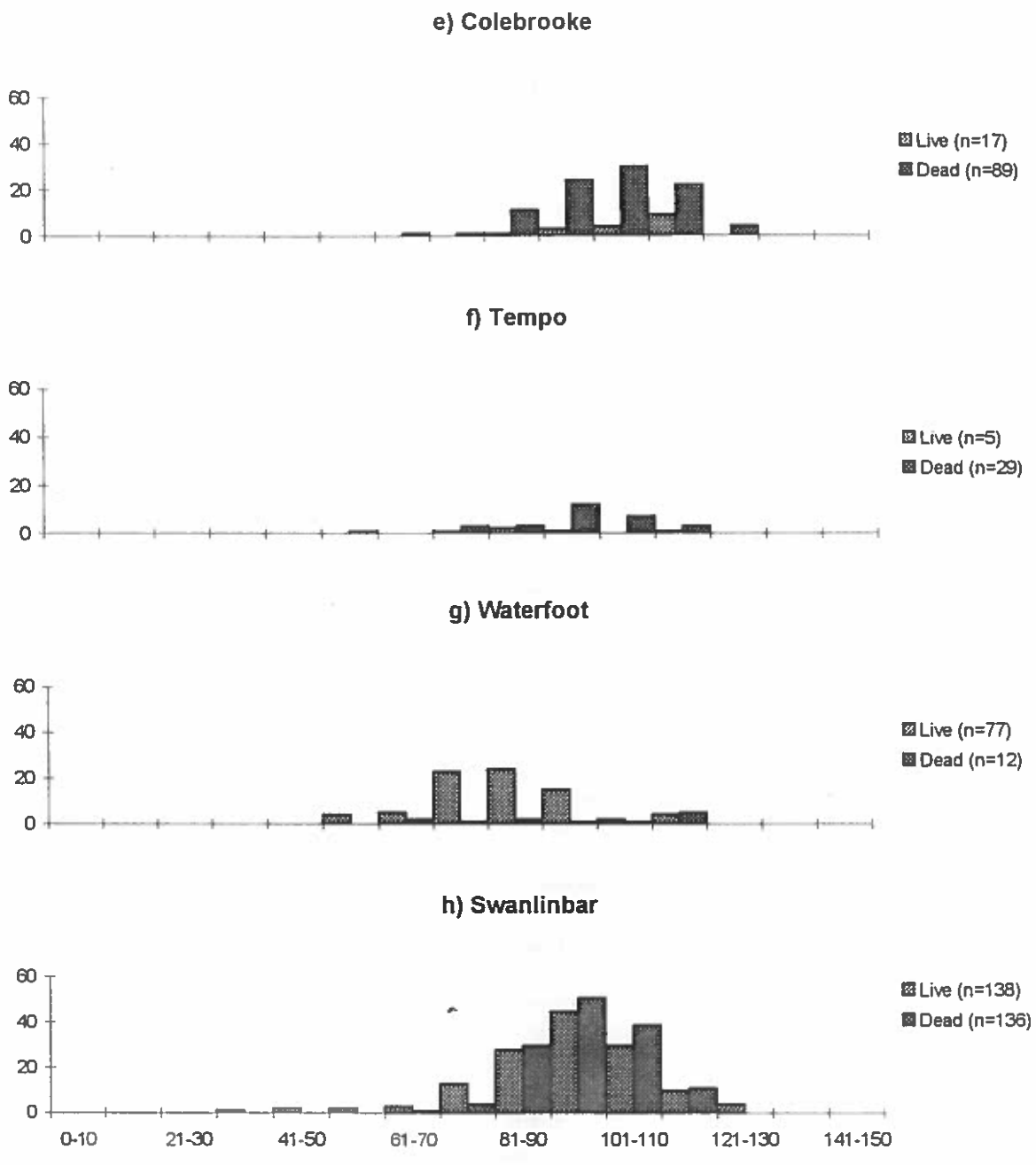


Figure 5e-h. Frequency distribution of shell lengths of living and dead mussels in rivers in Northern Ireland (n refers to the number of individuals measured).

Table 3. Biological water quality indices at 57 sites.

Rivers	Grid Reference	Location	Site No.	BMWP	ASPT	n Families	Mussels
Ballinderry	H672 803	Teebane Br.	1	96	5.64	17	Y
Ballinderry	H705 800	Dunnamore Br.	2	51	5.1	10	N
Ballinderry	H735 793	Corkhill Br.	3	71	5.46	13	Y
Ballinderry	H748 792	Wellbrook Mill	4	78	6	13	Y
Ballinderry	H788 782	Auglish Br.	5	84	5.6	15	Y
Moyola	H715 899	Bealnaslaght Br.	6	58	5.8	10	N
Moyola	H732 906	The Old Church Br.	7	71	6.45	11	N
Moyola	H752 928	nr. Ford	8	65	5.91	11	N
Moyola	H786 956	nr. Mullaghlahan	9	86	6.61	13	N
Blackwater	H479 509	Garlaw Br.	10	46	5.11	9	N
Blackwater	H501 514	nr. Castle	11	N/A	N/A	N/A	N
Blackwater	H532 523	U/s Clogher	12	90	5.29	17	N
Upper Bann	J248 285	opp. Hen Mountain	13	44	5.5	8	N
Upper Bann	J238 289	New Br.	14	130	6.5	20	N
Bush	D102 255	Crockarover	15	77	5.92	13	N
Bush	D097 263	Crockan Br.	16	75	6.25	12	N
Bush	D078 291	Ballyhoe Br.	17	91	6.06	15	N
Bush	D074 304	Seven Acres	18	78	6	13	N
Bush	C978 303	Stroan Br.	19	87	5.8	15	N
Mourne	H368 879	Strule/Derg confl.	20	68	5.23	13	Y
Mourne	H363 904	Victoria Br. 2	21	42	3.81	11	Y
Mourne	H357 905	Victoria Br. 1	22	50	5	10	N
Mourne	H344 912	Seein Br.	23	82	5.12	16	N
Strule	H386 867	Fishfarm	24	82	5.12	16	N
Strule	H369 878	Above Derg confl.	25	77	5.13	15	N
Broughderg Burn	H681 849	D/s Broughderg Br.	26	70	6.36	11	N
Broughderg Burn	H662 835	Evisheasan Br.	27	86	5.73	15	Y
Broughderg Burn	H642 840	nr. Cashel Wood	28	70	5.83	12	N
Broughderg Burn	H626 837	Crouck Br.	29	71	5.91	12	Y
Broughderg Burn	H613 847	Monameal	30	86	5.73	15	Y
Owenkillew	H438 873	Killymore Br.	31	46	4.6	10	N
Owenreagh (O'killew)	H624 805	nr. Tornoge	32	104	5.47	19	N
Owenreagh (O'killew)	H601 819	opp. Cashel Rock	33	73	5.21	14	Y
Owenreagh (O'killew)	H562 836	Aghamirigan Br.	34	65	6.5	10	N
Derg	H125 778	nr. Legvin	35	61	5.54	11	N
Derg	H161 796	nr. Ballyetragh	36	63	5.73	11	N
Derg	H191 806	Aghyaran Br.	37	68	5.66	12	N
Derg	H219 818	nr. Creeduff	38	82	5.12	16	N
Colebrooke	H509 410	opp. Mullaghfad	39	53	5.88	9	N
Colebrooke	H495 423	Glenoo Br.	40	95	5.93	16	N
Colebrooke	H459 429	Tattenabuddagh Br.	41	65	5.9	11	N
Colebrooke	H352 387	nr. Maguiresbridge	42	55	4.58	12	Y
Colebrooke	H333 362	Ballindarragh Br.	43	59	5.36	11	Y
Tempo River	H348 470	nr. Lettan	44	67	5.58	12	N
Tempo River	H341 447	opp. Drumderg	45	90	5.62	16	N
Tempo River	H338 432	opp. Glundeas Hill	46	95	5.58	17	Y
Tempo River	H342 392	Killashanbally	47	74	5.69	13	Y
Waterfoot	H073 654	nr. Knocknamona	48	45	4.5	10	Y
Waterfoot	H081 653	nr. Brookhill Hse.	49	88	5.5	16	Y
Waterfoot	H085 652	Letter	50	60	6	10	Y
Swanlinbar	H220 299	nr. Clontelaghan	51	68	5.66	12	Y
Swanlinbar	H235 298	nr. Drumroosk	52	67	5.58	12	Y
Swanlinbar	H242 302	Stragowna Br.	53	56	5.6	10	Y
Manyburns	H398 505	nr. Camgart	54	33	5.5	6	N
Manyburns	H384 499	nr. Tullyullagh	55	66	5.5	12	N
Manyburns	H384 473	Lwr. Manyburns Br.	56	82	5.86	14	N
Manyburns	H386 459	Coolraghkelly	57	89	5.56	16	N
Manyburns	H388 455	nr. Fort Hill	58	66	5.5	12	N



## 4.2 Baseline Monitoring

### 4.2.1 Numbers of mussels

The numbers of adult mussels found in each transect at each of the recommended monitoring sites are given in Table 4. No juveniles (i.e. mussels less than 30 mm in length) were found at any of the monitoring sites. However, at the Drumroosk site on the Swanlinbar River, several mussels measuring between 41 and 51 mm in length were found. The yellowish brown / khaki colour of the shells of these specimens (Plate 1D) suggest they may be young individuals. The estimated age of these individuals, based on growth studies of mussels in Donegal (Beasley, 1996), would be between 6 and 12 years.

Numbers of empty shells found at each monitoring site are given in Table 4. The greatest number of shells (n=35) was found at the Drumroosk site on the Swanlinbar River. At the other sites, the number of empty shells varied between 1 and 15.

Table 4. Numbers of adult mussels in transects (T) at recommended monitoring sites

Site	River	T1	T2	T3	T4	T5	Total	No. empty shells
4	Ballinderry	50	23	2	0	1	76	15
29	Broughderg B.	57	21	39	/	/	117	1
52	Swanlinbar	157	76	96	218	/	547	35
42	Colebrooke	8	1	0	/	/	9	6

### 4.2.2 Density maps

In order to visualise mussel densities at recommended monitoring sites and to assist future monitoring, diagrammatic maps of the mussel beds sampled are shown in Figures 6A-D. Densities of adults varied between 0 and 218 per 50 m transect and the results show that at many sites, mussels are confined to discrete areas near the banks of the river. At the Wellbrook Mill site on the Ballinderry R., a total of 76 mussels were encountered along five transects. The mussels appear to be confined to an area near the left bank (Figure 6A). Scattered pockets of mussels occur mainly towards the left bank further upstream. Mussels were also present below the mill bridge (Appendix VA). 117 live mussels and a single empty shell were found along three transects taken at the Crouck Br. site on the Broughderg Burn. Live mussels at the Crouck Br. site on the Broughderg Burn appear to occur close to the banks on either side and were also observed downstream of the bridge (Appendix VB). Fewer mussels occur in the central part of the river bed (Figure 6B).

At the Drumroosk site on the Swanlinbar R., mussels appear to be more dense beside the banks than in the central part of the river (Figure 6C). A total of 547 mussels were found along four transects taken at this site. Further upstream, there is a distinct area with few mussels where the substratum emerges and the water is very shallow. At this site small pockets of mussels occurred for at least a further 50 m upstream and also downstream of the farm bridge (Appendix VC). Finally, at the Maguiresbridge site on the Colebrooke R., mussel densities were low. Only 9 adult mussels were found along three transects. Mussels at the Maguiresbridge site on the Colebrooke R. are restricted to a small area near the right bank where they co-occurred with *Anodonta* (Figure 6D).

Figure 6 A-D. Diagrammatic representations of mussel beds at recommended monitoring sites showing numbers of mussels found in individual quadrats. Transects indicated T1, T2 etc. First and final quadrats in each transect indicated as Q1 and Q50 respectively. Mussel frequency class shown by shaded quadrats as follows:

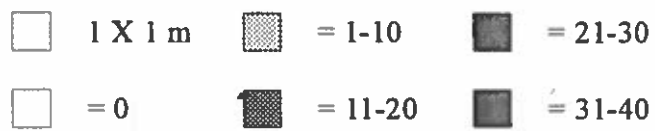


Figure 6 A. Ballinderry R.

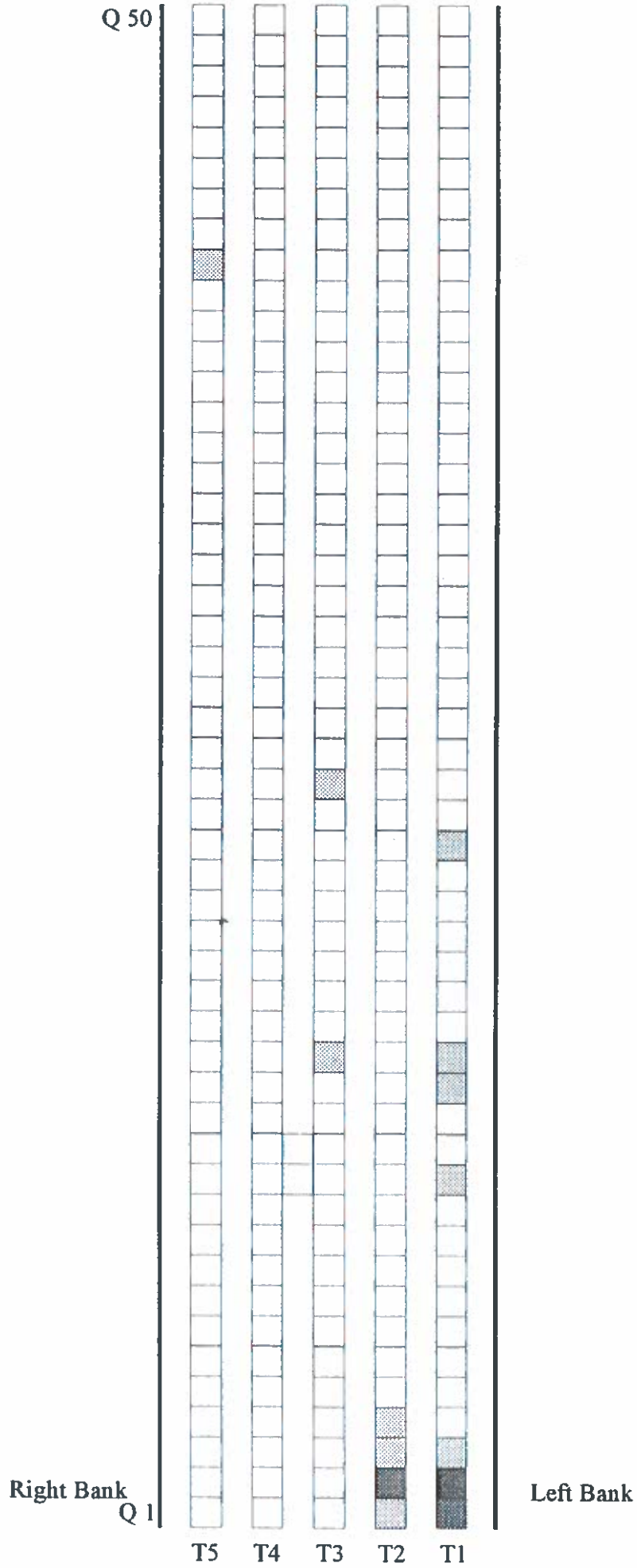


Figure 6 B. Broughderg Burn

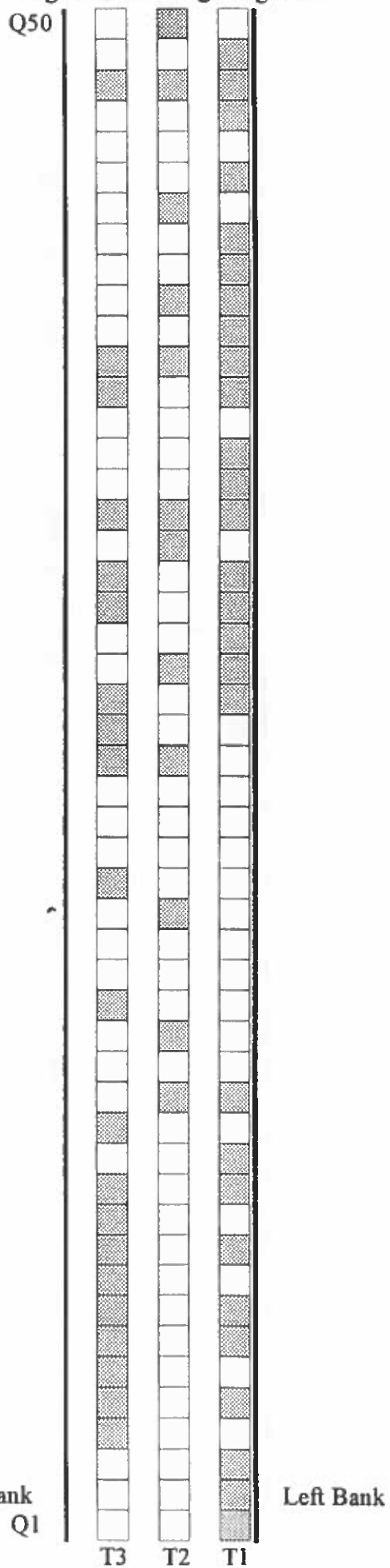
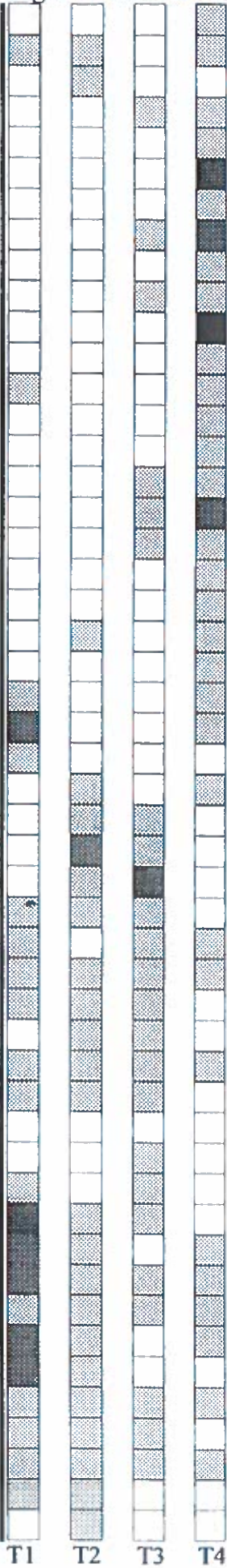


Figure 6 C. Swanlinbar R.

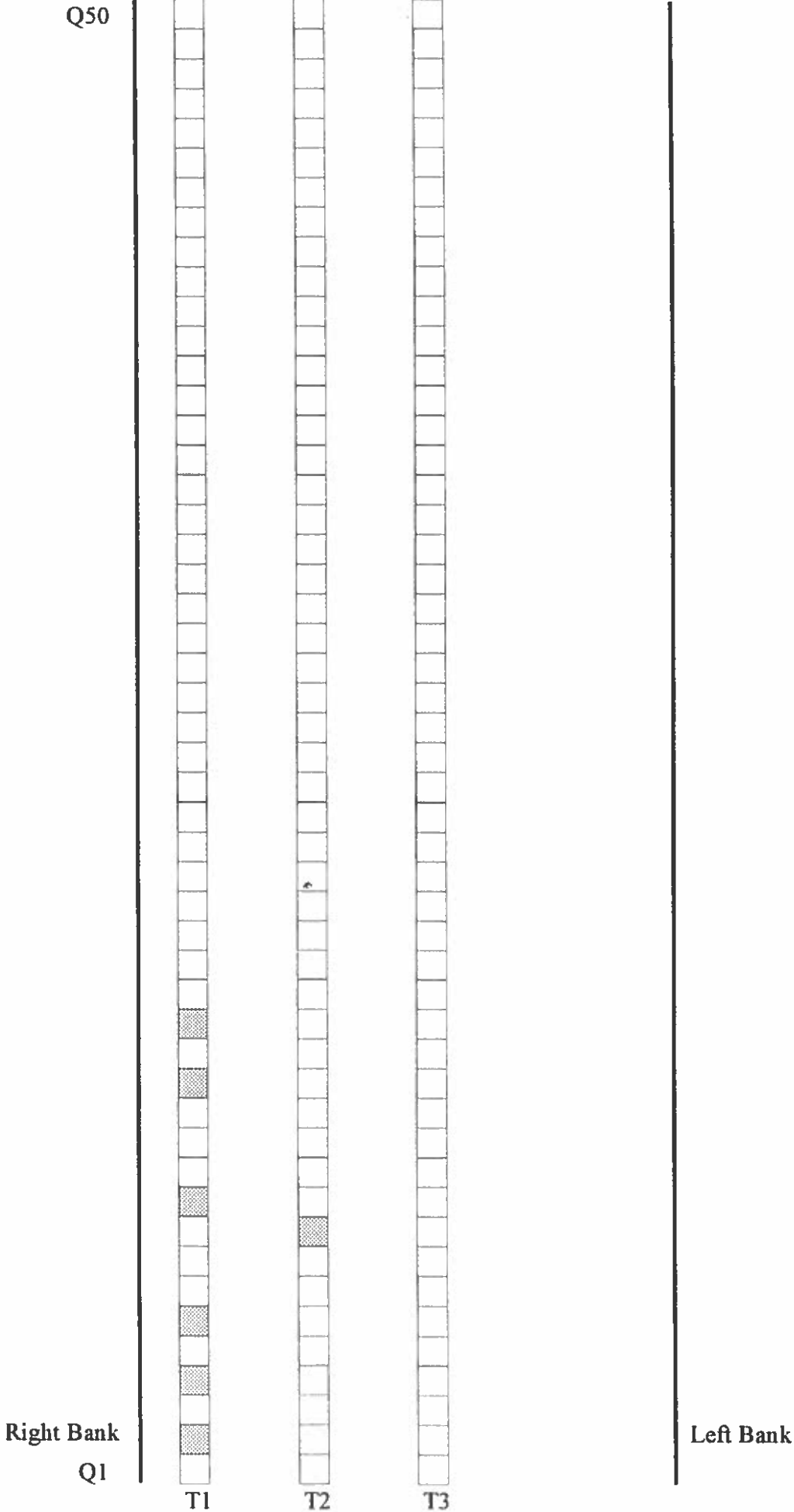
Q50

Right Bank  
Q1



Left Bank

Figure 6 D. Colebrooke R.







## 5 DISCUSSION

### 5.1 Distribution and densities of *M. margaritifera* in Northern Ireland

The present survey updates records of *M. margaritifera* in Northern Ireland. Any apparent increase in the distribution of freshwater pearl mussels in Northern Ireland is due to greater sampling effort in recent years.

From the present survey, *M. margaritifera* appears to be confined to the west of the province. Some previous records of live *M. margaritifera* from Northern Ireland (Roberts and Mackie, 1993) may be no longer valid. Habitat modification and pollution from intensive agriculture have been blamed for the extinction of populations of freshwater pearl mussels from the north east of Ireland (Ross, 1990). Because the remaining populations are generally small they are probably more vulnerable to disturbance as a result of water pollution, habitat modification and pearl fishing and are more likely to disappear.

The largest remaining populations occur in rivers and streams in Fermanagh and in the Sperrin region. Not surprisingly these areas have had little intensive agriculture and industrialisation in comparison with the eastern areas of Northern Ireland. Further west, in Donegal where the development of industry and intensive agriculture has been minimal, some large populations still exist (Beasley, 1996). Populations at some sites in Donegal are in excess of 6,000 individuals. In comparison, the largest population recorded at a site in Northern Ireland in the present survey was been estimated to be about 1,000 mussels (Figure 7). On the basis of the present survey, the sites supporting the highest densities of mussels were on the Swanlinbar and Broughderg Burn Rivers. A very detailed survey was carried out on the Broughderg Burn in 1995 by Mackie and Hale who estimated that the total numbers of mussels in the river 'could be in the region of 20,000'. Although no similar detailed extensive survey of this river was carried out in the present survey, estimates of mussel densities for a 50m stretch upstream of the Crouck Bridge, where Mackie and Hale (1995) reported 11 mussels, were between 117 [baseline survey ( Table 4)] and 300 [site survey (Table 1)]. Therefore, present findings support the view (Mackie and Hale, 1995) that the largest mussel colony in Northern Ireland is probably in the Broughderg Burn

Although sites in Northern Ireland where *M. margaritifera* has been recorded generally have smaller populations of mussels than similar sites in Donegal (Figure 7), mussel sites in Northern Ireland, particularly those on the Swanlinbar River and Broughderg Burn, are of considerable importance for the conservation of the species in Europe.

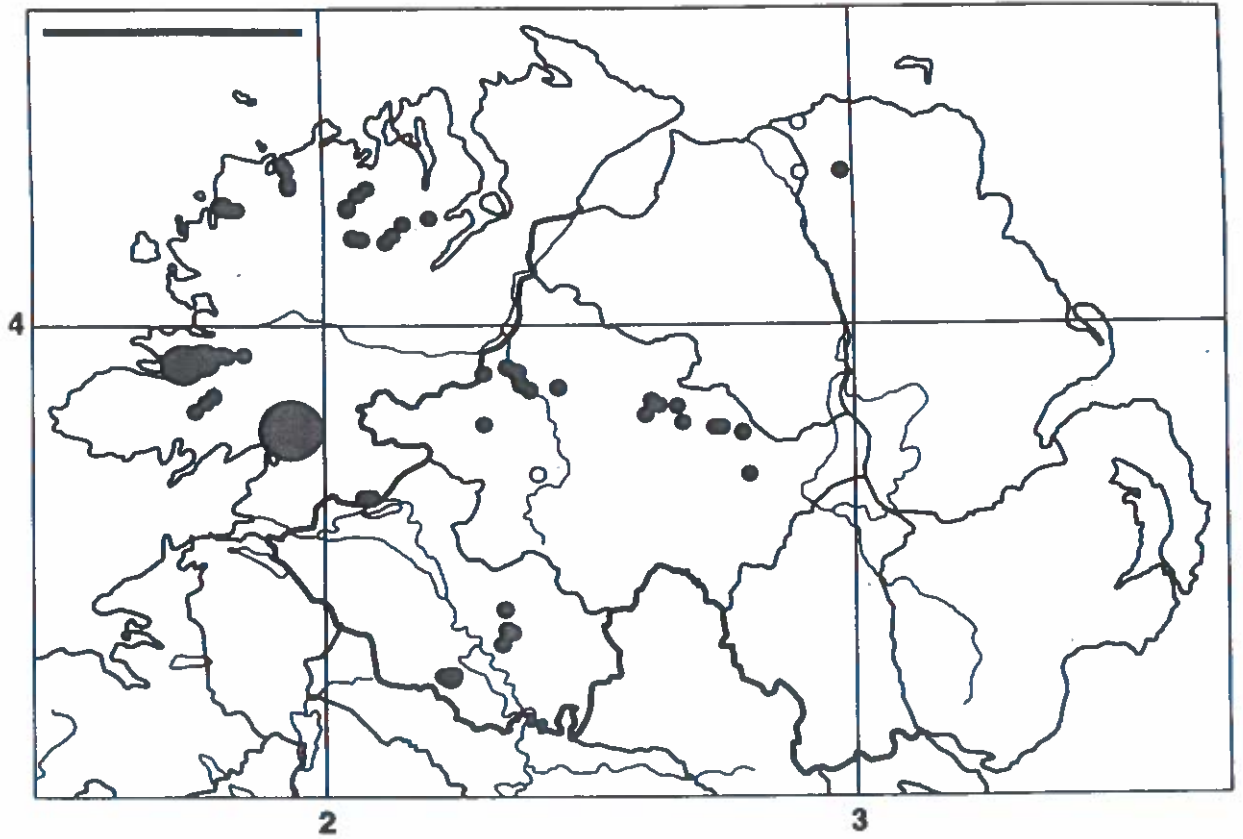


Figure 7. Sites found to contain living *M. margaritifera* in Donegal (Beasley, 1996) and Northern Ireland (the present study) mapped as six figure Grid References. The diameter of the circle represents the estimated population size at each site. The diameter of the largest circle (left) represents a population of just over 6,000 individuals. Scale bar on upper left = 40 km.

## 5.2 Status of *M. margaritifera* in Northern Ireland

Distributional and density data alone may not provide enough information about the status of *M. margaritifera* in a region. Size frequency data collected during the present survey confirms that juvenile mussels (<30 mm in length) are absent from all sites surveyed. Only one location (the Drumroosk site on the Swanlinbar R.) had mussels smaller than 50 mm in length. The smallest mussels found in the present survey at this site were between 41 and 51 mm long of an estimated age between 6 and 12 years old. However, these age estimates are based on growth studies carried out in Donegal (Beasley, 1996) and the extrapolation may not be strictly valid. Nevertheless, this still suggests that recruitment at this site is extremely low and may not be occurring at other sites. The Drumroosk site has the highest density of mussels and the largest estimated population size of all the sites surveyed during the present study. Although Bauer (1991) does not consider there is a critical density for fertility, Valovirta (1990) suggests a minimum population density of 500 individuals per 100 m of river for successful recruitment to take place. Given the low densities of adults at most sites, it may be this factor which is responsible for the apparent lack of recruitment in Northern Ireland.

Besides size frequency data, information on host fish abundance and numbers of parasitic glochidia on hosts are also very useful in assessing recruitment to populations of *M. margaritifera*. However, collection of this information in the field was beyond the scope of the present survey but could be included in future work.

## 5.3 Threats to *M. margaritifera*

The main causes for the disappearance of *M. margaritifera* are: water pollution; habitat disturbance; overfishing and decreasing abundance of host fish (Valovirta 1990; Ziuganov *et al.* 1994 and Beasley 1996).

### 5.3.1 Water quality and habitat disturbance

During the present survey, biological water quality at most sites was reasonably high. The ASPT value, which is the most useful comparative indicator of biological water quality as it is independent of sample size, was high at many mussel sites, indicating the presence of high scoring, pollution sensitive macroinvertebrate taxa. Although biological water quality appears to be reasonably good at many sites during the survey, adult freshwater pearl mussels are able to tolerate low water quality conditions (Bauer, 1988) and the presence of adults *per se* may not necessarily be taken as indicating high water quality. Water quality scores were lowest at

sites on the Strule/Mourne R. on which records of live *M. margaritifera* have declined in recent years. There is cause for concern over low water quality scores at some (but not all) sites on mussel rivers including the Ballinderry, Owenreagh, Colebrooke and Waterfoot rivers. Low interstitial water quality may occur at sites which may have good surface water quality. Mortality of juvenile freshwater pearl mussels is correlated with the build up of organic particles in the interstitial sediment (Bauer, 1988). Survival of juveniles in cages placed in rivers is correlated with the amount of silt and fine sediments accumulating in the cages (Buddensiek, 1995). Consistently high water quality scores were reported for the Tempo, Broughderg Burn and Swanlinbar rivers. The latter two rivers contained the most dense populations of freshwater pearl mussels recorded during the present study and the smallest mussels found occurred in the Swanlinbar River. A detailed assessment of water quality was not the primary focus of this study and further sampling over longer periods is necessary to evaluate whether or not water quality is declining at mussel sites.

At many mussel and non-mussel sites, habitat destruction and modification was noted. These include dredging of the river bed, creation of cattle wades (Plate 1C), erosion and modification of river banks (Plate 2), washing out of slurry tanks in the river (Plate 2), and the discharge of sediment-laden water from gravel-washing operations. On a local scale, these activities could have a significant impact on freshwater mussels in the vicinity. Mussels may be killed directly by being removed from the river in dredging material or by being crushed by agricultural machinery. Activities modifying the substratum and those such as gravel washing may increase the amount of suspended solids in the water. An increase in the level of suspended solids beyond  $30 \text{ mg l}^{-1}$  has been found to be detrimental for freshwater pearl mussels in Finland (Valovirta, 1990). At several sites on the Ballinderry R., high levels of sediment were observed on the river bed. We echo Mackie's (1992) call for measures to stop runoff from gravel washing from reaching mussel sites. Notably, there is quarrying taking place near a tributary upstream of the Drumroosk site on the Swanlinbar R., with an increase in the amount of silt washed downstream (Mr. G. Grahame, *pers. comm.*). The effect of increased sedimentation was clearly demonstrated at a mussel bed in a mill race at Sion Mills near the Strule river. Mackie (1992) had estimated the population in the mill race to be about 200. A resurvey of the site in 1995 showed that the population had dropped to just a few individuals (Beasley and Roberts, 1995). In the intervening period the substratum had changed dramatically and the underlying cobble and gravel was covered with a deep layer of fine sand and silt. The increase in fine sediment was the result of stopping the turbines at the end of the mill race, consequently reducing the current speed to almost zero and thereby increasing sedimentation.

The adult mussels had been unable to survive in the new conditions and many empty shells were found in the sediment. On the Waterfoot R. in Fermanagh, small dredge heaps were found at two sites. Although no dead shells were found amongst the dredgings, activities of this sort are potentially detrimental to freshwater pearl mussels.

### 5.3.2 Pearl fishing and abundance of host fish

During the present survey, anecdotal information was obtained which suggested that pearl fishing was still being carried out in Northern Ireland. As recently as 1994 pearl fishermen from the north of Scotland have been reported on the Swanlinbar river from Stragowna Br. as far as the border with Cavan. These fishermen have been operating for several weeks at a time during the summer. Although it is not known for how long the river has been fished, local sources say the fishermen have been coming regularly to Northern Ireland with breaks of a few years between each fishing episode. According to local people, the fishermen use a non-destructive method of fishing (tongs), opening shells slightly and returning mussels without pearls. However, this has yet to be substantiated and at Stragowna Br. over a hundred shells were found scattered about the site. Many of these shells had both valves intact and were opened wide, suggesting they may have been fished. At the Colebrooke site near Maguiresbridge, a local angler (Mr. P. Trotter) recalled a pearl fisherman, operating on the river about 15 to 20 years ago, who left large heaps of dead mussels on the river bank. Local opposition to his activities forced the pearl fisherman to cease fishing on the Colebrooke. It is not clear to what extent pearl fishing is occurring on other mussel rivers in Northern Ireland but given that there are reports of systematic pearl fishing in the Republic of Ireland (Allen, *pers. comm.*) it must be assumed that most, if not all, populations have probably been examined by pearl fishermen.

The status of host fish populations and numbers of parasitic glochidia on hosts was not assessed during the present survey ( see section 5.2 above) but should be included in future work as recommended by Mackie and Hale for the Broughderg Burn (1995).





**Plate 2.** Habitat modification (top) and slurry tank washing (bottom) on the River Bush, Summer 1996.





## 6 RECOMMENDATIONS

Ziuganov *et al.* (1994) identify four methods of restoration and conservation of pearl mussels:

1. passive protection of the remaining populations (creation of protected territories)
2. acclimatisation of the mussels in new water bodies by introducing adult specimens
3. semi-artificial reproduction by intensive infestation of fish with glochidia under natural conditions
4. artificial culture

Although other methods may be feasible in future, the only realistic immediate option in Northern Ireland at present is the first. However, The Ballinderry River Enhancement Association has recently been attempting to infect native trout, *Salmo trutta*, with *Margaritifera* glochidia with a view to releasing them into their home river (B Kelso, *pers. comm.*). If this approach is successful, it would make the third method a realistic option for the Ballinderry and other river systems and could have a significant impact on mussel recruitment which is seen as a major problem for the maintenance of mussel populations in Northern Ireland. However, although game fish stocks have been moved around widely in Northern Ireland in the past, to maintain genetic diversity it would be prudent to limit this approach to the use of fish and mussel stocks native to the river in which such mussel stock enhancement was attempted. This approach has been attempted by trials elsewhere in Europe (for references see Beasley, 1996) but the results of these are difficult to assess as the trial periods are long (Jungbluth, 1986).

### 6.1 Legislation concerning *M. margaritifera*

Having identified populations of *M. margaritifera* and established their status, the next step is to conserve them. Although a great deal of practical conservation work can be carried out in the field, an essential tool in any conservation programme is proper legislation. Unfortunately, the legislation in Northern Ireland is extremely ineffective and provides no legal protection of live *M. margaritifera* or their habitat. This contrasts with the situation in the Republic of Ireland and Great Britain where *M. margaritifera* is given full protection. Of course, legal protection is ineffective unless properly enforced but until the law is changed in Northern Ireland, very little credibility can be given to any conservation and/or educational programme involving freshwater pearl mussels. Therefore the species should be given full protection to bring Northern Ireland into line with the Republic of Ireland and Great Britain and the rest of Europe. To provide for the legal protection of the habitat of *M. margaritifera* is more difficult

because the precise habitat requirements of the species are not clearly established. The presence of adult mussels is the best criterion we have at present.

### **6.2 *M. margaritifera* and water quality**

Adult mussels can occur in sites with a wide range of water quality as indicated by the Biological Monitoring Working Party's index (BMWP) and average score per taxon (ASTP) scores (Beasley, 1996). However, water pollution, particularly nitrate pollution, can contribute to the decline of adult mussels (Bauer, 1988) and mortality of juvenile mussels has been correlated with elevated BOD, calcium and phosphate levels (Buddensiek *et al.*, 1993). It is therefore important that, in addition to strategies for species and habitat management, targets should be set to ensure that water quality does not decline at mussel sites. Indeed, there should be a long-term objective of improving water quality in mussel rivers.

### **6.3 ASSI Designation**

We strongly recommend that site 52 on the Swanlinbar R. and the Broughderg Burn between the Evishessan Br. and Monameal sites should be designated ASSIs given the high densities of mussels at these sites. The Wellbrook Mill site on the Ballinderry R. is also recommended as a conservation site. This site occurs within National Trust land and therefore should be more amenable to protection.

The Colebrooke, Tempo and Waterfoot rivers are notable for the co-occurrence of *M. margaritifera*, *Anodonta sp.* and *A. pallipes* and should also be considered for ASSI designation. Cross-border co-operation is recommended for the management of the Waterfoot and Swanlinbar populations. Notwithstanding whether the recommendations to designate any or all of the sites above as ASSIs are adopted, the sites should be monitored in future since they are the most likely locations in Northern Ireland where *M. margaritifera* has some chance of survival into the future .

### **6.4 Monitoring**

Four pearl mussel sites are recommended for monitoring in Northern Ireland. These sites represent the wide range of conditions in which *M. margaritifera* is found in Northern Ireland. During the present survey, detailed recording was carried out at each site so that the mussel bed can be sampled again in the same areas. This will provide a baseline for future comparisons (Figure 7A-D; Appendix IVA-D; Appendix VA-D).

#### 6.4.1 Monitoring sites

The recommended monitoring sites are as follows (see section 3.2 above):

River	Grid Reference	Location name	Survey Ref. No.
A. Ballinderry R.	H748 792	Wellbrook Mill	4
B. Broughderg Burn	H626 837	Crouck Br.	29
C. Swanlinbar R.	H235 298	nr. Drumroosk	52
D. Colebrooke R.	H352 387	nr. Maguiresbridge	42

#### 6.4.2. Frequency of monitoring

We recommend visiting the sites 1 year from when the baseline data was collected. Thereafter, monitoring sites may be visited annually. We recommend shorter intervals between repeat sampling than those recommended by Young (1995a) as mussel densities are very low overall in Northern Ireland and mussel populations here are less remote from human interference than those in Scotland. Serious declines in population size could occur over short periods of time, particularly where pearl fishing is concerned, therefore more frequent monitoring is required.

#### 6.4.3. Methodology

The recommended methodology is largely adopted from that of Young (1995a) and is detailed in the Methods (section 3.2.2) above.

The focus of a freshwater pearl mussel monitoring programme in Northern Ireland will, at least until juveniles are found, be on numbers of adult mussels. Young (1995a) recommends local action be taken where adult mussels decline in numbers by 25% or more. If a decline occurs over three sampling intervals but is less than 25% then action should also be taken.

#### 6.4.4. Local liason

We strongly recommend that a reliable local contact be established who could report pearl fishing and other activities which are potentially harmful to *M. margaritifera*. This contact could be from a local angling or conservation group. Additional information on the distribution of the freshwater pearl mussel could be obtained from anglers and local conservation groups. The suggested format of an information sheet on *M. margaritifera* which could be used for this purpose is given in Appendix VIII.



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## 8 APPENDICES





Appendix I. Rivers and sites surveyed for *M. margaritifera* between July and September 1996

Catchment	Rivers	Grid Reference	Location	Site No.	Mussels
L. Neagh	Ballinderry	H672 803	Teebane Br.	1	Y
		H705 800	Dunnamore Br.	2	N
		H735 793	Corkhill Br.	3	Y
		H748 792	Wellbrook Mill	4	Y
		H788 782	Auglish Br.	5	Y
	Moyola	H715 899	Bealnaslaght Br.	6	N
		H732 906	The Old Church Br.	7	N
		H752 928	nr. Ford	8	N
		H786 956	nr. Mullaghlahan	9	N
		H479 509	Garlaw Br.	10	N
	Blackwater	H501 514	nr. Castle	11	N
		H532 523	U/s Clogher	12	N
		J248 285	opp. Hen Mountain	13	N
	Upper Bann	J238 289	New Br.	14	N
D102 255		Crockarover	15	N	
Bush	Bush	D097 263	Crockan Br.	16	N
		D078 291	Ballyhoe Br.	17	N
		D074 304	Seven Acres	18	N
		C978 303	Stroan Br.	19	N
Foyle	Mourne	H368 879	Strule/Derg confl.	20	Y
		H363 904	Victoria Br. 2	21	Y
		H357 905	Victoria Br. 1	22	N
	Strule	H344 912	Seein Br.	23	N
		H386 867	Fishfarm	24	N
		H369 878	Above Derg confl.	25	N
	Broughderg Burn	H681 849	D/s Broughderg Br.	26	N
		H662 835	Evishessan Br.	27	Y
		H642 840	nr. Cashel Wood	28	N
		H626 837	Crouck Br.	29	Y
		H613 847	Monameal	30	Y
	Owenkillew	H438 873	Killymore Br.	31	N
		Owenreagh (O'killew)	H624 805	nr. Tornoge	32
	Derg	H601 819	opp. Cashel Rock	33	Y
		H562 836	Aghamirigan Br.	34	N
		H125 778	nr. Legvin	35	N
		H161 796	nr. Ballyetragh	36	N
		H191 806	Aghyaran Br.	37	N
H219 818		nr. Creeduff	38	N	
L. Erne	Colebrooke	H509 410	opp. Mullaghfad	39	N
		H495 423	Glenoo Br.	40	N
		H459 429	Tattenabuddagh Br.	41	N
		H352 387	nr. Maguiresbridge	42	Y
		H333 362	Ballindarragh Br.	43	Y
	Tempo River	H348 470	nr. Lettan	44	N
		H341 447	opp. Drumderg	45	N
		H338 432	opp. Glundeas Hill	46	Y
	Waterfoot	H342 392	Killashanbally	47	Y
		H073 654	nr. Knocknamona	48	Y
H081 653		nr. Brookhill Hse	49	Y	
Swanlinbar	H085 652	Letter	50	Y	
	H220 299	nr. Clontelaghan	51	Y	
	H235 298	nr. Drumroosk	52	Y	
Manyburns	H242 302	Stragowna Br.	53	Y	
	H398 505	nr. Camgart	54	N	
	H384 499	nr. Tullyullagh	55	N	
	H384 473	Lwr. Manyburns Br.	56	N	
	H386 459	Coolraghkelly	57	N	
	H388 455	nr. Fort Hill	58	N	

**Appendix I. cont'd**

<b>Catchment</b>	<b>Rivers</b>	<b>Grid Reference</b>	<b>Location</b>	<b>Site No.</b>	<b>Mussels</b>	
Bush	Well Water	D099 339	nr. Crosses	59	N	
		D087 337	nr. Doonans	60	N	
L. Neagh	Doughery Water	D048 342	Doughery Br.	61	N	
		D033 337	Carnkirk Br.	62	N	
	Fury	H558 504	nr. Lisbane	63	N	
		H575 473	nr. L. na Blaneybane	64	N	
	Rock	H742 719	nr. Scotch Hill	65	N	
		H773 723	nr. Ballinakilly	66	N	
	Glengomna White Water	H742 929	D/s Mountain View	67	N	
		H771 923	nr. Disert	68	N	
	Leitrim		H771 905	Corick Br.	69	N
			J215 272	opp. Trainor's Br.	70	N
L. Erne	Rocky Sillies	J218 285	Leitrim Br.	71	N	
		J233 277	Rocky R. Br.	72	N	
		H109 546	nr. Tullynagowan	73	N	

Appendix II. Specimen recording sheet for initial survey

Freshwater Pearl Mussel Survey

1. Name of River ..... 2. Region .....
3. Location of Site ..... 4. Grid Reference .....
5. Vice County .....
6. Name and contact address of recorder: Colin Beasley, Queen's University of Belfast
7. Date of Survey ..... 8. Time of Survey .....
9. Weather Conditions .....

10. Pearl mussels present YES / NO Please circle, if NO go to 15

11. Number of adult mussels in 50m transect .....

12. Number of juvenile mussels (<3cm) in quadrats .....

13. Number of dead shells found .....

14. Mussel Bed Length (m) ..... and Width (m) .....

15. Width .....m and average depth .....m of river

16. Substratum type at point of survey, record as % area covered

silt	fine sand	coarse sand	gravel	cobbles	boulders	bedrock

17 Shading .....

18. Main adjacent land use .....

19. Bankside vegetation .....

20. Pearl fishing YES / NO

21. Further comments-note human disturbance

.....



Appendix III. Physical characteristics of sites. See Appendix I for site details.

Rivers	Site No.	Width	Depth	Land Use	Vegetation	Mussels
Ballinderry	1	3.4	0.33	MH	C	Y
Ballinderry	2	6.9	0.54	IG, SU	C	N
Ballinderry	3	8.7	0.45	IG	C	Y
Ballinderry	4	10	0.26	BL	C	Y
Ballinderry	5	12.6	0.35	RP, TL, SU	C	Y
Moyola	6	4.9	0.16	RP	C	N
Moyola	7	6.7	0.15	RP	C	N
Moyola	8	8.3	0.21	SU	C	N
Moyola	9	11.7	0.17	IG, SC	C	N
Blackwater	10	3.8	0.3	IG, RP	C	N
Blackwater	11	2.3	0.3	IG	C	N
Blackwater	12	6.9	0.2	IG, RP	C	N
Upper Bann	13	8	0.05	RP, SC, M	S	N
Upper Bann	14	7	0.1	IG, RP	C	N
Bush	15	6.9	0.3	IG, RP	C	N
Bush	16	8.3	0.25	IG	C	N
Bush	17	10.7	0.33	IG, SU	C	N
Bush	18	7.3	0.32	IG, TL	C	N
Bush	19	13.3	0.13	IG, TL	C	N
Mourne	20	20	0.31	RP	C	Y
Mourne	21	25	0.15	BL	C	Y
Mourne	22	25	0.38	BL	C	N
Mourne	23	15	0.18	IG	C	N
Strule	24	20	0.25	SU, BL	C	N
Strule	25	20	0.33	BL	C	N
Broughderg Burn	26	10.8	0.22	MH	C	N
Broughderg Burn	27	5.6	0.17	RP, BL	C	Y
Broughderg Burn	28	4.5	0.35	IG, RP, CP	C	N
Broughderg Burn	29	7.5	0.38	IG	C	Y
Broughderg Burn	30	5.6	0.32	IG, RP	C	Y
Owenkillev	31	10	0.2	IG	C	N
Owenreagh (O'killev)	32	4	0.2	MH	C	N
Owenreagh (O'killev)	33	5.3	0.24	RP, SU	C	Y
Owenreagh (O'killev)	34	8.7	0.35	IG, RP	C	N
Derg	35	13	0.19	RP, HM	C	N
Derg	36	17.4	0.28	RP	C	N
Derg	37	13.8	0.3	IG, RP	C	N
Derg	38	19.2	0.35	IG, RP, TL	C	N
Colebrooke	39	5.4	0.2	CP	S	N
Colebrooke	40	6.2	0.34	BL, RP	C	N
Colebrooke	41	8.1	0.19	RP, SU	C	N
Colebrooke	42	17.6	0.22	RP, SU	C	Y
Colebrooke	43	21.4	0.36	RP, SU	S	Y
Tempo River	44	5.4	0.59	IG, RP	S	N
Tempo River	45	6.8	0.29	IG, RP	S	N
Tempo River	46	6.6	0.49	IG, RP	C	Y
Tempo River	47	8.8	0.4	RP	C	Y
Waterfoot	48	3.6	0.25	RP	C	Y
Waterfoot	49	6.4	0.16	RP	C	Y
Waterfoot	50	5.2	0.49	RP, BL	C	Y
Swanlinbar	51	10.6	0.38	RP	C	Y
Swanlinbar	52	9.9	0.23	IG, RP	C	Y
Swanlinbar	53	9.4	0.29	RP	C	Y
Manyburns	54	4.4	0.27	RP	S	N
Manyburns	55	4.8	0.26	RP	S	N
Manyburns	56	6.5	0.21	RP	C	N
Manyburns	57	7.6	0.14	IG, RP	C	N
Manyburns	58	5.1	0.29	RP	C	N

**Appendix III. cont'd**

<b>Rivers</b>	<b>Site No.</b>	<b>Width</b>	<b>Depth</b>	<b>Land Use</b>	<b>Vegetation</b>	<b>Mussels</b>
Well Water	59	2.6	0.16	IG, RP	C	N
Well Water	60	3	0.33	IG	C	N
Doughery Water	61	2.8	0.19	IG, TL	C	N
Doughery Water	62	5.8	0.14	IG, BL, SU	C	N
Fury	63	3.7	0.19	IG	C	N
Fury	64	3.4	0.05	IG	C	N
Rock	65	6.8	0.09	IG	C	N
Rock	66	3.8	0.28	IG	C	N
Glengomna	67	3.5	0.15	TL, RP	C	N
White Water	68	6.7	0.2	IG	C	N
White Water	69	3.7	0.07	IG, BL	C	N
Leitrim	70	4.4	0.1	TL, RP, IG	C	N
Leitrim	71	5.5	0.3	IG, RP	C	N
Rocky	72	5.8	0.45	SC, SU	C	N
Sillies	73	4.8	0.17	RP	C	N

**River Habitat Survey Abbreviations**

- BL=Broadleaf/mixed woodland
- CP=Coniferous plantation
- MH=Moorland/Heath
- SC=Scrub
- RP=Rough pasture
- IG=Improved/semi-improved grass
- TL=Tilled land
- SU=Suburban/urban development
- C=Complex vegetation
- S=Simple vegetation

Appendix IV. Substratum percentage cover at sites. See Appendix I for site details.

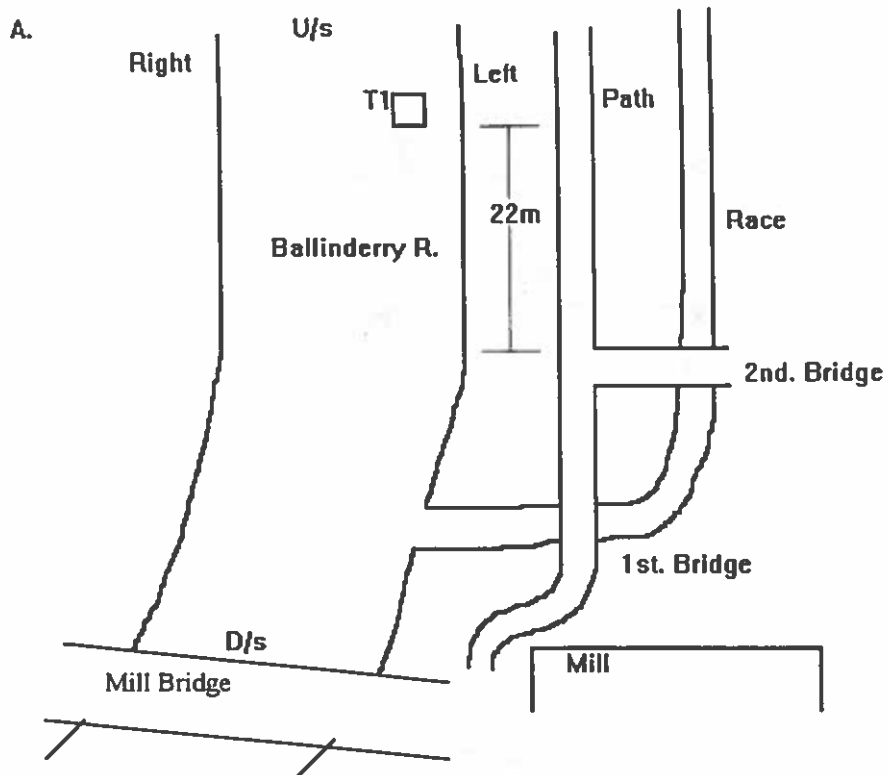
Rivers	Site No.	Silt	Fine sand	Coarse sand	Gravel	Cobbles	Boulders	Bedrock	Mussels
Ballinderry	1	90	0	0	0	0	10	0	Y
Ballinderry	2	0	10	20	50	20	0	0	N
Ballinderry	3	0	0	20	0	20	60	0	Y
Ballinderry	4	0	20	0	0	50	30	0	Y
Ballinderry	5	0	0	30	0	20	50	0	Y
Moyola	6	0	0	0	10	10	80	0	N
Moyola	7	0	0	0	10	20	70	0	N
Moyola	8	0	0	10	10	30	50	0	N
Moyola	9	0	0	0	10	90	0	0	N
Blackwater	10	100	0	0	0	0	0	0	N
Blackwater	11	0	0	0	20	30	50	0	N
Blackwater	12	0	0	10	30	50	10	0	N
Upper Bann	13	0	0	0	0	0	50	50	N
Upper Bann	14	10	0	0	5	0	85	0	N
Bush	15	0	5	5	0	20	70	0	N
Bush	16	0	0	0	5	0	20	75	N
Bush	17	0	0	60	0	30	10	0	N
Bush	18	0	0	10	10	70	10	0	N
Bush	19	0	0	0	100	0	0	0	N
Mourne	20	0	10	0	10	40	20	20	Y
Mourne	21	0	0	0	20	20	60	0	Y
Mourne	22	0	0	20	50	0	30	0	N
Mourne	23	0	0	0	0	20	80	0	N
Strule	24	0	0	0	10	20	70	0	N
Strule	25	0	0	5	5	10	40	40	N
Broughderg Burn	26	0	0	0	20	0	80	0	N
Broughderg Burn	27	0	20	30	50	0	0	0	Y
Broughderg Burn	28	0	0	20	0	20	0	60	N
Broughderg Burn	29	0	10	0	10	70	10	0	Y
Broughderg Burn	30	0	0	0	10	20	70	0	Y
Owenkillew	31	0	10	10	50	30	0	0	N
Owenreagh (O'killew)	32	0	0	20	30	20	30	0	N
Owenreagh (O'killew)	33	0	0	10	30	30	30	0	Y
Owenreagh (O'killew)	34	0	0	20	0	30	50	0	N
Derg	35	0	0	10	10	30	50	0	N
Derg	36	0	0	5	15	20	60	0	N
Derg	37	0	0	20	0	80	0	0	N
Derg	38	0	0	5	10	5	80	0	N
Colebrooke	39	0	0	0	0	10	90	0	N
Colebrooke	40	0	0	0	10	0	10	80	N
Colebrooke	41	0	0	0	5	15	80	0	N
Colebrooke	42	0	0	10	70	10	10	0	Y
Colebrooke	43	0	10	40	40	10	0	0	Y
Tempo River	44	0	50	50	0	0	0	0	N
Tempo River	45	0	10	0	0	20	70	0	N
Tempo River	46	0	20	0	0	70	10	0	Y
Tempo River	47	0	0	10	0	80	10	0	Y
Waterfoot	48	0	0	70	20	10	0	0	Y
Waterfoot	49	0	0	15	5	80	0	0	Y
Waterfoot	50	0	0	10	20	40	30	0	Y
Swanlinbar	51	0	0	50	20	30	0	0	Y
Swanlinbar	52	0	10	10	30	50	0	0	Y
Swanlinbar	53	0	5	0	15	80	0	0	Y
Manyburns	54	0	0	0	10	90	0	0	N
Manyburns	55	0	0	0	30	70	0	0	N
Manyburns	56	0	0	10	40	50	0	0	N
Manyburns	57	0	0	10	40	50	0	0	N
Manyburns	58	0	5	5	30	40	20	0	N

Appendix IV. cont'd

Rivers	Site No.	Silt	Fine sand	Coarse sand	Gravel	Cobbles	Boulders	Bedrock	Mussels
Well Water	59	0	30	0	70	0	0	0	N
Well Water	60	0	50	0	50	0	0	0	N
Doughery Water	61	10	10	0	50	30	0	0	N
Doughery Water	62	30	0	0	0	60	10	0	N
Fury	63	0	0	0	10	10	80	0	N
Fury	64	0	0	0	10	60	30	0	N
Rock	65	0	0	10	10	80	0	0	N
Rock	66	0	0	0	85	5	10	0	N
Glengomna	67	0	0	0	20	20	60	0	N
White Water	68	0	0	0	10	0	0	90	N
White Water	69	0	0	10	20	20	50	0	N
Leitrim	70	5	0	50	20	25	0	0	N
Leitrim	71	0	0	10	30	10	0	50	N
Rocky	72	0	0	15	5	30	50	0	N
Sillies	73	0	20	20	50	10	0	0	N



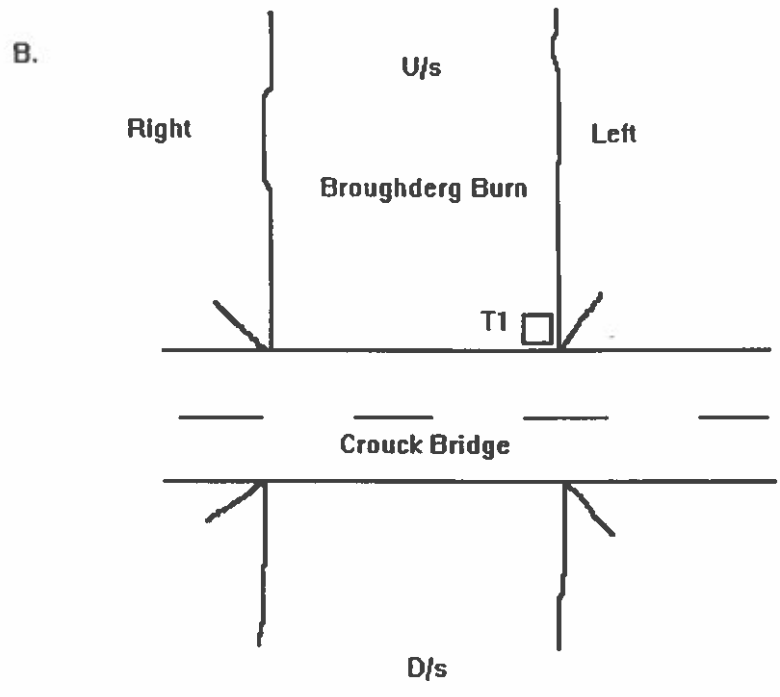
Appendix V. A-D Sketch maps showing details of recommended monitoring sites and positions of transects at each site with reference to Marker Points



**A. Ballinderry R. Wellbrook Mill H748 792**

Marker Point: Second wooden footbridge over mill race upstream of Mill.

- Transect 1 22 m upstream of Marker Point on LEFT bank and 1 m from bank.
- Transect 2 1 m LEFT of Transect 1
- Transect 3 1 m LEFT of Transect 2
- Transect 4 1 m LEFT of Transect 3
- Transect 5 1 m LEFT of Transect 4

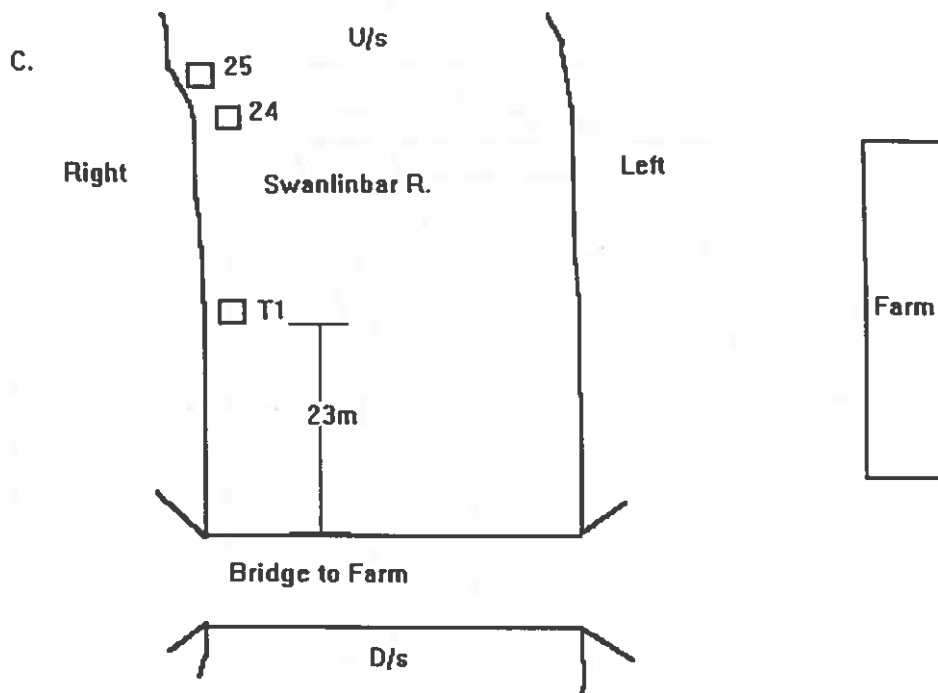


**B. Broughderg Burn Crouck Br. H626 837**

Marker Point: Crouck Br.

- Transect 1 Immediately under Marker Point on LEFT bank and immediately beside bank.
- Transect 2 1 m LEFT of Transect 1
- Transect 3 1 m LEFT of Transect 2





**C. Swanlinbar R. nr. Drumroosk H235 298**

Marker Point: Bridge leading to George Grahame's farm.

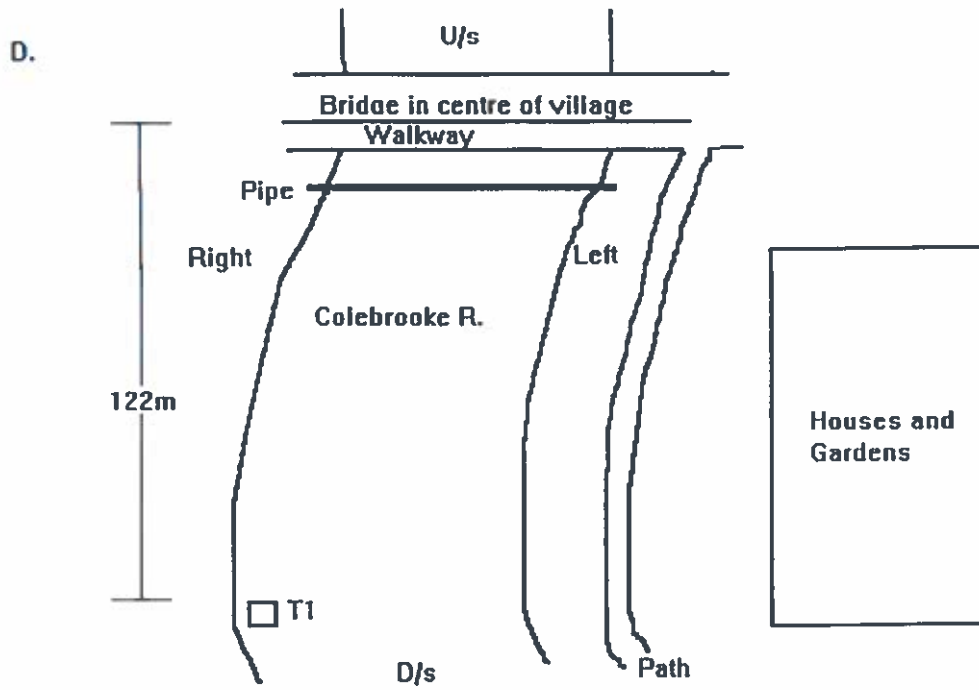
Transect 1 23 m upstream of Marker Point on RIGHT bank and immediately beside bank.

Transect 2 1 m RIGHT of Transect 1

Transect 3 1 m RIGHT of Transect 2

Transect 4 1 m RIGHT of Transect 3

Note: In order to correct for the curvature of the river, at quadrat 25, the transects were staggered 1 m to the LEFT.



**D. Colebrooke R. Maguiresbridge H352 387**

Marker Point: Bridge in village centre.

Transect 1 122 m downstream of Marker Point on RIGHT bank and 1 m from bank.

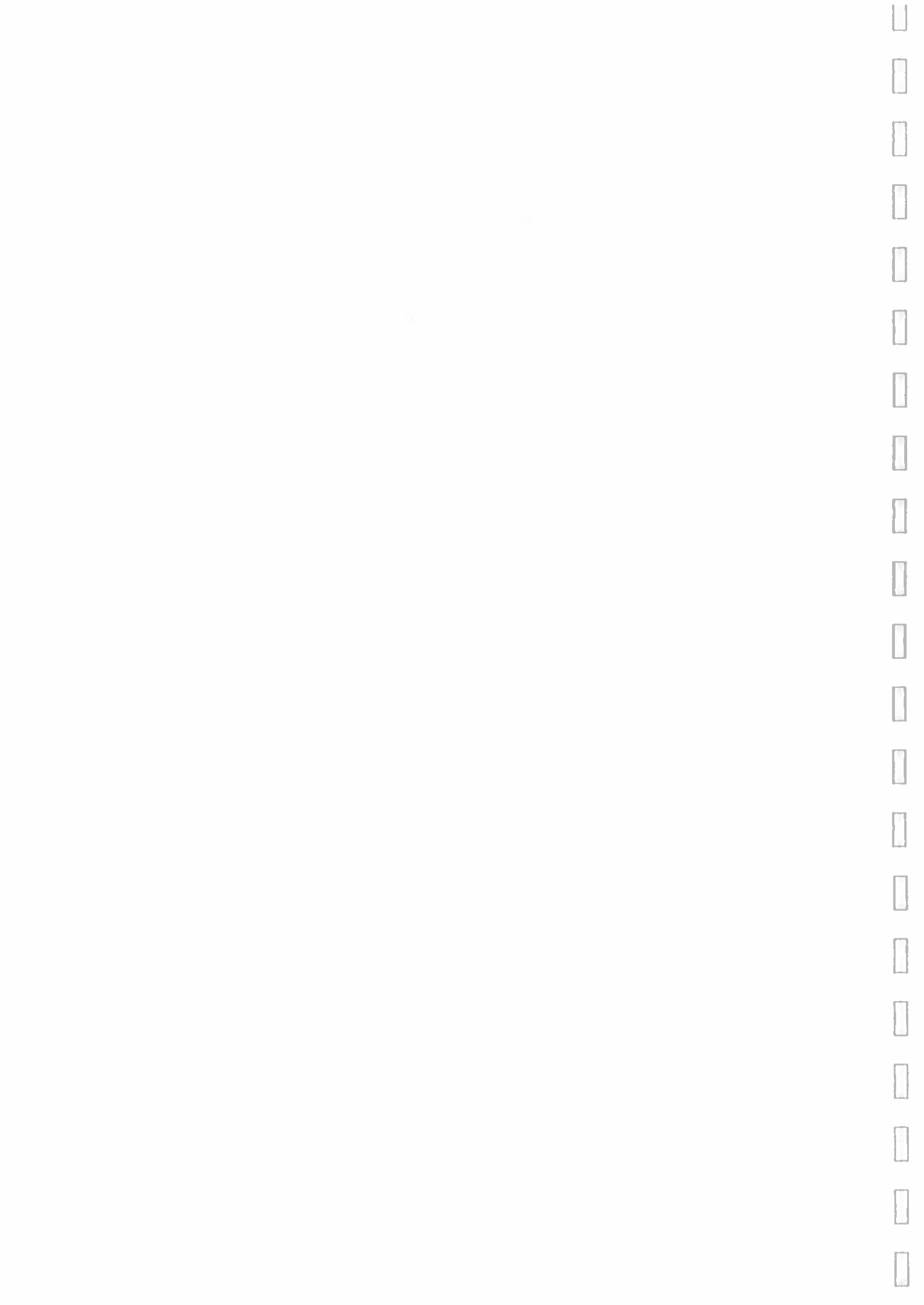
Transect 2 1 m RIGHT of Transect 1

Transect 3 1 m RIGHT of Transect 2

Transect 4 1 m RIGHT of Transect 3

Appendix VIA. Upstream (top) and downstream (bottom) view of monitoring site from close to the start of the first transect at Wellbrook Mill site no. 4, Ballinderry R.





**Appendix VIB.** Upstream (top) and downstream (bottom) view of monitoring site from close to the start of the first transect at Crouck Br. site no. 29, Broughderg Burn







Appendix VIC. Upstream (top) and downstream (bottom) view of monitoring site from close to the start of the first transect at Drumroosk site no. 52, Swanlinbar R.





## Endangered Mussels!



5 cm

The freshwater pearl mussel *Margaritifera margaritifera* (left) is a relatively large, black, kidney-shaped shell and is easily distinguished from duck and swan mussels (*Anodonta* sp.) (right). The freshwater pearl mussel is endangered throughout its range. Although recent E.U. legislation provides some protection of the species and its habitat, populations are declining mainly as a result of overfishing for pearls, water pollution from industrial and agricultural sources and habitat alteration through drainage and dredging projects. Freshwater pearl mussels were formerly common in Northern Ireland but have declined for the reasons above. They are long-lived; some individuals may reach up to 100 years of age. They are usually found in clean, fast flowing rivers and streams. No mussels below 30 mm in length have been recorded recently in rivers in Northern Ireland and *M. margaritifera* is facing extinction in the Province

If you are prepared to contribute to an ongoing survey of freshwater mussels in Northern Ireland and see dead shells or know of a living population, please send details of the site and any dead shells

(cleaned) to: **Environment and Heritage Section**

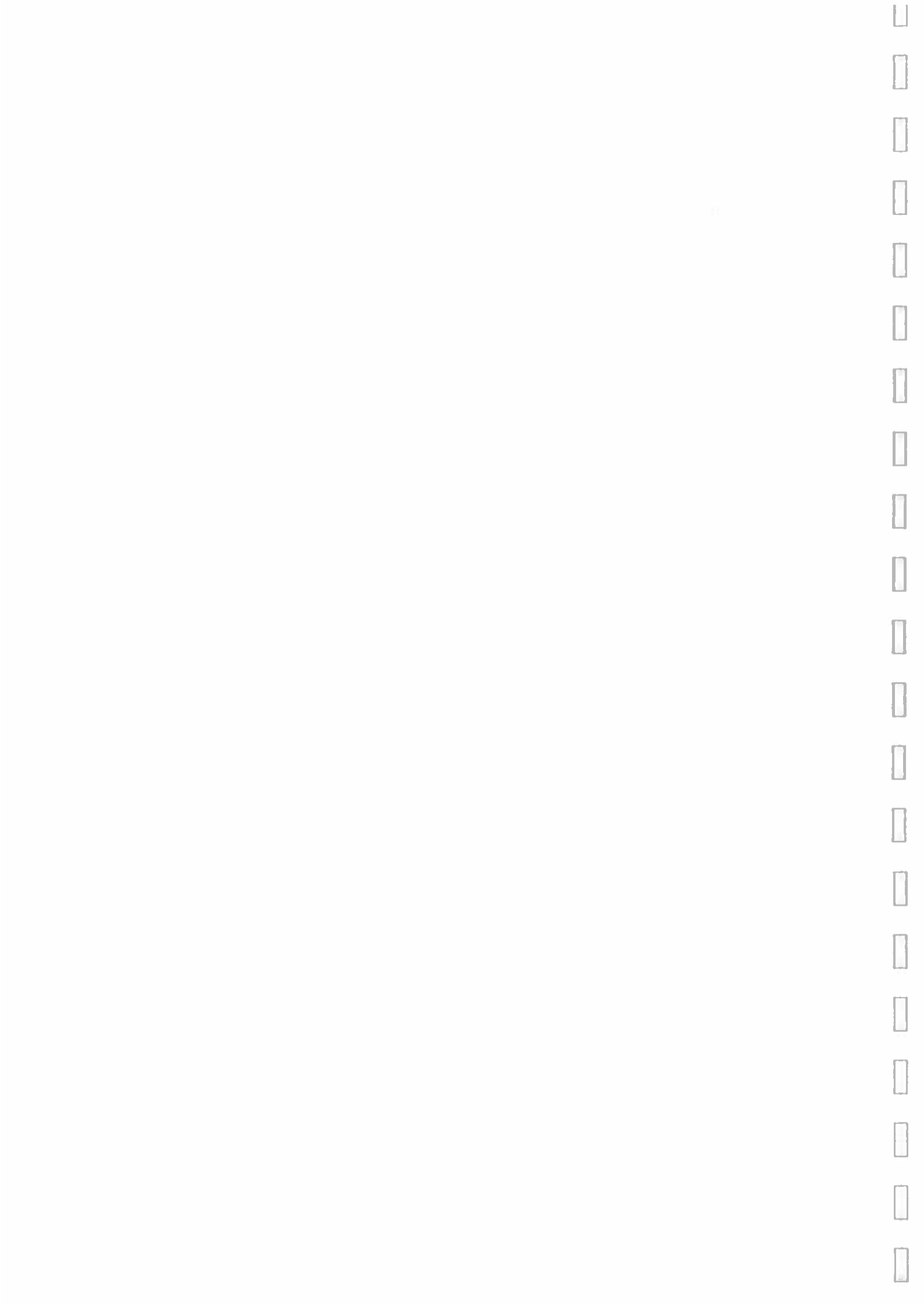
**Commonwealth House, Castle Street, Belfast BT1 1GU**

**Tel. (01232) 251 477**

Please include name of river, location, six figure grid reference (if possible), estimated numbers of living mussels and dead shells.

**REMEMBER: DO NOT REMOVE LIVING SPECIMENS**

**EXERCISE CAUTION NEAR WATER**







**Appendix VIII. Suggested format for an information leaflet on *M. margaritifera* for the purposes of obtaining distributional data from local angling and conservation groups**

