MAPPING OF THE DISTRIBUTION OF *MARGARITIFERA MARGARITIFERA* IN THE RIVER DEEL (MOY CATCHMENT), CO. MAYO.

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A report for Department of the Environment, Heritage & Local Government

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1.0 Background

The National Parks and Wildlife Service (NPWS), part of the Department of the Environment, Heritage and Local Government, is the statutory body responsible for nature conservation in the Republic of Ireland.

Both *Margaritifera margaritifera* and Margaritifera durrovensis are listed on Annex II and Annex V of the Habitats and Species Directive (92/43/EEC), under the modified list published in 1997 (97/62/EEC). *Margaritifera* is protected under Irish Law by the Wildlife Act 1976 and Wildlife (Amendment) Act 2000 (added to fifth schedule under Statutory Instrument No. 112, 1990). The species are also listed as "Protected fauna species" under Appendix III of the Bern Convention (Council of Europe's Convention on the Conservation of European Wildlife and Natural Habitats, 1979). *Margaritifera margaritifera* is listed on the most recent International Union for Conservation of Nature and Natural Resources (IUCN) Red Data List as "Endangered", while *Margaritifera durrovensis* is listed as "Critically endangered" (IUCN, 1996).

The pearl mussel *Margaritifera margaritifera* was once a very common Holarctic species, distributed from western Russia, through Europe to the northeastern seaboard of North America. However, over 90% of all *Margaritifera* individuals died out during the 20th century, leaving small populations scattered across EU territories.

Some of the best remaining European freshwater pearl mussel rivers are found in Ireland and Ireland holds up to 46% of the EU population. To date, 19 cSAC's have been designated for *M. margaritifera*, and one for *M. durrovensis*, the only known site for this animal in the world.

Margaritifera was first recorded from the River Deel during a 2004 survey of lamprey in the Moy catchment (Ecofact, 2004). Following this, a stretch of the river was surveyed for mussels in the vicinity of a proposed gas pipeline crossing (Moorkens, 2005) and a rapid assessment was conducted of stretch of the river in 2008 (Ross, 2008). The latter report recommended a thorough survey of the entire Deel system as a matter of urgency.

2.0 Aims and Objectives

The object of this project is to map the full distribution and elucidate the population profile of *Margaritifera margaritifera* (the Freshwater Pearl Mussel) in the River Deel system (Moy) during 2009.

The Deel system is large; the main channel of the River Deel is approximately 38km in length and the tributaries that have potential to have a presence of *Margaritifera* amount to a further 26km in total length.

3.0 Work carried out

The approach was as follows:

1) Rapid assessment of the main channel and tributaries to provide a best expert judgement of where the population of *Margaritifera* begins and ends.

2) For the length of the river inhabited by *Margaritifera*, the population was classified into stretches where the mussel was absent, occasional, frequent to common and abundant. The sections surveyed were described and their limits ascertained by hand-held GPS, and maps will be provided of the population abundance classifications.

3) For various stretches of the river, size profiles from quadrat studies were obtained and juvenile searches were carried out.

4) For selected sections of the river, redox potential measurements were made to determine the levels of siltation in the river.

4.0 Methodologies

4.1 Survey of Population Size and Distribution

Survey for *Margaritifera margaritifera* is generally designed to suit the purpose of the individual study. Standard methods for survey in the UK are based on population monitoring (Young *et al.*, 2003), concentrating on repeatable surveys of known mussel areas. Standard methods for survey of Irish rivers (Anon, 2004) divide study types into surveys of rivers with no records of *Margaritifera*, rivers with known *Margaritifera* populations that require a population estimate, and rivers that require more detailed ongoing monitoring, with different methodologies for each survey type. There is no standard survey method for finding every pearl mussel in a stretch of river, but the law of diminishing returns operates, where the more effort is put into surveying a small area of mussel habitat, the more mussels will be found (if they are present).

The principal objective of the present survey was to provide a confident assessment of the size and distribution of the mussel population.

4.1.1 Methodology

Surveys were carried out by two experienced surveyors using standard perspex-bottomed viewing equipment within safe water depths (1.2m maximum) and with due regard to health and safety issues. Depending upon the density of mussels, extent and width of mussel beds, the surveyors either worked individually or in parallel. Some deeper sections were surveyed by snorkelling.

In some sections total counts of mussels were made for the entire section or for a part of the section. In many sections the number of mussels was determined by the use of Sweep Transects. One surveyor using a viewing bucket crosses the river and records every mussel seen within the surveyor's sweep (this was measured as 2.5 metres). Counts were made for each $\frac{1}{4}$ of the river channel width to show the cross channel distribution. The number of sweep transects per section ranged from 4 to 15. Multiplication of the number of mussels in x transects enabled the number of mussels per 100 linear metres of river to be calculated. The abundance in each section was then assigned to 5 abundance categories: Abundant = >1500 mussels/linear 100m of channel; Common = 301-1500; Frequent = 41-300, Occasional = 1-40; Absent = 0.

It should be noted that for the entire survey (carried out from April to June 2009), conditions were excellent. Recorder error due to poor visibility is thought to be as low as is possible in the Deel.

4.2 Population demographics and juvenile searches

Population demographics and juvenile searches followed Moorkens (2004a, 2005a, b & c) and Ross (2004a & b, 2005a & b, 2006a & b).

The size/age structure of the population was determined by removing all of the mussels from a fixed area of substrate and measuring them. This consisted of laying a 0.5m x 0.5m metal quadrat on the river bed and counting the number of mussels visible from the surface. The visible mussels were then carefully removed from the quadrat with as little disturbance to the substrate as possible. The substrate was then disturbed with the fingertips and any additional mussels counted and removed. Finally, an aluminium framed sampling net equipped with a 0.5mm nylon mesh bag was stood vertically on the downstream side of the quadrat and the substrate was agitated to allow any remaining mussels to come to the surface and any very young (<15mm) individuals to be swept by the water current into the net. All mussel lengths were then carefully reburied in the substrate they were taken from. In addition, all dead shells found in the surveys were collected and measured. Sufficient quadrats were sampled to provide at least 50 mussels from any one site or habitat type.

The size measurements were transferred into an Excel spreadsheet, assigned to size classes with 5mm increments and shown as size frequency (%) histograms.

Juvenile mussels were also sought by kick sampling riffle areas. The substrate was vigorously disturbed by the surveyor's boot and all material swept up into the column was collected by the sampling net held against the substrate immediately downstream of the sample location. The material was tipped into a white plastic tray and examined for the presence of juvenile pearl mussels.

4.3 Redox potential measurements

4.3.1 Introduction

The key cause of decline in pearl mussel populations in most rivers is lack of recruitment brought about by the habitat for juvenile mussels after they fall off the gills of host salmonids being unsuitable. This stage requires the safety of remaining within the river bed gravels, before growing to a size that allows the emergence of the filtering siphons into the open water body. While the juvenile mussels remain within the river bed gravels, they filter the interstitial water within the gravels. Where the gaps between the gravel stones get clogged with fine silt, the flow of water in the interstices becomes very restricted. Without adequate water movement and replacement, oxygen levels are exhausted and young mussels die. The decline in interstitial water quality in silted gravels has been detailed by Buddensiek (1989), Buddensiek *et al.* (1993). Fine sediments in gravels were shown to increase mortality in juvenile mussels to 100% (Buddensiek, 2001).

Fine silt can become a problem due to excessive loading from various sources. Excessive nutrients in the water body lead to filamentous algal growth, which in turn decays and forms organic silt.

The differences in the redox potential between the water column and the substrate correlate with differences in oxygen levels, and thus, the level of clogging of the interstices by fine sediments (silt). These data are of greatest significance for juvenile mussels which require full oxygenation of the sediment. In suitable juvenile mussel habitat, there should be very little loss of redox potential between the open water and the gravels below. There should not be a significant reduction in redox potential to depths to 10cm (Geist & Auerswald 2007).

4.3.2 Methodology

The equipment comprises a 0.7m long probe fitted with a platinum tipped electrode, a reference potassium chloride electrode and a meter with a millivolt display. A reading is obtained by holding both electrodes in the water column until a stable reading is obtained (typically this would be 500-540mV). With the KCl electrode remaining in the water column, the platinum electrode is then inserted into measured depths in the substrate and a reading taken immediately. Separate readings are obtained for substrate depths ranging from 2cm to 8cm. Approximately 20 readings are taken at each site.



Figure 1: Taking redox measurements

The results were plotted as scatter graphs with a linear trendline added and the intercept set at the value of the redox potential of the open water. The redox potential value for the point on the intercept line co-incident with a substrate depth of 5cm was determined.

5.0 Results

The River Deel was separated into 69 sections which varied in length from c.100m to c.700m. A further 15 sections of tributaries, were also surveyed, principally in the Shanvolahan, Glasheens and Bar Deela Rivers.

Sections 1 to 12 are shown in Table 1, Map 1 and Photos P1 to P15. Sections 13 to 23 are shown in Table 2, Map 2 and Photos P16 to P27. Sections 24 to 47 are shown in Table 3 - 4, Map 3 and Photos P28 to P72. Sections 48 to 60 are shown in Table 5-6, Map 4 and Photos P73 to P102. Sections 61 to 69 are shown in Table 7, Map 5-7 and Photos P103 to P126.



Map 1: Survey sections from Lough Conn to Rathnamanagh River confluence (1-12)

Section	Start Point	End Point	Mussel abundance/ numbers	General habitat	Substrate	Macrophytes	Fil. algae	Notes
1	d/s old castle at G17955 18366	u/s at G18038 18551	Absent	Deep canalised section, occasional swifter flowing parts	Coarse cobble and boulders	Glyceria fluitans Fontinalis Potamogeton	Abundant	Cattle access, earth mounds on banks, slurry spreading, supp feeding on banks
2	Deelcastle d/s bridge at G17911 18848	u/s bridge at G18362 18973	Absent	Deep, slow canalised section	Coarse cobble and boulders	Full of <i>Potamogeton &</i> algae	Abundant	
3	G16938 19361	G16509 19207	Frequent	Shallow glides, ponded parts and swifter flowing sections	Mix of sand, gravel, cobble and occasional boulders – also builders rubble	Potamogeton, Nuphar, Myriophyllum (with silty flock)	Present, lots of algal flock	Zig-zag searching and 10 sweep transects 20 measured Many bankside issues (see photos)
4	G15942 19009	To N59 road bridge at G15782 19208	Frequent c. 50 seen	Shallow glide at d/s end of section becoming riffle in 50m to bridge	Sand/gravel, very silted, occasional cobble and boulder	Some <i>Fontinalis</i> covered cobble, & <i>Myriophyllum</i>	Moderate cover in places	Counted 35 mussels in E ½ of river d/s bridge. Fisheries people in river
5	N59 road bridge at G15782 19208	To stock access at G15623 19318	Occasional 10 seen	Mostly riffle habitat	Sand/gravel, very silted, occasional cobble and boulder	Some <i>Fontinalis</i> covered cobble, & <i>Myriophyllum</i>	Moderate cover in places	2 sweep transects
6		To drain at G15589 19403	Occasional 2 seen	Deeper, slower section	Angular cobble and gravel all covered in algal flock		Algal flock	Zig-zag searching
7		To bend at G15620 19523	Frequent 69 seen	Mostly shallow riffle and glide	Sand, gravel & cobble - silted	Occasional Fontinalis & Myriophyllum	Moderate cover in places	10 sweep transects 20 measured
8		To riffle at G15601 19601	Occasional 24 seen	Initially deep becoming shallower to riffle	Angular cobble and compacted clay d/s changing to cobble nearer riffle	Schoenoplectus Along east bank		23 mussels in east ¹ / ₄ amongst the <i>Schoenoplectus</i>
9		To powerlines at G1558819711	Occasional 2 seen	Generally deep and ponded	Bouldery with algal flock		Algal flock	2 mussels seen in east $\frac{1}{4}$

Table 1: Survey sections and locations & numbers of mussels – Sections 1 to 12

Fable 1 continued:	Survey sections	and locations & n	numbers of mussels –	Sections 1 to 12
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10	To bend with revetment at G15477 19896	Occasional 12 seen	Similar to short riffle at G15500 19832 then ponded again u/s	As above	Algal flock	Not continuous survey 4 sweep transects
11	To ditch with stock access at G15537 20041	Occasional 32 seen	Glide section with some riffle patches	Some good gravel habitat		Not continuous survey
12	To confluence of Rathnamagh River at G15662 20411	Occasional 25 seen	Mostly glides with occasional riffles	Some good gravel habitat		Not continuous survey







Map 2: survey sections from Rathnamanagh River confluence to Crossmolina (13 to 23)

Table 2:	: Survey sections and locations & numbers of mussels – Sections 13 to 22
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Section	Start Point	End Point	Mussel abundance/ numbers	General habitat	Substrate	Macrophytes	Fil. algae	Notes
13	Confluence of Rathnamanagh River at G15662 20411	To field boundary at G13917 20177	-	-	-	-	-	NOT SURVEYED
14		To G14731 18817	Frequent	Mostly glides with occasional riffles	Flat bed with mostly sand, gravel and pebble	<i>Myriophyllum</i> Occasional <i>Fontinalis</i> on larger clasts	Extensive cover of algae and flock	5 sweep transects
15		To riffle shoal at G14721 19755	Common	Mostly glides with occasional riffles	Flat bed with mostly sand, gravel and pebble	<i>Myriophyllum</i> Occasional <i>Fontinalis</i> on larger clasts	Extensive cover of algae and flock	10 sweep transects 73 mussels measured <i>Anodonta anatina</i> found
16		To bend near road at G14445 19641	Frequent	Riffles and shallow glides	Flat bed with mostly sand, gravel and pebble, very silty	Myriophyllum & Ranunculus	Extensive cover of algae and flock	8 sweep transects
17		To confluence with Toreen River at G14359 19321	Occasional c. 30 seen	Good riffle & glide to powerlines, then wide sluggish upstream	Flat bed with mostly sand, gravel and pebble, but coarser along east side	Marginal Schoenoplectus	Extensive cover of algae and flock	
18	G14111 19066	To stream confluence at G14074 18938	Occasional 6 seen	Glide	Flat bed with mostly sand, gravel and pebble	Myriophyllum	Extensive cover of algae and flock	
19	G14009 18348	To bend at G14001 18029	Occasional <20 seen	Riffles and shallow glides	Good mix of gravel and cobble	Sparse Myriophyllum & Fontinalis	Extensive cover of algae and flock	
20		To sharp bend at G14264 17869	Frequent <50 seen	Riffles and shallow glides, and shoals, some scoured parts	Mostly mix of gravel and cobble, with some boulders	Sparse Myriophyllum	Covered in algal flock	Parts of section revetted Cattle access
21		To bend at G13865 17746	Occasional <20 seen	Range of habitats from shallow riffles to deeper ponded sections	Mostly cobble and gravel	Sparse Fontinalis	Covered in algal flock	Parts of section revetted Cattle access

Table 2 continued:	Survey sections a	and locations & r	numbers of mussels	- Sections 13 to 22
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Section	Start Point	End Point	Mussel abundance/ numbers	General habitat	Substrate	Macrophytes	Fil. algae	Notes
22		To Crossmolina road bridge at G13759 17577	Occasional <20 seen	Very shallow downstream of Crossmolina Bridge	Scoured cobble mostly	Sparse Myriophyllum	Covered in algal flock	Riverbed altered







Map 3: Survey sections from Crossmolina to Ballyscanlan school bridge (23 to 47)

Section	Start Point	End Point	Mussel abundance/ numbers	General habitat	Substrate	Macrophytes	Fil. algae	Notes
23		To seating area at G13733 17324	Frequent c. 100 seen	Riffles and shallow glides, deeper towards downstream end of section	Cobble, pebble and gravel in riffle sections but coarser cobble in deeper u/s section		Present but patchy	15 sweep transects
24		To G13544 16966	Frequent c. 200 seen	Riffles and shallow glides	Mostly cobble and gravel		Present but patchy	
25	G13511 16963	Corner of bend at G13479 16857	Common c. 520 seen	Mostly riffle section becoming deeper towards bend	Cobble, pebble and gravel in riffle sections but coarser cobble in deeper u/s section	Some Fontinalis	Present but patchy	258 mussels mostly in S $\frac{1}{2}$ of channel to top of riffle at G13582 16923, then ~260 mussels in mid and N $\frac{1}{2}$ of channel to bend
26		To top of riffle at G13389 16837	Occasional 17 seen	Mostly riffle section, possibly too high energy	Substrate appeared to be good with clean cobble and gravel.	Very little Fontinalis	Very little	Mussels scattered
27		To bend at G13324 16842	Occasional 9 seen	Relatively slow section	Pebble & gravel along south ¹ / ₂ of channel, deeper & rockier along north ¹ / ₂ . Bed covered in silty veneer.			Mussels scattered Water turbid
28		To riffle at G 13264 16738	Occasional to Frequent c. 30 seen	Section with bends, riffles and glides	Sections with good cobble & gravel habitat	Sparse Fontinalis		Mussels scattered 5 sweep transects
29		To top of riffle at G13230 16651	Abundant at least 2000 in section	Good riffle section	Run of <i>Fontinalis</i> covered cobble and gravels	Fontinalis covered cobble and gravels	None seen	Mussels mostly on the deeper tail of the riffle 3 sweep transects
30		To narrow constriction at G13187 16592	Occasional 4 seen in 4 sweeps	Swift flowing section	Clean cobble and pebble	Sparse Fontinalis		4 sweep transects

Table 3: Survey sections and locations & numbers of mussels – Sections 23 to 35

Table 3 continued:	Survey sections and location	1s & numbers of mussels -	- Sections 23 to 35
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Section	Start Point	End Point	Mussel abundance/ numbers	General habitat	Substrate	Macrophytes	Fil. algae	Notes
31		To track down from road at G12963 16474	Common >300 mussels seen	Slow bend with long riffle run u/s	Mostly gravel and cobble			Mussels mostly on tails of riffles and on inside of bends Outside of bend revetted
32		To G12787 16419	Occasional, only 1 seen	Mostly glide	Mostly coarse cobble, may have been dredged		Algal flock in slow sections	Much of the bed in the section has been altered. Bankside issues, rubble and rubbish in river
33		To constriction at G12455 16223	Occasional	Long section with very little suitable mussel habitat. Pools, falls, deep glides, bedrock	Pools with cobble and gravel but extensive areas of bedrock		Lots of algal flock in slow sections	Mussels rare and scattered Much of the bed in the section has been altered
34		To G12227 16162	Occasional	Mostly gorge with glides and pools	Bedrock, some shallow glides with cobble and gravel			Mussels scattered
35		To causeway at G12135 16099	Common	Mixed habitats with mostly shallow riffles and glides	Mostly gravel and cobble but highly silted and compacted in places		Algae & algal detritus throughout	Much of the bed in the section has been altered







Table 4: Survey sections and locations & numbers of mussels – Sections 36 to 46

Section	Start Point	End Point	Mussel abundance/ numbers	General habitat	Substrate	Macrophytes	Fil. algae	Notes
36	Causeway at G12135 16099	To riffle at G12014 15882	Frequent	Mostly glide	Cobble and boulders, highly silted		Algae & algal detritus throughout	Many dead shells near upstream end, some broken by cattle trampling
37		To top of good riffle at G11905 15826	Common	Relatively narrow channel with good riffle habitat	Cobble and gravel but rather silted		Algal detritus throughout	Kick sample had Ephemeroptera but mostly low quality species. 27 mussels measured
38		To cascade at G11839 15785	Common	Mainly a large shallow ponded area with swift flow on downstream end	Cobble, gravel and sand - silted	Some Myriophyllim	Algal detritus throughout	50 mussels measured
39		To G11669 15472	Occasional	Section with extensive bedrock and cascades	Bedrock, boulder and cobble, very little suitable mussel habitat	Fontinalis		High energy
40		Cattle access point at G11477 15402	Common	Glide with some riffle sections	Mostly cobble and gravel with some bedrock	Fontinalis	Algal detritus throughout	
41		To cascade at G11304 15528	Abundant	Shallow, glides, riffles and runs. But some deeper sections	Shallow sections with gravel and cobble. Some bedrock at d/s end and boulder/cobble & gravel in deeper parts	Some Myriophyllim & Fontinalis	Some algae & algal detritus	Cattle access
42		To boundary at G11169 15577	Abundant	As for 41	As for 41	Some Myriophyllim & Fontinalis	Some algae & algal detritus	Cattle access
43		To cascade at G10850 15497	Common	Mostly slow glide	More bedrock than in 41/42, much of substrate covered in veneer of silt		Some algae & algal detritus	Cattle access

Table 4 continued: Survey sections and locations & numbers of mussels – Sections 36 to 46

Section	Start Point	End Point	Mussel abundance/ numbers	General habitat	Substrate	Macrophytes	Fil. algae	Notes
44a		To large boulder in river at G10798 15398	Common	Glides and riffles with some cascades	Bedrock, boulder and cobble mostly	Fontinalis	Some algae & algal detritus	
44b		Base of island at G10663 15311	Abundant	Glides and riffles with some cascades	Range from bedrock, boulder and cobble to pockets of gravel	Fontinalis	Some algae & algal detritus	Machine access to river
45		To riffle at G10578 15215	Abundant	Glides and riffles	Range from bedrock, boulder and cobble to pockets of gravel	Myriophyllim & Fontinalis	Some algae & algal detritus	
46		To bridge by school at G10115 15201	Common	Mostly glides and a pool with occasional rifles	Boulders, cobble occasional gravels, bedrock ledges	Occasional Fontinalis	Some algae & algal detritus	Mussels scattered











Map 4: Survey sections from Ballyscanlan school bridge to Cominch (47 to 61)

Table 5: Survey sections and locations & numbers of mussels – Sections 47 to 51

Section	Start Point	End Point	Mussel	General habitat	Substrate	Macrophytes	Fil.	Notes
			abundance/ numbers				algae	
47	Bridge by school at G10115 15201	Bankside flushes at G09884 15414	Frequent	Glide section with riffles and terraces	Mostly bedrock with gravel and cobble in runnels	Patchy Fontinalis	Algae & algal detritus throughout	Mussels occur throughout and are $2-3/m^2$ in the riffle areas
48		To field boundary at G09658 15462	Frequent to common	Deep glides, ponded in places with riffle run at upstream end	Boulders, cobble & gravel in glides, better in riffle run	Patchy Fontinalis	Algae & algal detritus throughout	Mussel distribution very patchy. Cattle access plus stock in river (photos)
49		To field boundary at G09121 15489	Abundant	Glides and riffle runs with good habitat throughout	Mostly gravel and cobble	Several areas with <i>Fontinalis</i> covered cobble	Some algae & algal detritus	14 sweep transects 120 mussels measured from xx quadrats
50		To G09206 15278	Common	Glides and riffle runs with good habitat throughout	Mostly gravel and cobble	Patchy Fontinalis+ occasional Myriophyllum	Some algae & algal detritus	
51		To Ballymulty Bridge G	Common to Abundant	Glides and riffle runs with good habitat throughout	Mostly gravel and cobble	Patchy Fontinalis with areas of Myriophyllum nearer the bridge	Some algae & algal detritus	25 mussels measured





Section	Start Point	End Point	Mussel abundance/	General habitat	Substrate	Macrophytes	Fil. algae	Notes
52	Ballymulty Bridge	To ditch at G08852 14976	numbers Frequent	Relatively slow flowing section	Bedrock, boulders and cobble, covered in silty veneer	Patchy Fontinalis & Myriophyllum	Some algae & algal detritus	
53		To G08803 14756	Common	Mostly glide with some short riffle sections	Mixed with boulders & cobble with pockets of sand & gravels, very silted	Extensive Myriophyllum, some Fontinalis	Lots of algae & algal detritus	Cattle access
54		To ditch at G08767 14525	Frequent	Mostly glide with some short riffle sections and deep ponded section on bend	Mixed with boulders & cobble with pockets of sand & gravels, very silted	Extensive Myriophyllum,	Lots of algae & algal detritus	
55		To field boundary at G08291 14592	Frequent	Mostly glide with some short riffle sections	Mixed with boulders & cobble with pockets of sand & gravels, very silted	Extensive <i>Myriophyllum,</i> some <i>Fontinalis</i>	Lots of algae & algal detritus	Cattle access
56		To track into river at G08010 14999	Common	Wide, relatively shallow riffles and runs	Mostly cobble and gravel, silty	Very weedy in places with Myriophyllum, Callitriche & Potmogeton	Some algae & algal detritus	5 sweep transects 50 mussels measured
57		To bend at G07519 14872	Frequent to common	Wide, relatively shallow riffles and runs	Mostly cobble and gravel, silty	Myriophyllum, Callitriche & Potmogeton	Some algae & algal detritus	
58		To G07180 15211	Frequent	Wide, relatively shallow riffles and runs	Mostly cobble and gravel, silty	Myriophyllum, Callitriche & Potmogeton	Some algae & algal detritus	
59		To bend at G06814 15332	Occasional c. 10 mussels seen	Mostly glides, more ponded at upstream end	Mostly gravels and cobble, but coarse cobble and bedrock towards u/s end	Very weedy with <i>Myriophyllum,</i> & Potmogeton	Luxuriant algae & algal detritus	Cattle have access at several places. Mussels all large and old
60		To confluence with Shanvolahan River at G06669 15462	Occasional 1 mussel seen	Shallow run	Mostly gravels and cobble, highly silted	Very weedy with Myriophyllum, & Potmogeton	Masses of algae and algal flock	Cattle have access throughout

Table 6: Survey sections and locations & numbers of mussels – Sections 51 to 60







Map 5: Survey sections from Cominch to Knockahome (62 to 63) and lower Glasheens River



Map 6: Survey sections from Knockahome to Bar Deela confluence (64 to 66) and Bar Deela River (82 to 84)



Map 7: Survey sections in the upper Deel (66 to 69)

Section	Start Point	End Point	Mussel abundance/ numbers	General habitat	Substrate	Macrophytes	Fil. algae	Notes
61	G06737 14568	Upstream of bridge at G06775 14231	Absent	Good riffle run d/s of bridge	Lots of gravels and some cobble but very silty and compacted	Nuphar even in shallow riffles + Myriophyllum, & Potmogeton		Bank erosion
62	G05972 14202	G05539 14469	Absent	Deep ponded section very poor visibility	Muddy, peaty over cobble	Nuphar		Forestry on south bank of section
63	G03208 15818	G02947 16118	Absent	Deep ponded section very poor visibility	Muddy, peaty over cobble	<i>Sparganium</i> at margins, some <i>Nuphar</i>		Possibly canalised. River runs through bog and forestry, drains from forestry into river
64	G01997 15798	To bend at G01793 01648	Absent	Riffle runs and glides with lots of potentially suitable mussel habitat	Cobble and gravels but highly silted	Myriophyllum, Fontinalis & Potmogeton	Patches of algae and flock	Mussels formerly known from this section. Habitat good but in poor condition
65	d/s Deel Bridge at G01602 15728	To u/s Deel Bridge at G00854 15672	Absent	Riffle runs and glides with potentially suitable mussel habitat	Gravels and cobbles, extensive areas of sand. Highly silted throughout and muddy in some places.	Myriophyllum, Fontinalis, Callitriche, Nuphar & Potmogeton	Patchy cover of algae and flock	Mussels formerly known from this section
66	G01319 14890	To u/s bridge at G01484 14666	Absent	Range of open and tree-lined habitats, glides and runs	Highly silted cobble and gravel	Myriophyllum, Callitriche & Potmogeton	Masses of algae and algal flock	Cattle access
67	100m d/s of bridge at G02328 11829	To 100m u/s bridge	Absent	Shallow run	Mostly scoured cobble		Masses of algae and algal flock	Stock in river, hard measures on banks, adjacent forestry
68	100m d/s of bridge at G02241 10843	To 100m u/s bridge	Absent	High energy, relatively steep gradient	Scoured cobble		Patches of algae and flock	Stock in river
69	Upstream from G02272 09571	To end of road at G01222 07369	Absent	High energy, narrow, swift flowing steam. Good looking habitat in places	Boulders, rocks, bedrock etc		No algae above forestry	May dry out in summer

Table 7: Survey sections and locations & numbers of mussels – Sections 61 to 69

P103: Section 61 downstream bridge	P104: Section 61 upstream bridge	P105: Section 62
P106: Section 62	P107: Section 63 forestry on bog by river	P108: Section 63 habitat





Table 8: Tributaries - Survey sections and locations & numbers of mussels – Sections 70 to 74 (downstream Crossmolina)

See	Мар	2	for	locations

Section/River	Start/End Point	Mussel abundance/ numbers	General habitat	Substrate	Macrophytes	Fil. algae	Notes
70 Rathnamagh River	Bridge at G15717 21170 to confluence with Deel at G15662 20411	Absent	Muddy stream, canalised with cattle access	Mud	Potamogeton and Sparganium	Luxuriant growth of algae	Drainage scheme channel
71 Unnamed stream	Bridge at G15224 20928	Absent	Shallow, weedy, silted up stream	Very silty	Very weedy		Cattle in stream
72 Toreen River	G14359 19321	Absent	Very narrow ditch	Muddy and trampled	Glyceria fluitans		Drainage scheme channel, very little water
73 Enagh More River	Upstream of bridge at G13650 18776	Absent	Slow flowing canalised section	Very muddy	Potamogeton	Abundant algae	Drainage scheme channel, earthworks along banks
74 Enagh More River	Downstream of bridge at G13650 18776 to Deel confluence	Absent	Canalised section with some swift-flowing parts	Some <i>Fontinalis</i> cobble and gravels, but mostly muddy cobble	Fontinalis Glyceria fluitans, Rorippa	Abundant algae	Drainage scheme channel, cattle access, drains and slurry spreading in adjacent fields, supp feeding

P127: Section 70 Rathnamanagh River	P128: Section 71 un-named River	P129: Section 72 Toreen River at Deel confluence
P120: Section 74 Enorth Marie Biron Hord	P111: Cation72 Encet Man Biyas restances	P122: Castian 74 Enach Mana Biyan despectance
1 150. Section 74 Enagn More River hear Deel	bridge	bridge

 Table 9: Tributaries - Survey sections and locations & numbers of mussels – Sections 75 to 84 (upstream Crossmolina)

Section/River	Start/End Point	Mussel abundance/ numbers	General habitat	Substrate	Macrophytes	Fil. algae	Notes
75 Shanvolahan River	G06581 15669 to G06477 15927	Absent	Moderate flowing stream with deeper channels	Mostly cobble and gravel with areas of bedrock, highly silted	Stands of Schoenoplectus	Luxuriant cover of algae	Potential habitat but in very poor condition. Several fords
76 Shanvolahan River	Bridge at G06227 17507, 100m u/s & d/s	Absent	Moderate flowing steam, shallow	Very compacted, highly silted cobble	Potamogeton, Nuphar rooted into stable substrate, marginal Carex	Luxuriant cover of algae	Water coloured
77 Shanvolahan River	Bridge at G06228 18055, 100m u/s & d/s	Absent	Moderate flowing steam, shallow	Very compacted, highly silted cobble	Potamogeton	Luxuriant cover of algae & algal flock	Water turbid
78 Carrowgarve	Bridge at G08728 15099	Absent	Narrow, shallow, swift flowing stream	Mostly highly silted gravels and pebble		Full of rotting algae	
79 Glasheens River	Near confluence with Deel at G05803 14342	Absent	Very shallow stream with little flow	Mostly very coarse cobble		Algae and flock present	
80 Glasheens River	Bridge at G05838 12756	Absent	Lowland peaty river, ponded, with drainage channels coming in from forestry & improved fields	Silt covered cobble	Potamogeton and Nuphar	Dense algae and algal flock	Miserable habitat
81 Glasheens River	Bridge at G04689 11210	Absent	Relatively shallow	Mostly cobble	None seen		No mussel habitat
82 Bar Deela River	At confluence with Deel at G01349 14679	Absent	Wide, relatively slow	Muddy cobble and gravel	Very weedy, Myriophyllum	Dense algae and algal flock	
83 Bar Deela River	G00603 14329, 100m u/s and 100m d/s	Absent	Alternating deep, slow sections and shallow swift sections	Boulders and coarse cobble, sparse smaller clast sizes	Potamogeton and some Fontinalis	Dense algae and algal flock	Heavily poached by cattle, possibly dredged
84 Bar Deela River	F99067 12489	Absent	Peaty river with alternating deep, slow sections and shallow swift sections	Rather rounded cobble and pebble, but some runs with good <i>Fontinalis</i> covered cobble and gravels	Very weedy Potamogeton & Myriophyllum with marginal Schoenoplectus and Menyanthes	Some patches of algae	Sheep access, drainage ditches







5.1 Survey of Population Size and Distribution

Pearl mussels were found in the River Deel over a distance of approximately 20km. The downstream limit was found to be near Deelcastle (G175191). Mussels may occur further downstream to Lough Conn but the river is very deep and ponded through that section. The upstream limit from the present survey was found to be just downstream of the confluence with the Shanvolahan River at G067154. Above the confluence, the river is mostly deep and ponded to downstream of Deel Bridge (G009157). Local residents reported that mussels were known in the section around and downstream of Deel Bridge within the last 10 years. In spite of good runs of potentially suitable habitat, no live mussels or evidence of dead shells were found during the present survey. Upstream of Deel Bridge, both the Deel and Deela rivers are generally unsuitable for mussels. Mussels were not found in the two other main tributaries, the Glashhens and Shanvolahan rivers, or in the smaller tributaries downstream of Crossmolina (most of which have been canalised).

Section	No of mussals	Section	No of mussals	Section	No of mussals
Section		Section		Section	
1	0	24	400	4/	500
2	0	25	700	48	100
3	1000	26	25	49	25000
4	100	27	25	50	2100
5	25	28	200	51	2250
6	25	29	2000	52	200
7	300	30	70	53	2000
8	50	31	500	54	600
9	25	32		55	3100
10	250	33	500	56	3720
11	100	34		57	1500
12	50	35	550	58	100
13	200	36	450	59	25
14	500	37	1300	60	5
15	750	38	3000	61	0
16	325	39	250	62	0
17	50	40	1500	63	0
18	20	41	10150	64	0
19	20	42	5200	65	0
20	100	43	1650	66	0
21	50	44a	500	67	0
22	50	44b	5500	68	0
23	440	45	5500	69	0
		46	3000		

 Table 8: Number of mussels estimated for each survey section

 (Figures in black are based on sweep transects, those in red are based on the general survey & best expert judgement)

Although mussels occurred more or less continuously over the 20km section, the abundance varied widely. This is due largely to wide variations in river geomorphology, some places with limestone gorges and deep ponded sections provide very little suitable habitat. The river has also been affected considerably by land drainage schemes (especially downstream of Crossmolina) and fisheries activities.

The core of the mussel population in terms of numbers lies between Crossmolina and Ballymulty Bridge (G090151). Several survey sections in this stretch were classified as having abundant mussels, i.e. >1500 mussels per 100m length of river, although never at capacity (i.e. places with >250 mussels/m²). Upstream of Ballymulty Bridge, the mussels were more patchy in distribution and only small areas had moderately high numbers. Further upstream the numbers gradually diminished until only occasional individuals were found towards the upstream limit. Downstream of Crossmolina the abundance was classified mostly as frequent with occasional sections classified as common. Table 8 shows the number of mussels estimated for each survey section. This indicates a total of around 89,000 individuals. Given that this is likely to be an-underestimate, it is likely that the total population of the Deel is around or in excess of 100,000 individuals.

5.2 Population demographics and juvenile searches

Quadrat searches were carried out throughout the length of river inhabited by mussels. The results from over 20 quadrat searches combined to determine the age/size profiles are shown in Figure 2.

This graph shows a relatively wide size profile with some evidence of recent recruitment. Young mussels under 65mm comprised 7.8% of the population (the ideal profile should have 20% of the mussels <65mm). The smallest mussel found was 22mm in length. Some parts of the river have a much better size profile – e.g. from downstream of Ballymulty Bridge (at this location 16.7% of the mussels were <65mm in length). The variation in size profile through the river can be seen in Figures 3 - 10).



Figure 2: Size distribution profile of mussels for River Deel – all quadrats combined



Figure 3: Size distribution profile of mussels for River Deel Section 7

Figure 4: Size distribution profile of mussels for River Deel Section 15



Figure 5: Size distribution profile of mussels for River Deel Section 37





Figure 6: Size distribution profile of mussels for River Deel Section 38

Figure 7: Size distribution profile of mussels for River Deel Section 45



Figure 8: Size distribution profile of mussels for River Deel Section 48





Figure 9: Size distribution profile of mussels for River Deel Section 49

Figure 10: Size distribution profile of mussels for River Deel Section 51



5.3 Results of redox measurements

Redox potential measurements showed that the substrate in the Deel is relatively highly silted in places. Even in the areas with the highest numbers and best size profiles, the loss in redox at 5cm depth was over 25% (20% is considered necessary for effective juvenile recruitment) (Figures 11 - 15).



Figure 11: Section 15, Loss at 5cm depth = 33.2%

Figure 12: Section 24, Loss at 5cm depth = 38.5%











Depth in sediment (cm)



6.0 Discussion

The results of this extensive survey have found that a large and important population of *Margaritifera* is still present in the Deel River, with some recruitment of young mussels occurring, a rare situation in mussel populations in Ireland. The Deel River was also found to have a co-occurrence of the duck mussel *Anodonta anatina* with *Margaritifera*, also very rare and of great ecological interest.

To place the Deel River *Margaritifera* into context, it can be compared with the 27 populations that are currently within SACs. This can be done in two ways, firstly by the status categories that are defined as follows:

- 1) Very large populations of adults (500,000+), all ages of juveniles, some juveniles in more than one area (5) (18.5% of cSACs)
- 2) Large widespread populations of adults, or smaller numbers in good but restricted habitat, some juveniles in more than one area (5) (18.5%)
- Large numbers of adults, some decline from larger numbers evident, few juveniles (6) (22.2%)
- 4) Small numbers adults from historical evidence (<20,000), very few juveniles (5) (18.5%)
- 5) Very poor population of adults (<10,000), few or no juveniles (6) (22.2%)

The second context is to place where the Deel population sits within the ranking system of the 27 cSACs, which have been ranked from 1 to 27 according to number of individuals, size profile, percentage juveniles under 65mm and 30mm and imminence of extinction (taking into account death rate from collected shells.

The Deel population fits in comfortably in Status 2, as the population is probably greater than 100,000 adult individuals, with some juveniles in more than one area. Within the ranking of SAC populations, the Deel would fall into 7th place out of 28 populations. Thus the Deel population is of high conservation value, ranking higher than 21 of the cSACs with *Margaritifera* as a designation interest.

However, the Deel system is large and intensively managed through much of its length. The absence of a lake upstream and the large catchment size means that the recovery of the population into favourable status would be very challenging, with strong management measures needed.

Most of the mussels, and those with the best size-age profile live in areas of very fast flow, and this slope and flow appear to be mitigating against the effects of siltation. These areas are within boulder-dominated habitats, and the boulders mitigate against scouring and thus aid the stability of the mussel environment. Cleanliness and stability are two equally vital ingredients of viable mussel habitat.

The river would benefit from conservation management measures, both in its upper catchment to cease the input of fine sediment loading into the river from the peaty areas, and in the more

intensively managed areas where some buffering from intensive management is needed and drainage inputs need to be either blocked or trapped en route. This is important as there are many mussels in small numbers spread through the 20km of river that face extinction as they cannot currently recruit, and the remaining pockets of mussels in the fastest riffles are not likely to be sustainable without the wider occupation of mussels. Due to the requirement of encysting glochidia onto salmonid fish, and young mussels needing to fall off fish in suitable habitat, populations restricted to small pockets of mussels and suitable habitat are unlikely to be successful through the law of diminishing chance.

As the population is of high value and requires conservation management improvements, a sub-basin catchment management plan similar to those being prepared for the 27 cSAC populations is recommended as a next step.

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Section	Bank	1/4	of chan	nel widt	:h –	Bank	Mussels/xm	Abundance	Estimate
		n	umber o	<u>f musse</u>	ls				For section
		0	0	0	0				
		0	0	0	0				
		0	0	0	0			Frequent	Estimate
		0	0	2	1	-		rrequent	for c.500m
3	South	0	0	1	0	North	38 mussels in	152 mussels in	section
_		0	0	3	3		25m	100m length of river	750 1000
		0	0	6	2	-			/50-1000
		0	1	8					
		0	3	0	3				
		0	0	2	2				
		0	 1	1	2				
		0	1	2	<u> </u>				Estimate
7		0	0	2	0 7			Frequent	for c.120m
		0	2	2	3	East	69 mussels in		section
	West	0	0	1	5		25m	276 mussels in	
		0	0	0	2		2.5111	100m length of	c.300
		0	0	3	4			river	
		0	0	2	11				
		1	1	0	6				
		0	1	0	2			Frequent in	
		0	0	2	1		12 muggala in	best part but	Estimate
10	West	0	0	0	3	East	12 mussels in	probably	for c.210m
		0	0	1	2		TOILI	Occasional	section
		0	0	1	2			overall	c. 250
		1	2	2	0			Frequent	Estimate
14		0	3	2	0		26 mussels in	200 1 .	for c.230m
14	West	1	5	0	0	East	12.5m	208 mussels in 100m length of	section
		0	1	1	1				c. 500
		0	3	4	0			livel	
		0	6	4	4				
		1	2	1	1				
		2	7	2	1			Common	Estimate
		0	0	2	1		83 mussels in		for c.225m
15	West	0	4	<u>2</u> <u>4</u>	3	East	25m	332 mussels in	section
		1	2	2	2	-	23111	100m length of	
		0	0	3	3			river	c. 750
		0	2	3	4				
		1	3	3	1				
		0	0	0	0				
		0	0	0	0				
16		0	0	3	0			Frequent	Estimate
		1	3	0	1		24 mussels in	120 1	for c.270m
	West	3	1	0	2	East	20m	120 mussels in	section
		0	1	3	1	1		river	0.205
		2	0	1	0	1		nver	C. 323
		0	1	1	0				

Appendix 1: Results of sweep transects

Section	Bank	1/4	of chan	nel widt	h –	Bank	Mussels/xm	Abundance	Estimate
		n	umber o	f musse	ls				For section
		0	0	0	0				
		0	1	2	0				
		1	1	1	0				
		0	1	1	0				
		0	0	2	1			Frequent	Estimate
	West	0	0	0	0		<i>(5</i>		for c.250m
23		0	1	1	0	East	37.5m	173 mussels in	section
		0	0	1	0		57.5111	100m length of	
		0	0	0	0			river	c. 440
		1	0	1	1				
		10	3	3	1	1			
		4	2	1	1				
		0	1	2	0				
		0	0	<u> </u>	9			Frequent	Estimate
		0	1	0	0			riequent	for c 390m
	North	0	0	0	0	South	6 mussels in	48 mussels in	section
28		0	1	0	1		12.5m	100m length of	
		0	0	1	1			river	c. 200
		0	13	24	6				Estimate
		0	3	39	15			Abundant	for c.90m
20	West					E t	120 mussels in	1600 mussels	section
29	west	0	0	14	6	East	7.5m	in 100m length	a 2000
		0	0	14	0			of river	based on
									total count
		0	0	0	0			Occasional	Estimate
		0	1	1	0		1 mussels in	40 mussels in	for c.165m
30	North	0	1	0	0	South	10m	100m length of river	section
		0	0	1	0				70
		5	1	1	1				C. /U
		3	4	1	4			Common	for a 175m
35	South	0	0	1	0	North	38 mussels in	308 mussels in	section
55	South	0	1	2	1	rtorui	12.5m	100m length of	section
		8	0	2	2			river	c. 550
		2	2	5	0				Estimate
		1	0	3	3			Frequent	for a 200m
36	South	3	0	0	0	North	33 mussels in	220 mussels in	section
50	South	2	1	0	0	ittorui	15m	100m length of	section
		1	3	0	0			river	c. 450
		0	2	3	2				Estimate
		8 5	2	4	0	ł		Common	for c 160m
37	South	12	0 	<u>5</u> Д	2	North	80 mussels in	800 mussels in	section
5,	South	12	-			1,011	10m	100m length of	5001011
		17	7	4	0			river	c. 1300
		1	0	0	3	ł		Abundant	Estimate
4.1	Care 1	0	0	0	2	North	564 mussels in	4512 mussels	tor c.225m
41	South	29	12	<u>6</u> 24	22		12.5m	in 100m length	section
		93	48	24 10	40 50	ł		of river	c 10.150
	ļ	140	13	19	32	ļ			0.10,150

Section	Bank	1/4	of chan	nel widt	h –	Bank	Mussels/xm	Abundance	Estimate
		<u>n</u>	umber of	f musse	17				For section
		39	46	49	17	-			
		69	82	14	23	-			Estimate
		24	/0	64	29		(47	Abundant	for c.160m
42	South	0	12	0	3	North	04 / mussels in	5255 mussels	section
		<u> </u>	4	2	1	-	20111	of river	
		4	/	3	1			ornver	c. 5200
		7	14	26	14	-			
		18	0	20	0				
		0	0	0	0			Common	Estimate
10	G 1	4	0	1	0	37.1	70 mussels in	467 mussels in	for c.350m
43	South	0	0	0	0	North	15m	100m length of	section
		9	0	0	26			river	0 1650
		4	5	1	2				c. 1650
		4	12	38	7			Abundant	Estimate
		24	73	41	2		285 mussels in	2850 mussels	for c.190m
44b	South	16	3	12	6	North	205 mussers m 10m	in 100m length	section
		9	9	26	3		Tom	of river	c. 5500
		6	0	2	9			Common	Estimate
16	South	4	1	7	3	North	46 mussels in	613 mussels in	for c.470m
40 5	South	4	4	5	1	norun	7.5m	100m length of river	section c. 3000
		6	12	7	3				
		19	36	11	7		42.4 1 .	Abundant	
49a	South	24	56	29	5	North	434 mussels in	34/2 mussels	
		11	19	18	4		12.5m	in 100m length	
		49	66	44	8			or river	
		19	28	14	0			Abundant	Estimate
49h	South	64	39	8	2	North	283 mussels in 7.5m	3773 mussels	for c.700m
190	South	12	78	16	3	ivorui		in 100m length of river	section
49c		8	19	4	2				c. 25,000
(first 2		6	3	2	0			Abundant	
in glide	South	16	26	19	14	North	504 mussels in	3360 mussels	
then	South	6	17	48	83	North	15m	in 100m length	
becomes		2	6	23	66	-		of river	
riffle)		18	24	33	59				
		6	9	3	4			Common	Estimate
50	West	14	21	0	3	Fact	95 mussels in	950 mussels in	for c.220m
50	west	3	9	6	8	East	10m	100m length of	section
		3	4	2	0			river	c. 2100
		3	4	2	0			Common	Estimate
		2	9	11	0		80 mussels in	640 mussels in	for c.350m
51	West	1	3	0	0	East	12.5m	100m length of	section
		2	8	4	5			river	0. 2250
		0	2	19	4				C. 2230
		4	<u>с</u> Л	2	4	ł		Common	for a 250m
53	East	5 16	+ /	2	2 8	West	79 mussels in	790 mussels in	section
	Lusi	7	3	2	0 6		10m	100m length of river	50011011
		'	5	-	Ŭ				c. 2000

Section	Bank	1/4 of channel width – number of mussels				Bank	Mussels/xm	Abundance	Estimate For section
54	East	2	1	3	4	West	23 mussels in 7.5m	Common	Estimate
		1	2	4	1			307 mussels in	for c.200m
		0	3	2	0			100m length of river	section c. 600
55	South	0	1	1	0	North	45 mussels in 15m		Estimate
		2	2	0	0			Common 300 mussels in	for
		4	3	4	5				c.1040m
		0	0	0	1			100m length of	section
		4	4	2	10			river	
		1	0	1	0				c. 3100
56	South	3	3	2	5	North	93 mussels in 12.5m	Common 744 mussels in 100m length of river	Estimate
		3	2	2	2				for c.500m
		12	11	6	4				section
		6	12	1	3				
		9	2	3	2				c. 3720