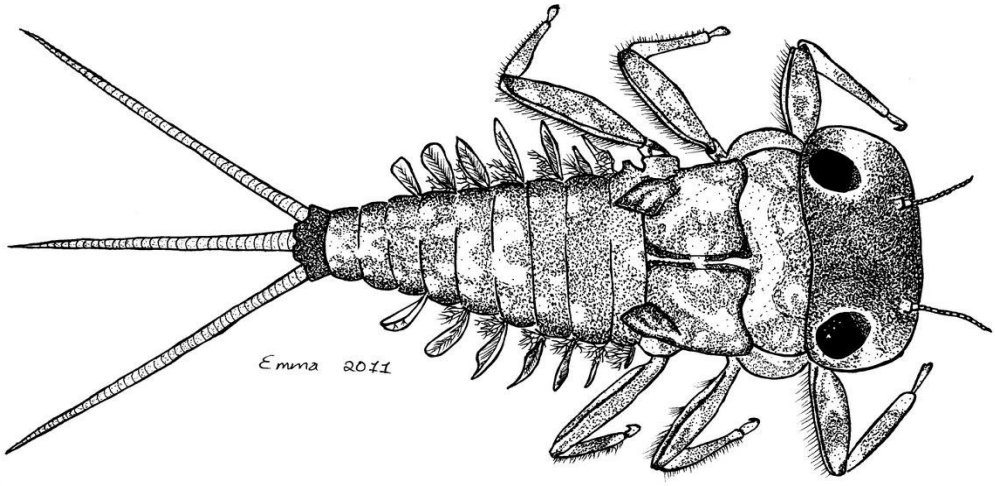
Invertebrate monitoring of the Millrace river Drumshanbo, Co. Leitrim.



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LoughAllenBasin.com is a voluntary project aimed at recording our environment and preserving our Heritage. We are mostly involved with Biodiversity; this report was initiated as part of our concern for water quality in the area.

The results are consistent over various tests with the overall condition of the Drumshanbo Millrace stream being mildly polluted. Certain issues did arise and particular areas of pollution were identified.

These may be easily remedied in the future...

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18th August 2011

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18th August 2011

Introduction

Water quality is related to the general health and cleanliness of a river, lake or stream. Water quality can be tested using physical, chemical and biological processes. The process which was chosen for the Millrace river was a biological process called Invertebrate Monitoring

The reason Invertebrate Monitoring was chosen is because it can provide you with information on pollutant levels, past and present, and it can quickly give you a accurate result about the water quality of an area. The most important invertebrates studied are typically the immature stages (larvae or nymphs) of insects that spend all their lives in the water until they are ready to transform into their adult form. The immature stages can last as long as two to three years. Invertebrates cannot migrate huge distances up rivers and they are sensitive to physical and chemical changes that may affect the water in the place in which they live. This is what makes them such suitable candidates for this type of analysis.

Invertebrate monitoring involves the collecting of data on the number of different organisms and species present or their absence in a specific area. Both the numbers and the presence or absence of particular species are then used to determine the quality of the water-body using a 'biotic index'. Biotic indexes are used by firstly identifying the invertebrates and counting the numbers present in the sample. You then refer to the biotic index to calculate a score. This score then indicates the level of pollution within a water-body, giving you your final result. It is always useful to use roughly three biotic indexes as this gives you a more accurate result.

The Millrace stream originates from Sliabh an Iarainn. It is then joined by two other small streams where it then flows through agricultural land past a small forestry and into two small lakes, Roscunnish, and one known as Pryce’s Lake. From here the river then flows into the suburbs of Drumshanbo, through the town and into Lough Allen at Wynne’s Bay.

Sampling Methods

a) Kick sampling.

Materials used: Sweep net, Stop watch, White tray, Bucket with lid, Labels.

The steps below describe the method for taking a kick sample in a stream:

1) An area of stream is picked where there is a mixture of slow water, fast water, pools, shallow and deep water and an area where there might be an obstruction (a fallen tree). This provides a good representation of the site.
2) A net is placed into the stream at your feet.
3) The bottom of the river is agitated and the disturbed sediment is caught in the net.
4) This should be done for three minutes at each site.
5) When the three minutes are up the material is collected and allowed settle.
6) You then decant off some of the water and then transfer the sample into the bucket.
7) Each sample is carefully labeled.

b) Stone wash sampling.

Materials used: White tray, brush, bucket with lid, labels.

The steps below describe the method for taking a stone wash sample within a stream:

1) Wade out carefully into the stream, a medium sized stone should be selected roughly the size of a closed fist or a little bit bigger.
2) Water should be placed into the white tray.
3) The stone is washed into the tray using the brush to wipe off any invertebrates, this can be done on one stone or multiple stones depending on how representative your sample is.
4) The sample is placed into a bucket and labeled.

Sites and sampling results

Four sample sites were chosen along the 2km length of the stream. Site A was close to a Lake at the base of the hills near where the stream originates. Site D was in the middle of the town and was the lowest site sampled.

Site A (Lake)

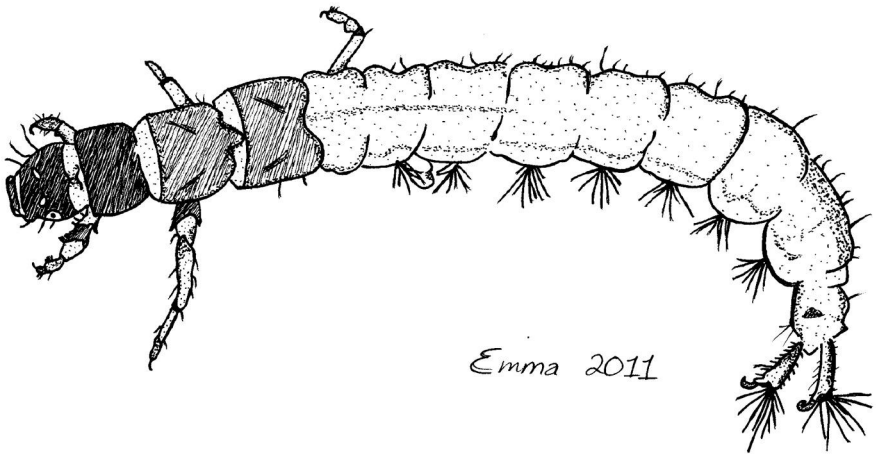
At the time of sampling there was slight breeze and occasional showers. The land on both sides of the river is used for agricultural purposes. There is a low density of housing near this site but the river can be accessed by livestock. On the day of sampling there was roughly thirty cattle present in the field that runs alongside the river. At the sampling site one side of the river was shaded by trees and shrubs and the other side was exposed to sunlight. This left the river 50% shaded. The substrate at this site was composed of small rocks and boulders. A good number of fish were observed rising in the deeper areas of the river when traveling up to the sampling area. There was no foam present at this site and the water had a high level of clarity. The Table below shows the Kick Sampling and Stone Wash numbers results from Site A:

TABLE 1. The Mill Race (Water Quality Invertebrate survey) Carrickbawn (28-06-2011)

Site A	Breezy, showery, overcast.	2.45pm	2.48pm	
Order	**Species**	Kick sample	Stone Wash	Totals of two Samples
Ephemeroptera	*Ephemerella*	22	0	**22**
	Baetis brunneicolor	4	3	**7**
	Ecdyonurus spp.	5	0	**5**
Plecoptera	*Isoperla similis*	1	0	**1**
Trichoptera	*Plectrocnemia conspersa*	23	1	**24**
Amphipoda	*Gammrus pulex*	25	0	**25**
Isopoda	*Asellus aquaticus*	4	0	**4**
Oligochaeta	*Eiseniella tetrehedra*	1	0	**1**
	Tubifex tubifex	3	0	**3**
Coleptera	*Hyphydrus ovatus*	1	0	**1**
	Larvae unknown	3	0	**3**
Diptera	*Chironomus pupa*	0	1	**1**
	Dicranota spp	6	0	**6**
	Unknown	1	0	**1**
	Simulium pupa	2	0	**2**

Observations:

The site appeared very clean and undisturbed by the surrounding livestock. This site had the biggest diversity of species in comparison to all the other sites. This site also has the most suitable shading for the invertebrates as 50% of the river was exposed and 50% shaded. The most abundant species at this site was the uncased Caddis fly larvae (*Plectrocnemia conspersa*), shown below.



Site B (Ballinamore Bridge)

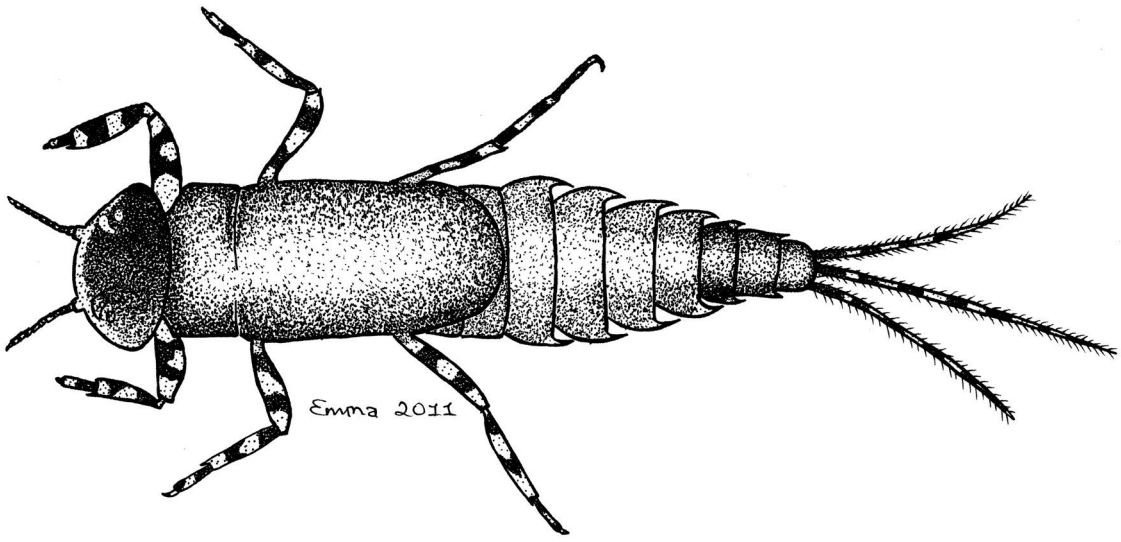
The weather conditions for this site are described in the table. The sample was taken just below a bridge on the Ballinamore Road which recently had to be reconstructed due to damage during the extremely hard winter. This new bridge now has a rectangular shape which allows a more light to penetrate into the tunnel. This may aid the migration of fish and invertebrates. This tunnel appears to be following the natural course of the river, creating minimal disturbance to the natural flow of the water. This is also beneficial to fish and other organisms. There was just one house on either side of the bank. There is no vegetation on either bank but there was about 10% shade, 5% at each bank. The substrate was composed of small rocks and boulders. There was no foam present at this site; the water had no smell and was very clear.

The data shown below is the results for Site B:

TABLE 2. The Mill Race (Water Quality Invertebrate survey)		Ballinamore Br. (28-06-2011)		
Site B	Sunny,calm,dry.	12.41	12.44	
Order	**Species**	Kick sample	Stone Wash	Totals of two Samples
Ephemeroptera	*Ephemerella*	37	3	**40**
	Baetis brunneicolor	0	2	**2**
	Ecdyonurus spp	4	1	**5**
Plecoptera	*Nemoura spp*	0	1	**1**
Trichoptera	*Plectrocnemia conspersa*	18	12	**30**
	Stenophylax spp	1	0	**1**
Amphipoda	*Gammarus pulex*	7	0	**7**
Isopoda	*Asellus aquaticus*	3	2	**5**
Diptera	*Dicranota spp*	2	0	**2**

Observation*:*

The construction of a new bridge did not appear to affect the invertebrates living in the water. The new shape of the bridge's tunnel is more environmentally friendly to the plants and animals in the stream as it has not altered the flow of the river and it allows a huge amount of natural light into the tunnel aiding the migration of fish. The most abundant invertebrate at this site was the mayfly nymph (*Ephemerella*).



Site C (Main St, Drumshanbo)

This site has many deciduous trees lining the banks, mainly Alder and Chestnut, which means that this site is extremely shaded in the region of about 85%. The substrate at this site is composed of small rocks and boulders which is a suitable substrate for invertebrates to survive in. An unsatisfactory smell was experienced coming from the river at this location. There was also a considerable amount of foam collecting on the shore of the river at this point. The river at the sampling site is exposed to a high density of housing and commercial establishments. The region of the river just above the sampling site was used formerly as a mill and the banks of the river are lined by narrow concrete paths which help direct the flow of the water. There is a concrete bridge at this place also.

The details of what was found at this site are shown in Table 3:

TABLE 3. The Mill Race (Water Quality Invertebrate survey) Main street (28-06-2011)

Site C	Sunny, calm,dry.	11.45	11.48	
Order	**Species**	Kick sample	Stone Wash	Totals of two Samples
Ephemeroptera	*Ephemerella*	3	3	**6**
	Baetis brunneicolor	0	13	**13**
	Ecdyonurus spp	4	1	**5**
Plecoptera	*Nemoura spp*	10	0	**10**
	Isoperla similis	4	0	**4**
Trichoptera	*Larvae unknown*	0	1	**1**
	Stenophylax spp	1	0	**1**
Amphipoda	*Gammarus pulex*	8	0	**8**
Isopoda	*Asellus aquaticus*	4	1	**5**
Oligochaeta	*Eiseniella tatrahedra*	1	2	**3**
	Tubfex tubifex	2	0	**2**
Decapoda	*Austropotamobius pallipes*	1	0	**1**
Unionida	*Anodonta cygnea*	1	0	**1**
Gastropoda	*Viviparidae spp*	0	1	**1**
Coleoptera	*Water beetle larvae, unknown*	0	1	**1**
Diptera	*Dixa spp*	0	2	**2**
	Simulium larvae	2	0	**2**

Observations:

This site is the first site where there was an accumulation of foam and a strong unpleasant smell. Investigations were undertaken but we are not sure where any possible pollution might have been coming from. Site A and Site B had a good diversity of invertebrates and there was no indicators of pollution at either site. This area mainly consists of invertebrates which are more tolerant to pollution such as the mayfly nymph *Baetis brunneicolor* that is shown below.

Site D (Drumshanbo Mart)

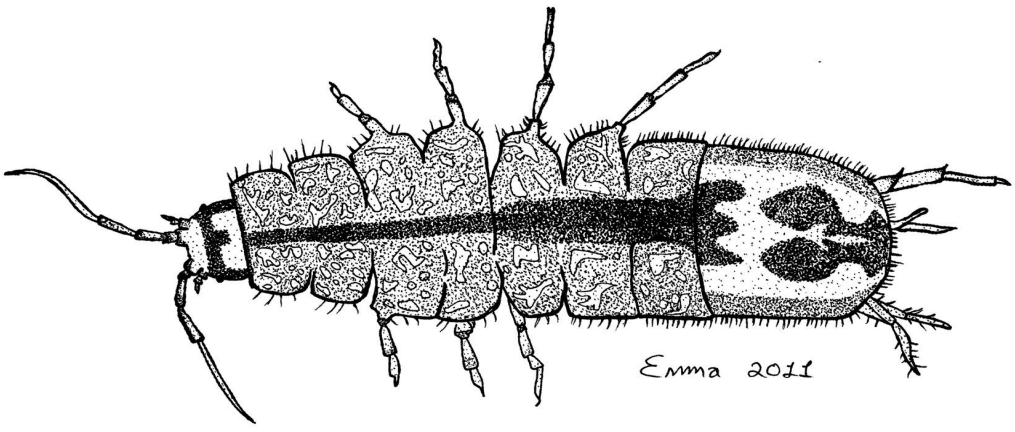
The housing at this site is situated on the eastern side of the river. There is a car park on the western side of the river which is connected to the major road that directs most of the traffic through the town. On the other side of this road there is a agricultural mart which holds auctions every Tuesday and Thursday night and on every last Saturday of the month. About 20m upstream of the sampling site there is a bridge that has a cylindrical tunnel directing the flow of the river. A very low amount of light enters the the tunnel, and there is no artificial light present to compensate for this. Also the natural flow of the river has been altered by the shape and rigidness of the tunnel. The area where the sample was taken was roughly 95% shaded due to Chestnut trees on the Western shore of the river. There was a small amount of vegetation on the eastern side of the river but this was composed of small plants such as horsetails. The substrate at this site is composed of small rocks and boulders. There was a significant amount of foam present and there was also a considerable amount of building and domestic waste present in the river. There was no smell from the water at this site.

The results from Site D are shown in below in Table 4:

TABLE 4. The Mill Race (Water Quality Invertebrate survey)		Carrick Na Brack (28-06-2011)		
Site D	Sunny, calm ,dry.	10.15	10.18	
Order	**Species**	Kick sample	Stone Wash	Totals of two Samples
Ephemeroptera	*Ephemerella*	4	0	**4**
	Baetis brunneicolor	5	1	**6**
	Ecdyonurus spp	4	0	**4**
Amphipoda	*Gammarus pulex*	7	0	**7**
Isopoda	*Asellus aquaticus*	19	1	**20**
Oligochaeta	*Tubifex tubifex*	5	1	**6**
Gastropda	*Lymnaea peregra*	9	0	**9**
Diptera	*Simulium larvae*	0	7	**7**
	Dicranota spp	1	0	**1**

Observations:

This site had large amounts of waste dumped in the river such as bottles and glasses and sheets of galvanized steel. One of the main roads through the town also runs near the stream and a small car-park is present near the sampling point. This could lead to pollution by run-off from the street water which might include oil, dust and a certain amount of litter. There also is a highly active agricultural mart within 50m. of the stream. This also could lead to a pollution problem if the waste from the Mart was mismanaged but, fortunately, this has not happened to date. The water appeared dirtier at this site and, like the site above, most of the invertebrates that were found at this site are typical of slightly polluted waters including the most abundant invertebrate, the water louse *Asellus aquaticus*. (See below)



Analysis

The results obtained above were analysed using Biotic indexes. These are means of standardising the recording of water quality using the variety and numbers of invertebrate species present.

Biotic indexes

There are various Biotic indexes used to determine the level of water quality within a water body. They do this by calculating the quantity of invertebrates present and their sensitivity levels to pollution. There are three main biotic indexes used at the present moment and they are called the **Trent Biotic index,** the **Biological Monitoring Working Party (BMWP) score**,and **the Chandler Biotic index.** These will be the three indexes that will be used throughout this report. The biotic indexes have been applied to two different sections of the river.

River Sections:

The two sites before the river enters the town (Sites A and B) are included in Section 1 and represent the 'cleaner' part of the river. Sites C and D are where the river flows through the town and will be grouped in Section 2.

The Indexes used

1. Trent biotic index

The Trent biotic index works by giving you a score of between 0 – 15, with 0 meaning extremely polluted and 15 meaning clean water. A reading of 10 or more is considered clean. Groups of Invertebrates (e.g. Mayfly or Stonefly) are listed according to how they need clean water to thrive. If few of these species are present (indicating pollution) the Index awards a low value. If many are present it awards a high value indicating good water quality. The first value that meets your criteria is the one that is taken and that concludes the test.

RESULT

The result that was obtained for the Millrace Section 1 was a score of 7, this score means that the water in the Millrace river is slightly polluted.

The result that was obtained for Section 2 of the Millrace was a score also a score of 7 which shows that this area of the river is also slightly polluted.

This test is a simplistic test and is the first biotic index that is used to help determine if the water is polluted or not. This test gives you a general idea of the lack or level of pollution within the water. Further biotic indexes are used to help in determining a more accurate level of pollution within a sampled area.

2. BMWP score.

The BMWP score is the second index that was used. The details of this system are shown in Appendix I. The revised scoring system was used for this survey. The BMWP system rates water quality by the variety of a large range of selected (and prioritised) types of invertebrates present in a sample.

RESULT

The results obtained by applying this test to the two sections of the stream are shown in Tables 5 and 6. Table 5 (Below) shows the results of the BMWP score applied to Section 1 of the Millrace. The system works by applying points for each species present. More points are applied for certain species based on how good an indicator of pollution they are. Points are then added up and divided by the number of species present. This provides a quotient which then yields the BMWP pollution index as indicated at the bottom of the Table.

Section 1:

To get the final result for Section 1 (**4.395**)and the level of pollution for the BMWP the points are divided by the number of species present. (96.7 ÷ 22 = 4.395)

The resulting number is the score given to determine the water quality of the water-body. The scale runs from 0-10 and the closer the number to 10 the cleaner and healthier the water.

The number obtained is significantly below the median number on the scale. This means that the water in Section 1 is polluted but not severely so at present.

All data and calculations are shown in Table 5 (below):

TABLE 5. BMWP score for the Mill Race (Water Quality Invertebrate survey) Section 1		
Order	**Families and Species**	**BMWP score**
Ephemeroptera	*Ephemerella*	7.7
	Baetis brunneicolor	5.3
	Ecdyonurus spp	-
Plecoptera	Nemouridae, *Nemoura spp*	9.1
	Perlodidae*, Isoperla similis*	10.7
Trichoptera	Limnephilidae, *Stenophylax spp*	7.1
	Polycentropodidae*, Plectrocnemia conspersa*	8.6
Amphipoda	Gammaridae*, Gammarus pulex*	4.7
Isopoda	Asellidae, *Asellus aquaticus*	1.5
Coleptera	Hydrophilidea, *Hyphydrus ovatus*	5.5
	Larvae unknown	-
Oligochaeta	*Eiseniella tatrahedra*	3.5
	Tubifex tubifex	3.5
Decapoda	Astacidae*, Austropotamobius pallipes*	9
Unionoida	Unionoidae*, Anodonta cygnea*	5.2
Gastropoda	*Viviparidae spp*	6.3
Limnaeidae	*Lymnaea peregra*	3
Diptera	Simuliidae, *Simulium pupa*	5.8
	Tipulidae, *Dicranota spp*	5.5
	Chironomus pupa	3.7
	Larvae unknown	-
Coleoptera	*Water beetle larvae, unknown*	-
Points for all families		96.7
Number of species present		22
BMWP score	Points divided by species =	**4.395**

Section 2:

The same test was applied to the two lower samples that make up Section 2 of the Millrace samples. This had a total of 73.7 points and 17 species, yielding a Score of **4.335**.

73.7 ÷ 17 = 4.335.

This score is also low and is lower than the result for Section 1. This result indicates that the water is slightly more polluted than the upper Section of the river.

The analysis is shown in Table 6 below:

TABLE 6. BMWP score for the Mill Race (Water Quality Invertebrate survey) Section 2		
Order	**Families and Species**	**BMWP score**
Ephemeroptera	*Ephemerella*	7.7
	Baetis brunneicolor	5.3
	Ecdyonurus spp	-
Plecoptera	Nemouridae, *Nemoura spp*	9.1
	Perlodidae*, Isoperla similis*	10.7
Trichoptera	*Larvae unknown*	-
	Limnephilidae, *Stenophylax spp*	7.1
Amphipoda	Gammaridae*, Gammarus pulex*	4.7
Isopoda	Asellidae, *Asellus aquaticus*	1.5
	Larvae unknown	-
Oligochaeta	*Eiseniella tatrahedra*	3.5
	Tubifex tubifex	3.5
Gastropoda	*Viviparidae spp*	6.3
Limnaeidae	*Lymnaea peregra*	3
Diptera	Simuliidae, *Simulium larvae*	5.8
	Tipulidae, *Dicranota spp*	5.5
	Dixa spp	-
Points for all families		73.7
Number of species present		17
BMWP score	Points divided by species =	**4.335**

3. Chandler biotic index

The Chandler biotic index works by also using levels of abundance of each of the different species to calculate a score which in turn determines the level of pollution of a water body. The levels of abundance are categorized into five different groups:

P= Present (1-2)

F= Few (3 -10)

C= Common (11 - 50)

A= Abundant (51 -100)

V= Very abundant more (than 100)

Using these ratings and the scores that are given to selected species according to their tolerance to pollution (the higher the tolerance the lower the score), Chandler devised an scoring system which can very accurately determine the pollution levels within a water body.

The score obtained is interpreted as follows:

0 = No organisms present, highly polluted.

45 – 300 = Moderate pollution.

300 -3000 = Mildly polluted to unimpaired conditions.

RESULT**:**

The results obtained using the Chandler system are shown in Tables 7 and 8. The results obtained are again very close with the lower Section of the river being similar but slightly more polluted. The consistency of the results across several test indicates that these results are accurate and the data has been sufficient to enable precise interpretation.

TABLE 7. Chandler Index data. The Mill Race. Results Section 1.			
Order	**Species**	**Total Nos. present**	**Chandler biotic score**
Ephemeroptera	*Ephemerella*	66	94
	Baetis brunnicolor	9	46
	Ecdyonurus spp	10	84
Plecoptera	*Nemoura spp*	1	84
	Isoperla similis	1	90
Trichoptera	*Stenophylax spp*	1	75
	Plectrocnemia conspersa	54	33
Amphipoda	*Gammarus pulex*	32	40
Isopoda	*Asellus aquaticus*	9	22
Coleptera	*Hyphydrus ovatus*	1	51
	Larvae unknown	3	55
Oligochaeta	*Eiseniella tatrahedra*	1	0
	Tubifex tubifex	3	18
Decapoda	*Austropotamobius pallipes*	1	30
Unionoida	*Anodonta cygnea*	1	30
Diptera	*Simulium pupa*	2	56
	Dicranota spp	7	72
	Larvae unknown	1	0
	Chironomus pupa	1	28
Final result			**908**

To get the final result for the Chandler biotic index all the scores calculated (Number found X Species value = Score) for each species are added up and compared to the key shown above. (0 - 3000).

The result for Section 1 was 908. Because it is on the lower end of the scale (300-3000) this means that the area is 'mildly polluted'.

A similar process was applied to Section 2. The final result for Section 2 is 829. This is a lower number in comparison with Section 1. This shows that this area is also mildly polluted but is exposed to slightly more pollution than Section 1. See Table 8 (below) for details.

Conclusion and Recommendation

Using the information above it is clear to say that the Millrace river is slightly polluted. All of the three biotic indexes confirm this result. Section 2 appears to have a higher level of pollution present than Section 1. This difference in pollution levels is most clearly seen using the Chandler biotic score as the two end results are more clearly differentiated.

There is a large variance of numbers and diversity between the two sections which may be due to the fact that Section 1 is further away from a busy town than Section 2. In Section 1 there is more diversity and better abundance of invertebrates that are sensitive to pollution. These invertebrates would not be there if the area was polluted. Section 1 is a more natural environment with less disturbance of the environment than in Section 2. Section 2 has a higher number of invertebrates present that are more tolerant of pollution, such as the water louse. Section 2 is more exposed and under treat from man-made pollutants such as waste water, diesel and oil. It is also at risk of people throwing household waste into the river and contaminating it even further. This may be the reason why Section 2 is slightly more polluted than Section 1.

TABLE 8. Chandler Index data. The Mill Race. Results Section 2.			
Order	**Species**	**Total Numbers present**	**Chandler biotic score**
Ephemeroptera	*Ephemerella*	6	84
	Baetis brunnicolor	18	48
	Ecdyonurus spp	9	84
Plecoptera	*Nemoura spp*	10	89
	Isoperla similis	4	94
Trichoptera	*Larvae unknown*	1	75
	Stenophylax spp	1	75
Amphipoda	*Gammarus pulex*	15	40
Isopoda	*Asellus aquaticus*	25	18
Coleptera	*Larvae unknown*	3	55
Oligochaeta	*Eiseniella tetrahedra*	3	0
	Tubifex tubifex	8	18
Gastropoda	*Viviparidae spp*	9	28
Limnaeidae	*Lymnaea peregra*	9	28
Diptera	*Simulium larvae*	9	61
	Dicranota spp	2	60
	Dixa spp	2	0
Final result			**829**

The Trent Biotic index indicates that both Section 1 and Section 2 are slightly polluted and has given each site a value of 7. This test is not the most accurate test but is merely used to get a rough estimate of the cleanliness of the water. When the Trent Biotic index has been used it is common procedure to perform testing with other Biotic indexes on the site.

The Biological Monitoring Working Party (BMWP) score gave two different results for each Section, but again they were very similar. The two scores indicated that the water where the samples were taken was also slightly polluted. The BMWP score has one main flaw. In Table 5 there are four different species which could not be identified, because of this you have to award them a score of 0. When performing the final calculation to acquire the final BMWP score you have to divide the number species into the final score that you have got from all the different families present. Because these invertebrates have not been awarded a score this reduces the overall final result giving a lower score than would otherwise be awarded. But this affects both Sections equally and does not alter the final result; Section 1 is significantly cleaner than Section 2.

The Chandler biotic score also gave a different score for each site (908 and 829). There was a difference in scores of 79. This index appears to be the most accurate as it showed the difference between the two sections which was clearly indicated on the day of sampling, e.g. by foam and smell. Although the two scores have a considerable difference between them they are both defined as 'mildly polluted' because they are at the lower end of the scale (300-3000). This shows that the river is slightly polluted at Section 1 and is more intensely polluted at section 2.

The overall conclusion that can be taken from the information above is that the river is mildly polluted and further work will have to be performed to amend this problem. Our recommendation is that this river should be opened up and made available to all. Paths could be installed, seating provided, wildlife encouraged, and obstructions and rubbish removed from the stream — in such a manner that any future pollution and littering can be readily identified and rectified.

Natural material will always enter the river and should not pose a problem under normal conditions. Improving water flow and aeration will always help in keeping the water well oxygenated and healthy for both fish and invertebrates. The town of Drumshanbo already has a first rate street cleaning programme and this will greatly help in maintaining the cleanliness of any surface water entering the stream.

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Appendix I: Biotic Tables. A. BMWP score chart

Common Name	Family	BMWP Scores:		Habitat Specific Scores		
		Original	*Revised*	*Riffles*	*Riffle/Pools*	*Pools*
Flatworms	Planariidae	5	4.2	4.5	4.1	3.7
	Dendrocoelidae	5	3.1	2.3	4.1	3.1
Snails	Neritidae	6	7.5	6.7	8.1	9.3
	Viviparidae	6	6.3	2.1	4.7	7.1
	Valvatidae	3	2.8	2.5	2.5	3.2
	Hydrobiidae	3	3.9	4.1	3.9	3.7
	Lymnaeidae	3	3	3.2	3.1	2.8
	Physidae	3	1.8	0.9	1.5	2.8
	Planorbidae	3	2.9	2.6	2.9	3.1
Limpets/Mussels	Ancylidae	6	5.6	5.5	5.5	6.2
	Unionidae	6	5.2	4.7	4.8	5.5
	Sphaeriidae	3	3.6	3.7	3.7	3.4
Worms	Oligochaeta	1	3.5	3.9	3.2	2.5
Leeches	Piscicolidae	4	5	4.5	5.4	5.2
	Glossiphoniidae	3	3.1	3	3.3	2.9
	Hirudididae	3	0	0.3	-0.3	
	Erpobdellidae	3	2.8	2.8	2.8	2.6
Crustaceans	Asellidae	3	2.1	1.5	2.4	2.7
	Corophiidae	6	6.1	5.4	5.1	6.5
	Gammaridae	6	4.5	4.7	4.3	4.3
	Astacidae	8	9	8.8	9	11.2
Mayflies	Siphlonuridae	10	11	11		
	Baetidae	4	5.3	5.5	4.8	5.1
	Heptageniidae	10	9.8	9.7	10.7	13
	Leptophlebiidae	10	8.9	8.7	8.9	9.9
	Ephemerellidae	10	7.7	7.6	8.1	9.3
	Potamanthidae	10	7.6	7.6		
	Ephemeridae	10	9.3	9	9.2	11
	Caenidae	7	7.1	7.2	7.3	6.4
Stoneflies	Taeniopterygidae	10	10.8	10.7	12.1	
	Nemouridae	7	9.1	9.2	8.5	8.8
	Leuctridae	10	9.9	9.8	10.4	11.2
	Capniidae	10	10	10.1		
	Perlodidae	10	10.7	10.8	10.7	10.9
	Perlidae	10	12.5	12.5	12.2	
	Chloroperlidae	10	12.4	12.5	12.1	
Damselflies	Platycnemidae	6	5.1	3.6	5.4	5.7
	Coenagriidae	6	3.5	2.6	3.3	3.8
	Lestidae	8	5.4			5.4
	Calopterygidae	8	6.4	6	6.1	7.6
Dragonflies	Gomphidae	8				
	Cordulegasteridae	8	8.6	9.5	6.5	7.6
	Aeshnidae	8	6.1	7	6.9	5.7
	Corduliidae	8				
	Libellulidae	8	5			5

Appendix I: Biotic Tables. A. BMWP score chart (contd)

Beetles	Haliplidae	5	4	3.7	4.2	4.3
	Hygrobiidae	5	2.6	5.6	-0.8	2.6
	Dytiscidae	5	4.8	5.2	4.3	4.2
	Gyrinidae	5	7.8	8.1	7.4	6.8
	Hydrophilidae	5	5.1	5.5	4.5	3.9
	Clambidae	5				
	Scirtidae	5	6.5	6.9	6.2	5.8
	Dryopidae	5	6.5	6.5		
	Elmidae	5	6.4	6.5	6.1	6.5
	Chrysomelidae	5	4.2	4.9	1.1	4.1
	Curculionidae	5	4	4.7	3.1	2.9
Alderflies	Sialidae	4	4.5	4.7	4.7	4.3
Caddisflies	Rhyacophilidae	7	8.3	8.2	8.6	9.6
	Philopotamidae	8	10.6	10.7	9.8	
	Polycentropidae	7	8.6	8.6	8.4	8.7
	Psychomyiidae	8	6.9	6.4	7.4	8
	Hydropsychidae	5	6.6	6.6	6.5	7.2
	Hydroptilidae	6	6.7	6.7	6.8	6.5
	Phryganeidae	10	7	6.6	5.4	8
	Limnephilidae	7	6.9	7.1	6.5	6.6
	Molannidae	10	8.9	7.8	8.1	10
	Beraeidae	10	9	8.3	7.8	10
	Odontoceridae	10	10.9	10.8	11.4	11.7
	Leptoceridae	10	7.8	7.8	7.7	8.1
	Goeridae	10	9.9	9.8	9.6	12.4
	Lepidostomatidae	10	10.4	10.3	10.7	11.6
	Brachycentridae	10	9.4	9.3	9.7	11
	Sericostomatidae	10	9.2	9.1	9.3	10.3
True flies	Tipulidae	5	5.5	5.6	5	5.1
	Chironomidae	2	3.7	4.1	3.4	2.8
	Simuliidae	5	5.8	5.9	5.1	5.5

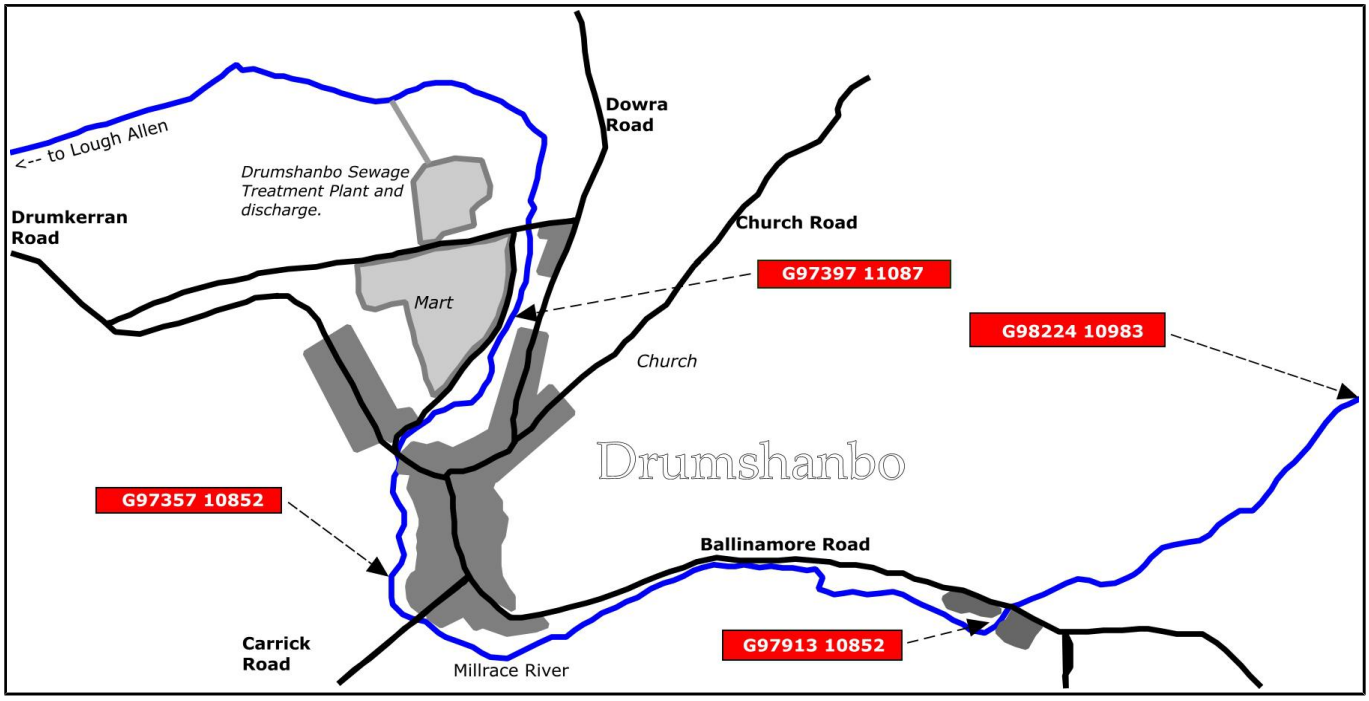
Appendix II: Biotic Tables. B. Chandler biotic score chart

		Increasing in Abundance weight scores				
	Groups present in sample	**P**	**F**	**C**	**A**	**V**
Each species of:	*Planaria alpina*, Taenopterygidae, Perlodidae, Isoperlidae, Perlidae, Chloroperlidae	90	94	98	99	100
Each species of:	Leuctridae, Capniidae, Nemouridae, (Excluding *Amphinemura*)	84	89	94	97	98
Each species of:	Ephemeroptera (excluding *Baetis*)	79	84	90	94	97
	Cased tricoptera, Megaloptera	75	80	86	91	94
	Ancylus	70	75	82	87	91
	*Rhyacophila(*Tricoptera*)*	65	70	77	83	88
Genera of:	*Diacranota, Limnophera*	60	65	72	78	84
	Simulium	56	61	67	73	75
	Cleoptera, Nematoda	51	55	61	66	72
	Amphinemura (Plecoptera)	47	50	54	58	63
	Baetis (Ephmeroptera)	44	46	48	50	52
	Gammarus	*40*	*40*	*40*	*40*	*40*
	Uncased tricoptera (excluding *Rhyacophila*)	38	36	35	33	31
	Tricladida (excluding *P. alpina*)	35	33	31	29	5
Genera of:	Hydracarina	32	30	28	25	21
Each species of:	Mollusca (excluding *Anylus*)	30	28	25	22	18
Each species of:	Chrionomidae (excluding *C. riparius*)	28	25	21	18	15
	Glossiphonia	26	23	20	16	13
Each species of:	*Asellus*	25	22	18	14	10
	Leech (excluding *Glossiphonia, Haemopsis)*	24	20	16	12	8
	Haemopsis	*24*	*20*	*16*	*10*	*7*
	Tubifex	*22*	*18*	*13*	*12*	*9*
	Chironomus riparius	21	17	12	7	4
	Nais	*20*	*16*	*10*	*6*	*2*
Each species of:	Air breathing species	19	15	9	5	1
	No animal life	0	0	0	0	0

Appendix III: Map of Drumshanbo town

SITES: Going downstream…

Site	Description	GPS Reference
A	**The Lake**	**G98224 10983**
B	**Ballinamore Bridge**	**G97913 10852**
C	**Main Street, Drumshanbo**	**G97397 11087**
D	**Drumshanbo Mart**	**G97357 10852**



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