Convention on Long-range Transboundary Air Pollution

International Cooperative Programme on Assessment and Monitoring of Acidification of Rivers and Lakes

81/2005

Biological intercalibration: Invertebrates 0905

NIVA Norwegian Institute for Water Research

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REPORT

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Abstract

The 9th intercalibration of invertebrates in the ICP Waters programme had contribution from 4 laboratories. Most of the laboratories identified a high portion of the individuals in the test samples, usually > 90% of the total number of species, but shortcoming identifications below this limit were also noted. Misidentifications and low % identified were in general made on material coming from regions outside the home region of the laboratory. No faults were recorded on genus level. The quality was sufficient for stating the acidity index. Improvements in taxonomic work were tested among laboratories participating several times. First time participants had a significant lower mean Quality index than second, third or higher times participants.

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1. Interkalibrering	1. Intercalibration
2. Invertebrater	2. Invertebrates
3. Akvatisk fauna	3. Aquatic fauna
4. Overvåking	4. Monitoring

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CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

INTERNATIONAL COOPERATIVE PROGRAMME ON ASSESSMENT AND MONITORING OF ACIDIFICATION OF RIVERS AND LAKES

Intercalibration: Invertebrate fauna 0905

ICP Waters Programme Subcentre
Laboratory of Freshwater Ecology and Inland Fisheries
University of Bergen, August 2005

Preface

The International Cooperative Programme on Assessment and Monitoring of Rivers and Lakes (ICP Waters) was established under the Executive Body of the Convention on Long-Range Transboundary Air Pollution at its third session in Helsinki in July 1985. The Executive Body also accepted Norway's offer to provide facilities for the Programme Centre, which has been established at the Norwegian Institute for Water Research, NIVA. A programme subcentre is established at the Laboratory of Freshwater Ecology and Inland Fisheries at the University of Bergen. Berit Kvæven, Norwegian Pollution Control Authority (SFT), has led the ICP Waters programme. SFT provides financial support to the work of the Programme Centre.

The main aim of the ICP Waters Programme is to assess, on a regional basis, the degree and geographical extent of the impact of atmospheric pollution, in particular acidification, on surface waters. Twenty-two countries in Europe and North America participate in the programme on a regular basis.

ICP Waters is based on existing surface water monitoring programmes in the participating countries, implemented by voluntary contributions. The monitoring sites are generally acid sensitive and representative of low acid neutralising capacity (ANC) and low critical load levels of the distributions for all the waters surveyed in the region. The ICP site network is geographically extensive and includes long-term data series (more than 15 years) for many sites.

The Programme objective is to establish an international network of surface water monitoring sites and promote international harmonisation of monitoring practices. One of the tools in this work is an inter-laboratory quality assurance test. The bias between analyses carried out by the individual participants of the Programme has to be identified and controlled.

We here report the results from the 9th intercalibration on invertebrate fauna.

Bergen, August, 2005

Gunnar G. Raddum

Contents

1. Introduction

The purpose of the biological intercalibration is to evaluate the quality of the taxonomic work on the biological material delivered to the Programme centre. The quality can influence on the evaluation of the acidification index, which is based on the species and their tolerance (Raddum *et al.* 1988, Fjellheim and Raddum 1990, Raddum 1999). The control is therefore important for evaluation of the significance of trends in the acidification index both for a specific site/watershed, as well as for comparisons of trends between different regions and countries. The material is also used for multivariate statistical analysis (Larsen *et al.* 1996, Skjelkvåle *et al.* 2000, Halvorsen *et al.* 2002). This type of data treatment is especially sensitive to the quality of the species identification. The intercalibration of biological material will in general have focus on the taxonomic work and through this be a basis for improving the quality, detect weak fields at the different laboratories as well as harmonisation of the biological database.

The methods for intercalibration of biological material were outlined in 1991 at the 7th ICP Waters Task Force meeting in Galway, Ireland. The different countries/laboratories have to know, first of all, their home fauna. Since the fauna in different geographical regions vary, it is necessary to prepare specific samples for each participating laboratory, based on their home fauna. It is a problem for the exercise of the intercalibration that it is not possible to use standardised samples for all participants. To solve this problem each laboratory send samples of invertebrates from their own monitoring sites to the Programme centre. Based on this material each laboratory receives individual test samples composed of the fauna from their own monitoring region. One problem with this procedure is that the Programme centre needs material from the different areas in the ICP Waters region. This material has to be collected, identified and sent by the participating laboratories to the centre for making test samples. For the tests carried out in 2004 three laboratories got test material relevant for their home region, while one participant received material that was based on fauna sampled outside their region.

In this report we have analysed the improvements of the taxonomic work of the participating laboratories over time. A method for this and the results is given in a separate chapter at the end of this report.

2. Methods

Preparation of test-samples
Between 200 and 300 identified invertebrates are received from two of the participating laboratories. In addition we had some surplus material from earlier exercises and from an EU-project which also was used for making the test samples. For one laboratory we did not have enough material from its home region. In this case the test sample was based on material from Scandinavia and material from other parts of Europe regarded as relevant for the participant.

Identification
When preparing the biological test-samples we try to be as accurate as possible, concerning the species and number of individuals put in the sample. To minimise possible faults the following procedure have been used for the laboratories that have sent us material:

- The participating country has first identified the source material for the test samples. Two of us have verified the identification of the species/taxa as far as possible without damaging the individuals.
- The content of the two test samples for each laboratory, with respect to species and numbers, is listed in a table. Two persons control that the right number and species is placed in the samples according to the list.

For the present test one participant received material mostly from Norway, but also from an EU-project. The laboratory had therefore not been involved in sampling and identification of the source material prior to the test. Due to this the content of the test samples will only relay on the skill of the Programme centre. This is not an ideal situation. Apart from this, the same procedure as mentioned for the other laboratories was followed.

Damages of the material
When handling invertebrates there is a risk of reducing the quality of the material with respect to taxonomic work. Important taxonomically parts as gills, legs, moth parts etc. can be lost or destroyed during handling connected with identification, sample composition and transportation. Contamination of larvae can also occur during these processes as well as during the identification work at the participating laboratories. All mentioned possibilities for faults can influence on the results of the identifications and disturb the results in a negative way.

Evaluation
For calculation of faults (in percent), we must take into account possible destructions of the material as mentioned above. Further, a wrong identification of a species is one fault even if the sample contains many individuals of the species. For some species, in the same genus, the time of sampling is important for discrimination between them. Faults made on species where time of sampling is important for determination have been neglected. Misidentification of species where important taxonomic characters easily disappear during handling, are also neglected. However, missing important parts for identification of a species should be pointed out by the participant.

We have discriminated between "short coming" identification, probably due to damaged material, and virtual fault (wrong species - or genus name).

Due to the circumstances mentioned above some subjective evaluation of the results have to be made. The percent of faults is therefore usually not the exact calculated percent of faults, but a modified value where some “expert judgement” is taken into account.

It is also of interest to know how many individuals that have been identified to species level of the total number in the sample. This is named *% identified*. A low percent means that many individuals are not brought to the species level and will consequently reduce the value of the taxonomic work.

Available material for making test samples varies. The number of individuals and number of species delivered will therefore differ between the laboratories. Samples with low diversity will be easier to handle than samples with high diversity, see Appendix tables. This should also be kept in mind when the results are evaluated.

3. Results and discussion

Four laboratories participated in the intercalibration of invertebrates in 2004. The content of species in the test samples delivered - and the results of the identification by the different laboratories are shown in Appendix Tables 1 - 4.

Mayflies

Laboratory 3 and 4 identified the mayflies (Ephemeroptera) without any faults (Figure 1). A minor fault was recorded by laboratory 2, while laboratory 1 did more faults. The latter was within the limit of 10% faults, regarded as good taxonomic work. However, the percent identification of the species was below 90% which is below high quality. It should be mentioned that the faults were made on specimen that was not from the home country of this laboratory and that the participant pointed this out for several of the species. The genus level was 100% right identified by all laboratories. In spite of normally high damages on mayflies in test samples, laboratories 2 and 4 finalised the species identification. Laboratory 3, which did no faults, stopped at the genus level for a few specimens. In summary the taxonomic work was generally good when taken into account that one of the laboratories had material from outside their home region.

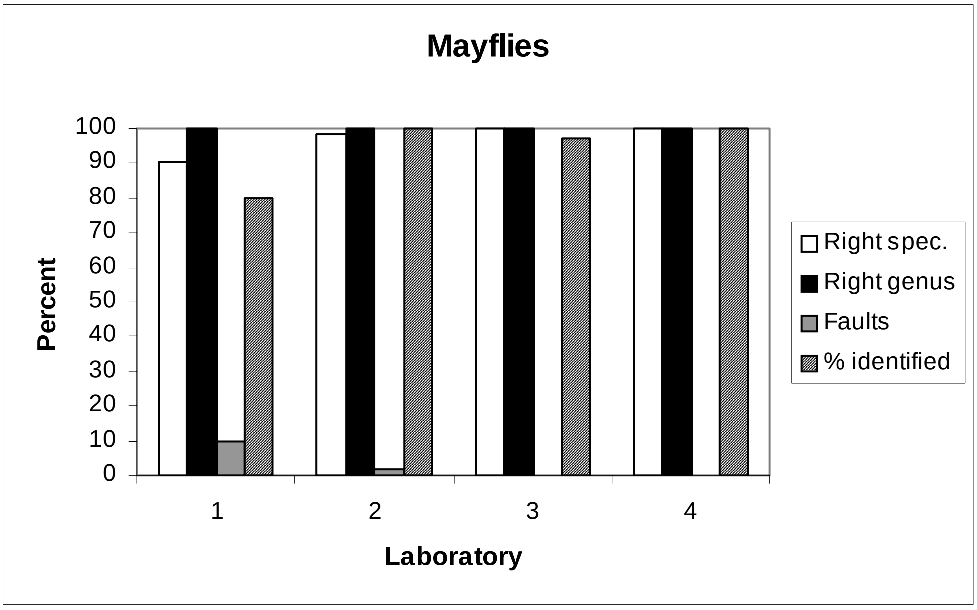


Figure 1. *Results of the identification of mayflies.*

Stoneflies

The identification of stoneflies were generally good. Three of the laboratories did some faults (Figure 2), while one (Lab. 4) did no mistakes. All larvae were identified to species level by laboratory 3 and 4, while laboratory 2 stopped at the genus level for one species. Participant 1 identified 90% of the species and did 10% mistakes. Right identified species were for all participants $\geq$ 90 %, which is regarded as good taxonomic work. The genus level was, however, 100 % right for all laboratories. Laboratory 1 identified material that was not sampled in its home region. It was also pointed out by the participant that some species did not belong to the home country. This is taken into account when the result was evaluated.

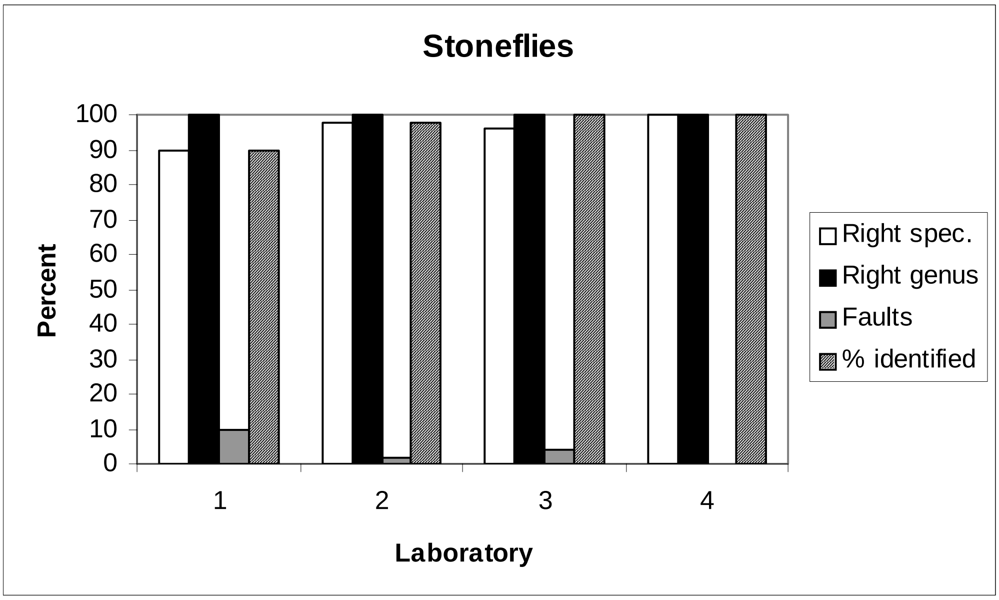


Figure 2. *Results of the identification of stoneflies.*

Caddisflies

The identification of caddis flies (Trichoptera) was also generally good (Figure 3). A few identifications were regarded as faults for Laboratory 3 and 4, while Laboratory 1 had 10% faults. No mistakes were done by participant 2. On genus level no faults were recognised for any of the Laboratories. The *% identified* was ≥ 90% for three laboratories, while one identified 85% of the individuals. The taxonomic work on caddisflies is also regarded as good and will be sufficient for most types of analyses.

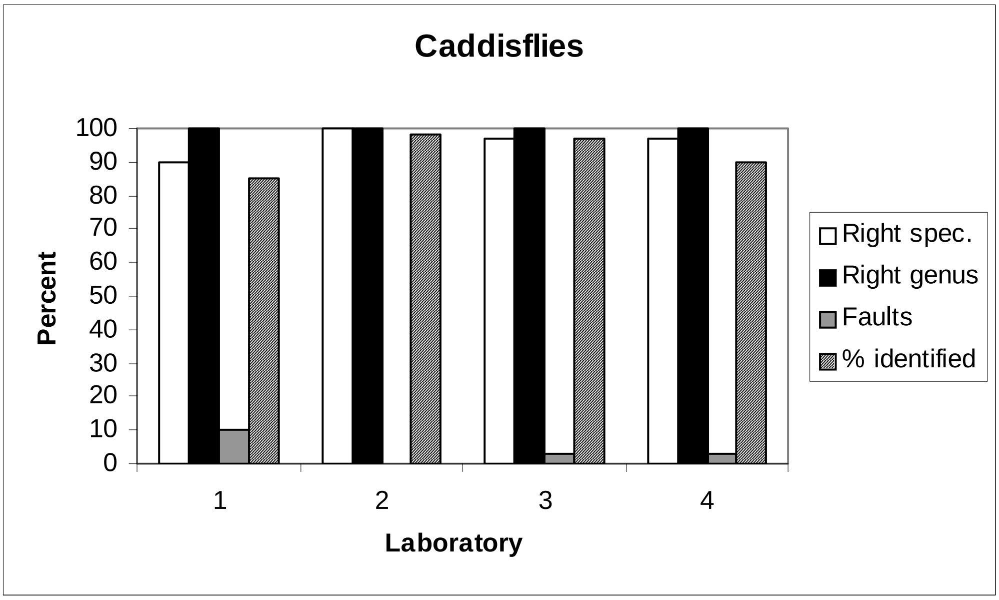


Figure 3. *Results of the identification of caddisflies.*

Other groups

In this intercalibration we have included coleopta (water beetles), larger crustaceans, oligochaets, molluscs, diptera etc. Both larvae and imagos have been included for some of the groups. Molluscs and larger crustaceans are sensitive to acid water and important for the evaluation of acidification. The tolerance of the invertebrates among coleoptera, diptera, odonats etc. is little known. Due to this the species in the last mentioned groups is treated as tolerant to acid water and consequently have low importance for evaluation of the acidity index. However, all species will be important for statistical analysis when using the whole community. Figure 4 shows the results of the identification of these groups. Laboratory 3 and 4 identified all individuals to the right species. Participant 1 identified 80% of the individuals and did 10% mistakes, while Laboratory 2 identified 97% of the individuals and made 3% faults. The identification of the genus was, however, 100 % right for all laboratories. The faults made on the mentioned groups are ≥ 90% which is regarded as good. However, low % identified for one of the participants draw in a negative direction.

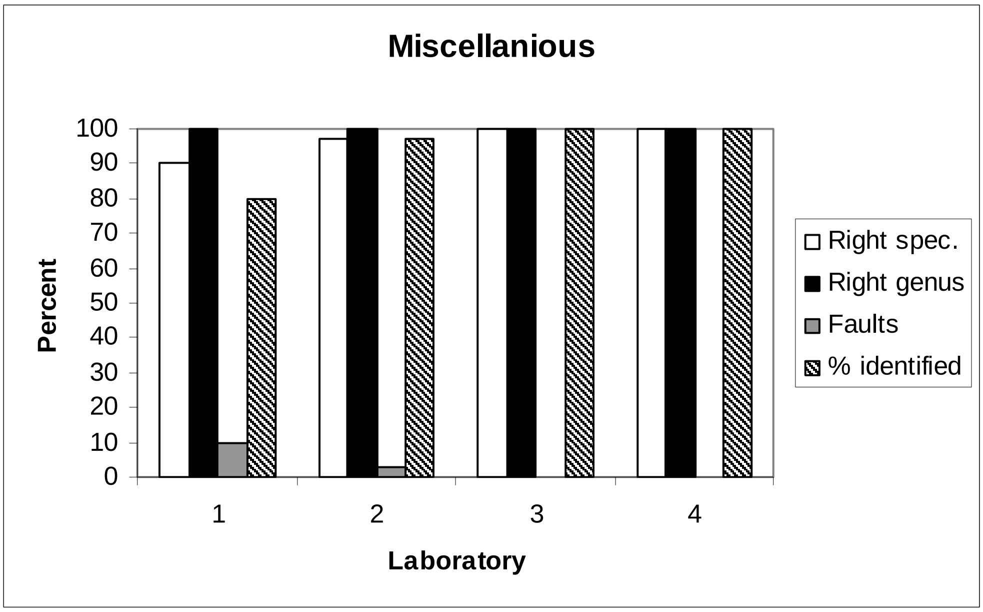


Figure 4. *Results of the identification of miscellaneous groups*

Total number of Species in the sample

It was generally low discrepancy between the number of individuals put into the samples and the reported number of larvae. However, some minor differences occurred between delivered and identified numbers of individuals, but these have been neglected in this test. Some small or juvenile larvae were also put in the samples. Such larvae can be impossible to identify if origin and time of sampling is unknown. This has also been taken into account during the evaluation.

4. Evaluation/conclusion

Three laboratories identified a high portion (≥ 90%) of the total number of species in the test samples. Shortcoming identification was, however, generally below this limit for one of the participants. On the other hand misidentifications did not exceed 10 % for any of the laboratories. This is regarded as good when the *% identified* is ≥ 90%. None of the participants did misidentifications that could result in a wrong acidity index. Clear improvements are observed among laboratories that have participated several times, see next chapter. This formalised exercise is also of high value for harmonising biological material/databases in general and will be of high importance in programmes where community analyses is in focus, like EU's Water Framework Directive.

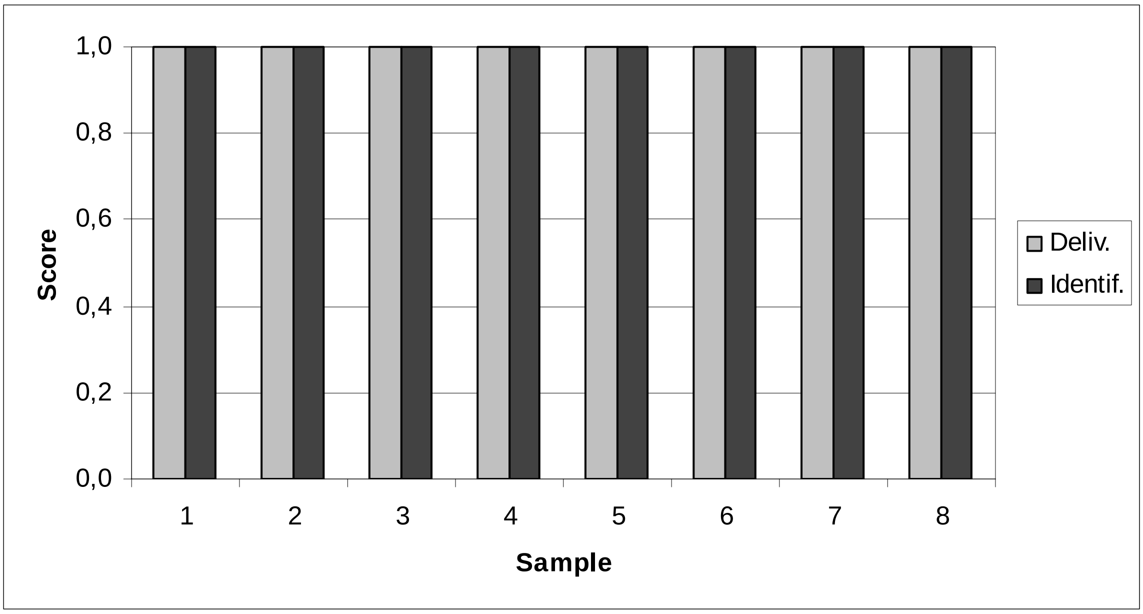


Figure 6. *Acidification score in delivered and identified samples.*

5. Invertebrate intercalibration – improvements over time

Methods

To analyse improvements in taxonomic work among laboratories participating the intercalibration we have used the following procedure. The results of the identifications are grouped into three categories:

- Results from the first exercise (1)
- from the second exercise (2)
- from the third and higher exercises (3)

Comparisons of the quality are analysed for these three categories of exercises.
A "Quality index" (Qi) is constructed to get an objective number of the quality. This index is based on the skill of the identification of species and genus. It takes also into account the identified portion of the individuals of the sample called % identified in the intercalibration reports. By this the Qi integrates the separate levels of the identifications used in the intercalibration test of invertebrates. To get a number that can be compared with the intercalibration results the Qi calculation is as follows:

Qi = % correct species/10 * % right genus/10 * % identified individuals/100

The Qi has been calculated from all earlier exercises. The value is a number between 0 and 100 and will decrease exponentially by faults made on genus and by a low % identified.

Example:

If a participant has 90 % correct species and 100% on the other parameters, the Qi value will be 90. If right genus also is 90 %, Qi will be 81. If in addition the participant only has identified 70 % of the identifiable individuals in the sample (% identified), Qi will fall to 56.7.

For the intercalibration on invertebrates we have used 90 % correct identifications as a limit for good taxonomic work. Since the Qi is exponential, a value of 90 might be to hard as a limit for acceptable determinations. A limit of 80 will be more in line with earlier practice. We therefore propose a Qi   80 as limit for good taxonomic work.

Results

After the intercalibration of invertebrates started in 1992, 21 laboratories/taxonomists have participated in the first tests. Of these 14 have participated two times, while 7 have participated three or more times. The last group contain 15 exercises. It is called the third exercise.

Figure 7 – 9 shows the distribution of Qi classes for the identification of mayflies, stoneflies and caddisflies. For first time participants the Qi varied between 40 and 100 for mayflies,

between 10 and 100 for stoneflies and 40 and 100 for caddisflies. For the second and the third time participation the Qi was mostly above 80, showing clear improvements. This was most pronounced among laboratories that got a low Qi during the first participation.

The improvement of the Qi has been tested statistically by use of ANOVA. For mayflies and caddiesflies the mean Qi for the first exercise was significant lower ($p < 0.05$) than for the second and third exercise. For stoneflies the significance was stronger with $p < 0.02$. No significant differences were recorded between the second and third exercises.

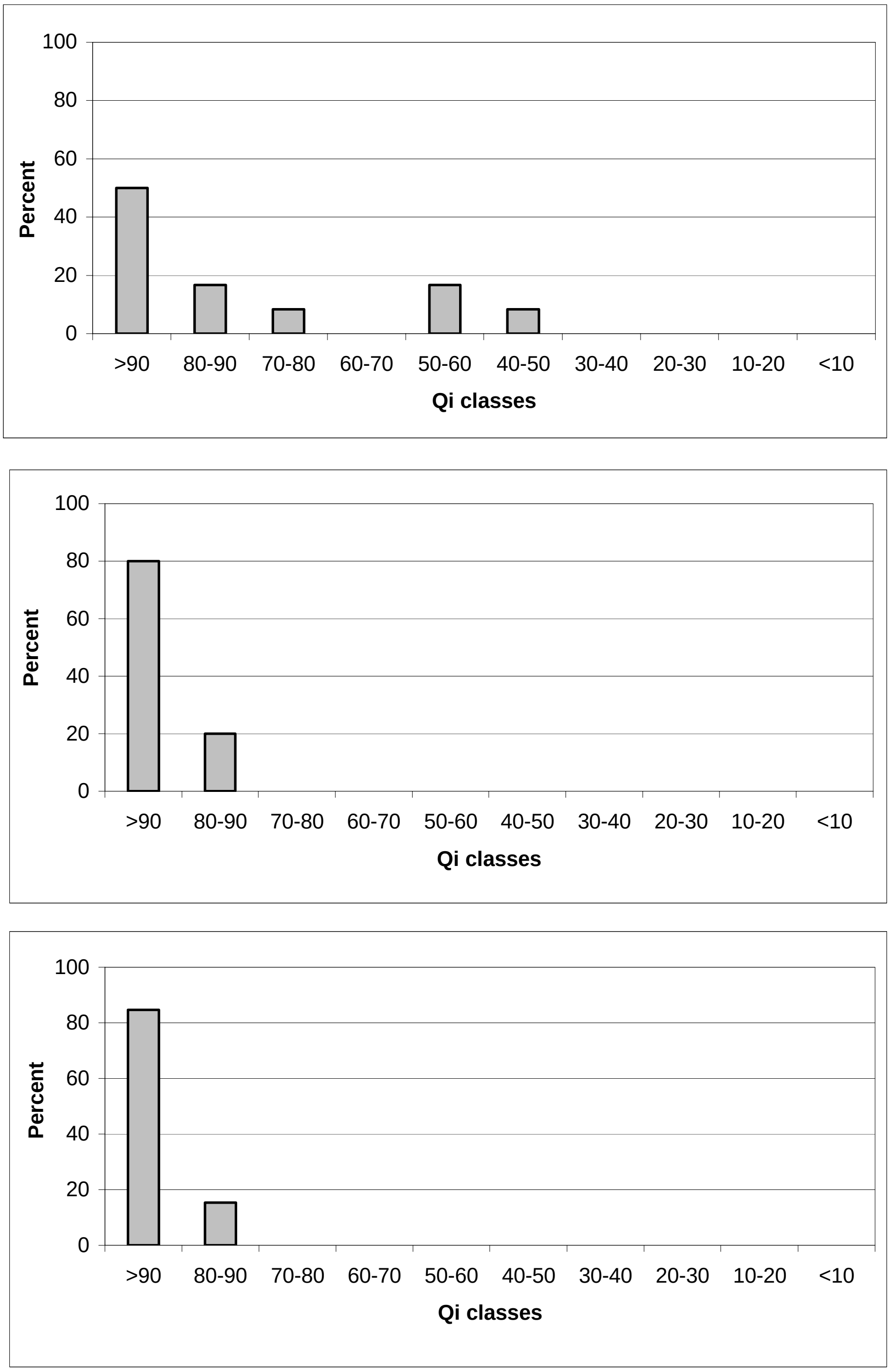
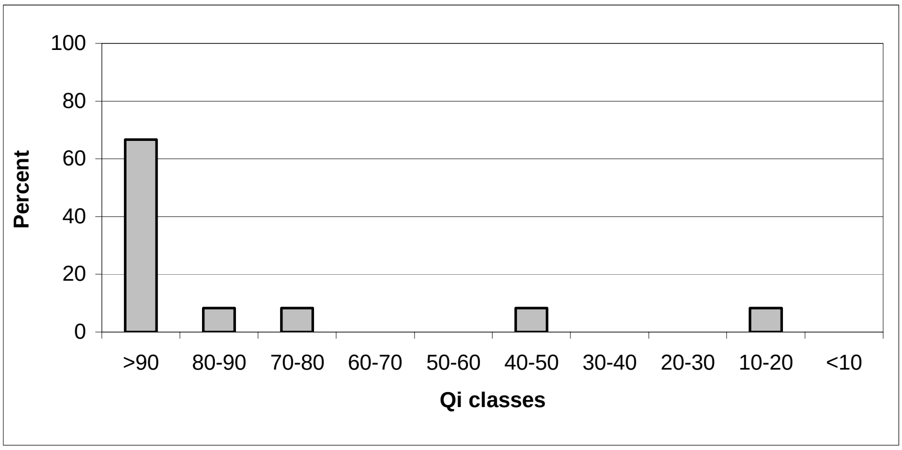
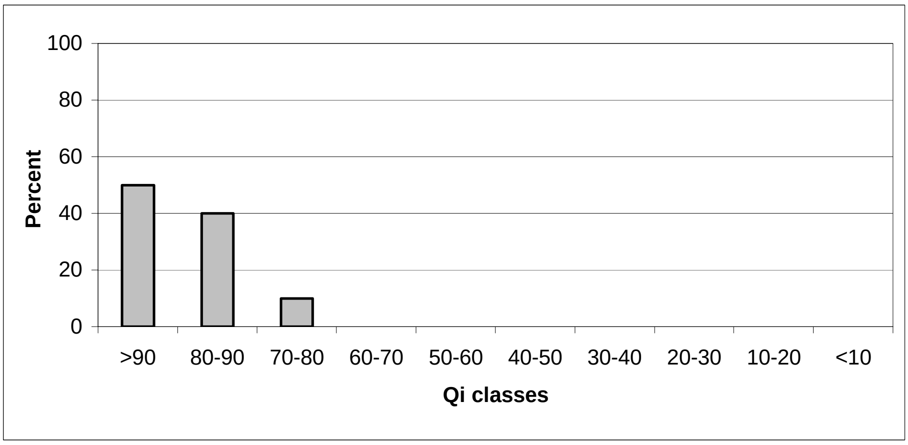


Figure 7. Distribution of Qi classes for identification of mayflies among laboratories

participating first time (top), second time (middle) and third time (bottom).





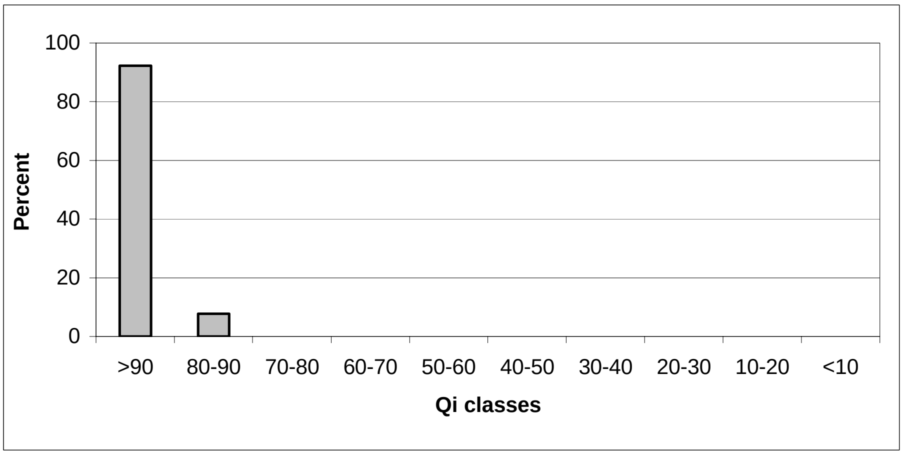


Figure 8. Distribution of Qi classes for identification of stoneflies among laboratories participating first time (top), second time (middle) and third time (bottom).

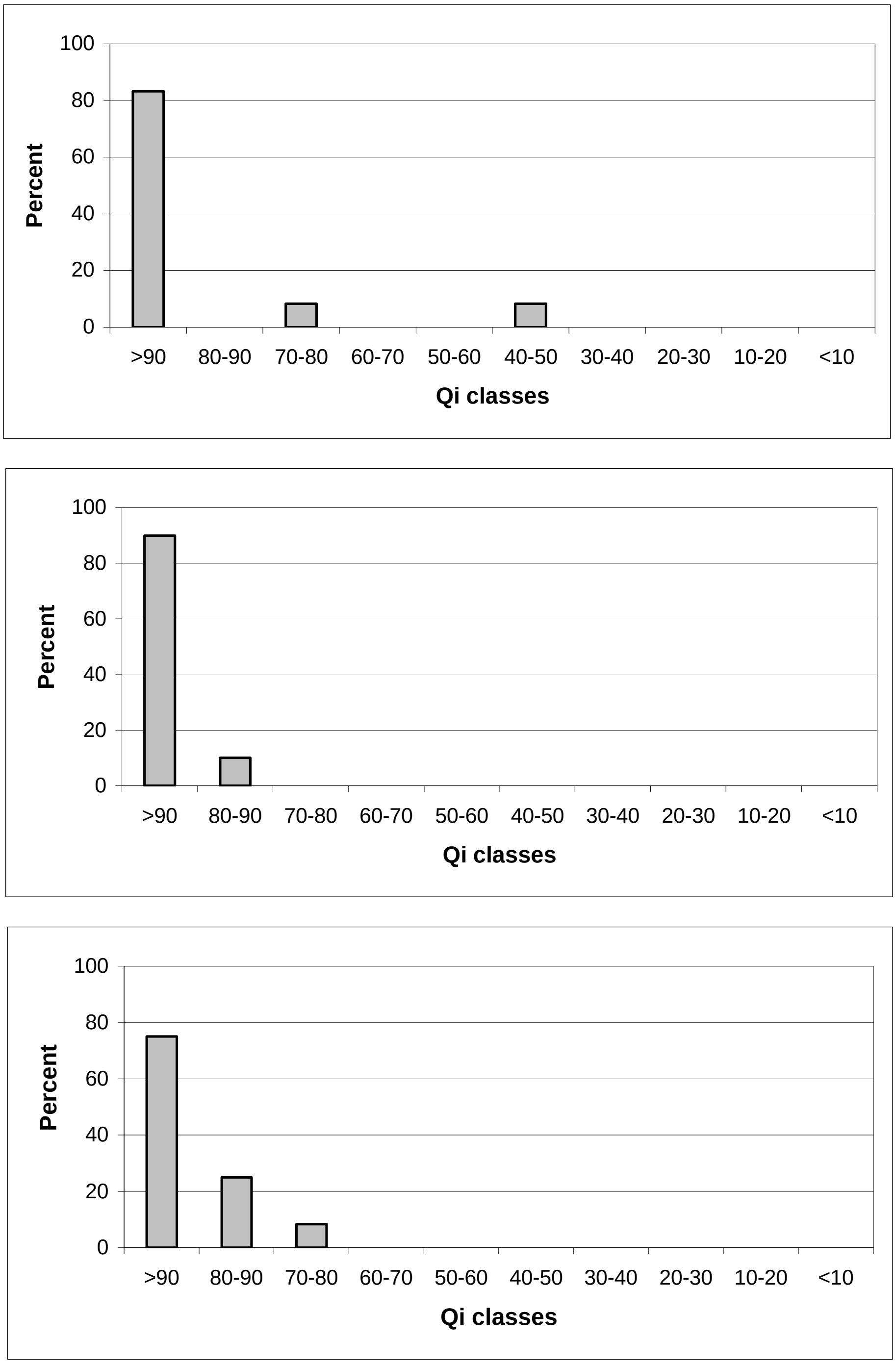


Figure 9. Distribution of Qi classes for identification of caddisflies among laboratories participating first time (top), second time (middle) and third time (bottom).

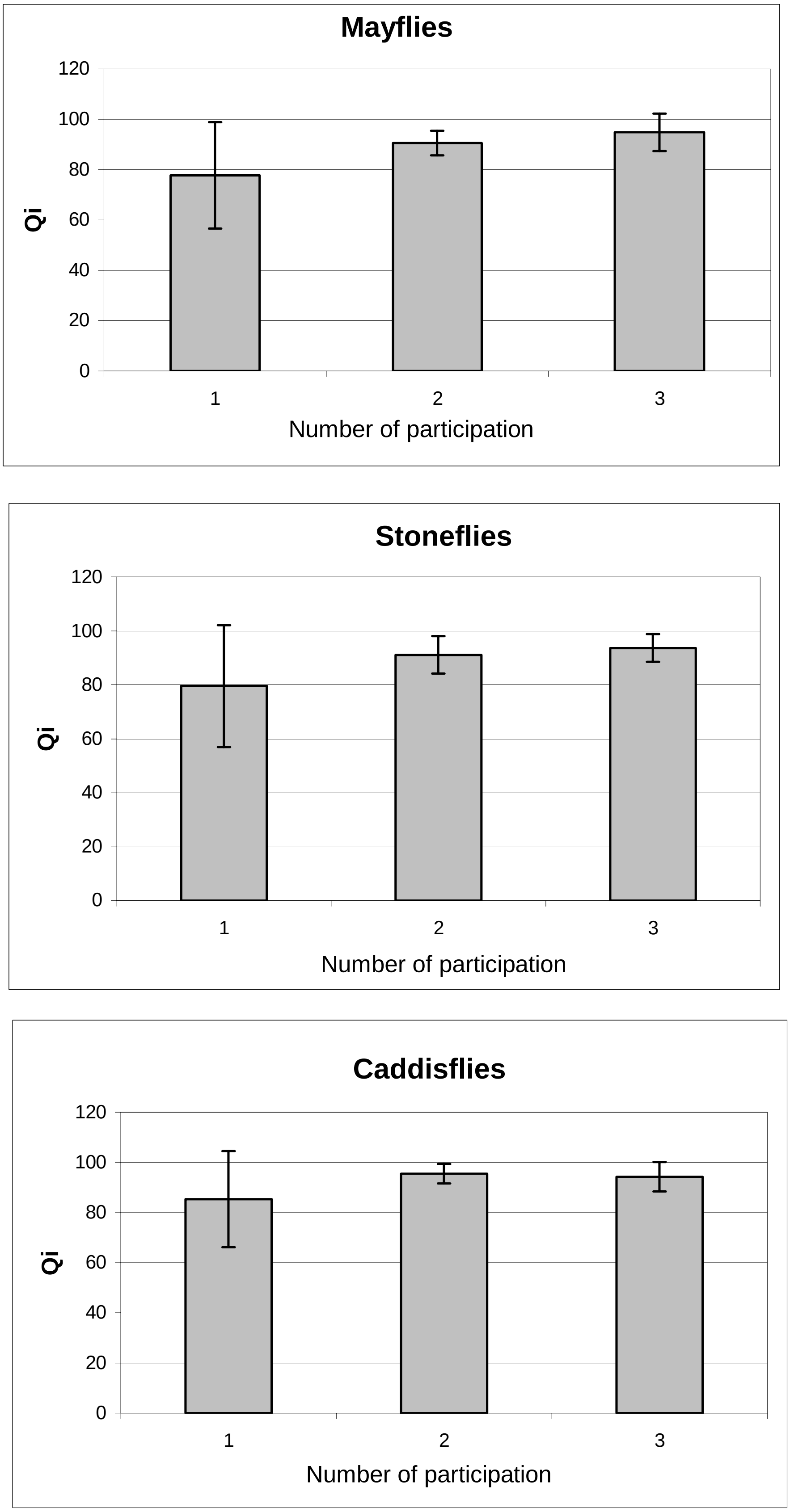


Figure 10. Mean Qi with standard deviation for first, second and third participation.

Summary of the tests

Many laboratories did very few or no faults at the first exercises, while other did mistakes both on species and genus level. In addition they had a low % identified, resulting in a low Qi. The reasons for this can be many. In some cases lack of adequate taxonomic literature and lack of experience in this type of work appeared to be the main reasons. It should be noted that the second participation was usually much better and well above the limit for good taxonomic work. The third exercise could sometime have higher fault % than the second, see Figure 9, but this was not significant. It is clear that the intercalibration increases the quality of taxonomic work and that the data become more harmonized. This is important for ICP Water where the biology shall point at damages caused by acid rain as well as recognize recovery of sensitive fauna. For other programmes, and for the Water Framework Directive, harmonization and quality control of biological work will probably be even more important. The reason is involvement of a larger number of laboratories; and the evaluation of ecological status based on biology in different regions and watersheds.

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Appendix A. Identified species/genus

Each participating laboratory is identified by a number, which is identical with table number. Laboratories participating in the intercalibration of invertebrates in 2004 and their code numbers are:

1. Environmental Protection Agency, Laboratory Pottery Road, Dun Laoghaire, ***Ireland***
2. Laboratory of Freshwater Ecology and Inland Fisheries, University of Bergen, ***Norway***
3. Swedish University of Agricultural Sciences, Dept. of Environmental Assessment, P.O. Box 7050, S-75007 Uppsala - ***Sweden***
4. Div. Ambiente Canton Ticino, Laboratorio Studi Ambientali, Sez. Protezione Aria AcquaRiva Paradiso 15, CH-6900 Lugano Paradiso, ***Switzerland***

Table 1. Identified species/genus in sample 1 and 2 by Laboratory 1

	Sample 1			Sample 2	
Taxa:	**Delivered**	**Identified**		**Delivered**	**Identified**
Ephemeroptera					
Ameletus inopinatus	1			1	
Baetis fuscatus	1				
Baetis niger	1				
Baetis rhodani	1	2		1	1
Baetidae		2			1
Caenis horaria	1	1			
Caenis luctuosa				1	1
Centroptilum luteolum				1	1
Ephemerella ignita		1			1
Ephemerella aurivilli	1			1	
Heptagenia fuscogrisea	1				
Hepatgeniidae		1			
Heptagenia sulphurea				1	1
Leptophlebia vespertina	1	1			
Plecoptera					
Amphinemura borealis				1	
Amphinemura sulcicollis	1	1			1
Brachyptera risi	1	1			
Dinocras cephalotes	1	1			
Diura bicaudata		1		1	1
Diura nanseni	1				
Isoperla grammatica	1	1		1	
Leuctra nigra	1			1	
Leuctridae		1			
Nemoura avicularis				1	
Nemoura cambrica		1			1
Nemoura cinerea	1				
Nemurella pictetii				1	1
Protonemura meyeri	1	1		1	1
Siphonoperla torrentium					
Siphonoperla burmeisteri	1				
Taeniopteryx nebulosa				1	1
Plecoptera indet					1
Trichoptera					
Beraeodes minutus	1	1			
Ceratopsyche silvenii	1				
Ecnomus tenellus	1	1			
Hydropsyche angustipennis	1				
Hydropsyche pellucidula		2		1	
Hydropsyche siltalai	1	1			
Lepidostoma hirtum	1	1			
Micrasema minimum				1	
Neureclipsis bimaculatus	1		1		
Notidobia ciliaris					1
Oecetis testacea				1	
Philopotamus montanus	1	1			
Plectrocnemia conspersa				1	
Plectrocnemia geniculata		1			
Plectrocnemia sp.					1
Polycentropodidae		1			1
Polycentropus flavomaculatus	1	1		1	1

	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Polycentropus irroratus	1			
Sericostoma personatum	1	1	1	1
Tinodes waeneri			1	
Wormaldia subnigra	1	1	1	2
Malacostraca				
Asellus aquaticus	1	1		
Gammarus pulex	1	1		
Hirudinea				
Helobdella stagnalis	1	1		
Gastropoda				
Teodoxus fluviatilis			1	1
Lymnaea peregra			1	1
Gyraulus acronicus	1			
Ancylus fluviatilis	1	1		
Bithynia tentaculata	1			
Valvata piscinalis		1		
Planorbis sp.		1		
Coleoptera				
Elmis aenea larver	1	1		
Limnius volckmari			1	
Elmidae				1

Table 2. Identified species/genus in sample 1 and 2 by Laboratory 2

	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Ephemeroptera				
Caenis horaria	1	1		
Caenis luctuosa			2	2
Ameletus inopinatus	1	1		
Baetis niger	2	1		1
Baetis digitatus			1	
Baetis rhodani	1	1		
Baetis cf. bundyae		1		
Baetis cf.fuscatus	1	1	1	1
Ephemerella ignita	1	1		
Ephemerella aurivilli			1	1
Heptagenia fuscogrisea	2	2	1	1
Heptagenia dalecarlica	1	1		
Heptagenia sulphurea			1	1
Plecoptera				
Diura nanseni	1	1		
Siphonoperla burmeisteri	1	1	2	2
Amphinemura borealis	1	1		
Amphinemura standfussi			1	1
Amphinemura sulcicollis			1	1
Protonemura meyeri	1	1	1	1
Protonemura cf.intricata	1	1		
Nemoura cinerea	1	1	1	
Nemoura avicularis	1	1	1	1
Nemouridae indet./Nemoura sp.				1
Trichoptera				
Micrasema sp.				1
Micrasema setiferum			1	
Lepidostoma hirtum	1	1		
Sericostoma personatum	2	2	2	2
Setodes argentipunctellus	0		1	1
Polycentropus flavomaculatus	2	2		
Polycentropus irroratus	0		2	2
Holocentropus dubius	1	1	1	1
Cyrnus trimaculatus	1	1	1	
Cyrnus flavidus			1	1
Oecetis testacea			1	1
Oecetis cf. notata		1		
Oecetis notata	1			
Chimarra marginata	1	1		
Ceratopsyche(Hydrosyche)silfvenii	1	1	1	1
Hydropsyche siltalai	1	1	1	1
Hydropsyche pellucidula	1	1	1	1
Diptera				
Chaoborus flavicans	1	1	1	1
Ibisia marginata	1	1		
Ptychoptera sp.				1
Ptycoptera lateralis			1	
Odonata				
Cordulegaster boltoni	1	1		
Onychogompus forscipatus			1	1

	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Somatochlora metallica			1	1
Heteroptera				
Aphelocheirus aestivalis	1	1		
Hirudinea				
Erpobdella octoculata	1	1		
Helobdella stagnalis			1	1
Turbellaria				
Dugesia sp.cf.lugubris		1		
Ddendrocoelum sp.	1			
Coleoptera				
Scarodytes halensis		1		
Orechtochilus villosus	1	1		
Limnius volckmari	2	2		
Noterus crassicornis			1	1
Stenelmis canaliculata			1	1
Stictotarsus multilineatus	1			
Corixidae				
Hespecorixa salhbergi			1	1
Gastropoda				
Gyraulus (Planorbis) albus		1		1
Planorbis corneus	1			
Bathyomphalus contortus	1	1	1	1
Lymnaea truncatula				1
Omphiscola glabra			1	
Malacostraca				
Gammarus lacustris	1	1		
Asellus aquatus	1	1	1	1
Pallasea quadrispinosa			1	1

Table 3. Identified species/genus in sample 1 and 2 by Laboratory 3

	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Ephemeroptera				
Ameletus inopinatus	1	1	1	
Baetis rhodani	1	1	1	1
Baetis niger	1	1		
Baetis fuscatus	1			
Baetis sp.		1		
Centroptilum luteolum			1	1
Ephemerella aurivilli	1	1	1	1
Heptagenia fuscogrisea	1			
Heptagenia sulphurea			1	1
Heptagenia dalecarlica	1	1		
Heptagenia sp.		1		
Leptophlebia vespertina	1	1		
Leptophlebia marginata			1	1
Caenis horaria	1	1		
Caenis luctuosa			1	1
Plecoptera				
Amphinemura borealis			1	1
Amphinemura sulcicollis	1	1		
Nemoura cinerea	1			
Nemoura avicularis		1	1	1
Nemurella pictetii			1	1
Protonemura meyeri	1	1	1	1
Taeniopteryx nebulosa			1	1
Leuctra nigra	1	1	1	1
Isoperla grammatica	1	1		
Diura bicaudata			1	
Diura nanseni	1	1		1
Dinocras cephalotes	1	1		
Brachyptera risi	1	1		
Siphonoperla burmeisteri	1	1		
Trichoptera				
Ecnomus tenellus	1	1		
Oecetis testacea			1	1
Mystacides azurea	1	1	1	1
Athripsodes albifrons	1	1	1	1
Hydropsyche siltalai	1	2		
Hydropsyche pellucidula			1	2
Hydropsyche angustipennis	1	1		
Hydropsyche contubernalis			1	
Hydropsyche saxonica	1	1		
Cheumatopsyche lepida	1	1	1	1
Ceratopsyche silvenii	1			
Beraeodes minutus	1	1		
Cyrnus trimaculatus	1	1	1	1
Polycentropus flavomaculatus	1	1	1	1
Neureclipsis bimaculatus	1	1	1	1
Plectrocnemia conspersa			1	
Plectrocnemia sp.				1
Polycentropus irroratus	1	1		
Philopotamus montanus	1	1		
Wormaldia subnigra	1			3
Wormaldia sp		1	3	

	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Lepidostoma hirtum	1	1		
Micrasema minimum			1	1
Tinodes waeneri			1	1
Sericostoma personatum	1	1	1	1
Malacostraca				
Asellus aquaticus	1	1		
Gammarus pulex	1	1		
Hirudinea				
Helobdella stagnalis	1	1		
Gastropoda				
Teodoxus fluviatilis			1	1
Lymnaea peregra			1	1
Gyraulus acronicus	1	1		
Gyraulus crista			1	1
Ancylus fluviatilis	1	1		
Bithynia tentaculata	1	1		
Coleoptera				
Elmis aenea larver	1	1		
Limnius volckmari			1	1
Olimnius trioglodytes/ turberculatus	1	1		
Elodes sp	1	1	1	1

Table 4. Identified species/genus in sample 1 and 2 by Laboratory 4

	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Ephemeroptera				
Ameletus inopinatus	1	1	1	1
Baetis fuscatus	1	1		
Baetis niger	1	1		
Baetis rhodani	1	1	1	1
Caenis horaria	1	1		
Caenis luctuosa			1	1
Centroptilum luteolum			1	1
Ephemerella aurivilli	1	1	1	1
Heptagenia fuscogrisea	1	1		
Heptagenia sulphurea			1	1
Leptophlebia vespertina	1	1		
Plecoptera				
Amphinemura borealis			1	1
Amphinemura sulcicollis	1	1		
Brachyptera risi	1	1		
Dinocras cephalotes	1	1		
Diura bicaudata			1	1
Diura nanseni	1	1		
Isoperla grammatica	1	1		
Leuctra nigra	1	1	1	1
Nemoura avicularis			1	1
Nemoura cinerea	1	1		
Nemurella pictetii			1	1
Protonemura meyeri	1	1	1	1
Siphonoperla burmeisteri	1	1		
Taeniopteryx nebulosa			1	1
Trichoptera				
Beraeodes minutus	1	1		
Ecnomus tenellus	1	1		
Hydropsyche angustipennis	1			
Hydropsyche pellucidula			1	1
Hydropsyche siltalai	1	1		
Hydropsyche sp. (Curtis)		2		
Lepidostoma hirtum	1	1		
Micrasema minimum			1	1
Neureclipsis bimaculatus	1	1	1	1
Oecetis testacea			1	
Philopotamus montanus	1	1		
Plectrocnemia conspersa			1	1
Polycentropus flavomaculatus	1	2	1	1
Polycentropus irroratus	1			
Sericostoma personatum	1	1	1	1
Rhyacophila sp.				1
Tinodes waeneri			1	
Wormaldia sp	1	1	1	2
Malacostraca				
Asellus aquaticus	1	1		
Gammarus pulex	1	1		

	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Hirudinea				
Helobdella stagnalis	1	1	1	1
Gastropoda				
Teodoxus fluviatilis				
Lymnaea peregra			1	1
Gyraulus acronicus	1	1		
Ancylus fluviatilis	1	1	1	1
Bithynia tentaculata	1	1		
Coleoptera				
Elmis aenea larver	1	1		
Limnius volckmari			1	1

Appendix B. Reports and publications from ICP Waters

All reports from the ICP Waters programme from 1987 up to present are listed below. All reports are available from the Programme Centre. Publications from 2002 up to present can be found at http://www.iis.niva.no/ICP%2Dwaters

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Norwegian Institute for Water Research, 1988. Data Report 1987 and available Data from Previous Years. Programme Centre, NIVA, Oslo.

Norwegian Institute for Water Research, 1988. Intercalibration 8802. pH, K_{25}, HCO_3, NO_3, SO, Cl, Ca, Mg, Na, K. Programme Centre, NIVA, Oslo.

Proceedings of the Workshop on Assessment and Monitoring of Acidification in Rivers and Lakes, Espoo, Finland, 3rd to 5th October 1988. Prepared by the Finnish Acidification Research Project, HAPRO, Ministry of Environment, October 1988.

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Norwegian Institute for Water Research, 1990. Data Report 1988. Programme Centre, NIVA, Oslo.

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Norwegian Institute for Water Research, 1991. The Three Year Report. Summary and results 1987 – 1989: Results from the International Co-operative Programme on Assessment and Monitoring of Acidification in Rivers and Lakes. Programme Centre, NIVA, Oslo.

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Norwegian Institute for Water Research, 1992. Data Report 1990. Programme Centre, NIVA, Oslo.

Norwegian Institute for Water Research, 1992. Evaluation of the International Co-operative Programme on Assessment and Monitoring of Acidification in Rivers and Lakes. Programme Centre, NIVA, Oslo.

Hovind, H. 1993. Intercalibration 9307: pH, k_{25}, HCO_3, $NO_3 + NO_2$, Cl, SO_4, Ca, Mg, Na, K, total aluminium, reactive and non-labile aluminium, TOC and COD-Mn. Programme Centre, NIVA,Oslo. NIVA-Report 2948-93.

Raddum, G.G. 1993. Intercalibration of Invertebrate Fauna 9301. Programme Centre, NIVA, Oslo. NIVA-Report SNO 2952-93.

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