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Intercalibration: Invertebrate fauna 09/04

Norwegian Institute for Water Research

REPORT

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Abstract

The 8th intercalibration of invertebrates in the ICP Waters programme had contribution from 4 laboratories. All of the laboratories identified a high portion of the individuals in the testsamples, usually ≥ 90% of the total number of species. The genus level was only used for juvenile larvae or larva that had lost important characters. The faults made were mostly on material coming from regions outside the region of the laboratory. This implies that some species could be new/unknown for the laboratory. The quality was sufficient for stating the acidity index, and for use in multivariate statistical analyses.

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1. Interkalibrering	1. Intercalibration
2. Invertebrater	2. Invertebrates
3. Akvatisk fauna	3. Aquatic fauna
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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 08/04

ICP Waters Programme Subcentre
Laboratory of Freshwater Ecology and Inland Fisheries
University of Bergen, April 2004

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 8th intercalibration on invertebrate fauna.

Bergen, April, 2004

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 2003 two laboratories got test material relevant for their home region, while two participants received material that was based on fauna outside their region.

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, which also was used for making the test samples. We have also used material from an EU-project.

For two laboratories we did not have enough material from their home region. In this case the test samples were based on material from Scandinavia and material from other parts of Europe regarded as relevant for the laboratories.

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 fault 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.
- 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 are placed in the samples according to the list.

For the present test participant 2 and 3 received material mostly from Norway. They 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, which 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.

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 samples for the test 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 2003. 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 1 and 4 identified the mayflies (Ephemeroptera) without any faults (Figure 1). The two other laboratories did a few misidentifications, but the quality of the identifications was evaluated above the fault limit of 10%. It should be mentioned that the faults were made on specimen that was not from the home country of these laboratories. The genus level was 100% right identified by all laboratories. In spite of normally high damages on mayflies in test samples, three laboratories finalised the species identification, while one laboratory stopped at the genus level for a few specimens. In summary the taxonomic work was generally good especially when taken into account that two of the laboratories had material from outside their home region.

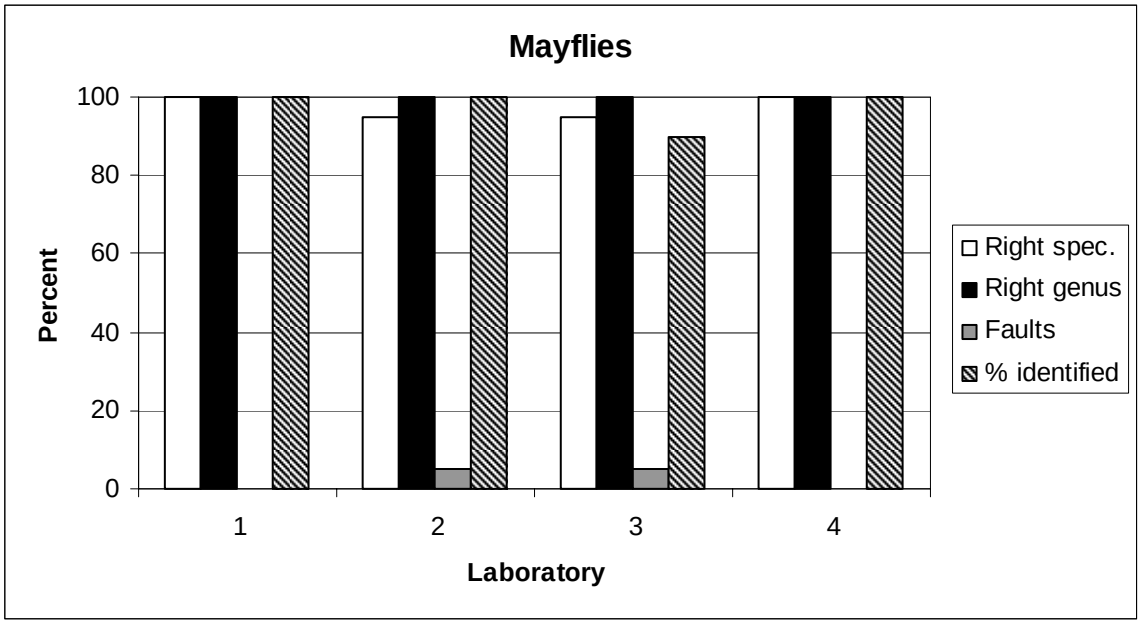

Figure 1. *Results of the identification of mayflies.*

Stoneflies

The identification of stoneflies (Plecoptera) was generally good, but all laboratories did some faults (Figure 2). All larvae were, however, identified to species level by laboratory 1, 3 and 4, while laboratory 2 stopped at the genus level for one species. Right identified species were ≥ 90 %, which is regarded as good for taxonomic work. The genus level was, however, 100 % right for all participants. Laboratory 2 and 3 identified material that was not sampled in their home region, and this material was consequently unknown and mostly new for them. In conclusion the identifications were in line with - or above the level regarded as acceptable for good taxonomic work.

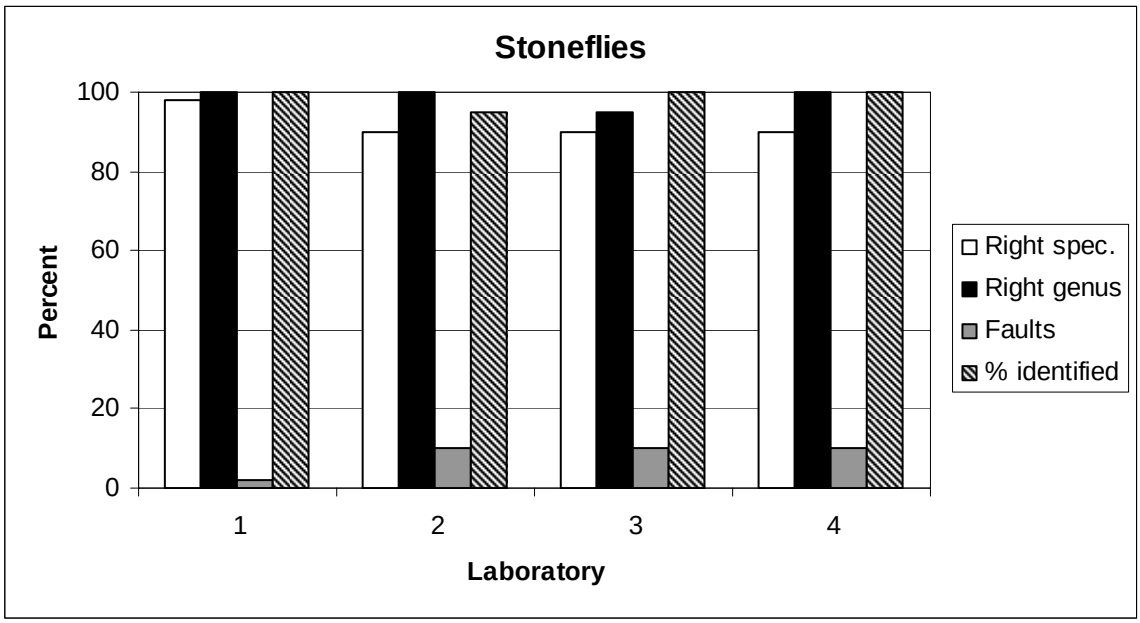

Figure 2. *Results of the identification of stoneflies.*

Caddisflies

The identification of caddisflies (Trichoptera) was also good (Figure 3). A few identifications were regarded as faults for Laboratory 1, 2 and 3, while Laboratory 4 did all identifications right. The *% identified* was 100 percent for all laboratories. On genus level faults were recognised for Laboratory 1 and 3, while the two other laboratories did no misidentifications on this level. The taxonomic work on caddisflies is also regarded as good and will be sufficient for all types of analyses.

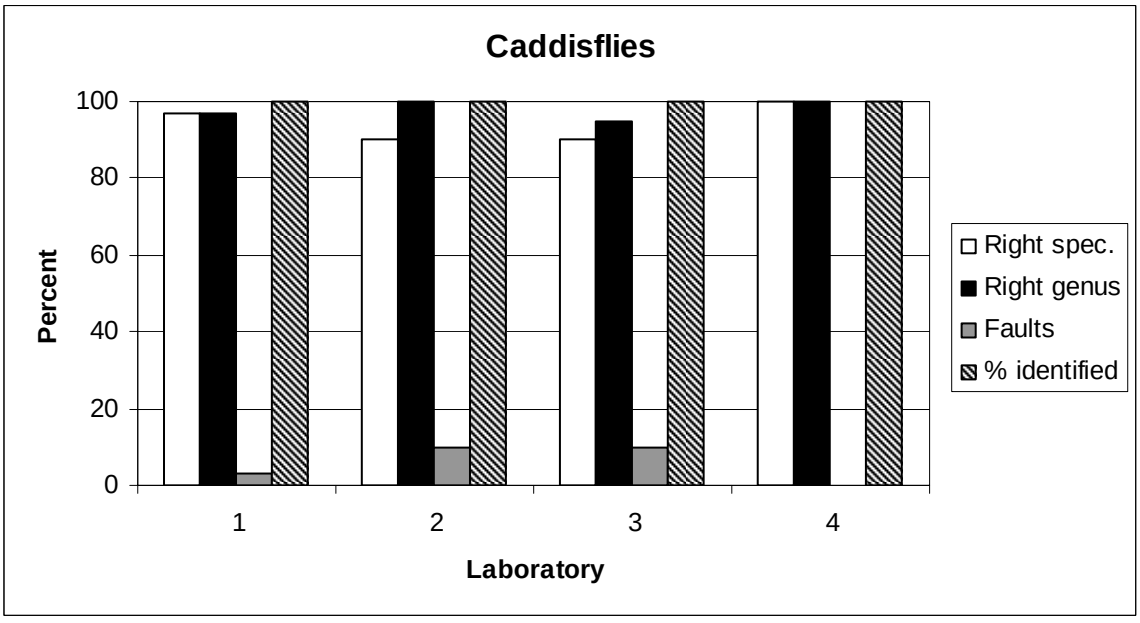

Figure 3. *Results of the identification of caddisflies.*

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 2, 3, and 4 identified all individuals to the right species, while laboratory 1 did one identification, which was regarded as a fault. The *% identified* was, however, 100 % for all laboratories and no faults were made on the genus level. The identification of the mentioned group is regarded as very good for all laboratories.

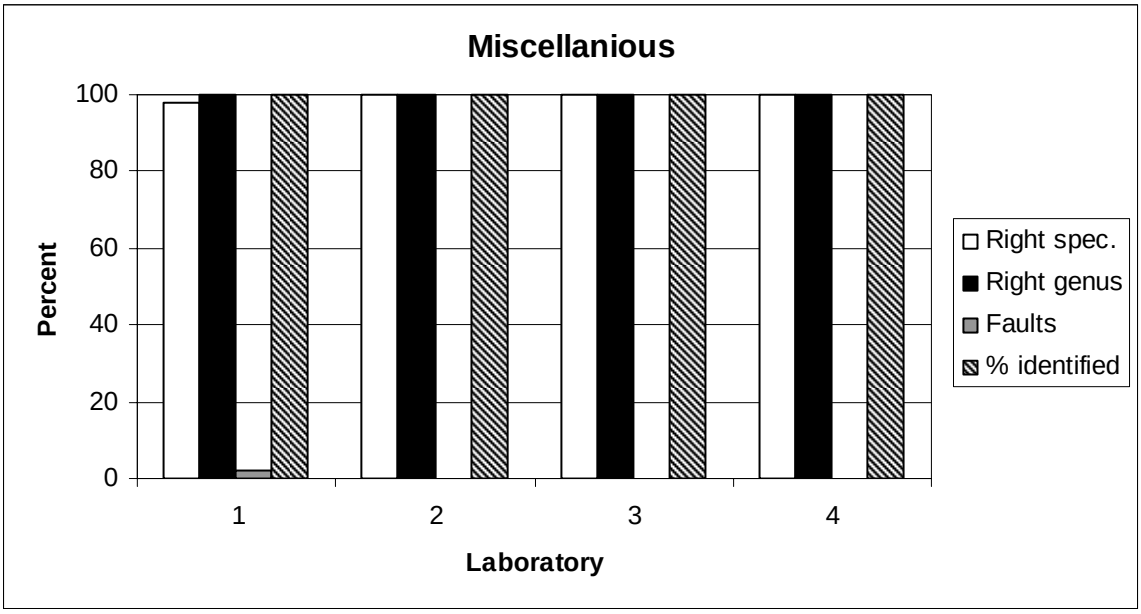

Figure 4. *Results of the identification of miscellaneous groups*

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. Small or juvenile larvae were put in the samples. Such larvae can be impossible to identify to species and this has also been taken into account during the evaluation.

4. Evaluation/conclusion

All laboratories identified a high portion of the total number of species in the test samples (Figure 5). Shortcoming identification was low. The misidentifications were mostly made on material coming from outside the home region of the laboratory. However, misidentifications did not exceed 10 % for any group. This is regarded as good. The value of *% identified* was in most cases 100%. This demonstrates that the identifications also are suited for multivariate statistical analyses. None of the participants did misidentifications that could result in a wrong acidity index. The results of the test are among the best since this exercise started. Clear improvements are observed among laboratories that have participated several times. 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.

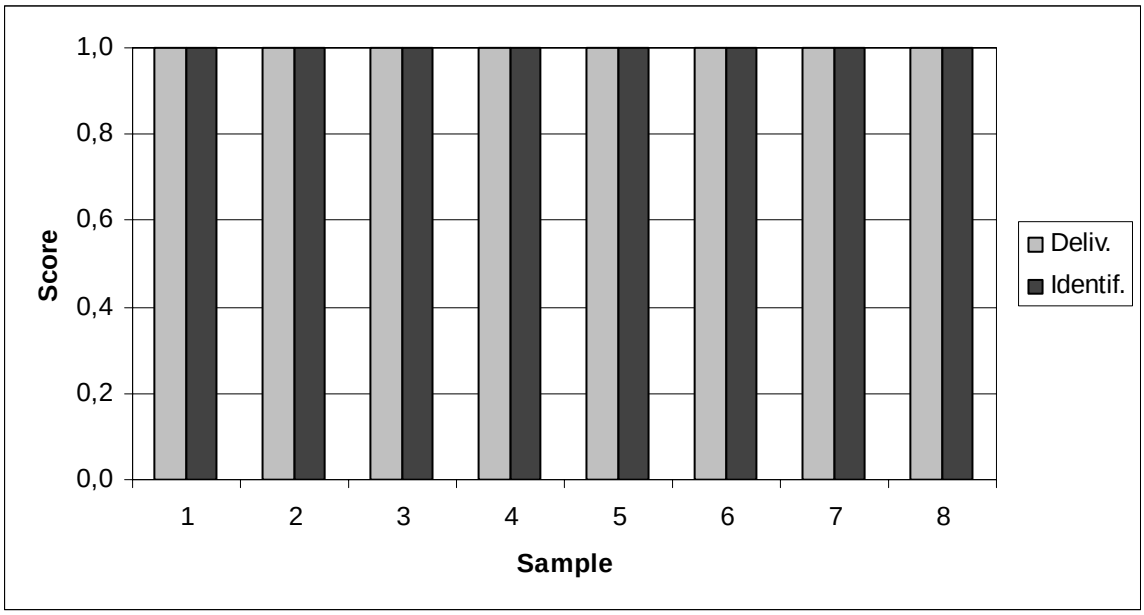

Figure 5. *Acidification score in delivered and identified samples.*

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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 2003 and their code numbers are:

1. Swedish University of Agricultural Sciences, Dept. of Environmental Assessment, P.O. Box 7050, S-75007 Uppsala - ***Sweden***
2. Charles University Dept. of Hydrobiology, Vinicna 7, CZ-128 44 Prague 2 - ***Czech Republic***
3. Estonian Environment Information Centre, Mustamàe Tee 33, 10616 Tallinn - ***Estonia***
4. Latvian Hydrometeorological Agency, EQOD , Environmental Quality Testing Laboratory, Riga - ***Latvia***

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

	Sampel 1		Sampel 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Trichoptera:				
Agapetus ochripes	1	1		
Athripsodes aterrimus	1			
Athripsodes cinereus		1	1	1
Chaetopteryx/Anitella				1
Chimarra marginata			1	1
Cyrnus flavidus			1	1
Ecnomus tenellus	1	1		
Glossosoma intermedium			1	1
Halesus sp.	1	1	1	
Holocentropus dubius	1	1		
Hydropsyche pellucidula	1		1	
Hydropsyche siltalai		1	1	2
Lepidostoma hirtum			1	1
Micrasema gelidum			1	1
Neureclipsis bimaculata	1	1	1	1
Oxyethira sp	3	3		
Philopotamus montanus	1	1		
Plectrocnemia conspersa	1	1		
Polycentropus flavomaculatus	1	1	1	1
Polycentropus irroratus			1	1
Rhyacophila nubila	1	1	2	2
Sericostoma personatum	1	1		
Plecoptera:				
Amphinemura borealis	2	2	1	1
Amphinemura standfussi			1	
Amphinemura sulcicollis			1	2
Brachyptera risi	1	1	1	1
Capnia bifrons			1	1
Capnopsis shilleri	1	1	1	1
Dinocras cephalotes	1	1	1	1
Diura nanseni	1	1	1	1
Isoperla difformis	1	1		
Isoperla grammatica	1		1	
Isoperla sp.		1		1
Leuctra hippopus	1	1	1	1
Leuctra nigra			1	1
Nemoura cinerea	2	2		
Protonemura meyeri	1	1	1	1
Siphonoperla burmeisteri	1	1	1	1
Taeniopteryx nebulosa	1	1		
Ephemeroptera:				
Ameletus inopinatus			1	1
Baetis fuscatus	1			
Baetis rhodani	1	1	1	1
Baetis vernus	1	1	1	
Baetis sp.		1		1
Caenis horaria	1	1	1	1
Caenis luctuosa	1	1		
Ephemerella aurivilli	1	1	1	1

	Sampel 1		Sampel 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Heptagenia dalecarlica	**1**	**1**	**1**	**1**
Hirudinea:				
Erpobdella octoculata	**1**	**1**		
Glossophonia complanata			**1**	**1**
Gastropoda:				
Bithynia tentaculata	**1**	**1**		
Gyraulus acronicus	**2**			
Gyraulus albus		**2**		
Teodoxus fluviatilis			**1**	**1**
Coleoptera:				
Elmis aenea	**1 larvae + 1 adult**	**1 larvae + 1 adult**	**1 larvae + 1 adult**	**1 larvae + 1 adult**
Limnius volckmari	**1**	**2**	**1**	**1**
Olimnius tuberculatus	**1**	**1**		
Oreodytes sanmarki	**1**	**1**	**1**	**1**
Megaloptera:				
Sialis lutaria	**1**	**1**		
Diptera:				
Dicranota sp.			**1**	**1**
Pedicia rivosa	**1**	**1**	**1**	**1**
Malacostraca:				
Asellus aquaticus			**1**	**1**
Gammarus lacustris	**1**			
Gammarus pulex		**1**	**1**	**1**

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

	Sampel 1		Sampel 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Trichoptera				
Hydropsyche incognita	**2**	**1**	**2**	
Hydropsyche siltalai	**1**	**3**	**1**	**3**
Hydropsyche pellucidula	**1**			
Rhyacophila nubile	**1**			
Rhyacoph. gr. Vulgaris		**1**		
Neureclipsis bimaculata	**1**	**1**	**1**	**1**
Polycentropus flavomaculatus	**1**	**1**	**1**	**1**
Plectrocnemia conspersa	**1**	**1**	**1**	**1**
Cyrnus flavidus			**1**	**1**
Molanna angustata	**1**	**1**	**1**	**1**
Oligotricha striata	**1**	**1**	**1**	**1**
Plecoptera				
Isoperla difformis	**1**		**1**	
Isoperla oxylepsis		**1**		
Isoperla sp.				**1**
Diura nanseni	**1**		**1**	

	Sampel 1		Sampel 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Diura bicaudata		**1**		**1**
Taeniopteryx nebulosa	**1**	**1**	**1**	**1**
Siphonoperla burmeisteri	**1**		**1**	
Siphonoperla neglecta				**1**
Brachyptera risi	**1**	**1**	**1**	**1**
Leuctra nigra	**1**	**1**		
Protonemura meyeri			**1**	
Protonemura nimborum				**1**
Amphinemura borealis	**1**	**1**	**1**	**1**
Ephemeroptera				
Ephemera danica	**1**	**1**		**1**
Ephemera vulgate			**1**	
Baetis rhodani	**2**	**2**	**2**	**2**
Baetis niger			**1**	
Baetis sp.				**1**
Siphlonurus armatus	**1**		**1**	
Siphlonurus aestivalis		**1**		**1**
Habrophlebia lauta	**1**	**1**	**1**	**1**
Diptera				
Chironomus plumosus	**1**		**1**	
Chironomus sp.		**1**		**1**
Atherix ibis	**2**	**2**	**1**	**1**
Dinocra sp	**3**	**3**	**3**	**3**
Odonata				
Lestes cf sponsa	**1**	**1**	**1**	**1**
Heteroptera				
Notonecta glance	**1**		**1**	**1**
Notonecta sp. cf. Viridis		**1**		
Aphelocheirus aestivalis	**2**	**2**	**2**	**2**
Megaloptera				
Sialis lutaria	**1**	**1**		
Sialis fuliginosa			**1**	**1**
Coleoptera				
Elmis sp.		**1**		
Limnius sp	**2**	**2**	**3**	**3**
Orectochilus villosus	**2**	**2**		

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

	Sampel 1		Sampel 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Ephemeroptera.				
Ameletus inopinatus	**1**	**1**	**1**	**1**
Baetis rhodani	**1**		**1**	
Baetis niger	**1**			
Baetis fuscatus	**1**			
Baetis sp.		**3**		**1**
Centroptilum sp. (juv)				**1**

	Sampel 1		Sampel 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Centroptilum luteolum			1	
Ephmerella ignita		1		1
Ephemerella aurivilli	1		1	
Heptagenia fuscogrisea	1			
Heptagenia sp.		1		
Heptagenia sulphurea			1	1
Leptophlebia vespertina	1	1		
Caenis horaria	1	1		
Caenis luctuosa			1	
Caenis sp. juv.				1
Plecoptera.				
Amphinemura borealis		1	1	1
Amphinemura sulcicollis	1			
Nemoura cinerea	1	1		
Nemoura avicularis			1	
Nemoura flexuosa				1
Nemurella pictetii			1	1
Protonemura meyeri			1	1
Taeniopteryx nebulosa			1	1
Leuctra nigra	1	1	1	1
Isoperla grammatica	2	3		
Diura bicaudata			1	
Diura nanseni	1	1		1
Dinocras cephalotes	1	1		
Brachyptera risi	1	1		
Siphonoperla burmeisteri	1			
Trichoptera.				
Ecnomus tenellus	1	1		
Oecetis testacea			1	1
Hydropsyche siltalai	1	1		
Hydropsyche pellucidula		2	1	1
Hydropsyche angustipennis	1			
Ceraptopsyche silvenii	1			
Beraodes minutes	1	1		
Polycentropus flavomaculatus	1	1	1	1
Neureclipsis bimaculata	1	2	1	1
Plectrocnemia conspersa			1	1
Polycentropus irroratus	1			
Philopotamus montanus	1	1		
Wormaldia subnigra	1	1	1	2
Lepidostoma hirtum	1	1		
Micrasema minimum			1	
Micrasema sp.				1
Tinodes waeneri			1	1
Sericostoma personatum	1	1	1	1
Malacostraca.				
Asellus aquaticus	1	1		
Gammarus pulex	1	1		
Hirudinea.				

	Sampel 1		Sampel 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Helobdella stagnalis	**1**	**1**		
Gastropoda.				
Teodoxus fluviatilis			**1**	**1**
Radix ovata			**1**	**1**
Gyraulus acronicus	**1**			
Gyraulus sp.		**1**		
Ancylus fluviatilis	**1**	**1**		
Bithynia tentaculata	**1**	**1**		
Coleoptera.				
Elmis aenea larver	**1**	**1**		
Limnius volckmari			**1**	**1**

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

	Sampel 1		Sampel 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Trichoptera				
Goera pilosa	**1**	**1**	**1**	**1**
Leptocerus tineiformis	**1**	**1**	**1**	**1**
Hydropsyche pellucidula	**2**	**2**	**1**	**1**
Hydropsyche angustipennis	**1**	**1**	**1**	**1**
Rhyacophila nubila	**1**	**1**	**2**	**2**
Lepidostoma hirtum	**2**	**2**	**2**	**2**
Polycentropus flavomaculatus	**2**	**2**	**2**	**2**
Neureclipsis bimaculata			**1**	**1**
Plectrocnemia conspersa	**1**	**1**		
Cyrnus flavidus	**2**	**2**	**2**	**1**
Cyrnus trimaculatus			**1**	**1**
Molanna angustata	**2**	**2**	**1**	**1**
Mystacides longicornis	**1**	**1**		
Mystacides azurea	**1**	**1**	**2**	**2**
Athripsodes cinereus	**1**	**1**	**1**	**1**
Brachycentrus subnubilus	**1**	**1**	**1**	**1**
Anabolia soror	**1**	**1**		
Beraeodes minutes	**1**	**1**	**1**	**1**
Ephemeroptera				
Caenis horaria	**1**	**1**	**1**	**1**
Caenis macrura	**1**	**1**	**1**	**1**
Habrophlebia fusca	**1**	**1**	**1**	**1**
Heptagenia sulphurea	**1**	**1**	**1**	**1**
Ephemera lineata	**1**	**1**		
Ephemera vulgata			**1**	**1**
Ephemera danica	**1**	**1**		
Ephemerella ignita	**1**	**1**	**2**	**1**
Centroptilum sp	**1**	**1**		
Plecoptera				
Nemoura cinerea	**1**		**1**	**1**
Nemoura dubitansa		**1**		**1**
Nemurella pictetii			**1**	
Protonemura meyeri	**1**	**1**	**1**	**1**

	Sampel 1		Sampel 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Taeniopteryx nebulosa	**2**	**2**	**2**	**2**
Isoperla grammatica	**2**	**2**	**2**	**2**
Sipholoperla burmeisteri			**1**	**1**
Leuctra nigra	**2**	**2**	**2**	**2**
Capnia pygmea	**1**		**1**	
Capnia bifrons		**1**		**1**
Amphinemura sulcicollis	**1**	**1**		**1**
Amphinemura borealis			**1**	
Gastropoda				
Ancylus fluviatilis	**1**	**1**	**2**	**2**
Teodoxus fluviatilis	**2**	**2**	**2**	**2**
Hirudinea				
Erpobdella octoculata	**1**	**1**	**1**	**1**
Coleoptera				
Elmis aenea	**1 larvae**	**1 larvae**	**1 larvae + 1 adult**	**1 larvae + 1 adult**
Limnius volckmari	**1**	**1**	**1**	**1**
Malacostraca				
Asellus aquaticus	**1**	**1**	**1**	**1**
Gammarus lacustris	**1**	**1**	**1**	**1**
Megaloptera				
Sialis sordida	**1**	**1**	**1**	**1**
Heteroptera				
Aphelocheirus aestivalis	**2**	**2**	**2**	**2**
Diptera				
Aterix ibis	**2**	**2**		

Appendix B. Reports and publications from ICP Waters

All reports from the ICP Waters programme from 1997 up to present are listed below. All reports are available from the Programme Centre.

Manual for Chemical and Biological Monitoring. Programme Manual. Prepared by the Programme Centre, Norwegian Institute for Water Research. NIVA, Oslo 1987.

Norwegian Institute for Water Research, 1987. Intercalibration 8701. pH, Ks, SO_4, Ca. Programme Centre, NIVA, Oslo.

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.

Norwegian Institute for Water Research, 1989. Intercalibration 8903: Dissolved organic carbon and aluminium fractions. Programme Centre, NIVA, Oslo. NIVA-Report SNO 2238-89.

Note: Some reflections about the determination of pH and alkalinity. Prepared by the Programme Centre, Norwegian Institute for Water Research. Håvard Hovind, NIVA, Oslo October 1989.

Hovind, H. 1990. Intercalibration 9004: pH and alkalinity. Programme Centre, NIVA, Oslo. NIVA-Report SNO 2465-90.

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

Norwegian Institute for Water Research, 1990. Data Report 1989. Programme Centre, NIVA, Oslo.

Proceedings for the 5th Meeting of the Programme Task Force Freiburg, Germany, October 17 -19, 1989. Prepared by the Umweltbundesamt, Berlin July 1990.

Hovind, H. 1991. Intercalibration 9105: pH, K_{25}, HCO_3, $NO_3 + NO_2$, Cl, SO_4, Ca, Mg, Na, K and TOC. Programme Centre, NIVA, Oslo. NIVA-Report 2591-91.

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.

Norwegian Institute for Water Research, 1991. Summary of The Three Year Report 1987 – 1989. Programme Centre, NIVA, Oslo.

Scientific papers presented at the Sixth Task Force meeting in Sweden 23 - 24 October 1990. Swedish Environmental Protection Agency, Sweden, September 1991.

Seventh Task Force meeting of international Co-operative Programme on Assessment and Monitoring of Acidification of Rivers and Lakes. Galway, Ireland. September 30 - October 3 1991. Proceedings.

Johannessen, M., Skjelkvåle, B.L. and Jeffries, D. 1992. International cooperative Programme on Assessment and Monitoring of Rivers and Lakes. In: Conference Abstracts, Intern. Conference on Acidic Deposition, Glasgow 16-21, sept. 1992, p. 449. Kluwer Academic Press.

Hovind, H. 1992. Intercalibration 9206: pH, K_{25}, HCO_3, $NO_3 + NO_2$, Cl, SO_4, Ca, Mg, Na, K, Al and DOC. Programme Centre, NIVA, Oslo. NIVA-Report 2784-92.

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.

Proceedings of the 9th Task Force Meeting in Oisterwijk, the Netherlands, November 1-3, 1993. Programme Centre, NIVA, Oslo.

Skjelkvåle, B.L., Newell, A.D, and Johannessen, M. 1993. International Cooperative Programme on Assessment and Monitoring of Rivers and lakes: Status and Results. In: BIOGEOMON - Symposium on Ecosystem Behaviour: Evaluation of Integrated Monitoring in small catchments. Prague, September 18-20, 1993. Czech Geological Survey, Prague 1993. s. 274-275.

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Norwegian Institute for Water Research, 1994. Data Report 1991. Programme Centre, NIVA, Oslo.

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