NIVA REPORT SNO 5883-2009

ICP Waters Report 99/2009
Biological intercalibration: Invertebrates 1309

Sample processing at ICP Waters subcentre in Bergen. Photo: Tore Wiers.

International Cooperative Programme on Assessment and Monitoring Effects of Air Pollution on Rivers and Lakes

Convention on Long-Range Transboundary Air Pollution

Norwegian Institute for Water Research
– an institute in the Environmental Research Alliance of Norway

REPORT

Main Office
Gaustadalléen 21
NO-0349 Oslo, Norway
Phone (47) 22 18 51 00
Telefax (47) 22 18 52 00

Regional Office, Sørlandet
Televeien 3
NO-4879 Grimstad, Norway
Phone (47) 22 18 51 00
Telefax (47) 37 04 45 13

Regional Office, Østlandet
Sandvikaveien 41
NO-2312 Ottestad, Norway
Phone (47) 22 18 51 00
Telefax (47) 62 57 66 53

Regional Office, Vestlandet
Thormøhlens gate 53 D
NO-5006 Bergen Norway
Phone (47) 22 18 51 00
Telefax (47) 55 31 22 14

Regional Office Central
Pirsenteret, Havnegata 9
P.O.Box 1266
NO-7462 Trondheim
Phone (47) 22 18 51 00

Title	Serial No.	Date
Biological intercalibration: Invertebrates 1309	5883-2009	21.11.09
	Report No. Sub-No. ICP Waters report 99/2009 23300B	Pages Price 30
Author(s) Arne Fjellheim, LFI, Uni Environment, Uni Research AS, P.O.box 7810, N-5020 Bergen, Norway	Topic group Acidification	Distribution
	Geographical area Europe	Printed NIVA

Client(s)	Client ref.
Norwegian Pollution Control Authority (SFT) United Nations Economic Commission for Europe (UNECE)	

Abstract
The 13th intercalibration of invertebrates in the ICP Waters programme had contribution from six laboratories. The laboratories identified a high portion of the individuals in the test samples, usually > 90% of the total number of species. Shortcoming identifications below this limit were also noted. Few faults were recorded on genus level. The mean Quality assurance index was > 90 for all participating laboratories, indicating very good taxonomic work.

4 keywords, Norwegian	4 keywords, English
1. Interkalibrering	1. Intercalibration
2. Invertebrater	2. Invertebrates
3. Akvatisk fauna	3. Aquatic fauna
4. Overvåking	4. Monitoring

Brit Lisa Skjelkvåle
Project manager

Rainer G. Lichtenthaler
Senior scientist

ISBN 978-82-577-5618-5

CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

INTERNATIONAL COOPERATIVE PROGRAMME ON ASSESSMENT AND MONITORING EFFECTS OF AIR POLLUTION ON RIVERS AND LAKES

Intercalibration: Invertebrate fauna 1309

ICP Waters Programme Subcentre
Laboratory of Freshwater Ecology and Inland Fisheries
Uni Environment, Uni Research AS, P.O.box 7810,
N-5020 Bergen, Norway

Preface

The International Cooperative Programme on Assessment and Monitoring Effects of Air Pollution on 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. Thirty countries in Europe and North America have participated in the programme since the start. Since 2002, ten countries have been involved in the biological intercalibration.

ICP Waters is based on existing surface water including biological 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 25 years) for some sites.

The Programme objective is to establish and maintain an international network of surface water monitoring sites and promote international harmonisation of monitoring practices. A tool in this work is the inter-laboratory quality assurance tests. The bias between analyses carried out by the individual participants of the Programme has to be identified and controlled. The tests will also be a valuable tool in improving the taxonomic skill of the participating laboratories.

We here report the results from the 13th intercalibration on invertebrate fauna.

Bergen, November 2009

Arne Fjellheim

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 samples, 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 biotic indexes 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). The results of this type of data treatment are especially sensitive to the quality of the species identification. The biological intercalibration focuses on the taxonomic skills of the participants and is a tool for improving the quality of work 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 identified samples of invertebrates from their own monitoring sites to the Programme centre. The Programme centre will additionally add species known to be present in the region of the specific laboratory. Based on this, each laboratory receives individual test samples composed of species representing their own monitoring region.

In this report we have calculated the quality assurance index for the participants, see Raddum (2005). This index evaluates the skill of identifying the species as well as the genus. It also takes into account the effort of identifying all specimens in the sample. The highest index score is 100, while a value of 80 is set as the limit of good taxonomic work.

2. Methods

Preparation of test-samples

Samples of identified invertebrates were received from all participating laboratories. These samples were used to compose test samples, with the addition of specimens from earlier exercises and from own stocks. The geographical distribution of species is checked by the use of the Fauna Europaea Web Service (2004).

Identification

To minimise possible faults the following procedure have been used in preparing the test samples:

- 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 correct number and species is placed in the test samples according to the list.

Damages of the material

The quality of the test material may be reduced during handling and shipping. Taxonomically important parts of the body, as gills, legs, cerci, mouthparts etc., can be lost or destroyed in actions 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 could influence on the results of the identifications and disturb the results in a negative way.

Evaluation

The results of the tests are sent to the laboratories for eventual comments before publishing the report. In this way we can remove taxonomical biases, for example misidentified or destroyed test material. In cases of disagreement material may be sent back to the programme subcentre for control. This procedure may act educational for both parts.

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. We encourage the participants to give comments on matters that may impede the identification. For example may misidentification of species, in cases where important taxonomic characters have been destroyed, be neglected if this is 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 this, some subjective evaluations of the results have to be made. The percent of faults is therefore not always the exact calculated percent of faults, but can be 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. Normally each laboratory gets between 50 and 80 individual species in the two samples. 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. On the other hand, small samples should be avoided as only a few misidentifications could result in a low score.

We have calculated the quality assurance index, Qi, for important groups of invertebrates as well as the mean index for each participant. The Qi integrates the separate levels of the identifications as follows:

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

Qi will be a number between 0 and 100. 100 are the highest score that can be obtained. A score ≥80 is regarded as good taxonomical work.

3. Results and discussion

Six laboratories participated in the intercalibration of invertebrates in 2009 (Appendix A). 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 - 6.

Mayflies

The identification of mayflies (Ephemeroptera) was generally good (Figure 1, Appendix Table 1-6). Laboratory 2 and 5 identified the mayflies without faults. The results from the other laboratories were acceptable, with only minor faults. The Qi was calculated to 88, 100, 94, 84, 100 and 88 for laboratories 1, 2, 3, 4, 5 and 6, respectively. This indicates high quality of work for all laboratories.

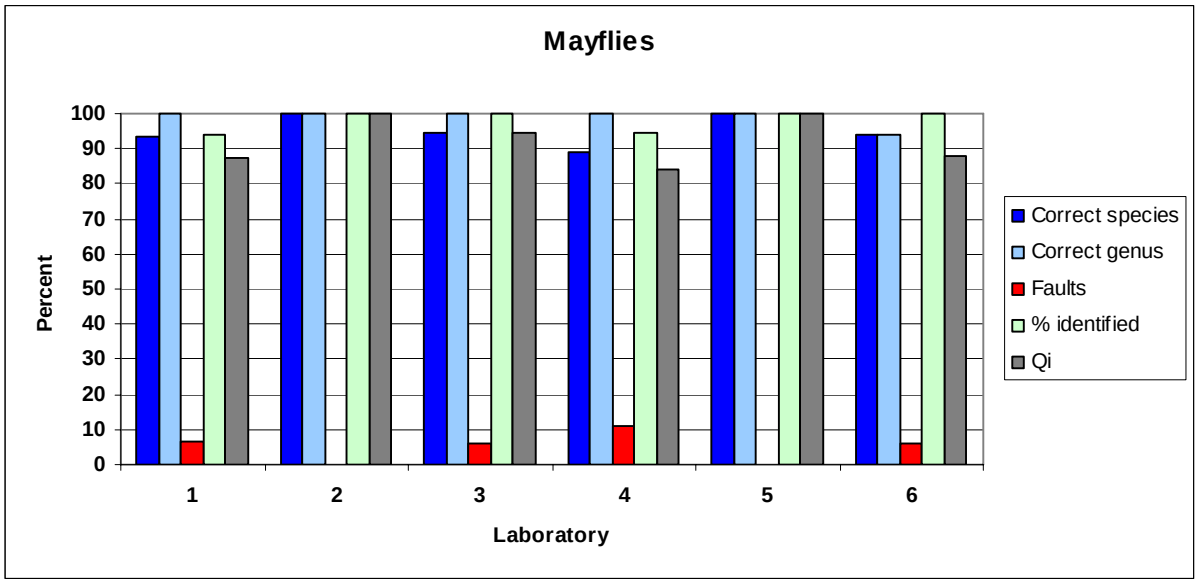

Figure 1. *Results of the identification of mayflies.*

Stoneflies

Laboratory 4 identified the stoneflies (Plecoptera) without faults, while the results from the rest of the participants were acceptable (Figure 2, Appendix tables 1 - 6). The Qi was calculated to 86, 82, 95, 100, 95 and 95 for laboratories 1, 2, 3, 4, 5 and 6, respectively.

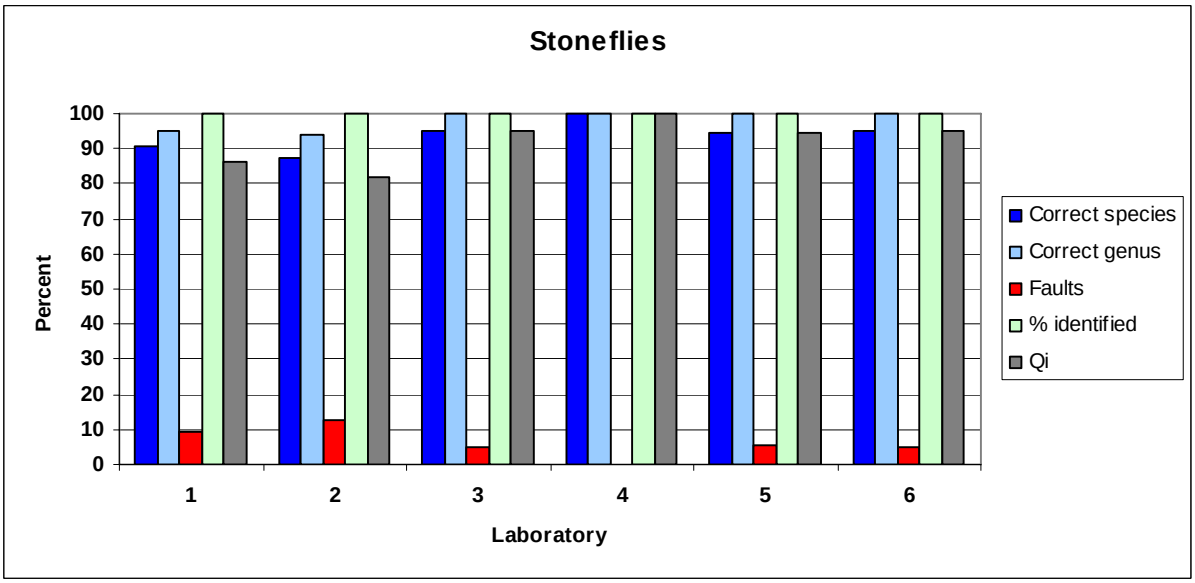

Figure 2. *Results of the identification of stoneflies.*

Caddisflies

The identification of caddisflies (Trichoptera) is presented in Figure 3. Laboratory 2, 3, 5 and 6 and 2 identified all specimens correctly. Laboratory 1 and 4 had 6 and 10 % faults, respectively. The *% identified* was 100% for all participants. The taxonomic work on caddisflies was overall regarded as very good with Qi values of 91, 100, 100, 86 and 100 and 100, for participants 1, 2, 3, 4, 5 and 6, respectively.

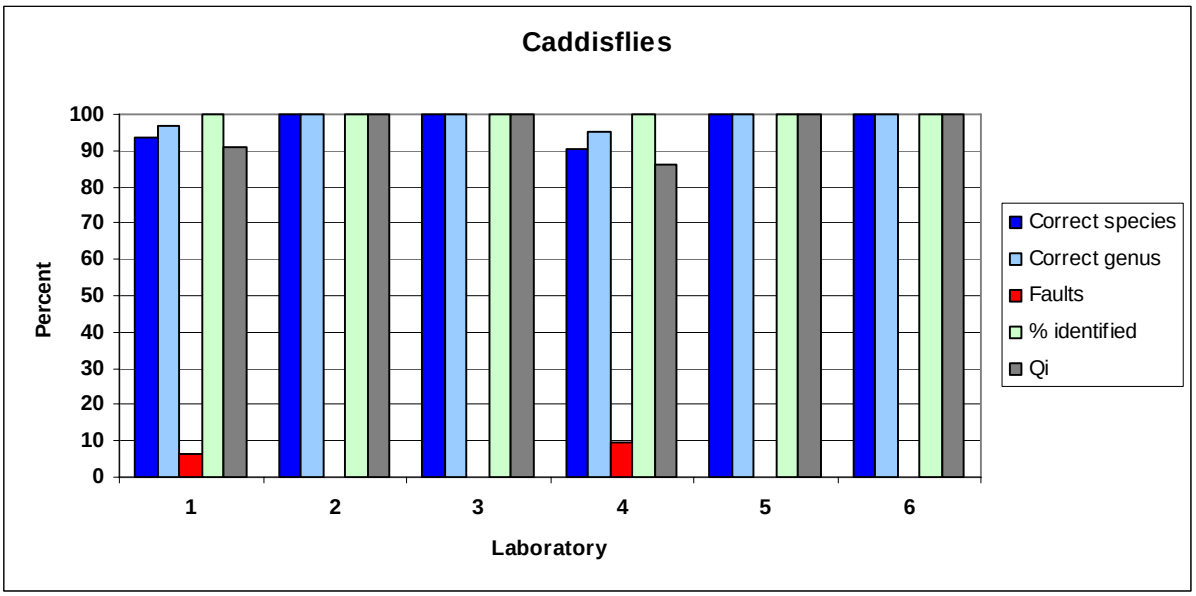

Figure 3. *Results of the identification of caddisflies.*

Other groups

In this intercalibration we have included water beetles (Coleoptera), larger crustaceans (Malacostraca), leeches (Hirudinea), molluscs (Gastropoda), alder-flies (Megaloptera), Diptera etc. Both larvae and imagines have been included for some of the groups. Leeches, molluscs and larger crustaceans are sensitive to acid water and important for the evaluation of acidification. The tolerance of the invertebrates among Coleoptera, Megaloptera, Diptera etc. is little known, but generally they are regarded as tolerant to acidic water and consequently have low importance for evaluation of acidity indices. However, all species will be important for invertebrate community analysis. Figure 4 shows the results of the identification of these groups. The identifications made by laboratory 1 and 2 were perfect with no faults. The quality of the other laboratories was acceptable. With one exception, all larvae were identified to correct genus. The *% identified* was 100% for all participants except one. The Qi score was acceptable: 100, 100, 95, 95, 90 and 88, for participants 1, 2, 3, 4, 5 and 6, respectively.

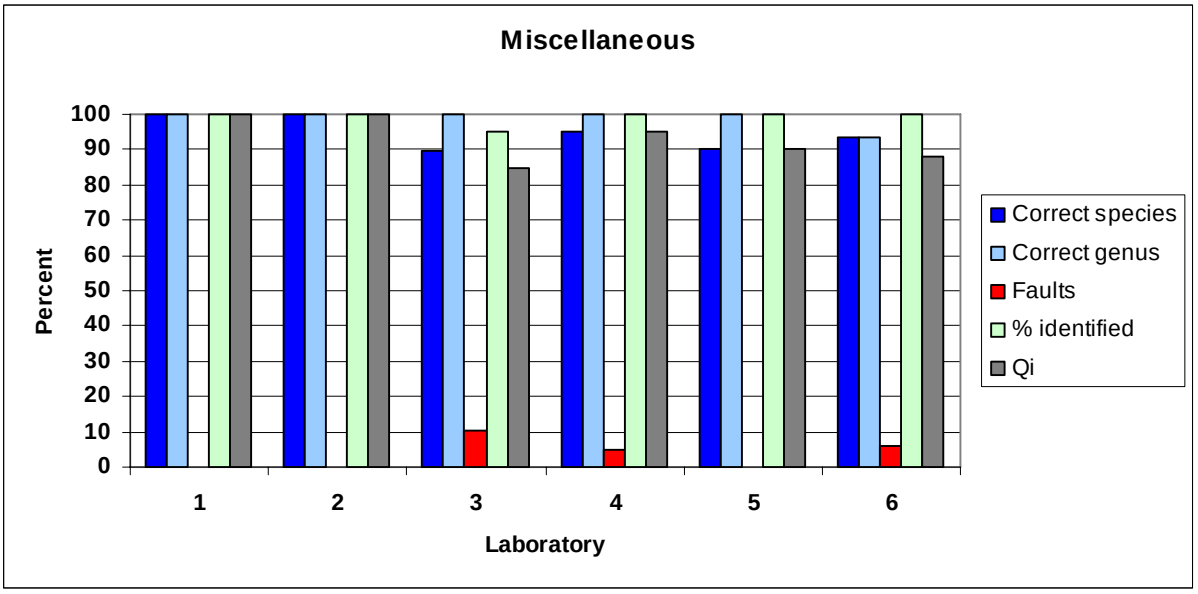

Figure 4. *Results of the identification of miscellaneous groups*

Total number of species in the sample

There were generally low discrepancy between the number of individuals put into the samples and the reported number of larvae. A total of 488 individual specimens were sent to the different laboratories. Of these 99.2 percent were reported back to the programme sub-centre.

4. Evaluation/conclusion

The laboratories generally identified a high portion (≥ 95%) of the total number of species in the test samples. Shortcoming identification was low and indicated a good taxonomic skill by all participants. The mean skill of identifying species and genus and Qi score per laboratory is shown in Figure 5. Laboratory 1 to 6 got a mean Qi score of 91, 96, 96, 91, 96 and 93, respectively. All tests were characterized as very good taxonomic work. The biological intercalibration is important for harmonising biological material/databases and will be of high value in programmes where community analyses is in focus or where the ecological status should be stated, like EU Water Framework Directive.

None of the participants did misidentifications that could result in a wrong acidity index, based on the Raddum score (Raddum et al., 1988).

The biological intercalibration under the ICP Waters programme is a unique test, as it operates on a species level. A similar test is run by the Natural History museum, London, aiming to test skills in identifying British freshwater macroinvertebrates to major groups, mostly to family level (Identification Qualifications – IdQ test). The invertebrate groups covered in this test are those used in the BMWP water quality score system (Armitage et al.,

1983) and include groups used for monitoring freshwater environments under the EU water framework directive (Schartau et al. 2008).

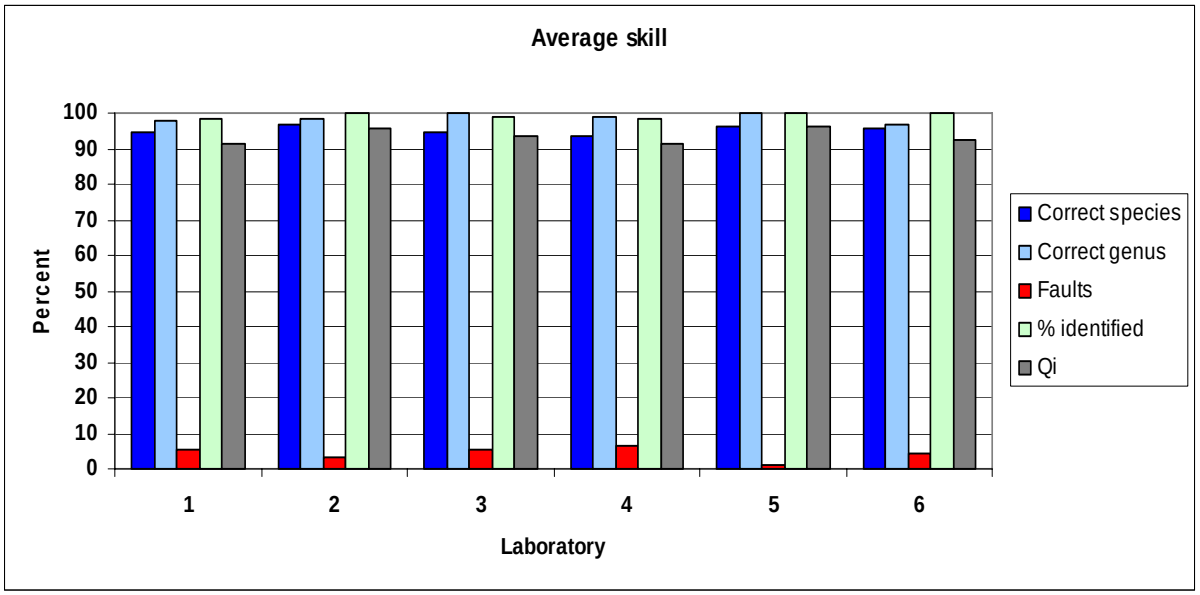

Figure 5. *Mean skill in percent of identifying species and genus and mean Qi for each laboratory.*

5. Acknowledgements

I wish to thank the participating laboratories, especially Dr. Johannes, Bauer, Bayerisches Landesamt für Umwelt, Germany. The present intercalibration was his last, as he will retire early 2011. We wish him a good retirement. A special thank to Torunn Landås and Arne Johannessen at the Programme subcentre in Bergen for handling the samples.

6. References

Armitage, P. D., D Moss, J. F. Wright and M. T. Furse, 1983. The performance of a new biological water quality score system based on macroinvertebrates over a wide range of unpolluted running-water sites. – Water Res. 17: 333–347.

Fauna Europaea Web Service (2004) Fauna Europaea version 1.1, Available online at http://www.faunaeur.org

Fjellheim, A. and G. G. Raddum, 1990. Acid precipitation: biological monitoring of streams and lakes. The Science of the Total Environment, 96, 57-66.

Halvorsen,G.A., E. Heegaard and G.G. Raddum, 2002. Tracing recovery from acidification – a multivariate approach. NIVA- Report SNO 4208/2000, ICP Waters Report 69/2002, 34 pp.

Larsen, J., H.J.B. Birks, G.G. Raddum & A. Fjellheim, 1996. Quantitative relationships of invertebrates to pH in Norwegian river systems. Hydrobiologia 328: 57-74.

Raddum, G. G., A. Fjellheim and T. Hesthagen, 1988. Monitoring of acidification through the use of aquatic organisms. Verh. Int. Verein. Limnol. 23: 2291-2297.

Raddum, G. G. 1999. Large scale monitoring of invertebrates: Aims, possibilities and acidification indexes. In Raddum, G. G., Rosseland, B. O. & Bowman, J. (eds.) Workshop on biological assessment and monitoring; evaluation of models. ICP-Waters Report 50/99, pp.7-16, NIVA, Oslo.

Raddum, G. G. 2005. Biological intercalibration: Invertebrates 0905. NIVA-report SNO 5067 2005, ICP Waters report 81/2005.

Schartau, A.K., Moe, J., Sandin, L., McFarland, B. and Raddum, G. G. 2008. Macroinvertebrate indicators of lake acidification: analysis of monitoring data from UK, Norway and Sweden. Aquatic Ecology, 42: 293–305.

Skjelkvåle, B. L.; Andersen, T.; Halvorsen, G. A.; Raddum,G. G.; Heegaard, E.; Stoddard, J. and Wright, R. F. 2000. The 12-year report: Acidification of Surface Water in Europe and North America; Trends, biological recovery and heavy metals. ICP Waters report, nr. 52/2000. Oslo: Norwegian Institute for Water Research; 2000. 115 s.

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 2009 and their code numbers are:

1. Swedish University of Agricultural Sciences, Dept. of Environmental Assessment, P.O. Box 7050, S-75007 Uppsala***, Sweden***
2. Estonian Environment Information Centre, Mustamàe Tee 33, 10616 Tallinn, ***Estonia***
3. EcoRing, Lange Str. 9, D-37181 Hardegsen, **Germany**
4. Bayerisches Landesamt für Wasserwirtschaft, Demollstr. 31, D-82407 Wielenbach, **Germany**
5. Div. Ambiente Canton Ticino, Laboratorio Studi Ambientali, Sez. Protezione Aria AcquaRiva Paradiso 15, CH-6900 Lugano Paradiso, **Switzerland**
6. School of Biological Sciences Queen Mary, University of London London E1 4NS, **UK**

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

	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Ephemeroptera				
Baetis rhodani	1	1		
Baetis muticus	1	1		
Baetis digitatus	1	1	1	
Baetis fuscatus			1	
Baetis sp.				1
Nigrobaetis niger				
Ameletus inopinatus	1	1		
Heptagenia dalecarlica	1	1		
Heptagenia fuscogrisea	1	1	1	1
Heptagenia sulphurea			1	1
Caenis luctuosa			1	1
Caenis horaria	1	1		
Ephemera danica	1	1	1	
Ephemera vulgata				1
Ephemerella aurivilli			1	1
Plecoptera				
Amphinemura borealis	2	1		
Amphinemura sulcicollis			1	
Amphinemura standfussi				1
Brachyptera risi	1	1	1	1
Capnia bifrons			1	1
Dinocras cephalotes	1	1	1	1
Diura nanseni			1	1
Isoperla grammatica	1	1		
Isoperla obscura			1	1
Leuctra nigra	1	1		
Nemoura avicularis	1	1		
Nemoura cinerea			2	1
Nemurella pictetii	1	1	1	1
Protonemura meyeri	1	1	1	1
Siphonoperla burmeisteri	1	1	1	1
Taeniopteryx nebulosa	1	1		
Arcynopteryx compacta	1			
Trichoptera				
Neureclipsis bimaculata	1	1		
Polycentropus flavomaculatus	1	1	1	1
Polycentropus irroratus			1	1
Cyrnus trimaculatus			1	1
Rhyacophila fasciata	1	1		
Rhyacophila nubila			1	1
Glossosoma intermedium			1	
Glossosoma sp.				1
Athripsodes cinereus	1	1		
Agapetus ochripes	1	1		
Mystacides azurea	1	1	1	1
Molannodes tinctus	1	1	1	1

Tinodes waeneri	1	1	1	1
Sericostoma personatum	1	1	1	1
Philopotamus montanus	1	1	1	1
Hydropsyche pellucidula	1	1		
Hydropsyche angustipennis	1	1		
Hydropsyche siltalai			1	1
Arctopsyche ladogensis		1	1	1
Crunoecia irrorata	1	1		
Lepidostoma hirtum			1	1
Potamophylax latipennis	1	1		
Potamophylax cingulatus			1	
Potamophylax rotundipennis				1
Potamophylax sp.				1
Micropterna sequax			1	
Ecclisopteryx dalecarlica			1	1
Coleoptera:				
Limnius volckmari	1	1		
Elmis aenea	1	1	1	1
Hydraena gracilis			1	1
Bivalvia:				
Pisidium sp.	1	1	1	1
Gastropoda:				
Physa fontinalis	1	1	1	1
Ancylus fluviatilis	1	1	1	1
Teodoxus fluviatilis	1	1	1	1
Bithynia tentaculata	1	1		
Bithynia leachi			1	1
Odonata:				
Somatochlora metallica	1	1	1	1
Erythroma najas	1	1	1	1
Hirudinea:				
Helobdella stagnalis	1	1	1	1
Malacostraca:				
Gammarus lacustris	1	1	1	1
Gammarus pulex	1	1		
Monoporeia (*Pontoporeia*) *affinis*			1	1
Asellus aquaticus	1	1	1	1
Diptera:				
Chaoborus flavicans			1	1
Pseudochironomus prasinatus	1	1	1	1

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

	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Ephemeroptera				
Ephemera vulgata	1	1	1	1
Ephemera danica			1	1
Baetis rhodani	1	1*	1	1
Cloeon dipterum			1	1
Heptagenia sulphurea			1	1
Ephemerella ignita	1	1	1	1
Brachycercus harrisella	1	1	1	1
Caenis horaria	1	1	1	1
Plecoptera				
Leuctra nigra	1	1		
Dinocras cephalotes	1	1		
Diura nanseni	1	1	1	
Diura bicaudata				1
Isoperla grammatica	1	1	1	1
Taeniopteryx nebulosa	1	1	1	1
Brachyptera risi	1	1*		
Siphonoperla burmeisteri	1			
Leuctra fusca		1		
Nemurella pictetii	1	1	1	1
Amphinemura borealis	1	1	1	1
Nemoura cinerea	1	1	1	1
Trichoptera				
Rhyacophila septentrionis/fasciata	1	1		
Rhyacophila nubila			1	1
Silo pallipes	1	1	1	1
Potamophylax latipennis	1	1	1	1
Potamophylax rotondipennis	1	1	1	1
Limnephilus rhombicus			1	1
Notidobia ciliaris			1	1
Ironoquia dubia			1	1
Hydropsyche angustipennis	1	1		
Hydropsyche siltalai	1	1	1	1
Hydropsyche pellucidula			1	1
Cheumatopsyche lepida			1	1
Athripsodes aterrimus			1	1
Polycentropus flavomaculatus	1	1		
Polycentropus irroratus			1	1
Neureclipsis bimaculata	1	1	1	1
Cyrnus flavidus			1	1
Beraeodes minutes	1	1	1	1
Agapetus ochripes	1	1*	1	1*
Philopotamus montanus	1	1		
Lepidostoma hirtum	1	1	1	1
Tinodes waeneri	1	1	1	1
Sericostoma personatum	1	1		
Odonata				
Enallagma cyathigerum	1	1	1	1

Erythromma najas		1		1				
Aeshna cyanea						1		1
Cordulea aenea						1		1
Gomphus vulgatissimus		1		1				
Bivalvia								
Sphaerium corneum		1		1		1		1
Hirudinea								
Erpobdella octoculata		1		1				
Helobdella stagnalis						1		1
Gastropoda								
Planorbis planorbis		1		1		1		1
Theodoxus fluviatilis		1		1		1		1
Bithynia leachi		1		1				
Bithynia tentaculata						1		1
Bathyomphalus contortus						1		1
Heteroptera:								
Aphelocheirus aestivalis		1		1				
Coleoptera								
Elmis aenea	1 larvae		1 larvae		1 adult		1 adult	
Limnius volckmari	1 adult		1 adult					
Olimnius tuberculatus					1 adult		1 adult	
Acilius canaliculatus		1		1		1		1
Hyphydrus ovatus		1		1		1		1

* Determined to sp.

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

	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Ephemeroptera				
Baetis rhodani	1	1	1	1
Baetis alpinus	1	1	1	1
Baetis muticus			1	1
Nigrobaetis niger	1	1		
Ameletus inopinatus	1	1	1	1
Caenis luctuosa	1	1	1	1
Caenis horaria	1	1	1	1
Ephemera vulgata	1			
Ephemera danica		1	1	1
Seratella ignita	1	1	1	1
Plecoptera				
Diura bicaudata	1	1	1	1
Isoperla grammatica			1	1
Dinocras cephalotes	1	1		
Brachyptera risi	1	1	1	1
Brachyptera seticornis	1	1	1	1
Leuctra nigra	1	1	1	1
Protonemura meyeri	1		1	1
Protonemura sp.		1		
Nemurella pictetii	1	1	1	1
Amphinemura sulcicollis	1	1	1	1
Amphinemura borealis	1	1	1	
Amphinemura standfussi				1
Taeniopteryx nebulosa	1	1	1	1
Trichoptera				
Sericostoma cf.personatum	1	1	1	1
Lithax niger			1	1
Ecclisopteryx madida	1	1		
Drusus discolor	1	1	1	1
Philopotamus ludificatus	1	1	1	1
Plectrocnemia conspersa	1	1	1	1
Cyrnus flavidus	1	1		
Cyrnus trimaculatus			1	1
Neureclipsis bimaculata	1	1	1	1
Polycentropus flavomaculatus	1	1	1	1
Hydropsyche siltalai	1	1		
Hydropsyche pellucidula			1	1
Lepodostoma hirtum	1	1	1	1
Agapetus ochripes	1	1	1	1
Glossosoma sp.cf.intermedium	1	1	1	1
Gastropoda:				
Teodoxus fluviatilis	1	1	1	1
Bithynia tentaculata	1	1		
Bithynia leachii			1	1
Radix peregra	1	1		
Radix balthica				
Gyraulus acronicus (*Planorbis*)			1	

Planorbis carinatus				1
Turbellaria:				
Polycelis felina	1	1	1	1
Chironomidae:				
Prodiamesa olivacea	1	1	1	1
Coleoptera:				
Limnius perrisi	1	1		
Limnius sp.			1	1
Oerodytes sanmarki	1	1	1	1
Malacostraca:				
Gammarus fossarum	1	1	1	1
Gammarus pulex			1	1
Gammarus lacustris	1	1		
Asellus aquaticus	1	1	1	1

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

	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Ephemeroptera				
Baetis rhodani	2	2	2	2
Baetis alpinus	1	1	1	1
Baetis muticus		1	1	1
Nigrobaetis niger	1			
Ameletus inopinatus	1	1	1	1
Caenis luctuosa	1	1	1	
Caenis horaria	1	1	1	
Caenis sp.				1
Ephemera vulgata	1	1		
Ephemera danica			1	1
Seratella ignita	1	1	1	
Ephemerella mucronata				1
Plecoptera				
Diura bicaudata	1	1	1	1
Isoperla grammatica			1	1*
Dinocras cephalotes	1	1		
Dinocras sp.				
Brachyptera risi	1	1	1	1
Brachyptera seticornis	1	1	1	1
Leuctra nigra	1	1	1	1
Protonemura meyeri	1	1*	1	1*
Nemurella pictetii	1	1	1	1
Amphinemura sulcicollis	1	1*	1	1*
Amphinemura borealis	1	1	1	1
Taeniopteryx nebulosa	1	1	1	1
Trichoptera				
Sericostoma cf.personatum	1	1*	1	1
Litax niger			1	1
Ecclisopteryx madida	1	1		
Drusus discolor	1	1	1	1
Philopotamus ludificatus	1	1	1	1
Plectrocnemia conspersa	1	1	1	1
Cyrnus flavidus	1			
Holocentropus dubius		1		
Cyrnus trimaculatus			1	1
Neureclipsis bimaculata	1	1	1	1
Polycentropus flavomaculatus	1	1	1	1
Hydropsyche siltalai	1	1		
Hydropsyche pellucidula			1	1
Lepodostoma hirtum	1	1	1	1
Athripsodes cinereus	1			
Athripsodes albifrons		1		
Gastropoda:				
Teodoxus fluviatilis	1	1	1	1
Bithynia tentaculata	1	1		
Physa fontinalis			1	1
Gyraulus acronicus	1		1	

Gyraulus albus		1		1
Turbellaria:				
Polycelis felina	1	1	1	1
Chironomidae:				
Prodiamesa olivacea	1	1	1	1
Coleoptera:				
Limnius perrisi	1 ad.	1 ad.		
Limnius sp.			1 larvae	1 larvae
Oerodytes sanmarki	1 ad.	1 ad.	1 ad.	1 ad.
Malacostraca:				
Gammarus fossarum	1	1	1	1
Gammarus pulex			1	1
Gammarus lacustris	1	1		
Asellus aquaticus	1	1	1	1
Diptera				
Prodiamesa olivacea	1	1	1	1

*** Determined to sp.**

Appendix table 5. Identified species/genus in sample 1 and 2 by Laboratory 5

	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Ephemeroptera				
Baetis melanonyx	1	1		
Baetis rhodani	1	1	1	1
Baetis fuscatus	1	1	1	1
Seratella ignita	1	1	1	1
Ecdyonurus sp.			1	1
Rhitrogena sp.			1	1
Epeorus assimilis			1	1
Habrophlebia pr.fusca	2	1		
Harbroleptoides sp.		1		
Plecoptera				
Chloroperla tripunctata/apicalis	1	1	1	1
Siphonoperla burmeisteri	1	1		
Brachyptera risi	1	1	1	1
Leuctra nigra	1	1	1	1
Perla grandis	1	1		
Dinocras cephalotes	1	1	1	1
Isoperla grammatica	1		2	2
Isoperla rivulorum		1		
Amphinemura sulcicollis/triangularis	1	1		
Protonemura meyeri	1	1	1	
Protonemura sp.				1
Nemoura sp.	1			
Nemoura mortoni		1		
Nemurella pictetii			1	1
Trichoptera				
Plectrocnemia conspersa	2	2		
Polycentropus flavomaculatus	1	1	1	1
Polycentropus irroratus	1	1		
Neureclipsis bimaculata	1	1	1	1
Rhyacophila tristis	1	1		
Rhyacophila torrentium			1	1
Rhyacophila sensu stricto			1	2
Rhyacophila fasciata			1	
Philopotamus ludificatus	1	1		
Hydropsyche pr.*dinarica*			1	1
Hydropsyche siltalai			1	1
Hydropsyche fulvipes	1	1		
Hydropsyche pellucidula	1	1		
Potamophylax latipennis			1	1
Potamophylax cingulatus	1	1		
Drusus discolor	1	1		
Glossosoma pr. intermedium	1	1		
Agapetus ochripes			1	1
Tinodes waeneri			1	1
Oligotricha striata			1	1
Odontocerum albicorne			1	1

Wormaldia copiosa			1	1
Sericostoma personatum/flavicorne			1	1
Turbellaria:				
Polycelis sp.	1	1	1	1
Bivalvia:				
Pisidium caseratanum	1	1		
Diptera:				
Atherix sp.	1	1	2	2
Coleoptera:				
Elmis aenea larve	1	1	1	1
Anisoptera:				
Somatochlora alpestris	1	1		
Aeshna cyaenea			1	
Aeshna coerula				1
Megaloptera:				
Sialis fuliginosa			1	1

Appendix table 5. Identified species/genus in sample 1 and 2 by Laboratory 6

	Sample 1		Sample 2	
Taxa:	**Delivered**	**Identified**	**Delivered**	**Identified**
Ephemeroptera				
Siphlonurus lacustris	1	1		
Ephemera vulgata	1	1		
Ephemera danica			1	1
Rhitrogena semicolorata	1	1		
Ecdyonurus torrentis			1	1
Kageronia fuscogrisea			1	1
Heptagenia sulphurea	1	1		
Ameletus inopinatus			1	1
Baetis muticus			1	1
Baetis rhodani	1	1		
Baetis niger	1	1		
Baetis digitatus	1	1	1	
Centroptilum luteolum				1
Caenis horaria	1	1		
Caenis luctuosa			1	1
Brachycerus harrisella			1	1
Plecoptera				
Protonemura meyeri	1	1	1	1
Dinocras cephalotes	1	1		
Diura bicaudata			1	1
Isoperla grammatica			1	1
Chloroperla tripunctata	1	1		
Leuctra fusca	1	1		
Capnia bifrons	1	1		
Brachyptera risi	1	1	1	1
Taeniopteryx nebulosa	1	1	1	1
Leuctra nigra	1	1	1	1
Leuctra geniculata			1	1
Nemurella pictetii	1	1	1	1
Nemoura cinerea	1	1		
Amphinemura sulcicollis	1		1	1
Amphinemura standfussi		1		
Trichoptera				
Sericostoma personatum	1	1		
Halesus radiatus	1	1		
Lepidostoma hirtum	1	1		
Brachycentrus subnubilus			1	1
Tinodes waeneri	1	1		
Ceraclea annulicornis	1	1		
Adicella reducta			1	1
Holocentrupus picicornis	1	1		
Cyrnus trimaculatus	1	1		
Cyrnus flavidus			1	1
Polycentropus irroratus	1	1		
Plectrocnemia conspersa			1	1
Neureclipsis bimaculata			1	1
Polycentropus flavomaculatus			1	1

Philopotamus montanus			1	1
Rhyacophila dorsalis			1	1
Cheumatopsyche lepida	1	1		
Hydropsyche siltalai			1	1
Hydropsyche pellucidula			1	1
Hydropsyche contubernalis	1	1		
Anabolia nevrosa			1	1
Ecclisopteryx guttulata			1	1
Drusus annulatus	1	1		
Silo pallipes			1	1
Triaenodes bicolor	1	1		
Mystacides longicornis			1	1
Coleoptera:				
Elmis aenea			1	1
Olimnius tuberculatus			1	1
Limnius volckmari	1	1	1	1
Coelambus novemlineatus	1	1		
Corixidae:				
Notonecta glauca	1	1		
Arctocorisa germani			1	1
Heteroptera:				
Aphelocheirus aestivalis			1	1
Odonata:				
Cordulegaster boltoni	1	1		
Somatochlora metallica			1	
Cordulea aenea				1
Gastropoda:				
Potamopyrgus antipodarum	1	1		
Viviparus viviparus			1	1
Hirudinea:				
Helobdella stagnalis	1	1	1	1
Malacostraca:				
Gammarus pulex	1	1		
Gammarus lacustris			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.icp-waters.no/

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.

Skjelkvåle, B.L. and Wright, R.F. 1990. Overview of areas sensitive to acidification: Europe. Programme Centre, NIVA, Oslo. Acid Rain Research Report 20/1990. NIVA-Report 2405-90. ISBN 82-577-1706-1.

Johannessen, M. 1990. Intercalibration in the framework of an international monitoring programme. Proceedings of the third annual Ecological Quality Assurance Workshop, Canada Centre for Inland Waters, Burlington Ontario. Programme Centre, NIVA, Oslo.

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 ThreeYear 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.

Hovind, H. 1994. Intercomparison 9408. pH, k_{25}, HCO_3, $NO_3 + NO_2$, Cl, SO_4, Ca, Mg, Na, K, total aluminium, TOC and COD-Mn. Programme Centre, NIVA, Oslo. NIVA-Report SNO 3142-94.

Skjelkvåle, B.L., Newell, A.D., Raddum, G.G., Johannessen, M., Hovind, H., Tjomsland, T. and Wathne, B.M. 1994. The six year report: Acidification of surface water in Europe and North America. Dose/response relationships and long-term trends. Programme Centre, NIVA, Oslo. NIVA-Report SNO 3041-94.

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

Stoddard, J.L. and Traaen, T.S. 1994. The stages of Nitrogen Saturation: Classification of catchments included in "ICP on Waters". In: M. Hornung, M.A. Stutton and R.B. Wilson (eds.) Mapping and Modelling of Critical Loads for Nitrogen: a Workshop Report. Proceedings of a workshop held in Grange-over-Sands (UK), 24-26 October 1994. pp.69-76.

Hovind, H. 1995. Intercomparison 9509. pH, k_{25}, HCO_3, $NO_3 + NO_2$, Cl, SO_4, Ca, Mg, Na, K, total aluminium, aluminium-reactive and nonlabile, TOC and COD-Mn. Programme Centre, NIVA, Oslo. NIVA-Report SNO 3331-95. ISBN 82-577-2849-7.

Traaen, T.S. and Stoddard, J.L. 1995. An Assessment of Nitrogen Leaching from Watersheds included in ICP on Waters. Programme Centre, NIVA, Oslo. NIVA-Report SNO 3201-95.

Norwegian Institute for Water Research, 1995. Data Report 1992-93. Draft 1994. Part 1, Introduction and Chemistry. Programme Centre, NIVA, Oslo.

Norwegian Institute for Water Research, 1995. Data Report 1992-1993. Draft 1994. Part 2, Biology and Site-data. Programme Centre, NIVA, Oslo.

Raddum, G.G. 1995. Aquatic Fauna. Dose/response and long term trends. Programme Centre, NIVA, Oslo.

Raddum, G.G. 1995. Intercalibration of Invertebrate Fauna 9502. Programme Centre, NIVA, Oslo.

Raddum, G.G., and Skjelkvåle, B.L. 1995. Critical limits of acidification to invertebrates in different regions of Europe. *Water Air Soil Poll.* 85: 475-480.

Hovind, H. 1996. Intercomparison 9610. pH, K_{25}, HCO_3, $NO_3 + NO_2$, Cl, SO_4, Ca, Mg, Na, K, total aluminium, aluminium - reactive and nonlabile, TOC and COD-Mn. Programme Centre, NIVA, Oslo. NIVA-Report SNO 3550-96.

Newell, A.D, and Skjelkvåle, B.L. 1996. Acidification trends in surface waters in the International Program on Acidification of Rivers and Lakes. *Water Air Soil Poll.* 93:27-57.

Proceedings of the 10th Task Force Meeting in Budapest 1994. Prepared by the Programme Centre, NIVA, Oslo March 1996.

Norwegian Institute for Water Research, 1996. Programme Manual. Programme Centre, NIVA, Oslo. NIVA-Report SNO 3547-96.

Raddum, G.G. 1996. Intercalibration of invertebrate fauna 9603. Programme Centre, NIVA, Oslo.

Lükewille, A., Jeffries, D., Johannessen, M., Raddum, G.G., Stoddard, J.L and Traaen, T.S. 1997. The Nine Year Report. Acidification of Surface Water in Europe and North America. Long-term Developments (1980s and 1990s). Programme Centre, NIVA, Oslo. NIVA-Report SNO 3637-97.

Hovind, H. 1997. Intercomparison 9711. pH, K_{25}, HCO_3, $NO_3 + NO_2$, Cl, SO_4, Ca, Mg, Na, K, total aluminium, aluminium - reactive and nonlabile, TOC and COD-Mn. Programme Centre, NIVA, Oslo. NIVA-Report SNO 3716-97.

Johannessen, M., and Skjelkvåle, B.L. 1997. International Co-operative Programme on Assessment and Monitoring of Acidification of Rivers and Lakes - ICP-Waters; Programme objectives, organization and main results. In:

Proceedings to "International Conference on management of Transboundary Waters in Europe" 22-25 September 1997 in Poland. Programme Centre, NIVA, Oslo. **ICP-Waters Report 43/1997**.

Henriksen, A. and Posch, M. 1998. Critical loads and their exceedances for ICP-Waters sites. Programme Centre, NIVA, Oslo. NIVA-Report SNO 3821-98, **ICP-Waters Report 44/1998**.

Smith, D. and Davis, I. 1997. International Cooperative programme on Assessment and Monitoring of Acidification of Rivers and lakes: 8th Task Force Meeting, 1992. Can.Tech.Rep.Fish.Aquat.Sci. 2155: iv 68 p.

Summary of The Nine Year Report from the ICP Waters Programme. NIVA-Report SNO 3879-98, **ICP-Waters report 46/1998**.

Raddum, G.G. 1998. Intercalibration 9804: Invertebrate fauna. NIVA-Report SNO 3912-98, **ICP-Waters Report 47/1998**.

Larsen, S.E., Friberg, N. and Rebsdorf, Aa.. (eds.) 1999. Proceedings from the 12th Task Force Meeting in Silkeborg, Denmark, October 23-25, 1996. National Environmental Research Institute, Denmark 52 pp NERI Technical Report, No. 271

Hovind, H. 1998. Intercomparison 9812. pH, K_{25}, HCO_3, $NO_3 + NO_2$, Cl, SO_4, Ca, Mg, Na, K, total aluminium, aluminium - reactive and nonlabile, TOC and COD-Mn. NIVA-Report SNO 3939-98, **ICP-Waters Report 49/1998**.

Rosseland, B.O., Raddum, G.G. and Bowman, J. 1999. Workshop on biological assessment and monitoring; evaluation and models. NIVA-Report SNO 4091-99, **ICP Waters Report 50/1999**.

Hovind, H. 1999. Intercomparison 9913. pH, K_{25}, HCO_3, $NO_3 + NO_2$, Cl, SO_4, Ca, Mg, Na, K, total aluminium, aluminium - reactive and nonlabile, TOC and COD-Mn. NIVA-Report SNO 4093-99, **ICP Waters Report 51/1999**.

Skjelkvåle, B. L., Andersen, T., Halvorsen, G. A., Raddum, G.G., Heegaard, E., Stoddard, J. L., and Wright, R. F. 2000. The 12-year report; Acidification of Surface Water in Europe and North America; Trends, biological recovery and heavy metals. NIVA-Report SNO 4208/2000, **ICP Waters report 52/2000.**

Stoddard, J. L., Jeffries, D. S., Lükewille, A., Clair, T. A., Dillon, P. J., Driscoll, C. T., Forsius, M., Johannessen, M., Kahl, J. S., Kellogg, J. H., Kemp, A., Mannio, J., Monteith, D., Murdoch, P. S., Patrick, S., Rebsdorf, A., Skjelkvåle, B. L., Stainton, M. P., Traaen, T. S., van Dam, H., Webster, K. E., Wieting, J., and Wilander, A. 1999. Regional trends in aquatic recovery from acidification in North America and Europe 1980-95. Nature 401:575- 578.

Skjelkvåle, B.L., Olendrzynski, K., Stoddard, J., Traaen, T.S, Tarrason, L., Tørseth, K., Windjusveen, S. and Wright, R.F. 2001. Assessment of trends and leaching in Nitrogen at ICP Waters Sites (Europe And North America). NIVA-report SNO 4383-2001, **ICP Waters report 54/2001.**

Hovind, H. 2000. Intercomparison 0014. pH, K_{25}, HCO_3, $NO_3 + NO_2$, Cl, SO_4, Ca, Mg, Na, K, total aluminium, aluminium - reactive and nonlabile, TOC, COD-Mn. Fe, Mn, Cd, Pb, Cu, Ni and Zn. NIVA-Report SNO 4281-2000, **ICP Waters Report 55/2000**.

Hovind, H. 2000. Trends in intercomparisons 8701-9812: pH, K_{25}, $NO_3 + NO_2$, Cl, SO_4, Ca, Mg, Na, K and aluminium - reactive and nonlabile, TOC, COD-Mn. NIVA-Report SNO 4281-2000, **ICP Waters Report 56/2000**.

Wright, R.F. 2001. Note on: Effect of year-to-year variations in climate on trends in acidification. NIVA-report SNO 4328-2001, **ICP Waters report 57/2001**.

Kvaeven, B. Ulstein, M.J., Skjelkvåle, B.L., Raddum, G.G. and Hovind. H. 2001. ICP Waters – An international programme for surface water monitoring. *Water Air Soil Poll*.**130**:775-780.

Skjelkvåle, B.L. Stoddard J.L. and Andersen, T. 2001. Trends in surface waters acidification in Europe and North America (1989-1998). *Water Air Soil Poll.***130:**781-786.

Stoddard, J. Traaen, T and Skjelkvåle, B.L. 2001. Assessment of Nitrogen leaching at ICP-Waters sites (Europe and North America). *Water Air Soil Poll*. **130**:825-830.

Raddum, G.G. and Skjekvåle B.L. 2000. Critical Load of Acidifying Compounds to Invertebrates In Different Ecoregions of Europe. *Water Air Soil Poll.* **130**:825-830.

Raddum.G.G. 2000. Intercalibration 0005: Invertebrate fauna. NIVA-report SNO4384-2001, **ICP Waters report 62/2001**.

Lyulko, I. Berg, P. and Skjelkvåle, B.L. (eds.) 2001. National presentations from the 16th meeting of the ICP Waters Programme task Force in Riga, Latvia, October 18-20, 2000. NIVA-report SNO 4411-2001. **ICP Waters report 63/001**.

Hovind, H. 2001. pH, K_{25}, HCO_3, $NO_3 + NO_2$, Cl, SO_4, Ca, Mg, Na, K, total aluminium, aluminium - reactive and nonlabile, TOC, COD-Mn. Fe, Mn, Cd, Pb, Cu, Ni and Zn. NIVA-Report SNO 4416-2002, **ICP Waters report 64/2001**.

Bull, K.R. Achermann, B., Bashkin, V., Chrast, R. Fenech, G., Forsius, M., Gregor H.-D., Guardans, R., Haussmann, T., Hayes, F., Hettelingh, J.-P., Johannessen, T., Kryzanowski, M., Kucera, V., Kvaeven, B., Lorenz, M., Lundin, L.,

Mills, G., Posch, M., Skjelkvåle, B.L. and Ulstein, M.J. 2001. Coordinated Effects Monitoring and Modelling for Developing and Supporting International Air Pollution Control Agreements. *Water Air Soil Poll.* **130**:119-130.

Raddum.G.G. 2002. Intercalibration 0206: Invertebrate fauna. NIVA-report SNO-4494-2002, **ICP Waters report 66/2002**.

Skjelkvåle, B.L. and Ulstein, M. 2002. Proceedings from the Workshop on Heavy Metals (Pb, Cd and Hg) in Surface Waters; Monitoring and Biological Impact. March 18-20, 2002, Lillehammer, Norway. NIVA-report SNO-4563-2002, **ICP Waters report 67/2002**.

Hovind. H. 2002. Intercomparison 0216. pH, K_{25}, HCO_3, $NO_3 + NO_2$, Cl, SO_4, Ca, Mg, Na, K, total aluminium, aluminium - reactive and nonlabile, TOC, COD-Mn. Fe, Mn, Cd, Pb, Cu, Ni and Zn. NIVA-Report SNO 4558-2002, **ICP Waters Report 68/2002**.

Halvorsen, G.A, Heergaard, E. and Raddum, G.G. 2002. Tracing recovery from acidification - a multivariate approach. NIVA-report SNO 4564-2002, **ICP Waters report 69/2002**.

Jenkins, A. Larssen, Th., Moldan, F., Posch, M. and Wrigth R.F. 2002. Dynamic Modelling of Surface Waters: Impact of emission reduction - possibilities and limitations. NIVA-report SNO 4598-2002, **ICP Waters report 70/2002.**

Wright, R.F and Lie, M.C. 2002.Workshop on models for Biological Recovery from Acidification in a Changing Climate. 9-11 september 2002 in Grimstad, Norway. Workshop report. NIVA-report 4589-2002.

Skjelkvåle, B.L. (ed.). 2003. Proceedings of the 18th meeting of the ICP Waters Programme Task Force in Moscow, October 7-9, 2002. NIVA-report SNO 4658-2003, **ICP Waters report 71/2002**.

Raddum.G.G. 2003. Intercalibration 0307: Invertebrate fauna. NIVA-report SNO-4659-2003, **ICP Waters report 72/2003**.

Skjelkvåle, B.L. (ed). 2003. The 15-year report: Assessment and monitoring of surface waters in Europe and North America; acidification and recovery, dynamic modelling and heavy metals. NIVA-report SNO 4716-2003, **ICP Waters report 73/2003.**

Hovind, 2003. Intercomparison 0317. pH, K25, HCO3, NO3 + NO2, Cl, SO4, Ca, Mg, Na, K, total aluminium, aluminium - reactive and nonlabile, TOC, COD-Mn. Fe, Mn, Cd, Pb, Cu, Ni and Zn. NIVA-report SNO 4715-2003, **ICP Waters report 74/2003.**

Raddum, G.G, et al. 2004. Recovery from acidification of invertebrate fauna in ICP Water sites in Europe and North America. NIVA-report SNO 4864-2004, **ICP Waters report 75/2004.**

ICP Waters report 76/2004. Proceedings of the 19th meeting of the ICP Waters Programme Task Force in Lugano, Switzerland, October 18-20, 2003. NIVA-report SNO 4858-2004, **ICP Waters report 76/2004.**

Raddum, G.G. 2004. Intercalibration: Invertebrate fauna 09/04. NIVA-report SNO 4863-2004, **ICP Waters report 77/2004.**

Hovind, 2004. Intercomparison 0418. pH, K25, HCO3, NO3 + NO2, Cl, SO4, Ca, Mg, Na, K, Fe, Mn, Cd, Pb, Cu, Ni and Zn. NIVA-report SNO 4875-2004, **ICP Waters report 78/2004.**

Skjelkvåle et al 2005. Regional scale evidence for improvements in surface water chemistry 1990-2001. *Environmental Pollution.* **137:165-176.**

Fjeld, E. 2005. An assessment of POPs related to long-range air pollution in the aquatic environment. NIVA-report in prep, **ICP Waters report 79/2005.**

ICP Waters report 80/2005. Proceedings of the 20th meeting of the ICP Waters Programme Task Force in Falun, Sweden, October 18-20, 2004. NIVA-report SNO 5018-2005, **ICP Waters report 80/2005.**

Raddum, G.G. 2005. Intercalibration 0307: Invertebrate fauna. NIVA-report SNO 5067-2005. **ICP Waters report 81/2005**

Hovind, H. 2005. Intercomparison 0317. pH, K25, HCO3, NO3 + NO2, Cl, SO4, Ca, Mg, Na, K, total aluminium, aluminium - reactive and nonlabile, TOC, COD-Mn. Fe, Mn, Cd, Pb, Cu, Ni and Zn. NIVA-report SNO 5068-2005. **ICP Waters report 82/2005**

Wright, R.F., Cosby, B.J., Høgåsen, T., Larssen, T., Posch, M. 2005. Critical Loads, Target Load Functions and Dynamic Modelling for Surface Waters and ICP Waters Sites. NIVA-report SNO 5166-2005. **ICP Waters report 83/2006.**

De Wit, H. and Skjelkvåle, B.L. (eds.) 2006. Proceedings of the 21th meeting of the ICP Waters Programme Task Force in Tallinn, Estonia, October 17-19, 2005. NIVA-report SNO 5204-2006, **ICP Waters report 84/2006.**

Raddum, G.G. and Fjellheim, A. 2006. Biological intercalibration 1006: Invertebrate fauna. NIVA-report SNO 5314-2006, **ICP Waters report 85/2006.**

Hovind, H. 2006. Intercomparison 0620. pH, K25, HCO3, $NO_3 + NO_2$, Cl, SO_4, Ca, Mg, Na, K, total aluminium, aluminium - reactive and nonlabile, TOC, COD-Mn. Fe, Mn, Cd, Pb, Cu, Ni and Zn. NIVA-report SNO 5285-2006. **ICP Waters report 86/2006.**

De Wit, H., and Skjelkvåle, B.L. (eds.) 2007. Trends in surface water chemistry and biota; The importance of confounding factors. NIVA-report SNO 5385-2007. **ICP Waters report 87/2007.**

Skjelkvåle, B.L., Forsius, M., Wright, R.F., de Wit, H., Raddum, G.G., and Sjøeng, A.S.M. 2006. Joint Workshop on Confounding Factors in Recovery from Acid Deposition in Surface Waters, 9-10 October 2006, Bergen, Norway; Summary and Abstracts. NIVA-report SNO 5310-2006. **ICP Waters report 88/2006.**

Wright, R.F., Posch, M., Cosby, B. J., Forsius, M., and Skjelkvåle, B. L. 2007. Review of the Gothenburg Protocol: Chemical and biological responses in surface waters and soils. NIVA-report SNO 5475-2007. **ICP Waters report 89/2007.**

Hovind, H. 2007. Intercomparison 0721: pH, Cond, HCO3, NO3-N, Cl, SO4, Ca, Mg, Na, K, Fe, Mn, Cd, Pb, Cu, Ni, and Zn. NIVA-report SNO 5486-2007. **ICP Waters report 90/2007**

Fjellheim, A and Raddum, G.G. 2008. Biological intercalibration: Invertebrates 1107. NIVA-report SNO 5551 – 2008, **ICP Waters report 91/2008**

De Wit, H. Jenssen, M. T. S. and Skjelkvåle, B.L. (eds.) 2008. Proceedings of the 23rd meeting of the ICP Waters Programme Task Force in Nancy, France, October 8 – 10 , 2007. NIVA-report SNO 5567-2008. **ICP Waters report 92/2008.**

Hovind, H. 2008. Intercomparison 0822: pH, Cond, HCO_3, NO_3-N, Cl, SO_4, Ca, Mg, Na, K, Fe, Mn, Cd, Pb, Cu, Ni, and Zn. NIVA-report SNO 5660-2008. **ICP Waters report 93/2008.**

Skjelkvåle, B.L., and De Wit, H. (eds.) 2008. ICP Waters 20 year with monitoring effects of long-range transboundary air pollution on surface waters in Europe and North-America. NIVA-report SNO 5684-2008. **ICP Waters report 94/2008.**

Fjellheim, A and Raddum, G.G. 2008. Biological intercalibration: Invertebrates 1208. NIVA-report SNO 5706-2008, **ICP Waters report 95/2008**

Skjelkvåle, B.L., Jenssen, M. T. S. and De Wit, H (eds.) 2009. Proceedings of the 24th meeting of the ICP Waters Programme Task Force in Budapest, Hungary, October 6 – 8, 2008. NIVA-report SNO 5770-2009. **ICP Waters report 96/2008.**

Ranneklev, S.B., De Wit, H., Jenssen, M. T. S. and Skjelkvåle, B.L., 2009. An assessment of Hg in the freshwater aquatic environment related to long-range transported air pollution in Europe and North America. NIVA-report SNO 5844-2009. **ICP Waters report 97/2009.**

Hovind, H. 2009. Intercomparison 0923: pH, Cond, HCO_3, NO_3-N, Cl, SO_4, Ca, Mg, Na, K, TOC, Al, Fe, Mn, Cd, Pb, Cu, Ni, and Zn. NIVA-report SNO 5845-2009. **ICP Waters report 98/2009.**

Fjellheim, A. 2009. Biological intercalibration: Invertebrates 1309. NIVA-report SNO 5883-2009, **ICP Waters report 99/2009.**

NIVA: Norway's leading centre of competence in aquatic environments

NIVA provides government, business and the public with a basis for preferred water management through its contracted research, reports and development work. A characteristic of NIVA is its broad scope of professional disciplines and extensive contact network in Norway and abroad. Our solid professionalism, interdisciplinary working methods and holistic approach are key elements that make us an excellent advisor for government and society.

NIVA
Norwegian Institute for Water Research

Gaustadalléen 21 • NO-0349 Oslo, Norway
Telephone: +47 22 18 51 00 • Fax: 22 18 52 00
www.niva.no • post@niva.no