NRA

NATIONAL RIVERS AUTHORITY
ANGLIAN REGION

1995 GQA BIOLOGICAL SURVEY

AUDIT REPORT

REF: 891/60/50

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CONTENTS

1.0 SUMMARY

The AQC (Analytical Quality Control) showed all labs meeting the target of a maximum of 2 missed taxa per sample.

The external audit was shown to be more rigorous with the mean number of taxa found per sample being significantly higher (At 90% conf.) than in the internal audit.

The external audit found that two of the labs in Anglian (Central and Eastern) failed the two missed taxa per sample target for samples which had not been subjected to AQC. Regionally the target was met with a figure of 1.96.

Quality was lower than for 1994 when measured as number of taxa missed per sample. Fewer samples were recorded with no additional taxa found, but fewer samples were found with >20% change in BMWP. This suggests that the sorting of samples is becoming less variable.

Quality improved from spring to autumn following disappointing results highlighted by the spring results of the external audit.

The Cusum sheets used by for AQC reached DEFER status, but did not reach ALARM status, the point at which remedial action should be taken.

Control charts used for the AQC showed that one high result for Central Area had caused a batch failure of all samples audited. This shows the limitation of this method of control, rather than a failing on the part of Central Area.

2.0 INTRODUCTION

2.1 Internal Audit

The internal audit or Analytical Quality Control (AQC) was carried out following the protocol developed for the 1995 survey. This involved the use of Cusum (Cumulative sum) charts to monitor the efficiency of sorters and thereby identify any problems early in the audit. These sheets should signal an alarm if quality deteriorates, at which point remedial action can be taken. SQC charts were also plotted as in 1994.

In previous years the internal and external audits were carried out independently. In 1995 however, samples which had been internally audited became a subset of those sent to the IFE for external auditing. It was hoped that this would provide quality assurance for the AQC. This methodology gives three groups of results as listed below.

Primary Samples Samples which were sent to the IFE directly after the primary sort.

Secondary Samples Samples which had been internally audited i.e. were sent to the IFE after two sorts.

AQC Samples The results of the internal audit.

A subjective comparison of Primary and Secondary samples would ideally validate the internal audit. However a sample will always tend to have some organisms overlooked with a few more being found on each sort. It is therefore not realistic to expect Secondary samples to have no unlocated organisms. A comparison of Primary and AQC samples is therefore the best validation of the internal audit to check if a statistical difference exits between the mean number of taxa found by internal and external auditors.

The R & D note 331 states that:
"The quality achieved by the laboratory as a whole is measured in terms of the average number of missed taxa over all analysts."

The number of taxa missed is the only valid way to assess the performance of a sorter, as other indices such as ASPT and BMWP vary depending upon which taxa are missed.

There has been some confusion at a national level over what the term 'missed taxa' refers to. National guidance suggested that this term should encompass both losses and gains. Most losses are caused by NRA biologists recording specimens as seen in the field, or by degeneration of fragile samples making it impossible for the IFE to locate or identify the specimens. This would make their inclusion inappropriate. Previous documentation has used gains only and it is this protocol which is followed in this document.

Missed taxa are not the only criteria considered by management. BMWP and ASPT scores are also used for management purposes, so the effect of the missed taxa on these indices has been included, and statistical analysis carried out.

2.2 External Audit

The Institute of Freshwater Ecology (IFE) was chosen nationally by the NRA to audit the biological samples taken in the 1995 GQA survey. The selection of the IFE to audit all samples allows valid comparisons to be made between both different Regions and different years, as the IFE have carried out all NRA external audits since 1990.

3.0 RESULTS

3.1 Internal Audit.

Table 1: Regional AQC Results for the 33 samples subsequently sent to the IFE.

AREA	NO. TAXA MISSED	CHANGE IN BMWP	% CHANGE IN BMWP	CHANGE IN ASPT	% CHANGE IN ASPT
NORTHERN	0.86	4	4.95	0.02	2.73
CENTRAL	1.08	5.53	7.2	0.08	1.75
EASTERN	1.69	9.23	11.27	0.11	6.75
REGION	1.27	6.67	8.33	0.08	3.88

Table 2: Individual performance based on AQC results for the 33 samples subsequently sent to the IFE.

SORTER	NO. TAXA MISSED	CHANGE IN BMWP	% CHANGE IN BMWP	CHANGE IN ASPT	% CHANGE IN ASPT	NO. OF SAMPLES
DMB	2	8	6.96	0.04	0.87	1
RPC	1	5	6.92	0.03	0.74	4
SH	0	0	0	0	0	1
ABA	1.75	10	15.07	0.14	3.29	4
SEH	0.8	3.8	3.93	0.06	1.29	5
SJL	0.5	2.5	2.27	0.02	0.35	2
CSA	4	22	21.92	0.2	4.58	2
EDT	1.29	7	10.49	0.1	2.4	7
JMG	1	6	6.25	0.07	1.53	1
LKB	1.33	7	7.67	0.13	2.68	3
LJS	0.67	2.67	3.05	0.04	0.8	3

Table 3: Regional results based on the 102 samples subjected to an internal audit.

AREA	NO. TAXA MISSED	NO. SAMPLES	AVERAGE NO. TAXA GAINED
NORTHERN	35	37	0.95
CENTRAL	21	24	0.88
EASTERN	55	41	1.34
REGION	111	102	1.09

Table 4: Individual results based on the 102 samples subjected to an internal audit.

SORTER	NO. TAXA MISSED	NO. SAMPLES	AVERAGE NO. TAXA GAINED
CAE	0	1	0
DMB	11	8	0.73
SH	1	3	0.33
RPC	11	10	1.1
SJB	8	5	1.6
ABA	13	8	1.63
LJS	6	13	0.46
SEH	5	7	0.71
SJL	2	6	0.33
CA	19	10	1.9
EDT	21	12	1.75
FE	4	3	1.33
JG	7	11	0.64
LKB	4	3	1.33
GR	8	2	4

3.2 External Audit.

A total of 60 samples were sent to the IFE for audit. Of these 27 were primary samples, while 33 had been internally audited and therefore sorted twice.

In all cases where the IFE reported a lower value for BMWP due to species they could not locate, or for ASPT via location of low scoring taxa, the absolute value of change was used to calculate the average values rather than a negative value.

3.2.1 Regional Results

Table 5: Regional Results of Primary Samples (Single sort -> IFE)

AREA	NO. TAXA MISSED	CHANGE IN BMWP	% CHANGE IN BMWP	CHANGE IN ASPT	% CHANGE IN ASPT
NORTHERN	1.46	7.77	8.58	0.05	1.22
CENTRAL	2.43	10	13.22	0.259	6.56
EASTERN	2.43	15.14	18.89	0.289	6.75
REGION	1.96	10.25	12.46	0.17	4.04

Table 6: Regional Results of Secondary Samples (Primary sort + AQC sort -> IFE)

AREA	NO. TAXA MISSED	CHANGE IN BMWP	% CHANGE IN BMWP	CHANGE IN ASPT	% CHANGE IN ASPT
NORTHERN	1	3.43	5.62	0.048	1.28
CENTRAL	1.15	6.54	7.61	0.112	2.53
EASTERN	1.38	5.69	6.26	0.084	0.96
REGION	1.21	5.67	6.73	0.087	1.99
REGION, 1^{y}& 2^{y} SAMPLES	1.55	7.73	9.31	0.12	2.91

A t-test was carried out to assess whether or not the number of taxa gained in the Primary samlpes and Secondary samples was statistically significant.

t_{calc} = 2.14 t_{table} (P=0.05) = 2.0 for 58 d.f.

$t_{calc} > t_{table}$ implying that the mean number of taxa found in the two groups is significantly different at the 95% confidence interval.

A t-test was carried out to assess wether or not the difference in the mean number of taxa gained in the Primary samples and in the AQC samlpes audit was statistically significant.

t_{calc} = 1.84 t_{table} (P=0.05) = 2.0 for 58 d.f.
t_{table} (P=0.10) = 1.67 for 58 d.f.

$t_{calc} > t_{table}$ at 90% confidence interval, but not the 95% confidence interval. This implies that the mean number of taxa found in the two groups are significantly different at the 90% confidence interval.

As the BMWP and ASPT scores are used for management purposes, it was decided to statistically test their differences of the means between these values.

BMWP (% CHANGE) t_{calc} = 0.41 t_{table} (P=0.05) = 2.0 for 58 d.f.
t_{table} (P=0.10) = 1.67 for 58 d.f.

ASPT (%CHANGE) t_{calc} = 1.46 t_{table} (P=0.05) = 2.0 for 58 d.f.
t_{table} (P=0.10) = 1.67 for 58 d.f.

The differences between the means of the Primary Samples and the AQC samples are therefore not significantly different for BMWP or ASPT.

3.2.2 Individual Results

Table 7: Individual Results for Primary Samples (Single Sort -> IFE)

SORTER	NO. TAXA MISSED	CHANGE IN BMWP	% CHANGE IN BMWP	CHANGE IN ASPT	% CHANGE IN ASPT	NO. OF SAMPLES
CAE	1	5	10.42	0.11	3.22	1
DMB	2.33	10	14.63	0.03	0.68	3
LJS	0.67	3.67	2.93	0.02	0.51	3
RPC	1.25	9.52	7.82	0.04	0.81	4
SJB	2	9	8.57	0.09	2.11	2
ABA	3	10.5	12.27	0.18	3.59	2
LJS	1	2	2.04	0.08	1.96	1
SEH	2	9	18	1.01	28.29	1
SJL	1.5	7	7.97	0.03	0.5	2
WTC	5	24	32	0.26	5.54	1
CA	4.5	25	54.76	0.37	8.34	2
EDT	2	15	12.71	0.2	4.24	1
FE	2.5	16.5	22.55	0.22	4.53	2
JG	1	3	6.67	0.06	1.6	1
LKB	0	5	6.76	0.5	12.85	1

Table 8: Individual Results based on Secondary samples (AQC sort -> IFE). The sorter is the AQC sorter.

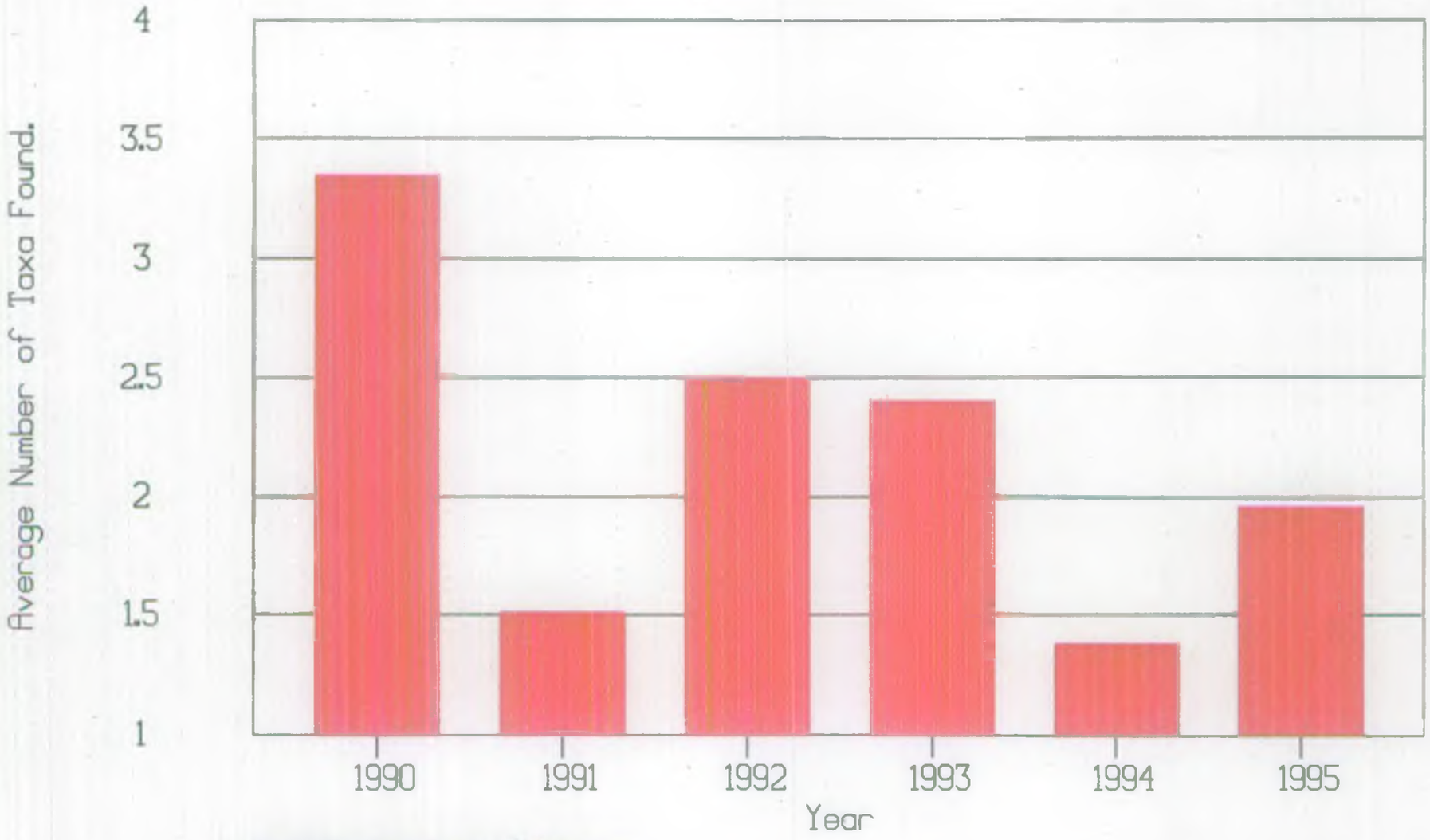
SORTER	NO. TAXA MISSED	CHANGE IN BMWP	% CHANGE IN BMWP	CHANGE IN ASPT	% CHANGE IN ASPT	NO. OF SAMPLES
CAE	1	3	9.08	0.095	2.37	2
DMB	1.33	4.33	5.7	0.013	0.31	3
RPC	0.5	2.5	2.03	0.02	0.11	2
ABA	3	13.67	16.71	0.09	1.89	3
LJS	0	3.5	2.76	0.14	2.81	2
SEH	.75	5.25	5.95	0.08	1.99	4
SJL	2	5	4.72	0	0	1
WTC	0.33	3.67	4.91	0.05	1.33	3
CA	1	4	2.6	0.14	2.82	1
FE	1	8	10.26	0.09	1.96	1
EDT	1.33	6.67	4.81	0.05	1.09	3
JMG	2	7.6	9.49	0.07	1.58	5
LKB	0.67	2.67	2.93	0.01	0.32	3

Table 9: Families responsible for 'missed taxa' errors

Family	Frequency
Unionidae, Chironomidae, Polycelidae, Elminthidae, Erpobdellidae, Ancylidae, Corophiidae, Limnophilidae, Gerridae, Dendrocoelidae, Haliplidae, Neritidae, Physidae, Gyrinidae, Corixidae, Scirtidae, Agriidae, Ancylidae, Goeridae, Hydropsychidae, Dryopidae, Nonectidae, Viviparidae, Polycentropodidae, Ryacophilidae, Libellulidae, Astacidae, Psycomyiidae	1
Coenagriidae, Baetidae, Gammaridae, Asellidae, Psychomyiidae, Hydromeridae, Piscicolidae, Hydrometridae, Hydrophilidae	2
Tipulidae, Limnephilidae, Glossiphonidae, Haliplidae, Planorbidae,	3
Leptoceridae, Valvatidae, Simulidae	4
Hydrobidae	5
Caenidae	6
Sphaeriidae, Elmidae, Planariidae	7
Hydroptilidae	10

115 missed taxa errors were identified of which 28 (24.3%) occurred only once. 9 taxa had 4 or more errors associated with them and accounted for 54 (47%) of the missed taxa errors.

FIGURE 1.
ANGLIAN REGION EXTERNAL AUDIT RESULTS.
Average Number of Taxa Found.



Notes: 1995 data is based only on the 27 single sort samples which are directly comparable.
Years 90-94 are based on Spring and Autumn data only.

4.0 DISCUSSION

4.1 Internal Audit.

A statistical analysis of the internal and external audits showed that there was a significant difference between the mean numbers of taxa found by each of these audits. As in 1994 the results of the internal audit are better than the results of the IFE audit which suggests that the internal audit is not as thorough as the IFE audit. This is to be expected as the IFE use more rigorous methods and longer time scales to sort samples which are not possible within an operational and resource limited laboratory. In addition a major function of the internal audit is to identify problems and rectify them quickly. The success of AQC is dependant upon samples being rapidly audited and the results quickly available for management action. The external audit is too slow to allow problems to be found and rectified on an operational time scale.

Statistical methods showed no significant difference between the mean BMWP % change and the mean ASPT % change for the two audits. As these indices are used for management purposes, these changes may be more important than the change in total number of taxa present. The failure of statistical analysis to show a significant difference was due to the high standard deviation of the data sets. In both cases the recorded change was greater for the external audit than for the internal. This again implies that the internal audit is less accurate than the external audit.

The Cusum alarm sheets signalled DEFER status occasionally, but at no time went to ALARM status. The SQC charts did however register a fail for Central Area. A single untypically high result caused a batch of ten and the batch of thirty fail. This highlights the limitations of this system rather than a generally low standard of sorting.

Overall the internal audit is performing as it should, rapidly identifying any problems so they can be quickly rectified. The internal audit is not as accurate as that of the IFE. Either targets should be altered to reflect the differences in accuracy, or more time should be spent on the internal audit of samples. This needs to be kept in balance with the need to have the results of the internal audit rapidly available.

4.2 External audit

The results of the external audit show that the IFE found no additional taxa in 16 of the 60 samples sent to them. This figure is the equal to that for 1994. In 1995 however, 33 samples had been sorted twice, so the samples which had taxa found in the AQC sort were subtracted from this total. This leaves only 8 of the 60 primary samples which seem to have been sorted perfectly in the initial sort. This represents a drop in error free samples of 50% since 1994.

Of the samples sent to the IFE only 4 had a BMWP % change of greater than 20%, the accepted level of error. This compares with 12 in 1994 which is an increase in the number of samples within acceptable limits from 80% to 93.3%. A 20% change is considered to be experimental error, while above this point the change is considered to be due to sorter error.

During the spring survey, the external audit highlighted the fact that the Region was just achieving its target of 2 missed taxa per sample, with a Regional average of 2.0 missed taxa per sample. In light of this, an increase in effort led to the Region meeting the target annually with an average of 1.96 taxa per sample. BMWP, ASPT and number of perfectly sorted samples all improved in Autumn due to concerns raised by the external audit. All four samples which recorded a change in BMWP of >20% occurred during the Spring.

Data from the years 1990-1994 was recalculated to find the average numbers of gains per sample for the spring and autumn samples only (Fig. 1.). This was to make the results directly comparable with the 1995 results, although the sample size was therefore reduced. This showed that the quality of sorting had decreased since 1994, but was considerably better than in 1992 or 1993. Looking at the picture of the 1990-1995 audit results, we can see that 1995 is of intermediate quality and passes its targets, making it acceptable. This is despite the extra pressures resulting from the GQA survey.

The BMWP score for samples sent to the IFE showed a slightly lower percentage change than in 1994, even when the double sorted samples were ignored. This indicates a slight improvement of the quality of data being used for management purposes. This rise in quality may be slightly mis-leading as the 1994 survey used samples from spring, summer and autumn, with summer data being the most variable. The 1995 survey contained data from spring and autumn sampling only and so the recorded rise in quality in 1995 may be due to the removal of the variable summer data.

The ASPT showed an improvement for the whole data set sent to the IFE but the Primary samples which are the directly comparable subset showed that the percentage change in 1995 had increased in comparison to 1994.

It is difficult to assess the quality of each sorter due to the fact that most sorters had only a few samples chosen for audit. This can be seen by the variability in sorter performance across the three different audit groupings. It was felt that it would be inappropriate to combine all the results for individual sorters as those with a greater proportion of samples audited by the IFE are likely to have poorer results than those with a higher proportion internally audited due to the more stringent IFE audit. Sorting times and fauna may vary between Areas making inter-Area comparisons difficult.

The overall Regional picture shows quality targets are being achieved. The number of samples being perfectly sorted has dropped, but so has the number of samples failing the 20% BMWP target. Quality therefore is meeting targets, as in 1994 but with less variability. The increase in the average number of taxa missed per sample could be due to the time constraints imposed by the GQA survey, chance, or 1994 being a particularly good year.