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ERAMMP Technical Annex-105TA1S4: Wales National Trends and Glastir Evaluation Supplement-4: Vegetation Quality Assurance

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Abbreviations Used in this Report

A Plot	Arable
B Plot	Boundary
CS	Countryside Survey
H Plot	Hedges
P Plot	Perpendicular Streamside
QA	Quality Assurance
QC	Quality Control
R/V Plot	Road/trackside
S/W Plot	Streamsides

Contents

1 SUMMARY

It is recognised that all field investigations involving a large number of surveyors must produce an inherent degree of variation despite the provision of a training course, a field handbook and on-site visits by supervisors (Quality Control). It is therefore important to attempt a measure of the consistency and reliability of the work done within the major components of the field programme (Quality Assurance). This report addresses the quality of the botanical recording across the various plots types surveyed during the ERAMMP national field surveys and compares the results with previous quality assurance exercises.

This QA exercise follows the same methodology as used in previous quality assurance (QA) exercises conducted during the 1990, 1998 and 2007 Countryside Surveys (CS), Glastir surveys (2014-2016) and more recent UKSCAPE (2019-2023) surveys.

A sample of 22 squares surveyed between 2021 and 2024 were selected for the QA assessment, with one quarter of each square initially selected for re-survey. Within each quarter, a least two examples of each plot type was selected; where two examples were not available, the resurvey extended to the next quarter. Issues of permission refusals in a number of squares resulted in some amendments to this protocol to sample sufficient plots. The re-survey involved the recording of 247 plots.

1.1 Species-richness

A basic measure of the standard of botanical recording is given by comparing the mean number of species per plot recorded by the surveyors with that found by the assessors. The average number of species that the QA assessors found in each plot was 25.1, whilst the surveyors recorded an average of 21.1 species per plot (83% of the QA species average). The difference between surveyor and assessor improved over the years (5.8 in 2021, 4.8 in 2022, 3.9 in 2023 and 1.6 in 2024), and the average difference was higher in comparison to the Glastir surveys (4.0 compared to 2.6).

1.2 Mis-matches in the species record

Mis-matches have been apportioned into a series of categories which reflect the nature of individual non-concordances:

Variation at time of survey (T1 variations)

- Mis-identification
- Species present but overlooked
- Over-zealous recording
- Mysteries including tablet errors
- Location/orientation errors.

Variations at time of QA (T2 variations)

- Management changes
- Seasonal changes
- Orientation errors
- Species present but overlooked by assessor
- Species mis-identified by the assessor

Of these, by far the greatest source of error was the overlooking of species by the surveyors. Overlooked species accounted for 49.3% of all errors recorded in the ERAMMP QA exercise, within the range of previous QA exercises (34.5 in CS 1990 to 57.6 in Glastir 2016).

Management and seasonal changes contributed to 2.9% of the total non-concordance, which varied depending on that season's weather pattern and how late in the season squares were surveyed. The mis-identification of species contributed to 7.9% of recorded errors, ranging from 3.0% in 2024 to 11.4% in 2022 and 2023.These involved; grass species, *Epilobium* species, *Juncus* species and sedge species. The 'mystery' species in the surveyors record, which peaked at 15.1% of all errors in 2016, decreased to a range of 6-12% during the ERAMMP survey.

Omissions by the QA assessors were low at 5.3% compared to the Glastir surveys of 2014-2016 (9.3%), which may reflect the greater efficiency of having a pair of QA assessors (as in 2021-2024) compared to a single assessor (2014-2016). Location errors accounted for 20.3% in the ERAMMP survey compared to 4.9% during the Glastir survey, which can be contributed to the surveyors only having to set up new plots during the Glastir survey instead of relocating existing ones in the ERAMMP survey. A new category was introduced in 2024 when the QA exercise was taken over by UKCEH to account for species that had been correctly identified by surveyors but incorrectly identified by the QA assessors.

1.3 Percentage agreement and accuracy of the survey.

The surveyors' species record, when expressed as a % of the QA species record, was 83%, ranging from 76.3% in 2021 to 93% in 2024. This is low compared to the Glastir survey value of 90%. Variation in % recorded was considerable between the plot types in all years.

The % agreement (percentage of species recorded on both surveyor and QA lists) and % accuracy (percentage of species on both surveyor and QA lists minus mis-matches outside of the control of the surveyor) for ERAMMP was 57.7% and 60.1%. This was lower in comparison to the Glastir surveys of 60.4% and 66.2% which can be attributed to the greater number of errors recorded in relocating existing plots during the ERAMMP survey as opposed to setting up brand new plots.

1.4 Individual species

A number of species were consistently 'under'-recorded by the surveyors. Recording of grasses was good, with surveyors recording 87% of the QA record. Surveyors recorded 87.7% of the QA rushes and sedges record based upon data from 2022-2024. The recording of bryophytes was extremely variable with a range of 57% - 102.6%, which could potentially be attributed to the skills and experience of both surveyors and QA assessors taking part in the survey that year.

1.5 Cover values

Mis-matches in the allocation of % cover values to individual species at 13.7% is within the range of previous surveys with the greatest number of discrepancies being for grass and shrub/tree species.

2 METHODS

2.1 Plot selection

The protocol for the selection of the quarter of the square to be used in the QA exercise was as follows:

- The quarter should ideally include examples of all the different plot types
- It should be relatively easily accessible
- It should involve as few landowners as possible

The full list of squares monitored, with times of original survey and assessment resurvey, is given as in Section 9 (Annex 1) of this report.

The eight plot types used in the survey and re-examined as part of the QA exercise may be sub-divided into quadrats and linear plots.

Quadrats:

200m^2	X plot	Random points and CS repeat plots
4m^2	Y plots	Targeted habitats
4m^2	U plots	Unenclosed (BAP) broad habitats.

In Glastir 2016 the 200m^2 'X' plots were replaced with 4m^2 plots except for those squares that were CS repeat squares when the 200m^2 'X' plot was retained. In ERAMMP all X plots are recorded as 200m^2, the original 2016 4m^2 plot forming the central nest of the new 200m^2 plot.

Linear plots, all 10m x 1m, which comprise:
H: Hedges, running parallel with the hedge line and commencing at the mid-point of the hedge. Simple 50m hedgerow diversity plots, introduced in 1998, have not been included in the ERAMMP or Glastir QA exercises.

S/W: Streamsides, from normal water level or at the lower limit of vegetation cover in the case of water courses with extensive gravel or pebble beds etc. Additional plots on larger water ways are designated W and are amalgamated with the S plots in the analyses.

P: Perpendicular streamside plots, upslope habitats adjacent to and centred on the S/W plots. A new plot type introduced as part of the Glastir monitoring program.

B: Boundaries, in enclosed land only; recorded at the boundary marker (GPS) point associated with the X plot.

A: Arable. 100m x 1m arable field margin plots. Introduced to CS, no samples were recorded during the current QA exercise.

R/V: Road/trackside plots. These were not recorded in the ERAMMP repeat surveys.

2.2 Field survey

2.2.1 Plate and plot relocation

No metal plates were used during the setting up of plots in the Glastir botanical survey, instead an accurate dGPS was used to fixed the corner/end of plot previously marked with a metal plate. These stamped positions were available on the field tablets for surveyors and the QA exercise. Thus, the tablet was used during the survey to get the first approximation to plot locations with final positioning relying on sketches and photos. This was particularly useful in the unenclosed areas for U and Y plots but still, in many cases, lacked confirmation of the precise dGPS fix.

Three CS repeat squares were included in the ERAMMP survey; one in 2021 and two in 2023. For these squares a metal detector was used in an attempt to re-find the metal plates buried during the 1990 survey. Plates were buried at the end of all linear plots and at the southern corners of small quadrats (Y and U); they were only used for X plots in unenclosed land, elsewhere location of the X plot relied on measurements from the associated B plate.

2.2.2 The Species record.

The methodology for recording the species complement of the plots was the same as that used in previous QA exercises. Plots were recorded using a standardised data sheet, all species of vascular plant and allowed cryptogams were listed and then assigned cover values using 5% cover bands. The plots were first recorded ‘blind’ (without reference to the surveyors data) and then compared with the surveyors record. Discrepancies between the two species lists were identified in the field and reasons sought for the non-concordant records.

3 DATA PRESENTATION

Plot location. A summary of the plot relocation rates is presented for the QA assessors but no comprehensive attempt has been made to determine the overall efficiency of the surveyors due to too little information.

Species richness. The simplest comparison between the Surveyors and QA species records involves assessment of species number/plot. Tukey Pairwise comparisons are used to test for significant differences between Surveyors and QA assessors. Results are also compared against those of the previous Glastir (2014, 2015 and 2016), and CS (1990, 1998, 2007) surveys.

Mis-matches in the species record. Although a basic comparison for each plot can be made between the results of the initial survey and the subsequent QA record, it is more instructive to compare the species lists critically and to apportion the mis-matches into a series of categories which reflect the nature of individual non-concordances. Ten such categories were established during the CS exercise and these have been adopted for ERAMMP with a few minor modifications and some additions. These data are used to arrive at values for the actual efficiency of the surveyors recording both by plot and by square.

T1 variations. Species recorded by the Surveyors but not confirmed for the plot by the Assessors (QA) or species present in the QA assessors plot but omitted from the Surveyors plots.

***A:** mis-identifications.* Three forms of non-concordance are amalgamated under this heading.

i. Species incorrectly identified and forming a couplet with the, hopefully, correctly identified species recorded at QA; for example *Eurhynchium striatum (*Surveyor) *versus Rhytidiadelphus loreus* (QA), *Erica tetralix* (Surveyor) *versus Erica cinerea* (QA), *Plagiomnium undulatum* (surveyor) *versus Mnium hornum* (QA).

ii. Species not apparently forming a couplet with any species recorded during the QA exercise e.g. where both *Ranunculus repens* and *R.bulbosus* appear in the T1 record but only one of these species was found at T2. Similar ‘hedge betting’ often occurs by recording more than one species of e.g. *Poa* .

iii. Apparent inputting errors: in previous surveys it was not unusual for a surveyor to tick the wrong box on the data sheet thus allocating a record to an adjacent species. *Primula vulgaris-Prunella vulgaris* and *Ranunculus flammula-Ranunculus ficaria* were the most frequently encountered examples. An analogous error seems to occur with the use of the tablet.

***B:** Species considered to have been overlooked during the initial recording*

When the two lists were compared it was common for more species to have been recorded by the QA assessor than by the Surveyor. Assuming that the QA assessor was confident that the two plots could be considered to be in the same place these 'missing' species were taken to have been 'overlooked' by the surveyor.

Where the Surveyors and QA assessors plots were not considered to be in exactly the same position then a slightly different approach was taken. Where it was clear to the QA assessor where the Surveyors plot had been recorded it was possible to distinguish between species not recorded by the surveyor because they were in the wrong place (J - location errors) from those species that were still in the overlapping areas that should

have been recorded by the surveyor (B- overlooked species). Similarly, species recorded by the Surveyor in this 'extended' plot area that were not in the QA assessors plot were also allocated as J-location errors,

C:** Over-zealous recording**. During the QA exercise particular care was taken to restrict recording to the exact plot size stipulated. The surveyors had, in some instances, not adequately measured the plot or had included species adjacent to but not strictly within the defined area. Such errors were most prevalent with stream plots where an inflated distance from water level was sometimes used and hedge plots where the recording area extended too far into the adjacent field. Some of these are probably incorporated with the J category; in previous surveys they were particularly common on road side verge plots. Also, in CS where a plate is found the precise location of the plot is determined so small transgressions are more obvious.

***D:** Mysteries*. Species records, apparently incorrect, for which no reasonable explanation could be advanced. Some of these are likely to be 'tablet' errors where a ghost record of a most improbable record may occur. A possible source of this error is where a common species is selected to get into the drop down list and then the wrong species is selected; e.g. *Trifolium repens* registered rather than *Triglochin palustre*. These errors are not always easy to spot and quantify.

J:** Location/orientation errors**. In previous QA exercises distinctions were made between non-concordances due to the incorrect orientation of a plot which was otherwise adequately located and mis-matches in the records due to the surveyors either being in the wrong place e.g. a B plot starting from the wrong whitebeam, or recording in the wrong direction e.g. going the wrong way from a plate. A further distinction was made between species recorded that should not have been, and species missed as a result of, incorrect position. These causes of mis-matches with the QA have been amalgamated into a single T1 location error.

T2 Variations. Species not recorded by the QA assessors but recorded by the surveyors or, *vice versa,* where the species concerned was most probably part of the T1 'real' plot record.

***E:** Species mis-matches due to management changes in plots between the survey and QA assessment.* These involve changes in crop type, changes in species recorded due to crop management, hay cutting etc. They represent species which were very probably present when the Surveyors recorded the plot but which were no longer evident at the time of the QA. Conversely, regrowth of species by the time of the QA assessment in plots which had been recently mown at time of the original survey.

***F:** Species mis-matches due to seasonal changes between Survey and QA assessment.* These non-concordances often represent vernal species which were not identifiable late in the season when the QA was undertaken. Most QA plots were re-visited within 3 weeks of initial survey and hence 'F' errors should be low. Common species included *Arum maculatum* and *Ranunculus ficaria*.

***G mis-matches:** Orientation errors.* In early QA work a distinction was made between non-concordances due to misalignment of the position of the plot by the assessors and misorientation of a plot (previously G & H errors). These have been amalgamated into the G error.

H: *Species misidentified by the QA assessors*. Similar to the A errors and also involving the use of couplets, the H error was introduced to the 2024 survey when the QA exercise was taken over by UKCEH assessors.

I: *Species missed by the QA assessors*. Species which were in the plot but only recorded when the plot was searched a second time during the comparison of the initial QA record with the Surveyors record.

Other variations.

K: *Species mis-match due to location problems.*

Mismatches due to uncertainty of whether the Surveyor or QA assessor is in the wrong place. This was used in assessing change over time in CS, and although it was dropped in the Glastir monitoring, as all the plots were newly set by the surveyors, it has been re-introduced here since both the surveyor and the QA assessor had to refind plots from sketches and photos and sometimes it was unclear whether either were in the correct, or even the same, place. These mis-matches have been divided equally into J and G/H errors for the summary presentations. On rare occasions where the QA assessor was also unable to relocate the original plot from the sketches and photos they followed the new sketches made by the surveyors that season.

Summary of recorder errors

Percentage Agreement. An objective means of comparing two species lists. Percentage Agreement = Species common to both samples/Aggregated species list from both samples expressed as a percentage. % Agreement is presented for each plot in each square.

Percentage Efficiency. This is a measure of the surveyors' accuracy and is calculated having removed discrepancies which can be attributed to the QA assessor, relating to changes in species present due to seasonal effects, management or location errors and those overlooked by the assessor.

4 RESULTS

Section 9 (Annex 1) presents a summary of the squares surveyed during the QA exercise with dates of initial survey and QA assessment.

4.1 Plot relocation

One of the specific objectives of the QA exercise was to assess the efficiency of plot location.

The assessors used a combination of the sketch maps and the surveyor photographs to determine the exact location of the surveyor plots. It was often clear from the surveyors photos that they were in a different place to the QA assessor, and occasionally a sketches are redrawn erroneously. Comments made by the surveyors in their notes were useful for determining the confidence of their relocation.

The QA assessors achieved an average recovery rate of 88%. This is good compared to other QA exercises; CS1990 (87.1%), CS1998 QA (86.7%) and CS2007 QA (86.5%). This does not indicate the level of uncertainty that arises from the lack of a 'fixed' reference point in unenclosed habitats.

4.2 The species record

4.2.1 Species richness.

Across the 247 plots surveyed in the ERAMMP QA assessment, the surveyors recorded, on average, fewer species per plot than the QA assessors. Although the sample size for each individual plot type was small, significant differences were noted for X, Y, B, P, S/W and U plot types (Table 4-1a); only H plots showed no significant difference between surveyor and assessor. This is typical of previous QA exercises which have not demonstrated a significant difference in the H plot survey . Also, there were significant differences in the efficiency of recording the linear and ‘quadrat’ plots which has yielded missed results in past surveys.

The expression of the surveyor's species richness value as a percentage of the QA assessor’s value provides a simple means of comparing the efficiency of recording of the different plot types. The overall value of 80.8% is on par with the value from CS2007 (80.71%) but low compared to other QA exercises, Glastir 2014 (90.9%), 2015 (92.2), 2016 (85.5%) and CS1998 (87.7%). Data for the individual plot types for the Glastir QA exercises are presented in Appendix 3 together with the 2007 Countryside Survey QA exercise. Values across all plot types are compared with past surveys in Table 4-1b.

Reasons for the discrepancies between plot types are unclear; in the past it was considered that the generally poor record for the small quadrats may partly reflect the greater diversity of habitats covered by these targeted plots.

Table 4-1a Comparison of species number per plot recorded by the Surveyors and Quality Assurance assessment (QA) for ERAMMP. Values are mean species/plot; p values are for paired t-test. The final column expresses the surveyors' records as a percentage of the QA assessors.

Plot type	Number of samples	Surveyors	QA	Paired t-test	Surveyor % of QA
All plots	**247**	**20.3**	25.2	**<0.001***	**80.8**
X	46	22.7	27.2	<0.001*	83.5
Y	30	13.6	17.7	<0.001*	76.8
H	25	20.4	22.44	0.06	90.9
P	37	21.5	27.2	<0.001*	79.0
B	41	18.9	24.6	<0.001*	76.9
U	24	14.7	19.4	<0.001*	75.9
S/W	43	26.1	32.1	<0.001*	81.4
Linears	147	21.9	27.0	<0.001*	81.1
Quadrat 4m^2	54	14.1	18.4	<0.001*	76.4
Quadrat 200m^2	46	22.7	27.2	<0.001*	83.5

*Surveyor and QA species numbers significantly different

Table 4-1b Comparison of species number per plot (all plot types combined) recorded in past QA exercises. Values are mean species/plot; p values are for paired t-test. The final column expresses the surveyors' records as a percentage of the QA assessors.

Survey	Year	Number of samples	Surveyor	QA	Paired t-test	Surveyor % of QA
ERAMMP	2021	82	18.7	24.5	<0.001*	76.3
	2022	59	20.4	25.1	<0.001*	80.8
	2023	87	21.19	25.8	<0.001*	82.1
	2024	19	23.26	24.95	0.099	93.24
Glastir	2014	67	20.00	22.00	<0.001*	90.9
	2015	75	20.94	22.72	0.002*	92.2
	2016	73	22.97	26.86	<0.001*	85.5
CS	2000	210	17.90	20.40	<0.001*	87.7
	2007	266	17.49	21.67	<0.001*	80.7

*surveyor and QA species numbers significantly different

Past QA exercises have highlighted the generally poor recording of some species groups with grasses and bryophytes making a major contribution to the lower species record of the surveyor. Table 4-2 presents values for the under-recording of species (as a percentage of the QA record) when partitioned into species groups. Values for Sedges/Rushes are unavailable for CS 2007, 2014 Glastir, 2015 Glastir, 2016 Glastir and ERAMMP 2021.

Across all species the ERAMMP values are good, with the percentage of the species recorded by the surveyors being 78.4% within the range of 76.1% to 80.7% in previous QA exercises. This better recording might highlights the benefit of better training in vegetative grass identification, and possibly the availability of the Aidgap Vegetative Grass ID Guide. Bryophyte recording improved over time (Table 4-2), and was comparable to the three Glastir surveys. The recording of sedges and rushes also improved over time.

Table 4-2 Percentage of species present recorded by Surveyors.

Species group	CS 2007	2014 Glastir	2015 Glastir	2016 Glastir	ERAMMP 2021	ERAMMP 2022	ERAMMP 2023	ERAMMP 2024	ERAMMP Total
All species	80.7	76.7	76.1	79.4	76.3	62.6	82.1	92.8	78.4
Cryptograms	40.2	67.5	69.1	68.5	57.0	57.8	70.0	102.6	71.9
Grasses	85.3	78.7	78.0	79.6	81.0	88.5	87.0	92.9	87.4
Sedges/ Rushes	-	-	-	-	-	88	81	94.1	87.7

4.2.2 Allocation of sources of error in the species record

Table 4-3 presents a summary of the allocation of the mis-matched species records as a proportion of the total mis-matches. For example, there were 1546 records of species having been over-looked by the surveyors, this equates to 49.1% of the total errors of 3149.

Table 4-4 presents a summary of the equivalent values for all previous Glastir, ERAMMP and CS QA exercises.

Table 4-3 Allocation of sources of error in the species record for the ERAMMP Survey. Total errors = 3149 mis-matched species records. These can be apportioned between errors arising from the surveyors (T1 errors) and those occurring during the QA exercise (T2 errors).

T1 mis-matches

Category	Description	Number of records	% of total
A	Species mis-identified	312	9.9
B	Species overlooked	1546	49.1
C	Over-zealous recording	20	0.6
D	Mysteries	223	7.1
J	Plot mis-alignment/orientation	611	19.4

T2 mis-matches

E	Species change due to management	79	2.5
F	Seasonal changes		
G	T2 Location/orientation uncertain	64	2.0
H	Species mis-identified by the assessor	2	0.06
I	Overlooked by the assessor	162	5.1

Uncertain location errors

K	Location problems: unclear if Surveyor or QA in wrong place	130	4

Table 4-4 Allocation of mis-matched records expressed as % of total errors for all past QA exercises. Figures in bold highlight the highest value recorded.

Type	CS 1990	CS 1998	CS 2007	Glastir 2014	Glastir 2015	Glastir 2016	CS repeats	'New' Glastir	2021	2022	2023	2024
Surveyor mis-matches												
A	6.3	8.5	7.8	7.1	6.5	6.8	5.99	7.79	5.9	**11.5**	11.4	3.0
B	34.5	39.8	48.9	53	49.4	56.6	55.49	**57.68**	51.5	52.4	48.4	45.8
C	**5.8**	1.9	1.9	2.8	3.3	1	1.2	0.84	0.1	0.7	0.1	5
D	2.8	4.6	5.2	10.8	11.1	12.2	9.38	**15.16**	7.8	6.4	6.3	12
J	3.7	19.9	14.5	1.9	3.4	9.3	14.17	4.21	19	15.9	**23.1**	22.9
QA mis-matches												
E	3.4	2	1.6	0.6	0	1.4	2	0.84	0.4	2.98	**4**	**4**
F	**20.8**	3.7	5	2.8	4.9	0.5	1	0	-	-	-	-
G	**17.7**	9.2	5.2	10.1	12.2	4.2	1.6	6.95	2.3	4.1	0.7	0
H	-	-	-	-	-	-	-	-	-	-	-	1.0
I	5	10.4	4.2	**10.9**	9.2	7.9	9.18	6.53	5.3	5.6	4.9	5.5
K Uncertain location errors	-	-	5.6	0	0	0	-	-	**7.7***	5.4*	0.6*	0

* These have been allocated to J and G/H equally.

The percentage of mis-identified species (A) had been remarkably consistent across the QA exercises until 2022, with a range between 6 to 8.5% of all errors. In 2022 the errors peaked at 11.5% of errors, and this was largely due to poor byrophyte identification (*Eurhynchium striatum v Rhytidiadelphus loreus*, *Mnium sp v Atricum undulatum*), and a few other consistent errors of identification by some surveyors (*Erica cinerea v Erica tetralix*) in addition to the usual suspects of *Epilobium, Rumex, Myosotis* and ferns. In the 2023 survey mis-identification remained high at 11.4% of errors, but there were less clear reasons in terms of individual surveyors or taxa. Some squares were more poorly recorded than others (28291, 14994, 18367, 12768), but these involved three different teams of surveyors. The percentage of A errors then dropped to below what was previously recorded, likely as a result of the small number of squares sampled and the experience of the teams. The overzealous records (C) remained low until a peak in 2024.

The percentage of overlooked species (B) peaked in the 2016 Glastir program. The 2021 and 2022 ERAMMP values were close to those of Glastir 2014 and 2015 but remained high compared to the early CS surveys. The 2023 and 2024 values are the lowest since the CS2007 survey, but still high compared to CS1990 and 1998.

What was concerning in the Glastir surveys was the more than doubling of the percentage of mysteries (D errors) compared to CS. Many of these are likely to have been tablet errors, however, since the use of tablets for field recording was introduced in 2007 the increase in these errors in 2014-2016 may relate more to a change in the pro-forma for data entry on the tablet than simply the introduction of field computers. The decline in the 2021-2023 surveys may reflect the greater emphasis during training of the risk of 'ghost' and 'disco' errors, with the peak in 2024 potentially attributing to the changeover of QA assessors.

The percentage of species overlooked by the QA assessor has declined in the 2021-2024 ERAMMP exercise at <6% compared to the Glastir monitoring program where it ranged from

7.9 – 10.9%. This reduction in species overlooked by the assessor may, in part, be attributable to the 2014-2016 QA exercises being carried out by a single assessor whilst most of squares in the ERAMMP QA exercises have been surveyed by a pair of assessors, confirming the benefit of surveyors working in pairs for the botanical recording.

The increase in the contribution of location errors to the total error has peaked in the 2023 and 2024 surveys. The value of J, at 23.1% of all errors in 2023, is the highest of all past QA exercises. The low scores for CS1990 and Glastir 2014-2016 can be attributed to all the plots being surveyed as 'new' plots in those years. This high location error indicates that often the surveyor did not appear to be in the correct place based on the photos and sketches provided by previous surveyors. In a few instances the sketches were so poor that is wasn't possible to determine whether either the surveyor or the QA assessor were in the correct place, and this has resulted in the re-introduction of the 'K' error term. When errors are used to calculate % agreement and % accuracy these 'K' scores are split equally between T1 and T2 errors.

An alternative approach to assessing error is to express the mis-matches as a proportion of the total species record. For the ERAMMP survey, the total species record was 7175 with 3149 errors, a percentage of 43.9%. This is the crudest form of comparison, and gives an overall % agreement based on the total species record of 57.7. This is consistent with the UKSCAPE surveys from 2019-2023 but lower than earlier CS and Glastir surveys (Table 4-5).

Table 4-5 Mismatches expressed as a percentage of the total species record, all plot data combined.

CS Year	% agreement	Glastir	% agreement
1990	79.3	2014	73.6
1998	73.1	2015	66.1
2007	65.6	2016	64.1
2016	64.0		
		ERAMMP	
2019 *	60.3	2021	56.5
2020 *	55.6	2022	54.2
2021 *	57.6	2023	58.4
2022 *	53.6	2024	61.6
2023 *	54.7	**Total**	**57.7**

* CS 2019-2023 was for X plots only

4.2.3 Cover values

An assessment of the allocation of species covers demonstrates that approximately 13.7% of cover records were substantially different between surveyors' and assessor (Table 4-6). Differences in cover are assessed for all species which are present in both the surveyors and QA assessors list for a plot with a cover of 5% or more in at least one of the records. A discrepancy is noted where the difference in the cover value allocated by the surveyor and assessor is equal to or greater than 20%. The main discrepancies were in hedgerow trees, grasses and estimates of bare ground.

Table 4-6 Comparison of cover allocation for the ERAMMP QA exercise by year

ERAMMP Year	2021	2022	2023	2024	Total
Count of discrepancies	102	79	90	26	297
Number of species present at>5% cover	758	529	764	124	2175
% of total	13.4	14.9	11.7	21.0	13.7

4.2.4 Percentage Agreement

This is the crudest, and simplest, measure of the level of agreement between two independently collected species lists. The number of species common to both lists is divided by the aggregate of all species recorded at time one (T1) and at time two (T2) and then expressed as a percentage. These data are calculated for each plot in each square and then averaged for each square.

Percentage agreement = Common species / cumulative species list from T1 and T2 * 100.

4.2.5 Percentage accuracy

A number of the species mis-matches will have resulted from the time elapsed between the surveyors recording and the QA assessment; these arise from management activities (crop harvesting, herbicide treatment, silage/hay cutting, hedge and verge cutting) and seasonal changes (die-back of early spring flowers e.g. *Arum maculatum, Ranunculus ficaria).* In addition, there will be instances of the QA plot being slightly mis-placed, and of the QA assessor overlooking species that are present. If these mis-matches are removed from the calculation then a new value of efficiency of initial recording is arrived at.

Percentage accuracy = Common species / cumulative species list from T1 plus (T2 species minus T2 errors) * 100

A summary of these data by plot type forms is in Table 4-7. No arable (A) plots or verge (V) plots were recorded in the ERAMMP QA exercise. In Glastir 2014-2016 the accuracy of recording the small Y plots appeared to be lower than the other small plot types, possibly reflecting their positioning in relatively small, and potentially species rich, habitats compared to the U and X plots, this was not observed in the ERAMMP surveys. In 2021 ERAMMP the accuracy of these plots was also lower than most other plots with the exception of the Stream plots (S/W). In 2023 P plots were particularly poorly recorded whilst X plots had the highest agreement. X plots also recorded a high agreement in 2024 with H plots scoring the lowest for that year.

Percentage agreement, at 56.8%, is better than Glastir 2016 and CS2007 but still lower than Glastir 2014 (60.9%), 2015 (65.5%) and CS 1990 (60.9%) and 1998 (73.0%). Table 4-8

ANOVA showed no significant difference in the percentage agreement and accuracy between the plot types during the ERAMMP QA exercise (*p=0.143, p=0.155*), however there was a significant difference between the 4m ^{2} and the 200m ^{2} broad plot types for the percentage agreement (*p=0.009*) and percentage accuracy (*p=0.015*). There was also a significant difference in the percentage accuracy between the linear and the 200m^2 broad plot types (*p=0.022*).

Percentage accuracy (taking out T2 errors) across all plot types was 59.0%, this is similar to the result observed in Glastir 2016 but low compared to the other Glastir and CS surveys.

Plot types X (200m2 plots), linear (10m x 1m plots, H, B, S, P,V) and small (4m2 plots, U + Y).

Number of samples for each group given in Table 4-1a.

Table 4-7 Summary of agreement by plot type and plot size for ERAMMP QA exercises 2021-2024

Plot type	2021 % Agreement	2022 % Agreement	2023 % Agreement	2024 % Agreement	2021 % Accuracy	2022 % Accuracy	2023 % Accuracy	2024 % Accuracy
All	52.9	53.9	58.7	61.7	56.3	57.3	61.7	65.0
X	57.9	53.5	63.7	73.3	62.1	56.5	68.1	76.2
B	51.3	60.3	58.3	59.3	52.8	61.6	60.2	62.7
Y	46	54.4	57.2	51.7	51.8	58.7	60.1	51.7
H	55.5	53.2	58.6	46.4	58.9	58.5	61.7	54.2
U	50.2	54.3	59.2	47.5	53.1	57.8	63.8	49.6
S/W	48.1	48.8	57.8	65.2	50.4	51.8	61.5	66.6
P	56.9	53.1	52.6	69.1	60.7	57.7	54.8	71.0
200m^2 X	57.9	53.5	63.6	73.3	62.1	56.5	68.1	76.2
4m^2 Y/U	47.7	56	58.4	48.6	52.4	59.8	61.9	50.1
Linear	52.5	53.1	57.2	63.8	55.1	56.4	59.7	66.4

Table 4-8 Comparison of % agreement and % accuracy with past QA exercises (where all plot sizes have been recorded).

Survey	CS 1990	CS 2000	CS 2007	Glastir 2014	Glastir 2015	Glastir 2016	ERAMMP 2021	ERAMMP 2022	ERAMMP 2023	ERAMMP 2024
% Agreement	60.9	73	57.2	60.6	65.3	55.4	52.9	53.9	58.7	61.7
% Accuracy	74	78	62.1	66.5	72.5	59.5	56.3	57.3	61.7	65.0

4.2.6 Habitat codes

For 2022, in general the allocation of habitat codes to the quadrat and wider polygon were good, with the exception of 30816 where there were a number of discrepancies between the surveyors assessment and that of the QA assessor.

In square 38360 the surveyors coded most of the plots as acid grassland (code 8) rather than fen, marsh, swamp (Code 11), and thus also failed to give a priority habitat code 36 to some of the polygons. They also allocated neutral grassland (code 6) to an area of acidic grassland (code 8). Elsewhere most of the discrepancies involved the grassland codes 4,5,6 and also the interpretation of the wider polygon, especially for some P and W plots.

2024 also saw a good general allocation of habitat codes, with the few exceptions of surveyors not coding linear plots as boundary and linear features, and coding wet neutral grassland as

purple moor grass and rush pasture despite the lack of wetland indicators. There was also an obvious tablet error in one of the squares where the surveyors classified a fen, marsh, swamp plot as arable & horticulture. In the same square they also coded as fen, marsh, swamp plot as acid grassland despite the lack of grass dominating the wet/peaty plot with a high *Juncus effusus* cover (55%)

QA for the habitat coding was not carried out in 2021.

5 DISCUSSION

5.1 General: retained from previous QA reports

Problems associated with variations in accuracy rates in vegetation recording have long been appreciated, especially in the identification of grassland species (Ellison 1942; Hope-Simpson 1940; Smith 1944) but also in mire (Clymo 1980) and forest situations (Hall & Okali 1978).

Many long-term plot-based monitoring programmes rely on teams of surveyors, often with new teams being recruited for each repeat survey. This inevitably introduces variation in the data set, within and between years, due to differences in the surveyors' accuracy of species recording (Kirby et al. 1986; Prosser & Wallace 1992; Scott & Hallam 2002) and in their assessment of species cover (Kercher et al. 2003; Kli*mes 20*03; Sykes et al. 1983) over and above genuine vegetation change.

Studies have used various measures to assess the level of mis-match between teams of surveyors. Within and between team sampling errors have been assessed using pseudo-turnover (Leps & Hadincova 1992; Nilsson & Nilsson 1985) which estimates the magnitude of species turnover due to recorder error above any natural change in species lists. It is based on the non-concordance of species in two lists collected in the same area at two different times, or by two different surveyors at the same time, expressed as a proportion of the total number of species recorded at each time. Nilsson & Nilsson (1985) found an average between-team pseudo-turnover of 13% for species lists from stands on small islands. Leps & Hadincova (1992) also report a turnover of 13% for two experienced observers recording 40 releves in 5m x 5m plots. A similar value (16%) can be calculated from the data of Hope-Simpson (1940) for chalk grassland plots. A rather higher value of 22% was found in small plots within a wide range of habitat types by Scott and Hallam (2002).

Other workers have approached the problem by considering the level of agreement between two lists; the number of common species is expressed as a percentage of the cumulative species list from the two records; reported values include a value of 83% for chalk grassland (Hope-Simpson 1940), a range of 32 to 80% for woodland (Kirby et al. 1986) and an average of 57% over a range of habitats (Scott & Hallam 2002). Prosser and Wallace (1992), as part of pre-CS1990 trial, reported average percentage agreements of 56% when two surveys were undertaken by different recorders, compared to 62% when the same recorders were used for both studies.

Where causes for differences in the lists are considered it seems that misidentification is relatively uncommon but the inability of surveyors to identify young plants and hence their omission from the record is probably often underestimated (Klimes, *et.al.* 2001). Similarly, surveyors with more field experience tend to overlook (omit) fewer species; the importance of training is emphasized (Smith 1944) as is care in the choice of surveyors (Oredsson 2000); Nilsson (1992) proposes that all vegetation analyses be based on teams of two investigators rather than a single recorder. Individual surveyors can thus have very different levels of survey accuracy; this may pose serious limitations in the use of such data sets for the assessment of changes in species diversity over time (Rich & Woodruff 1992; West & Hatton 1990).

The accuracy of plot relocation will also affect measures of species and community turnover (Prosser & Wallace 1992; West & Hatton 1990) and in this respect many authors have stressed the value of permanent quadrats (Bakker et *al.* 1996; Dodd et al. 1995; Herben 1996; Hill & Radford 1986). Klimes *et.al.* (2001) found a greater lack of concordance in smaller plots compared to larger quadrats.

5.2 Specific to the ERAMMP QA exercise

If the crudest form of comparison is made whereby the total number of errors across the whole survey is expressed as a percentage of the total species record across all plots combined then % agreement for ERAMMP is 56.8%. This is at the lower end of the range of past QA exercises from CS 2022 (53.3%) to CS 1990 (79.3%).

More meaningful comparisons of agreement are made by obtaining values for individual plots and then averaging these by square or plot type. In ERAMMP the average % agreement (based on individual plot records) was 57.7%; this again is low compared previous surveys, which ranged from 55.4% (Glastir 2016) to 73% (CS2000).

Average % agreement values for individual squares (44.4% to 66.9%) are within the range of previous QA exercises. Whilst for individual plots the range was 16.6 to 90.9%.

The main factor affecting % agreement remains the overlooking of species. At 49.1% of the allocated errors this is lower than the Glastir and early CS surveys. At least a proportion of these overlooked species are probably the result of tablet omissions whilst sedges, rushes and bryophytes gradually improved over time.

Plot relocation errors remain high despite the emphasis that was placed on this during the pre-survey training courses, highlighting the difficulty in plot relocation and the importance of standardisation in the methodology.

The reduction in ‘mystery’ errors has been maintained since 2021 at just over 6%, except for 2024 when there was a rise to 12%. With an average recording of 7.1% during the entire ERAMMP survey. this is an improvement compared with the previous Glastir surveys.

% accuracy, which takes account of mis-matches arising from the QA assessor, was still relatively low at 60.1% but improved over the ERAMMP surveys. More management and seasonal errors were recorded over time despite most squares being visited for QA assessment within a few weeks of the original surveyor; this may be linked to the lateness in the season of some of the surveys in 2023 and 2024.

6 RECOMMENDATIONS

6.1 Plot relocation

Errors associated with plot relocation were particularly high during the ERAMMP surveys; accounting for 19.4% of all errors, and has gradually increased over time compared to previous QA exercises. More time obviously needs to be allocated to this during the training course to emphasis the discrepancies that can occur through poor plot relocation. In addition the surveying of 'real squares' during the second week of training should be retained, ideally with more staff available to monitor all the teams. Sometimes to say ' the area was homogeneous therefore it didn't really matter' doesn't hold for most habitats or plot types. There is a field craft involved in following sketches and photos, and some surveyors seem to find it easier than others. Sketches can also be interpreted differently between surveyors, therefore breaking down the nuances of high quality and poor quality sketches is extremely valuable in training to improve relocation effort and time efficiencies. P plots in particular contribute to the high relocation errors, as do hedgerows where surveyors fail to start from the centre of the hedge.

Surveyors should avoid redrawing sketches unless they have failed to find the original and have had to establish a 'new' location OR there is clearly an additional feature that would aid relocation by future surveyors. Surveyors should be encouraged to write more comments in the notes section in order to approximate confidence of relocation. For future surveys, access to notes made by the surveyors in the previous cycle should aid in plot relocation.

6.2 Plot recording

The overlooking of species remains the biggest source of error, and even with teams of competent botanists a high proportion of species are still missed. Grasses and bryophytes remain the biggest source of these errors and so more training in their ID during the training course is recommended. Common species are often missed, and this may be due to a lack of recognition and efficient searching of the plots, especially bryophytes in areas not considered to be rich in bryophytes; therefore more supervision during the training course on plot recording might resolve some of these problems. It should be expected that all experienced botanists involved in this type of survey should be able to identify young specimens, and dried up bryophytes.

Tablet use. The appearance of 'mystery' species has been greatly reduced despite an increase in the most recent 2024 survey. Probably a result of highlighting, during training, the potential for rogue species to appear. It is still suspected that tablet use is contributing to the 'overlooked' category, but trials to demonstrate this have proved tricky. A number of species do get missed as shown during QA when for some squares data were entered simultaneously on paper and into the tablet. The loss of species seems to occur most frequently when a species is corrected, resulting in the previously recorded species going ‘missing’. More attention to this issue should be made during training so surveyors are alert to the problem.

6.3 Hedges

The greatest error is associated with surveyors’ plots not starting in the middle of the hedge, which is often hard to access where there is an intervening fence, and this results in the plot record including species of the adjacent field. This appears to be an ongoing problem and indicates the need for more training on plot lay out during the training course. The QA team

uses a 1m cane to measure out from the centre of the hedge, usually at the point where hedge has been planted, and this helps focus the recording when it is often impossible to actually run the tape out along the edge of the actual plot. For hedges behind fences it is only practical to measure out the 10m on the field side of the hedge, but in reality all of the hedge plot may be behind the fence. So, the surveyors should not take the position of the tape in the photo as definitive as to where the edge of the plot is. Again the use of the 1m bamboo cane can be invaluable here, and its position included in a photo would certainly help. Many hedges will have grown substantially since the past survey so it is very important that the centre of the hedge is identified, else it will appear all hedges are still narrow with field species at their edges.

6.4 Stream plots

Surveyors should be encouraged to show the plot marked out in the photo or include additional measurements in the sketches to help define the 'bottom' and 'top' of the surveyed plot area. A number of plots were recorded from the top of the bank, rather than 1m up the steep bank from the water's edge. Again, the use of a 1m cane helps here, both in the photo to emphasise where the plot should be, as it is often impossible to run the tape halfway down a vertical slope, it also helps in accurately keeping the 1m distance from the water up the slope. It should be emphasised it is 1m of ground surface, not a vertical projection. Care should be taken around rocks as surveyors are over-zealously recording bryophytes growing on them which goes against survey methodology.

6.5 P (perpendicular plots)

It is surprising how often no bearing was given for the orientation of these plots relative to the S plot. The protocol is to go perpendicular to the river but this can be tricky on small and meandering streams. If surveyors could add the bearing they used if not provided on the sketch this would help future surveyors.

6.6 Grasses

Assessment of grass ID suggests skills are improving over time. The provision of the AIDGAP vegetative grass ID book may have assisted here. More training is still however needed on vegetative grass identification early in the season. Also sedges tend to be poorly recorded, if recognised at all.

6.7 Bryophytes

In some squares these were hardly recorded, especially in lowland, not generally bryophyte-rich habitats. More attention to looking for small, often dried up, specimens should be emphasised during training. As there is large variation observed in bryophyte recording (57.0-102.6%), it is worth reviewing the level of detail that surveyors are going to when recording this typically poorly censored group.

6.8 Photos

Emphasise importance of photographs – do not take close-ups of plots if poorly illuminated; include salient background features; always indicate position of photo on plot sketch. It should be stressed that photos should be taken with the plot actually set up in them as well as just

showing the start point. The position of the tape for defining the limit of hedge, boundary and stream plots is very useful. However, there are a number of occasions where the position of the tape can be very misleading. For hedges behind fences it is only practical to measure out the 10m on the field side of the hedge, but in reality all of the hedge plot may be behind the fence. So, the surveyors should not take the position of the tape as definitive as to where the edge of the plot is. Again the use of the 1m bamboo cane can be invaluable here, and inclusion in a photo would certainly help. Many hedges have grown substantially since the past survey so it is very important that the centre of the hedge is identified, else it will appear all hedges are still narrow with field species at their edges. For the smaller 4m^2 plots it is essential to have the plot set up in at least one photo which is taken from the S-pole looking due N. Photos taken on the cardinal bearings are more useful than those along the side of the plots for accurate realignment. Where possible sticks/poles should be in place at the N and S poles.

6.9 Habitat Coding

The QA of habitat codes in 2023 raised a number of issues not previous noted in terms of both the allocation of codes to the plots, but also the coding of the wider polygon, especially for the P plots. More time should be spent on the training course, in the field, rather than in the classroom, going through the habitats codes and key. A few points are highlighted below:

- Ditches: if they are dry should they be coded 14 (rivers and streams) or with a more appropriate habitat code, often 11 (fen, marsh, swamp).
- Fences: they are linear feature (code 3), but sometimes, on steep banks, the first metre out from the fence may support, e.g. acidic grassland, in a wider field of improved grassland. In this instance, the plot should not be recorded as a linear feature as the feature itself (the fence) is not wide enough to form an area. If there were a combination of linear features (wall, ditch, fence or line of trees) wide enough to make up the majority of the plot, then it should be recorded as a linear feature.
- Code 11, Fen, marsh, swamp. It is usually easy to know which sub-type for Priority Habitat coding; 35 (fen) 36 (purple moor grass/rush pasture) or 37 (reed bed), the question was more whether the plot and wider polygon were of PH quality. Clarification is needed that allocation of the PH code is based not on the quantity of the desirable species but more just on their presence.
- Improved versus neutral grassland codes and wet neutral grassland versus purple moor grass/rush pasture. More training in the field and discussion with members of staff when surveyors are unsure should assist with this.
- P-plots and the wider polygon. It isn't always clear that the wider polygon code is based on the concept of being greater in size than the minimum mappable unit and not just what the plot is running through. If a P plots passes through a grassy strip that is only 8m wide going into an extensive area of woodland, then the wider polygon in woodland. Again, more clarification on the training course with real live scenarios.

6.10 Quality Control

Continue the early season visits to all teams, ideally within the first 2 weeks. This would cover correct plot location and layout, sketches and photos, species ID and cover issues.

6.11 Quality Assurance

The number of QA squares should equate to 10% of the total number of squares surveyed during that season. Ideally each team should be assessed twice in the season depending on the experience of the team and the number of squares being surveyed that year. The first QA should be within the first month of the survey to pick up any consistent problems, especially of species identification. It would be advisable not to attempt to schedule QA sooner than 2 weeks after the planned completion date for the surveyors. This would avoid the need to reschedule when surveyors are running late.

7 CONCLUSION

Quantifying discrepancies between surveyor and assessor records is an essential part of large-scale monitoring programmes to ensure that assessments of vegetation change are being captured reliably and accurately. The Quality Assurance exercise is essential for identifying these sources of error and providing recommendations (targeted training, frequency and timing of QA visits, adjustments to survey or QA methodology, or compensation analysis) to reduce or predict their occurrence.

Annual QA reviews between data analysts, management staff and surveyor trainers should take place at the end of that year's field season so that changes can be recorded and integrated into the planning for the following year.

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9 ANNEX 1 LIST OF SQUARES SURVEYED IN ERAMMP

Table 9-1 List of squares surveyed in ERAMMP

Square	Team	Scheduled Survey date	QA date
16065	DA,SS	21-23 September 2021	5-6 October 2021
19434	JW,CFB	13-17 September 2021	25-26 September 2021
38967	SC,JH	30 August – 1 September 2021	10-11 September 2021
39617	SC,AB	4-5 August 2021	1-2 September 2021
23059	SS,CFB	9-12 August 2021	6-7 September 2021
20081	JH,TH	21-15 July 2021	9-10 August 2021
17153	JW,JW	29 June-1 July 2021	29 – 30 July 2021
8459	JW,JW	27-30 June 2022	20-21 July 2022
33098	Team 3	27 June 2022	9-10 August 2022
36000	Team 5	15 July 2022	10-12 August 2022
30194	Team 4	2 August 2022	5-6 September 2022
30816	JH,TH	8 August 2022	7-8 September 2022
6489	JW,JW	13-14 August 2023	7 September 2023
12768	CF,DA	7-10 August 2023	30 Aug-1 Sept 2023
14994	CF,DA	27-30 June 2023	2-4 August 2023
18367	HS,SS	26-29 June 2023	31 July- 2 August 2023
28291	SC,RF	26-31 May 2023	3 - 4 July 2023
33347	JH,TH	18-22 July 2023	23-25 August 2023
38360	SC,AH	26-28 July 2023	21-23 August 2023
45056	JH,TH	1-12 May 2023	30 May- 1 June 2023
11511	JW,JW	22-26 July 2024	20-22 August 2024
37943	SC,DA	15-23 August 2024	10-11 September 2024

10 ANNEX 2 COMPARISON OF SPECIES RICHNESS RECORDS BY PLOT TYPE FROM PAST QA EXERCISES

Comparison of species number per plot recorded by the Glastir 2016 Surveyors (Glastir) and the 2016 Quality Assurance assessment (QA). Values are mean species/plot; *p* values are for paired t-test. The final column expresses the surveyors' records as a percentage of the QA assessors. 2014 and 2015 data are presented for comparison

Table 10-1 2016 QA

Plot type	Number of samples	Surveyors	QA	Paired t-test	Surveyor % of QA
All plots	**73**	**22.97**	**26.86**	**<0.001**	**85.52**
X	14	18.71	20.93	0.090	89.42
Y	8	16.88	16.75	0.961	100.75
H	9	27.22	31.44	0.053	86.57
P	8	25.88	30.13	0.094	85.89
B	12	18.25	24.83	0.002	73.50
U	5	15.20	17.40	0.189	87.36
S	12	31.25	36.58	0.007	85.42
V	5	31.60	37.20	0.041	84.95
Linears	46	26.17	31.45	<0.001	83.21
Quadrats	27	17.52	19.03	0.136	92.07

Table 10-2 2015 QA

Plot type	Number of samples	Surveyors	QA	Paired t-test	Surveyor % of QA
All plots	**75**	**20.94**	**22.72**	**0.002**	**92.2**
X	14	13.21	14.07	0.448	93.9
Y	5	17.2	24.0	0.021	71.6
H	7	26.2	23.1	0.296	113.4
P	13	24.69	27.23	0.040	90.6
B	14	21.07	22.43	0.123	96.6
U	9	12.33	14.33	0.131	85.9
S	13	29.92	32.92	0.070	90.8
Linears	47	25.29	26.76	0.053	94.5
Quadrats	28	13.64	15.93	0.013	85.6

Table 10-3 2014 QA

Plot type	Number of samples	Surveyors	QA	Paired t-test	Surveyor % of QA
All plots	**67**	**20.00**	**22.00**	**<0.001**	**90.9**
X	12	22.08	23.75	0.222	93.0
Y	9	13.88	15.33	0.044	90.5
H	9	18.33	21.00	0.057	87.3
P	10	21.5	22.5	0.148	95.5
B	10	19.30	21.90	0.040	88.1
U	6	21.5	22.5	0.148	95.5
S	10	27.6	31.0	0.027	89.0

Table 10-4 Comparison of species number per plot recorded by the CS 2007 surveyors (CS2007) and the 2007 Quality Assurance assessment (QA 2007). Values are mean species/plot; p values are for paired t-test. The final column expresses the CS 2007 surveyors' records as a percentage of the QA assessors.

Plot type	Number of samples	CS 2007	QA 2007	Paired t-test	CS 2007 % of QA
All plots	266	17.49	21.67	<0.001	80.71
X	51	19.82	24.57	<0.001	80.67
Y	44	12.23	15.82	<0.001	77.31
H	26	18.04	19.19	0.257	94.01
R	39	20.59	25.90	<0.001	79.50
B	43	16.86	21.37	<0.001	78.90
U	19	12.84	17.32	<0.001	74.13
A	7	19.71	20.57	0.861	95.82
S	37	19.60	24.73	<0.001	79.26

11 ANNEX 3 SUMMARY OF AGREEMENT BY PLOT TYPE FOR GLASTIR QA EXERCISES 2014-2016

Number of samples given in Table 4-1a

Plot type	2014 % Agreement	2014 % Accuracy	2015 % Agreement	2015 % Accuracy	2016 % Agreement	2016 % Accuracy
All	60.7	66.5	65.5	72.5	55.4	59.3
X	57.8	74.5	63.8	74.5	55.4	60.0
B	64.3	71.3	69.5	75.8	57.2	57.9
Y	56.2	64.1	61.0	64.8	41.0	46.6
H	62.9	66.1	61.0	67.4	57.0	59.5
U	59.3	66.8	67.0	74.5	56.0	59.4
S/W	62.6	66.0	66.6	71.7	56.3	61.5
P	62.3	68.1	63.9	72.2	61.1	66.7
V/R					60.6	63.2
CS repeat					55.7	59.5
New Glastir					55.2	59.1

12 ANNEX 4 SUMMARY OF GLASTIR AGREEMENT BY PLOT SIZE

Table 12-1 Summary of Glastir agreement by plot size. Values are % Agreement and % Accuracy. Plot types X (200m2 plots), linear (10m x 1m plots, H, B, S, P,V) and small (4m2 plots, U + Y and X in 2015 and 2016). N= number of samples.

Plot type	N	2014 Agreement	2014 Accuracy	N	2015 Agreement	2015 Accuracy	N	2016 Agreement	2016 Accuracy
All	67	60.6	66.5	75	65.35	72.5	73	55.4	59.5
200m^2 X	12	57.8	65.0				6	59.8	63.0
Linear	38	62.7	67.5	47	65.9	72.4	46	57.9	61.3
Small	15	57.5	65.2	28	64.3	72.8	21	48.8	53.9

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