INSTITUTE OF TERRESTRIAL ECOLOGY
(NATURAL ENVIRONMENT RESEARCH COUNCIL)

H/Q 3

NORTHERN IRELAND COUNTRYSIDE SURVEY 2000 QUALITY ASSURANCE

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Contract Report to the
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Executive Summary.

Within the Northern Ireland Countryside Survey 2000 (NICS), 25 sample squares were located, stratified by the region and proportional land class, for the purpose of an independent quality assurance survey (QA).

Within each sample square, nine regularly spaced points were marked on the sample map, and the land cover type and type of the field boundary nearest to each point were recorded using the same methodology as the NICS survey. The QA surveyor was trained to the same level as the NICS surveyors, but remained fully independent during field work, which was carried out in the same year as the NICS survey. ITE co-ordinator for the QA project also attended part of the training course, participated in the design of the sampling and was present at the start of the sampling. A total of 225 land cover points and 200 boundaries were surveyed. NICS surveyors were contacted after all survey work was done, and reasons for any difference survey results discussed and identified.

QA results show a similar balance of land cover and boundary types for the whole of Northern Ireland from a baseline survey completed 10 years ago, indicating that the QA sample is representative and covers the principal land cover and boundary types.

Correspondence between QA and NICS at the UK Broad Habitat level was 90.7%. The main reason for disagreement between the two surveys was due to different interpretations in the field of land cover criteria (4.9%). Categorical error only accounted for 0.9% of the disagreements.

At the NICS type level, correspondence of land cover types between QA and NICS was 70.4%. Of the disagreements, interpretation of land cover criteria accounted for 14.4%; splitting of one land cover type into two others accounted for 4.4%; seasonal changes accounted for 3.6%; interpretation of land parcel border location accounted for 1.8%; difficulty in identification of *Lolium perenne* varieties accounted for 1.3%; and categorical error accounted for 4.0%.

Within woodland land cover types, the correspondence between QA and NICS was 88.9%. Within seminatural land cover types the correspondence was 47.9%. Within agricultural land cover types, the correspondence was 69.8%. Within landscape land cover types, the correspondence was 81.3%.

The main reason for differences between QA and NICS in woodland, seminatural and agricultural land cover types was interpretation of land cover criteria between closely related types. In landscape land cover types the main reason was categorical error. The secondary reasons for differences between QA and NICS in seminatural vegetation were due to splitting of parcels into two land cover types and interpretation of parcel border locations in the unenclosed uplands, where the survey methods of QA and NICS differ in that QA did not map parcel borders. In agricultural land, secondary reasons for differences between QA and NICS were seasonal differences and categorical errors.

The NICS survey uses a change matrix to codify the reasons for change in land cover type from the baseline survey 10 years ago. In cases where both QA and NICS detected a change in land cover type, the correspondence in the change matrix code recorded was 88.1%. Of the codes that differed, NICS was more conservative in recording a categorical change, in the majority of cases recording an error in baseline where QA recorded a categorical change.

Correspondence between NICS and QA of boundary types was 77.0%. Of the disagreements, interpretation of boundary criteria accounted for 13.0%; seasonally related differences accounted for 2.0%; other reasons for differences accounted for 3.0%; and categorical error accounted for 5.0%.

Hedge boundaries had a correspondence of 94.6%. Wall boundaries had a correspondence of 33.3%, mainly because of problems distinguishing between ruined and complete dry stone walls, but were recorded in only 15 cases. Fence boundaries had a correspondence of 54.8%, mainly due to confusion with earth banks. Earth banks had a correspondence of 52.2%, the majority of difference accounted for by confusion with fence types. In all boundary types, interpretation of criteria was the main reason for differences between QA and NICS survey results.

In the boundary change matrix, QA and NICS agreed about the change matrix code in 56.0% of cases. Of the 11 cases that differed, five were cases where NICS had recorded an error code while QA had recorded a categorical change. Thus, NICS was more conservative than QA in recording a boundary change process.

Among the eight land class groups, there was a lower correspondence of land cover types in the most upland land class group and a complex lowland land class group. Other than this, in both land cover and boundary types, there was there was little difference in the level of correspondence between NICS and QA in different land class groups.

In conclusion, although the QA sample was small, it was adequate to draw valid conclusions about the reliability of the data, which is comparable to other surveys. The QA confirmed the reliability of the mapping procedure and showed that the results will be robust. Finally, the high correspondance at the Broad Habitat level shows the validity of using the categories for UK reporting.

1. Introduction.

The Northern Ireland Countryside Survey 2000 (NICS) is a land cover survey of the whole of Northern Ireland. Independent Quality Assurance (QA) was carried out to estimate standardisation between surveyors and to identify sources of differences between them.

1.1. Quality Assurance.

The purpose of quality assurance is to assess quantitatively the variation between landscape surveyors, the sources of variation between surveyors, and the landscape types particularly prone to variation between surveyors.

Previously, Cherrill and McClean (1995) investigated the difference between two 'Phase 1' surveys carried out by different people in the same area within the Northumberland National Park. Spatial correspondence was found to be 44.4%. The main reason for discrepancies between the surveys being identified as different interpretations of land cover types (classification error) between surveyors. A smaller amount of discrepancy was due to differences in boundary locations. When land cover types were aggregated, there was a 27% reduction in the area of discrepancy between the surveys. A difficulty in the analysis was presented by the fact that the two surveys were separated by a 12 month period. Cherrill and McClean (1995) acknowledge this and state that "resurvey exercises should run concurrently with the main sampling programme".

The land classification of Northern Ireland by the University of Ulster was carried out approximately 10 years ago (Murray, McCann and Cooper, 1992). A landscape ecological survey consisting of 628 quarter kilometre Ordnance Survey grid squares was undertaken as part of this work and it was recognised that the degree of error associated with recording needed to be assessed quantitatively. To this end, 26 squares were selected randomly, stratified in the same manner as the survey sampling programme. In each of these squares, a regular grid of nine points was superimposed over the sample map. The land cover type from each of the nine points, and the boundary type from the field boundary closest to each point was resurveyed. This total of 231 field parcels and 225 field boundaries was compared with the survey results. There was found to be similarity of 79% in recording field parcels and 74% in recording field boundaries. Recording error was notably associated with misidentification of Italian ryegrass (*Lolium multiflorum*) swards with perennial ryegrass (*Lolium perenne*) swards and "other" agricultural grassland swards with perennial ryegrass swards (Murray, McCann and Cooper, 1992, pp. 140).

In a similar manner, Barr *et al.* (1993) contains a quality assurance exercise of the Countryside Survey carried out in Britain. A sub-sample of the Countryside Survey sample was resurveyed and a correspondence in primary land cover codes of 84% was found between this and the original survey. This result was further found to have a correspondence of 95% in the lowlands and 71% in the uplands. This was likely to be due to difficulties in distinguishing between bog and heath types in the uplands.

In the Northern Ireland Countryside Survey 2000, the Steering Group identified that with so many surveyors, an independent quality assurance report would add weight to the results. The Institute of Terrestrial Ecology (ITE) would be responsible for, and supervise the report, in collaboration with the University of Ulster.

The main aims of this report were to conduct a quality assurance programme, using NICS survey methodology, to investigate:

1. The consistency of recording at the Broad Habitat level.
2. The consistency of recording at the NICS habitat type level.
3. The sources of inconsistencies between QA and NICS surveys.

1.2. NICS Survey methodology.

Land cover sampling of Northern Ireland by the University of Ulster began in 1987, with the initial objective of recording land cover in Areas of Outstanding Natural Beauty (AONBs). This work was extended to the wider countryside so that eventually land cover information was held about all of Northern Ireland that could then be used to guide land use decisions and research (Murray, McCann, Cooper, 1992). Broadly, the survey involved mapping woodland, agricultural, seminatural and landscape parcels in quarter kilometre Ordnance Survey grid squares. There was a total of 628 squares surveyed, stratified by a land classification of Northern Ireland. Within a square, each landscape parcel was assigned a land cover type and several structural, management and species codes. Boundaries were recorded in a similar manner.

A resurvey, the Northern Ireland Countryside Survey 2000 (NICS), was carried out from May to September 1998. This repeated the land cover survey done in the AONBs and wider countryside, using the same methods, sample squares and standardised land cover definitions. A description of the methods and definitions is given in Cooper and McCann (1997). Where the resurvey (NICS) information varied from the original survey (baseline) results, this was recorded in a change matrix; one for land cover and one for boundaries. In this way, categorical change in the landscape of Northern Ireland could be determined.

NICS field work was carried out by six teams of two surveyors each, rotated on a regular basis. All field workers underwent one fortnights training in the methodology prior to the survey. Checking procedures by the project co-ordinator were carried out in most squares during the survey and regular seminars were held to discuss issues brought up during these checks and the survey.

2. Methods.

25 squares were sampled in the QA survey, stratified by land area strata and multivariate land class. The land cover type of nine points was sampled in each square, along with field boundaries closest to each point. All sampling was carried out in September 1998.

2.1. Sample square stratification.

Northern Ireland was stratified by the AONBs, Fermanagh District, and the five remaining counties. 25 sample squares, proportional to land area, were allocated as shown in Table 2.1.

Table 2.1. Sample square allocation by land area stratum.

Abbreviation	Strata	Area Km²	Squares
MOU	Mournes AONB	59444	1
ANT	Antrim AONB	78735	1
NDE	North Derry AONB	10014	0
SPE	Sperrins AONB	109433	2
FER	Fermanagh District	171049	3
WAN	County Antrim wider countryside	212237	4
WDE	County Derry wider countryside	161858	3
WTY	County Tyrone wider countryside	239157	5
WAR	County Armagh wider countryside	86145	2
WDO	County Down wider countryside	186304	3
GUL	Sleive Gullion	39821	1
	Total	**1354197**	**25**

Within each stratum, the squares were chosen randomly within representative land class groups to ensure a degree of proportionality for each study area (Table 2.2). A 0.5% sample subset for Northern Ireland was used to avoid bias due to the different sampling intensities within and between strata.

Table 2.2. Sample square allocation by land class group.

	Land class group:								
Strata	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
MOU						1			**1**
ANT								1	**1**
NDE									**0**
SPE						1		1	**2**
FER		1			1		1		**3**
WAN			1	1	1	1			**4**
WDE				1	1		1		**3**
WTY			2		1	2			**5**
WAR	1			1					**2**
WDO	3								**3**
GUL	1								**1**
Total	**5**	**1**	**3**	**3**	**4**	**5**	**2**	**2**	**25**

Certain criteria were used to reject squares for inclusion in the sample:

1. Outliers in the distribution of the land class.
2. Predominately urban squares.
3. Squares consisting of isolated islands in lakes.
4. Squares unrepresentative of the 1 km square and/or land class.
5. Squares with survey permission denials.

2.2. Sampling methodology.

Within each sample square, nine regularly spaced points were marked on the sample square map. Each of these points was visited in the field and surveyed using the same methodology as the NICS survey (see Cooper and McCann, 1997 for detail): Using the baseline map as a guide, land parcels were resurveyed and recorded in data sheets. The nearest boundary to each point was also surveyed. Points which had another point between them and the nearest boundary were not used to locate boundaries for surveying to prevent over-sampling in squares where there were few boundaries. In unenclosed squares, a global positioning satellite receiver was used to locate points. One difference between the QA and NICS methodology was that the NICS survey was carried out by pairs of surveyors, while QA was done by one. There were a total of 224 land cover points (one was missed during field work) and 200 boundaries recorded.

2.3. Surveyor independence.

The QA surveyor undertook the same fortnights training course with the NICS surveyors, attended NICS seminars and did some NICS survey work prior to the QA survey. None of the squares in the QA sample were visited by the QA surveyor prior to the QA survey, nor was any contact made with any NICS surveyor or project co-ordinator regarding any QA square made until both sampling programmes were completed. The ITE co-ordinator of the QA sampling programme was present at the training course and at the outset of QA survey work.

2.4. Result analysis.

Each of the QA sample squares was compared with the corresponding NICS square. In each case where a land cover or boundary type differed, the reasons for the difference were discussed with the appropriate NICS surveyor. Case studies of two squares are presented in Appendix 1. No changes were made to either QA or NICS data sheets as a result of discussions.

3. Land cover.

There were 224 land cover points recorded by QA and 225 points identified from NICS resurvey sheets. These points are presented in Appendix 3 by their corresponding land cover type. The figure found at the baseline survey, approximately 10 years ago, and the figure for the whole of Northern Ireland 10 years ago are also shown.

The QA and NICS figures are broadly comparable, both showing a slight decrease in the amount of A11 ('other' agricultural grassland) agricultural land cover type from baseline and an increase in type A8 (perennial ryegrass). In other regards, QA, NICS and baseline are broadly comparable. All three are also similar to the figure for the whole of Northern Ireland at baseline, indicating that the QA sample is a robust one. It should be noted, however, that the QA sample is a low sampling percentage for Northern Ireland as a whole and is intended as a quality assurance only, not as a pre-sample of change from baseline.

From discussions between QA and NICS surveyors, six reasons for land cover type differences between the two surveys were determined:

1. Interpretation of land cover criteria. Cases where one surveyor had determined that there was sufficient of one or more land cover type criteria (usually abundance of a species) to assign the land parcel to one land cover type and the other surveyor had not.
2. Interpretation of position of boundary between land cover types. Cases where the land cover type that the point was in was recorded by QA as a land cover type identical to a type just across a boundary drawn on the map by NICS.
3. Splitting of one land cover type into two or more types. Cases where a single land cover type recorded by one surveyor had been split into two or more land cover types by the other surveyor.
4. Season related differences. Cases where the land cover type recorded by NICS had changed between the NICS survey earlier in the summer and the QA survey in September.
5. *Lolium* variety misclassification. Certain high yielding *Lolium perenne* varieties look very similar to *Lolium multiflorum*, and there were cases where an uncertain *Lolium* field had been classified differently by QA and NICS.
6. Categorical error. Cases where either QA or NICS could determine that an incorrect type had been recorded during survey.

3.1. Broad habitat types.

Broad Habitat types are used to combine results from the Northern Ireland Countryside Survey 2000 with the British Countryside Survey 2000 to construct a UK wide countryside survey. The NICS land cover types and their corresponding Broad Habitat types, produced as part of the Countryside Survey 2000 report, are presented in Table 3.1. Appendix 4 contains descriptions

Table 3.1. NICS types in UK Broad Habitat types.

Broad Habitat type	NICS type
1	W1, W2, W6, W7, W8, S7, S8, 50% S58
2	W4
4	A1, A2, A4, A10, A12
5	A7, A8, A9, A11, S34
6	S1
8	S3, S4, 50% S12
9	S32, 50% S58
10	S9, S57, 50% S12
11	S2, S16, S17
12	S5, S10, S13, S14, S15
13	L20
16	L18
17	L1, L2, L3, L4
3	L10

Table 3.2. shows the matrix of correspondence between QA and NICS Broad Habitat types.

Table 3.2. Matrix of correspondance of Broad Habitat types.

		NICS													
		1	2	4	5	6	8	9	10	11	12	13	16	17	3
QA	1	**19**						0.5							
	2		**9**												
	4			**17**											
	5	1			**110.3**					0.7					
	6				1										
	8	0.5			2		**7**			1.5	2				
	9							**2.5**							
	10	0.5					0.5		**2**		3.5				
	11				3.5					**7.5**	1				
	12						0.5			1.3	**13.7**				
	13											**3**			
	16												**1**		
	17													**6**	
	3														**6**

The correspondence between the QA and NICS survey results at the Broad Habitat level was 90.7%. Reasons for differences were as follows:

Interpretation of land cover criteria:	11 cases, or 4.9%
Interpretation of boundary position:	2 cases, or 0.9%
Splitting land cover type:	6 cases, or 2.7%
Categorical error:	2 cases, or 0.9%

Thus, only 9.3% of broad habitat types recorded in Northern Ireland varied between surveyors, and only 0.9% of types were categorical errors recorded incorrectly. The

other 8.4% was mostly interpretation of land cover criteria, particularly between type 11 (wet seminatural and rush-dominated grasslands) and type 5 (agricultural grasslands).

3.2. NICS types.

The same land cover type was recorded by both QA and NICS in 158.5 of the 225 points (Tables 3.3, 3.4). Differences between land cover types are shown diagrammatically in Figure 3.1.

Figure 3.1. Changes between NICS and QA recording of land cover types. The width of the lines is proportional to the number of changes between two land cover types.

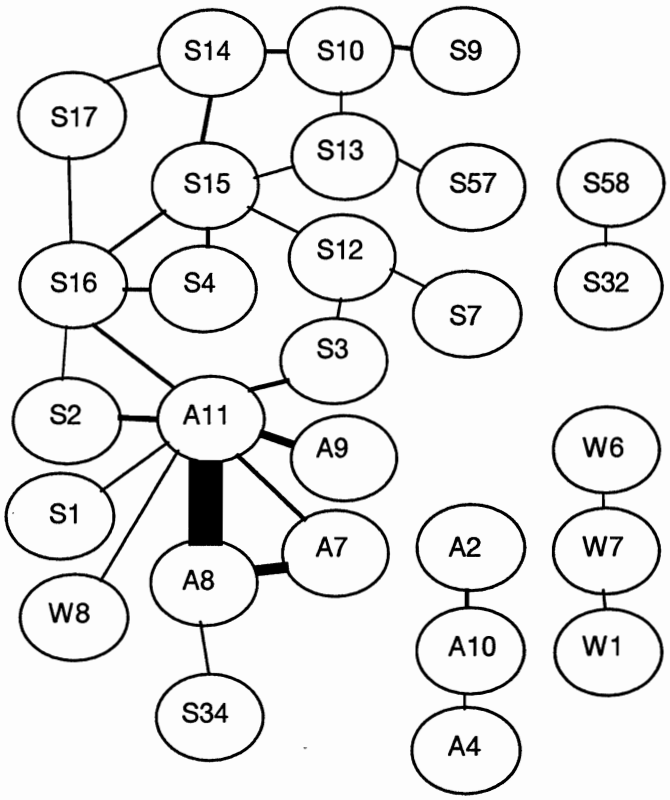


Table 3.4. Sources of differences between QA and NICS land cover types.

Result	Number of points	Percentage of points
QA and NICS same	158.5	70.4
Interpretation of land cover criteria	32.5	14.4
Interpretation of boundary position	4	1.8
Splitting land cover type	10	4.4
Season related differences	8	3.6
Lolium variety identification	3	1.3
Error	9	4.0
Total	225	100.0

Table 3.3. Correspondance matrix of QA and NICS land cover types. QA codes are on the vertical axis, NICS codes on the horizontal.

Q\N	W1	W2	W4	W6	W7	W8	S1	S2	S3	S4	S5	S7	S8	S9	S10	S12	S13	S14	S15	S16	S17	S57	S58	S32	S34	A1	A2	A4	A7	A8	A9	A10	A11	A12	L1	L2	L3	L4	L10	L18	L20
w1	6																																								
w2		2																																							
w4			9																																						
w6				6																																					
w7	1			1																																					
w8						1																																			
s1																																	1								
s2								1												0.5													2.5								
s3									2																								2								
s4										4.5									1.5	1.5																					
s5											1																														
s7												1																													
s8													1																												
s9															2																										
s10																	1																								
s12									1			1							1																						
s13																	2		1																						
s14															2			1	1																						
s15										0.5								1	3.7	1.3																						
s16																				5														1							
s17																		1		1																						
s57																	1					2																				
s58																								1																		
s32																								2																		
s34																															1										
a1																										4															
a2																											4					2									
a4																												4				1									
a7																														1			2								
a8																													4	58			10								
a9																																	2								
a10																																1									
a11						1														0.7										7	2		23.3								
a12																																		1							
L1																																			1						
L2																																									
L3																																				1	3	1			
L4																																									
L10																																							6		
L18																																								1	
L20																																									3

Thus, 4.0% of differences between surveyors can be attributed to categorical error. The main differences between surveyors were interpretation of land cover criteria between closely related land cover types. That this is the case is shown by the broad habitat result where, once closely related land cover types are combined, the difference between the two surveys drops to under 10%.

There are other sources of differences between QA and NICS that cannot be quantified. Although the differing dates of the QA and NICS surveys was directly responsible for 3.6% of the differences between the surveys, this may mask a larger figure, since the NICS survey was done within a week of baseline survey. Some differences attributed to interpretation of land cover criteria could thus have been due to changes in, for example, the proportions of different grass species throughout the summer.

Another non-quantifiable source of difference between QA and NICS concerns the checking procedures carried out by the project co-ordinator with the NICS surveyors. To ensure independence of the QA survey, no such checking was carried out of the QA surveyor by the NICS project surveyor. However, the ITE co-ordinator of the QA project did come into the field to perform checking procedures with the QA surveyor.

These non-quantifiable sources of error mean that the NICS survey results are likely to be more robust than the QA survey results.

3.2.1. Woodland land cover types.

There were 26 points located in woodland by QA and 27 points located in woodland by NICS. 24 of these points were the same type in both QA and NICS, a correspondence of 88.9%. Of the three points that differed, two were due to interpretation of land cover type criteria and one was an error.

Of the 24 woodland points that corresponded in type; woodland structure had a correspondence of 79.2%. Ground flora had a correspondence of 87.5%. Soil type had a correspondence of 45.8%, mainly because NICS recorded the same soil type, while QA varied. Grazing had a correspondence of 87.5%, most sites being ungrazed. Enclosure had a correspondence of 58.3%, mainly because QA usually recorded woodland as enclosed while NICS varied (see Appendix 2, Tables 1.1-1.6, for details).

3.2.2. Seminatural land cover types.

There were 54 points located in seminatural vegetation by QA and 47 points located in seminatural vegetation by NICS. 26.2 of these points were the same type in both QA and NICS, a correspondence of 47.9%. Of the 28.5 points that differed, 14.5 were due to interpretation of land cover criteria; eight were due to splitting parcels; four were due to interpretation of boundary locations; one was a seasonal change; and one was an error. That some of the variation was between closely related land cover types is shown at the broad habitat level, where the correspondence between seminatural broad habitat types (types 6, 8, 9, 10, 11, and 12) is 63.2%. Thus, seminatural vegetation is therefore a difficult land cover type to survey. The high number of

differences between QA and NICS associated with splitting parcels and parcel boundary locations indicates that a major source of variation stems from the surveying of unenclosed land, where much seminatural vegetation is located. In these areas, the surveying methodology of QA versus NICS may differ, since the mapping of land parcels, which was not carried out by QA, is likely to influence the decision on land cover type.

There were 7.5 cases where QA had recorded land parcels as seminatural types which NICS had recorded as agricultural types and only 0.7 points in the other direction. This suggests that QA was more likely to survey landscape parcels as seminatural than NICS.

Soil type had a correspondence of 82.8%. Of the structural and management attributes, only the presence of grazing was recorded with any degree of correspondence between QA and NICS (see Appendix 2, Tables 2.1-2.3, for details).

3.2.3. Agricultural land cover types.

There were 128 points located in agricultural land by QA and 134.8 points located in agricultural land by NICS. 95.3 of these points were the same type in both QA and NICS, a correspondence of 69.8%. Of the 41.2 points that differed, 21.2 were due to interpretation of criteria; eight were seasonal differences; five were errors; three were due to splitting parcels; one was due to interpretation of a boundary location; and three were due to the uncertain classification of *Lolium perenne* varieties.

A8 (perennial ryegrass) was the most common agricultural land type. 81 points were located in type A8 by either QA or NICS. Of these points, 58 were A8 in both QA and NICS, a correspondence of 71.6%. 17 of the 23 points that differed were classified as type A11 ('other' agricultural grassland) by either QA or NICS. Type A7 (Italian ryegrass) was never classified by both QA and NICS, mostly being classified as A8 instead. The same was true for type A9 (mixed species grassland), which was classified as type A11. These differences are all between closely related land cover types: at the broad habitat level, the differences disappear and the correspondence between agricultural types (broad habitat types 4 and 5) is 93.9%.

In cases where QA and NICS recorded the same agriculture type, the correspondence between QA and NICS with respect to soil type was 93.8%. That there may be hidden seasonal related differences between the QA and NICS is shown by the management attributes recorded in agricultural land cover types which QA and NICS agreed upon the land cover type. NICS recorded more land as silage/conserved (management code 17) than QA, which recorded only one case, reflecting the trend in the countryside to take silage cuts and then allow animals to graze on the land later in the season. Also, QA recorded more weed infestation (management code 21) than NICS, and weeds are more likely to be visible and, thus, recorded as an infestation later in the season (see Appendix 2, Tables 3.1-3.2, for details).

3.2.4. Landscape land cover types.

There were 16 points identified as landscape features by both QA and NICS. 13 of these points were the same type, a correspondence of 81.3%. Of the three points that differed, one was due to interpretation of criteria and the other two were errors.

Landscape attributes (including none present) were the same in 53.8% of records where QA and NICS recorded the same landscape type.

3.3. Land class groups.

There were eight land class groups used to develop the QA sampling methodology. These can be combined into two broad groups: an upland group, consisting of land class groups 6, 7 and 8; and a lowland group containing the first five land class groups. Land cover type differences between QA and NICS survey results, and the sources of these differences can thus be categorised by land class (Tables 3.5, 3.6)

Table 3.5. Land cover type differences by land class groups (land classes in the land class groups are shown in brackets).

Land class group	Points same	Points different	Percentage same	Percentage different
1 (1-4)	32	13	71.1	28.9
2 (5)	6	3	66.7	33.3
3 (6-8)	22	5	81.5	18.5
4 (9-12)	14	13	51.9	48.1
5 (13-16)	32	4	88.9	11.1
6 (17-19)	30	15	66.7	33.3
7 (20-21)	14.3	3.7	79.4	20.6
8 (22-23)	8.2	9.8	45.6	54.4
Lowland	106	38	73.6	26.4
Upland	52.5	28.5	64.8	35.2

Land class groups 4 and 8 have a lower correspondence than other land class groups. Land class group 8 is virtually unenclosed upland where mapping is a major source of difference between QA and NICS. Land class group 4 is flat terrain associated with the Lough Neagh basin and the Bann valley, providing a variety of sources of differences between QA and NICS.

Table 3.6. Sources of land cover type differences by land class groups (LCG). SA = same land cover type recorded by both QA and NICS; IN = difference due to interpretation of criteria; BO = difference due to interpretation of boundary position; SP = difference due to splitting of land type; SE = difference due to seasonal change; LO = differences due to problematic *Lolium perenne* variety; ER = categorical error.

LCG	SA	IN	BO	SP	SE	LO	ER
1	32	7	1		2		2
2	6	2		1			
3	22	3		1	1		
4	14	5			2	3	3
5	32	2			1		1
6	30	8	2	2	1		2
7	14.3	1.7		1			1
8	8.2	3.8	1	5			
Lowland	106	19	1	2	6	3	6
Upland	52.5	13.5	3	8	1		3

The sources of differences vary between upland and lowland surveys. In the lowlands, there are more season-related differences, mostly due to change in agricultural practice through the year. In the uplands, there are more differences due to splitting of parcels by either QA or NICS. This is because a large proportion of upland land is unenclosed, making the classification of land cover types susceptible to surveyor differences in the resolution to which they wish to survey land parcels (see Appendix 1 for case studies of typical upland and lowland squares).

3.4. Change matrix.

The change matrix is used by the NICS to detect categorical change between the NICS resurvey and the baseline. Surveyors are required to record a change matrix code for all changes in land cover type. QA also filled in a change matrix for changes in land cover type. Of the 59 points where both QA and NICS had identified a change process, 52 of the change processes were identical, a correspondence of 88.1% (Table 3.7). Of the seven processes that differed, six were due to interpretation and one was an error. It is notable that four of the seven processes that differed, NICS had recorded an ER (Error at baseline- no categorical change) process. Thus NICS is more conservative about recording change than QA.

Table 3.7. Land cover change matrix processes.

		NICS CP	ER	FO	RE	RG	IG	R	GA	CR	Total
QA	CP	**35**								1	36
	ER		**10**				1				11
	FO			**1**							1
	RE				**3**				1		4
	RG		1								1
	IG		3				**1**				4
	R							**1**			1
	GA								**1**		1
	CR										0
	Total	35	14	1	3	0	2	1	2	1	59

4. Boundaries.

There were 200 boundaries recorded by QA and NICS sheets. Where boundaries were found are presented in Appendix 3. The result found at the baseline survey, approximately 10 years ago, and the result for the whole of Northern Ireland 10 years ago are also shown. All four results are similar, suggesting that the QA survey was a representative sample of Northern Ireland.

4.1. Sources of differences.

The same boundary type was recorded by both QA and NICS in 154 of the 200 points (Table 4.1, 4.2). Of the remaining points, the following reasons for differences between QA and NICS survey results were identified:

1. Interpretation of boundary criteria. Cases where one surveyor had determined that there was sufficient of a boundary criteria (such as presence of an earth bank of the requisite height over the requisite length) to assign the boundary to one boundary type and the other surveyor had not.
2. Season related differences. Usually cases where a boundary had been built or changed between the QA and NICS surveys.
3. Categorical error. Cases where, upon discussion, either NICS or QA could determine that an incorrect type had been recorded in the field.
4. Other reasons for differences. There were five of these, mostly relating to boundaries not covered in the field handbook. Uncertainty about boundaries along woodland paths (two cases); uncertainty about priority of fence types (one case); uncertainty about the status of a large *Cupressocyparis* boundary (one case); difference due to splitting or joining boundaries (one case); and one case of an unknown reason for difference.

Table 4.1. Sources of differences between QA and NICS boundary types.

Result	Number of points	Percentage of points
QA and NICS same	154	77.0
Interpretation of criteria	26	13.0
Season related differences	4	2.0
Categorical error	10	5.0
Other reasons for differences	6	3.0
Total	**200**	**100.0**

Table 4.2. Correspondance matrix of QA and NICS boundary types. See Appendix 4 for descriptions of boundary types.

		NICS															
		2	4	6	7	10	9	11	12	D	BRF	BWC	BRB	MISS	BRW	E	BRD
QA	2	**87**	1			1		3									
	4		**2**			1											
	6		3	**1**			2										1
	7				**2**												
	10	2				**23.5**	1	4.5		1				4			
	9	1		1		3	**16**	1									
	11	1				2		**9**			1			1			
	12					1	1.5		**6.5**						1		
	D	1								**2**				2			
	BRF										**1**						
	BWC		1									**1**					
	BRB										1						
	MISS													**1**			
	BRW																
	E															**2**	
	BRD					1		1									

4.1.1. Hedges.

QA and NICS each recorded 92 hedges. 87 of these were recorded by both QA and NICS, a correspondence of 94.6%. Hedges are thus an easily recognised boundary type. Of the ten cases that differed, six were due to interpretation of whether there was adequate shrub cover or not, one was a seasonal change, two were errors, and one was uncertainty about the status of a large *Cupressocyparis* boundary.

There were eight hedge structural attributes comparable in the 87 hedges recorded by both QA and NICS (see Appendix 2, Tables 4.1-4.8, for details).

1. Lateral structure. 42 cases corresponded (48.3%), but a further 37 cases were of an adjacent lateral structure between QA and NICS records. 90.8% of hedges had the same or adjacent lateral structure between QA and NICS.
2. Additional fencing. 62 cases corresponded (71.3%).

3. Ground layer. 71 cases corresponded (81.6%). However, most of these had no ground layer recorded. Of the 19 cases where ground layer structure had been recorded by either QA and/or NICS, only three cases corresponded.
4. Ditches. 68 cases corresponded (78.2%).
5. Vertical structure. 58 cases corresponded (66.7%). Most were either flat-top hedges (structure 28), or unmanaged hedges 2-4m (structure 32).
6. Hedge bank height. 52 cases corresponded (59.8%).
7. Hedge base. 55 cases corresponded (63.2%). Most of these were dense hedge bases (structure 47), the correspondence of other types was low.
8. Tree density. 52 cases corresponded (59.8%), but a further 25 cases were of an adjacent tree density structure between QA and NICS records. 88.5% of cases had the same or adjacent tree density structure.

4.1.2. Walls.

QA recorded seven dry stone walls, NICS recorded three. Two of these were the same in both QA and NICS, a correspondence of 25.0%.

QA recorded two ruined dry stone walls, NICS recorded seven. One of these was the same in both QA and NICS, a correspondence of 12.5%.

The most common source of the disagreements was ruined dry stone walls recorded by QA being recorded as normal dry stone walls by NICS, indicating that NICS is more conservative about recording dry stone walls as ruined. This happened in three cases, twice due to interpretation of criteria, once as an error. There were seven other cases where either QA or NICS had recorded a wall and the other had not. Four of these were due to interpretation of criteria, and three were errors.

QA recorded two mortar/brick/concrete walls, as did NICS. Both records were the same in both QA and NICS, a correspondence of 100%.

Of the five walls whose type corresponded between QA and NICS (a correspondence of 33.3%), lateral structure and additional fencing structure codes corresponded in four of the five cases (80%), while tree density corresponded in only one case (20%) (see Appendix 2, Tables 5.1-5.3, for details).

4.1.3. Fences.

QA recorded 22 sheep fences, NICS recorded 20.5. 16 of these were the same in both QA and NICS, a correspondence of 60.4%. Of the 10.5 cases that differed; five were due to interpretation of criteria, two were seasonal differences, two were errors, one was uncertainty about priority of fence types, and 0.5 was due to two boundaries joined by one surveyor.

QA recorded 14 wire fences, NICS recorded 18.5. Nine of these were the same in both QA and NICS, a correspondence of 38.3%. Of the 14.5 cases that differed, 6.5 were due to either QA or NICS recording the boundary as an earth bank, six of these cases were interpretation of criteria, the other half case was where a boundary had been split into two types by one surveyor. Of the other eight cases that differed, two were due to

interpretation of criteria, three were due to seasonal changes, two were errors and one case was unknown why it differed.

QA recorded 10 other fences, NICS recorded 6.5. 6.5 of these were the same in both QA and NICS, a correspondence of 65.0%. Of the 3.5 cases that differed, one was due to interpretation of criteria, one was an error, one was uncertainty about priority of fence types, and 0.5 was due to two boundaries joined by one surveyor.

Fence structural attributes had a high correspondence between QA and NICS in the 31.5 cases where both QA and NICS had recorded the same fence type (a correspondence of 54.8%). However, this was because in both surveys, no structural attributes had been recorded in the majority of cases (see Appendix 2, Tables 6.1-6.3, for details).

4.1.4. Earth banks.

There were 36 earth banks recorded by QA and 32.5 recorded by NICS. 23.5 were recorded by both QA and NICS, a correspondence of 52.2%. Of the total of 45 earth bank records, 12.5 cases were recorded as a type of fence by either QA or NICS, accounting for the majority of the 21.5 earth bank records that disagreed: 18 were due to interpretation of criteria, one was an error, two were due to uncertainty about boundaries along woodland paths, and the remaining half-case was due to boundary which had been split into two types by one surveyor.

Earth bank definition using the criteria given is often open to interpretation between surveyors, interpretation that went in both directions with both QA and NICS interpreting earth banks as other types.

There were six earth bank structural attributes comparable in the 23.5 earth banks recorded by both QA and NICS (see Appendix 2, Tables 7.1-7.6, for details).

1. Lateral structure. 12.5 cases corresponded (53.2%). An additional eight cases had a lateral structure adjacent to the structure recorded by the other surveyor. Thus 20.5 cases (87.3%) had a lateral structure which corresponded with the same or adjacent structure between QA and NICS.
2. Additional fencing. 16.5 cases corresponded (70.2%).
3. Ground layer. 14.5 cases corresponded (61.7%). None of the cases where QA or NICS had recorded a structure code corresponded.
4. Ditches. 17 cases corresponded (72.3%).
5. Earth bank height. 11.5 cases corresponded (48.9%). However, all earth bank heights were the corresponded with at least an adjacent height structure, with the exception of one case that was erroneously not recorded.
6. Tree density. 12.5 cases corresponded (53.2%). All cases corresponded to at least an adjacent tree density structure.

4.2. Land class groups.

In the same manner as was done with land cover (section 3.3), boundary type differences between QA and NICS survey results, and the sources of these differences, were categorised by land class (Tables 4.3, 4.4)

Table 4.3. Boundary type differences by land class groups.

Land class	Points same	Points different	Percentage same	Percentage different
1-4	34.5	10.5	76.7	23.3
5	8	1	88.9	11.1
6-8	24.5	2.5	90.7	9.3
9-12	23	4	85.2	14.8
13-16	24	12	66.7	33.3
17-19	32	12	72.7	27.3
20-21	7	4	63.6	36.4
22-23	1	0	100.0	0.0
1-16	114	30	79.2	20.8
17-23	40	16	71.4	28.6

Table 4.4. Sources of land cover type differences by land class groups (LCG). SA = same boundary type recorded by both QA and NICS; IN = difference due to interpretation of criteria; SE = difference due to seasonal change; ER = categorical error; OT = other reasons for differences.

LCG	SA	IN	SE	ER	OT
1	34.5	7	1	1	1.5
2	8		1		
3	24.5	1			1.5
4	23	4			
5	24	4	1	6	1
6	32	9		2	1
7	7	1	1	1	1
8	1				
Lowland	114	16	3	7	4
Upland	40	10	1	3	2

There was thus little difference between boundaries in different land class groups, and between upland and lowland.

4.3. Change Matrix.

As with land cover types (section 3.4), there was a change matrix for boundaries which had changed between baseline and resurvey. Of the 25 points where both QA and NICS had identified a change process, 14 of the change processes were identical, a correspondence of 56.0%. Of the 11 processes that differed, five were cases where NICS had identified an error and QA had given a change process (Table 4.5). Thus,

NICS was more conservative than QA, and is more likely to record a change as an error at baseline than as a categorical change.

Table 4.5. Boundary change matrix processes.

	NICS												
QA	E	EOW	FEN	BWC	BRF	BRB	CHS	LHE	WAL	IBE	BRW	SGT	Total
E	**7**					1					1		9
EOW		**1**											1
FEN			**3**					1					4
BWC				**1**									1
BRF					**1**								1
BRB					1								1
CHS	1												1
LHE	2												2
WAL	1								**1**				2
IBE			2										2
BRW													0
SGT	1												1
Total	12	1	5	1	2	1	0	1	1	0	1	0	25

5. References.

Barr, C. J., Bunce, R. G. H., Clarke, R. T., Fuller, R. M., Furse, M. T., Gillespie, M. K., Groom, G. B., Hallam, C. J., Hornung, M., Howard, D. C., Ness, M. J. (1993). Countryside Survey 1990 Main Report. Department of the Environment, London.

Cherrill, A., McClean, C. (1995). An investigation of uncertainty in field habitat mapping and the implications for detecting land cover change. *Landscape Ecology*, **10**, 5-21.

Cooper, A., McCann, T. (1997). Northern Ireland Countryside Survey 2000 field handbook. University of Ulster, Coleraine.

Murray, R., McCann, T., Cooper, A. (1992). A land classification and landscape ecological study of Northern Ireland. University of Ulster, Coleraine.

Appendix 1. Case studies.

1. MOUR 36.

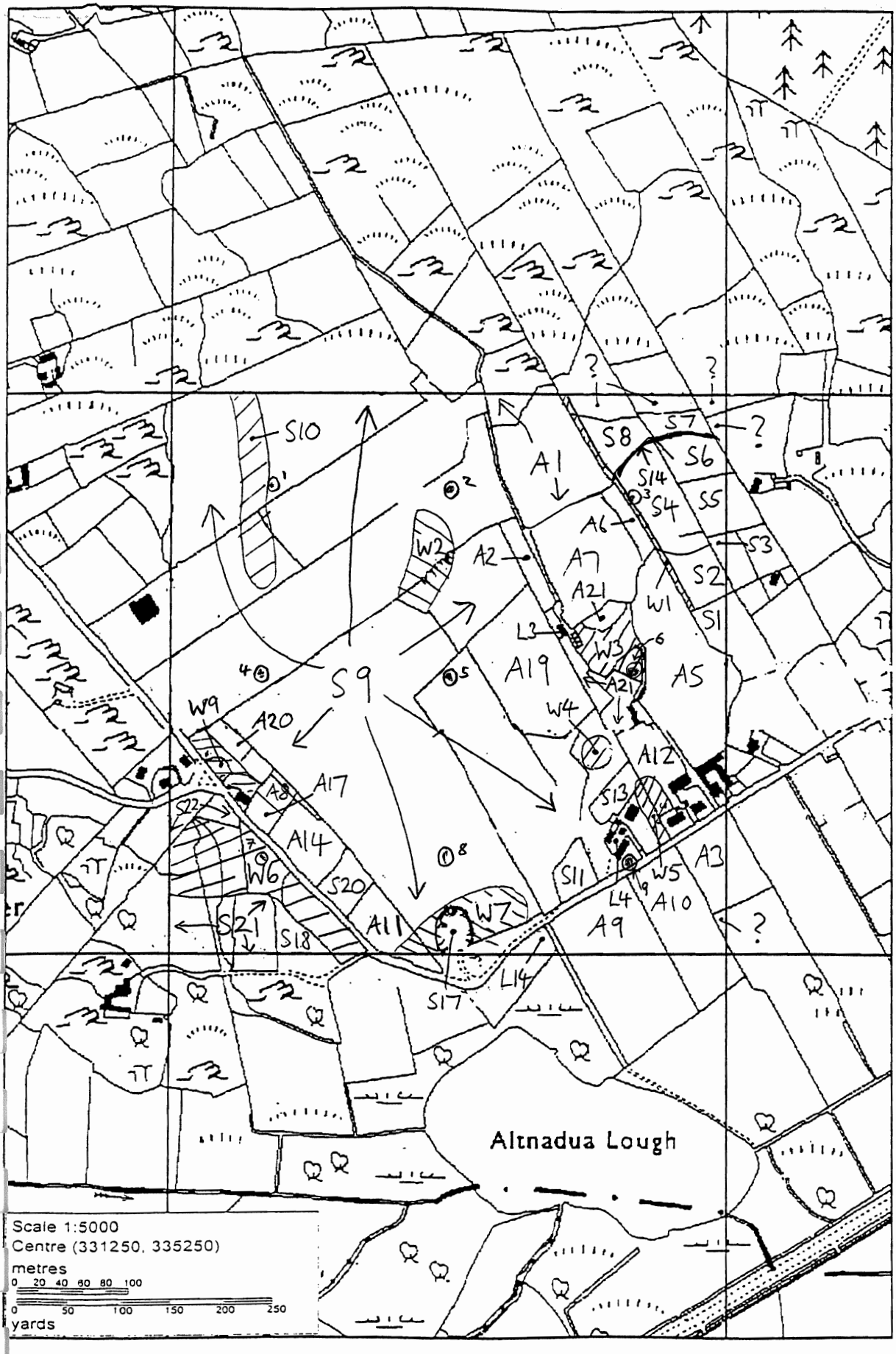
MOUR 36 is located in the northern part of the Mournes AONB. It is an upland square (land class group 6) that was recorded at baseline as a large parcel of gorse heath/bracken mosaic (land cover type S58), surrounded by assorted woodland and agricultural parcels. There are few boundaries in the large parcel (parcel S9), within which, six of the nine points are located.

1.1. Land cover.

Upon resurvey, the main change noted by QA was that the baseline survey of parcel S9 was an oversimplification of several distinct land cover types. This was also observed by NICS who re-mapped S9 into several other parcels. The results from resurvey of land cover and discussions between QA and NICS were as follows:

Point 1. This area contained grasses with *Ulex* and some *Erica cinerea*. There was thus a decision as to whether the heath cover was great enough for it to be surveyed as a dry heath mosaic or a seminatural grassland. QA determined that there was enough heath cover for a dry heath mosaic (type S12), while NICS did not, recording it as bent/fescue hill pasture (type S3). Upon discussion, it was clear that this difference was due to interpretation of criteria (heath cover).
Point 2. This lay within an area of continuous bracken, and there was agreement between QA and NICS that this are was in a parcel of type S32 (continuous bracken).
Point 3. This small field parcel was recorded as scattered bracken (type S33) at baseline. QA noted on resurvey that the parcel did contain a small amount of bracken, as well as grass and rush species, but did not consider the bracken cover to be high enough to resurvey as scattered bracken. Accordingly the grass and rush species were assessed and the parcel was resurveyed as an agricultural type (type A11). NICS, also determined that the parcel type had changed, but had determined that a number of *Prunus spinosa* plants colonising the parcel from the boundaries was sufficient for the parcel to be defined as scattered scrub (type W8). Upon discussion, it was agreed that this parcel was a borderline case, and difference was due to interpretation of criteria.
Point 4. This lay in an area of *Ulex* and *Erica cinerea* with scattered grass species. QA determined that the grass cover was great enough for this area to be surveyed as a dry heath mosaic, while NICS did not consider grass cover great enough and recorded the area as continuous gorse heath (type S7). This was clearly a difference due to interpretation of criteria.
Point 5. Both QA and NICS resurveyed this as part of a continuous bracken parcel.
Point 6. This point was in a small parcel of woodland recorded at baseline as broadleaf seminatural woodland. Both QA and NICS, upon resurvey, determined that the parcel was erroneously recorded at baseline and should in fact be scattered scrub.
Point 7. This parcel was recorded as dense scrub at baseline. Upon resurvey, QA determined that the parcel was unchanged, while NICS changed the type to broadleaf seminatural woodland. Upon discussion, both QA and NICS recalled that the parcel was dominated by hazel. As hazel should be recorded as broadleaf seminatural and not as scrub, this difference was a categorical error by QA.

MOUR - 36



Point 8. This was an area of continuous bracken with some *Ulex* in it. QA determined that there was sufficient gorse for the area to be recorded as gorse heath/bracken mosaic, but NICS did not agree and resurveyed the area as continuous bracken. This was another case of interpretation of criteria (*Ulex* cover).
Point 9. This had been reclaimed from the S9 parcel into the L4 parcel. QA recorded this as agricultural (type L3), while NICS recorded it as domestic (type L4). This area was not domestic, being a series of barns and workshops, and so the difference was a categorical error by NICS.

1.2. Boundaries.

The boundaries in this square reflected the general trend of land abandonment that had clearly occurred from the abundance of derelict buildings in the region. The boundaries were largely dry stone walls in various states of disrepair.

Boundary 1. A long fence at baseline, NICS resurveyed this as an earth bank, putting down the lack of earth bank at baseline as an error. QA disagreed and recorded the boundary as a fence, but only on the basis that the earth bank was less than the minimum criteria length of 50% of the boundary. The difference between QA and NICS was therefore due to interpretation of a criterion (bank length).
Boundary 2. This was a ruined dry stone wall, with a sheep fence making it stock-proof. Both QA and NICS recorded it as a ruined dry stone wall, both also determining that its survey as a fence at baseline was an error.
Boundary 3. Alongside the parcel S4, the interpretation of this boundary was influenced by the different resurvey results for parcel S4. NICS recorded the boundary as a dry stone wall, as it was at baseline. However, QA noted the invasion of *Prunus spinosa* along the boundary and accordingly recorded it as a hedge. As NICS had recorded the parcel as scattered scrub, it was decided that the *Prunus spinosa* on the boundary was part of the parcel and the boundary was not, therefore, a hedge. This difference was therefore due to criteria interpretation.
Boundary 4. A long ruined dry stone wall at baseline, this was left unchanged by NICS. QA, on the other hand, decided that less than 50% of the required length of the boundary remained as dry stone wall and recorded it as a sheep fence, with which it had been made stock-proof. This was therefore a case of interpretation of criteria (ruined dry stone wall length).
Boundary 5. A dry stone wall at baseline, this was unchanged upon survey by NICS, while QA decided that the dereliction was great enough for it to have become a ruined dry stone wall. A straightforward case of criteria interpretation (state of disrepair of dry stone wall).
Boundary 6. NICS recorded a boundary within parcel W3, an error since boundaries within woodland parcels are not to be surveyed.
Boundary 7. A long hedge between a road and parcel W6, this was recorded as a hedge by both QA and NICS.
Boundary 8. Similar to boundary 5, this was recorded as a dry stone wall by NICS and as a ruined dry stone wall by QA. This was due to interpretation of criteria (state of disrepair of dry stone wall).
Boundary 9. This small portion of dry stone wall was now between two landscape types (a road and a building, the extension of parcel L4) and was thus recorded as

BWC by QA. NICS did not record this change, and so the difference between QA and NICS was due to a categorical error.

2. WIDR 31.

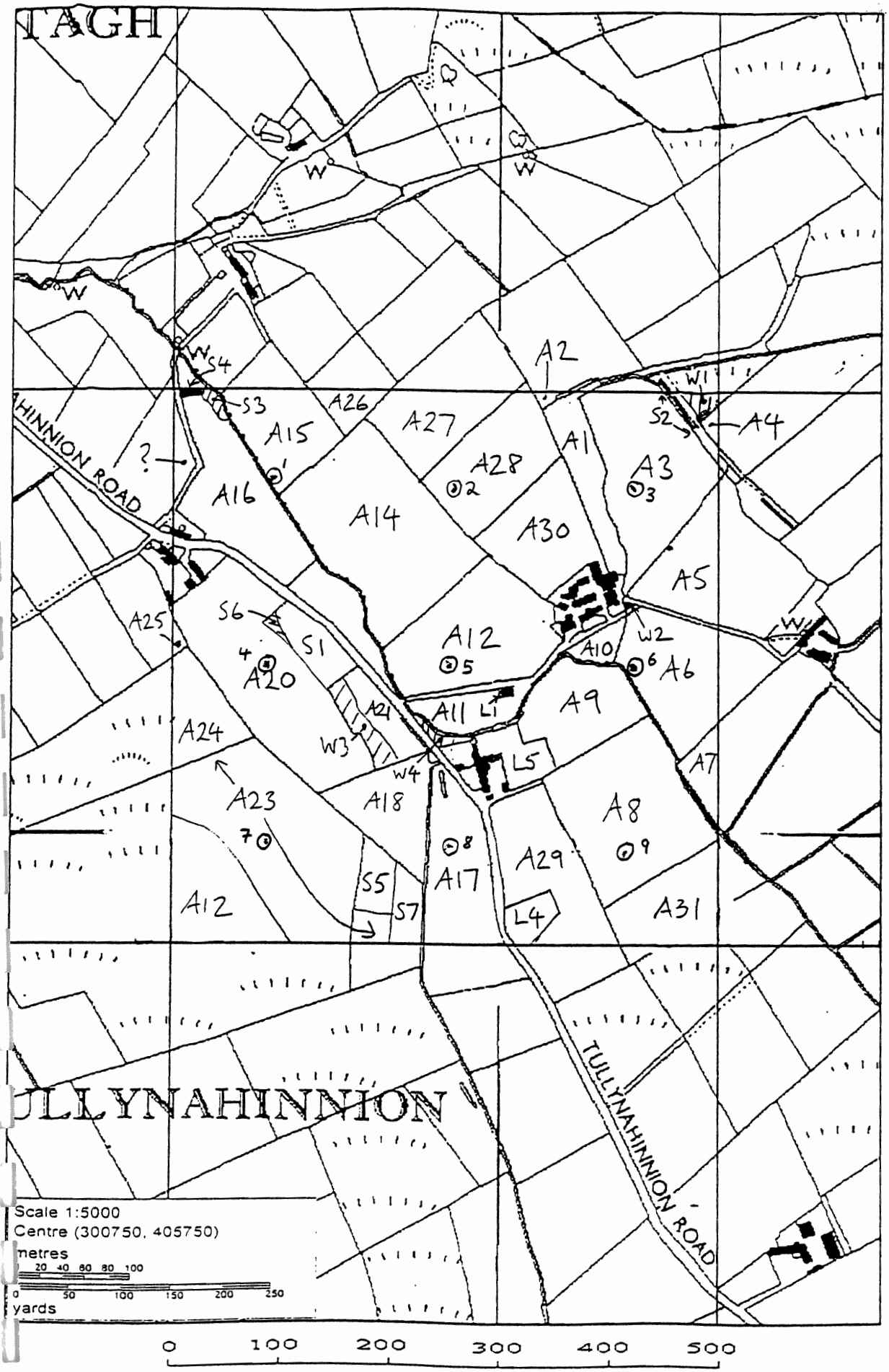
WIDR 31 is a typical lowland square, located in County Antrim at an altitude of 150 m on the edge of some low hills next to the Bann Valley. At baseline, the square consisted mostly of agricultural parcels bordered by hedges.

2.1. Land cover.

Point 1. This was a perennial ryegrass (type A8) field at baseline and both QA and NICS did not change it on resurvey.
Point 2. A perennial ryegrass field at baseline, resurvey by both QA and NICS did not change the land cover type.
Point 3. This point was recorded by NICS as a ploughed parcel (type A10), while QA recorded it as a barley field (type A2). As the NICS survey for this square was in May, and the QA survey was in September, this was clearly a case of change through the season, the NICS having surveyed the parcel before, and the QA after, planting with barley had occurred.
Point 4. This parcel was a potato crop (type A4) at baseline. Upon resurvey, both QA and NICS recorded it as perennial ryegrass, with a change matrix process of CP (crop planting).
Point 5. NICS recorded this parcel as Italian ryegrass (type A7), while QA recorded it as perennial ryegrass (type A8). Upon discussion both QA and NICS recalled that the ryegrass was an apparently intermediate form between *Lolium perenne* and *Lolium multiflorum*. The difference was thus due to identification difficulties presented by a high-yielding variety of *Lolium perenne*, which superficially resembled *Lolium multiflorum*.
Point 6. Recorded as an 'other' agricultural grassland (type A11) parcel by QA and as a perennial ryegrass parcel by NICS, the difference was acknowledged as an error by NICS where young *Elymus repens* had been misidentified as *Lolium perenne*.
Point 7. This parcel was recorded as 'other' agricultural grassland at baseline, but upon resurvey, both QA and NICS noted that it had changed to a species rich wet grassland (type S2) and recorded it accordingly. However, while NICS attributed this change from baseline as an error, QA recorded it as due to reduction in grazing in the parcel.
Point 8. Dangerous cattle prevented QA from entering this parcel and so the subsequent difference in type recorded by QA and NICS was likely to be due to an error in recording type by QA.
Point 9. Much the same as point 3, a seasonal change was due to NICS recording this field as ploughed, while QA recorded it as a barley crop.

2.2. Boundaries.

Most boundaries were hedges, and the correspondence between QA and NICS for the boundaries in this square was high.



Boundary 1. A hedge at baseline, both QA and NICS resurveyed this boundary as a hedge.
Boundary 2. Also a hedge at baseline, the type was unchanged by either QA or NICS at resurvey.
Boundary 3. Again, a hedge at baseline unchanged at resurvey.
Boundary 4. This was recorded as an earth bank at baseline; but upon resurvey, both QA and NICS noted that there was no earth bank, just a sharp change in topography between parcel A20 and parcels S6 and S1. Both QA and NICS recorded this as an error by baseline both on the boundary data sheet and the boundary change matrix.
Boundary 5. A hedge at baseline, both QA and NICS resurveyed this boundary as a hedge.
Boundary 6. This boundary was a fence on a degraded earth bank alongside a river. While recorded as an earth bank at baseline and by QA, NICS decided that the length of the earth bank was less than 50% of the length of the total boundary and accordingly recorded the boundary as a fence. The difference was thus due to interpretation of criteria (earth bank length).
Boundary 7. Recorded as a hedge by baseline, QA and NICS.
Boundary 8. This was a new fence across the middle of parcel A17. Both QA and NICS recorded it as a sheep fence, but only QA noted the change in the boundary change matrix.
Boundary 9. Another hedge, unchanged between baseline and resurvey by either QA or NICS.

Appendix 2. Land cover and boundary attributes.

This appendix contains matrices of attributes recorded by QA and NICS within broad land cover types (woodland, seminatural, agricultural, landscape) and broad boundary types (hedges, walls, fences, earth banks). They are referred to in the text in sections 3.2 and 4.1. The attribute codes are described in Cooper and McCann (1997).

1. Woodland land cover types.

Table 1.1. Woodland structure.

		NICS 24	25	26	27	Total
	24					0
QA	25	1	**4**			5
	26				2	2
	27			2	**15**	17
	Total	1	4	2	17	24

Table 1.2. Ground flora.

		NICS 28	29	30	Total
QA	28	**3**			3
	29	1	**12**		13
	30	2		**6**	8
	Total	6	12	6	24

Table 1.3. Soil type.

		NICS 32	33	34	35	36	Total
QA	32						0
	33		**1**		8		9
	34				1		1
	35				**10**		10
	36				4		4
	Total	0	1	0	23	0	24

Table 1.4. Management.

		NICS 39	42	40	51	45	37	Total
QA	39						3	3
	42							0
	40							0
	51							0
	45					**1**		1
	37		1		1	3	**15**	20
	Total	0	1	0	1	4	18	24

Table 1.5. Grazing.

		NICS 44	52	Total
QA	44		1	1
	52	2	**21**	23
	Total	2	22	24

Table 1.6. Enclosure.

		NICS 41	53	Total
QA	41		1	1
	53	9	**14**	23
	Total	9	15	24

2. Seminatural land cover types.

Table 2.1. Soil type.

		NICS 81	82	83	84	85	Total
QA	81	**3**					3
	82	1	**20**		2		23
	83						0
	84		1	1	**1**		3
	85						0
	Total	4	21	1	3	0	29

Table 2.2. Structure.

	42	*80*	*71*	*41*	*62*	*60*	*38*	*79*	*70*	*75*	*76*
QA and NICS		**2**	**5**				**3**			**5**	
NICS only	2	1					3		1	2	
QA only	1	3	9							4	2

Table 2.3. Management.

	43	*44*	*47*	*48*	*53*	*50*	*51*	*72*	*54*	*55*	*80*
QA and NICS		**1**		**23**							
NICS only		3					4				1
QA only				5			1		2	2	

3. Agricultural land cover types.

Table 3.1. Soil type.

		NICS 51	52	53	54	55	Missing	Total
QA	51							0
	52	1	**3**		3			7
	53							0
	54			1	**87**		1	89
	55							0
	Missing							0
	Total	1	3	1	90	0	1	96

Table 3.2. Management.

	23	*17*	*18*	*41*	*24*	*20*	*43*	*21*	*22*	*44*	*31*	*None*
QA and NICS		**3**	**58**			**2**	**5**	**6**				**13**
NICS only	2	16	1	1		7		5	3			3
QA only	2	1	20			4	6	22				

4. Hedge boundaries.

Table 4.1. Hedge lateral structure.

		NICS 15	13	14	16	17	Total
QA	15	**19**	5	1			25
	13	8	**12**	8	2		30
	14	2	8	**8**	2		20
	16		2	2		1	5
	17			1	3	**3**	7
	Total	29	27	20	7	4	87

Table 4.2. Hedge additional fencing.

		NICS 18	35	19	None	12	Total
QA	18	**23**	2	3	6		34
	35		**18**		4		22
	19						0
	None	9			**21**		30
	12			1			1
	Total	32	20	4	31	0	87

Table 4.3. Hedge ground layer.

		NICS 20	37	38	None	Total
QA	20	**3**		2	6	11
	37					0
	38	1			1	2
	None	6			**68**	74
	Total	10	0	2	75	87

Table 4.4. Hedge ditches.

		NICS 21	22	None	Total
QA	21	**3**	3		6
	22	4	**14**	5	23
	None	2	5	**51**	58
	Total	9	22	56	87

Table 4.5. Hedge vertical structure.

		NICS 29	30	28	31	32	33	None	Total
QA	29			1					1
	30	1							1
	28			**19**		1		1	21
	31			2	**1**	1			4
	32			6	3	**31**	4	1	45
	33				1	7	**7**		15
	None								0
	Total	1	0	28	5	40	11	2	87

Table 4.6. Hedge bank height.

		NICS 40	41	42	Total
QA	40	**37**	21	1	59
	41	10	**15**	2	27
	42		1		1
	Total	47	37	3	87

Table 4.7. Hedge base.

		NICS 45	46	47	48	Total
QA	45	**3**		2		5
	46			2		2
	47	11	4	**51**	7	73
	48			6	**1**	7
	Total	14	4	61	8	87

Table 4.8. Hedge tree Density.

		NICS None	50	51	52	53	Total
QA	None	**24**	2	3	1		30
	50	3	**17**	3			23
	51	2	5	**9**	2		18
	52	1	1	8	**2**	2	14
	53		1	1			2
	Total	30	26	24	5	2	87

5. Wall boundaries.

Table 5.1. Wall lateral structure.

		NICS 15	13	14	16	Total
QA	15	**3**	1			4
	13					0
	14					0
	16				**1**	1
	Total	3	1	0	1	5

Table 5.2. Wall additional fencing.

		NICS 18	35	None	Total
QA	18	**1**			1
	35		**1**		1
	None		1	**2**	3
	Total	1	2	2	5

Table 5.3. Wall tree density.

		NICS None	50	51	Total
QA	None	**1**			1
	50	3			3
	51	1			1
	Total	5	0	0	5

6. Fence boundaries.

Table 6.1. Fence ground layer.

		NICS None	20	Total
QA	None	**28.5**		28.5
	20	3		3
	Total	31.5	0	31.5

Table 6.2. Fence ditches.

		NICS 21	22	None	Total
QA	21	**1**			1
	22			2	2
	None	2		**26.5**	28.5
	Total	3	0	28.5	31.5

Table 6.3. Fence tree density.

		NICS None	50	51	52	53	Total
QA	None	**21.5**		1			22.5
	50	1	**1**				2
	51	2					2
	52	1					1
	53	4					4
	Total	29.5	1	1	0	0	31.5

7. Earth banks.

Table 7.1. Earth bank lateral structure.

		NICS 15	13	14	16	Total
QA	15	**7.5**	5	1		13.5
	13	1	**1**	2	1	5
	14			**3**		3
	16		1		**1**	2
	Total	8.5	7	6	2	23.5

Table 7.2. Earth bank additional fencing.

		NICS None	18	35	Total
QA	None	**11**	1		12
	18		**2.5**	2	4.5
	35	2	2	**3**	7
	Total	13	5.5	5	23.5

Table 7.3. Earth bank ground layer.

		NICS None	20	38	Total
QA	None	**14.5**	1	2	17.5
	20			3	3
	38	3			3
	Total	17.5	1	5	23.5

Table 7.4. Earth bank ditches.

		NICS 21	22	None	Total
QA	21	**2**		1	3
	22	3	**3**	1	7
	None	0.5	1	**12**	13.5
	Total	5.5	4	14	23.5

Table 7.5. Earth bank height.

		NICS 40	41	42	None	Total
QA	40	**4**	7		1	12
	41	1	**5.5**	1		7.5
	42		2	**2**		4
	None					0
	Total	5	14.5	3	1	23.5

Table 7.6. Earth bank tree density.

		NICS None	50	51	52	53	Total
QA	None	**6.5**	2				8.5
	50	3	**3**	1			7
	51		5	**1**			6
	52				**1**		1
	53					**1**	1
	Total	9.5	10	2	1	1	23.5

Appendix 3. Percentage of land cover and boundary types recorded in different surveys.

Table 1. Percentage of different land cover types recorded by QA, NICS, from baseline, and the actual percentage figures for the whole baseline survey (Northern Ireland).

Type	QA Points	Percent	NICS Points	Percent	Baseline Points	Percent	Northern Ireland
W1	6	2.7	7	3.1	7	3.1	1.8
W2	2	0.9	2	0.9	1	0.4	0.2
W4	9	4.0	9	4.0	10	4.4	4.0
W6	6	2.7	7	3.1	6	2.7	0.4
W7, W8	3	1.3	2	0.9	1	0.4	0.8
W total	**26**	**11.6**	**27**	**12.0**	**25**	**11.1**	**7.3**
S1	1	0.4	0	0	1	0.4	0.6
S2	4	1.8	1	0.4	1	0.4	2.0
S3	4	1.8	3	1.3	2	0.9	0.9
S4	7.5	3.3	5	2.2	6	2.7	1.1
S5, S15, S57	10.5	4.7	11.2	5.0	11.5	5.1	3.3
S7, S8	2	0.9	3	1.3	1	0.4	0.6
S9	2	0.9	0	0	0	0	0.2
S10	1	0.4	4	1.8	1	0.4	1.8
S12	3	1.3	0	0	0	0	0.6
S13	3	1.3	4	1.8	3	1.3	2.3
S14	4	1.8	3	1.3	11	4.9	4.7
S16	6	2.7	10	4.4	8.1	3.6	2.1
S17	2	0.9	0	0	0	0	0.6
S32	2	0.9	3	1.3	0	0	0.3
S33	0	0	0	0	1	0.4	0
S34	1	0.4	0	0	0	0	0.7
S58	1	0.4	0	0	6	2.7	0.1
S total	**54**	**24.1**	**47.2**	**21.0**	**52.6**	**23.4**	**22.0**
A1, A2	10	4.5	8	3.6	9	4.0	3.7
A4, A5, A12	6	2.7	5	2.2	5	2.2	1.0
A7	3	1.3	4	1.8	0	0	1.8
A8	72	32.1	67	29.8	59	26.2	29.5
A9	2	0.9	2	0.9	4.4	2.0	3.3
A10	1	0.4	4	1.8	0	0	0.9
A11	34	15.2	43.8	19.5	55	24.4	23.2
A total	**128**	**57.1**	**133.8**	**59.5**	**132.4**	**58.8**	**63.4**
L1, L2, L3, L4	6	2.7	6	2.7	1	0.4	1.2
L10	6	2.7	6	2.7	-	-	-
L18	1	0.4	1	0.4	1	0.4	-
L20	3	1.3	3	1.3	-	-	-

Appendix 4. Broad Habitat and NICS types.

1. Correspondence of Broad Habitat Types with NICS land cover types.

The following table gives the complete list of correspondence given in the order of the NICS handbook (Cooper and McCann, 1997) of Northern Ireland habitat types with UK Broad Habitat (BAP) categories from the NICS Steering Group report.

5.1 Woodland

BAP1	NI W01	Broadleaf semi-natural
BAP1	NI W02	Broadleaf plantation
BAP 1	NI W48	Fen carr
BAP 2	NI W03	Coniferous semi-natural
BAP2	NI W04	Coniferous plantation
BAP1	NI W05	Mixed semi-natural
BAP1	NI W06	Mixed plantation
BAP1	NI W09	Parkland
BAP1	NI W07	Dense scrub
BAP1	NI W08	Scattered scrub

5.2 Semi-natural Vegetation

BAP6	NI S01	Species-rich dry grassland
BAP11	NI S02	Species-rich wet grassland
BAP8	NI S03	Bent/fescure hill pasture
BAP8	NI S04	Mat-grass hill pasture
BAP12	NI S05	Molinia grassland
BAP7	NI S06	Calcareous grassland
BAP1	NI S07	Gorse heath-continuous
BAP1	NI S08	Gorse heath-scattered
BAP10	NI S09	Ericaceous (dry) heath
BAP12	NI S10	Wet heath
BAP08 (50%)		
BAP10 (50%)	NI S12	Dry heath mosaic
BAP12	NI S13	Wet heath mosaic
BAP10	NI S57	Mixed heath vegetation
BAP01 (50%)		
BAP09 (50%)	NI S58	Gorse heath/bracken mosaic
BAP12	NI S14	Wet bog
BAP12	NI S15	Dry bog
BAP11	NI S16	Poor-fen
BAP11	NI S65	Fen meadow
BAP11	NI S17	Reedbeds
BAP11	NI S18	Fen
BAP13	NI S19	Freshwater vegetation
BAP11	NI S66	Swamp
BAP11	NI S67	Ditch vegetation
BAP11	NI S68	Water inundation vegetation

BAP09	NI S32	Bracken-continuous
BAP08	NI S33	Bracken-scattered
BAP05	NI S34	Ruderal vegetation
BAP16	NI S29	Crevice/ledge vegetation
BAP19	NI S20	Intertidal
BAP19	NI S21	Saltmarsh
BAP19	NI S22	Shingle/gravel ridge
BAP19	NI S24	Foredune
BAP19	NI S25	Dune grassland
BAP01	NI S27	Dune scrub
BAP18	NI S28	Coastal cliff vegetation

5.3 Agriculture

BAP05	NI A07	Italian ryegrass
BAP05	NI A08	Perennial ryegrass
BAP05	NI A09	Mixed species grassland
BAP05	NI A11	Other agricultural grassland
BAP04	NI A12	Orchard
BAP04	NI A13	Soft fruit
BAP04	NI A14	Vegetables
BAP04	NI A01	Wheat
BAP04	NI A02	Barley
BAP04	NI A03	Oats
BAP04	NI A04	Potatoes
BAP04	NI A05	Brassicas
BAP04	NI A39	Root crops
BAP04	NI A10	Ploughed/fallow
BAP13	NI A20	Lough/lake
BAP13	NI A21	Reservoir
BAP14	NI A22	River/stream

5.4 Landscape

BAP17	NI L01	Urban
BAP17	NI L02	Industrial/commercial/public
BAP17	NI L03	Agricultural buildings
BAP17	NI L04	Domestic building
BAP05	NI L05	Amenity grassland
BAP03	NI L06	Verge/embankment
BAP03	NI L10	Road/track
BAP03	NI L11	Railway track
BAP16	NI L15	Land fill/dumping
BAP16	NI L16	Bare soil/peat/mud
BAP16	NI L17	Sand/gravel
BAP16	NI L18	Boulders/scree
BAP16	NI L19	Rock

2. NICS Boundary types.

NI B02 Hedge
NI B04 Dry stone wall
NI B06 Ruined dry stone wall
NI B10 Earth bank
NI B07 Mortar/brick/concrete wall
NI B09 Sheep wire fence
NI B11 Wood post and wire fence
NI B12 Other fence
NI D Ditch
NI BRF Boundary removed due to field enlargement
NI BRD Boundary removed due to dereliction
NI BRW Boundary removed due to afforestation
NI BRB Boundary removed due to building
NI BWC Boundary within curtilage
NI E Boundary removed due to baseline error