RIVER HABITATS IN ENGLAND AND WALES

A National Overview

March 1996

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Cover photograph: River Rawthey, near Sedburgh.

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River Habitat Survey Report No 1
March 1996

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The RHS technical group overseeing the project comprises Paul Raven (project manager), Peter Fox, Marc Naura, Mark Everard, Cath Beaver, Hugh Dawson (IFE), Nigel Holmes (AEC) and Malcolm Newson (Newcastle University). External advisors are Professor Ron Edwards (Environment Agency), Dr Phil Boon (Scottish Natural Heritage), Professor Mike Clark (Southampton University) and Professor John Jeffers.

1. PURPOSE

1.1 The purpose of this report is to provide a preliminary and illustrative overview of river habitat features resulting from the first two years of a national 3-year survey of rivers and streams in England and Wales. It provides, for the first time, a nationally representative picture of the state of river habitats.

1.2 It is aimed primarily at National Rivers Authority staff and external organisations which have taken part in the River Habitat Survey (RHS), development of which has generated the field and map-based data used in this report. However, the results will also be of use to all those with an interest in rivers generally.

1.3 Although the data input has been validated, the results should be treated as provisional and reference to them must be taken in this context. Indeed, *use of specific results in external papers should not be made without prior permission of the NRA, and, after 1 April 1996, the Environment Agency.*

2. SCOPE

2.1 The report is necessarily a synoptic national overview, briefly summarising an enormous amount of data. To put this into context, the dataset from more than 3000 sites surveyed in England and Wales during 1994 and 1995 extends to more than two million entries on the computer.

2.2 Although RHS has been carried out in both Scotland and Northern Ireland, **the results refer to England and Wales only.** It is anticipated that a UK-wide report will be produced in 1997 following completion of survey work of the UK site reference network.

3. STRUCTURE OF THE REPORT

3.1 There is a short introduction to RHS, explaining the need, principles and approach. However, the bulk of the report comprises maps, bar charts and pie charts illustrating selected river habitat features at 3000 RHS reference sites in England and Wales. These are presented with reference to two main criteria: (i) national distribution of selected features and (ii) distribution according to river segment type (see Table 3). For convenience, all the Figures are presented *en bloc*, following the text. A glossary of terms is also included.

3.2 A short section on the impact of certain management activities on the occurrence of selected features follows a preliminary assessment of the extent of artificial modification to sites nationally. This provides the basis for a preliminary link between two major influencing factors affecting riverine wildlife, namely water quality in the form of pollution and physical degradation of the habitat.

3.3 There is also a forward look to the development of a system for assessing habitat quality based on the occurrence of characteristic channel features and those bankside features of intrinsic value to wildlife.

4. STATUS OF THE RESULTS

4.1 The data are derived from RHS reference sites surveyed in 1994 and 1995 only. *All the results are preliminary.* The development of RHS is continuing and there will be refinements in the rules governing river types, habitat modification and habitat quality assessment. ***In particular, the results expressed in relation to river type are based on a prototype classification. This will inevitably change as further data are analysed.*** However, the geographical basis for surveying sites has proved to be an extremely robust basis for developing an inventory of features and modifications, so the results should be a reasonable description of the physical state of rivers and some of the pressures which modify them on a national basis.

5. BACKGROUND TO RIVER HABITAT SURVEY (RHS)

The need

5.1 River Habitat Survey (RHS) is a new system for assessing the habitat quality of rivers and streams based on their physical structure. It has been developed in response to the need for a nationally applicable classification of rivers based on their habitat quality. River management by the NRA and other equivalent bodies, in the form of regulation, operational works and advice to planning authorities, can then take full account of the need to protect highly valued sites, implement appropriate measures to enhance degraded reaches and identify relevant mitigation where development proceeds.

5.2 When fully developed and implemented, RHS will provide four distinct but related outputs: (i) a standard field survey method; (ii) a computerised database containing information from a national reference network of UK sites; (iii) a classification of river types based on a predictive model of physical structure; and (iv) a scheme for assessing habitat quality.

5.3 Established by the Water Act 1989, and consolidated by the Water Resources Act 1991, the NRA is a non-departmental public body with statutory powers and duties in respect of water pollution control, water resource management, flood defence, freshwater and migratory fisheries, and for certain rivers, navigation in England and Wales. The NRA has a statutory duty, *in so far as it is consistent with its other functions,* to further conservation. It also has a duty generally to promote so far as it considers desirable, the conservation of flora and fauna dependent on the water environment and also to promote recreation on waters.

5.4 The Authority operates through an integrated river basin management approach and its activities and priorities are set out in Catchment Management Plans. One of the current weaknesses in these plans is the lack of a standard descriptive assessment of physical structure to complement those developed for water quality and quantity. Without this

capability it is difficult to set targets for habitat quality, or measure the success or otherwise of river management techniques. The NRA currently reports on chemical water quality through published surveys every five years. Development of its General Quality Assessment scheme will allow reporting on other aspects of water quality, including invertebrate biology, nutrients and aesthetic quality (NRA, 1994). Physical structure is one of the primary determinands of ecosystem quality, so to complete the picture, a reporting mechanism of this aspect is clearly needed.

5.5 The Environment Act 1995 establishes from 1 April 1996 an Environment Agency for England and Wales, bringing together the functions of the NRA, Her Majesty's Inspectorate of Pollution and the Waste Regulatory Authorities. The collective responsibility for land, air and water quality, including reporting on the state of the environment, linked *inter alia* with government commitments on biodiversity and sustainability, reinforce the need for a sound method for assessing the quality of river habitats.

5.6 The draft European Framework Directive on the Ecological Quality of Water (COM(93)680 Final) requires a broad approach to assessing and reporting quality, taking account of *physical* as well as chemical conditions of inland waters, including the contribution made by the riparian zone. Furthermore, the Directive states that the national systems adopted by member states must be notified to the scientific community and that the details should be published. The European Habitats Directive (92/43/EEC) and the establishment of *Natura 2000* sites is another major influence, since member states are required to monitor the state of Special Areas of Conservation (SACs) with a view to maintaining, or where necessary, restoring favourable conservation status. The state of habitats within river SACs will have to be monitored as part of this process.

5.7 *The UK Biodiversity Action Plan* (DoE *et al.*, 1994), published as a result of the 1992 Earth Summit Conference in Rio de Janeiro, places significant emphasis on the need to evaluate, report and monitor biodiversity. The use of physical structure as a surrogate measure for biodiversity is likely to be an important aspect in reporting on the state of running freshwater habitats, a key component of the British landscape.

Approach

5.8 The aim from the outset was to develop a system to assist river management decisions. It would be based on the ability to predict, with statistical probability, those physical features which ought to occur at unmodified sites for the full range of river types in England and Wales. The scheme for assessing habitat quality would comprise a simple classification (e.g. excellent, good, fair, poor, bad) derived from the comparison between *observed* features in the site and those *expected* for that particular river type in an unmodified state.

Development of this system therefore had to fulfil the following basic requirements:

1. A robust, tried and tested field method.
2. An objective sampling strategy to establish a statistically valid national inventory.
3. Appropriate computer database facilities with the analytical capability to derive a statistically valid and recognisable river classification from the data.
4. Compatibility with existing methods such as river corridor surveys.
5. Practical and simple outputs, easily understood by river managers and amenable to reporting at catchment and national scales.
6. A tool providing significant input to the environmental appraisal process.
7. Acceptance by external organisations, notably the conservation agencies.
8. With the European Directives in mind, applicability in the UK and beyond.

Further details of the approach and rationale can be found in Raven *et al.* (1996).

Field survey

5.9 RHS is essentially an assessment of the physical structure of watercourses. Procedures for field survey have been established and refined by extensive trials and subsequent analysis of data. RHS does not require specialist geomorphological or botanical expertise, but consistent recognition of features included on the field survey form is essential. An illustrated manual has been produced (NRA, 1995), and accreditation of field surveyors will be ensured through attendance at approved RHS training courses.

Data collection

5.10 Data collection is based on a standard 500m length of river. The RHS form is four pages long and simple to complete (Appendix 1). It requires input of selected information obtained from maps and other readily available sources, plus field data. Background information for each 500m site includes grid reference, altitude, slope, solid and drift geology, mean annual flow and distance from source. Features recorded on site are associated with the channel, banks and riparian corridor to 50m either side of the river (Table 1). The method of recording ensures maximum information content and accuracy without excessive time penalty. Features that broadly characterise the site (e.g. valley form, and adjacent land use) set the scene. Bankfull and water width, together with bankfull height and water depth, are measured at one selected location because the width:depth ratio, taken in the context of other physical features, provides information about geomorphological processes acting on the site.

5.11 Attributes such as channel substrate type, presence of key habitat features, aquatic vegetation types, complexity of bank vegetation structure and type of artificial modification are recorded at each of 10 equidistant *spot checks* along the 500m. The format is simple, and coded two-letter abbreviations for attributes are entered into a matrix. These codes are included on a spot check key which acts as a prompt card for the surveyor. Each feature is also clearly illustrated in a photo gallery included in the RHS manual.

5.12 A *sweep-up* checklist within the 500m length ensures that the presence of features occurring between the spot checks is included (Table 1). The actual number of selected key geomorphological features (e.g. riffles, point bars) is recorded, as well as the type and extent of artificial modifications to the channel and banks.

5.13 Considerable effort has been made to minimise surveyors' variation in recording different features through training and clear guidance with accompanying photographs in the RHS manual. Although there are more than 100 different features in total, analysis of responses indicates that inter-surveyor variation is low.

Establishing a site reference network

5.14 One of the principal objectives during the development phase of the project was to establish a national reference network of sites chosen on a stratified random basis (*cf.* paragraph 5.16 and 5.17). These sites would therefore provide an objective database to establish (i) a national inventory of features and (ii) a statistically valid basis for a classification of river types. Thereafter, any 500m length of river in the country surveyed using RHS could be categorised on the basis of river type and the observed features compared with a national or regional 'norm'.

5.15 In common with other census-type surveys (e.g. breeding birds atlas, Gibbons *et al.* 1993), the Ordnance Survey 10 x 10 km grid square has been used as the basis for the site reference network. For convenience, all squares with >50% of land below high water mark have been omitted from the sample. On this basis, there are 1523 sample squares in England and Wales. To provide a truly national (i.e. UK) context, 779 squares in Scotland and 133 in Northern Ireland have also been included.

5.16 Rivers and streams from source to tidal limit indicated on 1:250,000 scale topographical maps represent the 'sample population'. Sample sites are selected on the basis of the random selection of a 2 x 2 km tetrad within the 10 km square. The main qualifying criterion for England and Wales is that the watercourse is classified for water quality as indicated by the published 1985 River Quality Map based on the National Water Council classification (National Water Council, 1981). Where no such classified watercourses exist within a 10 km square, unclassified watercourses qualify. In the few cases that no watercourses appear on the 1:250,000 scale map, unclassified watercourses shown on the 1:50,000 scale Ordnance Survey map qualify.

5.17 For England and Wales, three sites per 10 km square, one sampled in each of three years (1994 - 1996) will form the reference network. When complete, coverage by the reference network will comprise 4569 sites, representing 2284 km of watercourse or 6.6% of the total length classified for water quality purposes. Analysis of the 1994 tranche of reference sites using the Strahler (1957) method for stream order, indicates a similar distribution to that for streams and rivers across the UK calculated by Smith and Lyle (1979) (Table 2). This indicates that the RHS network is a good representative sample in terms of size, distribution and geographical range.

6. A CLASSIFICATION OF RIVER TYPES

6.1 A cornerstone of RHS is the derivation of a working classification of river types. This in turn forms the basis for the predictive model and the basis for assessing habitat quality (Figure 1). In essence, the primary aim is to identify those factors which shape and influence watercourses represented by the reference network sites. The RHS computer database provides the analytical capability, containing both map-derived and field data.

6.2 A key requirement is the ability to divide whole rivers into one or more types (segments) of similar physical character. Each watercourse can then be classified according to type, and the physical character of an unmodified channel predicted on the basis of map-derived information. This allows for cross-comparison of similar river types nationally, and an estimate of the extent and quality of the resource to be produced.

6.3 The first exercise was to isolate those sites surveyed in 1994 which appeared to be most natural, i.e. those with little or no obvious artificial modification affecting structure or flow. Only 10% of reference sites were completely free of modification to the channel or banks. Given the need for a bigger number of sites for analytical purposes, a *semi-natural* subset was selected, based on sites where *modification was recorded in no more than one spot check*. Using discriminant and cluster analysis of the data, together with photographs of sites, 478 semi-natural sites yielded 67 distinct variants. Each could be determined on the basis of mathematical rules regarding geology, altitude, slope and size.

6.4 In order to make the classification manageable on a national basis, the cluster analysis dendrogram was used to aggregate the 67 variants into 11 river segment types (Table 3). A detailed description of the analytical techniques involved will appear as a separate publication (Fox *et al.*, in preparation).

6.5 Rules for these 11 river segment types have been used to produce, for the first time, a working map of river categories in England and Wales based on the predicted physical character of unmodified channels (*cf.* Figure 5). The map will be refined as the original rules are modified. The

intention is to produce a classification of river types applicable to the UK as a whole, using the reference network sites in Scotland and Northern Ireland. It is important to note that the 11 segment types are preliminary categories for national reporting purposes.

7. RESULTS

Geographical scope

7.1 The extent of RHS reference sites surveyed in 1994 and 1995 is shown in Figure 2. By the end of 1996, full UK coverage of 10 km squares will have been completed, with 3 sites per square in England and Wales, 2 sites per square in Northern Ireland and 1 site per square in Scotland, representing more than 5600 sites in total.

Overall characteristics of rivers and streams

7.2 Figure 3 illustrates that the bulk of watercourses are small streams, with more than 50% less than 10m wide. Most are short and gently-sloping. The altitude range closely reflects the topography of England and Wales. The similarity between the 1994 and 1995 distributions reflect the robust sampling strategy for the reference sites.

Semi-natural sites

7.3 The influence of artificial modifications is considerable. The distribution of *semi-natural* reference sites in 1994 and 1995, using the definition in paragraph 6.3, is indicated in Figure 4.

River types

7.4 A preliminary map of the 11 river segment types in England and Wales is shown in Figure 5. The type of river is based on slope, geology, size and altitude and the map forms the basis for predicting which physical features should occur in the absence of any artificial modification.

7.5 The broad level of detail provided by Figure 5 does not provide an instant regional flavour of the distribution of river segment types. This is provided by Figures 6 and 7.

Valley shape

7.6 Valley shape is an important influence on stream power which in turn determines the physical character of rivers. The distribution of sites with four predominant valley forms is illustrated in Figures 8 - 11. *Vee-shaped* valleys are associated with headwaters, *concave/bowl* valleys with soft geology, *symmetrical floodplains* with gentle channel slope and *terraced* valleys with glacial deposits.

Channel features

7.7 Classification of river types has been derived from establishing a national inventory of habitat features. Indeed, the inventory aspect of RHS provides the most powerful tool for site appraisal. Moreover, distribution maps of features will not be altered by any future refinement of the river segment types.

7.8 For the purposes of this report, a number of channel features have been selected. These represent a range of flow types, features and substrates which are important both geomorphologically and ecologically.

7.9 *Waterfalls, bedrock cliffs, bedrock outcrops* and *exposed boulders* (Figures 12 - 15) are characteristic of upland torrents, notably river segment types 10 and 11. Bedrock outcrops are particularly important controlling factors for channel flow.

7.10 *Riffles* (Figures 16 and 17) are important controlling features of flow in more gently-sloping rivers. An important habitat for aquatic invertebrates, riffles have been traditionally surveyed by biologists for assessing water quality.

7.11 *Mid-channel bars* and *point bars* (Figures 18 - 21) are characteristic of relatively high energy streams. By contrast, mature islands (Figure 22) reflect active erosion, whether current or historic, depending on river segment type.

7.12 *Eroding cliffs* (Figure 23) indicate an actively meandering river, either in a natural state or reflecting an adjustment to locally steepened channel gradient caused by straightening associated with realignment. Eroding cliffs are often found on the outside of bends, opposite point bars (*cf.* Figure 20).

7.13 *Side bars* (Figures 24 & 25) characterise certain types of both upland and lowland rivers. Side bars in actively eroding upland streams comprise coarse material, whilst sluggish lowland rivers often have silty side bars vegetated with emergent reeds.

7.14 *Rapids* (Figure 26) are associated with steep gradient rivers and streams, and their occurrence closely reflects that of exposed boulders (cf. Figure 15). On the other hand, *glides* are smooth, gently-flowing features (Figure 27), which often dominate river segment type 1.

Channel vegetation

7.15 *Liverworts and mosses* are predominantly associated with upland torrents, so their distribution (Figure 28) reflects that of exposed boulders and bedrock (Figures 14 and 15).

7.16 By contrast, *emergent reeds* (e.g. *Sparganium erectum*) are characteristic of gentler, lower altitude rivers, often forming extensive fringes along such watercourses (Figure 29). Sites with channels choked with vegetation are illustrated in Figure 30. This is often the result of tree removal, allowing emergent reeds to dominate in warm, sunlit conditions.

7.17 *Floating-leaved vegetation* such as yellow water lily (*Nuphar lutea*) and free-floating vegetation such as duckweed (*Lemna* spp.) are often associated with large lowland rivers (Figures 31and 32). *Submerged vegetation*, such as pondweeds (*Potamogeton* spp.), on the other hand, is fairly ubiquitous, except in upland streams (Figure 33).

Trees and associated features

7.18 The distribution pattern of bankside trees is shown in Figure 34. Similar patterns are shown by left and right banks. The distribution of treeless reference sites is shown in Figure 35. These comprise either predominately moorland sites or heavily managed lowland sites. By contrast, the occurrence of heavily shaded sites is illustrated by Figure 36.

7.19 Sites with extensive bankside tree roots, which often make good otter holts, and extensive underwater tree roots, which provide good habitat for aquatic invertebrates such as damselfly nymphs and water beetles, are illustrated in Figures 37 and 38 respectively.

7.20 Coarse woody debris is an important habitat for invertebrates and also represents a major inhibiting influence on flow. The distribution of sites with extensive coarse woody debris, shown in Figure 39, highlights remnant storm damage in Kent and Sussex following the "hurricane" of October 1987.

Land use

7.21 Land use is an important influencing factor which affects rivers and streams. The national proportion of different land use types adjacent to the reference sites is indicated in Figure 40, whilst a more detailed analysis relative to river segment type is shown by Figure 41.

7.22 Semi-natural land use is often an indicator of good quality sites. In particular, the occurrence of extensive adjacent *broadleaf woodland* and *wetland* (Figures 42 and 43) provides a clue to the distribution of such sites.

Vegetation structure

7.23 Vegetation structure of both the bankface and banktop is an important indicator of the wildlife value. In unmodified sites there will be a preponderance of *complex* vegetation with plentiful shrubs and trees, although in grazed moorland sites, *simple* structure with a mixture of short woody shrubs, grasses, herbs and mosses is likely to be predominant. *Uniform* structure (i.e. predominantly one type, such as grasses or nettles) usually indicates a degraded habitat. Complex or simple banktop structure provides a good buffer strip or wildlife corridor through intensively managed floodplains. Figures 44 and 45 illustrate nationally the proportion of bare ground, and uniform, simple and complex vegetation structure.

Alien plant species

7.24 Introduced invasive weeds can cause problems. *Giant hogweed* poses a public health hazard since if touched its sap will cause a skin rash in the presence of sunlight. *Japanese knotweed* spreads by rhizomes and forms dense thickets. When the stems die back in winter the exposed river bank can be prone to erosion, causing flood defence problems. By contrast, *Himalayan balsam* spreads by seed, propelled from pods which explode like pop-guns. The distribution of these plants is shown in Figures 46 - 48.

Diseased alders

7.25 A recent phenomenon has been the spread of a fungal root disease affecting alders (Figure 49). Since these riverside trees are predominant over large areas of England and Wales, the extent of diseased trees is cause for concern in landscape and wildlife terms. There are serious flood defence implications as well, associated with the potential reduction in bank stability as roots die and rot.

Wildlife

7.26 Although RHS is a method to survey and assess physical features, some of the more obvious wildlife information is also collected. In 1995, more than 60 types of dragonfly, fish, amphibian, reptile, mammal and bird were recorded by RHS surveyors.

7.27 Given that the data are dependent upon observer expertise and experience, as well as chance and weather conditions, the distribution maps of wildlife sightings are tentative. However, the occurrence of *kingfisher, dipper, grey wagtail* and *otter spraints* reflect a not unexpected distribution (Figures 50 - 53).

8. ARTIFICIAL MODIFICATIONS

Types of Modification

8.1 The extent of artificial modification is illuminating. Only 10% of reference sites have no artificial modification to channel or bank. The proportion of sites with *culverts, weirs, bridges* and *outfalls* is shown in Figure 54.

8.2 The distribution of extensively *reinforced* sites (i.e. at least 33% of channel length reinforced) closely reflects urban areas or major rail and road routes which have to be provided with strong protection against possible bank erosion (Figure 55).

8.3 Flood defence is a key issue in many lowland areas. The distribution of both extensively *resectioned* channels and extensively *embanked* sites reflects modifications to river channels in order to protect industry, intensive agriculture and property from flooding (Figures 56 and 57).

8.4 Protection against bank erosion involves a range of materials. Figure 57 illustrates the proportion of spot checks reinforced with the "hard" range of materials such as *concrete, sheet piling* and *brick*.

Degree of modification

8.5 The extent of artificial modification over each 500m length of river can be expressed by a Habitat Modification "Score" derived from a simple set of rules.

8.6 For example, by assigning a score of 1 for each occurrence of resectioning, and 2 for reinforcement, and allowing for other types of modification (e.g. weirs) to be accounted for as well, a cumulative score broadly reflects the extent and severity of artificial modification to the channel bed and banks.

8.7 On this basis, pristine sites will score 0. The semi-natural sites used for deriving the river segment classification (Section 6.3) will score 0,1 or 2 on this scale, while the most heavily modified sites score 45 or more.

8.8 Figure 59 illustrates that, taken as a whole, the bulk of rivers and streams are modified but about a third of them only to a relatively small degree. This reflects the pattern of frequent but localised modifications such as bank reinforcement on bends, bridging points etc. About one in five of the 1995 reference sites was extensively modified (score >20), with a further 3% represented by the most extreme category (i.e. score ≥45) of alteration and constraint (Table 4).

Specific impacts

8.9 One of the major advantages of the RHS field survey is that channel and bank features and any modifications are recorded at ten equi-distant locations within each site. This means that for each site there are 10 channel and 20 bank data entry points which allow for analysis of the impacts of various modifications on natural features. The 1994 and 1995 dataset therefore contains more than 30,000 channel and 60,000 bank data sources available for analysis.

8.10 To make the data manageable for this report, it is necessary to be very selective. To this end, the impacts of resectioning, reinforcement and impoundment from selected river segment types will be used. For resectioning and reinforcement, river segment type 1 (low altitude, low gradient rivers on soft geology) and type 3 (low altitude, low gradient streams on soft geology) provide examples. For impoundment, both ends of the extreme, i.e. river segment types 1 and 11 (high altitude, very steep gradient streams on hard geology) are used.

8.11 *It should be noted that the following sections (8.12 - 8.19) provide only a flavour of the results. Statistical analysis has not yet been carried out, so the conclusions are preliminary and need further verification.*

Resectioning

8.12 Resectioning is the mechanical reprofiling of river banks and/or bed to produce a larger more uniform cross-section which can carry flood flows more efficiently. This often involves dredging and regular maintenance of a smooth straight cross-section, together with regular mowing and brush clearance.

8.13 Not surprisingly, there is a clear adverse impact on features such as the number of riffles, occurrence of point bars, eroding cliffs, and the type of bankface vegetation structure compared with semi-natural examples of the same river segment type (Figures 60 and 62).

8.14 Extensively resectioned sites also have a greater proportion of silt and less gravel/pebble substrate in the channel than semi-natural sites of the same segment type.

8.15 The implications for management are clear and highlight the need for best environmental practice, including for example, working from one bank. Further analysis of the RHS database should reveal, for each river segment type, which particular practices are of benefit to habitat features and vegetation structure, either through minimising loss, or identifying appropriate methods to enhance degraded sites.

Reinforcement

8.16 Reinforcement represents protection against erosion to the channel or bank and can take many forms. Indeed, the whole or just the bottom part of banks may be involved. Various materials can be used, depending on the level of protection needed. Concrete, sheet piling, brick /laid stone, rip-rap and rock-filled gabion baskets are used for heavy reinforcement (*cf.* Figure 58).

8.17 In similar fashion to resectioning, there is a clear adverse impact on bank features and bankface vegetation structure compared with semi-natural sites of the same river segment type. However, the effect regarding channel silt is less clear (Figures 61 and 62).

Impoundment

8.18 Weirs are common throughout England and Wales, with at least one occurring in 16.5% of the 1994 and 1995 reference sites. Their impact on habitat features is dependent on river segment type. In lowland rivers, there is a disproportionately large impact on riffles, pools and point bars. By contrast, weirs have very little apparent impact on riffles, pools and point bars in steep, upland streams (Figure 63).

8.19 The impact of weirs is dependent both on the height of the impounding structure and channel gradient. Many rivers managed for salmonid fisheries have small weirs installed to provide refuge areas for larger fish. Clearly, there is a need to ensure that river management involving construction of weirs for whatever purpose takes full account of the potential impact on channel features and the plant and animal communities dependent on them.

9. TOWARDS HABITAT QUALITY ASSESSMENT

Principles

9.1 The development of a system to classify overall habitat quality is still continuing. However, the basic principles are as follows:

- evaluation is based at the site (500m) level;
- habitat quality scores are generated by the presence and extent of features, *i.e.* an inventory approach, related to diversity;
- these scores are separated into two components, namely (i) *characteristic channel features* which can be predicted and (ii) vegetation structure and other features which contribute to *intrinsic value;*
- scores are weighted in favour of characteristic features;
- determination of the characteristic features is based on their occurrence in the least modified sites;
- overall assessment is based on class intervals using the whole reference site network, and calibrated on the basis of "top quality" examples.

9.2 The critical factor in this process is that the classification of river segment types is sufficiently robust to allow characteristic features to be identified with confidence (*cf.* paragraphs 6.1 - 6.5 and Figure 1).

9.3 Currently, there are insufficient examples of unmodified sites in the dataset to allow evaluation to be carried out at the segment sub-type level, but this should be largely rectified when the 1996 survey is completed and further semi-natural sites identified. Habitat quality will be included in the next version of this report which is scheduled to be produced in May 1997.

Linking habitat and water quality

9.4 One of the aims of RHS is to enable habitat quality at the site level to be compared with other attributes, notably water quality.

9.5 A preliminary attempt to do this on a national basis is represented by Table 5. This is, in effect, a matrix of the two primary pressures (habitat modification and pollution) acting on the 1995 reference sites.

9.6 For example, Table 5 indicates that 40.4% of reference sites have few modifications (score 0-8) and contain good quality (NWC class 1a or 1b) water. At the opposite extreme, 4.2% of sites are predominantly or heavily modified (score > 21) *and* have poor or bad quality (NWC class 3 or 4) water.

9.7 It will now be possible to base priority-setting with regard to (i) protecting the best sites and (ii) identifying the best focus (water quality or habitat) for improving degraded sites. The implications for policy and targeting resources at a national, regional and catchment level are significant, particularly in light of relevant habitat and species action plans in the UK Biodiversity Steering Group Report (DoE, 1995).

10. CONCLUSIONS

10.1 The sampling strategy for RHS provides a sound basis for establishing a national inventory of river habitat features.

10.2 The preliminary results, based on more than 3000 reference sites, provide for the first time, a national overview of river and stream habitats, including modifications to their physical structure.

10.3 The inventory approach of RHS provides a statistically valid basis for (i) a classification of river types, (ii) assessing the impact of modifications and (iii) a system for assessing habitat quality.

10.4 The capability for cross-reference between habitat quality and water quality will have major benefits for targeting pollution control and river management practices at national, regional and catchment level.

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TABLE 1

The main features recorded during an RHS survey.

Feature	Spot Checks	Sweep-Up
Channel dimensions *(at one predetermined point)*		
Predominant valley form		✓
Predominant channel substrate	✓	
Predominant bank material	✓	
Flow type	✓	✓
Channel and bank modifications	✓	✓
Bankface vegetation structure *(uniform/simple/complex)*	✓	
Channel vegetation types	✓	✓
Bank profile *(unmodified and modified)*	✓	✓
Bankside trees and associated features		✓
Channel habitat features	✓	✓
Artificial features	✓	✓
Features of special interest on the floodplain		✓
Notable nuisance plant species		✓
Land use	✓ *(banktop)*	✓

TABLE 2

Frequency distribution of stream order: a comparison between the UK distribution calculated by Smith & Lyle (1979) and the 1994 RHS reference sites.

Stream Order	Smith & Lyle (1979)	RHS (1994) *(n = 1521)*
1	75%	70%*
2	20%	17%
3	4%	10%
4	1%	3%

* represents "zero order" (not shown on 1:625,000 scale map), plus first order streams, based on the method of Strahler (1957).

TABLE 3

A working classification of river types in England and Wales, based on 1994 RHS data.

Segment Type	Descriptor	Predominant distribution in England and Wales
1	Low altitude, low-gradient rivers on soft geology	Central & S. England
2	Low altitude, low-gradient rivers on mixed geology	Cornwall, S.W. Wales, also scattered in Wales in N. England
3	Low altitude, low-gradient streams on soft geology	Midlands, Southern & S.E. England
4	Low altitude, steep-gradient streams on mixed geology	Devon & Cornwall, scattered elsewhere
5	Medium altitude, low-gradient rivers on soft geology	N. England and Devon; a few in Wales
6	Medium altitude, moderate-gradient rivers on mixed geology	N. England and Wales
7	Medium altitude, moderate-gradient streams on soft geology	Mid Wales & Midlands
8	Medium altitude, steep-gradient streams on mixed geology	N. England, S.W. Wales, Cornwall
9	High altitude, moderate-gradient rivers on mixed geology	Pennines, Wales, Devon
10	High altitude, steep-gradient streams on mixed geology	Pennines, Wales, Devon
11	High altitude, high-gradient streams on hard geology	Pennines, Wales, Devon

Mean altitude (m):	low = 38	medium = 103	high = 253	
Mean gradient (m /km):	low = 3.6	moderate = 9.7	steep = 25.0	high = 69.0

TABLE 4

The extent of modification to the 1995 reference sites.

Category	Habitat Modification Score	Number of sites	*(%)*
"Semi-natural"	0 - 2	572	*38*
Predominantly unmodified	3 - 8	309	*20*
Obviously modified	9 - 20	306	*20*
Extensively modified	21 - 44	290	*19*
Heavily and extensively modified	≥ 45	46	*3*

TABLE 5

The 1995 reference sites expressed in terms of habitat modification and 1990 water quality. *Figures represent percentage of total.*

1990 Water Quality	'semi-natural'	HABITAT MODIFICATION SCORE			heavily modified
NWC class	0 - 2	3 - 8	9 - 20	21 - 44	≥ 45
1a (good)	13.7	6.6	3.9	1.7	-
1b (good)	13.1	7.0	8.2	5.8	1.1
2 (fair)	6.1	3.6	4.5	5.7	1.1
3 (poor)	2.0	1.5	2.4	2.8	0.6
4 (bad)	0.3	0.3	0.1	0.5	-
Unclassified	*2.2*	*1.3*	*0.9*	*2.6*	*0.2*

1. River Test (Type 1)

2. River Rawthey (Type 2)

3. Eye Brook (Type 3)

4. Roxby Beck (Type 4)

5. River Ottery (Type 5)

6. River Wye (Type 6)

7. St. Catherine's Brook (Type 7)

8. Swarland Burn (Type 8)

9. River Irfon (Type 9)

10. River Glasffrwd (Type 10)

11. Tributary of Langdale Beck (Type 11)

FIGURE 1

An overview of how RHS works.

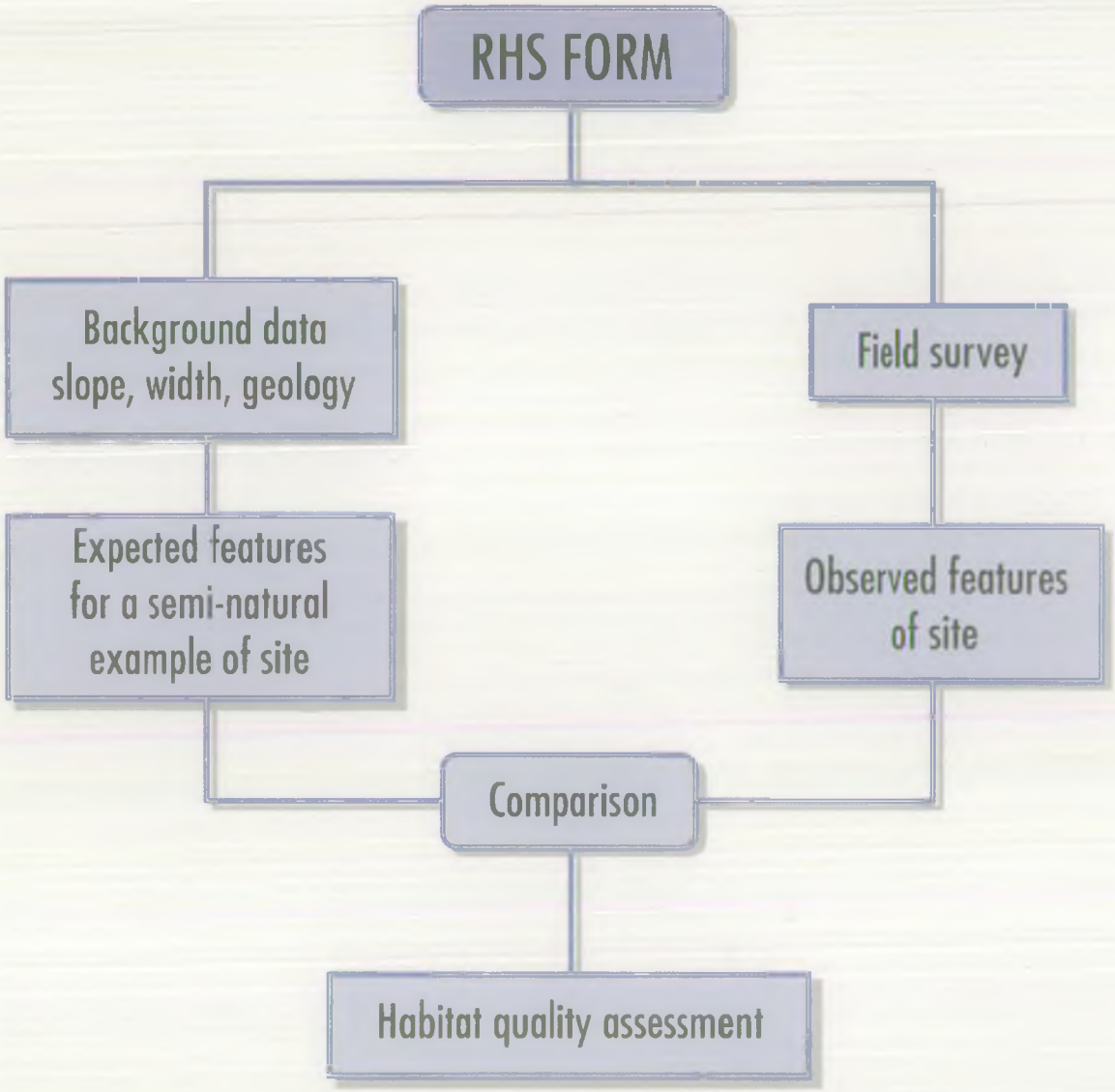


FIGURE 2

The geographical scope of RHS: 10km grid squares surveyed in 1994 and 1995.

FIGURE 3

Frequency distributions of altitude, slope, bankfull width and distance from source of RHS sites in 1994 and 1995.

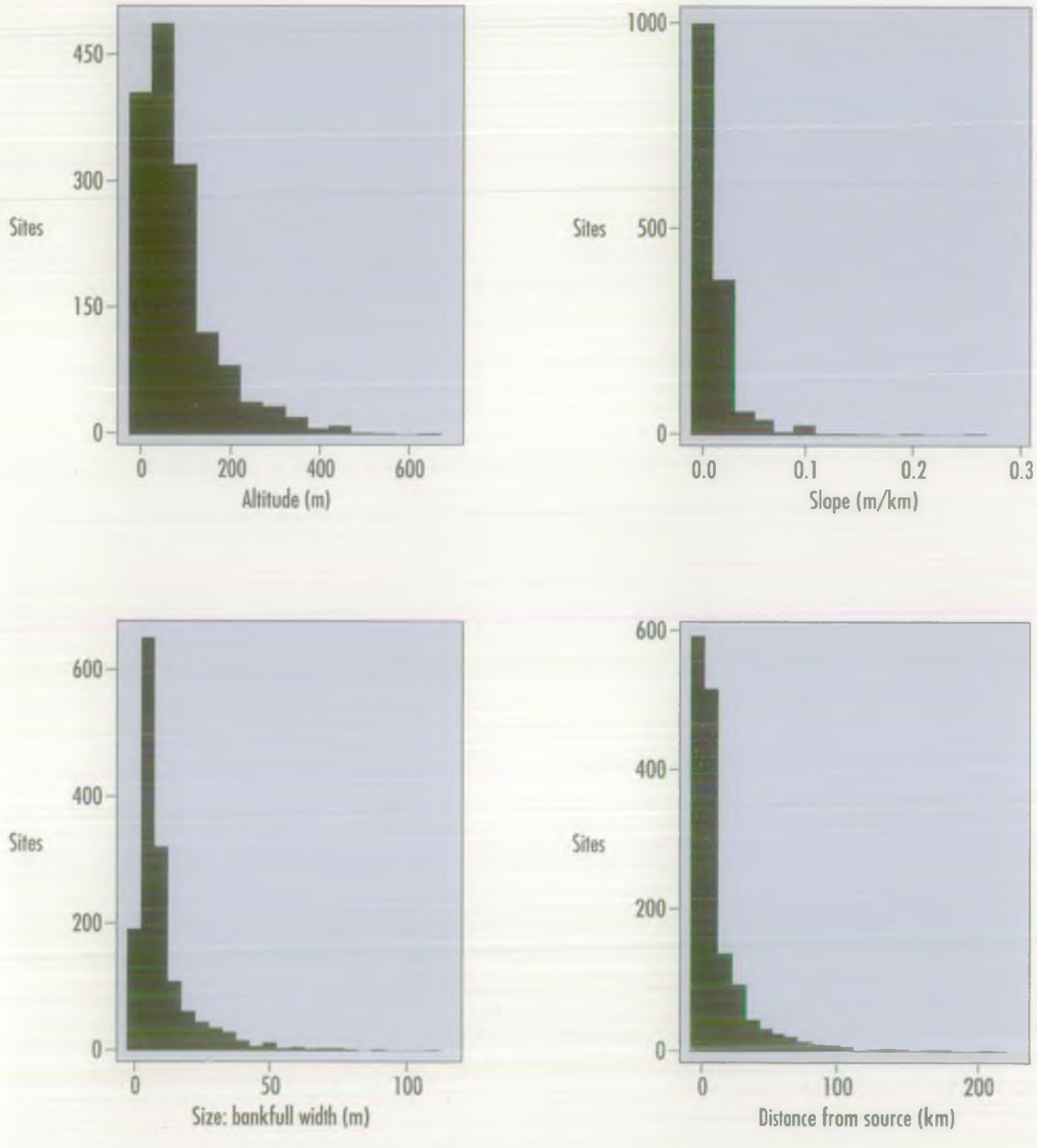


FIGURE 4

The distribution of 'semi-natural' RHS sites surveyed in 1994 and 1995.

FIGURE 5

A preliminary map of river segment types.

FIGURE 6

The proportion of river segment types in England and Wales.

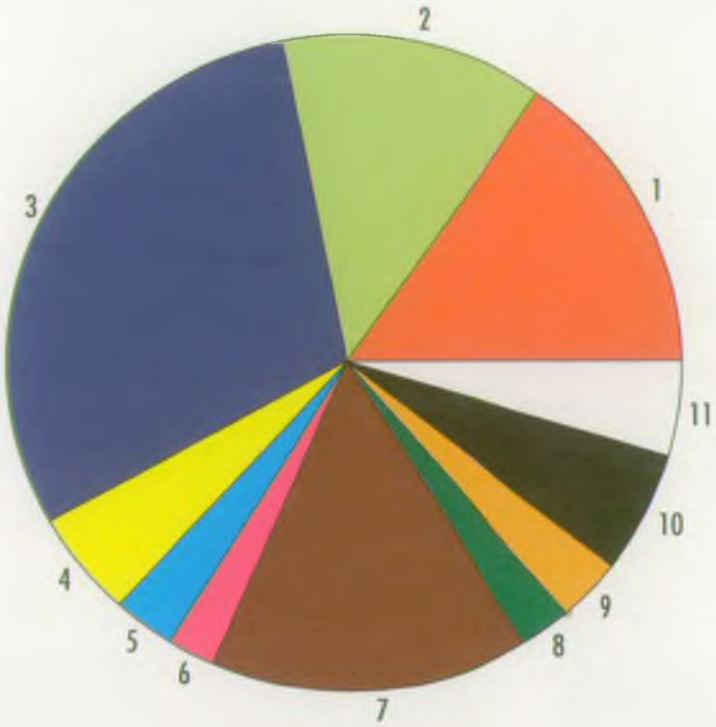


FIGURE 7

The distribution of river segment types by NRA Region.

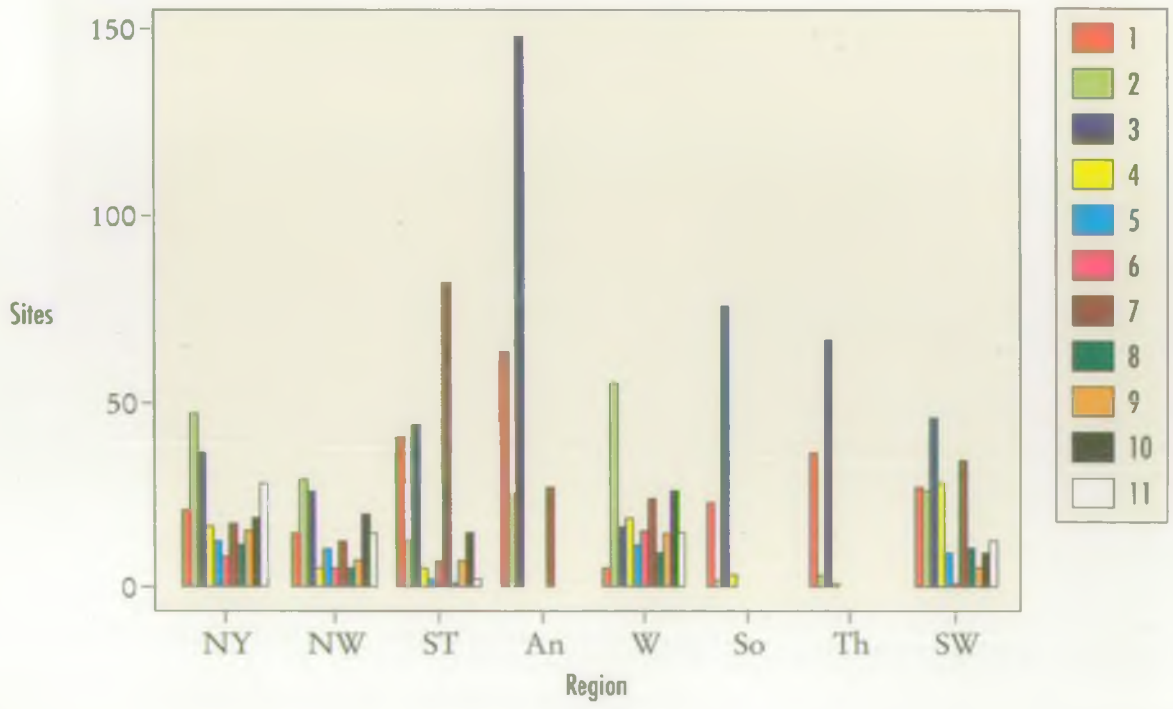


FIGURE 8

The distribution of vee-shaped valleys in 1994 and 1995.

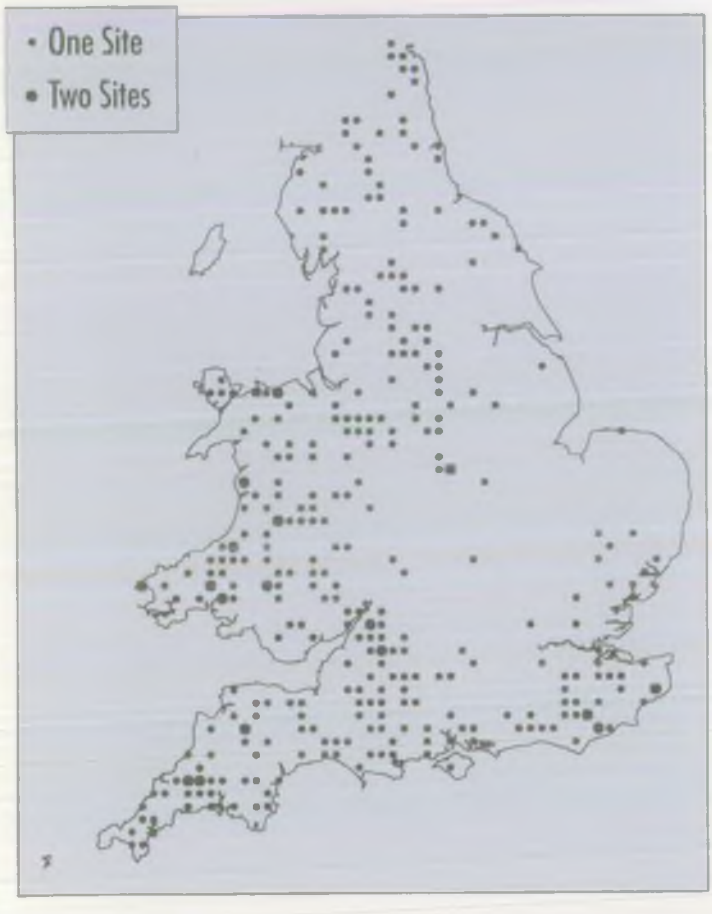


FIGURE 9

The distribution of concave/bowl shaped valleys in 1994 and 1995.

FIGURE 10

The distribution of symmetrical floodplains in 1994 and 1995.

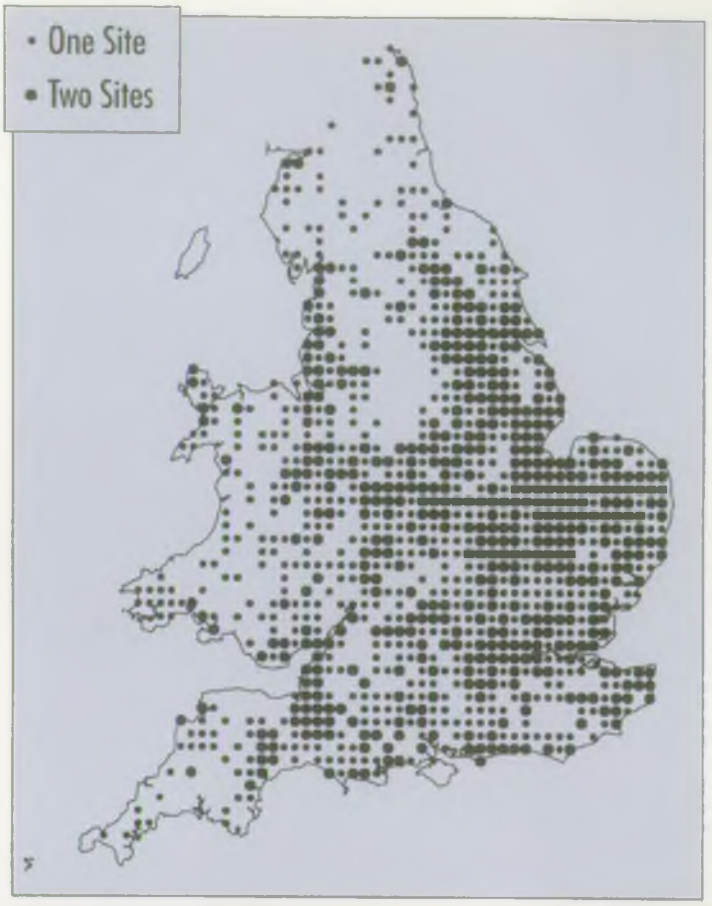
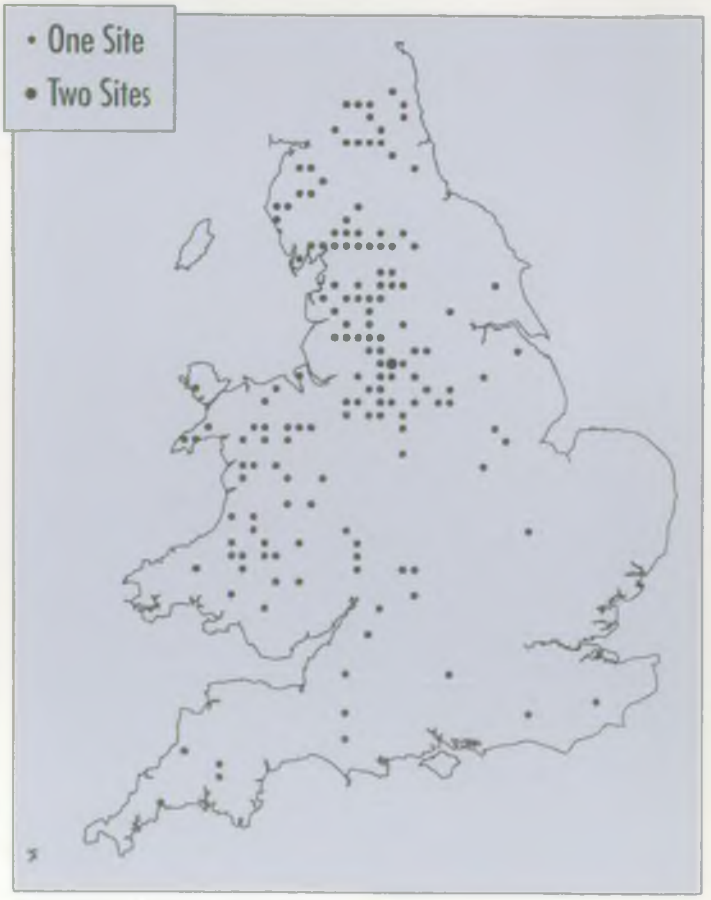


FIGURE 11

The distribution of terraced valleys in 1994 and 1995.



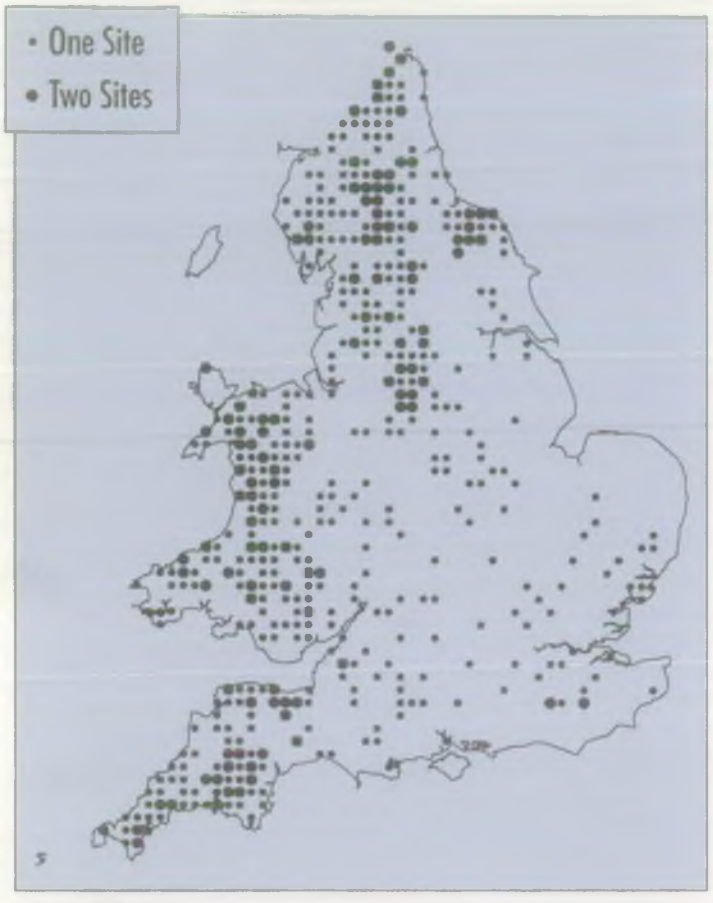


FIGURE 12

The distribution of waterfalls and cascades in 1994 and 1995.

FIGURE 13

The distribution of bedrock banks in 1994 and 1995.

FIGURE 14

The distribution of exposed bedrock in 1994 and 1995.

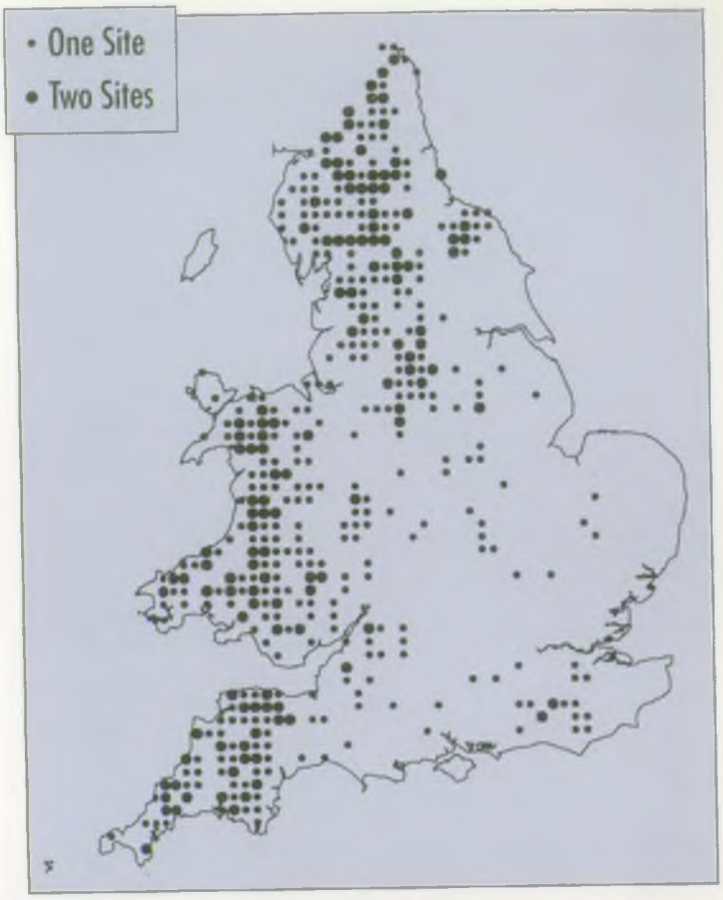


FIGURE 15

The distribution of exposed boulders in 1994 and 1995.

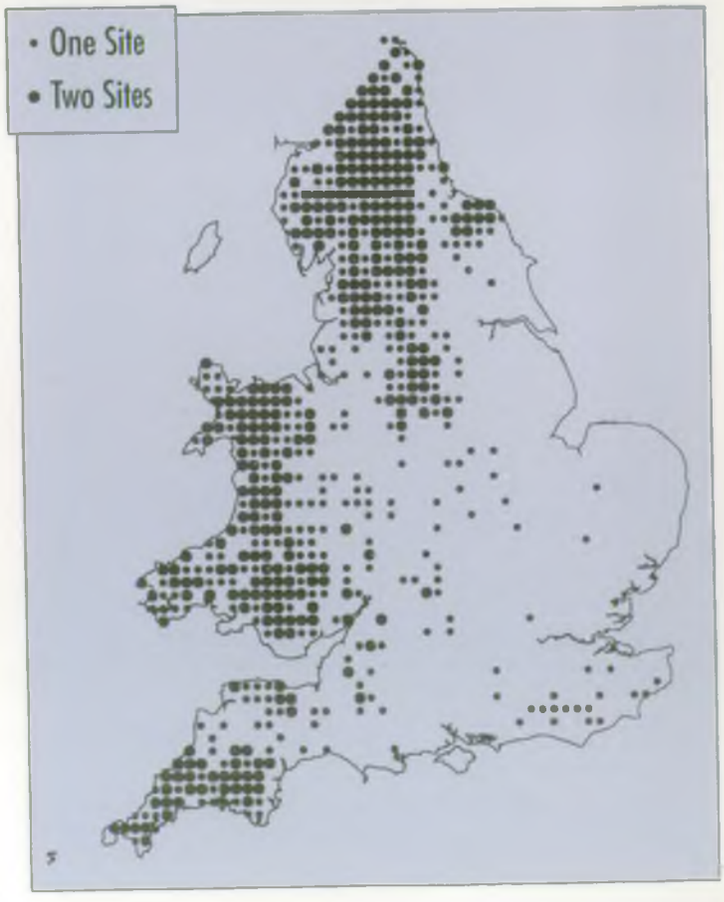


FIGURE 16

The distribution and extent of riffles in 1994.

FIGURE 17

The distribution and extent of riffles in 1995.

FIGURE 18

The distribution of unvegetated mid-channel bars in 1994 and 1995.

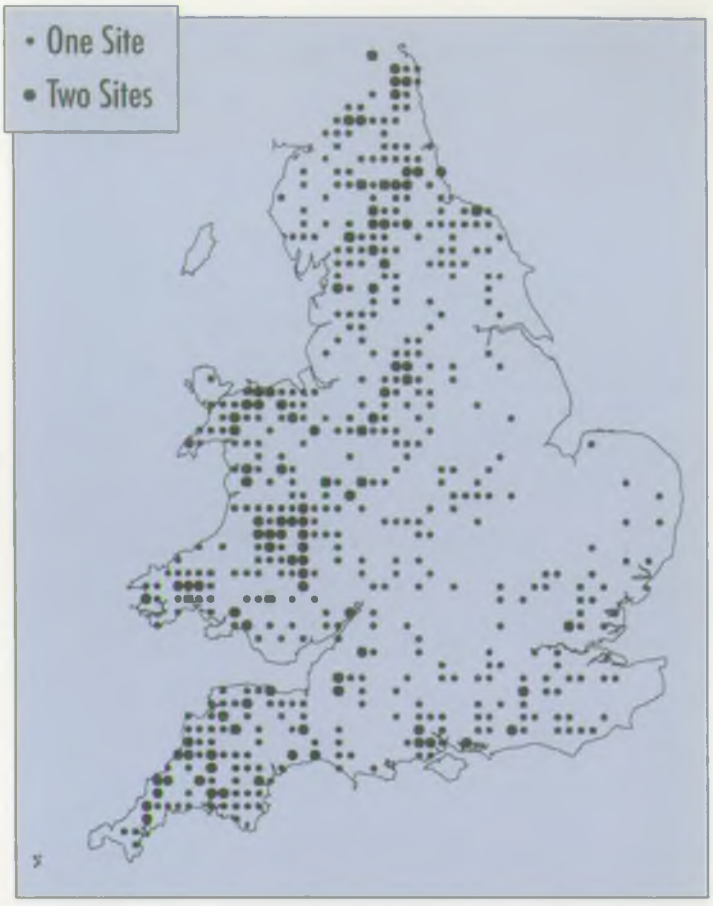


FIGURE 19

The distribution of vegetated mid-channel bars in 1994 and 1995.

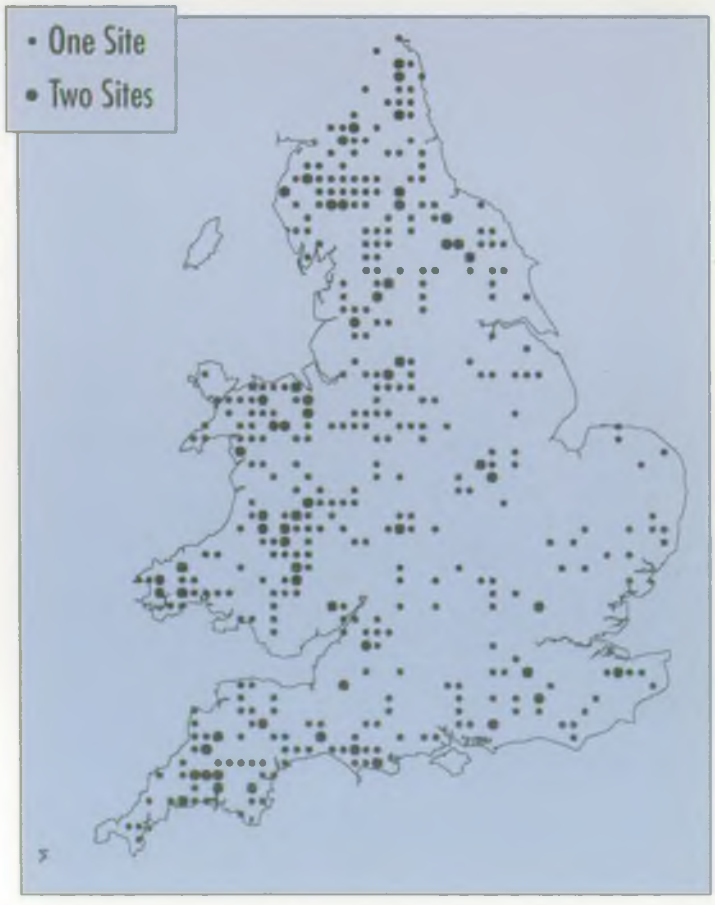


FIGURE 20

The distribution of unvegetated point bars in 1994 and 1995.

FIGURE 21

The distribution of vegetated point bars in 1994 and 1995.

FIGURE 22

The distribution of mature islands in 1994 and 1995.

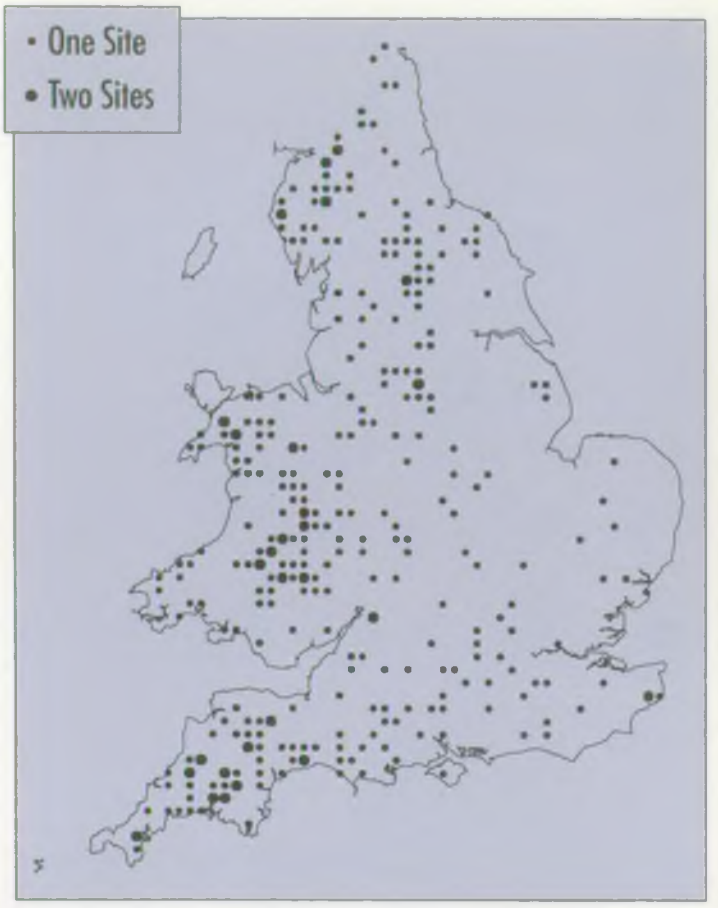


FIGURE 23

The distribution of eroding cliffs in 1994 and 1995.

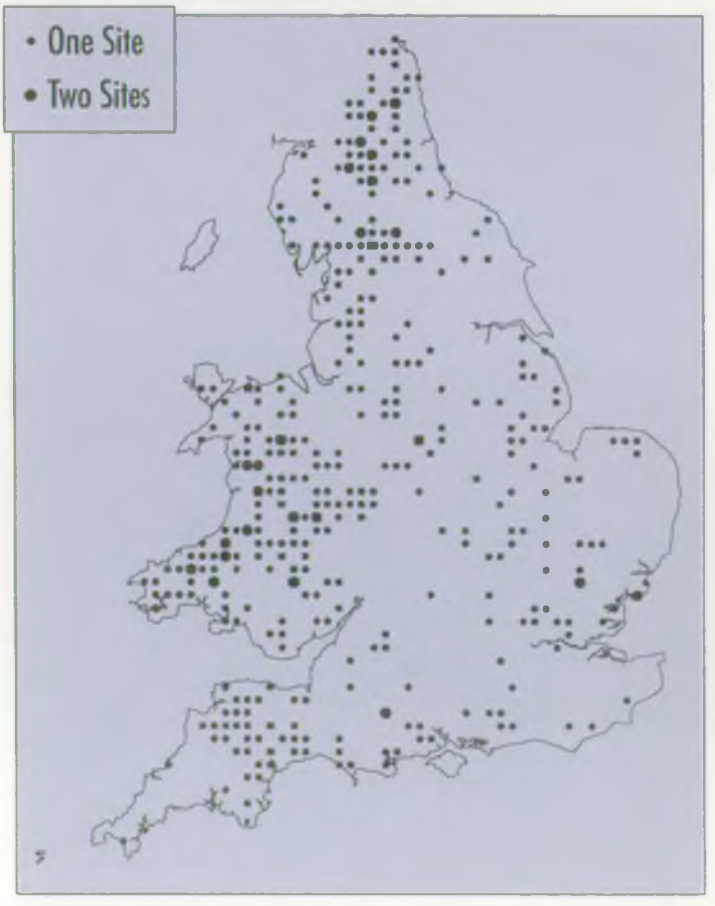


FIGURE 24

The distribution of unvegetated side bars in 1994 and 1995.

FIGURE 25

The distribution of vegetated side bars in 1994 and 1995.

FIGURE 26

The distribution of rapids in 1994 and 1995.

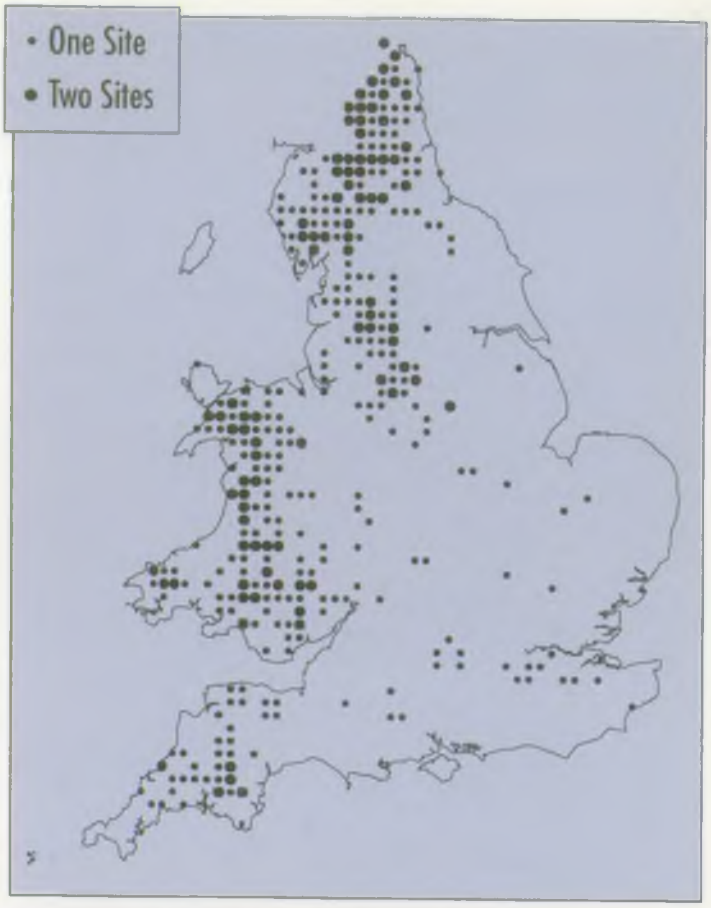
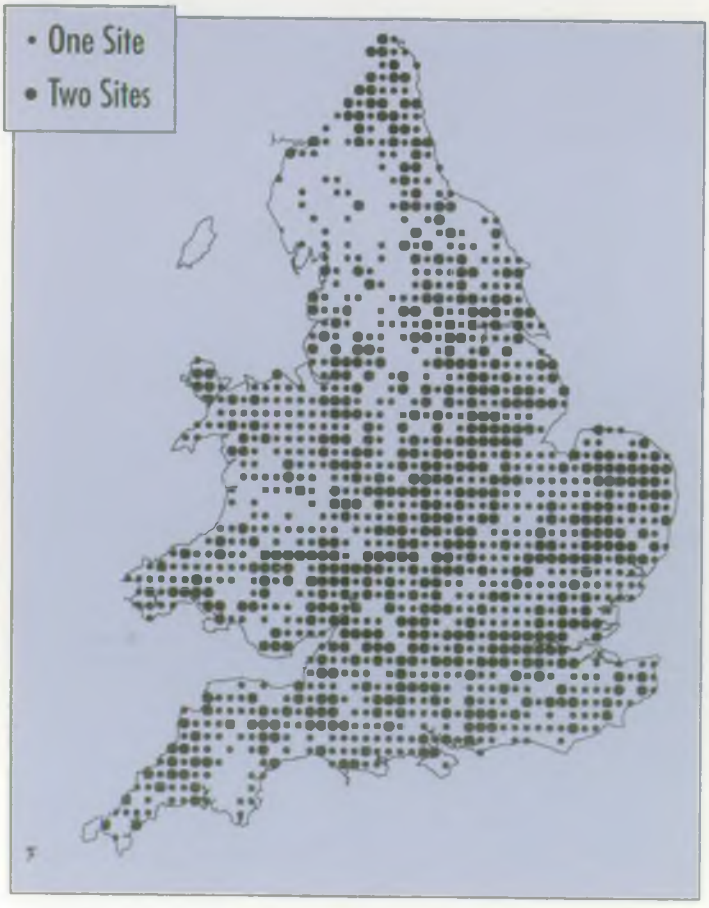


FIGURE 27

The distribution of extensive glides in 1994 and 1995.



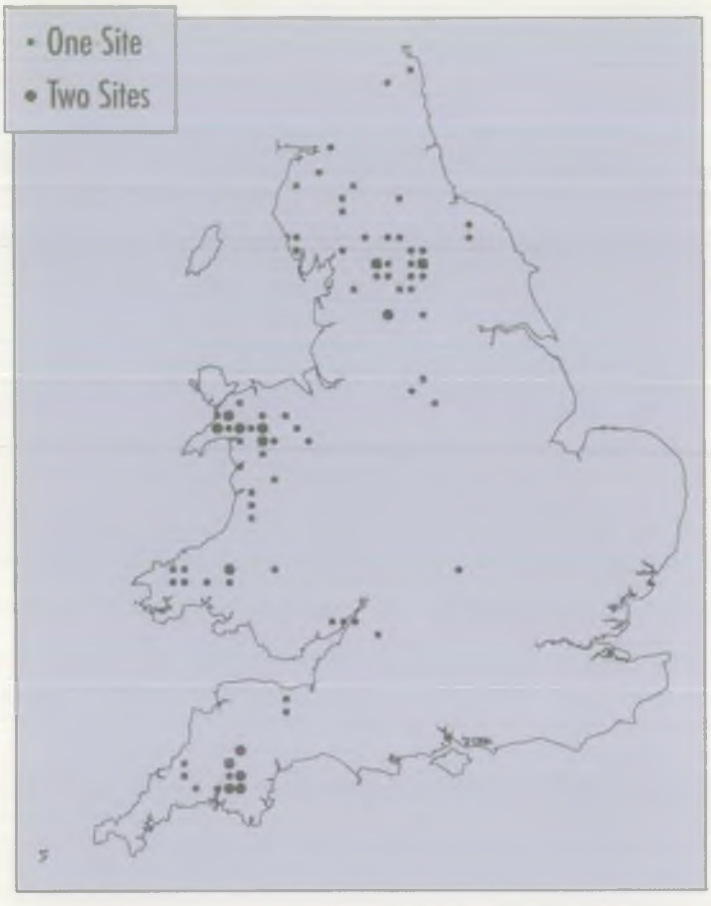


FIGURE 28

The distribution of extensive liverworts and mosses in 1994 and 1995.

FIGURE 29

The distribution of extensive emergent reeds in 1994 and 1995.

FIGURE 30

The distribution of channels choked with vegetation in 1994 and 1995.

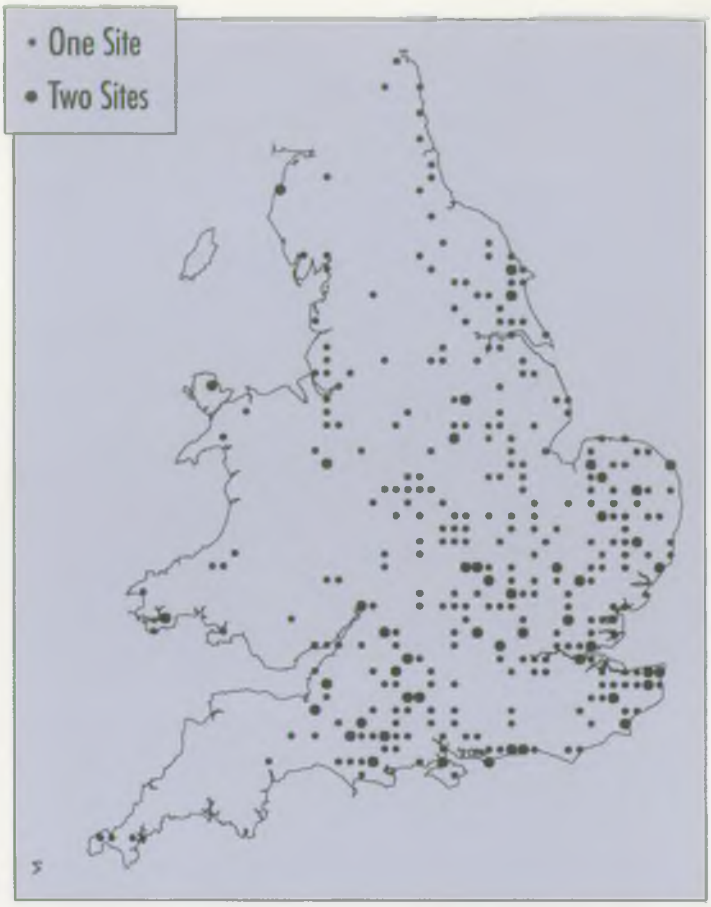


FIGURE 31

The distribution of floating-leaved vegetation in 1994 and 1995.

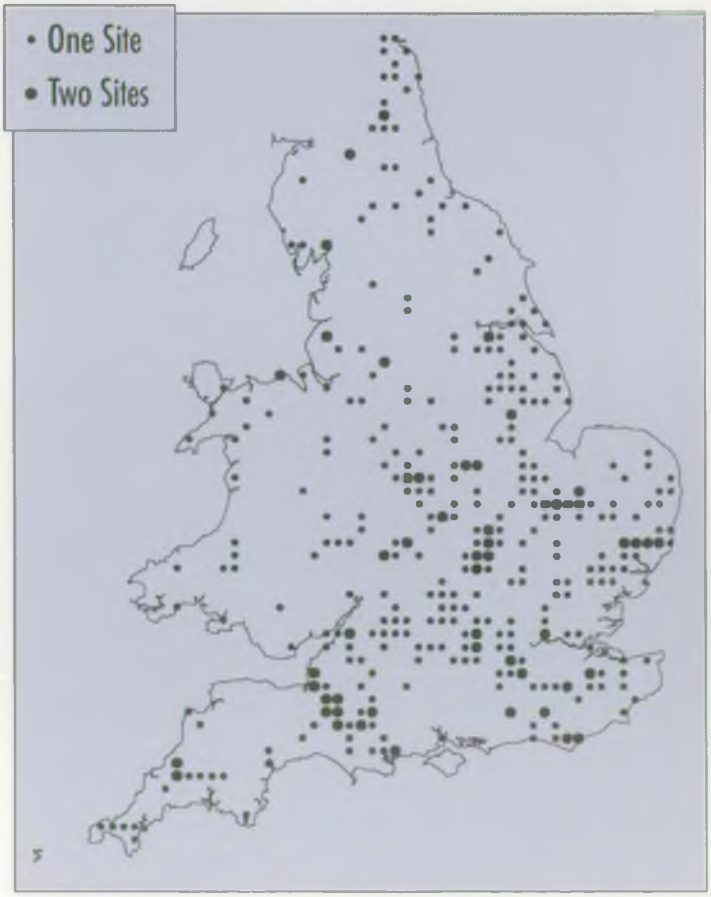


FIGURE 32

The distribution of free-floating vegetation in 1994 and 1995.

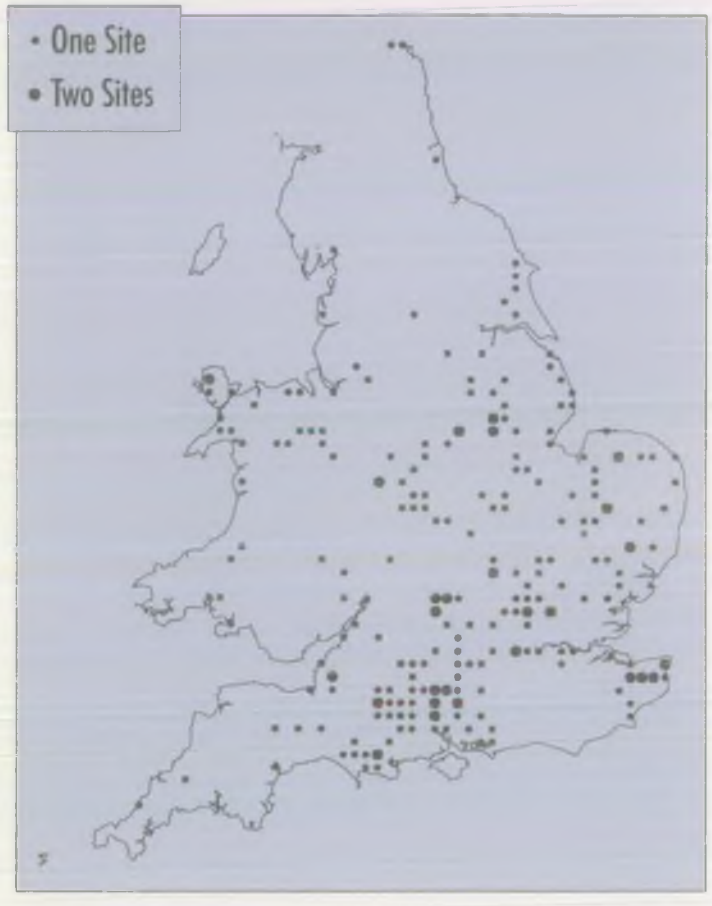


FIGURE 33

The distribution of extensive submerged vegetation in 1994 and 1995.

FIGURE 34

The extent of bankside trees in 1994 and 1995.

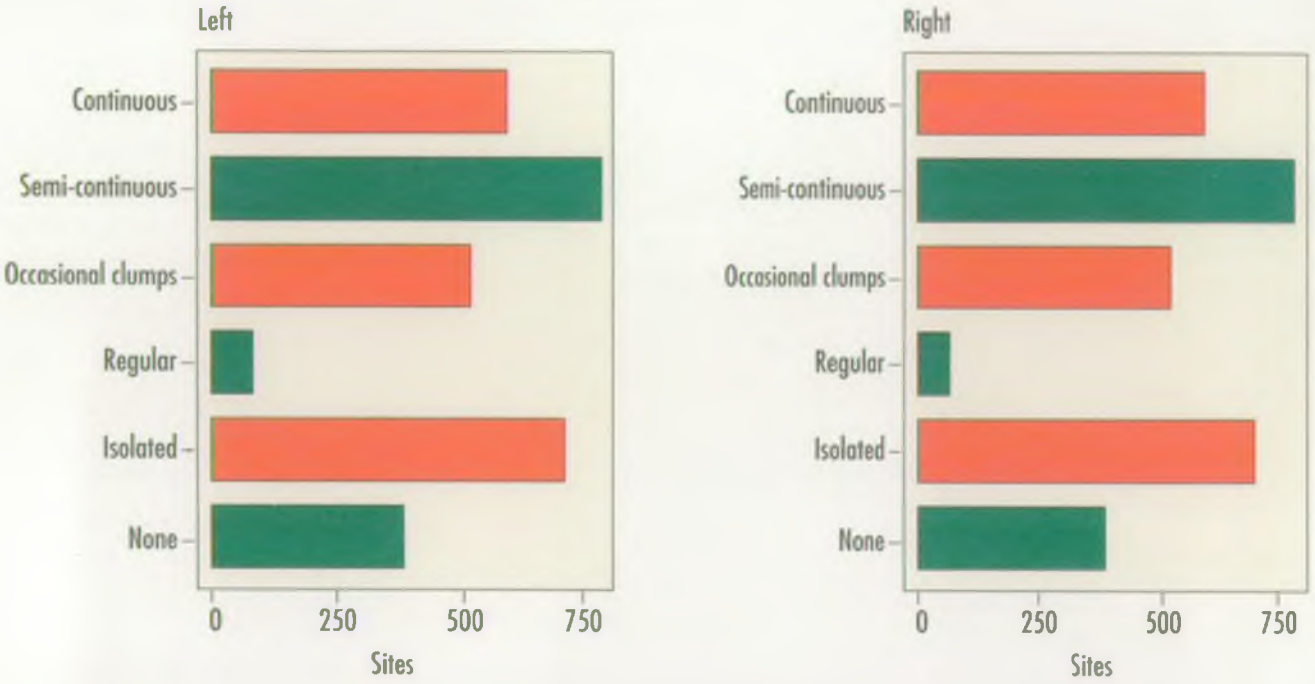


FIGURE 35

The distribution of treeless sites in 1994 and 1995.

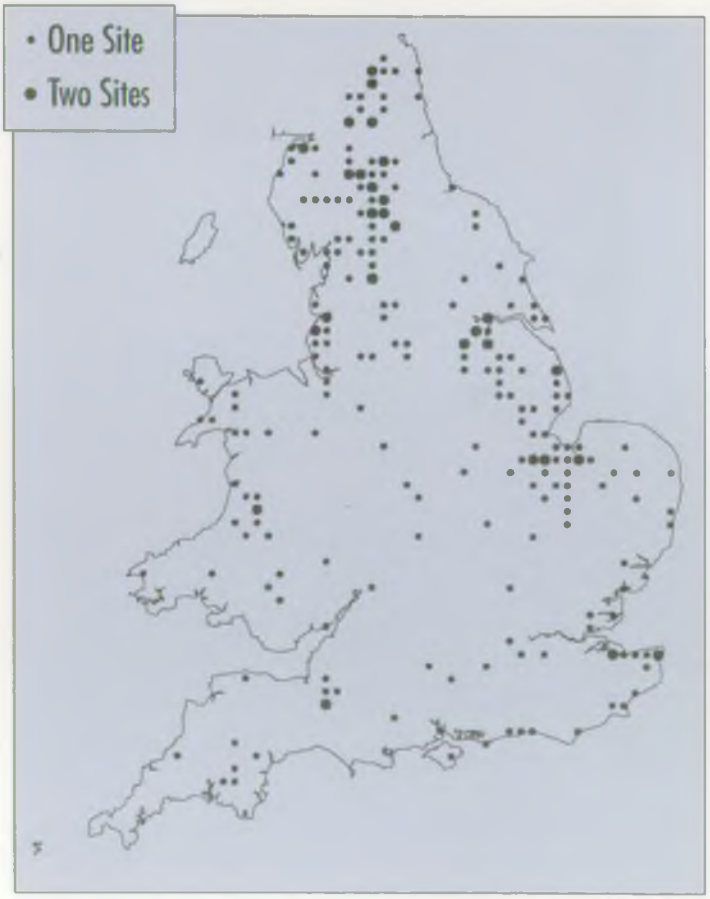


FIGURE 36

The distribution of extensively shaded channels in 1994 and 1995.

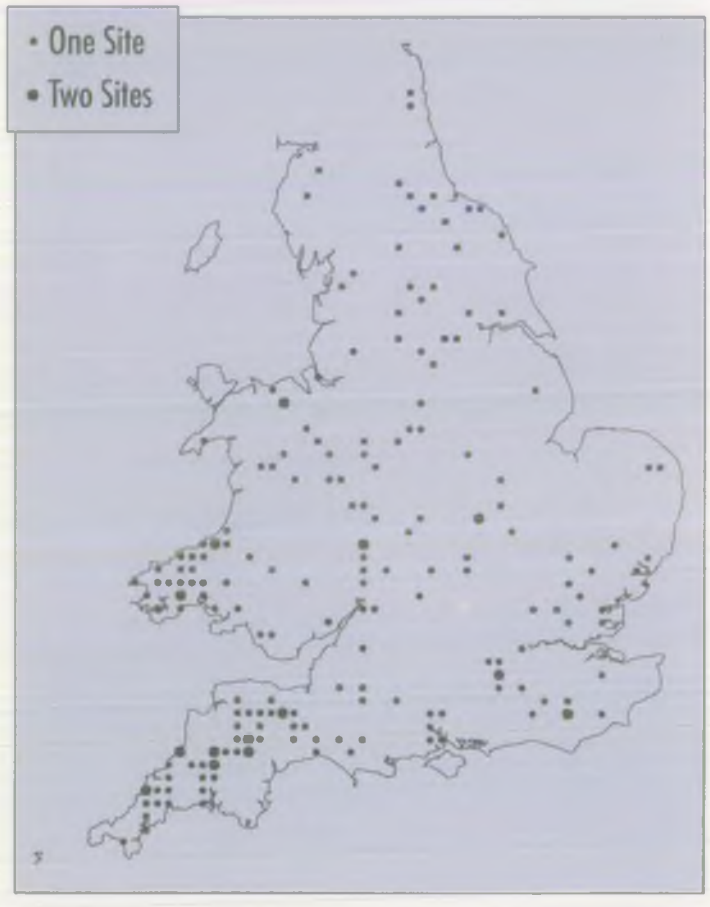


FIGURE 37

The distribution of extensive bankside roots in 1994 and 1995.

FIGURE 38

The distribution of extensive underwater tree roots in 1994 and 1995.

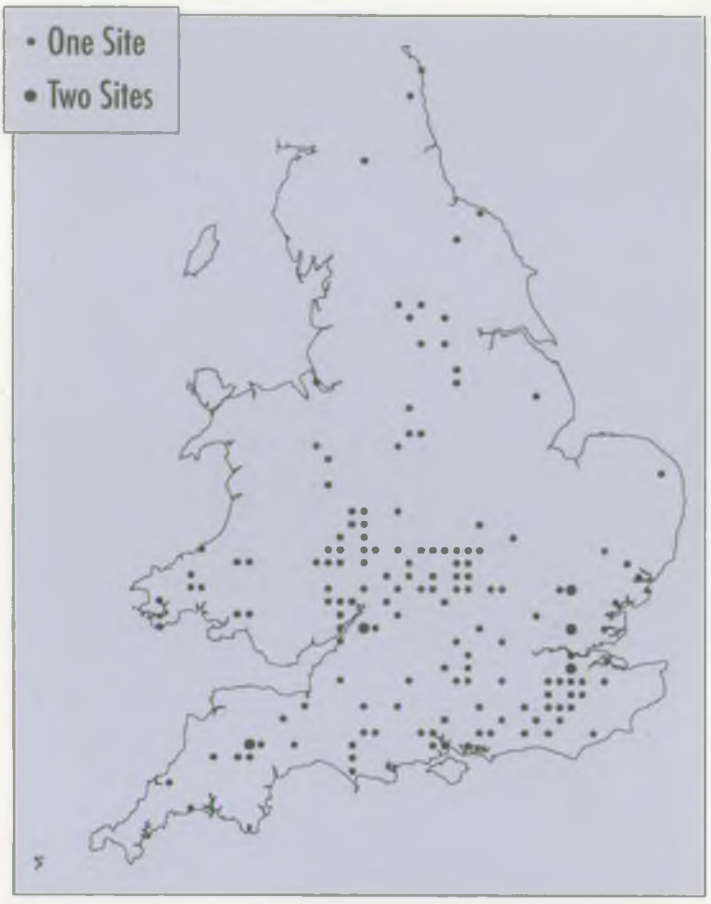


FIGURE 39

The distribution of extensive coarse woody debris in 1994 and 1995.

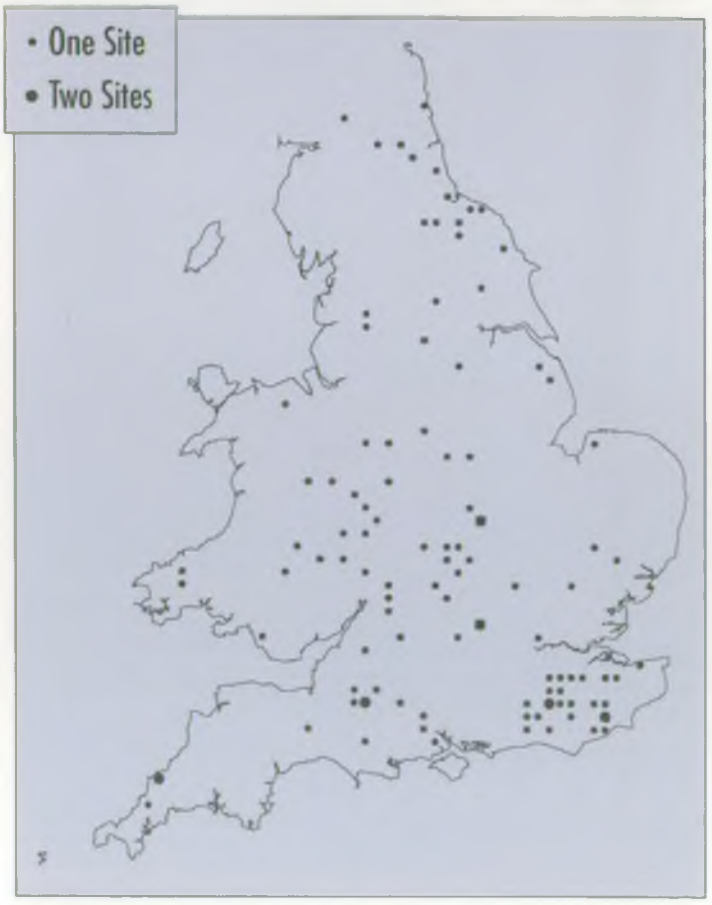


FIGURE 40

The relative proportions of adjacent land use in 1994 and 1995.

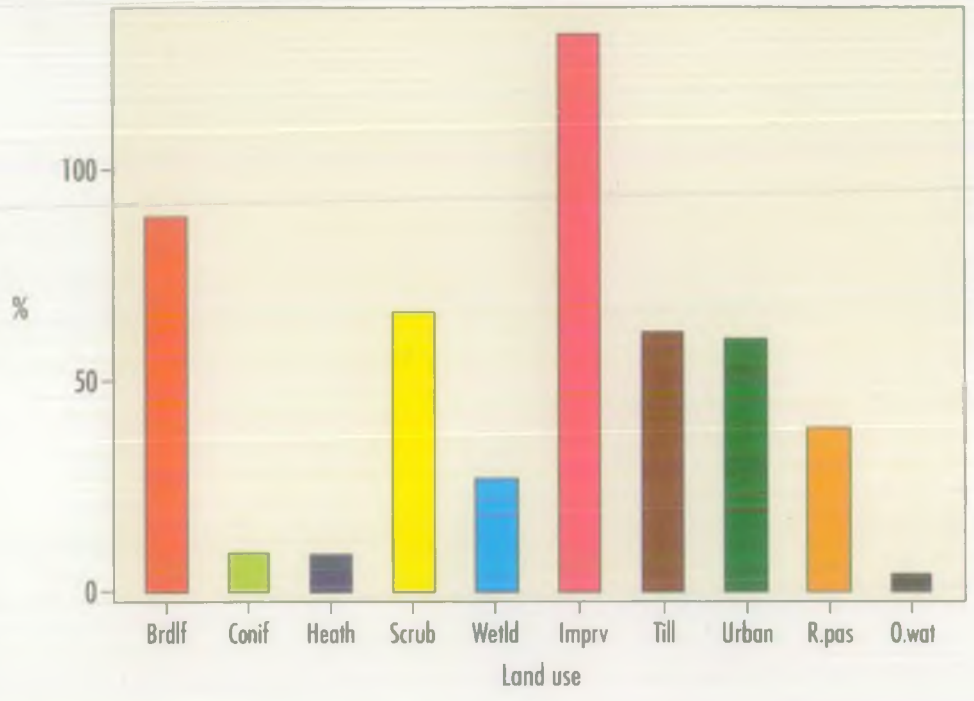


FIGURE 41

The relative proportions of adjacent land use in 1994 and 1995 associated with river segment type.

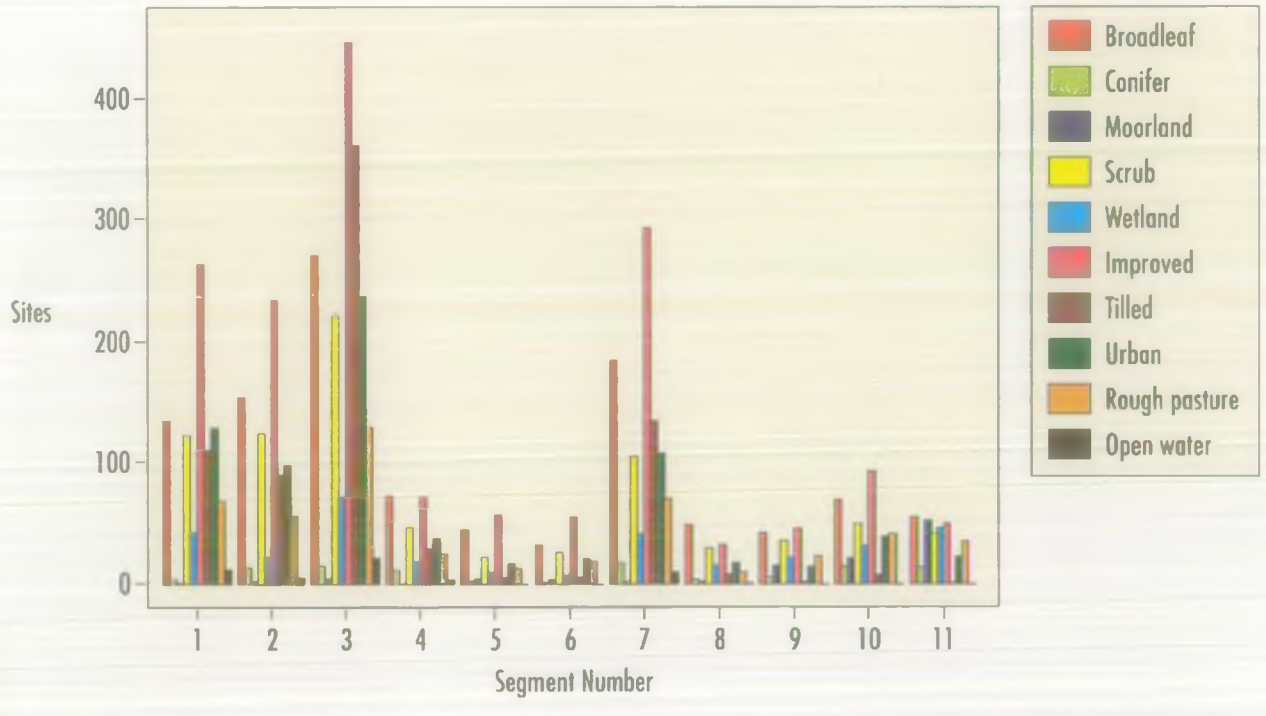


FIGURE 42

The distribution of extensive broadleaf woodland at sites in 1994 and 1995.

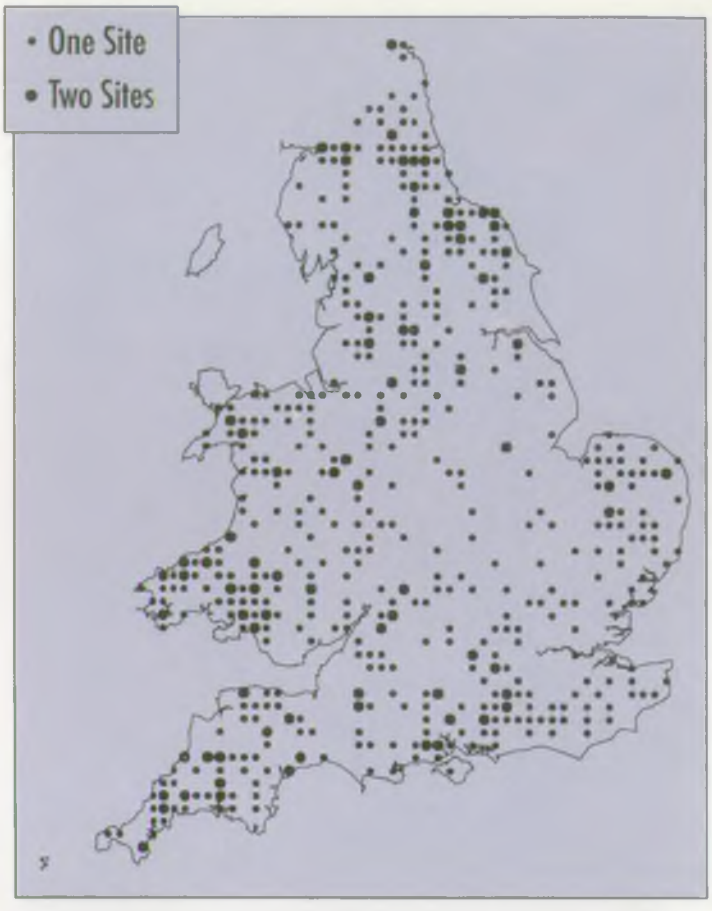


FIGURE 43

The distribution of extensive wetland at sites in 1994 and 1995.

FIGURE 44

The relative proportions of banktop spot checks with bare, uniform, simple and complex vegetation structure in 1995.

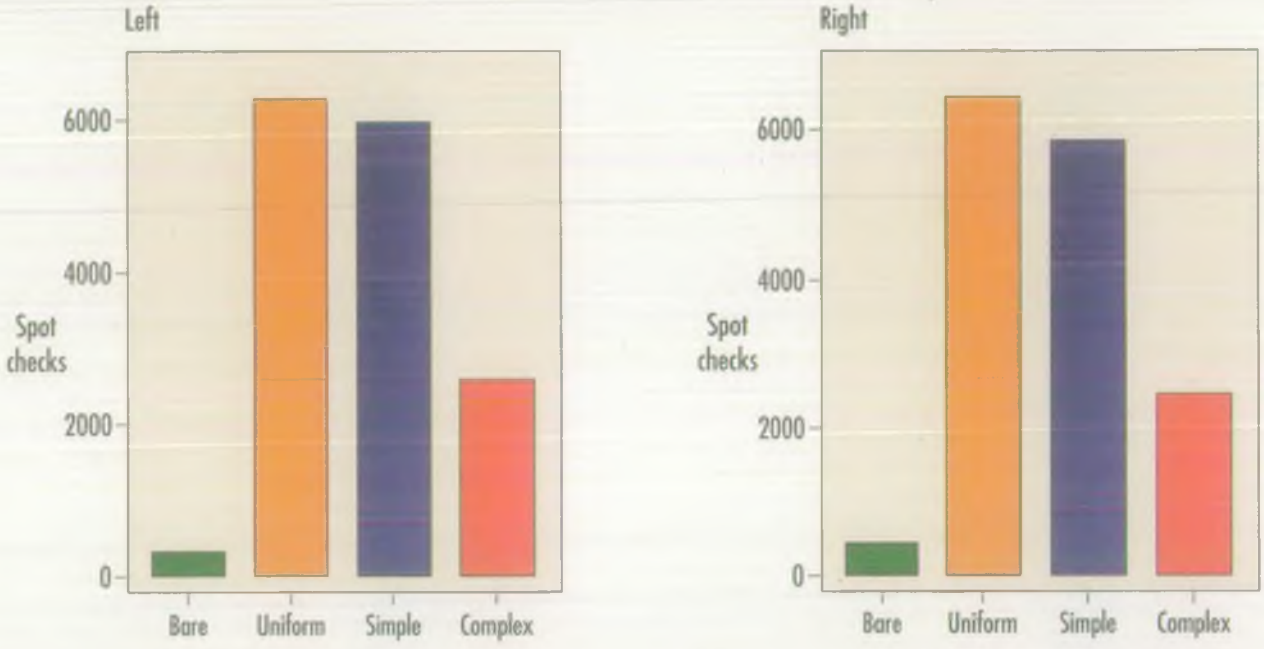


FIGURE 45

The relative proportions of bankface spot checks with bare, uniform, simple and complex vegetation structure in 1994 and 1995.

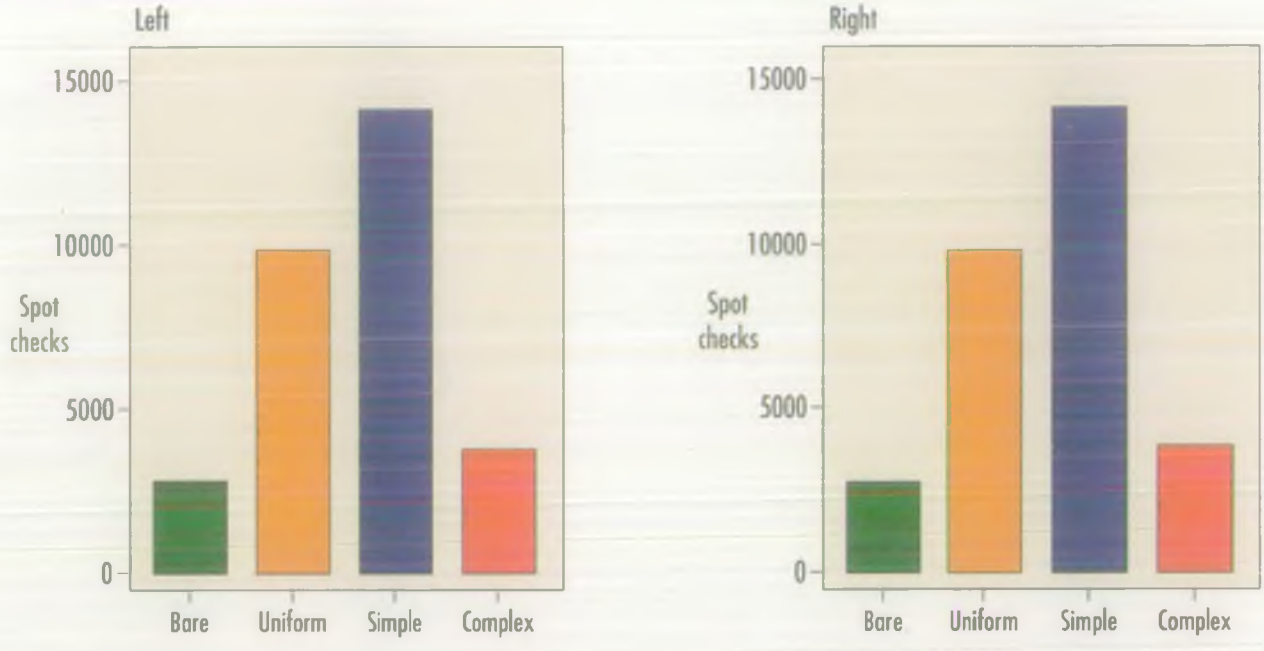


FIGURE 46

The distribution of giant hogweed in 1994 and 1995.

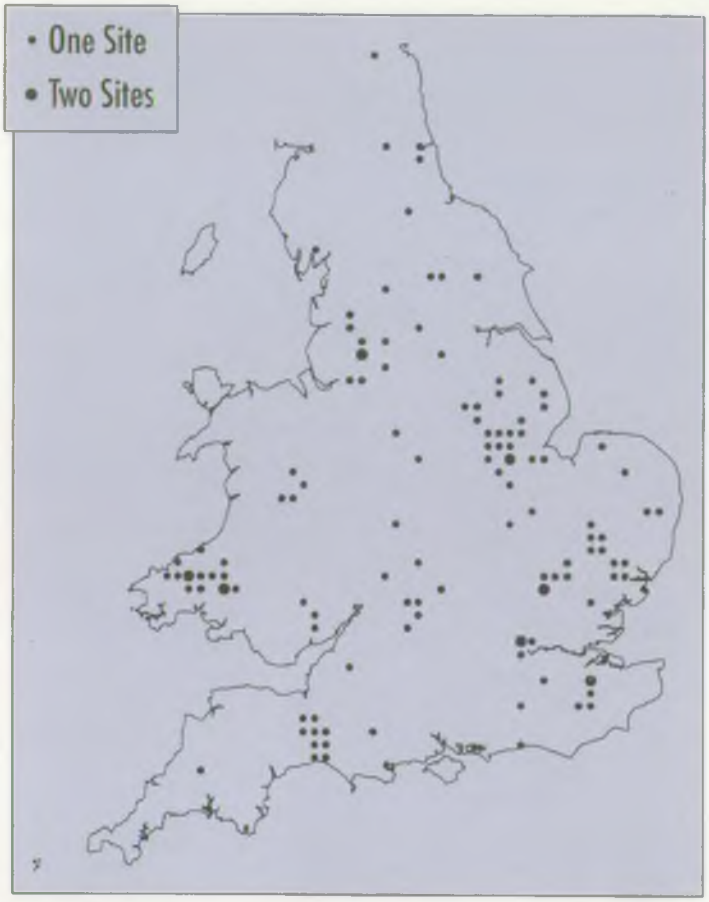


FIGURE 47

The distribution of Japanese knotweed in 1994 and 1995.

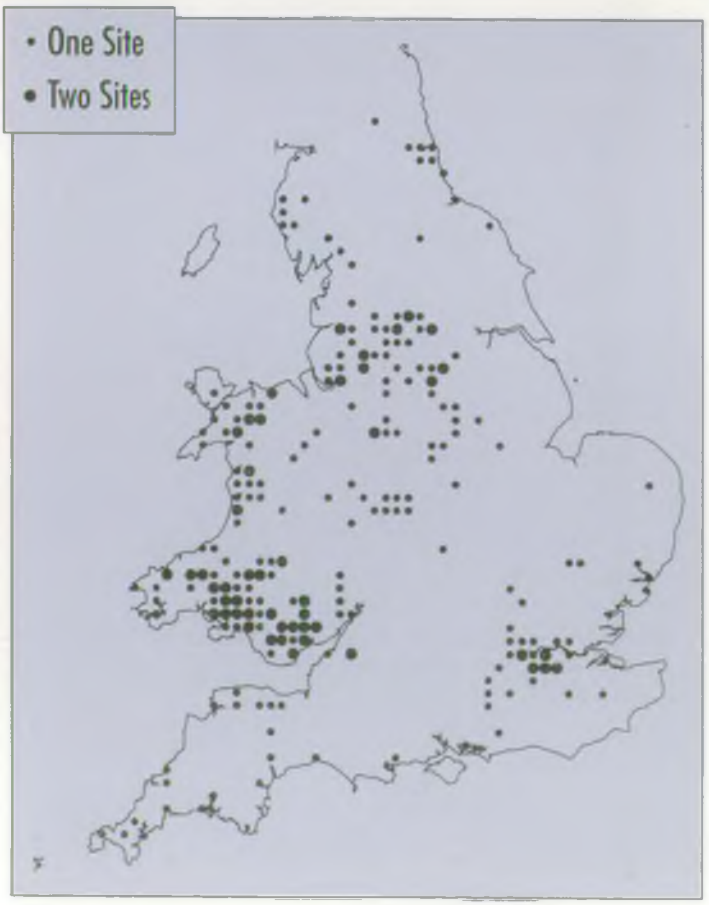


FIGURE 48

The distribution of Himalayan balsam in 1994 and 1995.

FIGURE 49

The distribution of diseased alders in 1995.

FIGURE 50

The occurrence of kingfishers in 1994 and 1995.

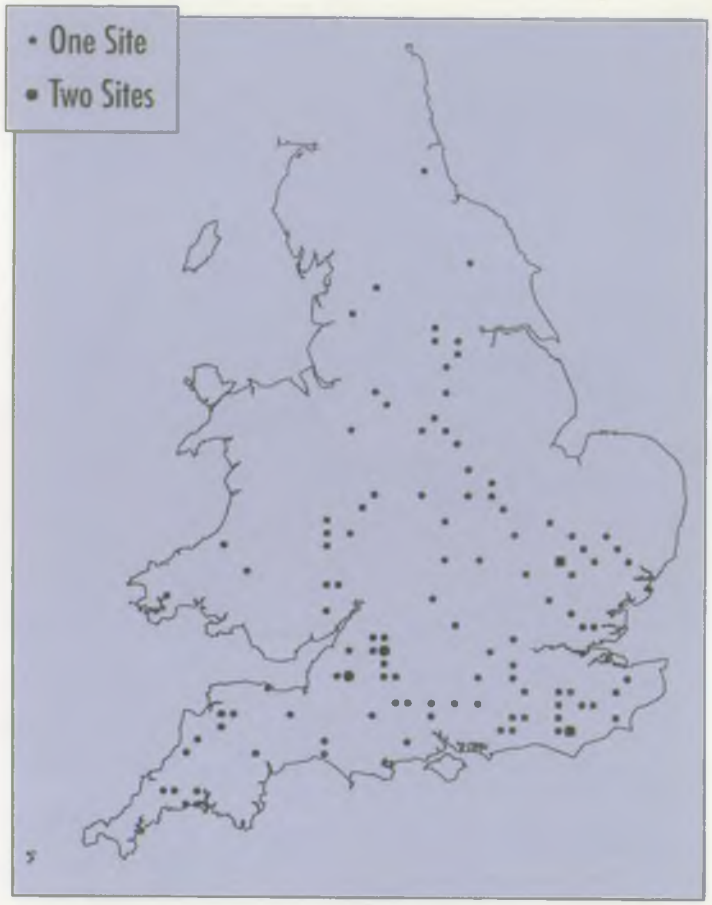


FIGURE 51

The occurrence of dippers in 1994 and 1995.

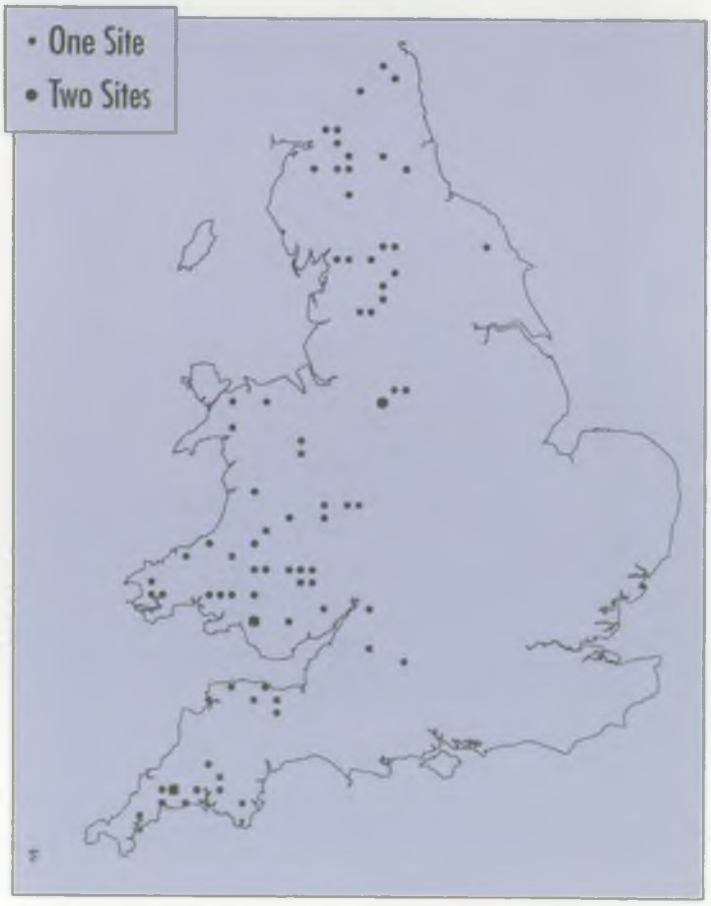


FIGURE 52

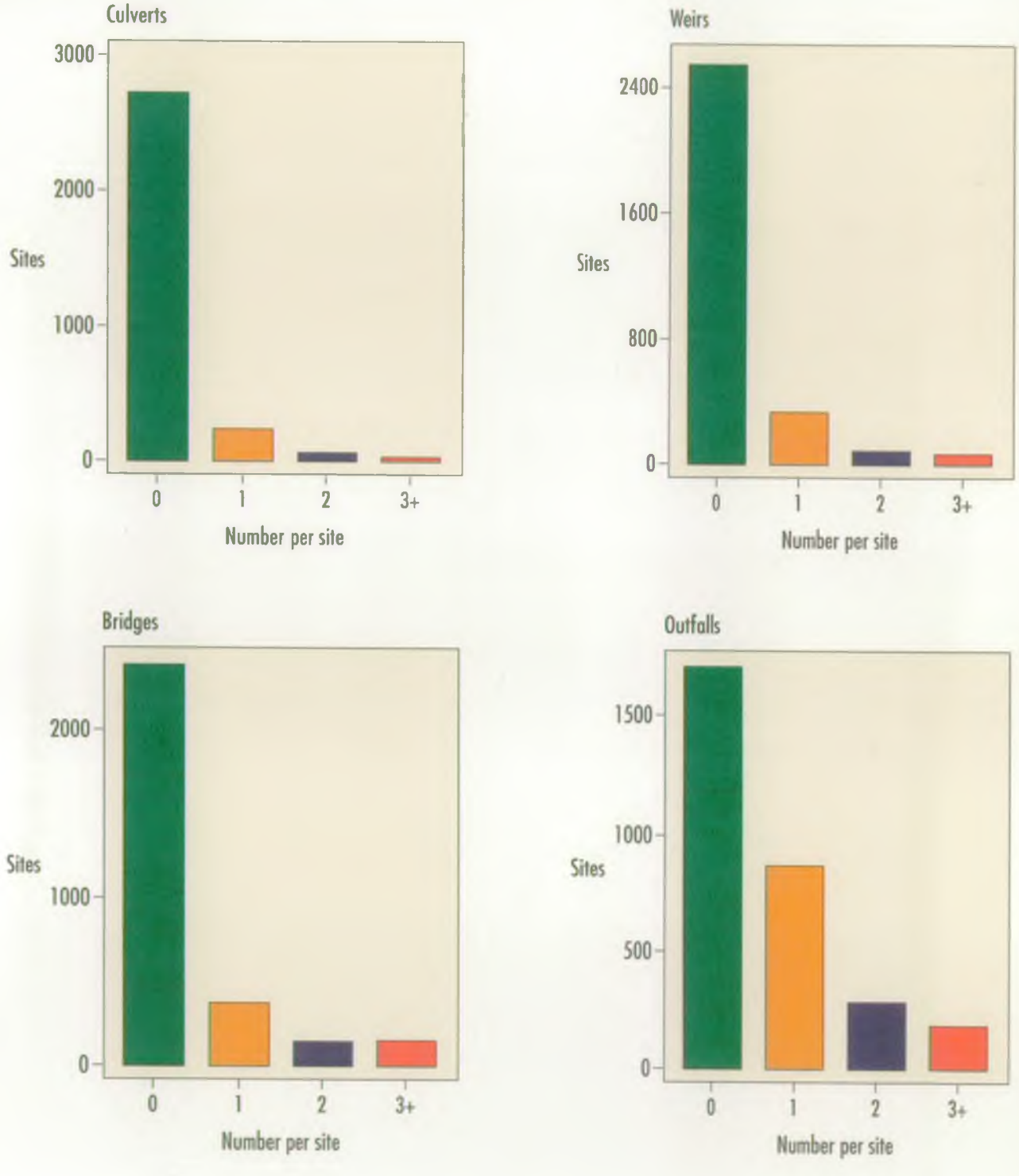
The occurrence of grey wagtails in 1994 and 1995.

FIGURE 53

The occurrence of otter spraints in 1994 and 1995.

FIGURE 54

The number of culverts, weirs, bridges and outfalls recorded at sites in 1994 and 1995.



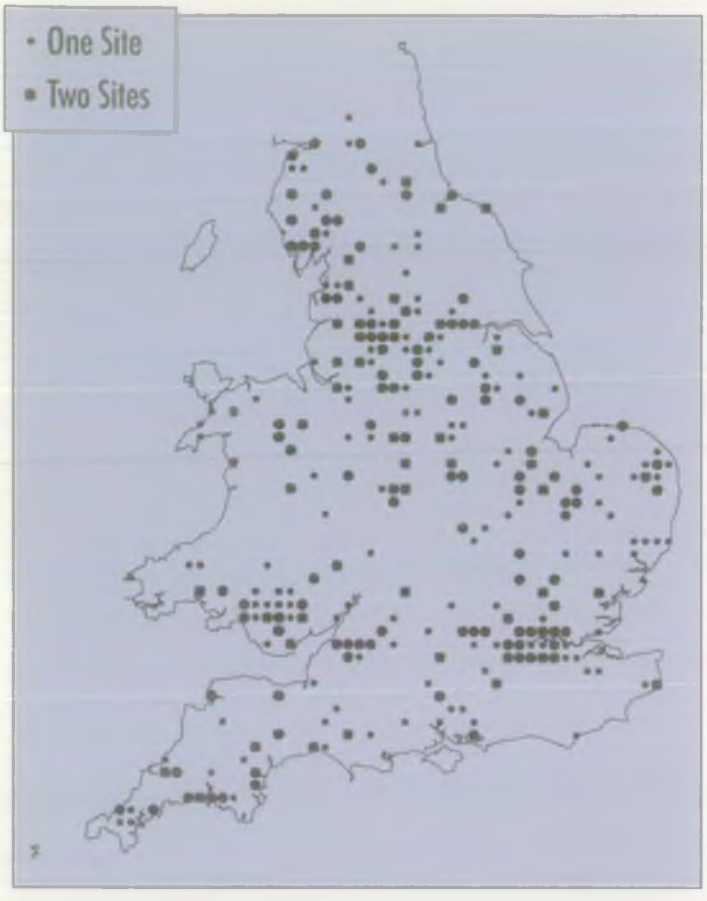


FIGURE 55

The distribution of extensively reinforced sites in 1994 and 1995.

FIGURE 56

The distribution of extensively resectioned sites in 1994 and 1995.

FIGURE 57

The distribution of extensively embanked sites in 1994.

FIGURE 58

The proportion of reinforced sites with concrete, gabion, sheet piling, brick and rip-rap in 1994.

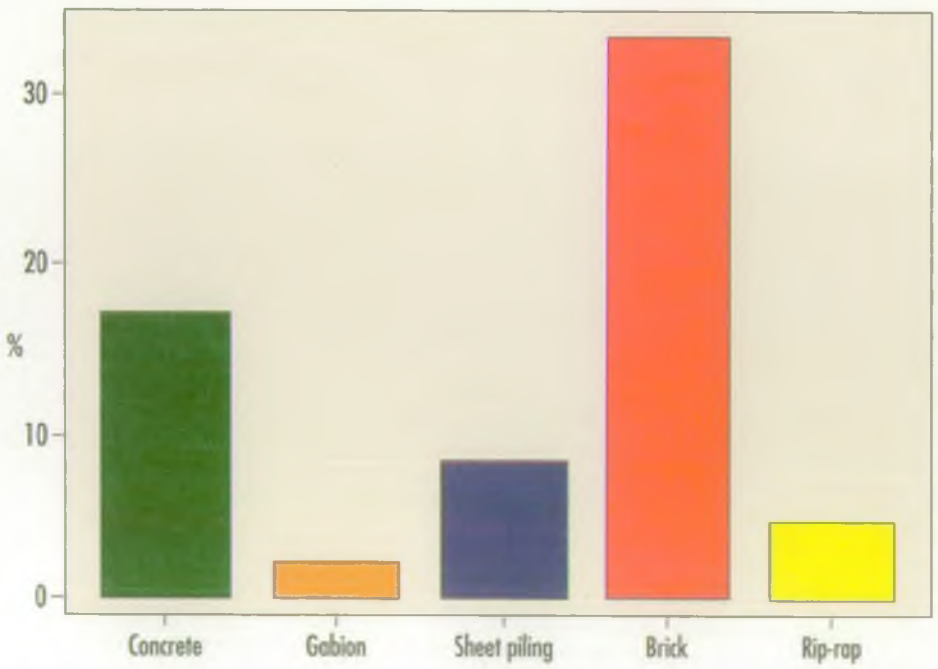


FIGURE 59

A national overview of habitat modification, using the 1995 reference sites.

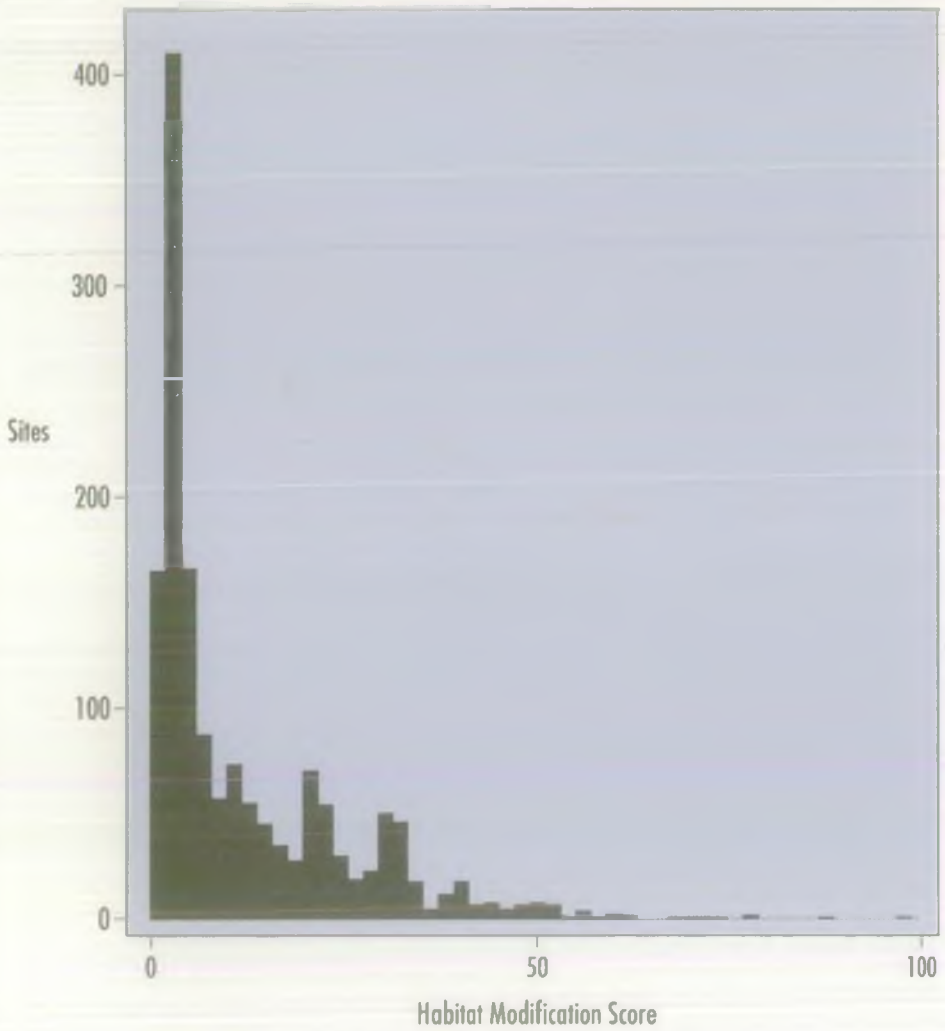


FIGURE 60

The impact of extensive resectioning on riffles, unvegetated point bars, vertical cliffs, gravel/pebble and silt substrates, using 100% as a benchmark level of occurrence in semi-natural sites.

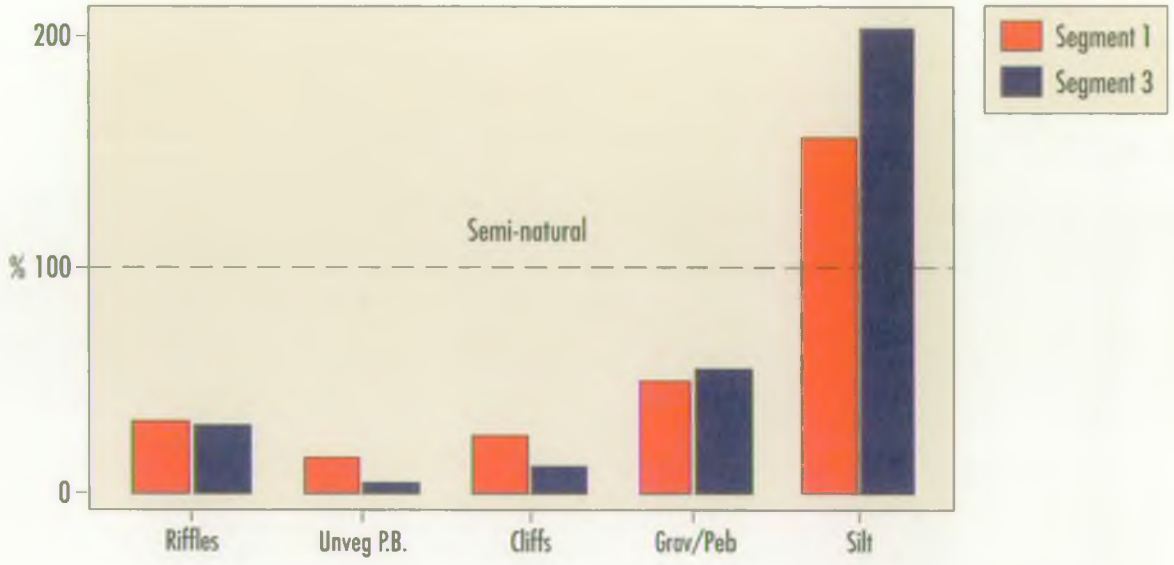


FIGURE 61

The impact of extensive reinforcement on riffles, unvegetated point bars, vertical cliffs, gravel/pebble and silt substrates, using 100% as a benchmark level of occurrence in semi-natural sites.

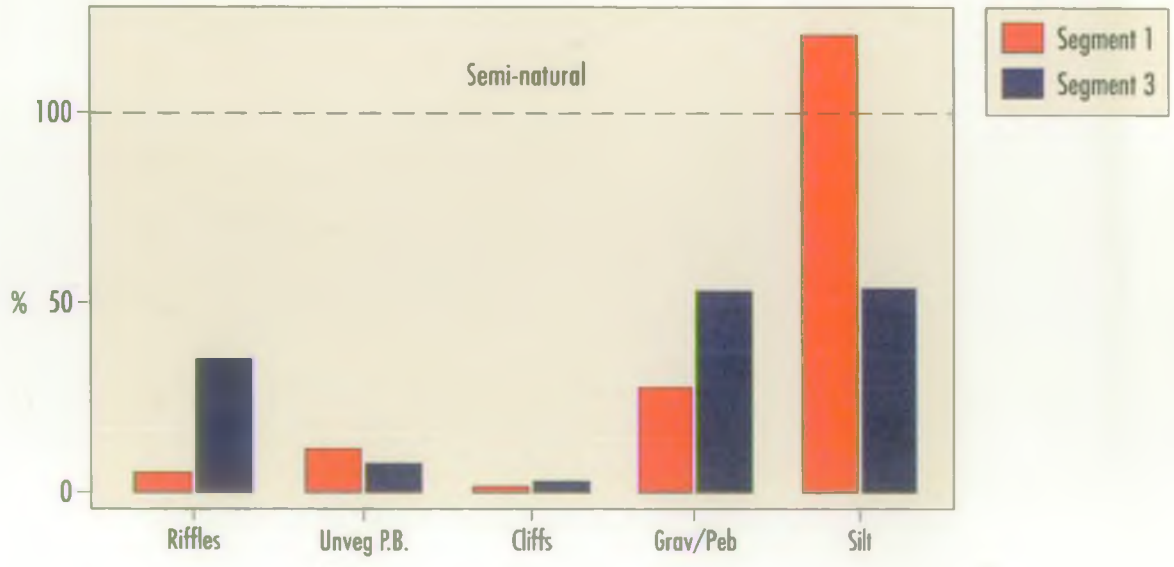


FIGURE 62

A comparison of bankface vegetation structure found on resectioned and reinforced banks, compared with those with no obvious modification.

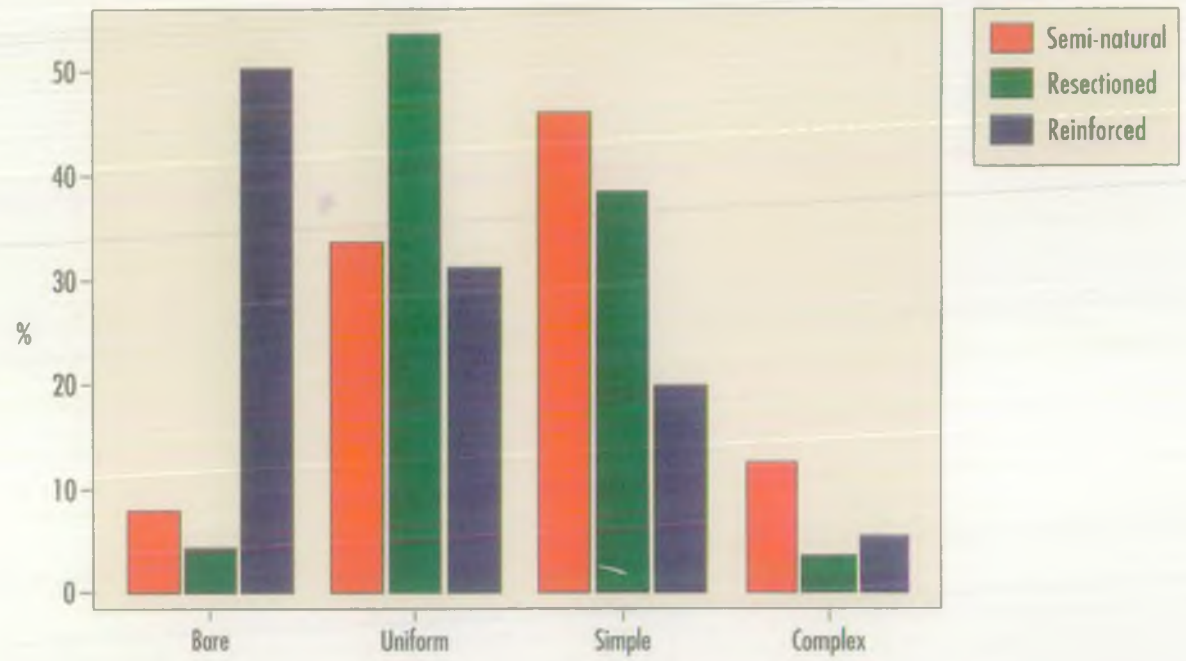
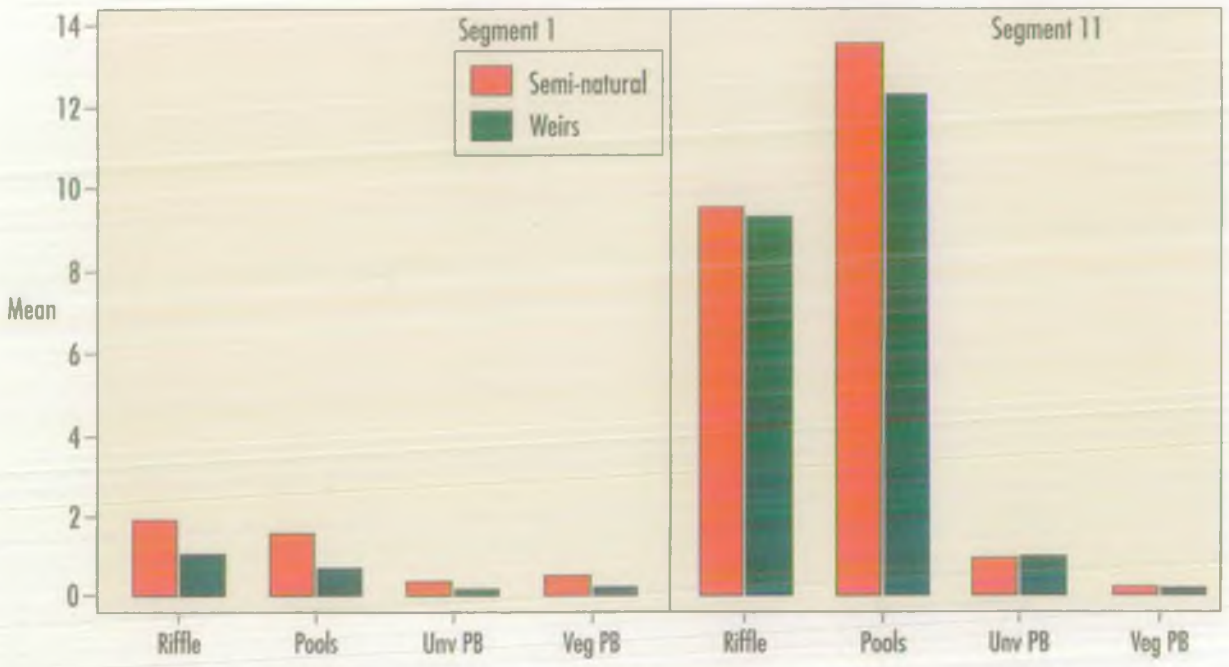


FIGURE 63

The impact of weirs on riffles, pools and point bars: a comparison between semi-natural sites and those with one or more weirs in river segment types 1 and 11.



APPENDIX 1: RHS SURVEY FORM

NRA RIVER HABITAT SURVEY 1995 Page 1 of 4

A BACKGROUND MAP-BASED INFORMATION

Altitude (m)	Slope (m/km)	Flow category (1-10)
Solid geology code	Drift geology code	Planform category
Distance from source (km)	Significant tributary?	Navigation?

B FIELD SURVEY DETAILS

Reference network site number:

Mid-section grid reference of network site if different from designated location:

COMPLETE THE FOLLOWING FOR **ALL** SITES

Grid Reference: River:

Date ..../..../1995 Time: ..... Surveyor name .....

Adverse conditions affecting survey? No ☐ Yes ☐ *If yes, state* .....

Bed or river visible? No ☐ partially ☐ entirely ☐ (*tick one box*)

Duplicate photographs: general character? No ☐ Yes ☐ (*tick one box*)

Site surveyed from: left bank ☐ right bank ☐ channel ☐ (*tick as appropriate*)

C PREDOMINANT VALLEY FORM *(tick one box only)*

☐ shallow vee

☐ deep vee

☐ gorge

☐ concave/bowl

☐ terraced valley floor

☐ symmetrical floodplain

☐ asymmetrical floodplain

D NUMBER OF RIFFLES, POOLS AND POINT BARS *(Use 𝍸 then indicate total number)*

Riffles	Unvegetated point bars
Pools	Vegetated point bars

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Spot check 1 is at: upstream end ☐ downstream end ☐ of site (*Tick one box*)

E PHYSICAL ATTRIBUTES (*to be assessed across channel within a 1m wide zone*)

Mat. = Material ' = one entry only	1	2	3	4	5	6	7	8	9	10	
LEFT BANK											
Mat ' *BE,BO,CO,GS,EA,PE,CL,CC,SP,WP,GA,BR,RR,BW*											
Bank modification(s) *NO,RS,RI,PC,BM,EM*											
Bank feature(s) *NK,NO,EC,SC,PB,VP,SB,VS*											
CHANNEL											
Channel substrate ' *NV,BE,BO,CO,GP,SA,SI,CL,AR*											
Flow type ' *FF,CH,BW,UW,CF,RP,UP,SM,NP,NO*											
Channel modification(s) *NK,NO,CV,RS,RI,DA,FO*											
Channel feature(s) *NO,RO,MB,VB,MI,TR*											
RIGHT BANK											
Mat ' *BE,BO,CO,GS,EA,PE,CL,CC,SP,WP,GA,BR,RR,BW*											
Bank modification(s) *NO,RS,RI,PC,BM,EM*											
Bank feature(s) *NK,NO,EC,SC,PB,VP,SB,VS*											

F BANKTOP LAND USE AND VEGETATION STRUCTURE (*to be assessed over a 10m wide transect*)

Land use: choose ***one*** *from BL, CP, MH, SC, RP, WL, OW, IG, TL, SU*

LAND USE WITHIN 5m OF BANKTOP (L)											
LEFT BANK-TOP (*structure within 1m*) *B/U/S/C*											
LEFT BANK FACE (*structure*) *B/U/S/C*											
RIGHT BANK FACE (*structure*) *B/U/S/C*											
RIGHT BANK-TOP (*structure within 1m*) *B/U/S/C*											
LAND USE WITHIN 5m OF BANKTOP (R)											

G CHANNEL VEGETATION TYPES (*fill in relevant boxes with one entry: use E (≥ 33% area) or ✓ present*)

NONE (*tick as appropriate*)											
Liverworts/mosses/lichens											
Emergent broad-leaved herbs											
Emergent reeds/sedges/rushes											
Floating-leaved (rooted)											
Free-floating											
Amphibious											
Submerged broad-leaved											
Submerged fine/linear-leaved											
Filamentous algae											

Use end 'catch-all' column for types not occuring in spot checks as well as overall assessment over 500m (use E or ✓) ↑

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SITE NO.	NRA RIVER HABITAT SURVEY 1995: 500m SWEEP-UP	Page 3 of 4

H LAND USE WITHIN 50m OF BANKTOP *Use E (≥ 33% banklength) or ✓ if present)*

	L	R		L	R
Broadleaf/mixed woodland *(BL)*			Wetland (e.g. bog, marsh, fen) *(WL)*		
Coniferous plantation *(CP)*			Open water *(OW)*		
Moorland/heath *(MH)*			Improved/semi-improved grass *(IG)*		
Scrub *(SC)*			Tilled land *(TL)*		
Rough pasture *(RP)*			Suburban/urban development *(SU)*		

I BANK PROFILES *(Use E (≥ 33% banklength) or ✓ if present)*

Natural/unmodified	L	R	**Artificial/modified**	L	R
Vertical/undercut			Resectioned		
Vertical + toe			Reinforced - whole bank		
Steep (> 45°)			Reinforced - top only		
Gentle			Reinforced - toe only		
Composite			Artificial two stage		
Use this space to draw profile if different from above, after ticking predetermined box			Poached		
			Embanked		
			Set-back embankments		

J EXTENT OF TREES AND ASSOCIATED FEATURES

TREES *(Tick one box per bank)*

	Left	Right
None	☐	☐
Isolated/scattered	☐	☐
Regularly spaced, single	☐	☐
Occasional clumps	☐	☐
Semi-continuous	☐	☐
Continuous	☐	☐

ASSOCIATED FEATURES *(Tick one box per feature)*

E ≥ 33%	None	Present	E
Shading of channel	☐	☐	☐
Overhanging boughs	☐	☐	☐
Exposed bankside roots	☐	☐	☐
Underwater tree roots	☐	☐	☐
Fallen trees	☐	☐	☐
Coarse woody debris	☐	☐	☐

K EXTENT OF CHANNEL FEATURES *(tick one box per feature)*

	None	Present	E		None	Present	E
Waterfall(s) ~ *free-fall*	☐	☐	☐	Marginal deadwater ~ *slack*	☐	☐	☐
Cascades(s) ~ *chute*	☐	☐	☐	Exposed bedrock	☐	☐	☐
Step/pool sequence	☐	☐	☐	Exposed boulders	☐	☐	☐
Rapid(s) ~ *whitewater*	☐	☐	☐	Unvegetated mid-channel bars	☐	☐	☐
Riffle-pool sequence	☐	☐	☐	Vegetated mid-channel bars	☐	☐	☐
Run(s) ~ *disturbed, rippled*	☐	☐	☐	Mature island(s)	☐	☐	☐
Boil(s) ~ *upwellings*	☐	☐	☐	Unvegetated side bars	☐	☐	☐
Glide(s) ~ *smooth, no eddies*	☐	☐	☐	Vegetated side bars	☐	☐	☐

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NRA RIVER HABITAT SURVEY 1995: DIMENSIONS AND INFLUENCES

L CHANNEL DIMENSIONS to be measured at one site on a straight uniform section, preferably across a riffle

LEFT BANK		Banktop width (m)		RIGHT BANK	
Banktop height (m)		Water width (m)		Banktop height (m)	
Embanked height (m)		Water depth (m)		*Embanked height (m)*	

If trashline lower than banktop break in slope, indicate: height (m) width (m)

Bed material at site is: consolidated (compact) ☐ unconsolidated (loose) ☐ unknown ☐

Location of measurement is: **riffle** ☐ run or glide ☐ other ☐ *(tick one box)* ***Slope (IFE only)***

M ARTIFICIAL FEATURES *(use 卌 Indicate total number, tick "none" where appropriate)*

None ☐ Number of Culverts = Weirs = Outfalls = Fords =

Footbridges = Roadbridges = Other =

Is water level controlled by weir/dam downstream? No ☐ Part of site ☐ Most/whole of site ☐

N EVIDENCE OF RECENT MANAGEMENT *(Tick appropriate box)*

dredging ☐ mowing ☐ Other? State .....

weed-cutting ☐ enhancement ☐

O FEATURES OF SPECIAL INTEREST *(Tick appropriate box(es))*

CHANNEL		FLOODPLAIN (50m corridor)				
Waterfalls > 5m high	☐	Artificial open water	☐	Bog	☐	Other (state).....
Braided/side channels	☐	Natural open water	☐	Carr	☐	
Debris dams	☐	Water meadow	☐	Marsh	☐	
Leafy debris	☐	Fen	☐	Flush	☐	

P CHOKED CHANNEL *(Tick one box)*

Is 33% or more of the channel choked with vegetation? NO ☐ YES ☐

Q NOTABLE NUISANCE PLANT SPECIES *(Use ✓or E)*

Giant Hogweed ☐ Himalayan Balsam ☐ Japanese Knotweed ☐ Other? ☐ State .....

R BRIEF DESCRIPTION *(Use prompts and key words as appropriate)*

Descriptive sentence:

Plants of note:

Major conservation features:

Major impacts:

Incidental observations (animals etc.):

S DISEASED ALDERS *(Tick one box)*

None ☐ Present ☐ Extensive ☐ Other diseased trees? State.....

SEND COMPLETED FORM TO HUGH DAWSON, IFE, RIVER LABORATORY, EAST STOKE, WAREHAM, BH20 6BB

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GLOSSARY

Cascade
Chute flow occurring over boulders or bedrock outcrops.

Coarse woody debris
Trees, large branches etc., swept downstream and temporarily occupying part of the channel.

Culvert
Underground structure, often circular, for carrying water.

Embanked
Artificial embankment to increase the banktop height.

Emergent reeds
Narrow-leaved monocotyledons (reeds/sedges/rushes) rooted below water or along water's edge, e.g. *Sparganium erectum, Schoenoplectus, Typha, Phragmites, Glyceria maxima, Juncus* spp., *Carex* spp.

Eroding cliff
Vertical or near vertical river bank cliff, often undercut, showing a clean earth face.

Extensive
Feature occupying at least a third of an RHS site.

Floating-leaved vegetation
Rooted in river bed but with floating leaves, e.g. *Nuphar lutea, Potamogeton natans, Sparganium emersum.*

Free-floating vegetation
E.g. *Lemna* spp., *Hydrocharis, Ceratophyllum, Stratiotes.*

Glide
A distinct length of river where water moves effortlessly in a 'smooth' fashion.

Mature island
Permanent mid-channel feature often with established scrub and trees, at or above flood level height.

Mid-channel bar
Distinct, exposed deposit in mid-channel. Unvegetated bars usually comprise loosely packed gravels and sands. Vegetated bars have >50% of their area occupied by perennial vegetation, often reedgrass.

NRA
National Rivers Authority.

NWC
National Water Council.

Point bar
Coarse or fine exposed deposit on the inside of distinct meander bends. Point bars with >50% covered with plants defined as 'vegetated'.

Pool
A distinct feature of deeper water. In dry-weather conditions, there is no perceptible flow. Back currents may be present. Pools are mainly central or occupy most of the channel width.

Reinforced bank
Whole or parts of bank artificially strengthened for bank protection purposes.

Resectioned (reprofiled) bank
Profile modified but not reinforced, often to accommodate flood flow and access for maintenance machinery. Normally a relatively smooth, angled slope.

RHS
River Habitat Survey.

Riffle
Fast-flowing water with distinctly disturbed surface, forming unbroken standing waves usually over gravel. Spans most of the channel width but may be diagonal in sinuous streams.

Rapid
Area of broken standing waves, forming whitewater, normally over cobble or boulder substrate.

Segment
A length of river with similar physical characteristics. In RHS, these characteristics can be predicted on the basis of geology, slope, altitude and size. Segment type is used for national reporting purposes; segment sub-type or variant for site-specific purposes.

Semi-natural
A condition where the river channel and banks are artificially modified at no more than one spot check per RHS site.

Side bar
Distinct exposed deposit of coarse or fine unconsolidated material found along the base of a bank in locations other than the inside of meanders. 'Vegetated' if plants occupy more than 50% of area.

Spot check
One of ten equidistant points at which physical and vegetation features of the river channel and banks are recorded during RHS, using transect widths of 1m and 10m for physical and vegetation features respectively.

Spraint
Otter faeces.

Submerged vegetation
Rooted and completely submerged channel plants. Includes submerged *Nuphar, Elodea* spp., *Callitriche* spp.

Terrace
An old glacial or river deposit which has been eroded, forming a distinct step or terrace in a valley.

Waterfall
A feature of bedrock channels. Free-fall flow which separates from rock and normally spans most of the channel width.

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The NRA is committed to the principles of stewardship and sustainability. In addition to pursuing its statutory responsibilities as Guardians of the Water Environment, the NRA will aim to establish and demonstrate wise environmental practice throughout all its functions.

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