Monitoring the Otter

Lutra lutra

Conserving Natura 2000 Rivers

Monitoring Series No. 10

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Conserving Natura 2000 Rivers

This protocol for monitoring the otter (*Lutra lutra*) has been produced as part of **Life in UK Rivers** – a project to develop methods for conserving the wildlife and habitats of rivers within the Natura 2000 network of protected European sites. The project's focus has been the conservation of rivers identified as Special Areas of Conservation (SACs) and of relevant habitats and species listed in annexes I and II of the European Union Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) (the Habitats Directive).

One of the main products is a set of methods for monitoring species and habitats, which complements reports containing the best available information on their ecological requirements. Each report has been compiled by ecologists who are studying these species and habitats in the UK, and has been subject to peer review, including scrutiny by a Technical Advisory Group established by the project partners. In the case of the monitoring techniques, further refinement has been accomplished by field-testing and by workshops involving experts and conservation practitioners.

Conservation strategies have also been produced for seven different SAC rivers in the UK. In these, you can see how the statutory conservation and environment agencies have developed objectives for the conservation of the habitats and species, and drawn up action plans with their local partners for achieving 'favourable conservation status'.

Life in UK Rivers is a demonstration project and, although the reports have no official status in the implementation of the directive, they are intended as a helpful source of information for organisations trying to set conservation objectives and to monitor for 'favourable conservation status' for these habitats and species. They can also be used to help assess plans and projects affecting Natura 2000 sites, as required by Article 6.3 of the directive.

Favourable conservation status

The purpose of designating and managing SACs is to maintain at, or restore to, 'favourable conservation status' the habitats and species listed on annexes I and II of the directive.

The conservation status of a natural habitat can be taken as favourable when:

- Its natural range and areas it covers within that range are stable or increasing.
- The specific structure and functions necessary for its long-term maintenance exist and are likely to exist for the foreseeable future.
- The conservation status of its typical species is favourable.

The conservation status of a species may be taken as favourable when:

- Population data indicate that the species is maintaining itself on a long-term basis as a viable component of its natural habitats.
- The species' natural range is neither being reduced nor is likely to be reduced for the foreseeable future.
- There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

The conservation status of a species or habitat has thus to be assessed across its entire natural range within the European Union, in both protected sites and the wider countryside, and over the long term.

Monitoring techniques

The Habitats Directive requires the condition of the habitats and species for which an SAC has been designated to be monitored, so that an evaluation can be made of the conservation status of these features and the effectiveness of management plans. An assessment of conservation status must, therefore, be applied at both site and network level.

Standard monitoring methods and a coherent assessment and reporting framework are essential to allow results to be both compared and aggregated within and across EU member states.

While the directive outlines the data reporting required from member states at a national level, it did not set out detailed assessment techniques for data collection at habitat and species level.

The Conserving Natura 2000 Rivers series of monitoring protocols seeks to identify monitoring methods and sampling strategies for riverine species and the *Ranunculus* habitat type that are field-tested, cost-effective, and founded on best scientific knowledge.

Titles in the monitoring and ecology series are listed inside the back cover of this report, and copies of these, together with other project publications, are available on the project website: www.riverlife.org.uk.

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Section 1: Protocol for otter monitoring in SACs

1 Background

This protocol is designed to provide the practical information needed to undertake the monitoring of otters in Special Areas of Conservation (SACs) as required under the Habitats Directive. The directive requires not only that the status of the species be assessed but also the condition of its habitat.

It is important to recognise that, for otters, it is not possible to fulfil the directive's requirements exactly owing to two factors:

- The impossibility of determining the otter 'population' in a cost-effective way.
- The otter's tolerance of a very wide range of habitat conditions. A more detailed discussion of these problems is presented in Section 2.

This document describes how to achieve two main objectives:

- Monitoring the distribution of otters in an SAC by searching for signs of their presence at a series of sampling points throughout the catchment.
- Detecting changes in the habitat which might affect otters – particularly changes in potential food supply.

2 Monitoring otters

It will be necessary to identify approximately 60 sites in each SAC that will be monitored for signs of otters. It is desirable to split up large SACs into sub-catchments or sections, and a total of 60 sites is needed for each of these.

Otters frequently deposit spraint under or near bridges, where footprints are also frequently found. Since bridges are also easily accessible, most monitoring sites will consist of a bridge and the adjacent banks within 50 m.

A preliminary survey will be required to identify suitable bridges where spraint sites can be found or artificial ones provided if necessary. During this survey, sufficient information will be collected to determine whether or not a particular bridge should be used and to enable future surveyors to locate spraint sites quickly.

Subsequent monitoring surveys will be undertaken, annually at first, then at intervals of three years.

2.1 Preliminary survey

2.1.1 Preparatory work

- On large catchments, make provisional decisions about division into sub-catchments and sections.
- In the UK, identify location of sites used in the National Survey that should be always be used as monitoring sites unless they are unsuitable. Information on these should be available from the relevant conservation agency.
- Use 1:50,000 maps to locate public road bridges.

- Record grid references.
- Identify any large gaps between bridges and look for alternative sites to fill these – for example, private roads or footpaths leading to bridges or weirs. Aim to minimise time to reach site from car.
- Assess number of sites and determine whether there is a need to find additional sites, or to select from a surfeit. Approximately 60 sites are needed for each section of the catchment to be monitored. Aim for 80–100 sites for the preliminary assessment.
- Where there is a shortfall, consider including sites from adjacent catchments.
- Where there are substantially more sites than required, a sampling mechanism is needed. Since statistical analysis can be undertaken with non-parametric tests, a strategy should be devised to achieve even coverage of the area.

2.1.2 Surveyor experience

It is essential to use a surveyor who has sufficient experience to be able to confidently find and identify otter spraints and footprints.

2.1.3 Equipment

- **Recording forms**. One per site plus spare copies (example in Appendix C).
- **Ordnance Survey maps**.
- **Thigh waders**.
- **Sturdy 'wading' stick**. A ranging pole is a suitable substitute and may be used as a scale in photographs.
- **Safety vest**. For road safety.
- **Camera**. Preferably digital.
- **Global Positioning System (GPS)**. Not essential but helpful in confirming locations in areas where roads are small and landscapes relatively featureless (mainly uplands).
- **Binoculars**. Not essential but make it possible to inspect potential sprainting sites from a distance or to check mud or sand banks for footprints.
- **Torch**. For searching in culverts and under bridge arches.

2.1.4 Health and safety matters

The employer's health and safety guidance on working in rivers should be used as the basis for fieldwork. The following matters should also be taken into consideration:

- Waders will be needed for many sites. Chest waders are not required for this work and should not be used on safety grounds. A stout stick approximately 1.5 m long may be used for testing water depth and providing additional stability.
- Since survey sites will be mainly based on bridges there is also a need to be aware of road hazards. High visibility jackets or vests should be worn and safe parking places should be identified during preliminary visits.

2.1.5 Surveying

Access

It is often difficult to determine where permission for access is required before visiting a site. At some sites it will be possible to carry out a preliminary survey without going on to private or enclosed land. Elsewhere enquiries at a local house or farm at the time of survey should be sufficient. Note information on ownership and any requirements for permission on the recording form.

Carry out a preliminary survey of each site to decide which sites to use and which sites can be omitted, and record information to facilitate future surveys. Recording forms (example appended) should be used to provide sufficient information to ensure that a risk assessment can be carried out and that a different person would be able to carry out the survey in future years.

At each site the immediate vicinity of the bridge should be searched for potential spraint sites (dry bridge arches, rocks, ledges, tree roots, etc.) and places where otter footprints might be recorded (mud and sand banks - which are also sometimes used as spraint sites).

Record

- Ease of physical access.
- Need for permission for access.
- Presence or absence of otter signs and location of likely sites for these.
- Whether site is suitable for finding spraints or footprints during summer.
- Whether it could be made suitable by providing artificial sprainting site.
- If so, type of artificial site recommended and suggested location.
- Surveying conditions: potential hazards (e.g. deep water, fast roads).
- Safe parking places.

Photographs

Photographs of the site can be a useful *aide memoire* when checking results and can also be used to show the position of potential spraint sites away from the bridge itself. It is essential to record frame numbers on the recording form.

2.1.6 Following the survey

- Plot sites using a Geophysical Information System (GIS). Use sub-catchment overlay to assess areas where site density may be high.
  No sub-catchment to have less than 60 sites.
- Use information recorded in preliminary survey to make decisions on omitting sites if density is too high in some areas. Spacing of 1–3 km is preferred. Where necessary, ensure that there are more than 60 sites for each sub-catchment to be monitored.
- Make arrangements for installation of artificial spraint sites if necessary.

2.2 Monitoring surveys

2.2.1 Timing and frequency

Surveys should be carried out between May–September when water levels are less variable. In order to build up a baseline of data, surveys should be carried out annually for the first five years and then at three-year intervals.

Surveys should not be carried out during periods when there is heavy rain. Ideally, there should be a period of at least five days without rain before surveying.

2.2.2 Preparatory work

Obtain copies of the recording forms filled in during the preliminary survey, selecting only the sites chosen for regular monitoring. Mark survey sites (including reference numbers) on 1:50,000 Ordnance Survey map.

2.2.3 Equipment

As for preliminary survey, except that copies of the original survey forms are required as well as recording forms (example in Appendix D).

2.2.4 Field work

For each site record only:

- Site reference number.
- Presence or absence of otter signs.
- Number of otter spraints in three categories: Dried fragmented (Df); Dried intact (Di); Not fully dry (Nd).
- Changes in circumstances since preliminary survey.
- Any need for maintenance of artificial sprainting site if present.

Enter results into spreadsheet, recording each site as either 1 = positive or 0 = negative.

2.2.5 Interpretation and analysis

- Plot the distribution of positive and negative sites within the catchment using GIS.
- Examine the distribution of positive records and compare with previous surveys. Some changes in the distribution of positive and negative records are to be expected. If several sites in one part of the catchment change from positive to negative, this should give cause for concern.
- Compare the proportion of positive sites with previous survey. If there has been a decline of 10% or greater, carry out statistical tests. A significant decline of 10% or more should give cause for concern.
- Where there has been a decline in the proportion of positive sites, or an apparent change in the distribution of otters, the first step should be to determine whether this might be due to survey circumstances. These include changes in surveyor experience compared to previous years, and extreme weather conditions (drought as well as heavy rain or high water). It may be appropriate to resurvey some areas.
- If these factors can be ruled out, a review of the habitat features described below should be the next step.

3 Monitoring habitat

Being large mammalian predators, otters are tolerant of a wide range of habitat conditions (Chanin 2003). In order to determine whether their habitat is in favourable condition, only two main factors need to be considered: food supply and pollutants.

Food supply may be measured directly by monitoring fish populations, or assessed indirectly by looking at changes in water flow rate, water quality or to the natural structure of the river channel.

The environment protection agencies monitor a wide range of pollutants at a large number of sites, generating considerable quantities of data. Analysis and interpretation of these data is best done by specialists. For example, in the UK, the Environment Agency's National Centre for Ecotoxicology and

Hazardous Substances produces an annual report on pesticides in the aquatic environment. On these grounds the impact of toxic chemicals on otters in SACs is best assessed at a national rather than a local level.

In the UK, consideration of favourable condition for otters also include reference to anthropogenic mortality (mainly road casualties). This is not considered to be a problem in most areas and monitoring is not mandatory. Where it is thought that there may be a problem, it is recommended that efforts should be made to record all road casualties to enable the identification of sites where mitigation measures might be necessary.

3.1 Food supply – direct measurement

Populations of some species of fish are monitored by the environment protection agencies in each country (together with the Scottish Fisheries Co-ordination Centre, which co-ordinates the monitoring of salmonid fish in Scotland). Policies and strategies for monitoring fish populations differ between countries but, owing to the requirements of the Water Framework Directive, are currently under review.

It will be necessary to approach the local office of the appropriate agency to determine the nature and extent of fish monitoring within each SAC. The advice of local fish biologists should be sought to determine whether the extent of monitoring is adequate to detect significant changes in the food supply for otters. Where there are sufficient sampling sites within a SAC, data on the main fish species present should be used. Elsewhere it will be necessary to use indirect measures of food supply.

Targets:

- Fish stocks appropriate to the nutrient status of the river.
- No significant decline in fish biomass or species diversity.

3.2 Food supply – indirect measurement

3.2.1 River channel 'naturalness'

Man-made changes to river channels lead to simplification of the natural structure that is very likely to reduce both biodiversity and biomass. This will lead to reduced food supply for otters. It follows that increases in the extent of modifications to natural channel structure will lead to less favourable conditions for otters.

The Environment Agency collates data from the River Habitat Survey, which covers the whole of the UK and from which is derived a Habitat Modification Score (HMS). Scores of eight or lower describe sites where the channel is pristine, semi-natural or predominantly unmodified, and it would clearly be preferable for all sites within SACs to fall within these categories.

Data may be obtained from local offices of the appropriate environment protection agency.

Target:

- No reduction in Habitat Modification Score either overall or for individual sites.

Water flow rate

Although significant reductions in flow rates are also likely to lead to reduction in food supply for otters, under natural conditions flow rates very a great deal between months and years, as well as between different types of catchment. The environment protection agencies have sophisticated systems for recording flow rates and accumulate considerable volumes of data each year, which are available in summarised form. Interpretation of these data requires some care.

It is most likely that comparisons of monthly (or seasonal) mean flows between years will show whether or not significant changes are occurring, but it is also likely that detecting these against natural variation will require specialist advice.

Under the circumstances it will be necessary to approach the local office of the appropriate agency, not only to obtain data but also for advice on assessing changes in flow.

Target:

- No long-term reduction in flow.

Water quality

Otters are not directly affected by water quality and will forage in conditions that seem extremely unpleasant to humans. However, where deterioration in water quality leads to a deterioration in food supply there will clearly be an indirect effect.

Environment protection agencies regularly monitor water quality to satisfy a number of legal requirements. Measurements include physical, chemical and biological parameters. The simplest and most relevant measure as a surrogate for food supply for otters is the biological class. This is recorded on a six-point scale from A (Very Good) to F (Bad).

Data are available from local offices of the respective agencies.

Targets:

- No decline in biological class if 'Good' or 'Very good'.
- Improvement in biological class if 'Fairly good' or worse.

3.2.2 Timing and frequency

Clearly, there is a need to review these habitat features at least once during each reporting cycle of six years. However, the extent to which the data available will be up to date depends on the nature of the information and the monitoring strategy employed by the environment protection agency concerned.

Some data are collected on a daily basis (river flow), some regularly through the year (water quality) and some at intervals of one or more years (RHS data and fish monitoring).

In addition to carrying out a review when required for the reporting cycle, it should also be undertaken where otter monitoring surveys reveal a significant decline in positive sites or otters appear to have stopped using part of a catchment.

4 Monitoring protocol summary

4.1 Monitoring otters

4.1.1 Preliminary survey:

- On large catchments, make provisional decisions about division into sub-catchments and sections.
- Use 1:50,000 maps to locate all public road bridges.
- Record grid references for GIS.
- Assess number and distribution of bridges and determine any gaps > 5km between bridges or potential shortfall in number of sites.
- Look for alternative sites to fill these gaps – for example, private roads or footpaths leading to bridges or weirs. Aim to minimise time to reach site from car.
- Where necessary, include sites from adjacent catchments to ensure that a minimum of 60 can be monitored (aim for 80–100 sites for preliminary assessment).

- Carry out preliminary survey of sites to facilitate future surveys and record sufficient information to ensure that someone else can carry out the survey.
- Record:
    - Ease of access.
    - Presence or absence of otter signs and location of likely sites for these.
    - Whether site is suitable for finding spraints or footprints during summer.
    - Whether it could be made suitable by providing artificial sprainting site.
    - If so type of artificial site recommended and suggested location.
    - Surveying conditions: potential hazards (e.g. deep water), need for waders, etc.
    - Safe parking place.
    - Take photographs.
- Plot sites on GIS. Use sub-catchment overlay to assess areas where site density may be high. No sub-catchment to have less than 60 sites. Amalgamate as necessary.
- Use information recorded in preliminary survey to make decisions on omitting sites if density is too high in some areas. Spacing of 1–3 km preferred. Ensure more than 60 sites for each area to be monitored.
- Make arrangements for installation of artificial spraint sites where necessary.

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4.1.2 Monitoring surveys

Obtain copies of recording forms for original survey.

For each site record only:

- Site number.
- Presence or absence of otter signs.
- Number of otter spraints in three categories: Dried Fragmented (Df); Dried intact (Di); Not fully dry (Nd).
- Changes in circumstances since preliminary survey.
- Any need for maintenance of artificial sprainting site if present.

Enter results into spreadsheet, recording each site as either 1 = positive or 0 = negative. Carry out statistical tests as advised.

4.2 Monitoring habitat

Prepare base maps for SAC in ArcView or MapInfo. These should include:

- Major geographical boundaries for orientation (e.g. coast).
- Rivers.
- SAC boundary.
- Sub-catchment boundaries.

Ensure you have access to main GIS resources:

- RHS database.
- Pesticide monitoring sites.
- Recent aerial photographs covering catchment.

4.2.1 Assessment:

Food supply – direct measures

- Fish – obtain data from relevant environment protection agency monitoring programme where available.

Food supply – indirect measures

Habitat modification:

- Calculate Mean HMS and compare with previous results
- Plot HMS data from RHS database using HM Classes where
  - HMC = 1 = semi-natural
  - HMC = 2 = predominantly unmodified
  - HMC = 3 = obviously to severely modified

Abstraction:

- Direct monitoring not feasible, but there should be input from the Catchment Abstraction Management Scheme (CAMS) process.

Section 2: Review of assessment techniques and protocol rationale

1 Introduction

In this section, existing methods available for detecting, monitoring and counting otters are briefly reviewed and the 'Standard Otter Survey' method is considered in some detail. The protocol for monitoring otters in small areas, such as SACs, is recommended, using a higher density of sites but reducing the effort at each. This may be achieved by selecting sites where the chances of finding signs are high or can be manipulated to increase them. This will enable statistically useful information to be recorded without requiring excessive resources although it is more suitable for making comparisons over time within one area than to making comparisons between areas.

Statistical approaches to detecting changes are described in Appendix A. In Appendix B we report on a preliminary survey of an SAC in southwest England to test the viability of the proposed monitoring scheme.

1.1 Monitoring otter populations

Monitoring populations of small, numerous organisms or those that only travel short distances is much easier than monitoring populations of otters, which are relatively large and can cover considerable distances in their daily travels. In one day an otter may travel along several kilometres of a river, and its home range is likely to extend over tens of kilometres. Therefore, monitoring populations of otters within single catchments presents considerable difficulties. For example, two candidate SACs (cSACs), the rivers Camel and Itchen, are both of a size that might accommodate one or two male otters and up to three females, assuming territory sizes are similar to those on Scottish rivers. This is hardly a viable, self-sustaining population unless otters also live in adjacent river systems.

It is only on large catchments that the numbers of otters will be sufficient to form sustainable populations and, even then, there are likely to be many animals that move between adjacent catchments. It is important to recognise, therefore, that the monitoring of otter 'populations' is not a realistic aim for most SACs.

2 Methods of assessing otter numbers

2.1 Direct observation of animals

Although otters are mainly nocturnal, cryptically coloured and sparsely distributed, there have been a few studies in which information on European otter populations has been gained through direct, systematic observations. The methods require a substantial investment of time and personnel and are not suited to long-term monitoring, but useful data have been obtained.

2.1.1 Systematic watches

In Shetland, Hans Kruuk and colleagues (Kruuk 1995) took advantage of the fact that coastal otters are usually diurnal in habit and forage close to the shore. Over a period of several years they used small numbers of observers to build up information on the resident female otters of a relatively small area (approximately 16 km of coast on the Lunna Ness Peninsula). Diet, home range size and organisation, den use, breeding and population size were recorded and, although less information on male otters was collected, the ratio of adult breeding females to other otters was determined.

Some of these data were then used to determine the total population of otters in the Shetland Isles, by counting the number of active dens in 5 km stretches of coastline. Two sample surveys covering approximately a third of the coast were carried out in 1988 and 1993, and revealed an increase in the estimated otter population over that period (Conroy & Kruuk 1995).

Kruuk and his colleagues supplemented these data with information from radiotracking otters. However, trapping and tracking are more suited to obtaining information about individuals than about populations.

In Spain, Ruiz-Olmo and others (Ruiz-Olmo *et al*. 2001) attempted to use direct counts of otters to estimate the population in a river catchment. By placing observers at 500 m intervals along a river and carefully comparing times when otters were observed, estimates of the minimum number present were determined. In an attempt to validate the technique, Ruiz-Olmo *et al.* (2001) used it in an area where a known number of otters had been released as part of a re-introduction programme.

Although Ruiz-Olmo *et al.* (2001) concluded that all otters present could have been seen if they were in the visual field of their observers, it was not made clear whether or not all were seen. The results do not show clearly the relationship between the numbers of otters known to be present and the number seen. Given the difficulties of observing otters, particularly in places where there is overhanging vegetation, the technique would seem to have limited value in monitoring otter populations in UK rivers.

2.1.2 Remote cameras

Tim Sykes (pers. comm.) has used a single, fixed video camera to record the movements of otters under a mill in central Winchester. On some occasions the 'genetic' identity of the otter recorded was determined by DNA fingerprinting from spraint deposited *en route*. Similarly, members of Wildcru (University of Oxford) have used video recorders to monitor the movements of otters under bridges in an attempt to understand factors leading to road casualties.

This technique does enable one to record groups of animals travelling together, which has potential for not only confirming the presence of breeding females, but may also provide information on the size of family groups. In some areas, otters have distinctive and variable marks under the chin (like mink) so there may also be potential for identifying individuals. However, there are problems of getting clear close-up pictures of this part of the body in a living animal, and it is probably impractical.

Road kills

There is good evidence from southwest Britain to show that, as the otter population expands within an area, the number of road casualties increases (Figure 1). However, the relationship between the two is not linear and is confounded by many factors, including different levels of rainfall in different years (flooding seems to lead to higher casualties), and changes in the number of people reporting dead otters.

Over a period of time considerable numbers of otter casualties may occur in a region, or even on one catchment. Thus, between 1988 and 2000, more than 200 otters were recorded as road casualties in Devon and Cornwall, and by the end of this period approximately 35 were being reported each year. This provides a substantial and useful sample at the regional level.

Over the same period 34 otter casualties were recorded from the river Exe catchment and 20 on the River Taw. The only SAC in the region, the river Camel, had 14 casualties plus another six in the headwaters of adjacent catchments (and therefore potentially part of the same population). These catchment samples are too small to detect demographic trends, but could provide information on pollutant burdens, so therefore form an important resource for monitoring the population of an SAC.

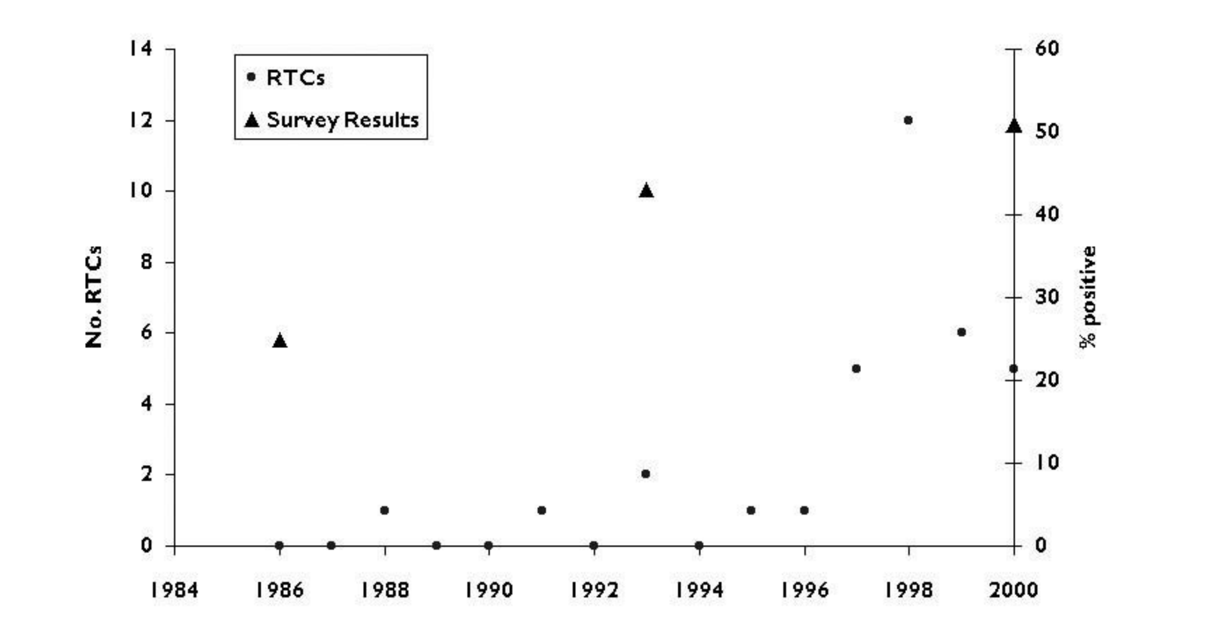

Figure 1. Otter Casualties on the River Exe from 1988, and results from the second, third and fourth national otter surveys (RTCs = road traffic casualties).

2.2 Dens

From their work on the Lunna Peninsula on the east coast of Shetland, Kruuk *et al.* (1989) were able to demonstrate a relationship between the density of active otter dens and the number of breeding females in the area. Since they also knew the ratio of breeding females to other otters they were able to devise formulae for calculating the numbers of otters on Shetland from the number of dens.

They divided the coast of Shetland into 5 km sections and, using a one-third sample survey, calculated that the population in 1988 was between 700 and 900 otters (estimated as 718 adults). The survey was repeated five years later (after the oil spill from the MV Braer), revealing a significant increase in otters to between 800 and 1,050 individuals (an estimate of 836 adults) over the archipelago as a whole, although the animals were scarce in the immediate vicinity of the Braer.

This technique clearly has value in some coastal areas but is not applicable to rivers where otters have much large home ranges and many more den sites. Although it has potential value in monitoring populations in coastal SACs, it should be employed with care, since the relationships between den use and the number of breeding females may not apply in areas where the shoreline has a different overall structure to the Shetland Isles, where a layer of peat covers a large proportion of the coast.

2.3 Tracks

Systematic monitoring of otters by tracking them in snow was employed most successfully by Sam Erlinge who, over a period of years, was able to determine the size of the resident population, home ranges, numbers of males and females, and family group size. He also estimated that the proportion of non-residents in his population was 40% (Erlinge 1968).

Elsewhere in Europe and North America other otter populations have been monitored by tracking in snow and attempts have been made to determine actual numbers, though the methods used to discriminate between individuals is rarely reported in detail.

Tracking in snow has little or no value in the UK, but Bonesi & Macdonald (in prep) have investigated he relationship between the presence of field signs (mainly footprints) and the abundance of mink determined by live trapping. They found a positive correlation between mink abundance and the proportion of sections of river with mink signs within them (apart from during the breeding season). They also found a weak, but significant, correlation between the abundance of 'soft verges' suitable for revealing footprints, and the numbers of footprints recorded.

A similar relationship between the abundance of footprints and availability of suitable surfaces was found for otters. However, they were unable to determine the abundance of otters, so it was not possible to investigate the relationship between otter numbers and the abundance of signs.

In Spain, Ruiz-Olmo *et al.* (2001), working with fairly small numbers of re-introduced otters, were able to discriminate between individuals on the basis of footprint size. They found that there was a correlation between the number of otters detected by fresh tracks and the number seen during visual censuses. However, this method is only likely to be useful where there are few otters that are known to have different-sized feet. This would probably only be known in the early stages of a re-introduction programme, not during natural recolonisation.

As otter footprints are very distinct, they are used as evidence of otters during national surveys, which use signs to indicate only presence or absence, rather than the abundance, of otters. During surveying, spraints are generally recorded more frequently than footprints, but there are times when otter footprints may be detected in places where suitable sprainting sites are not present (for example in small culverts).

It is possible to improve the chances of finding footprints by manipulation. The use of tracking boards for small mammals (including small mustelids) is well known, and David Jenkins (pers. comm.) used prepared surfaces on otter trails in Scotland to make it easier to find and measure the size of otter footprints. A number of people have tried to used the size of prints to differentiate between individual otters, but it is difficult to overcome the problem of varying consistency of substrate, and it is probably not advisable to do more than identify the three categories recognised by Erlinge (1967):

- Large prints = males
- Medium sized prints = females or subadult males
- Small prints = juveniles.

2.4 Spraints

2.4.1 The 'standard' survey

In Europe the most frequently used technique for detecting the presence of otters, and in some cases estimating their abundance or relative abundance, is to search for spraints. Over the past 25 years a 'standard' survey method has evolved, based on recommendations made by Sam Erlinge and first adopted on a large scale for the national surveys of Britain and Ireland.

Essentially, 600 m lengths of river are selected at intervals of 5–8 km and searched for evidence of the presence of otters. At each site the presence or absence of otters is recorded together with a wide range of habitat features. Results are usually expressed in terms of percentage positive sites, whether in describing the data for a country, a region, or a catchment, or some artificial unit such as a 100 km square, a 50 km square, etc.

The rationale for the survey method was originally based on Erlinge's observations of otter activity in Sweden. Most home ranges of family groups that included lakes within their boundaries were found to extend over distances greater than 5 km, and those on rivers were larger (Erlinge 1967). Therefore, the chances of a home range lying entirely between two survey points was low. Erlinge (pers. comm.) also found that where otters were present, the chances of finding spraint within 600 m was high. For the various British national surveys it was normally possible to find a bridge crossing rivers at such intervals. It was also clear that surveys at this frequency in a British context led to reasonably large sample sizes in the smallest areas used for comparison – 50 km squares in England and Ireland, hydrometric areas in Wales and administrative regions in Scotland.

By virtue of its wide use – particularly following its export to continental Europe by Chris Mason and Sheila Macdonald – it has become the *de facto* 'standard method' and was recognised as such in a major review of surveying methods carried out by Reuther *et al*. (2000). Strachan & Jefferies (1996) provide a good overview of the method and the ways in which the data may be used.

In Britain, sites suitable for surveying are mainly selected for ease of access and are usually adjacent to, or centred on, bridges. This enables a higher number of sites to be surveyed per day, and since otter spraints are frequently found beside or under bridges, it maximises the probability of finding signs quickly. Overall, this has resulted in a density of sample sites ranging between five and eight per 10 km square in UK national surveys (Table 1). Between six and 10 sites may be surveyed in a day, depending on the number of surveyors employed (working in pairs increases the rate per day but not per surveyor), length of the working day (summer versus winter), weather conditions, and the nature of the watercourse.

Table 1. Basic statistics for the British surveys

	Approximate no. of sites	Total time (person/years)	Mean sites/10 km^2
Wales[1]	1,000*	2	7.7
England[2]	3,000	2¼	6
Scotland[3]	4,500	4	5.3
Ireland[4]	1,000	2	5.3

* plus about 700 'spot-checks'
[1]Crawford, Jones & McNulty (1979). [2]Lenton, Chanin & Jefferies (1980).
[3]Green & Green (1980). [4]Chapman & Chapman (1982).

2.4.2 What is being recorded?

A significant drawback with the standard survey technique is that it is not obvious what the signs recorded actually represent.

Some authors have described the proportion of sites where signs were found as being the percentage of sites occupied. This is misleading since otters occupy stretches of water extending for many kilometres rather than a few hundred metres. There may be many reasons why signs are not recorded from some sites, including facets of otter behaviour (lack of suitable sites for leaving spraints, for example) or weather conditions (heavy rain washing away signs).

In the absence of any means of calibration, it is clearly not possible to interpret the percentage of positive sites in an area as a measure of population size or density. Nevertheless, if a hundred sites are checked in each of two regions (50 km squares or hydrometric areas, for example) and signs of otters are found at nine sites in one and 90 in another, it is hardly unreasonable to suggest that otters are likely to be both more numerous and more dense in the second of these.

Changes in distribution at the catchment level also suggest that there is a consistent pattern, with signs being found on larger tributaries first, intermediate ones next and the smallest ones last. The results of the first three surveys on the river Exe illustrate this well (Figure 2) and a similar pattern has emerged on the river Eden for the second, third and fourth surveys. This pattern of spread of positive sites seems very likely, to some degree, to reflect changes in actual otter distribution.

Finally, it is notable that between the second and third surveys, very few sites (10 out of 284, or 3.5%) changed from being positive to being negative, indicating a high degree of consistency between surveys. The proportion changing from positive to negative between the first survey and second surveys was much higher (44 out of 170, or 25%) but nearly half of these were in East Anglia, where the population was continuing to decline.

On these grounds therefore, the standard survey method may be regarded as an appropriate method for monitoring otters with our current state of knowledge. It is probably more suitable for comparing results within areas over time than it is for comparisons between areas, at least where the differences are not great. A corollary of this is that one should be more confident that statistically significant differences within areas between different times are biologically more significant than those between areas at one time.

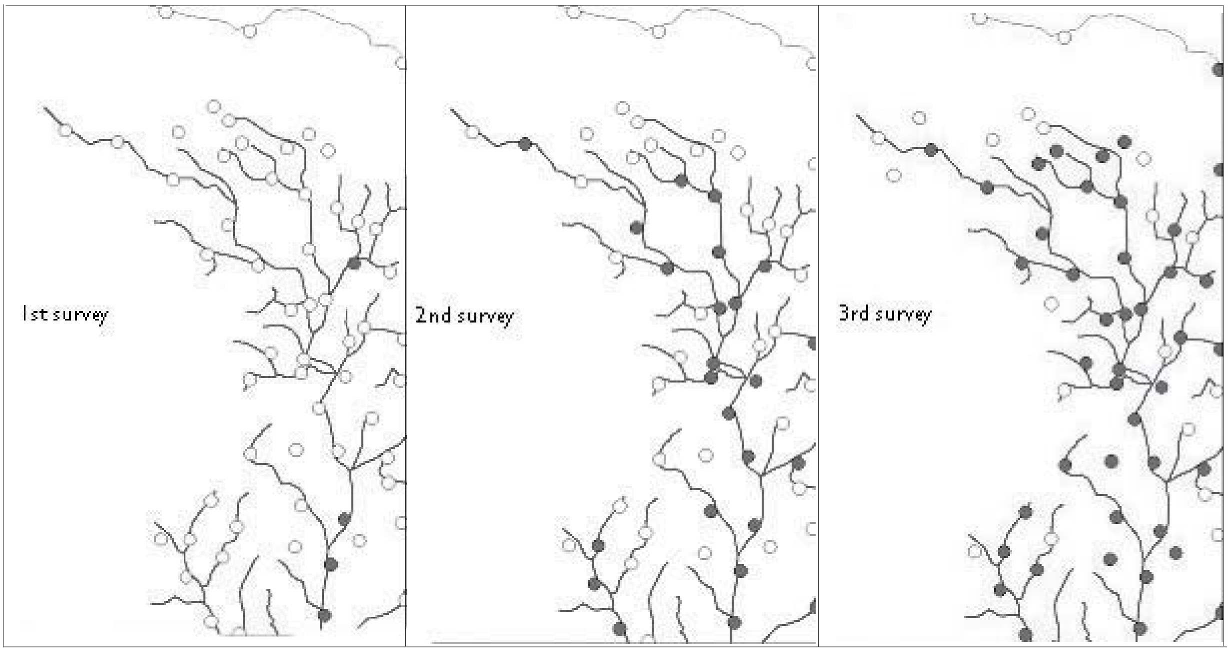

Figure 2. Distribution of positive (filled dots) and negative sites on the Exe.

2.4.3 Variations within the standard survey

There are a number of ways in which the survey technique may vary within the general parameters outlined above:

- Surveying one bank versus both banks.
- Stopping surveying as soon as evidence of otters is found, versus surveying the whole length and counting all spraints.
- Incorporating or omitting spot checks (these are sites where the immediate environs of a bridge are searched and the presence or absence of signs noted but no habitat recording is carried out).
- Recording a full set of habitat data, or less than this.

In all of these there is a trade-off between the gains in time by doing less against the loss of potentially useful information. Reuther *et al.* (2000) concluded that it would be difficult, if not impossible, to prohibit variants, but that it was important that the methods used should be described in full in reports. It is also important that repeated surveys of the same sites should use the same procedures.

There have also been attempts to suggest enhancements to the survey – for example by searching longer stretches (Mason & Macdonald 1987; O'Sullivan 1993a) – and to extract more information from the data, either by using spraint numbers as a refinement (Green & Green 1980; Strachan & Jeffries 1996), or devising an index incorporating both proportion of positive sites and spraint density (Mason & Macdonald 1993).

Survey length

It is not always clear that varying the survey length has real value, or what it actually means. For example, using data from Wales, Mason & Macdonald calculated that by increasing the length of river surveyed at each site to 1 km, the proportion of positive sites could be increased by 12%. However, this means a substantial increase in effort, 40% more river to be surveyed before giving up. If the standard survey method is seen as a means of obtaining an indication of otter distribution and status rather than an attempt to locate every otter, this does not appear to be a prudent use of time. O'Sullivan demonstrated that in Ireland, where a higher proportion of sites were positive, the gain in positive sites was half of that calculated by Mason & Macdonald.

Conversely, the data presented by these authors can also be used to demonstrate the effectiveness of reducing the length of river surveyed. Mason & Macdonald show that 80% of sites which turn out to be positive can be assigned to this category within 100 m of the starting point. In Ireland, O'Sullivan breaks down his data into 50 m lengths and shows that on one river, 66% of sites were identified as positive by searching the immediate vicinity of the bridge (his '0 m' category) and 72% within 50 m. A second river yielded values of 50% and 66% respectively. These data suggest that providing the results of the survey are seen as only as an index, the length of river searched can be dramatically reduced, particularly in areas where otters are reasonably widespread.

Spraint density

Although data from coastal otters in Shetland revealed no relationship between spraint density and otter density, there has been a persistent belief that such a relationship does exist on rivers. There is some indirect evidence to support this, since spraint density is correlated with the percentage of positive sites (Strachan & Jefferies 1996). However, despite a strong correlation, it is not clear how the spraint density provides more information than that derived from the site data.

Mason & Macdonald (1993) derived an 'Annual Index of Population' by combining these two measures in a formula and used this to set a target value for otter populations. This was based on the lower 95% confidence limit of the mean annual index for a population of otters in the Upper Severn catchment. This had been surveyed annually between 1981 and 1991, the population index was relatively constant, and otters were known to breed regularly in the area.

Clearly, an important question is whether the index provides more information than the simpler measure of percentage of sites occupied. To test this, data from Strachan & Jefferies (1996) for the third English National Survey were used to calculate the index, and were then plotted against the percentage of positive sites (Figure 3). There was a very strong correlation between the two measures and only

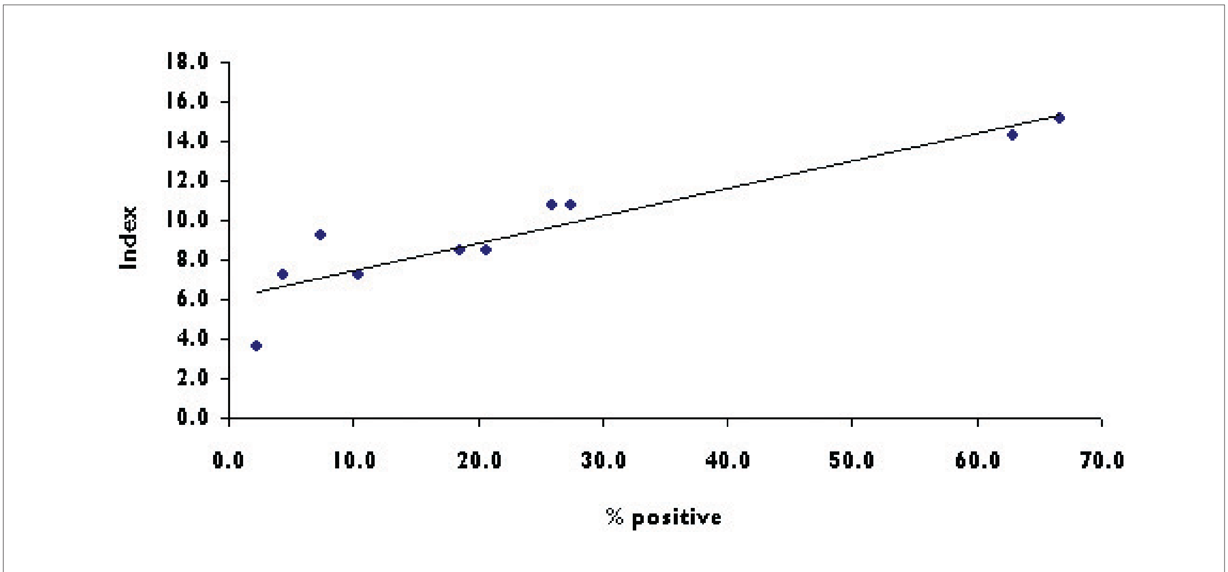

Figure 3. Index of Population plotted against percent positive sites for English regions (from Mason & Macdonald 1993).

two areas yielded index values more than 10% outside the values predicted by the regression. These corresponded to the Thames region, where spraint density was very low (1.2 per site, compared to a minimum of 3.2 for all other areas), and the Anglian region, where spraint density was relatively high (6.1 per site, compared to a maximum of 6.0 for all other sites).

The biological significance of the two outlying values is difficult to discern. At the time of the third survey, otters were recorded at only four out of 180 sites in the Thames region, so the relatively low number of spraints may reflect the fact that when otter populations are very low and there is no interaction between individuals, otters do not use their spraints for signalling purposes. The otter population in the Anglian region is believed to consist mainly of the descendants of animals bred in captivity and released by the Otter Trust. These are scattered fairly widely over the region and the population has not developed by natural spread and breeding as elsewhere.

Nevertheless, the fact that the index generally yields results in line with those derived from simple percentage data suggests that it has rather limited use since it provides little information beyond that obtained from the percentage of positive sites.

2.4.4 Non-standard surveys

Complete searches of long lengths

A number of authors have carried out surveys of long lengths of rivers, usually with a view to determining habitat use by otters (for example, Thom 1997; O'Sullivan 1993b; Bas *et al.* 1984). There are some difficulties with these studies since they generally use abundance of spraint as an indicator of otter activity or habitat use (Chanin 2003), and the substantial investment in time renders the approach impractical for long-term monitoring of river catchments.

Spot checks

During the surveys of England and Wales, surveyors made additional observations by carrying out 'spot checks' at bridges they encountered during their travels. At these sites, the bridge and its immediate environs were searched for evidence of otters. No habitat data were recorded, just the grid reference and whether the survey yielded positive or negative results. In England, constraints of time resulted in these being a relatively small proportion of the total sites surveyed (about 5%). In Wales the proportion was 36% in the first survey, rising to 41% in the third.

Given the results of O'Sullivan's study of the distance at which spraint was first found, one might predict that there would be fewer positive sites from spot checks than full surveys, but that there would be an approximately linear relationship between the two. This appears to be the case. In the third survey Welsh otters were recorded at 53% of full survey sites and 40% of spot checks. In other words, full surveys detected signs of otters at approximately 33% more sites than spot checks, which is in line with the data O'Sullivan reported for two Irish rivers. As the number of spot checks carried out in Wales was fairly large, it is feasible to make comparisons on the basis of hydrometric areas (the scale used for regional comparisons in this survey). These data, which indicate a good correlation between spot checks and full surveys (see Appendix A), suggest that spot checks would be an efficient means of gathering data, since large numbers of sites can be surveyed in a relatively short time, compared to full surveys where long distances have to be walked.

DNA fingerprinting

The fact that DNA can be recovered from otter spraint offers the potential for a dramatic step forward in the study of otter populations. In a pilot project carried out in south and southwest Britain during 1997–8, Coxon *et al.* (1998) detected the presence of at least 13 different otters on the river Itchen and 23 in the Tone catchment. The sex of each animal was already known, and for one individual, repeated identifications provided sufficient information to calculate a minimum home range size.

During the pilot project, approximately 600 spraints were collected. However, despite the fact that only fresh spraints were collected early in the morning, useable DNA was only extracted from 20% of them. In addition, on the River Itchen (a relatively isolated population, resulting from the reintroduction of a small number of individuals), the genetic diversity was so low that there were two pairs of otters that could not be identified separately on the basis of the six primers initially used. One pair of animals was later separated by further analysis with additional primers, and the other by the fact that one (a female cub) was recovered after drowning. Its fingerprint was the same as another animal known to be alive before the female was born and also after her death – possibly her mother.

In the pilot project, volunteers collected spraint and it was possible to determine the effort required to collect sufficient samples to provide useful information. In total, over 1200 man-hours were needed to collect 600 spraints – approximately two man hours per spraint. However, the effort per spraint from which DNA was extracted was five times this – about 10 hours per fingerprint.

Since the pilot project there have been further developments in the extraction and analysis of DNA from faeces and a second project is underway on the River Itchen for a period of one year from May 2002. Preliminary results suggest that new methods of extraction of DNA may yield better results. Useable otter DNA was extracted from 45 out of 47 spraints in the first sample, although it is not yet known how much of this it will be possible to type.

Costs

Cost must be considered carefully when planning a monitoring programme. There is the cost of extracting DNA from otter spraint and the cost of the analytical procedure leading to DNA fingerprinting. It may be necessary to repeat the analysis if there are ambiguities in the results. In addition, the costs involved in collection are significant unless volunteers are used to do this.

Potential for monitoring otter populations

The technique clearly has considerable potential for studying various aspects of otter biology, including monitoring the population. However, it must be emphasized that in many ways DNA sampling from spraint is akin to 'trapping' the animals. Thus, a positive identification locates the position of one animal at one moment in time but gives no information on the status of the animal, and whether it is resident or transient. While the DNA profile will enable the determination of the sex of the animal, unlike trapping, it is not possible to discriminate between adult or juveniles on the basis of a single capture. To elucidate these details one needs a long-term study.

One area in which there may be value in a DNA study might be an investigation of the relationships between spraint density, as recorded during surveys, and the actual population of otters. It seems likely that this will be feasible in areas where otter populations are moderate or high, but it may be difficult to find sufficient spraints where otter populations are low. Nevertheless, once the fingerprinting process has been demonstrated to be reliable, this possibility should be considered.

While there may be some value in collecting suitable spraints during routine monitoring, the limitations of the method need to be borne in mind. In particular:

- The difficulty of obtaining adequate numbers of fresh spraints when sites are only visited once a year.
- The fact that spraint that is not collected first thing in the morning may be degraded and unusable. It is more likely that the technique can be usefully employed in areas where large numbers of volunteers can be persuaded to take part in the collection of spraints (as has happened in Hampshire and Somerset).

3 Monitoring in river SACs

From the above it is clear that the most practical method of monitoring the condition of otter populations in river SACs will involve the recording of signs – mainly spraints and footprints. The main questions, therefore, are whether or not to use the standard survey method and if not, how to devise a suitable protocol.

3.1 Pros and cons of the standard survey

The most powerful argument in favour of using the standard survey is that it is a well-known, well-regarded and well-established technique, which has been used nationally and internationally for many years. Consequently, there is a considerable body of historic data available to enable rigorous statistical testing of the protocol, providing a sound basis for powerful analysis.

On a national and regional scale the standard survey appears to be robust, providing results that are consistent with each other (rates of increase, for example) as well as with perceived changes in otter populations.

There are two main drawbacks to the standard survey. First, it was designed for national surveys and at the local level, small sample sizes make useful statistical analysis difficult, if not impossible. Second, it is very time consuming not only because large distances are covered but also because a considerable amount of habitat data is normally recorded (though rarely analysed).

3.2 The 'spot check' alternative

The relationship between spot checks and full surveys described above suggest that these might provide a useful alternative to the standard survey since, although the results may not be directly comparable, there is a clear statistical relationship between the two when samples sizes are moderately large.

Using spot checks will reduce the time taken to do surveys but in order to overcome the problem of small sample sizes the sampling intervals need to be decreased. The distance between sites in the National survey is normally 5–8 km, and on a large SAC such as the Wye (630 km within the SAC), this results in a total of just over 200 sites (combining English and Welsh surveys). However, most riverine SACs are much smaller than this – for example, on the Camel (69 km) there are only 14 sites. In addition, there are benefits in being able to monitor otters at the sub-catchment level (see below).

For clarity such sites will be described as SAC monitoring sites where necessary below to distinguish them from National Survey sites and (potentially) National Surveillance sites.

3.2.2 SAC extent versus monitoring area

It is clear from diagrams supplied to show SACs in Wales and Scotland that there is not a single approach to designation. Some SACs cover the main stem of a river only (for example, the Tywi or Spey), some the main stem and the main tributaries (such as the Tweed), and some cover most of the tributaries (for example, the Cleddau rivers). There do not appear to be any where the whole catchment is designated, as far as can be determined from the maps, except possibly the Tay, though this is under revision.

Otters will clearly not respect such administrative boundaries and although it is understood that the objective is to monitor otters in SACs, the only ecologically sound approach to this is to consider the catchment as a whole. In some cases (such as the River Mease) monitoring of the whole sub-catchment is recommended.

3.2.3 Sample size on smaller SACs

Clearly there would be a benefit in reducing the distance between sites, at least on smaller SACs, and there is no reason in principle why all bridges on a catchment should not be considered as potential sampling sites. On both the rivers Camel and Itchen for example, 94 and 72 sites could be identified from the 1:50,000 OS Landranger map. These sites consisted of bridges crossed by public roads (other than motorways) together with bridges on roads which were not public but crossed by a footpath and close to a road. By incorporating motorway, rail and some other bridges on private land, Chris

Matcham (pers. comm.) identified a total of 102 potential sites on the river Itchen but, these were not all accessible.

Elsewhere, it may be more difficult to find enough suitable sites. Only 47 could be identified on the River Mease, for example, and in Scotland, where roads are more sparse, small- and medium-sized SACs may present problems. Here the selection of less-accessible sites or the incorporation of sites on adjacent catchments (or parts of them) may be necessary in order to achieve a sufficiently large number of sites for analysis.

3.2.4 Subdividing catchments

On large catchments there may be benefits in dividing the SAC into smaller areas which can be analysed separately. Inspection of the results of the first three National Surveys suggest that on some rivers, the Exe for example, as the otter population recolonises an area, spraints are recorded first on the main river, then the main tributaries and finally the minor tributaries. A different pattern can be detected on the River Severn where the Welsh tributaries flowing from the west were recolonised before those flowing from England to the east.

On some SACs it will almost certainly be necessary to analyse all the data together, owing to the small number of sites available for monitoring. In medium-sized catchments it may be possible to analyse the main stem of the river separately from the tributaries or divide the catchment according to geological, geomorphological or land-use differences. The largest rivers such as the Spey, Tweed, Eden or Wye could be divided into the main river and each of the major tributaries, possibly with subdivisions of the main river as well. Thus the river Wye might be treated as follows:

- Lugg sub-catchment.
- Monnow and Troddi sub-catchments together.
- Main river (including tributaries).
  - Upstream of Builth Wells.
  - From Builth Wells to Hereford.
  - Downstream of Hereford.

3.2.5 Bridge ‘suitability’

Not all bridges have suitable places for depositing spraints, and many factors will determine the proportion that do – bridge design, river size and the nature of the river (upland vs lowland for example). This is likely to lead to regional variations in the proportions of suitable bridges. Generally speaking, the following are likely to provide potential permanent spraint sites:

- Ledges integral with the bridge structure or the bank.
- Areas of sand, gravel or mud under the bridge structure (these may also provide a suitable substrate for revealing tracks).
  - Dry bridge arches.
  - Large natural stones and rocks or brick/concrete debris.

3.2.6 Artificial spraint sites

In some places, there will be opportunities to manipulate this by the provision of artificial sprainting sites. Where the water is deep or inclined to spate, these could take the form of a metal ledge with ramps bolted to the bridge wall (Figure 4). In shallower water an artificial rock spraint site could be constructed, possibly using materials found at the site, or importing blocks of stone as used in bank reinforcement. Although otters will use stone-filled gabions and other manmade materials (such as breeze blocks), aesthetic considerations suggest that these are unlikely to find favour. Environment Agency staff in the Devon conservation team, for example, have argued strongly against the use of gabions. In addition, if these are not filled with large stones they can deteriorate and collapse over time

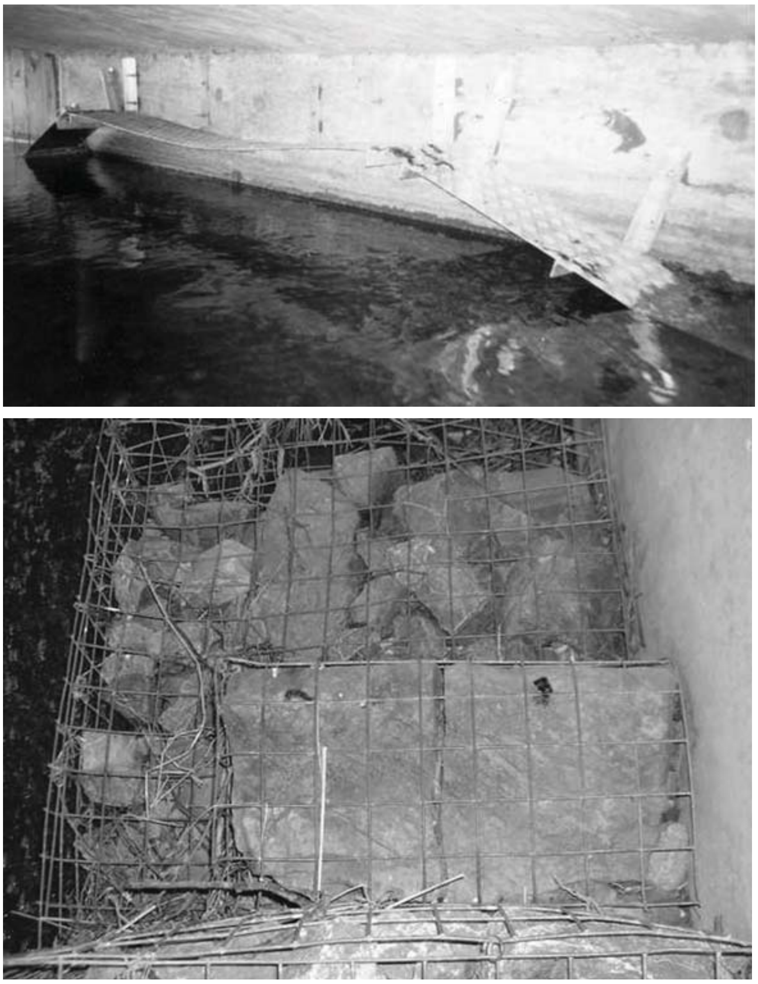

Figure 4. Artificial spraint sites (note presence of spraint on each). Top: Ledge fixed under bridge on the river Itchen. Bottom: Gabion baskets used to enable otters to bypass the weir.

as smaller ones are washed out.

It may be thought that manipulation of otter behaviour in this way might invalidate the survey results. It certainly makes it more difficult to make comparisons between areas where the degree of manipulation may differ. However, the objective here is to monitor within an area, and provided sites are comparable through time, this objective may be achieved.

At some sites where the bridge itself is unsuitable, there may be other potential spraint sites nearby. Since the aim is to maximise the probability of finding spraints while minimising effort, the most cost-effective approach would be to check any potential site within view of the bridge (or perhaps within 50 m). If it has spraint on it or appears likely to, use this site rather than the bridge. This needs to be recorded to ensure consistency between sampling sessions.

3.2.7 Artificial spraint sites in Somerset

James Williams and his colleagues have created a small number of artificial sites and monitored them regularly over periods up to 12 years (some of them daily for much of this time). Figure 5 illustrates the results at one of these.

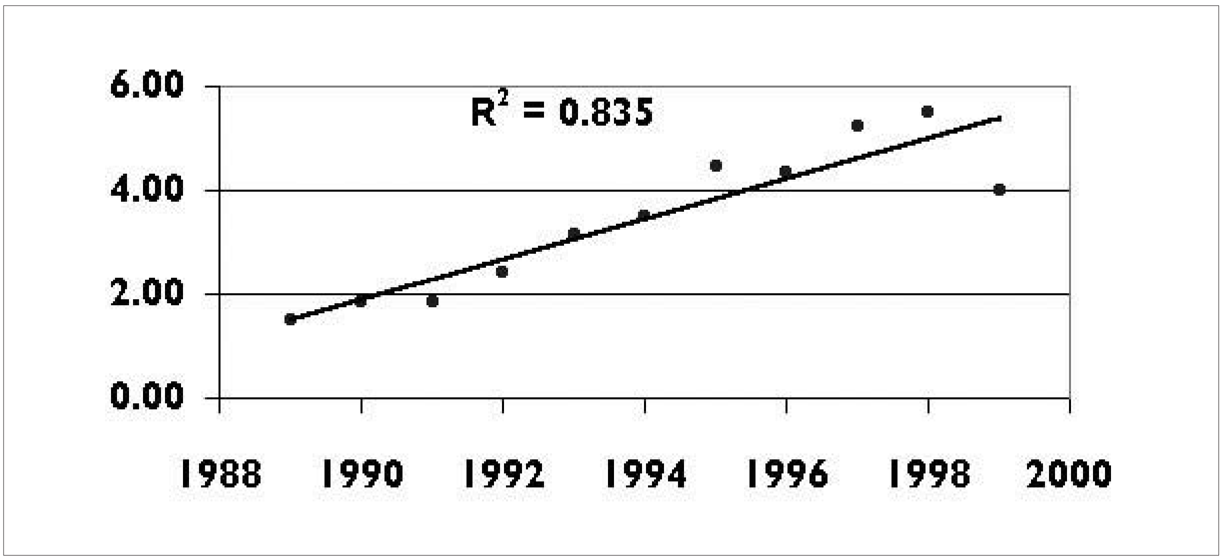

Figure 5. Mean monthly counts of spraints at James Williams' artificial site.

Although there is a clear increase in the number of spraints per month between 1989 and 1998, the number of months when no spraint was recorded was very low (6% from 1990–97). It would appear therefore that artificial sites are readily adopted by otters if placed appropriately. The increase in use with time in James Williams' study may reflect an increase in the otter population, since the River Tone was being recolonised during this period.

Note that the introduction of structures in the watercourse may need consent from the Environment Agency, which should be consulted before any work is carried out.

3.2.8 Minimum number of sites

The number of sites monitored has to be a compromise between the need for a large enough sample to provide statistical robustness as against the availability of sites suitable for monitoring and the time taken to survey them. There are strong statistical grounds for recommending an absolute minimum of 60 sites in one catchment and considerable benefits in aiming to use twice this number.

The rivers Itchen, Mease and Camel represent a range of relatively small river SACs that had between 45 and 95 potential monitoring sites. A preliminary survey of 60 of the sites on the river Camel (about two-thirds) showed that 50 of these were suitable for surveying subject to the installation of artificial sprainting sites at some of them (see Appendix B). A target of 60 sites for this river would seem to be achievable, although it is clear that this would not be possible on the River Mease without using sites on adjacent catchments or searching for suitable sites which were not at bridges. In order to ensure this target is reached it would be advisable to select 70–80 sites for preliminary survey where possible, with a view to discarding those that are difficult to survey or where signs are least likely to be found, and the installation of an artificial sprainting site is impractical.

Needless to say, where catchments are subdivided, the minimum sample size applies to each subdivision.

3.2.9 Sampling frequency

A significant problem with using the SAC monitoring sites is that there are no historic data on which to base confidence limits or determine levels that should trigger a warning. The statistical approach we have adopted (Appendix A) overcomes this by making it possible to make comparisons between only two consecutive surveys. However, it will be beneficial to build up such a body of data as quickly as possible. Initially, therefore, sampling should be carried out annually, for a period of 10 years. This has the benefit of indicating whether the proportion of sites found to be positive is increasing or not.

Following this period (and possibly after five years) it would be prudent to carry out a formal analysis of the data from SACs across the country in order to confirm that the approach that has been adopted is appropriate. Thereafter, surveys may be undertaken at longer intervals of either two or three years.

3.2.10 Timing

The data from James Williams' artificial sprainting site showed no obvious seasonal pattern in the months without signs, nor was there a significant seasonal pattern in the numbers of spraints found.

In a study on the River Torridge, where spraints were counted once a month along a length of 1 km over five years (Hilary Marshall, unpubl. data) there was no significant seasonal variation but there was a significant correlation with water flow in the river.

On these grounds, therefore, there would be considerable benefit in carrying out surveys during May to September when water levels are less variable. This is also the period when water levels are lowest. This has two significant advantages:

- Sand and mud banks are most likely to be exposed and reveal footprints.
- Working in rivers is safer. One of the disadvantages of carrying out otter surveys in the summer normally is that bankside vegetation is at its most dense, making progress along riverbanks more difficult and spraint sites on the bank more difficult to find. These problems

are overcome here by confining searching to the immediate environs of the bridge and pre-chosen, easily accessible spraint sites nearby.

3.2.11 What information should be recorded?

Preliminary surveys

Before monitoring begins, an initial inspection should be carried out at all bridges that have been identified as potential sites. The following should be recorded:

- All potential sprainting sides at bridge and within 50 m.
- Ease of access; safe places to park; survey conditions and hazards (deep water, need for waders).
- Water width and depth. No other habitat recording is necessary.
- Whether an artificial spraint site should be installed, and if so, what type would be appropriate.
- Presence or absence of otter signs (indicative of otter activity only; not to be used in analysis).

It would be beneficial to take digital photographs at each site, partly as an *aide mémoire*, but also to show where artificial sprainting sites need to be installed.

3.3 Monitoring surveys

Once artificial sites have been installed and annual monitoring is under way the only information that should be recorded at each site is:

- Presence or absence of otter signs.
- Number of spraints.
- Whether water levels are higher than normal for the time of year.
- Need for maintenance of artificial spraint sites.

It might be argued that, at the moment, there are no benefits to recording the number of spraints found at a site although the time taken to do this is small. However, in the future it may be possible to calibrate spraints numbers against otter numbers using DNA fingerprinting, so it would seem prudent to record them from the start.

No habitat data should be collected during these visits since the sites will be highly biased towards areas of anthropogenic activity and interference with the water course.

3.3.1 National survey sites

SAC monitoring sites will be much more numerous on a river system than National Survey sites, but since both are selected by choosing bridges from which to gain access to the river, where National Survey sites exist on a river they should always also be SAC monitoring sites. This might also apply to National Surveillance sites, should a scheme for riparian mammals be set up.

3.3.2 Adding value to monitoring surveys

Spraint analysis

In Chanin (2003), a minor recommendation was that further studies of the diet of otters in lowland areas could usefully be carried out, particularly in areas where there was a risk of otters interacting with still-water fisheries. One source of material for such a study would be spraints collected during annual SAC monitoring surveys. Collection of spraint is not time-consuming, but it is important to have suitable collecting tubes available as well as storage facilities.

The number of spraints collected during SAC monitoring is likely to be fairly small (and confined to one time of year). However there may be opportunities to combine data from a number of SACs in similar areas to provide a more substantial data set and it would be preferable to have a nationally agreed programme rather than leave it to the managers of individual SACs.

DNA fingerprinting

Similar principles apply to DNA fingerprinting, except that requirements for collection and storage are much more stringent and have additional safety implications. Spraints need to be collected very early in the morning (before 10.00 am), stored in chilled industrial methylated spirit and either despatched for analysis immediately or kept in an ultra freezer.

Given the high cost of analysis, health and safety considerations and the relatively low number of very fresh spraints likely to be collected during SAC monitoring, this should only be undertaken as part of a wider study.

Statistical analysis

There are a number of statistical methods that are used for monitoring populations of animals and plants but these are not generally suitable for the proposals outlined here for otters. The reasons for this are simple:

- Each sampling site can only return a positive or negative result (otter signs present or absent).

At the moment there is no means of relating the proportions of positive and negative sites to the abundance of otters in the area.

Sampling sites are not selected at random and will be chosen at least in part because it is likely that otters will leave signs at them if they pass by.

We have therefore recommended using a confidence interval approach together with the McNemar hypothesis test. This approach is commonly used in medical, psychological and epidemiological studies where studies based on changes in proportions are regularly encountered. The rationale for this approach, together with examples, are presented in Appendix A. The details of how the analysis is carried out will depend on the statistical packages available to those undertaking it, but we have recommended using tests which are widely available.

In essence, there are three complementary approaches:

1. Plot consecutive results with confidence intervals. This illustrates the trends between years and the level of confidence that can be placed in these trends.
2. Calculate confidence interval for the differences between years. This allows a broad assessment of the size and statistical significance of these differences.
3. Carry out a McNemar test to calculate the probability (p values) that the difference in proportions is statistically significant.

3.4 Resources

Survey effort

During July 2002 a preliminary survey of the Camel SAC was carried out to assess the following:

- The number of sites that could be visited in one day.
- The suitability of sites for monitoring in the recommended manner.
- How many sites would benefit from the addition of an artificial sprainting site.
- The number of sites at which signs would be found.

In addition, a form for recording information during a preliminary survey was tested in the field. Over two days, 60 sites were visited and trial recording forms filled in for each. Thirty sites were identified as suitable for use and a further 21 as possibly suitable. Two thirds of the 'suitable' sites had spraints but none of the 'possible' category. Artificial spraint sites could successfully have been installed at 15 of the latter. Full details are provided in Appendix B.

Clearly, less-experienced surveyors might be expected to take more time to carry out the surveys, and in large SACs where sites may be distributed more widely, the time taken would be correspondingly longer. Nevertheless, it seems likely that it would be possible to carry out at least 20 preliminary surveys in a single day, and the time taken for sampling surveys should be similar. This compares favourably with the national survey method, in which two people working together were able to record up to 10 sites in a day, and surveyors working on their own were more likely to achieve six.

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Appendix A: Analysing changes in populations based on spraints

A1 Background and targets

As discussed previously, the use of sprainting activity as an indicator of changes in otter populations has a problem because there is no direct relationship between numbers of spraints, or spraint sites, and numbers of otters. It is a convenient method, and works well for establishing changes in the national distribution of otters, but is less useful at the smaller SAC scale where the concern is in changes in numbers more than changes in distribution. Nonetheless, alternative methods are labour intensive, expensive and require specialist skills that, together, make them difficult to use for long-term monitoring programs.

Given the lack of direct relationship between otter numbers and otter spraints, the quantitative aspects of the monitoring are based on a simple concept that in a SAC fully populated by otters all good sprainting sites will show evidence of use and be considered a positive otter site. Identifying good sprainting sites would be based on experience from other surveys. Therefore, the monitoring should concentrate on sampling only sites that are considered to be good sprainting sites, with an idealistic objective that 100% of these sites will have spraints if the SAC is fully populated with otters. This will also allow a spot-sampling approach, where only good sprainting sites will be monitored, rather than adopt the existing national otter survey method where up to 600 m of river bank is inspected at each sampling location.

From existing results over 90% positive sites have been recorded in areas where otter populations are doing well, but this has been from sampling sites that are up to the full 600 m long. In Ireland, when undertaking spot counts at bridges, 66% were positive when checking only the bridge, but this increased to 72% when extending the survey up to 50 m from the bridge. However, not all bridges have suitable sprainting sites, and installing artificial sprainting sites should increase the number of positive sites at bridges.

In Wales, a comparison of spot counts from easily accessible sites such as bridges was compared against the full (600 m) survey and this showed a fairly good relationship between spot counts and full counts (Figure A1). Although the linear regression presented in this figure may not represent the best model, it does suggest that in areas that had over 70% positives from the full survey around 50% positives from a spot count survey can be expected. As with the Irish study, we do not know whether all the spot count sites had suitable sprainting sites.

Based on the above, and only as a starting point, it is suggested that a target of over 70% positive should be regarded as an indicator of a healthy otter population. This seems more realistic than aiming for a 100% positive result, as not all spraint site will be used all the time. Nor is it possible to be entirely confident that the otters' idea of a good spraint site will always match the otter surveyor's idea of a good site. It also assumes the use of spot counts at locations with good otter sprainting sites. At obvious survey points, such as bridges, if there are no suitable sprainting sites, then these should be introduced.

This approach falls into the category of convenience sampling (Lohr 1999) and may result in some sampling bias, that would be avoided by using a random sampling design. However, because of the practical difficulties of accessing the river bank at any specified point, a random sampling design is considered difficult or even impossible to implement. Therefore, in practice a random sampling design could well need modification to the extent that it would resemble the convenience sampling approach that is being proposed.

This does mean that some caution is needed in trying to infer too much about what is happening in the entire SAC based on the survey samples. However, the sample sites will still have a good geographic

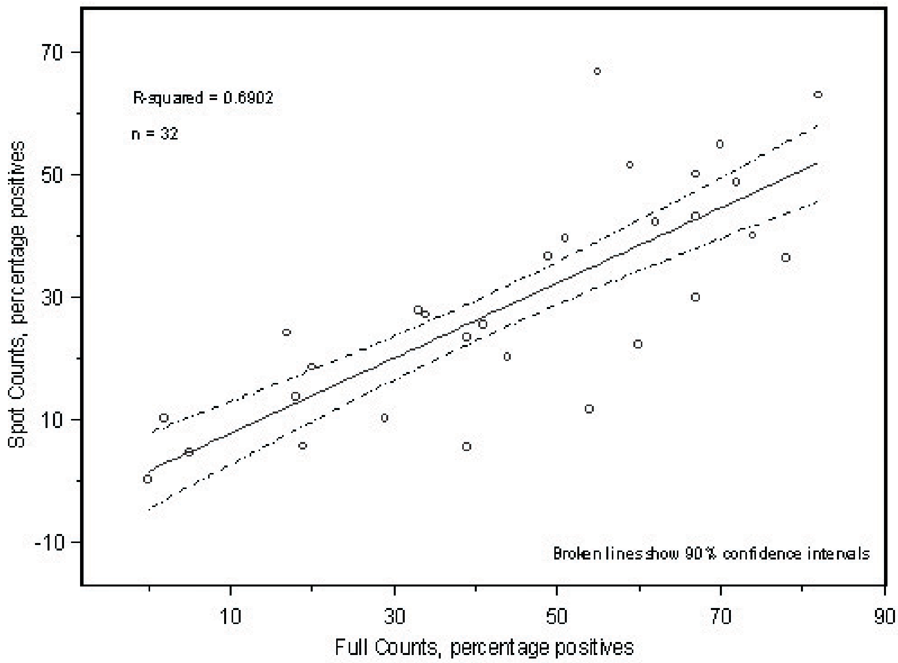

Figure A1. Regression analysis of full survey results on spot counts from surveys in Wales.
The results from the regression suggests that a 70% success rate from full survey approximately equates to 45% (40% to 50%: 90% CI) in the spot survey. Based on this we can say that, in this instance, approximately 45% success in the spot survey represents a 70% success rate in a full survey.

spread across the SAC, and inferences are being restricted to a narrow population of other good sprainting sites within the SAC the samples were collected from. Generally, particularly in the smaller SACs, it will be difficult to find a meaningful number of accessible sampling sites and all available sites will need to be included in the sample. However, for larger SACs where there may be sampling sites available than actually needed, then the sample sites could be selected randomly.

A2 Statistical approach

A statistical approach has been adopted that can be easily implemented and understood by non-statisticians, is comparable with the national surveys that have already occurred and is suitable for more advanced analysis if required.

The absence of a rigorous relationship between spraint numbers and otter numbers means that there has been an emphasis on methods that help to understand what the data may be showing, rather than relying on the use of classical statistical tests, or more advanced statistical techniques that require specialist statistical training. Central to this is the extensive use of graphical techniques and the use of confidence intervals (Smithson 2000).

Confidence intervals give a measure of uncertainty over the measured value that results from sampling error. That is the likely error resulting from observing only a sample of the entire population in which we are interested (Thompson 2002).

For example, assume we sampled 75 spot sites, and 53 (70%) had signs of otter spraints. Calculating the 90% confidence intervals would suggest that if we resampled these same 75 sites 100 times, then 90 times out of the 100 we would expect the percentage positive sites to lie between 61.4% and 78.5%. Although technically incorrect, this is commonly interpreted to mean that based on our sample of 75 good sprainting sites, we can be 90% confident that the true percentage positives from all good sprainting sites within the SAC will lie between 61.4% and 78.5% (based on the Wilson's method of calculating confidence intervals, Altman *et al.* 2000).

This may seem a fairly broad band of uncertainty, and this can be improved by increasing the sample size. Increasing the sample size from 75 sites to 150 sites gives 90% confidence that the true percentage positives lie between 63.5% and 75.8%. A further increase in sample size to 225 sites improves our 90% confidence that the true percentage positives lie between 65% and 75%. A range of 10 percentage points compared to 17.5 percentage points for a sample size of 75.

To illustrate how the increase in sample size can improve confidence levels, results from the Otter Survey of England are used. In the first example (Figure A2), which has a sample size of 60, the confidence interval is large and although there has been a substantial increase between the 1980s surveys and the 1990s it is not implausible that this increase is due to sampling error.

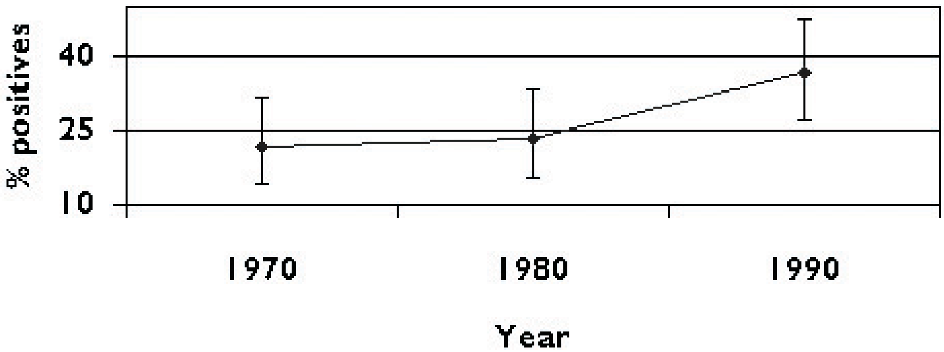

Figure A2. Otter survey of England results for O.S. square NZ. This illustrates the percentage positive sites with 95% confidence intervals (Wilson's method for a single sample; Altman *et al.* 2000) n=60.

In the second example (Figure A3) the sample size is larger (n=123) and the confidence interval much narrower.

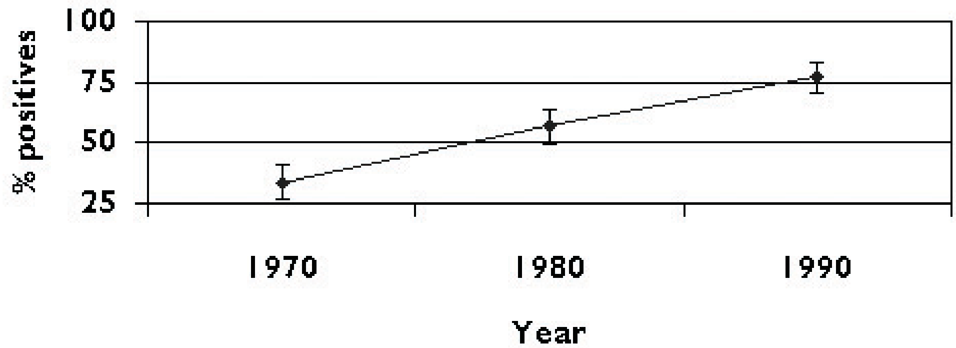

Figure A3. Otter survey of England results for O.S. square SX. This illustrates the percentage positive sites with 95% confidence intervals (Wilsons method for a single sample; Altman *et al.* 2000) n=123.

In this instance we can have a higher degree of confidence that there has been a real increase in otter sprainting activity between surveys. Equally, in this example, given the 70% indicator target for a healthy SAC otter population, we can be 90% confident that OS square SX has exceeded this target during the 1990s survey. The 90% confidence interval range is from 70.4% to 82.8%.

The use of confidence intervals allows for sampling errors in the data and provides an easily interpreted measure of changes in otter sprainting activity. Generally, a confidence interval approach provides a better grasp of the information provided by a data set and allows a level of confidence to be applied to any ecological interpretation of that data. As with all statistical tools, this approach is only an aid to ecological decision making and it would, for example, be unwise to ignore a consistent downward trend in sprainting activity, even if all the variation fell within the calculated confidence interval.

A2.1 Statistically significant changes between years

Indicating confidence intervals around percentage positive counts for each year gives a good idea about how much confidence we can have on the figures being representative of the population of good spraint sites across the SAC. However, they do not provide a direct measure of changes between years and the levels of confidence that these changes are real, and not a result of chance. For this, some form of statistical comparison needs to be applied to see if the observed changes are statistically significant.

A confidence interval approach provides an easily understood graphical assessment of the data that can then lead on to deriving statistical significance. Looking at the changes from OS square NZ between the 1980s survey and the 1990s survey shows a measured change of 13.3 percentage points. The confidence intervals around this change can be calculated for different levels of statistical significance and plotted (Figure A4).
Statistical significance is a measure of probability, with the different p values indicating different levels of

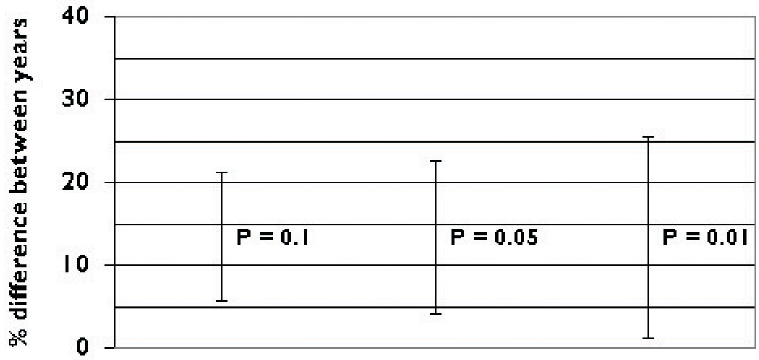

Figure A4. Confidence intervals for the difference between counts from the 1980's surveys and the 1990's survey for OS square NZ. The difference was an increase of 13.3 percentage points between years (Wilsons method for paired samples; Altman *et al.* 2000). n=60.

probability that a measured value might have occurred by chance. As before, strictly, the results in Figure 4 are showing that if you could repeat the comparison 100 times, then 90 times out of 100 you would expect the percentage difference between years to fall within the confidence band labelled P=0.1. This is normally interpreted as being 90% confident that the real percentage change lies somewhere, in this instance, between 5.6% and 21.1%. The actual measured value of 13.3 % is still the most likely value, but any value within that range is plausible. As the range does not include zero, this indicates that a zero percentage difference between years is not considered a plausible value, and it is possible to conclude that there is a statistically significant difference between years.

Looking at the same comparison for OS grid square SX (Figure A5) shows that in this instance the changes between years can be considered statistically significant, even at the P=0.01 level. In this case we can be 99% confident that the real percentage change between years lies somewhere between 10.5% and 29.6%. Or we can be 90% confident that there has been a real increase in otter sprainting sites, in OS square SX, of at least 10.5% between the 1980s survey and the 1990s survey.

In both of the above examples a P value of 0.1 has been used rather than the more commonly used 0.05 or 0.01 levels. These latter values of P are commonly used to minimise the risk of making Type 1 errors, but in ecological monitoring, the normal presumption of avoiding Type 1 errors may not be the best approach. (Caughley & Gunn 1996, Underwood 1997).

A Type 1 error (rejecting the null hypothesis even if it is true) may be appropriate when testing the safety of a new drug, but runs the risk of dismissing a genuine decline in otters, simply because it does

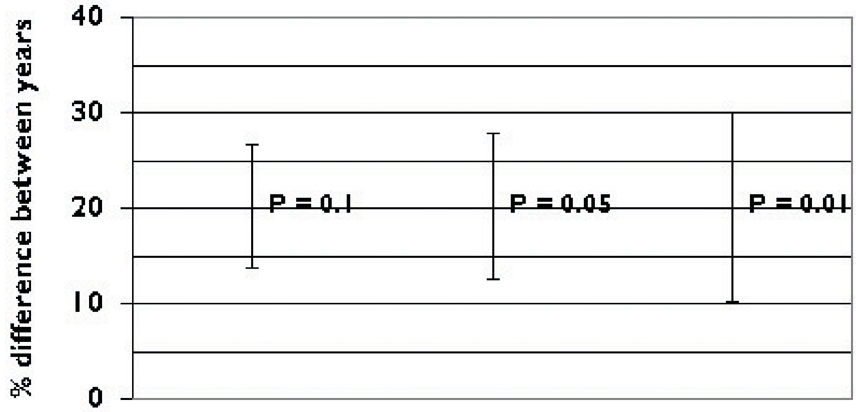

Figure A5. Confidence intervals for the difference between counts from the 1980s surveys and the 1990s survey for OS square SX. The difference was an increase of 20.3 percentage points between years (Wilson's method for paired samples; Altman *et al.* 2000) n=123.

not meet the P<0.05 criteria. For monitoring of an endangered species the use of P<0.1 seems a better compromise between making Type 1 and Type 2 errors. A Type 2 error would be deciding there had been a decline in otters when in fact there had been none.

All the data available to us show increases in otter sprainting activity and this has been used for illustration. However, this approach can be applied equally effectively to assess declines in otter sprainting activity. In this situation, the differences that are being assessed for size and significance are simply the decreases in the proportions of positives, rather than the increases. The numbers stay the same, but the direction reverses.

A3 Ecological significance

As should be evident from the previous figures, the presence of a statistically significant change between years, in itself says nothing about the likely size of that change.

Deciding on a difference (often called the effect size) between years that is ecologically significant is difficult. Looking at the England survey data shows that, within any particular OS 100 km square, otters seem capable of making some incredible increases within a seven-year period. For example, Square NT saw a 45% increase in positive sites between the 1980s survey and the 1990s survey, albeit with a small sample size (n=42). Using all OS 100 km squares with sample sizes larger than 100 (n=14) gives an average increase of 14.5% over the seven-year period (range 1.5% to 35%). Only looking at squares that started out with more than around 20% (actually 19.6%) positive sites (n=5) gives an average increase of 25% (range 13% to 33%) over the same seven years.

With the target percentage positives set at 70% to indicate a healthy otter population, then looking at the two OS squares that exceeded 70% positives in the 1990s survey (SS and SX) could also be informative. For these two squares, positive otter signs rose from 47% to 78% in square SS and 57% to 77% in square SX. Rises of 31% and 20% (giving an average of 25%). This supports the idea that assuming a reasonable healthy starting point, otters apparently have the ability to recover by around 25 percentage points in a seven-year period. So based on the above, what level of decline should be considered ecologically significant?

The starting point would seem to be a decline of 25% over a seven-year period. However, while this may well be an ecologically significant decline, it may be too large a figure to use as a trigger that all is not well with any particular otter population. For example, assuming a 25% decline is detected over seven years and it takes another seven years to identify the reasons for this decline and implement remedial action, then we may have seen a further 25% decline before otters are given the opportunity to begin recovery.

While admittedly based on very little evidence, this suggests that ecological significance should be based on changes of roughly half 25% (say between 10% and 15%). This appears to be a level that otters should be able to recover from relatively easily, even if several years are required to identify and correct the causes of this decline. It means that any monitoring program should be sensitive enough to confidently identify this level of change.

A4 Statistical tests

The confidence interval approach outlined above provides a valuable tool for understanding monitoring data. However, while still considering the normal caveats of statistical significance testing (Johnson Douglas 1999, Altman *et al*. 2000) a classical hypothesis test can still add a more precise measure of significant change (Moyé 2000).

For this type of data, the test must be able to work with binomial data (only one of two possible outcomes) and allow for repeated measures (repeatedly observing the results from the same sample sites every year). Simple hypothesis tests that meet these requirements are the McNemar test and the Cochran Q test (Morrison *et al.* 2001). The McNemar test provides the rough equivalent of a paired t-test, while the Cochran Q test provides the equivalent of a repeated measures ANOVA, but with both designed for repeated measures of binomial data.

The McNemar test is readily available in most statistical programs and tests the proportion of sample sites that have changed status in one direction against the number you might expect to have changed by chance (Pett 1997).

This means that if you have a 10% increase in positive sites, and that increase is entirely due to sites that were negative in the previous year becoming positive in the current year, then this is likely to result in the McNemar test giving a significant result. This is considered a low proportion of discordant pairs.

However, if a large number of negative sites have changed to become positive sites and large number of positive sites have changed to become negative sites, and the net change is still 10%, the McNemar test may not produce a significant result. This is considered a high proportion of discordant pairs.

In the first instance described above, there was a consistent upward trend in the number of positive sites, and therefore there is lower probability that this increase has occurred by chance. Equally, as this has been a consistent increase, it adds to our confidence that this statistically significant result is reflecting what is happening across the whole SAC. In the second example, there is no consistent trend and a large number of sample sites have changed status, indicating a less stable situation and increasing the probability that the changes recorded may have occurred by chance. Therefore, in this second example it is less safe to assume that the net 10% increase represents a real change across the whole SAC and there is lower likelihood that the McNemar test will give a significant result.

The changes recorded for OS squares NZ and SX were both considered statistically significant when tested using the McNemar test. The contingency tables for these tests (tables A1 and A2) give the raw data and illustrate how the numbers of positive counts and negative counts have changed between survey periods. It is convention to publish a contingency table when presenting the results of a

Table A1. Contingency table for McNemar test on differences in positive sites between the 1980s survey and the 1990s survey (n=60, p=0.0133).

OS square NZ		**1990s**	
		positive	negative
1980s	negative	8	38
	positive	14	0

Table A2. Contingency table for McNemar test on differences in positive sites between the 1980s survey and the 1990s survey. n = 123, p = 0.0000.

OS square SX		1990s	
		positive	negative
1980s	negative	26	27
	positive	69	1

McNemar test.

For example, in Table A1, the bottom right corner shows none of the positive sample sites in the 1980s survey became negative in the1990s survey, but in the same period eight sample sites that were negative during the 1980s surveys were positive in the 1990s surveys (top left corner of table), 14 sampling sites were positive in both surveys, and 38 sampling sites were negative in both surveys.

The Cochran Q test is rarely found in statistical programs, and while it may prove useful if there was a desire to compare several years survey at the same time, in practice it is unlikely to be required.

A4.1 Sample size and power

The statistical power to detect changes and to reduce the level of uncertainty over interpreting the results relies heavily on the size of the sample collected. Increased sample sizes generally increase power and reduce the confidence interval size.

In figures A2 and A3 the confidence intervals were shown around each value for percentage positives in each OS sample square. The confidence intervals show the range of values that we are 90% confident the true value will lie within. Increasing the sample size reduces the confidence interval size and increases the probability that the measured proportion of percentage positives from the sample is a good estimator for the percentage positives across the whole SAC. The importance of sample size is illustrated in Figure A6.

Continuing to work on the assumption that a difference of 10% to 15% is an ecologically significant difference, then, based on Figure 6, a sample size of around 75 sampling sites would appear to be a desirable minimum. However, that is 10% either side of the measured proportion – a total confidence interval of 20%. To be 90% confident that the true value of percentage positive sites for the SAC lie within a 10 to 15% band, we would need a sample size greater than 300.

The McNemar test, because it uses paired samples, is more powerful than simply plotting confidence intervals. The required sample sizes for the McNemar test are illustrated in Figure A7.

For the McNemar test, sample sizes are dependent on the proportion of discordant pairs. In the national surveys, where nearly all the changes were in one direction, there were only low numbers of discordant pairs. The McNemar test is powerful at detecting these types of changes. In these instances, only small sample numbers are required and with only 11% of the sample made up of discordant pairs a sample size of only 50 has the power to detect a change of 10% between years for P=0.1.

If the changes between years have been less consistently in one direction, larger sample sizes are required. For the example just given, but with 16% discordant pairs instead of 11%, the sample size would need to be more than doubled to retain the 90% power (120 sample sites).

There is therefore no single correct sample size. A balance between power and practicality would suggest a sample size of around 130. A sample of 130 still provides 80% power to detect a 10% change, even when there are 21% discordant pairs in the sample, P=0.1 (Figure A7). Equally, this same sample size allows reasonably small confidence intervals when used to plot changes between years (Figure A6), and sits at a point where further increases in sample size need to be relatively large before making any important reductions in the confidence interval.

Reducing the sample size, reduces the level of confidence that can be placed in the results, but it is recommended that sample sizes should initially, not be set at less than 60 per SAC. This should be just sufficient to detect significantly steady declines in otter sprainting activity.

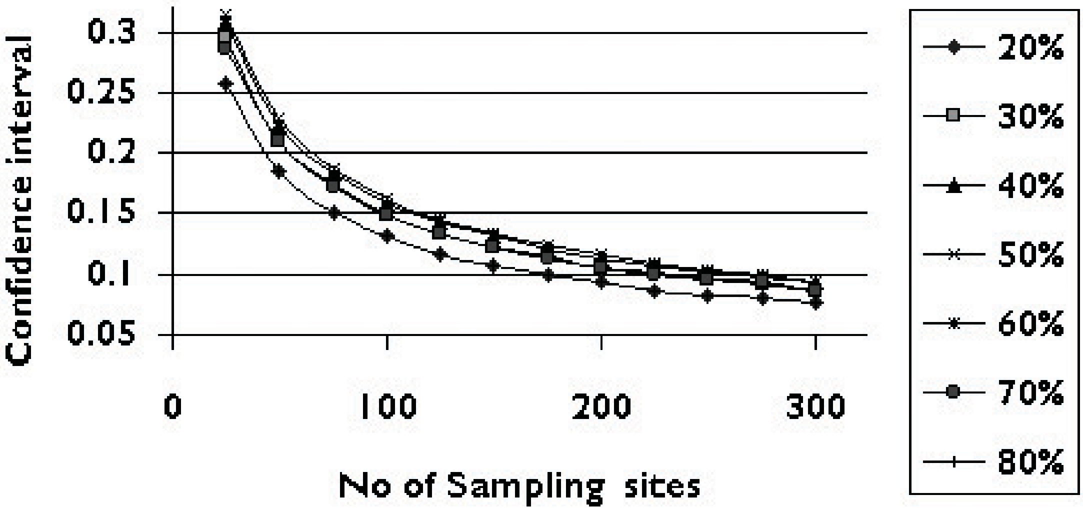

Figure A6. Reduction in confidence intervals with increasing sample size (Wilson's single sample method. Altmann *et al*. 2000). The initial proportion affects the sample size, and the 90% confidence intervals have been calculated for a range of starting points 20% to 80% at 10% increments. The confidence intervals are shown as proportions and should be multiplied by 100 to convert to percentages.

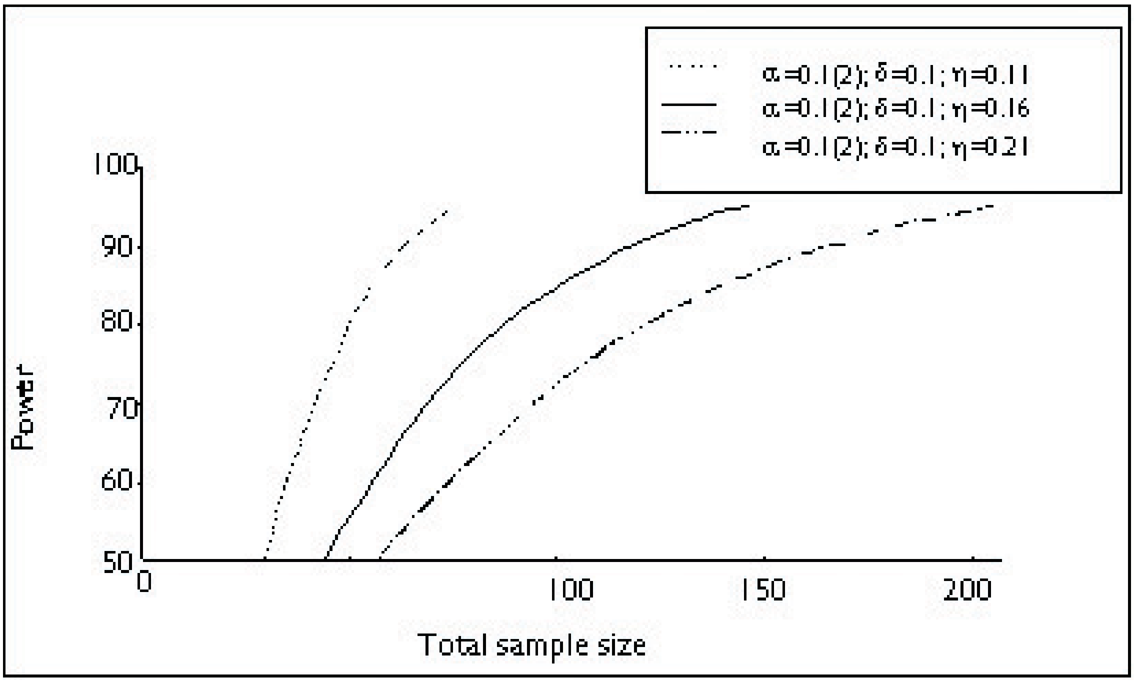

Figure A7. Power curves for the McNemar test (Elashoff 1997). These are based on p=0.1 and an effect size of 10%. That is the power to detect a 10% change in sprainting activity between years. As the McNemar test compares the proportions of discordant pairs, three curves have been drawn for 11%, 16% and 21% discordant pairs.

An inspection of figures A6 and A7 show the implications of using a sample size as low as this, and the surveyor should be confident that these are acceptable before using a sample size this small.

A5 Interpreting the results

Three methods have been presented to identify significant changes in otter sprainting activity at good sprainting sites.

The first (figures A2 and A3) provides a tool for plotting trends that include confidence intervals to help decide how closely the measured changes represent the likely changes across the whole SAC.

The second method plots the size of the change between survey periods and graphically shows the confidence that can be placed in these changes. This method also allows a crude assessment of statistical significance. (figures A4 and A5).

The third method is a standard hypothesis test that provides a measure of statistical significance associated with the observed differences between study periods. That is a measure of the probability that the measured changes have not occurred by chance (tables A1 and A2).

Using all three provides a powerful toolkit of complimentary methods to understand and interpret changes in otter sprainting activity.

A6 Recommendations

The practical constraints on surveying for otters; the poor relationship between otter spraints and otter populations; and the need to try and keep the survey results compatible with the national survey results have limited the scope of these recommendations – as has the desire to make the methods accessible to those with little or no statistical training. There has been no attempt at analysing trends or interpreting why any observed changes might be happening. For example, it would be valuable to compare environmental changes against sprainting activity using a method such as GLM (Generalised Linear Models), and techniques such as Incidence Function Models (IFM) might also be valuable.

Nevertheless, the tools presented, and the principle of detecting changes away from a desired optimum level of sprainting activity, provide a relatively robust and easy to implement a method of detecting probable changes in otter populations within SACs.

The major failing in the methods, apart from the poor relationship between spraint numbers and otter numbers, is the absence of a proper random sampling approach. However, as described earlier, the adopted approach may well still provide a representative sample of the population being studied (good sprainting sites).

It is important to review the results, targets and methods at the end of each survey period to ensure that the targets are reasonable and the methods are working as anticipated.

The confidence intervals were calculated using the CIA programme, which provides an improved method for proportional data (Altman et al. *2000) and it is recommended that this low-cost software and book are purchased for use with this monitoring program. The McNemar power curves were calculated and drawn using Nquery Advisor 2.0: Study Planning Software (Elashoff 1997), but power can be calculated using the free DSTPlan software (Brown 2000). All the graphs were produced using Microsft Excel 97, and the McNemar tests were calculated using Statistica 5.5, but this test is available in most statistical software programs.*

Appendix A References

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Appendix B: Survey of the River Camel

B1 Introduction

In July 2002, two days were spent carrying out a preliminary survey of the River Camel in order to:

- Assess how many bridges might be suitable as survey sites.
- Assess the practicality of installing artificial sprainting sites.
- Provide an indication of the time required to carry out surveys.
- Test a recording form.

To ensure a useful sample in a short time, visits were briefer than would be normally be required. In order to maintain a reasonably representative sample, all bridges on the main river, the Allen, the De Lank and the larger tributaries were checked. Tributaries flowing direct into the estuary (for example, the Amble) and a few small southern tributaries were not surveyed.

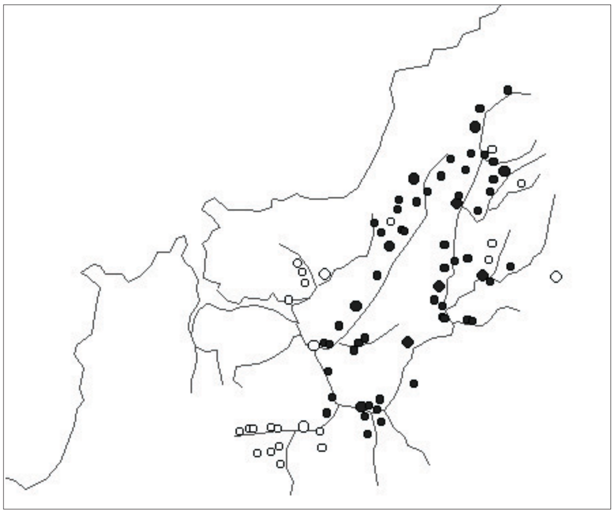


Figure B1. Distribution of potential SAC monitoring sites on the Camel (excluding some small tributaries) showing those checked in preliminary survey (filled circles) and those that are National Survey Sites (larger symbols).

B2 Results

A total of 60 sites were checked over the two days, approximately two-thirds of the potential sites identified on the river.

Nine sites were considered unsuitable for use as monitoring sites, some because they were difficult to access. Others were impossible to find, and some had no suitable sprainting sites and could not be adapted (for example, because they were tidal). Twenty-one sites were considered 'possible' and artificial sprainting sites could have been provided at all but six of these. No signs of otters were found at these sites, but it was considered that signs might be found at any of them (provided artificial sites were provided where necessary).

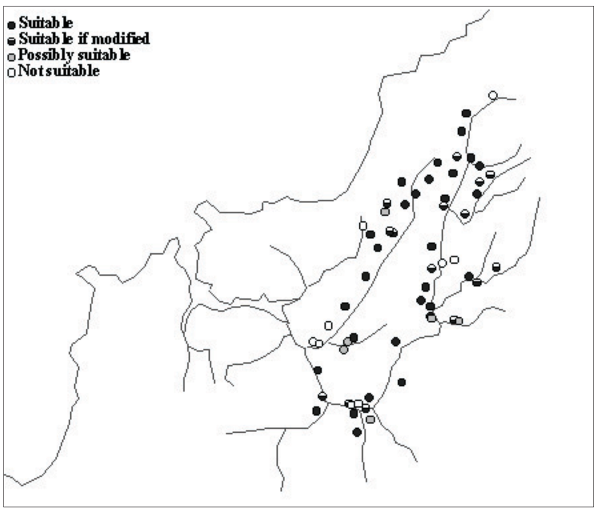


Figure B2. Potential for use as monitoring sites.

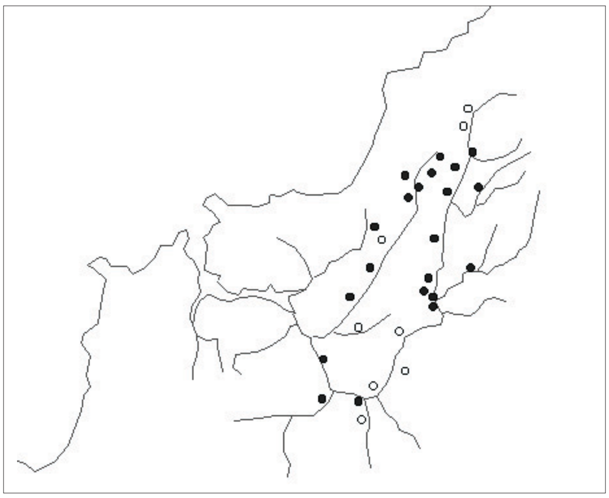


Figure B3. Distribution of signs (filled circles) at those sites suitable for surveying without modification.

Signs of otters were found at 21 of the 30 remaining sites.

At a few bridges it was not possible to carry out a survey because it was clear that permission for access was needed and there was not sufficient time to obtain it.

B3 Conclusions

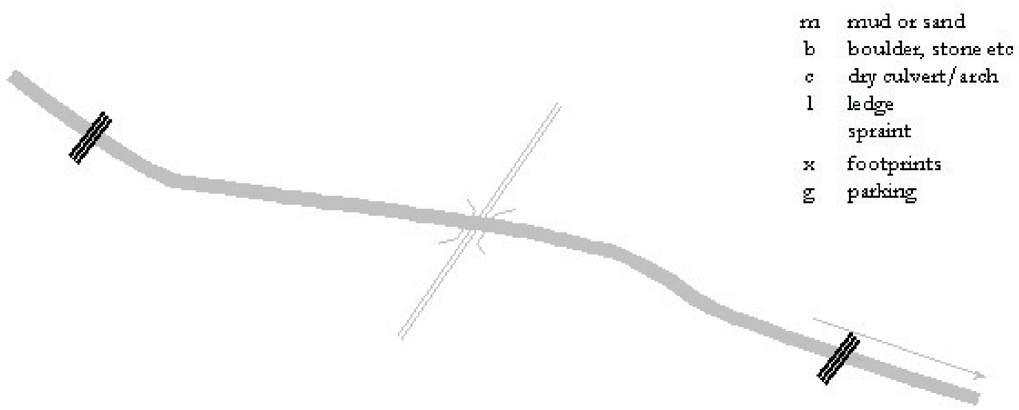
It is clear that there should be no difficulty in assessing up to three sites an hour during the preliminary survey, and probably and up to four an hour when monitoring where access is easy and sites are not too far apart. It will certainly save time and improve efficiency if detailed notes are taken during the initial survey, not least because subsequent surveys might be undertaken by a different person. The rather simple recording form first used was found to be inadequate and a more detailed, redesigned form is appended.

On the Camel it should be possible to achieve a sample size in excess of 60 sites, providing artificial sprainting sites are installed at some bridges – possibly up to 70, indicating that on rivers of this size the recommended approach to monitoring is feasible.

Appendix C: Recording form for preliminary survey of potential spraint monitoring sites

Ref number	Sub catchment		
Grid Ref.	Stream name		
Suitable for use?	Yes/No/Possibly	Width of bridge	>15m / 5-15m / <5m
Needs Artif. site?	Yes/No/Possibly	Max depth under bridge	<25cm / 25-75cm / >75cm
Permission needed?	Yes/No		
Spraints recorded	Dried Fragmented:	Dried intact:	Not fully dry:
Footprints found?	Yes/No		

Mark: nature and position of potential spraint sites; location and type of signs found; parking place.



Notes on:

Suitability; need for artificial spraint site:

Potential spraint sites:

Parking/Access:

Hazards:

Post survey notes:

Appendix D: Recording form for monitoring surveys

Year:					**Date of Survey:**
		No. of spraints			
Site ref no.	**I/0**	**Df**	**Di**	**Nd**	**Notes**

Presence (1) or absence (0) of otters
For: Dry fragmented (Df) /Dry intact (Di) /Not dry (Nd)
Are water levels normal? Have there been changes since preliminary survey?
Record any need for maintenance of spraint site.

Conserving Natura 2000 Rivers

Ecology Series

1 Ecology of the White-clawed Crayfish, *Austropotamobius pallipes*
2 Ecology of the Freshwater Pearl Mussel, *Margaritifera margaritifera*
3 Ecology of the Allis and Twaite Shad, *Alosa alosa* and *A. fallax*
4 Ecology of the Bullhead, *Cottus gobio*
5 Ecology of the River, Brook and Sea Lamprey, *Lampetra fluviatilis*, *L. planeri* and *Petromyzon marinus*
6 Ecology of Desmoulin's Whorl Snail, *Vertigo moulinsiana*
7 Ecology of the Atlantic Salmon, *Salmo salar*
8 Ecology of the Southern Damselfly, *Coenagrion mercuriale*
9 Ecology of the Floating Water-plantain, *Luronium natans*
10 Ecology of the European Otter, *Lutra lutra*
11 Ecology of Watercourses Characterised by *Ranunculion fluitantis* and *Callitricho-Batrachion* Vegetation

Monitoring Series

1 A Monitoring Protocol for the White-clawed Crayfish, *Austropotamobius pallipes*
2 A Monitoring Protocol for the Freshwater Pearl Mussel, *Margaritifera margaritifera*
3 A Monitoring Protocol for the Allis and Twaite Shad, *Alosa alosa* and *A. fallax*
4 A Monitoring Protocol for the Bullhead, *Cottus gobio*
5 A Monitoring Protocol for the River, Brook and Sea Lamprey, *Lampetra fluviatilis*, *L. planeri* and *Petromyzon marinus*
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These publications can be obtained from:

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They can also be downloaded from the project website: www.riverlife.org.uk

The Life in UK Rivers project was established to develop methods for conserving the wildlife and habitats of rivers within the Natura 2000 network of protected European sites.

Set up by the UK statutory conservation bodies and the European Commission's LIFE Nature programme, the project has sought to identify the ecological requirements of key plants and animals supported by river Special Areas of Conservation.

In addition, monitoring techniques and conservation strategies have been developed as practical tools for assessing and maintaining these internationally important species and habitats.

Life in UK Rivers

ENGLISH NATURE

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Environment Agency

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SCOTTISH NATURAL HERITAGE

SNIFFER

The otter declined over much of its range after the introduction of pesticides in the 1950s. However, it is gradually making a comeback, and can now be found in many UK and European rivers.

This report suggests monitoring methods that can be used to determine whether otter populations are in favourable condition, and what conservation action is necessary for their survival.

Information on Conserving Natura 2000 Rivers and the Life in UK Rivers project can be found at
www.riverlife.org.uk

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