

Surveying and Report Writing for Lichenologists

Guidelines for surveyors, consultants
and commissioning agencies

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British Lichen Society
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Introduction

1.1 *What these Guidelines are*

These Guidelines are about how to commission and conduct surveys, and prepare reports, for conservation organisations (statutory and non-statutory), consultancy companies and any other organisation requiring information about lichens on a site.

1.2 *How they arose*

The need for these Guidelines arose because lichen surveys have been commissioned without any clear idea of what the lichenologist was being asked to do. There were also lichenologists being asked to do what was palpably impossible. There have been instances where lichenological reports were not up to a standard expected by the British Lichen Society (BLS).

1.3 *Who they are for*

These Guidelines are both for organisations and individuals commissioning surveys, and for lichenologists carrying out the work. Both groups must use the same information and guidelines.

1.4 *How they are to be used*

These are guidelines rather than rules. They are meant to explain what is expected of both those commissioning lichen survey and those carrying them out. Some aspects are essential and others advisable. There are also suggestions for particular situations. It is hoped that the levels of priority within these Guidelines are clear. For example, the section **4.4 Validating Identification** is of the utmost importance in all **cases**. (If in doubt about any matter, it should be raised with the others involved (client with the lichenologist and *vice versa*) and any problems discussed to resolve what should be done.

1.5 *How they were written and authorship*

This publication is the result of a Workshop that was organised by the British Lichen Society and held in Royal Botanic Garden Edinburgh 12-13 January 2004. It was attended by 34 people, mainly lichenologists who are surveyors but a few who commission lichenologists. The workshop involved the use of focus-groups providing information and feedback for the Guidelines. The main aspects that arose are set out in this publication. The feedback and notes from people presenting the topics were taken and used to draft the text. The four sections were then edited for this publication. The authorship is as follows:

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1.6 Disclaimer

The British Lichen Society and the authors and editor take no responsibility for any incident or liability with regard to health and safety or a contract arising from anyone or group of people using this publication. These Guidelines only constitute suggestions of matters that might be considered by those carrying out surveys and commissioning such surveys prior to contract and to starting any work. It is the responsibility of the surveyors and clients between each other to decide upon and follow safe and appropriate practices and agree clear and robust contracts.

1.7 Acknowledgements

This publication would not have been possible without the contributions of all those attended the Workshop in Edinburgh (see Appendix), and the help and encouragement given by those above who kindly commented on, and provided valuable suggestions for, the draft.

2 Commissioning Surveys: Contracting and Tendering

2.1 Introduction

There are two parties to contracting and tendering: the commissioner and the lichenologist. The commissioner may have no expertise in lichenology but needs to be aware of certain aspects of the survey process in order to be able to negotiate and commission good contracts that satisfy both parties. The lichenologist needs also to know about administrative aspects of the commissioning process. Both parties should read the parts of this chapter addressed to the other party.

2.2 Some general points

Compared with surveying groups of larger organisms, lichenologists may need to spend a significant part of their time identifying specimens in the laboratory. The identification time may be similar for some other groups of organisms such as beetles and other insects. Therefore, lichen surveyors will often require permission to collect material on site. The ratio of time between fieldwork and identification time depends on the experience of the surveyor, the type of habitat surveyed and the richness of the lichen flora. For very rich areas, up to four days identification for every one day in the field is quite usual, although for less rich areas this time may be only one to two days. In some instances when detailed species recording is not the main requirement, time for identification may not be necessary. Both commissioner and surveyor should be willing to be flexible and, if necessary, come to a compromise between what the commissioner regards desirable or required and what the surveyor considers practical. This compromise will depend on the reasons for the survey. There is presently no standard form of contract for ecological work as there is, for example, for the landscaping industry though some consultants suggest using the landscaping standard form of contract for ecological work.

2.3 Timing

The time of year for lichen surveys, in theory, is not a consideration as lichens are present and can be identified in any season. From a practical point of view, the cost and quality of work can be greatly affected by the season. Surveying between December and February can be more expensive (days being shorter with about 6 hours of good light per day) and in bad weather conditions (rain and or wind), small species are easily overlooked leading to poor coverage, or, at worst, species recording has to be stopped altogether.

2.4 Team working

For health and safety reasons, working in the field alone (lone-working) is sometimes regarded as not good practice. Commissioners and/or surveyors may insist on working in the field in pairs or as a group. The frequently proposed solution of running a team of surveyors in the same area, each individual covering a different group of organisms, is rarely satisfactory because the pattern of fieldwork activity can vary enormously between each taxonomic group. As a result of this, either the surveyors do not keep together, or one is left waiting for another, leading to inefficient or unsatisfactory work. Unless a surveyor has agreed to work in this way, this solution should be resisted. If lone-working is not permissible, it is far better to send two lichenologists together as they can cover the area in half the time, can confer with each other and ultimately provide a joint report based on broader lichenological expertise. The thoroughness of coverage in the field and the content of the report will, therefore, both be improved.

2.5 For the Commissioning organisation/person

2.5.1 General

Being prepared in advance for specialist survey work is helpful. A list of competent and suitable lichen surveyors should be prepared well in advance. It can also be prudent, especially for larger contracts, to find someone either within the organisation, or from outside it, who can give general independent advice about lichens if the commissioning officer has no knowledge of them.

2.5.2 Selecting a list of potential lichen surveyors

The names of suitable lichenologists may be obtained by consulting the following:

- Local Environmental Record Centres. They may know of local lichen recorders.
- The British Lichen Society has lists of referees for identification and local contacts which may be obtained from the Society's website (www.thebls.org.uk) or from the Society's Secretary.
- Natural England, Countryside Council for Wales, Scottish Natural Heritage or Natural Heritage Directorate of Environment and Heritage Service of Northern Ireland may know of local lichenologists who have been commissioned before.
- Local museums and universities may know of a good local lichenologist.
- Known lichen surveyors may be able to recommend colleagues.

A list with any additional information, e.g. CVs, may be kept on file, ready to consult when the need for a lichen survey arises, but will need keeping up to date.

The sort of expertise and ability that is expected of a professional lichen surveyor can only be achieved by such a person being an active member of the BLS. These members have recourse to their own body of literature including *The Lichenologist* and *BLS Bulletin*. They will know how to tackle lichen identification and will also be aware of the Workshops for help in specific genera which are run by the BLS. They will have had opportunities of attending seasonal field meetings, where experts are on hand to assist with identification, and where they have the chance to familiarize themselves with lichens found in various habitats and localities throughout the British Isles.

It is worthwhile building a relationship with a surveyor by giving feedback from the work he or she has done and, if considered satisfactory, by using this person again.

2.5.3 The size of projects

When a lichen survey is required, decide, with advice if necessary, the scale of the task. For small projects, especially in the private sector, it may be possible to take the direct employment route (see below). If it is large, especially in the public sector, the tender route may be necessary to arrive at a formal contract. The decision may depend on the practice of the commissioning organisation, although there may be a range of options. For a survey of 1-3 days, or for less than £1000, there may be little need to issue a formal contract, particularly if the commissioning person has previous knowledge of a surveyor's work. In this way tendering, which is time-consuming and expensive, can be avoided for both parties. The funding available must also realistically match the requirements of the survey and, if there is doubt, advice should be sought from a lichenologist.

2.5.4 Direct employment

First draw up a short list of potential surveyors; then select the most suitable for the project on the basis of lichenological ability, local knowledge, proximity to the site and willingness to do the work. Provide this person with the project brief (see below) and ask for a quotation and negotiate directly with the individual. Quotations from more than one surveyor may be needed to demonstrate value for money. When agreement is arrived at, issue a contract as necessary. A phone call, email or letter can constitute a contract and be legally binding.

2.5.6 Tender route

Where competitive tendering is necessary the setting of a clear, **fully informative**, detailed but concise document (the “brief”) inviting tenders from (usually four) prospective contractors (selected from a list) **is essential** for the smooth running of the project. The information in it should be all that is needed for the lichenologist to prepare accurate planning, risk assessment and a realistic tender. **It is imperative that the brief provides as much information as possible about the site** allowing those responding to provide an accurate tender. Incomplete or inaccurate information will create considerable difficulties which may not be realised until later but which will hamper the project.

Writing a brief assumes that the commissioner knows what is needed, but this may not necessarily be the case, or perhaps not clear. Therefore it is sensible, especially if the project is sizable, to have discussions with an independent lichenologist before preparing the brief to check that it will provide appropriate, accurate and sufficient information for the recipient to respond to.

A checklist of items to consider when preparing a brief is as follows:

- Explain the reason for the project and what the main objectives are, as these will strongly influence the contents of the report.
- State what elements will be required in the final report of the survey e.g. site assessments, management prescriptions etc. State whether a draft must be submitted in advance to ensure that technical terms and jargon are fully explained.
- Provide a clear and concise document and include as much information as possible, such as references, and preferably the location of previous surveys and/or records.
- Provide a clear map (e.g. 1:10,000 scale) with an outline of the survey area and some indication of the size of the area to be surveyed.
- State what information the surveyor will be expected to provide in the report including, maps, aerial photos, tree tags, GPS locations, etc.
- Provide access details, including whether the commissioner or the lichenologist will contact the owners. (This may take a considerable amount of time and add to the cost of the survey.)
- Provide a clear and **realistic** deadline.

- Provide any details relevant to health and safety (e.g. for contaminated land, land with underground voids or areas subject to rock falls). Alternatively provide a risk assessment relevant to the habitats that require survey work.
- Make it clear in what form the final report is required e.g. how many paper copies, whether the reports need binding, in what format digital information is required, the types of maps expected, and whether copyright has been cleared with Ordnance Survey.
- Indicate how the surveyor is to incorporate the time and cost for fieldwork, identification (laboratory work) and report writing into the tender.
- Indicate whether the commissioner, or the surveyor, will send records to the local Environmental Records Centre and the BLS Database Manager etc. or whether the data must remain confidential and, if so, what the reasons are. Indicate also if the surveyor may deposit a copy of the report in the British Lichen Society Library or elsewhere for others to consult.
- Indicate if the report is to be presented in a specific format. Be aware that this may result in extra cost to the surveyor.
- Indicate whether the surveyor may visit the site prior to submitting a tender. For a large contract, especially where there is limited information available, a site visit may be needed to price the project accurately.
- Set out the payment schedule.

2.6 For the lichen surveyor

2.6.1 General

The surveyor should know where he/she stands professionally as a lichenologist with regard to experience and expertise to ensure that he/she is suitably qualified to take on the surveys that are being asked for. For example, if this experience is mainly in lowland Britain, it may be unwise to undertake a contract in Scottish mountains. The commissioner will not necessarily be aware of this, and may ask for survey work requiring other experience and expertise. Therefore, be prepared to decline work and recommend other lichenologists who may be more suitable. Surveyors should be members of the BLS to have access to the professional resources and training offered to members.

Do try to understand what the commissioner needs, and why, and be willing to give guidance. The commissioner is a client, and, as a professional, the surveyor should give full consideration of what is in the best interests of the client in trying to meet his/her needs.

Sometimes the commissioner may only have a vague idea about what is required. The surveyor must agree with the commissioner at the outset what exactly he/she is expecting and that this will meet his/her needs. In some instances, for example when dealing with the possible impact of pollution, the commissioner may ask for a lichen survey, but what is required may be a monitoring project. In this case only a limited survey may be needed to identify suitable monitoring sites which would then be used to record presence, cover or abundance of certain indicator species.

2.6.2 Large and small contracts

The scale of the work should be assessed, as should the surveyor's resources (manpower and time), for completing it to the client's requirements. For a small project, a surveyor may not be asked to submit a tender, or even receive a formal contract, but may just be asked to provide a quotation (fee rate and time), perhaps verbally or by email. The commissioner may not know what is involved so be careful not to underquote. It may not be possible for either the surveyor or the commissioner to tell how large a job will be, and the commissioner may be willing to accept the surveyor charging at an hourly or daily rate to a maximum figure. The following section relates mainly to larger contracts but as the principles apply to all contracts, the key points should be born in mind for small projects.

2.6.3 Larger contracts

Before agreeing to a contract, read the tender brief and any appendices very carefully. In the tender include:

- Time (usually days) for the searching and analysis of existing data ("desk study"). If information is needed from Local Record Centres or other agencies, this may have to be paid for, so include this in the estimate of the survey or agree that the cost will be passed to the commissioner.
- Meetings with commissioners, landowners and land managers, and other meetings etc (with travel expenses).
- Field work time and expenses (travel, subsistence etc.) and insurance.
- Identification time and time for inputting and analysing data if this is a significant part of the project. Costs of specialist literature, materials and TLC analysis.
- Report writing; include printing costs and report production, postage and VAT (if appropriate). Also include translation costs if, for example, a Welsh summary is required as it is for Countryside Council for Wales.

Check, and be sure, that the ratio of time for field work days to that of identification and report writing is realistic. And for longer periods of fieldwork, include some contingency days in case of bad weather.

If there is any doubt about any aspect of the brief, contact the commissioner and ask for clarification. As an example, clarify if not indicated whether the records may be passed to the BLS Database and Mapping Schemes or the local Environmental Record Centre (if there is one). This should not prove a problem unless the report is confidential, in which case, ask at what stage the records may be disseminated in this way. Do remember that the commissioner cannot provide any significant additional information beyond the original brief unless it is absolutely essential. In situations where additional information is imperative, the same information must be legally also sent in writing to all the other tendering parties in sufficient time before the tender submission date. Therefore, be sure to discuss issues with the commissioners well in advance of the deadline for submission.

2.6.4 Planning a project

Before submitting a tender or agreeing to do a survey, you must identify the type of survey that is needed and do outline planning. Consider the follow general points:

Identification and location of main community types present for overall/preliminary conservation requirements (see James *et al.* 1977).

Presence, location and abundance of main sensitive/indicator species, if a survey for assessing pollution or ecological continuity.

Suitable locations that will easily be found when revisited for monitoring.

If photographic recording is to be used, identification of suitable surfaces (e.g. large smooth-barked trees, gravestones, etc.) which enable good focus across the image.

Consider whether the *main* objective is a full floristic survey required for conservation needs (e.g. BAP), a survey required for planning needs (e.g. EIA), a repeated survey for monitoring, or a survey for some other specified purpose.

2.6.5 During the project

When the project is running, keep the commissioner informed of any difficulties, or any changes that have to be made, for example, if the schedule is falling behind because of illness and, therefore, the deadline for completion may not be met. This also applies to any unexpected findings. The commissioner should be kept informed of progress at key points, for example at the completion of field work.

3 Fieldwork

3.1 General points

The approach that should be taken to fieldwork depends on the type of work being planned. For example, if the survey is in a remote part of Scotland, it may be more akin to an expedition. **In all instances fieldwork must be well-planned and done carefully.** Be aware that it is not the intention of these Guidelines to be overly prescriptive, but rather to draw attention to a range of points to take into account.

3.2 Preparation

Preparation should be started as soon as a survey project has been agreed since some necessary information may take some time (possibly weeks) to acquire. (This work includes what some consultants refer to as “desk study”.) Examples include ordering maps, searching for literature, and contacting key people from whom to obtain advice and permission. The following checklist, though not intended to be exhaustive, may help in planning fieldwork.

- Seek permission for access to a site at least two weeks before surveying is due to start.
- Search for published and unpublished literature, especially in the BLS library, electronic data bases such as Web of Knowledge™ and EDINA. This search may be for previous surveys (e.g. ‘Grey¹’ literature from BLS library), local floras and accounts of lichen ecology of the habitats likely to be found and/or general ecology of the region. [See also **4.2 Literature** and **5.6 Surveying the literature and background information.**]
- List and then investigate notable lichen species likely to be found in the BLS Database or Local Record Centre as well as the literature. Also look at the distribution of possible rare species and check if the national or local herbaria have specimens from the site.
- Acquire and consult the best maps and aerial photographs that can be obtained. Historical maps (e.g. tithe/1st series of OS) may also provide useful information. Bear in mind that the minimum standard for location of notable species is a 6-figure O.S. Grid Reference and annotated maps may be an essential part of the final report. Maps and aerial photographs may be obtained from numerous sources including the internet. Landmark provides a service for providing maps of all kinds (historic, geological) for a specified area for consultants in the environmental sector. Here are some URLs of some providers but there are many more. In most cases, quality maps and aerial photographs will have to be paid for.
<http://www.multimap.com/>
http://www.bl.uk/collections/map_aerial_photos.html
<http://www.bl.uk/collections/maps.html>
<http://www.bluesky-world.com/aerialphotography.html>
<http://www.promap.co.uk/promap/index.jsp>
<http://www.ordnancesurvey.co.uk/oswebsite/>
<http://www.old-maps.co.uk/>

¹ The ‘Grey’ Literature is the term used for unpublished reports. These are often reports written as a result of contracts or investigations for a particular organisation or client.

- Geological information – i.e. geological survey reports and maps may need to be obtained. The Geological Survey (and Landmark) will charge for maps and services.
- Ecological information about the general area. Such information, or help in obtaining it, may be obtainable from Scottish Natural Heritage, Natural England or Countryside Council for Wales.
- Consider the scale of sampling and methodological approach, i.e. what the objectives are (base line list, repeat monitoring, indicator survey, environmental impact studies), and the peculiarities of a site which may need specific methodologies. [See **3.6 Field methodology.**]
- Consider how species are going to be recorded. Decide on notation method to suit your individual style e.g. recording card and target notes vs. abbreviated names in field note book, or perhaps use of tape recorder to be replayed later. Decide whether “presence only” is to be recorded or a more quantitative recording system and whether this suits the objective better. For example ‘frequency table’ for 5-10 trees rather than single list can be more informative for a ‘habitat’ or community description. Lichen communities should also be recorded. Which ones are expected and what species are likely to be present (see James *et al.* 1977)? Find out whether suitable quadrats (or other recording equipment) are available, or whether these will have to be obtained or made.
- Identify where good weather forecasting can be accessed before and during the survey. The Meteorological Office website (<http://www.met-office.gov.uk/>) with local 5-day forecasts is very useful, but will need to be accessed while doing the fieldwork. Local radio stations also broadcast forecasts.
- Site specific Health and Safety information needs to be acquired. This may be obtainable from those commissioning the work but site managers, wardens or rangers may need to be contacted.[See **3.4 Health and safety.**]
- Contact other people who have worked on the site and who may give helpful information about working there; for example, access and parking, Health and Safety information, the location of places to find lichens, and finding your way around the site.

Read the brief again thoroughly and check that the planned approach will provide the data needed to meet the client’s objectives.

3.3 Access

Some of this information may be in the project brief from the commissioner.

Permission to visit a site must obtained by the commissioner or the surveyor.

Generally it is preferable if the commissioner arranges it. Here are some notes that may help.

- It is good practice to ask for written permission for carrying out surveys and collecting specimens (suggest using the phrase ‘may need to collect some small samples or specimens’ in your permission request letter).
- The surveyor should make specific arrangements for access with landowners following the granting of initial formal permission. This may also be needed for a companion or a dog.

- Once a contract is secured, leave at least two weeks for access to be arranged, and give about two weeks notice to the commissioner before surveying is due to start. Sometimes shorter time scales are required.
- Try to find out about access points, where to park, and, if along tracks, seek permission to use a vehicle. A mountain-bike has been found useful by some surveyors.
- Whilst on site, carry some form of personal identification and a copy of the permission to enter the site in case someone asks to see it.
- Mark all access points and tracks on a good quality map which should be provided by commissioner.
- Access permission may be needed not just from the landowner but also possibly from other parties, e.g. a tenant or shooting syndicate.
- If an authorised person is reluctant to allow access to a site, your courtesy and enthusiasm for lichens, the survey and the environment may overcome this obstacle.
- Powers may exist to gain access without permission if absolutely necessary but this should only be used as a last resort.

3.4 Health and Safety

Health and Safety is a vital issue for you, the surveyor, and not only concerns your personal safety but also affects many other people, including the site owner, the public relations of the commissioner and, possibly, people having to help, or rescue, you after an incident. It is part of your professional responsibility to be able to work with appropriate precautions for Health and Safety. [Also see **1.6 Disclaimer.**]

3.4.1 General points

Prepare a Risk Assessment in writing prior to going on site. This is a standard process, and if necessary, you should have appropriate training. As a lichenologist, remember that the use of knives, hammers and cold chisels presents particular dangers and can cause injury. The basic procedure is to write down briefly and clearly the following:

- An outline of the procedures you will follow.
- What could go wrong (specific possible incidents).
- The likelihood of each incident happening.
- The severity of each incident.
- What measures you would take to prevent each incident occurring.
- If an incident occurred, what you would do, including contact details of sources of help (e.g. emergency phone numbers).

Be ready to revise, at any time, your Risk Assessment if new relevant information is obtained from the commissioner, landowner or from previous visits.

Risk Assessment is meant to concentrate the mind about what **could** happen, its prevention and action should an incident occur.

3.4.2 Other points

- Risk Assessment and Health and Safety precautions should be site specific and not just for the type of work being done.
- **Leave information each day with a responsible person (designated contact) at home, or where you are staying, indicating where you are going to be and when you are likely to be back and, if not back by a certain time, what to do about it. This is strongly advisable even if working in groups since a whole group can get into difficulties in the field.**
- Always work carefully and cautiously even when working with others.
- Know your own physical limits (e.g. the height of fences you can get over, the size of rivers you can cross, and the distance you can cover on foot in a day).
- Identify the essential equipment, including first aid kit, before seeing if you can carry other useful equipment.
- Brightly coloured clothes help you to be being seen (e.g. a ‘high-vis’ jacket). Brightly coloured equipment also helps its re-location and prevents loss.
- Ticks – if there is a risk of ticks, do not sit directly on the ground or vegetation. Take steps to avoid the risk of contracting Lyme’s Disease (see: www.oeghmp.at/eucalb/leaflet.htm, www.brecon-beacons.com/lyme-disease.htm and www.nfdc.gov.uk/media/adobe/ACFDD1D.pdf).
- If you work in or near water, take precautions against Weil ’s disease which is spread by rats (www.iphe.org.uk/health/weils_disease.html).
- Wear appropriate clothing for prevailing conditions and use common sense at all times.
- Be sure that you put safety ahead of curiosity, the desire to complete the fieldwork or to please your commissioner.
- **Take a mobile phone (fully charged) and a whistle. Remember: six regular whistle blasts repeated at intervals of one minute.**

3.4.3 Lone Working

You are at risk when working alone. You may be attacked, or have an accident, and no one would know. **Precautions are essential!** Consider the following:

- **You must take extra care and be very vigilant. When working alone, have a means of calling for help.** Mobile phones are OK if you are in transmitter range, but lichenologists will often visit sites out of range. Check that your battery is charged before going out, and when on site, check if you are in range. If you are out of range be especially careful.
- **Before you go out, inform your designated contact at home (or where you are staying) about where you are going, your designated route and your car registration number and make and your return time and STICK to it. Having told your contact that you will be back at a certain time, agree with them what you expect them to do (e.g. call the police, come looking for you, phone someone on a given number) and when (e.g. half an hour or an hour later) if you are not back by a certain time. DO NOT change your plans WITHOUT telling this person.**

- **Do not get drawn into talking with strangers**, e.g. trying to help stranded motorists or other seemingly philanthropic activities, **without being very careful** – they may be trying to trick you. If you do talk with someone who is apparently *bono fide* be sure you find out exactly who they are when you first speak with them.
- **Wear high visibility clothing** and/or high-visibility equipment
- If you feel unsure about your safety, leave the site and go home early. It is OK to be back early!

Other points and suggestions:

- **Attitude to risk taking:** by taking a risk you may be risking the safety of others who you are expecting to help you. If you have an incident, you will cause trouble and possible danger for others.
- **Leave a note/guidance that can be seen through the windscreen of your car** (which should be parked in prominent position).
- Plan your route using landmarks.
- **Keep your whistle, phone and your GPS within easy reach** e.g. in the same pocket rather than buried in your bag. They will then be handy if you have to call for help even if you are separated from your bag or stuck awkwardly.
- **Phone your designated contact on arrival, and on leaving, the site** (if possible). In addition to, or instead of, contacting them on return to base/home.
- If you know someone who is local to the site, it is useful to have their phone number in case you have a problem.
- Agree with the designated contact another person who you can call if your designated contact is called away.

3.4.4 COSHH (Control of Substances Hazard to Health)

The precautions regarding the use of chemicals in the field are similar to those for their use in the laboratory. Of additional concern is the safe transport of chemicals. The following points may aid their safe use:

- Take only small amounts (1-2 ml).
- Make sure that the containers (bottles) are tightly closed.
- Keep the containers in a leak-proof sealed plastic pot with absorbent tissue in the bottom to retain any liquid that might leak.
- When using chemicals in the field, be careful not to spill or use excess on the substrate in such a way that they would be a hazard for any one touching the surface after you have left (e.g. on a gate post).

3.5 **Equipment**

In limiting what has to be carried, there must be a decision as to what equipment is essential and what might be useful. The choice largely depends on where the site is, the length of time the survey will take, what work is planned on the site and how much the surveyor is capable of carrying. The full list below would be a massive amount to take and unwise for long arduous days in difficult terrain. If it is necessary to take a lot of equipment, it helps to have two people working together so that the load can be shared.

In the following checklist, items which may be regarded as essential are indicated in bold. First identify those items that relate to your health and safety.

3.5.1 Lichen Surveying Equipment

- **Paper packets** of various sizes (pre-printed with the site name) with space to add date, location, cross reference to field notes, and initial ID.
 - **Tobacco tins/plastic boxes** and plastic bags/cloth bag (specimen collection) with toilet tissue to wrap specimens to prevent them rubbing.
 - **2 x10 hand lenses (one as a spare)**. Some lichenologist also take a x20 for seeing finer details.
 - **Clipboard/notebook** – waterproof (e.g. in a large plastic bag). Some field workers use Aquascribe (www.aquascribe.com/) notebooks which can be used in heavy rain or even underwater!
 - **Pencils**. Some surveyors recommend oil-based ball point pens, which tend to write better on damp paper.
 - **Sheath-knife** (sharp) and a stone to sharpen it. **NEVER us a pen-knife (or shut-knife) to collect lichen specimens unless the blade can be locked in the open position.**
 - **Hammer**. A geological hammer is preferable as the head is made of hardened steel.
 - **2 cold chisels** (one as a spare) with a triangular file to keep it sharpened. When dropped, cold chisels notoriously disappear into inaccessible rock crevices.
 - **Chemicals including K, C**, dilute HCl (10% hydrochloric acid or strong pickling vinegar), PD (Steiner's solution).
 - **Maps**.
 - **GPS**. For the location of trees or lichen communities of even thalli, and route mapping – The Garmin GPS12CX is recommended. It is handheld and has provision for plugging in an extra aerial which may help reception, e.g. under a tree canopy.
 - **Digital camera**. The Nikon Coolpix 4500 is recommended, with the illuminator Nikon CL-1 Coolight, which allows the camera to be placed and held still against surface for photographing crustose species.
 - **Spare batteries** (for camera and GPS).
 - **Compass** (navigation and determining rock face, or tree-trunk, aspect).
 - Quadrats.
 - Umbrella – some surveyors find this very useful, allowing some work during rain showers.
- Striped marker tape (red/white) (for identifying areas for later more detailed surveying).
- Tape measures (for measuring tree girth at chest height).
 - White 10cm plant tags (to aid the location of species in photography).
 - Coloured notice-board push-pins for marking thalli on bark or wood in photographs.

- Razorblade (in a small tin for protection) to cut apothecial sections in the field.
- Secateurs. (e.g. Spear & Jackson's Razorsharp Multi-tool which includes a variety of tools, e.g. small saw and a pair of secateurs).
- Tree tags (for re-identifying trees) – with proud aluminium nails (use only with permission).
- Binoculars (for checking the presence of lichens in distant or inaccessible places, e.g. higher tree trunks and branches).
- Small voice recorder if you need to record information where you do not expect to be able write.
- **If the surveyor uses glasses, take a spare pair.**
- **Plastic bags to keep water-sensitive equipment dry during rain.**

3.5.2 Personal Protective Equipment/Clothing

- **Warm water-proof clothing** (especially in winter) e.g. **waterproof trousers/jackets**. “There is no such thing as bad weather, only inappropriate clothing” (Norwegian ecologist). Failure to have appropriate clothing and footwear is one of the commonest causes of difficulties experienced by people in the field.
- **First-aid kit.**
- **Hiking boots.**
- **Contact telephone numbers.**
- **Mobile phone (charged).**
- **Whistle** (Acme Thunderer).
- **Medication.**
- **Eye protection** (for rock chipping).
- **Sun cream**, hat and sun-glasses.
- **Food: packed meal with high energy dried food in reserve.**
- **Water (drinking).**
- Toilet roll.
- Insect repellent.
- Fingerless gloves.
- Stick for walking over loose/rocky ground and crossing streams.
- Survival bag/aluminium sheet.
- Torch.
- Portable radio for weather forecasts.
- Hard hat if visiting areas where rocks may fall, e.g. in old quarries, under unstable cliffs or in gorges.
- High-visibility jacket can be useful when working in the public eye to distinguish the surveyor from members of the public and so you can be seen on a mountain side.

3.6 **Field methodology**

The method of working on a site is to be, to some extent, a choice for the individual surveyor as it will depend on the aims of the project. Smith (2002), Feest (2006) and Hill *et al.* (2005) provide some advice that may help plan an appropriate methodology. The following list of suggestions is to help the planning of the work to be done on the site.

3.6.1 Survey and sampling strategy

- Allow extra time on a site that has not been visited before as it takes some time to find the best way to reach all parts of the site, identify the main habitats and assess the scale of the landscape.
- Divide large sites which contain different habitats or zones into smaller survey units.
- Before starting to record, walk around a small site, or a survey unit of a large site.
- Consider sampling a number of trees of different girths.
- Decide whether to devise a structured walk that takes in habitat or landscape features or follow a path intuitively whilst recording. Latter may sometimes be better for lichens because the multiple niches encountered can be unpredictable. Feest (1999) used 20 plots (in a line 20m apart) and this method may be suitable for a continuous habitat e.g. grassland, *Cladonia*-heath, or even trees in a woodland.
- In discontinuous habitats (e.g. woodland/rock outcrops), a two-phased approach may be best including commoner species and communities first followed by a second phase concentrating on rarer species, although in a continuous habitat, a structured walk with regular stops could be used.
- Fieldwork could be phased to ensure thorough and systematic cover:
 - Stage 1 – preliminary walk and recording common species
 - Stage 2 – looking for unusual/specialised habitats/rare species including photography but this depends on project requirements.
 - Stage 3 – quadrat sampling, if standardisation of lichen recording is needed, or tree marking and recording is required
- Use the full range of topographical and habitat scales in sampling the site when recording. This means making sure that lichens are recorded from a full range of available niches, individual rocks, trees or other small-scale features such as quadrats or rock crevices. Also make sure that all the parts of the site at the largest scale have also been sampled (e.g. ensure ‘even’ coverage over the whole site).
- For planning more detailed monitoring programmes, see Nimis *et al.* (2002) and Tucker *et al.* (2005). The former has details of specific methods for lichens; and the latter has methods which are more generic, but may be useful for planning lichen monitoring.
- If you plan to use quadrats, check that they are of a suitable design (e.g. see Scheidegger *et al.* 2002) and that the sampling strategy has been thought through to data analysis.

- If you plan to conduct a statistical analysis of data you anticipate collecting, make sure that the sampling methodology (sample size and type of data) is suitable for the analysis. Fowler *et al.* (1998) and Zar (1996) are useful sources of information on statistical methods.

3.6.2 Species recording

- Make notes of the lichen communities present (See James *et al.* 1977). Consider making a diagrammatic map of their distribution on a rock outcrop or tree.
- Make species/community lists for each tree species and substrate. Specify the nature of the substrate e.g. dead wood (lignum) or bark. Make a frequency table for 5-10 trees of the same species.
- Habitat-specific features should be recorded, e.g. for trees: size and growth form (maiden, pollard, old coppice stool), aspect and species. These should be included in notes about management. For rocks, include notes on geological information, e.g. rock type, acidic/basic, stratigraphy and mineralogy.
- List species that were expected for a particular reason such as those previously recorded for the site but which were not found. Be aware that databases cannot record the absence of species – indeed absence is not definitive because it simply means that a species was not found. For such unrecorded species, it may be helpful to indicate if it was searched for and how this was done. Specifying this may be informative in surveys where pollution monitoring is a feature.
- Relate survey lists (species and communities) to features such as habitats, tree species, rock types or structures.
- Ensure minimally destructive sampling. When surveying monuments only take small scrapings. Do not take too many or large specimens from rocks or trees. Always leave plenty of any thallus from which a specimen is taken. (See Section 4.1.4)
- Some clients find semi-quantitative measures useful even if they are subjective. Commonly used scales are DAFOR (Dominant, Abundant, Frequent, Occasional or Rare) or ACFOR (Abundant, Common, Frequent, Occasional or Rare). The latter seems more appropriate for most lichen communities.

3.6.3 Photography

- Photography should be standard. Use digital equipment.
- Take images of rare or notable species, communities and habitats.
- Use plant labels or tags to indicate the names of lichen species in images of communities.
- Photographs may be helpful to ‘monitor’ the general health of thalli or communities. Images should be relevant, labelled and explained in the context of the purpose of the survey; therefore, record full notes about all photographs in the field at the time they are taken.
- Make corresponding diagrams of the object photographed so that it is clear what is included in the photograph.
- Wirth (2002) provides valuable guidance for taking photographs. Although this is out-of-date in that it is aimed at film photography, much of the advice is applicable to digital formats.

3.6.4 Note taking

- Write down as much as possible. **Commit nothing to memory!** Use diagrams.
- Note the time and conditions when taking notes.
- If future monitoring is possible, select suitable sites for it during the survey.
- Remember to take notes about management as the site is surveyed. Such information may be difficult to recall later, and returning to areas already visited after completion of other field work is a nuisance and extra cost.
- Management comments need to be realistic and specific (e.g. saying ‘control ivy’ is not very helpful). They should be in terms easily interpreted and put into practice by the commissioner (or client). Consider the primary use of the site, and whether the recommendations will be what the client may be willing and able to do.

3.6.5 Other relevant material gathered whilst taking notes

- Reporting – think what will be put included in the report whilst surveying in the field.
- Make drawings and use diagrammatic representations of all sampling and communities whilst on site. These may be useful when compiling and interpreting the data and writing the report.
- Record the survey methodologies followed while in the field so they are ready for writing the report. Otherwise, details of what was actually done may be forgotten.
- Remember that making a definitive list for a site is never possible when recording species in the field, but what is recorded may be used to assess conservation potential of the site.
- A description of the general ecological and geological understanding of the site is useful to help commissioners or clients interpret the context of a site. It may help relate the lichenological content of the report to the reports from other ecologists, or surveyors of other taxonomic groups.

4 Identification

4.1 *The approach*

4.1.1 Identification is in three stages

- 1 The first stage is identification in the field and is done mainly on sight with perhaps spot tests. This mainly involves common species which usually form the bulk of a species list [See **4.1.4 In the field**].
- 2 The second stage of identification is done at home in the laboratory and is based on specimens taken where microscopical examination or chemical analysis is needed. These specimens are usually discarded if the species turn out to be common (as is sometimes the case) or if the material is too poor to enable identification (which can also happen). Unusual specimens are retained by the surveyor, unless they are of regional, national or taxonomic importance, in which case they should be deposited in a herbarium. [See **4.1.5 On return from the field** and **4.3 Identifying specimens**].
- 3 The third and final stage is the confirmation of unusual/unexpected/critical species by another specialist lichenologist [See **4.5 Using specialist referees**].

4.1.2 Planning identification

As soon as the commission for a survey has been received, make arrangements to locate or acquire the literature [see **3.2 Preparation**] that might be needed for identification before going into the field and plan out time for identification in the laboratory immediately after returning from the field.

4.1.3 Preparation before going on site

It is highly desirable to read relevant guides and survey reports where they exist before going to a site, to note the species to be expected and to become familiar with them. This can be done through the literature [see **4.2 Literature**] and by studying specimens from an herbarium [see **4.6 Herbaria**]. Notes about the habitat, ecology and field characters including spot test reactions and other notes about the species to be expected can be very useful when looking for them in the field.

4.1.4 In the field

- Take lists of species and notes previously made (see above) together with copies of survey reports to identify where previous surveyors had been recording or collecting. Chemicals [see **4.3.5 Chemistry**], good maps and a handheld GPS are essential. [see **Chapter 3 Fieldwork**].
- Record field identifications in a notebook or on a record card, adding notes about abundance, substrate and population features (e.g. if population is mainly old or young thalli) where appropriate. [see **Fieldwork 3.6 Methodology**].
- For species that cannot be identified in the field, locate other thalli and establish the size and extent of the population before collecting. This is not always possible, as lichens can often be niche-specific, and time-constraints may restrict such searching. If it is decided not to collect at first sight (for whatever reason), the species may be found again later in the day, so note it as “sp. 1” etc, so there is a record of its distribution on the site.

- Make notes about its ecology, abundance, substrate and population features etc as above.
- If other examples are found in the locality, check whether the thalli are uniform. Look to see if there are any clinal variations (e.g. with distance from water, in and out of shade, higher or lower on tree). Choose a thallus, or thalli, with all the features that are going to be needed for identification. Finally select a representative thallus, or thalli, for collection.
- In selecting a representative part of a thallus to make a specimen, choose a part which has:
 - a good edge (foliose and crustose species), or branch ends (fruticose species)
 - examples of ascocarps of all stages of development (age-range of fully formed ascocarps is desirable, as young ones may have immature spores, and old ones may be empty)
 - if soredia, isidia, schizidia, blastidia, phyllidia or other vegetative propagules are present, make sure all stages of development are represented on the specimen
 - for fruticose species, (e.g. *Usnea* sp.) the holdfast is often characteristic and needs to be included
 - sufficient quantity of material for chemical analysis e.g. TLC.
- Then decide how much of the thallus, or parts of which thalli, to collect. If there is sufficient material more than one collection may be made, especially if it is very variable or if the first collection did not have all the features seen later. Make sure that good material is collected and that plenty is left after the specimen is collected and try not to take a whole thallus unless absolutely essential.
- Collected specimens should be carefully conserved, e.g. in tissue, but be careful since removing damp tissue can damage delicate features which may be useful for identification. Place in a paper packet.
- Old tobacco tins or plastic boxes are useful for collecting *Cladonia* spp. and pin-head lichens to prevent them from being squashed, crushed or damaged by the use of tissue paper. Make sure that a slip of paper describing the precise location of the specimen is included in the tin.
- It is vital that all paper packets, tins and boxes should be carefully labelled with the site name, the date, and that a locality is cross-referenced into the field notebook. Some surveyors may include a personal note which will recall of the field location to mind, e.g. the time, description of view, events or just “a.m. after coffee”. This labelling is essential; otherwise, there may be scant record of where the specimen was collected.
- Then double-check that all the features of the lichen are represented in the specimen collected by comparing the specimen carefully with several other thalli *in situ*. Check careful notes in field notebook including how many thalli are present, distribution together with features of the community of which the species is a component and of the habitat. The time taken to do all this will be

insignificant compared with the time it would take to return to the site to obtain another specimen.

- If possible, enough material should be collected to divide into duplicates. This matter is a matter of judgment and has to be decided on the basis of the importance of the species (if known) and the amount of material present in the field.
- Notes to take include the following, depending on the substrate. For a corticolous species record where it occurs on a tree, the tree species, angle of branch, aspect etc. For saxicolous species record rock type (geological terms), location on outcrop (e.g. near ground or bird perches), aspect, inclination, presence of any water nearby, etc. For terricolous species, record inclination, aspect, soil type (soil science terms), shading, higher plants nearby (NVC community type). [See **3.6 Survey methodology**].

4.1.5 On return from the field

Sort the material carefully, check the packets and dry them as soon as possible. All boxes and tins should be left open, with the lids off, so that the lichen material can dry out. Otherwise it quickly goes mouldy, and will be of no use. If staying in a hotel, or other accommodation, while carrying out the survey, open all paper packets and place as close to room radiators as possible (without causing a fire hazard). If there are a lot of wet, soggy packets, ask the host or proprietor if they would allow the packets to be spread out in the room to dry, perhaps on old newspaper. Do not place specimens directly on the radiators as that can damage the lichen material.

On return home and before starting laboratory identification, ensure that all the packets are thoroughly dry. Then, put them in a sealed plastic bag and place it in a freezer for two days to kill off any lichenivorous invertebrates, especially mites. Remove from the freezer but be sure to allow the specimens to return to room temperature (the plastic bag preventing water condensation and dampening of the specimens; in particular allow plenty of time for rocks to warm up). Remove the specimens from bag and store on an open tray while the material is systematically worked through. Work on collections as soon as possible after return while details of observations made in the field are still fresh in the mind ensuring that anything additional to the field notes may be recalled.

4.2 **Literature**

It is essential to have appropriate literature on which to base identifications. There are guides and keys of several types and a surveyor should be familiar with these in case they can help in particular circumstances. New guides are being published every year making it necessary to keep up to date. The British Lichen Society Library can help with out-of-print publications, papers, articles and unpublished reports ('grey' literature). The current serial publications of the BLS are *The Lichenologist* and the *Bulletin*, both of which may contain useful information. [See **5.6 Surveying the literature and background information**.]

4.2.1 General guides

The main printed works relevant to the British lichen flora are as follows.

Lichen Flora of Britain and Ireland, 1st edition (Purvis *et al.* 1992) is the standard work which should be consulted. It has keys and descriptions of most of the British

species, although it is now out of date and is currently being revised. About 200 additional names are included in the latest checklist (Coppins 2002) but are not in this work. Until the new edition of the flora is published both works are essential.

Lichens an Illustrated Guide to the British and Irish Species, 5th edition (Dobson 2005), is a more elementary book but nonetheless useful for common and distinctive species. It includes about half the species treated in Purvis *et al.* (1992) with photographs and distribution maps for most of them.

Lichen Identifier, 2nd edition (Dobson 2003b), is a multi-access key in which the characteristics observed are selected from drop-down texts or entered into a dialogue box and the programme lists the species in which this combination of characters is found. The character data used is that from Purvis *et al.* (1992) but with the names according to the latest checklist (Coppins 2002). It has a user guide that explains the various features. It also has distribution maps and 300 colour photographs.

There are also earlier books which are mainly only of historic interest. Details of these can be found in the list of references in Purvis *et al.* (1992) and Hawksworth and Seaward (1977).

4.2.2 Local floras

There are several local county lichen floras, floras of areas and even of specific habitats, especially those by O. L. Gilbert. These may not have keys but do give an indication of the species to expect. Older references up to 1975 may be traced through Hawksworth and Seaward (1977) and more recent ones published in *The Lichenologist* may be found through indices (Vol. 20 (1988) pp 401-425 and Vol. 35 (2003) pp.417-489). Recent county floras published separately are Devon (Benfield 2001), Brecknock (Woods 2003) and Cheshire and the Wirral (Fox *et al.* 2003).

Table 4.1 identification Guides of Specific Habitats

Rocky shores	Fletcher (1975a and b)
Lichenicolous fungi	Hawksworth (1983 and 2003)
Twigs	Wolseley <i>et al.</i> (2002) – also on-line [see Computer-based Aids below] and Table 4.3
Churchyards	Dobson (2003a)
Rocky overhangs	James (1970)
Limestone pyrenocarpous lichens	Coppins (1984)
Sterile crustose saxicolous and terricolous lichens	Fryday and Coppins (1997)
Coastal Schist in Devon	(Hawksworth 1980)

4.2.3 Specialist guides

A number of guides deal with the identification of particular groups on a habitat (Table 4.1) or taxonomic (Table 4.2) basis. If working for a statutory organisation, a member of the staff may be able to help. It is quite appropriate to include the cost of the acquisition of appropriate specialist literature in expenses when negotiating, or tendering for, a contract. Some of this literature may be obtained from the BLS (see www.thebls.org.uk).

Those that are recent and better known include:

Table 4.2 Identification Guides to lichens within Taxonomic Groups

<i>Cladonia</i>	Hodgetts (1992)
<i>Dermatocarpon</i>	Orange (1998)
<i>Lepraria</i> and <i>Leproloma</i>	Orange (1995)
<i>Parmelia</i> (CD)	British Lichen Society (1997) [see Computer-based Aids below]
<i>Porpidia</i>	Fryday (2005)
Non-yellow <i>Rhizocarpon</i>	Fryday (1996)
<i>Usnea</i>	James (2003)

Works in journals:

There are many useful papers which can help with the identification of certain groups and species. These are published in a variety of journals (see also below), the main ones in Britain being *The Lichenologist* (see *Lichenologist* vol. 35 pp 450-451 for index to keys published since the first edition of the *Lichen Flora of Britain and Ireland* (1992)) and the *Bulletin of the BLS* of which Volumes 1-70 were indexed.

Works dealing with European lichens

A number of works deal with lichens in other parts of Europe and include species which also occur in Britain. These works can be very useful.

- Wirth (1995) for Baden-Württemberg, Germany (in German) with keys, and some excellent colour photographs.
- Dahl and Krog (1973) for macrolichens of Scandinavia (in English) with keys.
- Nimis and Martellos (2004) for terricolous lichens of Italy (in English) with keys and species descriptions.
- Ozenda and Clausade (1970) for France (in French) with keys, species descriptions and black and white photographs.

See also Hawksworth (1990), which is a list of lichen floras of the world where other literature may be found.

Monographs of lichens families and genera (often on a worldwide basis) are published in the series *Bibliotheca Lichenologica* (published by Cramer).

Computer based aids

- Compact discs

Parmelia Key (British Lichen Society 1997) is a useful interactive CD with excellent illustrations. For the *Lichen Identifier* (Dobson 2003b) see General Guides above.

- Web resources

There is an increasing number of on-line keys (Table 4.3) for identifying lichens. Some of these are for non-British species, but may be useful for identifying British lichens.

In addition, Grube (2002) describes online documentation of lichen biodiversity and Rambold (2002) discusses computer-aided identification systems for lichens.

Table 4.3 Online Keys and Websites for Locating Identification Literature

Italian lichen keys	http://dbiodbs.univ.trieste.it/
Lichens on twigs	http://internet.nhm.ac.uk/jdsml/nature-online/lichen-id-guide/index.dsml
Lichen keys various	www.bgbm.fu-berlin.de/sipman/keys/default.htm
Some keys for USA	www.huh.harvard.edu/collections/lichens/index.html
Lichen key archive	www.toyen.uio.no/botanisk/lav/LichenKey/
A Global Information System for Lichenized and Non-Lichenized Ascomycetes	http://lias.net/
For searching for other lichen literature	www.toyen.uio.no/botanisk/lav/RLL/RLL.HTM
Checklists of lichens on a worldwide basis	www.biologie.uni-hamburg.de/checklists/portalpages/world_1.htm

4.2.4 Checklists

The latest printed checklist of British Lichens (Coppins 2002) is available from the BLS, but a frequently updated version is on-line at www.thebls.org.uk. Synonyms can be found online in the Synlist at the BLS website (www.thebls.org.uk). Synonyms in printed form can be found from older checklists. There is also a checklist of Welsh lichens (Woods 1999). (See Table 4.3 for checklists for other countries on a worldwide basis.)

4.2.5 Previous survey reports

Previous lichen information should, in the first instance, be supplied by the commissioning body. This is especially so if surveys are at the request of the statutory government agencies, who should (theoretically) hold all previous data. If they do not, or if for a survey for other commissioners, the pathway and options set out below may help surveyors locate previous site information.

- (i) Request from the contracting body any past information on lichens that they hold for the site.
- (ii) If they are not able to comply, then go to the British Lichen Society (BLS) web-site (www.thebls.org.uk) and look under "Grey Literature". This is periodically updated, however, it only contains the reports that authors have sent in to the BLS Grey Literature manager (Dr B.J. Coppins), so is probably not as comprehensive as it could be.
- (iii) If relevant reports are listed there, copies may be obtained from the BLS Library (Librarian: A. Fletcher afletcher@leics.gov.uk), which is the repository for some site reports.
- (iv) If this is unsuccessful (but the site in question has received a previously commissioned lichen survey), approach the body which commissioned the earlier survey (English Nature, the Countryside Council for Wales, and Scottish Natural Heritage all have Libraries, where copies of biological reports are sometimes held).
- (v) If this is unsuccessful, it may be possible to contact the author(s) of the reports and ask if they have a copy. Depending on the sensitivity of the information,

they may be able to help, but it may be necessary to pay for copies. Some author(s) may feel inhibited about releasing the data (Data Protection Act), or they may feel constrained by institutional confidentiality. Of course all Government Agencies recognise that legitimate requests for data contained in reports contracted by GOs should be made available.

- (vi) A guide to older reports is published in Hawksworth and Seaward (1977).
- (vii) Field meeting reports are indexed in *Lichenologist* vol. 35 p 447 (2004), vol. 20 p. 409 (1988), vol.10 p.246 (1978).
- (viii) Field meetings are also reported in the BLS Bulletin. An index to volumes 1-70 (1992) was published.
- (ix) Local Record Centres, Wildlife Trusts and Museums should also be consulted.

4.2.6 Communities

The standard text for lichen communities in Britain and Ireland is James *et al.* (1977). Although dated (and many of the names of lichens have changed) this is still very useful. The account lacks many communities that will be encountered in Scottish mountains and perhaps elsewhere. Another useful, though even more dated account is that of epiphytic communities by Barkman (1958). This latter account is useful in that it records a huge amount of detail about the communities, and is the only account available to include mosses.

4.2.7 General site information

When dealing with identification, it is useful to refer to general ecological and geological information about the site.

4.2.8 Distribution information

The BLS Mapping Recorder (Prof. M. Seaward, contact details in BLS Bulletin) can supply distribution maps of species on a 10km square basis and species lists for specified 10km squares. The new BLS mapping scheme (J. Simkin, contact details in BLS Bulletin) is a developing database based on grid reference locations, has fuller details and may be able to supply useful site information. Thumbnail maps are published in Dobson (2005) and Dobson (2003b). The BLS also publishes fascicles of distributions maps for genera (see <http://www.brad.ac.uk/acad/envsci/research/herbarium/database.php>).

4.3 *Identifying specimens in the laboratory*

4.3.1 Equipment and identification techniques

A certain amount of equipment is needed for identification in the laboratory, or at home. There will be variations in what individuals have, and each person must equip themselves as well as they can. It is possible to manage without a dissection microscope in preparing slides for a compound microscope using a hand lens but it is more difficult.

Certain chemicals are needed for microscope work and for chemical testing of lichen specimens. These must be fresh and of good quality, and there are health and safety issues relating to their use. Information given here does NOT constitute health and safety instructions and neither the authors nor the publisher take any responsibility for the personal safety of the reader, of any other person, using the general guidance

presented here. Any information regarding safety is included here simply to indicate that care should be taken to find out what health and safety procedures should be followed and adhered to.

Keep a “lab book”. This is a notebook, rather like a diary, in which meticulous notes are made detailing what is being done. This is invaluable for personal reference to check later. Details include: date, specimen number, line drawings, measurements, descriptions, chemical test results, etc duplicating everything written on the specimen packet. In the future, this lab book will become very useful to you and also useful to future lichenologists, if it is eventually deposited in an appropriate herbarium.

4.3.2 Dealing with specimens

Specimens must be handled carefully. Poor handling technique rapidly reduces their value. In preparing a specimen of a lichen species, it is helpful to consider a few main points as indicated below (see also Orange 2003).

- Is the material good enough to be of real value when looked at again?
- Is there more than one species present? List on the packet the other species present. It may be helpful to divide specimens if the species of interest is not the most prominent species present. This can be difficult with certain types of rock, for example. It is usually inadvisable to try and fracture a rock supporting a specimen as the rock may fracture through the specimen. Some “pruning” of a rock might be attempted by chipping bits away but, if the specimen is a really good example, it may be best to leave it although there are good diamond saws available cheaply. When a rock specimen has to be divided it may be better to fracture the rock rather than saw it. This is because dust from sawing can be very hard to control and if it contaminates the material, this may reduce its value significantly. Holding padding of soft material on the specimen can protect it from dust during sawing.
- When identifying material be economical with it. If possible, only use a portion of one fruiting body, and a small part of the thallus for chemical analysis, at the edge of the specimen of where it might become detached later anyway. It is best to remove parts of the thallus before testing with spot tests otherwise remove the part tested afterwards.
- Make sure the specimen material is dry, and, if wetted, it is allowed to dry again, before returning to the packet for storage. Dry fresh material SLOWLY, leaving it in ambient conditions rather than heating it. Remember to freeze lichens for two days before examination to kill off psocids, mites, etc., or the specimen may be destroyed in time.
- The value of a specimen is significantly increased by the information written on the packet, in addition to the correct name. Use plain paper for specimen packets rather than gummed envelopes or, worse still, plastic bags. Fragile specimens can be placed in small clear cellophane packets and be examined with a lens or dissecting microscope through the cellophane. Even if the specimens are for personal use only, the advice above greatly adds to the value of a specimen. See Orange (2003) and Powell and Fryday (2004) for advice on the care of collections and labelling specimens.
- Every lichenologist should build up a collection of reference specimens for their own use in identification. A substantial, well-labelled and maintained collection

may constitute an herbarium. Obermayer (2002) provides advice on herbarium management.

4.3.3 The identification process

The lichenologist requires equipment, procedures and skills. The following sections outline these.

Microscopy

Equipment

Obtain the best microscopes that can be afforded. Two principle types are :

1. a dissecting microscope with up to 40x (or more) magnification for morphological details (replacing the hand lens in the laboratory).
2. a compound microscope with x100, x400 and x1000 magnification and a calibrated eye-piece graticule for anatomical details.

Occasionally second-hand microscopes suitable for lichen identification can be bought from Universities (which have to replace sets used for teaching) or other establishments. When buying microscopes second-hand it is worth checking the following.

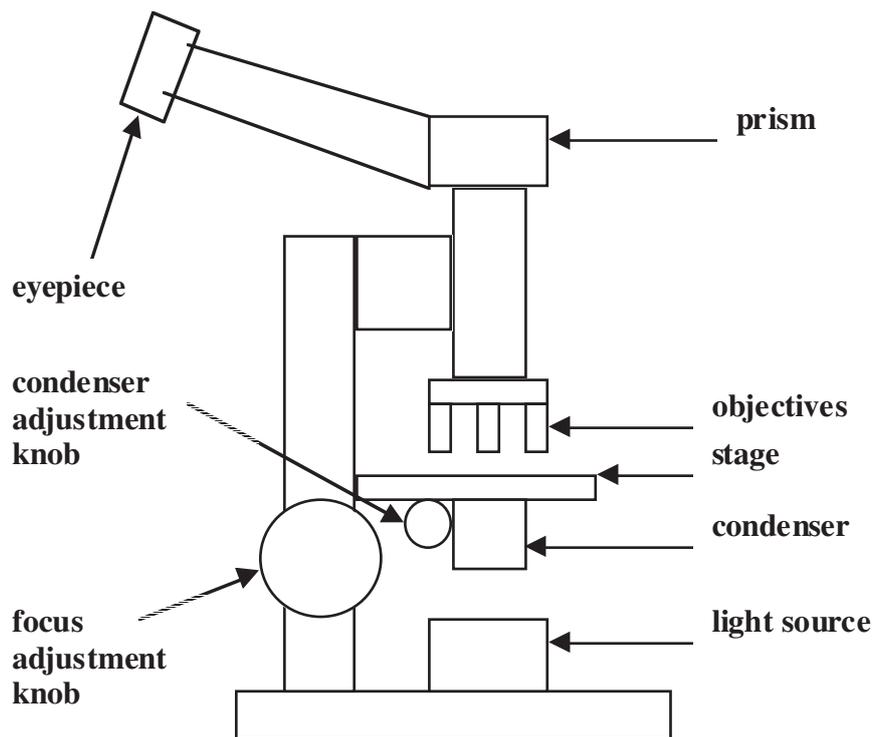
- That the rack and pinion used for focusing is not worn at the point where the slide comes into focus such that it slips out of focus again. This is can be a very difficult part to replace in an obsolete microscope.
- That the lenses are not damaged, dirty or otherwise in a bad state. The quality of a microscope can be limited by the quality of its lenses. A second-hand microscope may be upgraded by buying new lenses. The screw sizes and threads etc. are, for the most part, standard in all microscopes, so new lenses should be compatible. If buying lenses for a second-hand compound microscope, buy a set of objectives, not individual ones. Check that they are all parfocal (all have the same point of adjustment for being more or less in focus) so that objectives can be swung around without major adjustment of the coarse focus knob. Compound microscopes normally have x10, x40 and x100 objectives with a x10 eyepiece giving magnifications of x100, x400 and x1000. The x100 objective is nearly always oil-immersion and is useful for measuring and observing the details of small spores and conidia.
- Other things needed with the microscope can include:
- A pair fine of tweezers (with a spring just strong enough to be able to hold the tweezers without them closing. Note that the tips can be made finer by closing the tweezers and filing the end with a fine file or grinding it on a sharpening stone).
- A fine-pointed scalpel with a disposable blade.
- Razor blades for cutting sections: stiff, single-sided razor blades can be obtained from microscope suppliers. Double-edged razor blades may be obtained from the high street shops. The safest method is to break the latter in half before removing them from the wrapping. By holding half a blade in one's hand only one sharp edge is being handled. But with care this is not necessary.
- Slides and coverslips.

There are many commercial suppliers of microscopes and microscope accessories. For example, <http://www.brunelmicroscopes.co.uk/>, among others, supplies microscopes as well as slides, coverslips, immersion oil, eyepiece- and stage-micrometers, single-edge razor blades, 10% KOH and Lugol's iodine.

Adjusting a compound microscope to obtain maximum resolution.

The usual and best procedure is as follows. See Figure 1 for the terms used to describe the parts of a compound microscope.

Figure 1. **The parts of a compound microscope**



1. Set up the microscope with a slide (with a section on it covered with a coverslip) on the stage and a light source focused from beneath on the slide with the condenser. Using the x10 objective, carefully focus on the edge of the section on the slide so that only 1/3-1/4 of the field of view is covered by the section.
2. Focus the light source with the condenser so that the image of the light source (ground glass screen, bulb surface for a "pearl" bulb or filament for a "clear" bulb) is clearly seen down the microscope.
3. Move the condenser very slightly so the image of the light filament or ground glass surface just disappears (i.e. so that it provides an even illumination)
4. Adjust the iris-diaphragm within the condenser down as far as it will go. The illumination will suddenly become darker. Open it back up until the intensity of light is back to its maximum. and no further. This setting allows the iris-diaphragm to cut out stray light.

5. The microscope is now ready for use. If the light is too bright, adjust the light source with dimmer, or by moving it further away (if the latter, go back to stage 1). Do not reduce the intensity of illumination with the iris-diaphragm. The depth of field of view can be temporarily increased by closing the iris diaphragm further for purpose of location of structures, but then return it to the original setting to restore resolution.

Calibrating the eye-piece graticule

Eye graticules are calibrated with a stage-micrometer. This is rather expensive since it usually needs to be used only once and then occasionally as a check. It may be possible to borrow one from another lichenologist, or someone in a local school/college/university department or the BLS. Otherwise, when attending a BLS Workshop, ask the workshop leader if s/he would bring one. Check that the measurements and calculations are correct, and then double-check by measuring something whose approximate size is already known (e.g. spore of a known species) or, better still, something on a slide another lichenologist has measured.

Microscopic examination of a lichen specimen

With a dissecting microscope:

It is good practice to examine specimens carefully using a dissecting microscope, paying particular attention to the possible presence and details of specific structures such as soredia, isidia, pseudocyphellae and pycnidia, which may not have been clearly seen with a hand lens. Examine the whole specimen before deciding whether any structures are absent, and even then, bear in mind that the specimen collected may not, by chance, have them represented (although this should have been checked in the field when collecting).

With a compound microscope:

When identifying a specimen the genus may have been determined, and the species suggested, by macroscopic examination. Microscopic examination is to find out or confirm a particular feature, or identify the specimen. If it is not known to what genus the specimen belongs, such as can be the case for a crust with black lecideoid apothecia, full microscopic examination may be necessary. This involves preparing at least 3 slides as follows:

1. Thin vertical section to look at ascocarp structure
2. Section of ascocarp for teasing out asci for staining with iodine
3. At least one slide with a section as in 1. for testing with chemicals such as KOH or HNO₃.

Preparing a section of a fruiting body

Some fruiting bodies can be sectioned on the thallus, but some thalli do not provide a firm enough support, and it may be better to remove the fruiting body to a microscope slide. First, soak the fruiting body or the thallus in water for several minutes: some (e.g. those heavily “carbonised” with melanins) take longer than others. Meanwhile, place a small drop of water on each microscope slide ready to receive the sections. Under the dissecting microscope, remove excess water with tissue-paper and cut away a segment of the outside, then cut a series of sections as thinly as possible with a razor blade. When cut, they may remain as separate sections next to the fruiting body. In this case dip the end of the razor blade in the drop of water on the microscope slide, and then pick up the sections with the minute drop on the end of the razor-blade and place the sections in the drop of water on the slide. Do this for each slide.

Staining asci

Tease apart the sections on one of the slides. Remove most of the water with tissue and replace it with 5% KOH (potassium hydroxide) solution to prepare the asci for staining. Leave for a few minutes and then remove the KOH with tissue and replace with acidified water (50 ml water with a few drops of strong acid) to neutralise the residual KOH. Blot and repeat to rinse the KOH away. Add a drop of Lugol's iodine, and leave for a few moments to stain the asci and then add a coverslip. The strength of the iodine is fairly critical, so if it is too strong when made up, dilute it until it gives good results. With regards to staining with iodine, the depth of colour is in proportion to the concentration of the iodine in the surrounding solution so it should be possible, if the stain is too dark, to wash it out with water or if too pale, to deepen it by adding more iodine.

Measuring spores and other structures

Ascocarp structures (spores, asci and paraphyses) are observed in 5% KOH and measured with the eyepiece graticule. Smaller spores and paraphyses are best measured using x100 oil immersion objective, although for medium and larger spores, the x40 objective may be satisfactory. Perispore structure can be best seen after bleeding-in diluted Indian ink under the coverslip. When determining the size of a spore with the eye-piece graticule, take measurements from 10 spores selected at random and calculate an average. (Note: statistically, 30+ measurements are necessary to obtain a reasonable estimate of the true mean and standard deviation.) Take care that spores are lying flat, mature and well-formed.

Making notes and drawings

Make notes of all the features observed and measurements taken, preferably on or in the specimen packet so that new preparations do not have to be made to compare it with others later. This is essential if sending the specimen off later to a referee, as it saves a lot of his/her time. If there is doubt, the referee can make another preparation.

4.3.5 Chemistry**Literature**

The methods for the identification of lichen substances are not described here, but the most useful guide is by Orange *et al.* (2001). An earlier edition (White and James 1985) is somewhat less advanced. Other useful guides are by Huneck and Yoshimura (1996) and those by Culberson (cited in Orange *et al.* 2001)

Objectives

In most cases, identification of a lichen species can be done with spot tests and UV-fluorescence. These methods are cheap and readily available to all lichenologists. Occasionally, the presence of a particular substance needs to be confirmed, or the identity of a substance has to be determined. This usually involves thin layer chromatography (TLC). Unfortunately, this technique is unavailable to most lichenologists who do not have access to laboratory facilities.

UV Fluorescence

There are two main types of UV light source (wavelength about 350 nm): an inexpensive battery torch style lamp with runs of batteries (e.g. UV 4W Blacklight Lantern which can be obtained from <http://www.uv-light.co.uk/> £10) or a mains powered lamp of the type used for inspecting TLC plates (e.g. Blak-Ray UVL-21 made

by UVP Inc obtainable from <http://www.esslabshop.co.uk> for less than £100}. Care must be taken to protect the eyes and skin from the effect of UV (see Orange 2001). Use the lamp in the dark and take time for the eyes to become adapted to the low light levels emitted by the fluorescence. Have some standard fluorescent lichen material (e.g. *Cladonia protentosa*) for comparison.

Spot tests

The commonest problems can occur with C (bleach) reactions and cause errors in identification. Chemicals must be fresh. Store C in a refrigerator and check it each time with some standard common lichen (e.g. *Ochrolechia androgyna*). Change it if it does not give really bright colour. **One of the commonest errors in identification arises from incorrect negative tests with C.** Some C reactions are fleeting and some are not very intense so it is essential to do these tests very carefully under a dissecting microscope. Tests for C+ medulla in the field tend to be unreliable.

It is often helpful to use a microscope with chemical testing, for example, the reaction when bleeding in K beneath the coverslip under a compound microscope on x100 magnification. For example, with KOH (potassium hydroxide) norstictic acid forms stars of red crystals; and with NaOH (sodium hydroxide) confluent acid forms fans of colourless crystals. Take great care not to drop chemicals on the microscope, or allow the lenses to come in contact with chemicals.

Dobson (2004) provides further advice on spot tests.

Crystal tests

In the absence of TLC, it is occasionally possible to distinguish between different substances by comparing their crystal structure; this can be useful for distinguishing between certain pairs of substances (e.g. lecanoric vs. gyrophoric acids, and between some pulvinic acids). In addition, extraction of K- yellow pigments from thallus fragments with acetone on a microscope slide leads to a deposition of the pigment on the glass. Examination of this deposit at x100 may distinguish needles (vulpinic acid which crystallizes very easily) vs. globules (rhizocarpic acid) but crystal tests with the use of defined solvents should be done. The description of the technique and photographs of crystals can be found in the handbooks by Huneck and Yoshimura (1996) and Hale (1961).

TLC

TLC is essential for identifying some specimens of certain genera like *Lepraria* and *Porpidia*. In the absence of personal access to laboratory facilities it may be possible to send specimens to another lichenologist who has such facilities and is willing to provide this service. However, this may incur a cost which should be catered for in the budget for the commission. Remember TLC analysis is time consuming. For example, just one run, which includes, (i) preparing samples of thalline tissue from up to 15 specimens, (ii) spotting extracts on a TLC plate duplicated for each additional solvent, (iii) running the plates in the solvents (which may have to have been made up fresh) in tanks, (iv) drying off the solvent from the plates after removal from the tanks, (v) marking spots under UV light, (vi) spraying and heating plates, (vii) further marking of spots in visible and UV light, with possibly further heating, and finally (viii) interpreting the plates, can take a whole day to perform.

Health and safety issues

Check that care has been taken with other aspects of identification, e.g. the use of razor blades and how they are disposed of. Slides and coverslips should also be disposed of safely into a robust rigid pot.

All UV light, be it UVA or UVB, is hazardous, and exposure to UV light should be kept to a minimum. Check that protective screens/shields are being used wherever required because UV light can cause skin cancer and damage to eyes.

Check that COSHH (Control of Substances Hazard to Health) regulations are being complied with. Many chemicals have safety warnings and it is imperative that these warnings are heeded. **See Orange *et al.* (2001) for appropriate precautions and procedures. If in doubt, seek advice or look up COSHH regulations**

(<http://www.coshh-essentials.org.uk/>). The main dangers are associated with the use of *para*-phenylenediamine and solvents (especially in TLC). Written Material Safety Data Sheets (MSDS) should be included with the chemical when delivered by the suppliers. If these substances, or any other chemicals, are provided or obtained privately, it is essential that the safety information is also passed on. Safety information may change with time as better understanding of hazards develops, so safety information must be up to date. **Aspects that must be considered include:**

- **the numbers of chemical used,**
- **what the chemicals are,**
- **how they are stored,**
- **how they are used and**
- **how they are disposed of.**

Also required is a risk assessment for their use (see 3.4.1 Risk Assessment for fieldwork: these Guidelines and bullet points also apply for use of chemicals).

4.4 Validating identification

Validation means carrying out sensible checks that records (identification and location and other details) are correct so that they can be counted as a valid for the national database. Records that do not pass checks are discarded. Validation steps are taken by anyone, or organisation, accepting records from other people or organisations.

Therefore, before preparing a species list for a report, or passing on a record, it is essential that you, the surveyor, have fully checked the identification of species (other than common species within their well-known range) and the location where it was found. State in your report what steps you have taken. Without this element of validation, records are likely to be considered worthless, thus spoiling the survey and letting the client down. Unvalidated records have to be deleted and incorrect records cause other people a lot of trouble in removing the error. Errors are damaging to the ongoing monitoring of our environment.

To put this into practice, before making a list or writing a report, you must go through the following steps:

1. **Make sure you have carefully checked the specimen for ALL the features of the species against a full description of the genus and the species in the appropriate literature (e.g. Purvis *et al.* 1992).**
2. **Does it agree with previous material collected?** Check with previously collected specimens in an herbarium - personal, local and national in that

order. If it does not agree, ask why it does not. But remember not to assume automatically that the herbarium material is correctly identified, especially if it is a personal or local herbarium. If in any doubt, go to Step 4.

3. **Check that the location of the find is within the established range of the species.** Check a published distribution map. If the location is outside the known range, or where the species is uncommon, it does NOT mean that the identification is wrong, go to Step 4. **Discard any records outside the known range (e.g. a new vice-county record) for which you do not have a voucher specimen.**
4. **If you think the specimen in question may be remarkable or interesting e.g. rare or a common species on an unusual substrate, check it with an Advanced Referee [see 4.4 Using specialist referees] or more experienced lichenologist.**
5. If there is doubt as to the identity of a specimen at the species level, use the prefix “cf.” before the species epithet and retain the specimen. This allows the identification, as far as you have been able to take it, to be included in your report but excludes it from entering the database of environmental records.

4.5 Using specialist referees

Referees are people who have had more experience of lichen identification. There are general, regional and specialist referees. Specialist referees may have research experience of one or more groups and are most likely to be consulted for their expertise for identifying specimens of unusual material. Details clearly setting out the procedure for using referees see BLS web-site (www.thebls.org.uk/referees.html also published in BLS *Bulletin* (2003) 93:55–59).

The help of referees must be acknowledged in the report, indicating which species have been checked, and by whom. More than one referee may be needed – it is better to send one specimen each to five appropriate referees than to send all five specimens to one referee who may be a specialist in only one area.

4.6 Herbaria

The use of herbarium specimens is germane to identification. A correctly named specimen of good material is worth any number of descriptions or illustrations. There are private herbaria belonging to individuals which can be consulted with agreement with the individual owner. Public local and national herbaria are even more valuable but permission to use them still has to be obtained. Keepers can refuse permission if a) they are not confident that the specimens can stand up to use, b) if the specimens are not accessible or c) there is insufficient staff time to deal with locating them and making them available.

When seeking permission, always explain the need to consult the collection, as the keeper may well be able to provide invaluable advice or information regarding additional material located elsewhere.

4.6.1 Private Herbaria

The lichenologist’s own private collections are extremely valuable. It is always worth comparing recently collected specimens with those obtained previously. This can help avoid misidentification as well as improve knowledge of the species concerned. Unusual material of common species, good material of critical species, and collections

of notable species (e.g. those that represent new records) should be added regularly to your collection. Other lichenologists may be willing to loan specimens from their own private collection or herbarium. The BLS has a herbarium which is mainly used as a reference collection by BLS members who are developing their knowledge of British lichens and their identification skills.

4.6.2 Public National and Local Herbaria

Many regional museums <http://www.mda.org.uk/vlmp/> and <http://www.museums.co.uk/> have local herbaria with lichens in them. Seaward and Hawksworth (1977) provide a list (somewhat out of date now) of herbaria made by lichenologists, past and present, with indications of their locations. They provide a list of museums that house collections. These are very under-used but extremely valuable resources both in terms of the records the specimens represent and also for providing local material of species. These herbaria are often in danger of neglect by museum authorities because they are under-used, so using and referring to them has a double benefit. National lichen herbaria are in the Natural History Museum in London, National Museum of Wales in Cardiff and the Royal Botanic Garden Edinburgh. Prior arrangement must be made to use these collections, and guidance on care of the specimens must be strictly followed. These herbaria are best used when the identification of the material is in the national interest, but they are also useful for seeing rare species that may be encountered BEFORE collecting in the field. (A list of herbaria for the rest of the world can be found at <http://nature.ac.uk/> by searching with the term “lichens”.)

4.7 Preparing lists of species recorded

Species should be listed according to the latest checklist that is available (Coppins 2002) or the online checklist in the BLS website. The checklist you use should be cited in the references of the report. The spelling of species names should be checked carefully. An electronic list of names in the British Lichen Flora (available from BLS website) may be added to the spell-check on a computer. [See also **2.2.4 Checklists.**] If a voucher specimen is kept this should be recorded, and any unusual form or chemotype noted.

If a specimen cannot be assigned to a species with confidence, refer to it as “*Genus* cf. *species*” or, if the specimen cannot be identified at all, refer to it as “*Genus* sp. indet”. If you collections include more than one species in the same genus, distinguish them as “Indet. A”, “Indet. B” etc.

Field identifications are acceptable for common species. For species outside their known range and critical species where field identification presents problems, identification should be based on collected material. If a field identification is made of a species, and later it is found that the location was outside the range of the species (e.g. new vice-county record) discard this record and return to the site to collect material. If this is not possible, comment that an unconfirmed field sighting was made of the species. For further guidelines see **5.7.4 Presenting Results.**

4.8 Communicating the results of identification

When possible, records should be sent to the Local Record Centre nearest to the site surveyed (see <http://www.nfbr.org.uk/html/links.html#BRCs> for a list of centres); also send the records to the BLS database (Database Manager is Ms. J. Simkin, 41 North Road, Ponteland, Newcastle upon Tyne, Northumberland, NE20 9UN), and to the BLS

Mapping Scheme (Professor Mark R.D. Seaward, Department of Environmental Science, The University, Bradford, West Yorkshire BD7 1DP).

Lodging specimens of notable species encountered during a survey in a national or local herbarium may be made a condition of a survey contract by the commissioner, especially if it is a statutory agency. If possible, also offer specimens of all species that are remarkable e.g. from locations out side their range, or checked by a specialist referee. These specimens will then be available for others to use.

5 Report writing

5.1 Introduction

The quality of a survey can only be assessed through the quality of the report resulting from it. Thus preparing a good report is as important as the other aspects of a project or contract. These Guidelines have been written in an order that reflects logical steps that may be taken in preparing a report.

From here onwards the commissioner of the survey is called the ‘client’

A report should be concise, understandable, accurate and logically presented. It should meet all the requirements of the client and be written in a manner appropriate for both the client and any other users.

5.2 Understanding the client and his/her needs

In writing a report, the surveyor must be mindful of what the client expects and needs, as well as what he/she will want to do with the report document. Read the brief or contract and try to imagine the client’s reactions to the final report in the light of its purpose. Then consider what can be done in the way the report is written and presented to help the client. Different clients, e.g. a consultancy preparing the ecological part of an Environmental Impact Assessment compared with a conservation trust or agency that has conservation as a main aim, may require different styles, approaches and tones. As a commitment, always remember that the surveyor owes a duty of care to the client and is not a free agent exploring his or her own interests.

5.3 What is necessary for the preparation of a report

5.3.1 Equipment

To prepare a good-looking report, appropriate equipment is needed, for example:

- Computer with a good colour printer (colour for maps and photos).
- Software: Microsoft Word is used by most people but Microsoft Publisher or Adobe PageMaker might suit better some circumstances, for example, in producing special reports (e.g. for commercial printing). These packages can handle complex layouts with images, figures and maps, etc. Check with the client first if anything other than Microsoft Word is to be used. Microsoft Excel, or similar spread sheet, will be needed for numerical data, and for tabulating other forms of information. Simple statistical analysis can be done with Microsoft Excel but, for more advanced statistics, dedicated packages will be needed. Examples include Minitab (<http://www.minitab.com/>) or SPSS (<http://www.spss.com/spss/>) (for which there are some help guides on the internet). In addition, GIS software may be needed for creating maps (see <http://gislounge.com/ll/softwarereviews.shtml>).

Be sure to get training in the use of essential software. MS Word and MS Excel for example have a vast array of features. Use them to maximum advantage in the preparation of professional quality reports. Statistical packages like SPSS may not seem very user friendly, until one has received training, even if you are familiar with the statistical tests it uses. For further information about statistical analysis see Fowler et al. (1998) and Zar (1996).

5.3.2 Information

Before starting, have the following at hand:

- Information from the client
- Survey data
- References (or notes from reading) e.g. background reports and publications
- Maps (see below)
- Time plan (see below)

5.4 **Information from the client**

Obtain as much information from the client as possible. For example, what size, length and style of report does the client want? Has the client provided maps of the quality expected in the report? If not, what maps are expected? What use does the client want to make of the report? Is it a report to use internally, or to pass on to others as submitted? Or is it a report that the client will edit and reformat in the client's own house style? If the latter an electronic copy only may be required and, as long as it is clearly presented, the formatting and printing may not matter to the client.

Some clients provide very detailed requirements for the report such as font, paragraph and page layout, or a specified template. If so, it may be worth asking if the client can provide an electronic style sheet that can be added to MSWord.

Whatever instructions the client provides about the preparation of the report, **it is essential that they are followed to the letter**. If this is not possible, for whatever reason, contact the client and agree a format **before** the report is prepared.

5.5 **Time plan**

It is essential to plan report writing. Writing a report is usually more time consuming than most people expect. Always allow plenty of time for preparing a report, including "contingency days". These are specially useful for tasks such as printing since computers and printers tend to break down when an important or large job is being done ('Murphy's law').

If all the necessary reports and publications have not been gathered earlier in the project (see previous chapters), literature searches should be done urgently. Allow plenty of time for making maps and figures, which can also be very time-consuming. Writing itself can often take longer than realised. When the report is drafted, checking, re-reading, correcting and rewriting sections can add days to the time needed. Printing, collating and binding a report can, even if all goes well, also take extra days.

The surveyor should think through each stage of the whole process of report preparation and be pessimistic about the time it takes. Write a plan with dates enabling you to meet the deadline without running out of time, or having a crisis.

5.6 **Surveying the literature and background information**

Sources of literature and information which may be of value are as follows:

Physical (hard copy)

- Personal collections
- BLS library (including the Sowter Collection in Spain with Prof David Hawksworth, see <http://www.thebls.org.uk/librar.htm>). The approximately 6000

items may be consulted by arrangement, and items can be loaned. Contact Dr. Anthony Fletcher, Leicestershire Museums Service, Collections Resources Centre, Sileby Rd., Barrow on Soar, Leicestershire LE12 8LD. Tel: 01509 815514 or email: afletcher@leics.gov.uk

- Libraries at Natural England, Countryside Council for Wales and Scottish Natural Heritage,
- The six National Copyright Libraries: Bodleian Library, Oxford (www.bodleian.ox.ac.uk/), Cambridge University Library (www.lib.cam.ac.uk/), National Library of Scotland (www.nls.uk/), Library of Trinity College Dublin (www.tcd.ie/Library/), National Library of Wales (www.llgc.org.uk/) and The British Library (www.bl.uk), which are legally bound to have copies of all publications in UK and the Republic of Ireland (see www.llgc.org.uk/cla/). Any UK citizen can go to the British Library and consult its collections – and it is worth gaining familiarity with its website – there is access to 60,000 journals!
- Libraries in local museums (www.mda.org.uk/vlmp/) and local offices of statutory nature conservation agencies (<http://bubl.ac.uk/link/b/britishnaturalresources.htm>)
- Libraries in Universities and institutes of higher education (<http://copac.ac.uk/libraries/>) and research institutes (e.g. Centre for Ecology and Hydrology) (www.rcuk.ac.uk/rescolinc/rcliblist.asp) or (www.library.ex.ac.uk/internet/uklibs.html). For University libraries (and possible others) registrations as a ‘lay reader’, which means permission to consult its collections, may be possible. Borrowing rights, however, may be a little more difficult to obtain.
- Books may be purchased from Natural History Book Service (www.nhbs.com) or Summerfield Books (www.summerfieldbooks.com/). The latter also sells BLS publications. You can also use other of the numerous online book sellers (e.g. www.amazon.com) or high street bookshops who can obtain books for you. For old literature Wheldon and Wesley offer a service (www.wheldonandwesley.co.uk/) (or try also www.bookfinder.com and www.bibliofind.com).

Electronic (internet)

- HERO (Higher Education and Research Opportunities in the UK) (www.hero.ac.uk/uk/about_hero/index.cfm). This is a gateway to many useful resources such as all the online library catalogues of UK Universities. For some libraries the surveyor may have to register and pay a charge but a colleague who works in a research institution or university may be able to help you with applying for access.
- Online bibliographic search engines most commonly used for the scientific literature are Edina, which uses the Biosis database, and Web of Knowledge and most journals are now available in electronic format online. But these services are mostly only available through institutions and are paid for by the institution. They require registration for access and, consequently, you may be charged for their use.

- Lichenological literature databases are also extremely useful. For example a very useful database is Mattick’s literature index to recent literature on lichens www.toyen.uio.no/botanisk/lav/RLL/RLL.HTM or www.nhm.uio.no/botanisk/lav/RLL/RLL.HTM. Another worth looking at is <http://ces.asu.edu/ASULichens/links/links.jsp#95>. These are, however, not specifically for literature related to British lichens.
- The internet and web sites can be useful but check these in the usual way (appropriate URL, specified webmaster, date displayed when last updated etc). Do not trust any website without good reason as it may be unreliable or dishonest.

5.7 Contents

5.71 Report structures

Decide what structure the report will have. There may be many options so choose the right one for the project. The work itself may suggest using the standard ‘scientific paper’ structure (i.e. introduction, methods, results, discussion, summary, references). But this may need to be varied. Whatever is chosen, make sure it is clear and that each section contains text that is relevant to it. Write in a disciplined way within the structure so that the headings clearly indicate what is written within each section.

Reports commonly have a structure similar to the following:

- Title page
- Non-technical summary
- Contents
- Technical summary/abstract
- Introduction
- Method
- Results and data analysis
- Conclusions
- Recommendations
- Acknowledgements
- References
- Appendices

Table 5.1 sets out the suggested contents of the sections of a report with this type of structure.

Table 5.1: Summary of sections which may be included in the structure of a report

Section	Notes
Title page	Title should be concise and relevant. Page should also contain the author’s name, date, and person/organisation commissioning the report.
Non-technical summary	Not always requested, should be no longer than one page long. This should be readily understandable by the layman, otherwise see Summary/Abstract below.

Contents	All main sections, sub-sections and Appendices of the report should be listed in sequence with relevant page numbers. Titles should be identical to those used in the report. Complete this section after completing the rest of the report.
Summary/Abstract	Always include a summary; the non-technical summary may be additional. The summary may be the only part of the report read by some people. It should be no longer than one page long and should briefly identify: the purpose of the report, the method, the main findings, the conclusion and main recommendations. Do not include information/statements not used in the main text of the report. Complete this section after writing the rest of the report. Top and tail the page with the report title, date and surveyor's name and qualifications as this is the part that may be photocopied and be detached from the rest of the report.
Introduction	Include background information, objectives, purpose, use, limitations (weather, safe access etc.). Only include information that the reader needs to know. This may include: aims, description of the site, information on lichens in general, and legal issues e.g. species on the Wildlife and Countryside Act 1981 as amended.
Methodology	Describe the methods used for fieldwork and identification. Describe the process in a logical way and do not assume that the reader has any prior knowledge of the methods and techniques involved. State where specimens are held. Do not include any results, conclusions or recommendations.
Results and data analysis	See sections 5.7.4 Presenting results and 5.7.5 Use of maps for information on species lists. Pick out useful information from species lists. The full species list should be presented in the appendices and details of notable species (e.g. IUCN category species etc.) should be presented in this section. Use field information to describe the site and species found in a local/national/international context. For a large site it may be best to split this section into the main and survey units of the site (see section 3.6.1).
Discussion	As appropriate to the questions to be answered. May not be required in addition to the results and data analysis section. State how complete species list is thought to be. Compare sites visited with each other, with other local sites, and with nationally important sites. Describe lichen species and assemblage in a local, national, international context.
Conclusions	State the conclusions from the study relevant to the clients needs.
Recommendations	This section is vital. If their inclusion is in the interests of the client, include issues beyond what the client expected or requested. Do not be afraid to state 'of no lichen interest, recommend no further concern' or 'possibly of considerable lichen interest and requires re-surveying by national expert'. If your recommendations relate to management objectives, they should be Specific, Measurable, Achievable, Relevant to the clients needs and with Times (SMART).
Acknowledgements	Briefly acknowledge all those who have facilitated the production of the report.
References	Use a standard referencing system. Include all references so that a reader can trace where your information comes from. It is useful to cite scientific sources so that other scientists can evaluate your work.

Appendices	These should include supplementary information not required, or too long to put in results etc. sections. Unless specifically used to illustrate the points made within the main report, illustrations are best placed in an appendix. Long species lists should be placed in an appendix. Totals, e.g. for nationally rare species, are of more value in the results sections. Other information that should be placed in the appendices includes: maps, route taken through site, previous species lists, fieldwork conditions (e.g. weather) and any constraints (e.g. difficulties of access to any locations). A list of names and addresses of those contacted (e.g. for access) should be included (which should be on a separate page as it may need to be removed for data protection purposes should the report be circulated widely).
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5.7.2 Writing style

Writing about technical matters in a way that can be easily read and understood is a challenge. Some basic pointers are as follows:

- When reading other people’s writing, note what is good or bad, and why. Read current scientific literature, including that by scientific journalists, and consider how it has been written.
- Use guidance on good scientific writing. For more information see <http://www.plainenglish.co.uk/> and/or a book on good English usage (the original classic is Gower (1987). Natural History Book Service (www.nhbs.com) list 122 titles under ‘Reference: editing and writing’ mostly dating from the 1980s and 1990s.
- Write simply. Always write easily understood words and sentences. Avoid clichés and edit out all unnecessary words and phrases like “It is interesting to note...” “It is important that...” and try to use shorter rather than longer words that have the same meaning e.g. “start” rather than “commence” and “do” rather than “carry out” or “perform”. In deciding whether to write something, the motto is “if in doubt, leave it out”. (see http://owl.english.purdue.edu/handouts/general/gl_sentclar.html)
- Reports should be written in past tense and the third person. ‘I’ and ‘we’ should not be used.

In formatting the report, follow instructions provided by the client. If there are no instructions, consider the points below:

- Sections should be given titles and numbered. Try not to overburden the numbering system with too many tiers of subsections because the long series of numbers tend to be confusing. In this document the sections have been limited four tiers:
 1. Heading
 - 1.2 Section heading
 - 1.2.3 Sub-section heading
 - bullets

- Pages should be numbered 1,2, 3 etc. or with chapter number e.g. 1.1, 1.2, 1.3.etc. Contents and other preliminary pages may be numbered with a Roman numeral i.e. i, ii, iii.
- Illustrations, tables, figures should be given a title and numbered e.g. Table 1, Table 2, Table 3 etc.
- References should be cited in the text and in the reference section using for example the Harvard System. It can be helpful to add the relevant page number(s) when referring to a book. Add the date accessed for references to electronic sites. (See <http://libweb.lancs.ac.uk/g79.htm> for further advice.)

5.7.3 Methods and procedures

Report exactly what has been done so that another surveyor can repeat it (as is the usual practice for scientific papers) and achieve the same overall results. This applies to fieldwork, identification and data analysis. You should refer to these Guidelines too. The report should also state where any specimens are going to be deposited and to whom records are going to be sent (with permission from the client). Refer to Orange *et al.* (2001) for chemical methods used, and also refer to identification guides used (e.g. Purvis *et al.* 1992 and Dobson 2005)

5.7.4 Presenting results

Results can include:

- Lists of species for each location, habitat, substrate, community etc. Refer to the current standard checklists (currently these are Coppins 2002 and Hawksworth 2003). Species lists may be annotated with abundance indicators e.g. DAFOR or ACFOR. Citing nomenclatural authorities is optional.
- In species lists, how each species was identified should be stated, i.e. whether it was determined in the field or in the lab, the presence of a voucher specimen and whether critical a species was confirmed by an expert. This is essential for rare or critical species and especially helpful when the report is being reviewed, or a record is followed up by another lichenologist. This information could be indicated by a superscript against the species name, or presented in a table (see Table 5.2).
- Indicate notable species, stating whether in the local, national or international context, such as those which are vulnerable or endangered, rare or otherwise of conservation value (see Woods and Coppins 2003).
- Mention the occurrence and location of recognisable communities (e.g. James *et al.* 1977) if it is relevant. Communities can often reveal more than just the list of species.

Table 5.2 Example of type of content for species list

Lichen species	How identified*	Abundance**	Conservations status (Woods and Coppins 2003)
<i>Parmelia saxatilis</i> (L.)Ach.	F	C	LC
<i>Cystocoleus ebeneus</i> (Dillwyn) Thwaites	S	F	LC

Lichen species	How identified*	Abundance**	Conservations status (Woods and Coppins 2003)
<i>Parmelia submontana</i> Nadv. Ex Hale	VS	O	DD, NR
<i>Bacidia subincompta</i> (Nyl.) Arnold	VS (confirmed by Dr B Coppins)	R	VU, NS

* F=field identification, S=identified from specimen and VS=voucher specimen kept.

** Abundant, Common, Frequent, Occasional or Rare

5.7.5 Use of maps

Most ecological survey reports include maps to illustrate site locations and survey findings. A good quality map of the site should be provided by the commissioner and included in the report. Maps should contain the following information: label/title, X and Y coordinates, contours, scale, and direction of north. They can be generated by a GIS package such as MapInfo or ArcInfo. For further information see <http://gislounge.com/library/blsoft.shtml>. Most maps are copyright-protected and may only be used with permission. A licence is needed to copy Ordnance Survey maps for business purposes. Details of the various kinds of licence are available at www.ordnancesurvey.co.uk/oswebsite/business/copyright/index.html

5.7.6 Data analysis and interpretation

This depends on what was required in the brief (check this or the contract). The following may be relevant: RIEC (Revised Index of Ecological Continuity), NIEC (New Index of Ecological Continuity), NPIEC (Native Pinewoods Index of Ecological Continuity) (Coppins and Coppins 2002) or air pollution indices such as IAP (Index of Air Purity) (Richardson 1992) or indices of diversity (Magurran 2004). The report may contain statistical analysis (stating statistical test and probabilities calculated: see Fowler et al. (1998) and Zar (1996)) or other techniques such as principle components analysis e.g TWINSpan. (Jongman *et al.* 1995). Hill *et al.* (2005) is a detailed discussion of survey and monitoring methods with useful sections on biodiversity evaluation, data analysis and data interpretation.

The completeness of the survey and hence the species lists should be assessed. Data, such as the presence of certain species, or the relative species richness compared with other sites, should be pointed out with reasons, and deductions should be made. The ecology of any communities identified can be discussed in a way that would help with site management.

5.7.7 Discussion

Some authors choose to write a discussion section, and some readers may like to read a section discussing the data, but this may not be relevant. Write here how well the aims and objectives of the project were met, any problems that need highlighting, options for management, suggestions for further work that should be done etc.

5.7.8 Conclusions and recommendations

These may be the only parts read, especially by those making decisions based on the report, so they need careful attention. What conclusions should be drawn from the results considering the aims of the survey? The question “So what?” asked of the results should have an obvious answer. The client may, or may not, have asked for recommendations about management, but consider if they are useful to the report, even if not specifically asked for. A recommendation might be, for example, that further surveying of the site is necessary before a final decision or conclusion can be made.

5.7.9 Appendices

These are not usually read, but in the future they may be referred to as they can contain valuable information about the site. Information which can be put into an appendix includes:

- A copy of the brief as an appendix, so in the future anyone can see what the reason for the work was, and what had been asked for.
- Site details, location plans, site descriptions etc. These could all be useful for repeat surveys in the future.
- Detailed species lists.
- Quadrat data, and photographs, especially those required for monitoring.
- Detailed data of value to future monitoring should be included.
- Report of fieldwork conditions.
- Caveats [see **5.7.11 Caveats**].

5.7.10 Providing additional information

When writing the report, there may be information available that is beyond what the clients asked for. This can be added as an additional section or included in the main body of the report on the grounds that it provides added value to the report so that the client benefits, and hopefully so will the environment. It may encourage the client to use you again for further survey work. This is approach is preferred in most cases but it should be clear that the additional information is provided at no cost to the client. Alternatively this can be excluded from the report on the grounds that the client has not asked for it or paid for it.

5.7.11 Caveats

There have been contracts where the client has not enabled the surveyor to provide a complete and accurate survey and report. This can happen for various reasons e.g. surveying under poor conditions (time of year or weather), not allowing access to certain parts of the site, not allowing sufficient time, or not paying for suitable maps or previous records. These are usually inadvertent and may stem from time constraints, lack of awareness of surveying, or an insufficient budget for the work. Sometimes constraints are placed for commercial reasons. In all cases where the quality of the work is at all limited, explain how the work has been limited, and what the possible consequences might be.

5.7.11 Introduction

This should be written last so that the reader can be introduced to what has actually rather than what might have been included.

It should be simply written and clear so that the reader is encouraged to continue reading. Check the content and writing many times. Components of the introduction could include information about:

- The site.
- Lichens in general.
- Ecology of the site and lichens.
- Previous literature.
- The law.
- The aims and objectives of the project and how it is planned meet them.
- What the report contains.

5.7.13 Summary, non-technical summary, executive summary and abstract

There is much discussion about the difference between a summary and an abstract, and what kind of summary should be included.

Whether called a summary or an abstract, it should contain all the essential points (i.e. contents) of the report. It should embody the factual substance, and NOT merely indicate what the report contains. For example:

- Why the project was conducted and its aims.
- Methods.
- Results.
- Conclusions and recommendations.

Remember, this part may be the only part read (and photocopied separately) and may be the basis of decisions. Therefore, 'Top and tail' (in Microsoft Word with Header and Footer) the Summary page with the title, surveyor's name and qualifications, who it is for, date, so that all the essential bits of information are included, if the page is photocopied. A non-technical summary should contain, in non-technical language all the contents of the report. An executive summary should emphasise the information and recommendations that enable the client to make decisions in relation to the reason for the survey.

5.8 Presentation, formatting and binding

These tasks do take time. If not specified, make sure that it is appropriate for the client's needs. If in doubt, ask the client, or someone else who has done a report for them previously. Often a client has better equipment for report reproduction than the surveyor and may request an electronic copy. Electronic submission is often required, especially if the surveyor is being subcontracted, as the report may be reformatted before it reaches the client.

5.9 Checking

Check, check and check again. **Table 5.3 is a checklist – photocopy it and tick off each stage in the last column when completed.** If possible, get someone who has not been involved with the project to read it through. Ask if it can be followed and understood in the way required by the client. Alternatively, if time allows, leave a draft for two to three days and then read it again from the client's point of view. **If you are a**

subcontractor, and the report has been reformatted, edited or redrafted by another consultant, insist on checking the final version before submission to the ultimate client.

Table 5.3 Checklist for checking

1	Read the contract or instructions from the client and check that the report addresses what was required.	
2	Presentation: spelling, grammar, layout, consistency of format. page/section/illustration/table/figure/appendix numbering, figure/table/illustration/map titles, print quality etc.	
3	Are the grid references for locations correct?	
4	Completeness: is anything missing, e.g. references, data sheets or illustrations?	
5	Is there anything unnecessary?	
6	Is there any information or statement in the summary that has not been introduced elsewhere in the report?	
7	Accuracy – check that numbers and calculations are correct	
8	Confidentiality: are all names people and their contact details included? These can be in a separate appendix which can be removed if necessary.	
9	The number of copies required by the contract.	
10	Has the client agreed that a copy of the report can be sent to the BLS library?	
11	Has the client agreed that the species records can be sent to the BLS recorder and local environmental record centre? Is the location of any voucher specimens stated?	
12	Acknowledgements – has everyone been acknowledged?	
13	If required on a CD, are the copies of the CD saved in a format compatible with any computer?	
14	Check again that the contract requirements have been met.	

6 References

N.B. ISBN numbers are added where they may aid the ordering of copies from book suppliers. References to electronic sites are included in the text they were accessed to check their existence in February 2006.

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7 Appendix

Surveying and Report Writing Workshop

This workshop was held in Edinburgh at the Royal Botanic Garden. 12-14 January 2004 for all lichenologists and those commissioning lichen surveys

Introduction

This is aimed at current practitioners and would-be practitioners, and will discuss methodology, best practice, problems and pitfalls, and aim to establish a common professional standard amongst contract Lichen Surveyors.

What is the aim?

This workshop is a workshop and not a training course or a conference. The aim is to collect and collate participants experiences, ideas, views and thoughts about lichen surveying and report writing and to evaluate these and distil them into guidelines which will be written up afterwards for all to share.

What will happen?

The format of the workshop is for a speaker to outline each of four major aspects and then for participants to discuss these openly and frankly, without prejudice. After this process, a series of written notes will be voiced, discussed and agreed, encapsulating the main points arising from the outline and discussion. These notes will later be used to construct guidelines on lichen surveying a reporting for use by the British Lichen Society and, if agreed by Council, disseminated.

Who should attend?

ALL lichenologists are WELCOME, “professional” and “amateur” alike. Those who feel that they not have much to say are also welcome to just come and listen. If you are doing mapping of lichens and sending in records you are not only welcome but also encouraged to attend as much of the workshop is also relevant to this.

Why is the workshop being run?

Lichens are difficult to identify and, in surveying sites, have no well-established standard methods (Hunter and Webb 2002). As a result there is a “grey literature” of survey reports which are quite difficult to interpret. There is a real need to arrive at a consensus of approach to surveying lichens and report writing which can help find added value hidden in the large amounts of data that can arise from surveys.

Consideration of the whole process from tendering for survey contracts to the presentation of information at Public Inquiry will be included. We will look at surveys relevant to endangered species, biodiversity recording (e.g. mapping), site evaluation, environmental impact assessment and environmental monitoring.

What will participants gain from attending?

All lichenologists can have an input and benefit. The main benefits are that lichenologists and those commissioning lichen surveys will be able to undertake and contract work with much more confidence and competence. Lichenologists will know how to survey better and make better use of their identification skills and get more out of their surveys. They will be able to write even better reports and raise their reputations and the profile of lichens and lichenology in Britain.

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Facilitators

Dr Brian Coppins (Royal Botanic Garden, Edinburgh)

Mrs Sandy Coppins (President British Lichen Society)

Dr Flemming Ulf-Hansen (English Nature)

Dr David Hill (University of Bristol)

Programme

Monday 12 January 2004

9.30 Registration and Introduction

10.00 Contracting and tendering

10.00 Introduction

David Hill

10.10 A conservation agency perspective

Flemming Ulf-Hansen

11.00 Coffee

11.30 Problems, questions and discussion

12.00 Draft of main points for guidelines

Bryan Edwards

12.30 Lunch

13.30 Fieldwork

13.30 Introduction

David Hill

13.45 Fieldwork in general

Sandy Coppins

15.00 Problems, questions and discussion

15.45 Tea

16.15 Draft main points for guidelines

Flemming Ulf-Hansen

Tuesday 13th January 2004

9.00 Identification

9.00 Introduction

David Hill

9.10 Techniques and methods

Brian Coppins

10.30 Problems, questions and discussion

11.00 Coffee

11.30 Summary of problems and solutions to them

11.45 Draft of main points for guidelines

David Hill

12.30 Lunch

13.30 Report writing

13.30 Introduction

David Hill

13.40 Writing skills

David Hill

14.30 Problems and discussion

15.00 Draft of main points for guidelines

Anna Griffiths

15.30 Conclusion – next steps and dissemination

David Hill

16.00 Tea

16.30 depart

List of people who attended.

Facilitators, chairmen and note-takers

Coppins, Brian	Griffith, Ann
Coppins, Sandy	Hill, David
Ulf-Hansen, Flemming	

Participants

Acton, Andy	Orange, Alan
Benfield, Barbara	Pedley, Ivan
Blatchlet, Ishpi	Quelch, Peter
Chambers, Steve	Reid, Sheila
Cullen, Maria	Ricketts, Joy
Davey, Simon	Sanderson, Neil
Dobson, Frank	Simkin, Janet
Douglass, John	Smith, Justin
Edwards, Bryan	Smith, Paul
Fox, Howard	Street, Leslie
Hewson, Richard	Street, Sheila
Hitch, Chris	Waterfield, Amanda
Hope, Joe	Wells, Alice
Kennedy, Simon	Wolseley, Pat
Larsen, Rene	

