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The four constituent countries of the UK have been developing their own individual methodologies for assessing the favourable condition status of sites which are legally protected – at least in part – for their saproxylic beetle assemblages. In England a formal methodology has been developed which defines how the site survey event is organised, and the resulting species list – the saproxylic assemblage – is then assessed using a Microsoft Excel application designed for the purpose. This calculates a Saproxylic Quality Index (SQI) for each data set; the Index is based on the conservation status of each species found. Individual species are not targeted other than through a broad search of the full range of habitats present. An assemblage approach is also taken in Northern Ireland but in a much more informal way, and involving lists of named target species and thresholds for species-richness which should be met through sampling in order to achieve favourable condition status. In Scotland, a shorter list of named target species needs to be sought and the condition assessment is based primarily on expert opinion following site survey. In Wales, the emphasis is placed on assessing the quality and quantity of the key habitat features rather than sampling the fauna directly. A case study is presented which illustrates the value of the SQI approach using three parkland sites and a traditional orchard in the English Midlands.

Keywords: Conservation; saproxylic beetles; favourable condition assessment.

INTRODUCTION

The Joint Nature Conservation Committee (JNCC) is the UK Government Agency responsible for the establishment of common standards for the monitoring of nature conservation (under the Environmental Protection Act 1990). The EU Habitats Directive 1992 also requires monitoring of favourable condition of all species listed under Annexes I and II. The JNCC has developed 'Guidance for Common Standards Monitoring' – the emphasis is on providing a framework of guidance rather than recommending particular methodologies. Operational practices are developed by the four country agencies and each has accordingly developed its own methodology for assessing favourable condition of saproxylic beetle assemblages – within the JNCC framework; each methodology aims to combine practicality with cost-efficiency. The approaches adopted include combinations of the following: i) assessment of quality and quantity of habitat availability, relying on visual inspection, ii) assessment of species-richness of the saproxylic assemblage, by active targeted sampling, and iii) searching specifically for selected target species. The amount of time allocated for the assessment varies considerably from agency to agency.

Natural Resources Wales (Cyfoeth Naturiol Cymru) has focused solely on the quality and quantity of saproxylic habitat present on each site. The national invertebrate specialists have identified the key features of each site for the known saproxylic invertebrate interest. This enables the assessment of favourable condition to take place during a single site visit event and does not require the assessor to have specialist entomological expertise.

Scottish Natural Heritage (Dualchas Nàdair na h-Alba) has developed a list of target species for each site. They then contract in specialist invertebrate experts to carry out a single visit per site at an appropriate time of year for those target species; for large sites the visit may extend to two consecutive days. The visiting specialist carries out an exploratory survey, searching either for the species themselves or for signs of their recent activity. Time spent on site can vary according to the speed at which the target species are encountered. The assessment of favourable condition is based on the expert opinion of the surveyor and focuses both on the saproxylic habitats present (in terms of quality and quantity) and the results of the targeted survey. In many cases a site will have more than one target species listed and these species may not all be readily detected at just one time of year; the assessment may therefore have to be based on only the partial discovery of the interest features.

The Northern Ireland Environment Agency has developed a more sophisticated approach which combines habitat quality, species richness, and target species; and is based on two separate site visits, thereby enabling some trapping to take place between the two visits (Nelson 2003; Alexander 2006). Exploratory surveys are carried out at two key times of year for recording the fauna – usually during the May-June and July-August periods. The contractor searches specifically for the defined target species but also aims to record as wide a range of saproxylic invertebrates as possible, and also makes notes on the key habitat features that support the fauna. Flight interception traps are placed during the first visit and removed on the second visit – two traps per site have been suggested as a standard, at least initially. The assessment is based on both the target species and species-richness – using recommended site-based threshold criteria as a guide – and supported by the habitat information.

Natural England has developed the most complex and most demanding system. The methodology is described in great detail in a manual (Drake *et al* 2007). For sites with saproxylic interests, it recommends a baseline seasonal survey, involving three visits across the field season to be carried out: late spring (May/June), high summer (July/August) and autumn (September/October). This ensures that the site is assessed at each of these key times of year. Typically a site of 60–70 ha requires one day on site; the site is divided into four quarters and each receives 1½ hours of exploratory survey, targeting the saproxylic habitats available. Trapping is discretionary – in many cases the first visit occurs in high summer or autumn rather than late spring, the survey crossing into a second year, and so trapping may be difficult to standardize. The resulting species list is copied into an Excel Spreadsheet application which automatically calculates a «Saproxylic Quality Index» for the whole «broad assemblage» and also for «specific assemblage types» (SATs):

— Heartwood decay
— Bark and sapwood decay
— Bracket fungi associates

The three SATs enable sites which are important for ancient and veteran trees to be assessed primarily using the first and last SATs, whereas conventional closed woodland sites would only be expected to be rich in the bark and sapwood decay SAT – dense woodlands do not normally contain large old trees due to canopy competition issues but may still be of national importance for bark and sapwood decay fauna. Heartwood decay can be particularly difficult to sample if access into the interior of trees is not available at the time of surveying and so the bracket fungus invertebrate assemblage enables an exterior assessment to take place - bracket fungi initiate the heartwood decay and so a species-rich fauna of fungus associates is assumed to suggest that the heartwood decay fauna may also be species-rich.

The Excel application is named ISIS (Invertebrate Species and habitats Information System). Each saproxylic species has an individual score based on its national conservation status. ISIS takes a species list and calculates the total of these scores; the total is then divided by the number of species involved and multiplied by 100 to form a Site Quality Index (SQI). This is effectively a rarity index and thresholds have been set for the achievement of «favourable condition». The intention is that ISIS will be developed as an on-line application, that it will become available through the Internet.

All of these approaches have strengths and weaknesses. This article explores the SQI concept further and uses some field survey examples to illustrate the results and discuss the implications.

The first attempt to provide a standardised framework for site assessment of saproxylic beetles in Britain was the Index of Ecological Continuity (IEC), developed by the author in 1988 and subsequently updated (Alexander 2004, 2005); it parallels work carried out on epiphytic lichens by Francis Rose and colleagues (Harding & Rose 1986). The IEC scores each species in relation to their known association with historic wood pasture sites – taken to be the closest surviving habitat structure to old growth (Alexander & Butler 2004). The scores are summed, and the IEC builds up with continued recording – the IEC value is a minimum value for the site; all surveyed sites can be compared and the sites which are most species-rich in this old growth fauna are thereby identified for conservation attention.

Biogeographical influences, however, mean that the IEC highlights sites across the lowlands of England, and the less species-rich areas become neglected. Wales has only a handful of sites with relatively high IEC values due to the shorter list of saproxylic beetles present, but still supports key rarities. An alternative index was therefore proposed which takes recorder effort into account and emphasises rarity rather than species-richness. The Saproxylic Quality Index (SQI) approach was first suggested for saproxylic beetles by Fowles (1997) and further developed by Fowles *et al.* (1999). By standardising recorder effort, the SQI is actually stronger than the IEC at assessing site condition, but the IEC is a stronger assessment of site quality as it is led by species-richness of the old growth fauna.

MATERIAL AND METHODS

The SQI calculation involves scoring all native saproxylic beetle species (around 600 British species) found at a defined site during a survey event, summing these scores (Saproxylic Quality Score, or SQS), dividing this sum by the number of native beetle species recorded (SPP) and multiplying the result by 100 to form the SQI.

$$SQI = SQS/SPP \times 100$$

The individual species scores are based on an assessment of the species rarity across Great Britain (see Tab. 1). The SQI effectively calculates the average rarity within the species list.

Tab. 1. Scores allocated by national status for calculation of the Site Quality Index.

GB conservation status	Score
Common and widespread species	1
Uncommon, localised species	2
Very localised species, or status uncertain	4
Nationally Scarce species, category 'b' (known from 31-100 hectads nationally)	8
Nationally Scarce species, category 'a' (known from 16-30 hectads nationally)	16
Nationally Rare species (up to 15 hectads)	24
Endangered or Vulnerable species	32

A survey event can be anything from a single site visit to a compilation of all known historic records – the SQI calculation aims to eliminate the influence of recorder effort. This means that a series of survey events can be compared, preferably a series of standard survey events. It is recommended, however, that the SQI calculation should be based on a minimum list of 40 species as there is too much scope for wild fluctuation below this threshold.

All indices remain meaningless statistics of course until an assessment framework can be provided. The recommended national significances for SQI values were 500+ for GB importance and 590+ for European importance. These values were based on the experience of calculating SQI values for in excess of 100 British sites and comparing the highest scoring sites with Speight's (1989) listing of top European sites. With experience, however, it does seem clear that the threshold for national significance is actually more like 300, with notably very few sites exceeding 500.

The author has been involved in arranging a series of surveys of three National Trust (a major land-owning charity with multiple objectives) owned parkland sites within the English Midlands county of Derbyshire: Calke Park, Hardwick Park and Kedleston Park. Surveys were commissioned of all three sites from Colin Johnson (Manchester Museum; see Johnson 2008) and of Calke Park from Tony Drane (Ecosurveys) while the author was employed by the owner. The author also carried out specialist saproxylic surveys at Kedleston Park while a member of the National

Tab. 2. Statistics from the Saproxylic Quality Index methodology arising from a series of surveys carried out in Calke Park.

Calke Park	Drane 1986	Johnson 1986-87	Alexander 2004	Alexander 2012
Saproxylic Quality Score	240	441	314	336
No of qualifying species	65	117	76	76
Saproxylic Quality Index	**369**	**377**	**413**	**442**

Trust's Biological Survey Team. Since becoming an independent consultant, he has also been commissioned to carry out updating surveys at all three sites on two occasions each (Alexander & Abrahams 2006; Alexander 2011). This provides an almost unique opportunity in Britain to examine SQI values over time at three sites in a single Midland county.

It should be noted, however, that recorder effort does vary between survey events. The Johnson surveys involved a long series of visits, the Drane survey three days on site, the NT Bio Surveys a single day on site, while the Alexander surveys followed the ISIS methodology – flight traps were used on the second occasion only.

These three parkland sites are compared and contrasted with a single traditional orchard site, Rough Hill Orchard Nature Reserve, in the southern Midland county of Worcestershire. This has been subject to three surveys, once by Paul Whitehead in 2000 and twice by myself, in 2004 and 2013. The first two were based on hand-searching techniques whereas two flight traps were operated alongside hand-searching on the third occasion.

Tab. 3. Statistics from the Saproxylic Quality Index methodology arising from a series of surveys carried out in Kedleston Park.

Kedleston Park	NT Bio Survey 1987	Johnson Survey 1987-88	NT Bio Survey 2001	Alexander Survey 2004	Alexander Survey 2012-13
Saproxylic Quality Score	81	396	97	288	288
No of qualifying species	26	117	26	74	69
Saproxylic Quality Index	**311**	**338**	**373**	**389**	**417**

RESULTS

Tabs 2, 3 and 4 show the SQS (Saproxylic Quality Score), SPP (Number of qualifying species) and SQI (Saproxylic Quality Index) values for each survey on a site by site basis.

Site condition over time is shown in Fig. 1. The survey events are numbered 1 to 4 and the NT Bio Survey of Kedleston Park in 1987 has been omitted.

The equivalent trend line for Rough Hill Orchard is shown in Fig. 2.

Tab. 4. Statistics from the Saproxylic Quality Index methodology arising from a series of surveys carried out in Hardwick Park.

Hardwick Park	Johnson 1996	Alexander 2004	Alexander 2012
Saproxylic Quality Score	294	174	148
No of qualifying species	93	59	47
Saproxylic Quality Index	**316**	**295**	**315**

DISCUSSION

All three parkland sites are very clearly assessed as being of national importance for saproxylic beetles, with SQI values above 300. They have broadly similar histories of land-use. Calke Park and Hardwick Park were formed from old enclosures taken from the edges of the medieval Sherwood Forest; Kedleston Park was similarly enclosed from the edge of the medieval forest of Duffield Frith. Calke and Kedleston Parks have broadly similar SQI values despite substantial differences in recent land management, with large areas of Calke Park retaining a wild and semi-natural appearance in contrast to Kedleston where 18th century and subsequent landscape gardening has degraded the wood-pastures to a considerable extent. Hardwick Park is characterised by a poorer saproxylic fauna, almost certainly reflecting the more extensive loss of ancient and veteran trees over time. All three have suffered recent histories of clearance of fallen deadwood, but this has largely ceased at Calke Park which now has the richest area designated as a National Nature Reserve. Kedleston Park has also been managed more positively for its old trees and deadwood in recent years, but conservation progress has continued to be slow at Hardwick Park.

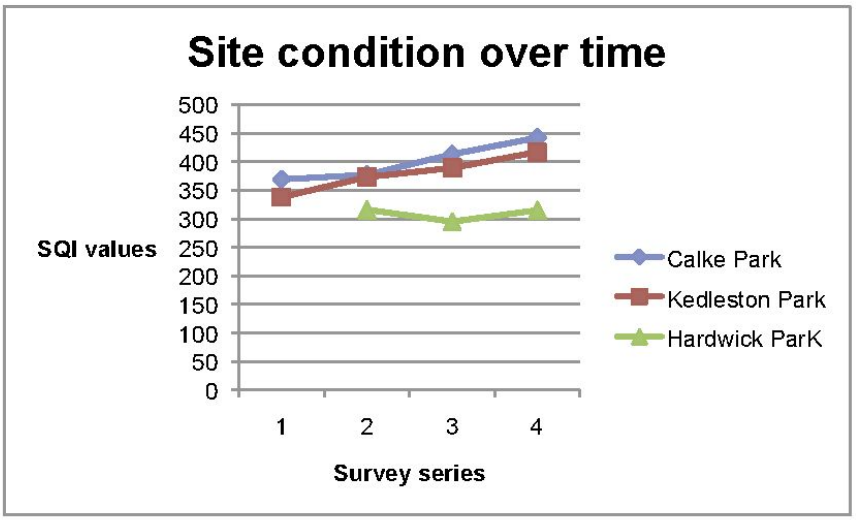

Fig. 1. Site condition over time for the three Derbyshire parklands.

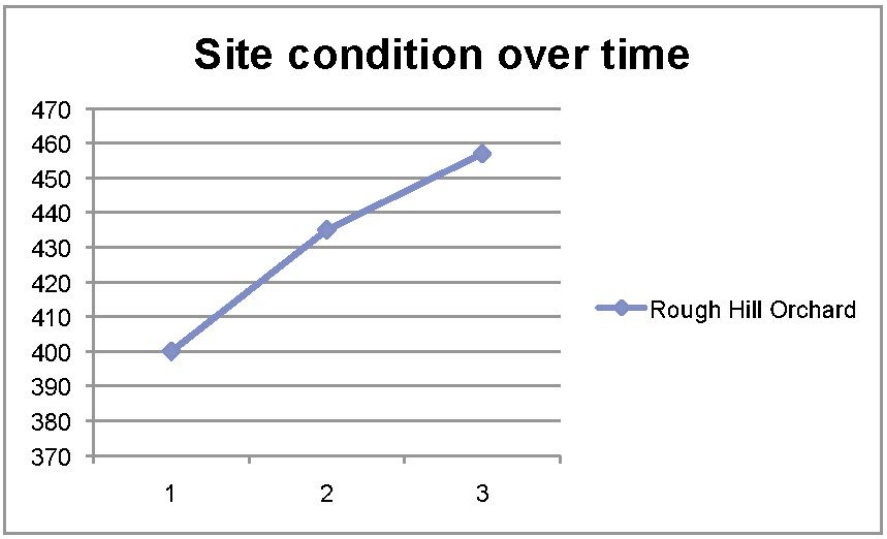

Fig. 2. Site condition over time for Rough Hill Orchard.

The slow conservation progress at Hardwick is reflected in the SQI trend which shows no increase over time, in contrast with both Calke and Kedleston Parks. Calke Park, which has been consistently well-managed, shows a gradual increase in SQI. Kedleston Park, which came to the National Trust in poor condition but has been more sympathetically managed since, shows a steady strong increase in saproxylic condition.

These three parkland examples appear therefore to illustrate that the SQI approach is a useful and reliable one, at least for sites of this extent – each is approximately 100 ha. However, the dramatic increase in SQI values for the much smaller – fewer than 80 veteran apple trees – Rough Hill Orchard are difficult to reconcile. Certainly conservation management has been very sensitive here, but it seems unlikely that this small site can be conserving viable populations of so many rare beetles all by itself. Each survey event in this orchard has resulted in a different list of rarities; there has been no overlap in the rarer species from survey event to survey event. This does suggest that this small site may be acting as a stepping stone within a particularly rich landscape for saproxylic beetles. It does lie close to the famous Bredon Hill (Whitehead 1996), with another notably rich site, Croome Park (Lott et al 1999) to the north. The faunal composition is most similar to that of Bredon Hill and drift of the Bredon Hill rarities across the local landscape does seem a more likely explanation for the richness of this tiny site. In contrast the species lists for each of the three parklands show considerable similarity in species compositions from survey event to survey event.

A strong overlap in the species composition of the samples from survey event to survey event is clearly important if the site can sensibly be considered to be in favourable condition. The situation at Rough Hill Orchard appears to indicate a significant turnover in the rarities present, which does not automatically imply favourable condition of course. Rapid turnover in species composition could be argued to be due to unfavourable condition, although the causes of this affect should be ascertained before any judgement can sensibly be made. There is clearly a need

to enhance the SQI approach by developing a parallel assessment of the overlap in species composition.

A key issue may be that rarer species are often more difficult to detect when present than commoner and more widespread species. Many species tend to be detected in very low numbers – maybe just one or two specimens a sample – and this may have a significant impact on the level of overlapping in the species composition of two concurrent samples.

A prerequisite for the SQI approach is of course the availability of a list of the full saproxylic beetle fauna of the country concerned. Many European countries appear not to have developed their own lists. Another requirement is a conservation assessment for each species and, again, this may not yet be available for each country. Until these are available, thresholds for local significance of the SQI results cannot be determined. The need for favourable condition assessment imposed by the EU Habitats and Species Directive may have the benefit of stimulating the development of country lists and species status assessments, thereby enabling the SQI approach to be adopted more widely. It is unclear at present how EU countries are assessing favourable condition of SACs for saproxylic beetles without such a framework being available. Assessments based solely on vegetation features – such as volumes of dead wood – may be seen as practical options by site managers but there needs to be real evidence that this approach is sensitive enough to detect significant change.

CONCLUSIONS

The Site Quality Index approach is a potentially useful tool for assessing favourable condition of important saproxylic sites, and could readily be adopted by other European countries. It should perhaps, however, be part of the conservation monitoring toolbox only. There is still a need to consider the similarity between successive species lists, to ensure some degree of stability in the species assemblage of each site. Assessment should not lose sight of the key target species which may define the special interest for which a site has become famous and why it may be in receipt of special conservation protection. The four separate systems currently in operation across the UK perhaps belie the idea of 'common standards' monitoring. Ideally any monitoring scheme should consider target species as well as the full assemblage (species-richness), and also link both with habitat quality.

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