MONITORING HEATHLAND FIRES IN DORSET: PHASE 2

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EXECUTIVE SUMMARY

Lowland heathland is a rare and threatened habitat and one for which the United Kingdom has international responsibility. Dorset has around 6000 ha of heathland that gives it the third largest area for an English county. Much of the recent decline in heathland area has slowed in recent years but there are many concerns over quality. In Dorset in particular there has been widespread concern that repeated incidences of fire have been diminishing the resource and threatening important heathland species. In July 1998 the Council of Europe's Bern Secretariat undertook an "on-the spot" appraisal visit to the Dorset heathlands. Part of the remit was to assess the effect that fires had on the conservation interest of the heathland, particularly those areas lying close to or within the large urban conurbation of Poole and Bournemouth where the problems were thought to be most severe. In anticipation of the Standing Committee's recommendations the European Wildlife Division of the Department of the Environment, Transport and the Regions decided to commission independent research to draw together existing records of heathland fires. The main purpose of this research was to establish a baseline data set and to analyse these data to help target future actions and produce proposals for recording future fire events. This report is a product of all Phases of the research and concentrates on the assessment of requirements for recording future fire events. It also includes a section on the ecological assessment of fire impacts to heathland by the ITE.

The research was based upon a variety of methods including gathering data from face-to-face interviews, questionnaires and seminars. Data were analysed in a variety of ways including quantitative statistics and spatial analysis using GIS. User requirements were generally assessed qualitatively.

Phase 1 of the study concentrated on drawing together existing records of heathland fires with the aim of establishing a baseline data set. Fire data was contributed by many organisations with the vast majority being provided by Dorset Fire and Rescue Service. A combined data set of 3333 heathland fires in Dorset from 1990-1998 was produced. Data were dispersed amongst many organisations and hence difficult to gather. They were also highly variable in content and accuracy. There was insufficient information available to fully assess the impact fire had had upon heathland conservation interest. The results showed fires can occur at any time of the year but are most frequent between April and August when, unfortunately, they are likely to cause most damage to heathland vegetation and wildlife. Fires were concentrated in heathlands in or adjacent to urban areas and many of these areas had been subject to large numbers of fires.

Phase 1a of the study investigated the relationships between heathland fires, meteorological variables and fire risk. It also considered the utility of the fire prediction system employed by Forest Enterprise in the New Forest in predicting fires on Dorset heathland. The study found that cumulative weather patterns for concurrent periods provided the best explanations for variations in fire frequencies. There was a high level of fire danger when the preceding 10/11 day period had over 100 sunshine hours, cumulative relative humidity was <600% and when there had been <5mm of total rainfall. Both Fire Hazard and Fire Danger ratings, calculated by Forest Enterprise for the New Forest, contributed useful information to the assessment of fire danger on the Dorset heathlands.

Phase 2 of the work concentrated on the evaluation of current fire information, users needs and proposals for a future monitoring system. The recording of information was found to be fragmented and sectoral. Information is spread amongst several organisations and is not available from a single organisation. There were a variety of data quality issues presented by such a situation. Data were not collected to common standards and key data for the assessment of fire impact were not consistently recorded. In addition to hindering strategic information requirements this situation also prevented the effective sharing of information between organisations in Dorset. The work conducted for Phase 1 brought together baseline information on heathland fires in Dorset for the first time and proposals are made for a Dorset-wide information system that addresses the deficiencies in current information and provides a system for the management and dissemination of standardised information in the future. Detailed system specifications are made with the recommendation that a monitoring system is developed as a module for the forthcoming Recorder 2000 software and is integrated with the National Biodiversity Network initiative.

I. ACKNOWLEDGEMENTS

A great many people have provided help with this project. First and foremost, we are grateful to Richard Chapman for expertly guiding the project and Mark Taylor, Alison Briggs, Vic Jennings and Neale Oliver for assisting him at the Department of the Environment, Transport and the Regions.

We also thank our collaborators, Professor Nigel Webb and Rob Rose of the Institute of Terrestrial Ecology's Furzebrook Research Station and Mark Stevenson of the Northmoor Trust for contributions of ideas, informed comment and the tackling of specific tasks for the project. Appendix 4 of this report was written by Professor Nigel Webb.

Questionnaire, fire or other data, or expert comment, was provided by many: AFV Gunnery School, Lulworth Camp (Mick Burgess); Bournemouth Borough Council (Stuart Clarke and Richard Asquith); Christchurch Borough Council (P Holloway); Dorset County Council (Stuart Crane, Phil Sterling, Andy Elliot); Dorset Environmental Records Centre (Alison Stewart and Carolyn Steele); Dorset Fire and Rescue Service (Alun Morgan, Andy Motteram); Dorset Police (Mike Humphrey, Simon Merry); Dorset Wildlife Trust (Rob Brunt, Andy Fale, Lesley Haskins and Brian); East Dorset District Council (Phil Baarda, Phil Thompson); English Nature (Andrew Nicholson, Nick Squirell and Tim Brodie-Jones); Forest Enterprise (Alison Field, Harold Gillen, Richard Mihalop); Herpetological Conservation Trust (Keith Corbett, Chris Parker and Sandy Dolbear); Poole Borough Council (Jez Martin, Nick Woods); Royal Society for the Protection of Birds (Neil Gartshore and Nigel Symes).

Weather data were provided by Steve Jebson of The UK Meteorological Office, whilst Alison Field and Robin Muir from Forest Enterprise provided Fire Hazard and Danger ratings from the New Forest.

We are grateful to all for the kind assistance so readily provided and apologise to anyone we have unknowingly omitted.

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1 INTRODUCTION

Lowland heathland is a rare and threatened habitat that supports a range of characteristic plants and animals, some of which are rare and many of which are in decline (Moffat, 1994). The rare species present on heathlands include Marsh gentian, Marsh clubmoss, Dorset heath, Sand lizard, Smooth snake, Silver-studded blue, Southern damselfly, Small red damselfly, Dartford warbler, Woodlark and Nightjar. Overall, heathlands support an abundance of Red Data Book plants and animals and numerous species afforded the highest priority for protection with the UK Biodiversity Action Plan (HMSO, 1995). Species protection is therefore of fundamental importance across the lowland heathlands of the UK.

Heathland habitat was once more extensive in England than it is today. Indeed, only one sixth of the heathland area present in 1800 now remains (HMSO, 1995). Threats to lowland heathland include the decline of traditional management, habitat fragmentation and disturbance and, to a lesser extent, agricultural improvement. In the past losses were to urban and industrial development, agriculture and forestry. Controlled burning was formally an important technique in the management of heathland in Europe. Together with other traditional methods of heathland management, such as grazing, turf-stripping and cutting of scrub and bracken, burning prevents tree and scrub colonisation, halts degeneration of the shrub layer and maintains low soil nutrient concentrations (Webb & Haskins, 1980). Today, however, a significant problem is that most fires on lowland heaths are uncontrolled, being either accidental or caused deliberately, particularly near urban areas (Farrell, 1993). Whereas controlled burns are carried out in winter or early spring and are intended to be small, fast and of low intensity, uncontrolled fires tend to occur later in the season and may cover a large area and burn intensely for a long time. Additionally, rates of re-colonisation after fire can be slow where large areas have been burnt (Bullock & Webb, 1995). These uncontrolled fires may therefore destroy all above ground vegetation, burn deeply, cause loss of nutrients and destroy invertebrate and reptile populations. Uncontrolled fires are generally considered to be harmful and to create conservation problems, although this has not been extensively researched (Bullock & Webb, 1995).

Dorset's heathlands once covered over 40,000 ha and supported a small but diverse local economy. Traditional management encouraged and maintained a rich variety of heathland wildlife but the heathland areas that remain today are now fragmented and tend to be much smaller than in the past. Overall, only an estimated 6100 ha of heath remain in Dorset today (Veitch *et al.* 1995), which represents the third largest area of heathland for an English County (Moffat, 1994). Together with heathland in other counties this heathland resource has been recognised as having considerable international importance by the Bern Convention and the EC Directives on the Conservation of Natural Habitats and the Conservation of Wild Birds. Dorset heathlands are also afforded other designations, including Ramsar site status and six National Nature Reserve sites. About 95% of the Dorset heathland area has been notified as SSSI (Site of Special Scientific Interest).

With a large urban population nearby, Dorset's heathlands are particularly vulnerable to fire, started either deliberately, or as a result of carelessness. Here, as elsewhere, uncontrolled fires are perceived to be a problem for lowland heaths - resulting in loss of habitats and species, contributing to habitat fragmentation and disturbance, and precipitating serious management problems with post-fire invasive species such as bracken. Over the last few years, this has triggered international concern over the threat of fire to Dorset's heathlands. In July 1998 the Council of Europe's Bern Secretariat undertook an "on-the spot" appraisal visit to the Dorset

heathlands. Part of the remit was to assess the effect that fires had on the conservation interest of the heathland, particularly those areas lying close to or within the large urban conurbation of Poole and Bournemouth where the problems were thought to be most severe. In anticipation of the Standing Committee's recommendations the European Wildlife Division of the Department of the Environment, Transport and the Regions (DETR) decided to commission independent research to draw together existing records of heathland fires. The main purpose of this research was to establish a baseline data set and to analyse these data to help target future actions and produce proposals for recording future fire events. The objectives of the research were to:

i. Establish the extent of existing records of heathland fires held by local bodies.

ii. Collate and analyse existing records, about the time, location and causes of fires as well as the nature and extent of the damage.

iii. Identify any existing patterns or trends from existing records.

iv. Devise a simple, standardised but effective means of collecting information on future heathland fires.

v. Consider and make recommendations on how that information should be collected, co-ordinated and disseminated.

vi. Identify any additional costs involved in implementing those recommendations.

The work was initially divided into two phases. Phase 1 included objectives i – iii and Phase 2 included objectives iv - vi. Part way through Phase 1 the preliminary results suggested that the consideration of preceding/prevailing weather conditions were possibly important in assessing fire risk. Thus a new phase of the project, Phase 1a, was developed, this provided an investigation of the influence of weather conditions on fire risk, and on considering whether a risk system may be developed to help predict when fire incidents are more likely to occur. This further work was jointly commissioned by DETR and English Nature.

The detailed results from Phase 1 are documented in the project report *Monitoring heathland fires in Dorset: Phase 1* (Kirby & Tantram 1999a).

The detailed results from Phase 1a are documented in the project report *Monitoring heathland fires in Dorset: Phase 1a. Meteorological triggers and the evaluation of fire danger* (Kirby & Tantram 1999b).

This report is the Phase 2 report that summarises the main findings of Phases 1 and 1a and presents the findings of Phase 2. As such it constitutes the main research project report. This report also includes a paper (Appendix 4) which considers the assessment of the ecological impact of fire on heathlands. This chapter was written by Professor Nigel Webb of the Institute of Terrestrial Ecology's Furzebrook Research Station.

2 METHODS

As discussed in the introduction this report covers three different phases of work for the project and therefore includes a variety of different methods. The methods employed in Phase 1 are referred to in the following section and covered fully in the Phase 1 report (Kirby & Tantram 1999a). Methods for the Phase 1a work are touched on below and are covered in detail in the Phase 1a report (Kirby & Tantram 1999b).

The information for Phase 2 was gathered in four main ways. Firstly from the Phase 1 questionnaire (Appendix 1) this provided information on; data available, geographical coverage, habitat coverage, variables recorded and methods used, data access details, format and quality assurance and basic information requirements. Questionnaires were completed by the organisations that were major data providers in Phase 1. Secondly, a data holder's seminar was held in March 1999 for all organisations with an interest in the proposed monitoring system. The seminar had the following objectives:

- To produce a representative set of management objectives for heathland from different organisations.
- To produce a representative set of information needs (relating to monitoring heathland fires) for different organisations.
- To test our proposed model and seek further refinements/developments/alternatives.
- To consider IT-related constraints and opportunities for a future monitoring and information system.

These objectives were met through a series of linked workshop sessions as outlined below:

Workshop Agenda

1 **Introduction**
The project, why we are holding a seminar – what we are aiming to achieve

2 **Overall objectives workshop**
Participants produce summaries of their main management objectives for heathland.
Consideration of the common themes and differences.

3 **Information recording workshop**
Assessment of information required to fulfil? objectives outlined in previous workshop.
e.g. - Information on Fires, ecological condition, timing ?
What kinds of data are needed?
e.g. - Time, location, extent, boundaries ?

4 **Presentation of proposed model.**
Possible model for information collection and management.
Evaluation by participants – does it meet your objectives and consequent information needs? If not what else is required?

5 **Information/monitoring system implementation.**
Taking the draft model and comments from part 4 how would the model work in practice?
We need to consider:
- How information is posted
- Where it is posted
- How it needs to be managed – speed, format etc
- Who needs access to it, how quickly and in what form ? – verbal, written, maps etc.

6 **Recap**
Résumé of results.

Thirdly, an additional questionnaire to evaluate IT systems (Appendix 2) was distributed amongst relevant organisations. This covered the topics of dominant hardware types, operating systems employed, availability and type of Internet connection and methods for data storage.

Fourthly, at different stages of the work interim results were presented to the project Steering Group and to the Dorset Heathlands Working Group. At each of these meetings careful note was made of comments and feedback.

In addition to these four main formal methods other information and opinion was provided during various informal meetings and discussions.

In parallel with these Phases of the Project Professor Nigel Webb and Rob Rose of the Institute of Terrestrial Ecology's Furzebrook Research Station collated available knowledge on the ecological processes and impacts associated with fire on heathlands. This work is based upon both published and unpublished research and professional knowledge of the Dorset heathlands and provided the basis for a paper on the Ecological assessment of fire impacts which is included with this report (Appendix 4) for additional background information.

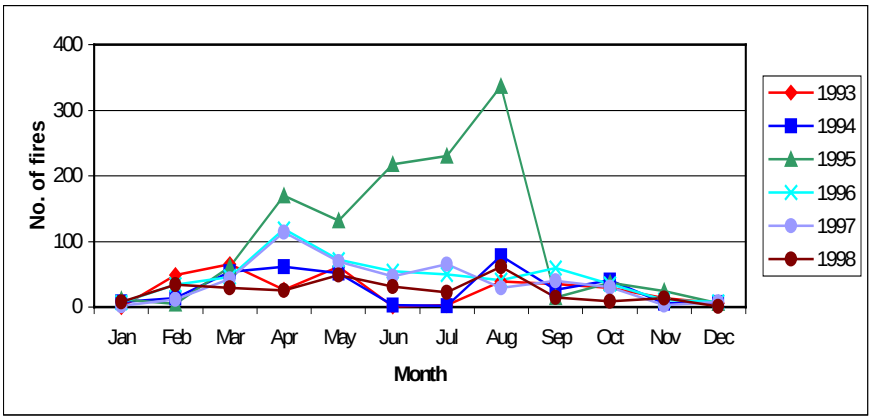
Thus this Phase 2 report is based upon a mixture of more formal research activities and more qualitative 'action-based' research and brings together multiple strands of results to provide the basis for formal recommendations for a future monitoring system in Section 7.

3 PHASE 1

Phase 1 of the project concentrated on drawing together existing records of heathland fires with the aim of establishing a baseline data set. These data were analysed to identify trends and to provide the factual basis for recommendations for recording future fire events to be made in Phase 2.

A large number of records of heathland fires were gathered from a variety of relevant organisations. The vast majority (85%) of these records were generated by the Dorset Fire and Rescue Service and other records were contributed by local authorities, conservation organisations, English Nature and Forest Enterprise. The data received were cleaned and normalised and imported into a project GIS system. The resulting data set contained 3333 incidents for the period 1990-1998 across Dorset. Data were analysed both statistically and spatially and results presented in terms of temporal and geographic characteristics. Data collection methods and standards varied across different organisations and there were some problems with data quality, most striking were locational errors in grid references. Few data were available for the period 1990-1992 so many analyses were based upon data from 1993-1998.

Figure 3.1: Total numbers of unplanned fires on the Dorset Heathlands each month and shown separately for each year from 1993-1998.



The results showed that uncontrolled fires can occur at any time of the year (Figure 3.1) but are most frequent between April and August when, unfortunately, they are likely to cause most damage to heathland vegetation and wildlife.

Fires were more likely to occur at weekends than weekdays, during school holiday periods rather than term time (Table 3.1) and during the afternoon and early evening compared to other times of the day.

Table 3.1: The numbers of unplanned fires on the Dorset Heathlands during non-holiday and holiday periods and the results of tests for statistical significance. Significant differences are shown in bold.

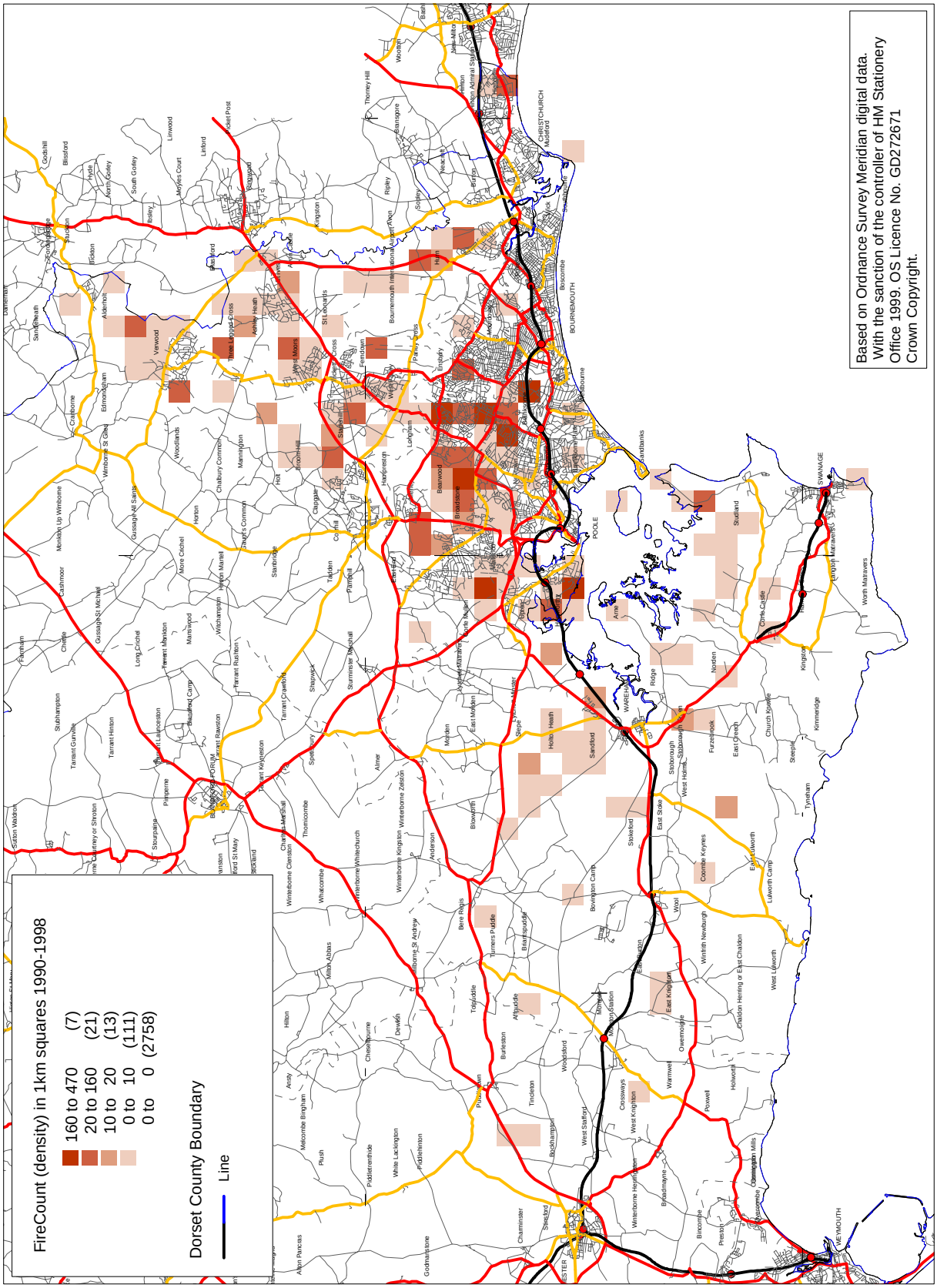
Type of holiday	Number of fires		Statistical significance	
	Non-holiday	Holiday	χ^2	P
Public holidays	86	93	0.27	0.60
School holidays	251	454	**58.45**	**0.01**
Autumn half term	21	42	**7.00**	**0.05**
Spring half term	24	37	2.77	0.10
Easter	89	164	**22.23**	**0.01**
Summer half term	55	68	1.37	0.24
Summer holiday	62	143	**32.01**	**0.01**

Fires occurred on nearly all patches of heathland over the study period with higher concentrations on heathlands within or near to conurbations (see Map 3.1). A geographic analysis of number of fires in heathland SSSIs compared to the degree of urbanisation around each SSSI produced a high positive correlation (r=0.839). The fire density (number of fires per ha over the study period) in SSSIs ranged from less than 1 up to over 5 for an urban fringe site. The incidence of fires in SSSIs is shown in Table 3.2. Because there were discrepancies in the names given to sites between the fire records data and SSSI data both possible names are given in the table.

Table 3.2: Fire incidence in SSSIs. Table is sorted by fire density (number of fires per hectare). Note site areas refer to area designated, this is not necessarily all heathland.

Fire density	Fire Count	SSSI name	Fire Records name(s)	Area ha
5.355013	176	Ham Common	Ham Common	32.865
2.581276	188	Bourne Valley	Bourne Bottom, Alder Hills	72.831
1.632511	107	Ferndown Common	Ferndown Common	65.542
1.458486	604	Canford Heath	Canford Heath, Knighton heath	414.128
1.274847	130	Corfe & Barrow Hills	Rushcombe Bottom, Corfe Hills	101.973
0.812211	179	Upton Heath	Upton Heath	220.386
0.518422	85	Parley Common	Parley Common	163.959
0.364927	13	Turbary & Kinson Commons	Turbary Common, Kinson Common	35.624
0.277502	71	Town Common	Sopley Common, Ramsdown, St Catherines Hill, Town Common	255.854
0.074913	2	Verwood Heaths	Dewlands Common, Stephens Castle	26.696
0.065046	18	Holton & Sandford Heaths	Holton Heath	276.729
0.044388	15	Stoborough & Creech Heaths	Stoborough Heath	337.927
0.034075	18	Hurn Common	Ashley Heath, Avon Heath, Barnsfield Heath	528.227
0.029850	4	Cranborne Common	Cranborne Common	134.004
0.028372	2	Black Hill Heath	Black Hill Heath	70.491
0.018458	2	Highcliffe to Milford Cliffs	Chewton Common	108.354
0.018140	1	Warmwell Heath	Warmwell Heath	55.127
0.014873	18	Povington & Grange Heaths	Coombe Heath, Lulworth Ranges, Povington Heath	1210.220
0.013309	4	Hartland Moor	Hartland Moor, Middlebere Heath	300.547
0.010571	7	Morden Bog & Hyde Heath	Hyde Heath, Wareham Forest	662.194
0.007100	1	Powerstock Common	Powerstock Common	140.853
0.007019	2	Winfrith Heath	Winfrith Heath	284.936
0.005801	1	Rempstone Heaths	Newton Heath	172.386
0.005726	2	Christchurch Harbour	Hengistbury Head	349.254
0.005286	4	Studland & Godlingston Heaths	Studland Heath, Godlingston Heath	756.706
0.005231	4	Holt & West Moors Heaths	Whitesheet Plantation	764.613
0.004473	1	Moors River	Week Common	223.551
0.003598	2	Arne	Arne, Slepe Heath	555.846
0.002733	6	Poole Harbour	Lytchett Bay, Brownsea Island, Studland Heath	2195.190
0.000626	1	South Dorset Coast	Durlestone Country Park	1598.580

Map 3.1: Density distribution of heathland fires in Dorset 1990-1998 in 1 km squares.



Relatively little information was available on the possible causes of fires but where the data were available the vast majority of fires were thought to be deliberately set. Similarly very few data were available for the assessment of impact upon sites and species. It was clear that many sites were repeatedly burnt but it was not possible to determine from the available information whether particular areas of heathland were re-burnt frequently. However, it was clear that a number of heathland sites have been subject to substantial numbers of fires and that these may have caused significant ecological disturbance and damage.

From the work conducted during Phase 1 it was possible to make a number of summary conclusions:

- Currently fire data are created and held by a variety of different organisations, with no single point of access.
- Data quality is highly variable with often inaccurate grid references, non-standard heath names, few records on area burnt, difficulties in establishing what is and what is not a 'heathland fire' and very little ecological information.
- Due to lack of data, assessment of ecological impact was very limited.
- Fires occur at all times of year with most activity between April and August, this corresponds with the time when vegetation is at its most vulnerable.
- More uncontrolled fires occur at weekends than weekdays, in school holidays than in term times and fires are more likely to occur in the afternoon and early evening.
- Fires are concentrated within more developed areas, heathlands in or adjacent to urban areas have higher numbers of fires than those in more rural locations.
- The long-term impact of the fires recorded is unclear, but some sites have large numbers of fires that are likely to cause significant ecological disturbance and damage.

4 PHASE 1A

Phase 1a of the project investigated the relative importance of preceding/prevailing weather conditions in influencing fire risk on Dorset heathlands. Additionally, it examined the utility of the fire prediction system used by Forest Enterprise in the New Forest to predict periods of risk on Dorset heathlands. The findings of the study are summarised here, further detail can be found in the full report (Kirby & Tantram 1999b).

Meteorological data were obtained from Bournemouth International Airport, the only recording station within the core area of heathland fires shown by previous work. The variables investigated were; air temperature, sunshine hours, rainfall, relative humidity, mean wind speed and wind direction from 1993-1998 inclusive. The data were analysed in order to assess average and cumulative weather patterns. The New Forest Fire Hazard and Fire Danger ratings for the same period were obtained and matched to numbers of fires recorded in the Phase 1 work.

The results showed significant yearly variation in most of the weather variables examined. The monthly trends showed July and August to be the hottest months but there was slightly less sunshine then than in May and June. It tended to be windier earlier in the season also, dry in July, whilst there was relatively little variation in relative humidity between months. Wind directions varied significantly between years, blowing most often from the north in two years (1993, 1995), from the south in three (1994, 1996, 1997) and from the west in one (1998). Across months, the wind blew most often from the south early in the season (April-June), then from the west (July-September).

Relationships between Hazard Rating Indices calculated for the New Forest and the numbers of fires on the Dorset heathlands showed there was considerable variation between years in the power of the index to predict the frequency of fire events. 1996 proved exceptional, with quite a strong relationship between the index and fire frequencies in five of the six months considered. In the other years, the index proved reliable in predicting fire frequencies in two or fewer months. Across all years, the relationships were strongest in May, August and September, with significant correlations in three or four of the years considered.

Analyses comparing the total number of fires in 10/11-day periods with the mean, maximum and cumulative Hazard Rating Index produced quite strong relationships in all cases. The best relationship was obtained by using a cumulative index, with fire frequency increasing greatly during periods when the cumulative Hazard Rating Index exceeded 500. The relationships between fire frequency and mean, maximum and cumulative Hazard Rating indices were in all cases poorer with, than without, a lag effect.

The results of comparisons of fire frequencies between days with different Fire Danger Ratings (*i.e.* nil, low, moderate, high and extremely high) - using only the data from days with fires showed a clear tendency for a greater average number of fires with increasing severity of the Fire Danger Rating.

Cumulative weather patterns for concurrent, not lagged, periods provided the best explanation for variations in fire frequencies. Cumulating weather seems important for its incremental drying-effect on the heathland vegetation whilst the stronger effects for concurrent periods implies that any consideration of the weather more than c.10 days previous is irrelevant. The current analyses suggested that there was a high level of fire danger when, in a given 10/11-day period, the number of sunshine hours reached 100, cumulative relative humidity was <600% and when there had been <5mm of rainfall overall. During such weather conditions, heathlands are warm and dry and the risk of fire appears great. Both Hazard- and Fire Danger Ratings,

calculated by Forest Enterprise for the New Forest, contributed useful information to the assessment of fire danger on the Dorset heathlands. Cumulative indices for concurrent, not lagged, periods provided the best prediction of fire danger. In this respect a high frequency of fires was associated with periods with a cumulative Hazard Rating Index of greater than 500, corresponding with particularly warm and dry periods.

There was a clear tendency for a greater average number of fires with increasing severity of Fire Danger Ratings (*i.e.* nil, low, moderate, high and extremely high), which held true in most years and months.

From the work conducted during Phase 1a it was possible to make a number of summary conclusions:

- The results of Phase 1a provided a first approximation of meteorological relationships, based on the data that was available.
- There was significant yearly variation in the weather variables examined.
- Relationships between the numbers of fires and Hazard Rating Indices calculated for the New Forest showed there was considerable variation between years in the power of the index to predict the frequency of fire events. In all years, the relationships were strongest in May, August and September.
- There were relatively strong relationships between the total number of fires in 10/11-day periods and the mean, maximum and cumulative Hazard Rating Index.
- Considering only days within which fires occurred, their frequency increased with an increase in the severity of the Fire Danger Rating.
- Cumulative weather patterns for concurrent periods provided the best explanation for variations in fire frequencies.
- The analyses suggested that there was a high level of fire danger when, in a given 10/11-day period, the number of sunshine hours reached 100, cumulative relative humidity was <600% and when there had been <5mm of rainfall overall.
- Both Fire Hazard and Fire Danger ratings, calculated by Forest Enterprise for the New Forest, contributed useful information to the assessment of fire danger on the Dorset heathlands.
- Further work, and on-going monitoring of the weather in relation to heathland fire-risk, should be designed to establish the sensitivity of thresholds, and thus the power of prediction.
- Current knowledge of the relationships suggest that Forest Enterprise Fire Hazard and Fire Danger ratings provide useful additional information for site mangers to assess fire risk.

5 INFORMATION SUPPLY AND MANAGEMENT

5.1 INFORMATION RECORDING

Eight questionnaires were completed during Phase 1. These questionnaires were analysed to assess general trends regarding current fire recording practice within Dorset. Results from the IT questionnaire are dealt with separately as returns were made by a slightly different group of organisations.

Table 5.1: Organisations returning Phase 1 questionnaires and their acronyms.

Organisation	Acronym
Dorset Fire and Rescue Service	DFRS
Dorset Police Service	DP
Dorset Wildlife Trust	DWT
East Dorset District Council	EDDC
Forest Enterprise	FE
Herpetological Conservation Trust	HCT
Poole Borough Council	PBC
Royal Society for the Protection of Birds	RSPB

5.1.1 Field recording

Only two of the organisations consulted (DWT and RSPB) have adopted a standard definition of heathland (in each case, Phase 1 Habitat Survey definitions), though two others (HCT, EDDC) use their own definitions that are probably closely related to Phase 1 or National Vegetation Classification (NVC) categories. However half of the organisations have not adopted standards for identifying heathland habitat and all organisations select not to distinguish between different types of heath. This means that some current fire records may not relate to heathlands at all, whilst there can be no assessment of the relative impact of unplanned fires on different types, e.g. wet, humid or dry heaths.

The majority of organisations adopted loosely structured field recording (RSPB, HCT, PBC, EDDC and DP), requiring the completion of text narratives that may vary substantially between different recorders. DWT used a short and simple, standard recording form specifically designed to capture fire event information. The procedures of FE and DFRS are more detailed and complex, those adopted by DFRS fitting statutory reporting requirements for human health and safety, and not specifically tailored to meet the needs of ecological monitoring. The procedure used by FE is the most suited to purpose, though some information (e.g. valuations) is collected only for woodlands and not for areas of heathland habitat.

5.1.2 Geography and geo-referencing

One of the organisations consulted (FE) carries out fire recording in an area that only overlaps with Dorset, i.e. the New Forest District. Two organisations (DFRS, DP) will attend fires at any location throughout Dorset, whilst two others (PBC, EDDC) operate within Boroughs or Districts within Dorset. The remainder (DWT,

RSPB and HCT) are primarily interested in the sites managed (directly or indirectly) by their respective organisations, with HCT active mainly in urban and semi-urban areas and DWT/RSPB in more rural localities.

It was obvious from the consultations conducted for the project and from the fire data collected during Phase 1 of the study, that heath names were not standardised between organisations. It was therefore never clear if different organisations were referring to the same area of land.

Five organisations (DWT, RSPB, HCT, PBC, FE) regularly use "compartment names" within sites, usually linked to management plans and habitat and species survey information. Grid references are not recorded at all in the fire recording activities of DP and DWT, though in the latter case they can be calculated retrospectively from fire maps. DFRS record a mixture of different grid references - for general localities, for heathland sites and, from May 1998, for the centres of fires themselves. Thus six organisations (DFRS, RSPB, HCT, PBC, EDDC and FE) currently record grid references for fire events in preference to those for the whole heath or heath compartment.

Five organisations (DWT, RSPB, HCT, EDDC and FE) record the boundaries of fires on maps, though some choose to record these only for larger fires. DP and DWT do not estimate the extent of land burnt by a particular fire event, though for DWT this is mapped. All other organisations record visual estimates of the extent of burn.

5.1.3 Quality control, data security and sharing

None of the replying organisations used standard quality assurance procedures, either for field recording or processing of paper or computer records for fires.

Whilst virus checking (DFRS, RSPB, HCT, PBC, EDDC) and regular back-up of fire data (DFRS, RSPB, PBC, EDDC, DP) were performed for most, but not all, organisations, only two used password protected systems (DFRS, DP) and only the RSPB took steps to ensure that their paper records were duplicated and safely stored.

Five of the organisations consulted had the ability to e-mail data and information (DWT, HCT, PBC, EDDC, DP) but only two organisations hosted World Wide Web sites (PBC, FE).

For four organisations (DWT, HCT, EDDC and DP) there was generally no distribution of the fire records to others not involved in their collection. Four others undertook quite extensive distribution within their respective organisations (DFRS, RSPB, PBC and FE). DFRS was the only body to distribute fire record information, albeit in summary reports, to a range of external parties.

5.1.4 User requirements

As might be expected there was a range of user requirements. DFRS was the only organisation with a statutory reporting requirement for heathland fires. The larger fires, and those leading to loss of property and injury to people, are reported in the greatest detail. To ensure human safety was a primary objective for both DFRS and FE, and five organisations (DFRS, PBC, EDDC, DP and FE) stressed the value of the fire records in making resource allocation decisions. Three organisations were also interested in the records to help assess conservation impact (DWT, HCT and PBC), whilst needing the information to assist in habitat management decisions was cited as an objective of fire recording for four (DWT, RSPB, PBC and EDDC).

5.2 IT FACILITIES

Additional data on IT facilities and data storage were collected through a data holder's questionnaire distributed to participants in the data holder's seminar. These were used to gather basic information about IT hardware and data management practises, to assess the degree of commonality between organisations and to look for any major limiting factors that may affect the design or implementation of a future monitoring system.

Table 5.2: Organisations returning IT Systems questionnaires and their acronyms.

Organisation	Acronym
Bournemouth Borough Council	BBC
Dorset County Council	DCC
Dorset Environmental Records Centre	DERC
Dorset Fire and Rescue Service	DFRS
Dorset Police Service	DP
Dorset Wildlife Trust	DWT
East Dorset District Council	EDDC
English Nature (Dorset Team)	EN
Forest Enterprise	FE
Herpetological Conservation Trust	HCT
Poole Borough Council	PBC
Royal Society for the Protection of Birds	RSPB

5.2.1 IT infrastructure

The dominant system architecture was Intel-based Pentium systems running Microsoft Windows, the only exception to that was DFRS who also run a Unix server. The majority of respondents ran 32 bit systems, six also ran 16 bit systems and EN and RSPB ran 16 bit systems only. Six organisations (DERC, DP, DWT, EN, HCT and PBC) had email facilities. DFRS has email facilities for software support only and BBC, DCC, EDDC, FE and RSPB had none. This pattern was repeated for Internet access with the exception of DP who had no Internet access. The majority of organisations used modem dial-up facilities, three had network connections to the Internet.

5.2.2 Data storage

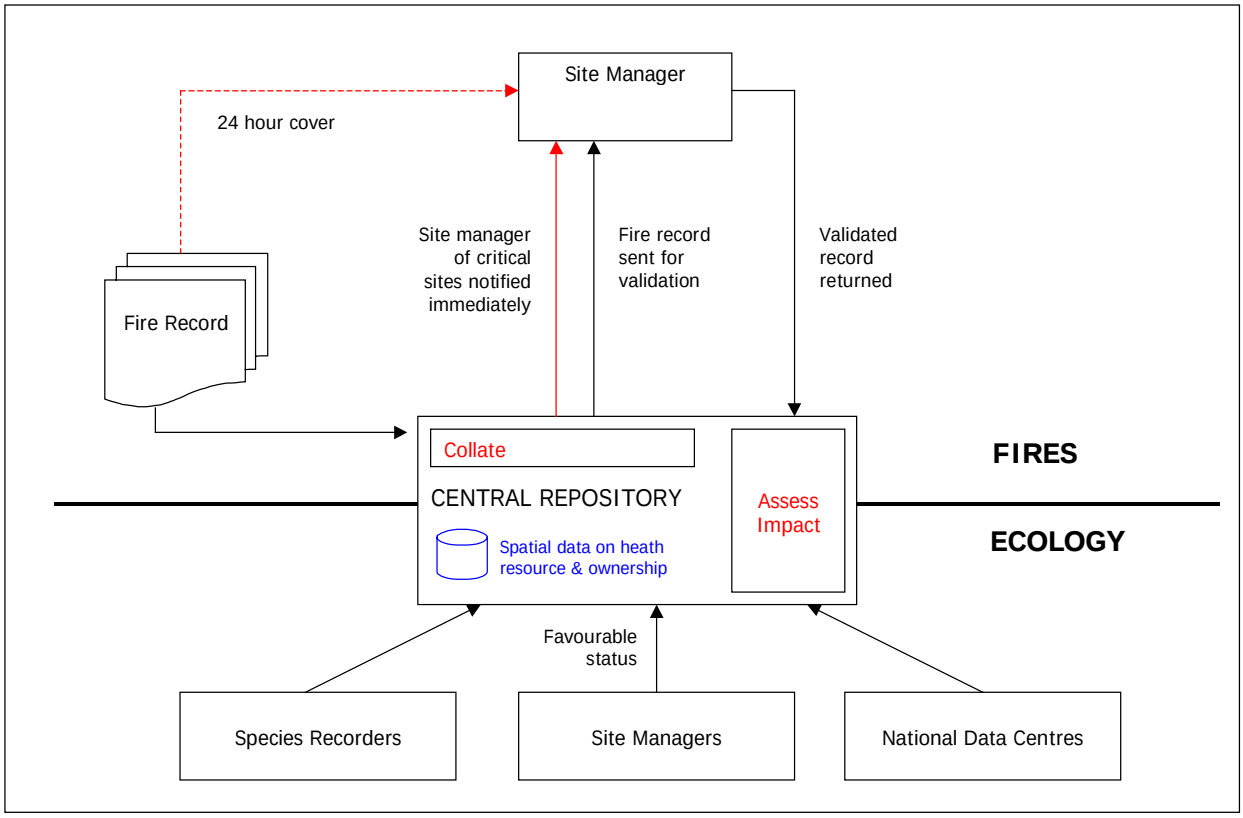
Of the nine responding organisations all except EDDC and HCT stored their data electronically. Data were most commonly stored in spreadsheets and Microsoft Access databases. Recorder was used by two organisations (DWT and DERC) and RSPB use the Countryside Management System (CMS). Two organisations stored geographic data electronically, both making use of MapInfo. Five organisations stored their data in flat tables, two of these also used relational structures. In total five organisations used relational data structures. These results do not tie in exactly with other information gathered throughout the study and it was clear from the responses that some organisations were unclear about their data storage methods. Only half of the organisations used standard terms for data entry.

5.3 User requirements

Information on user's requirements for a future monitoring system was gathered through the Data holder's seminar. All organisations that had participated in the study were invited. Nine organisations attended and these represented a good cross-section of those that might participate in the future monitoring system, including local authorities, NGOs, civil authorities and the voluntary sector.

In preparatory work before the seminar the project team developed a draft information model for the proposed monitoring system. This was based upon the requirements set out in the brief and upon questionnaire responses and feedback from relevant organisations. The model (see Figure 5.1) sought to address the current problems illustrated by the project. In the model Fire Records are collected by participants in the system and 'posted' to a central repository for processing. They are then sent out to site managers for supplementary information and validation and returned for collation. In addition to this information ecological

Figure 5.1: Draft Information Model



data on habitats, species and favourable condition are also collated by the central repository. In this way information on fires and contextual information on heathland type and condition can be brought together to assess impact. All these data are then subject to a single point of control and available through a single point of access.

The Data holder's seminar was used to test the validity of the proposed model. With this in mind, in addition to the organisations that had attended before, Dorset Environmental Records Centre (DERC) were invited with the objective of assessing their willingness and suitability to provide the proposed central repository for information.

Table 5.3: Organisations participating in the Data holder's seminar and their acronyms.

Organisation	Acronym
Bournemouth Borough Council	BBC
Dorset County Council	DCC
Dorset Environmental Records Centre	DERC
Dorset Fire and Rescue Service	DFRS
Dorset Police Service	DP
Dorset Wildlife Trust	DWT
English Nature (Dorset Team)	EN
Herpetological Conservation Trust	HCT
Poole Borough Council	PBC

5.3.1 Management objectives

The first topic of the seminar was assessment of organisation's management objectives for heathlands. Each organisation's representative was asked what their objectives for heathland management were (there was some confusion, with some organisations going beyond objectives to procedures and monitoring and therefore the results were not complete). They are summarised below:

Dorset Police HQ objectives:

- Collate information to direct resources more effectively.
- Obtain evidence sufficient for a prosecution where appropriate.
- Target schools in the vicinity of vulnerable sites and initiate a peer led education programme.
- Improve communication between organisations.

Poole Borough/Dorset County Council objectives:

- Maintain the heathland in favourable condition, including the maintenance of ideal conditions for the range of specialist organisms.
- Maintain public access and amenity at a level appropriate to the site.
- Ensure public health and safety.
- Education.

Herpetological Conservation Trust objectives:

- Reduce heathland fires.
- Combat adverse pressures.
- Promote reptile conservation.
- Encourage more police action.

Dorset Environmental Records Centre objectives:

- Provide a repository of centralised information.

Bournemouth Borough Council objectives:

- Maintain and enhance biodiversity.
- Manage heath to benefit a wide range of heathland flora and fauna (e.g. provide suitable areas for Dartford Warblers and open, sandy patches for sand lizards).
- Interpret the heath to schools and the public.
- Allow continued access for informal recreational use.
- Encourage 'proper use' of the site.

English Nature objectives:

- Manage whole heath for a complete suite of flora and fauna (including variety in structure and diversity of species).
- Maintain population of key species (e.g. Biodiversity Action Plan Species).
- Promote long-term sustainable management.
- Enable/allow for controlled burning for conservation.
- Reduce uncontrolled burns.
- Improve fire planning and communication.

5.3.2 Information required to meet objectives

It was important that any monitoring/information system that was proposed for this project should help the organisations meet their objectives. Organisations were therefore asked to list the information that they would need to fulfil these objectives. The salient points are listed below:

HCT identified 4 steps in an information gathering process, required in order to respond to heathland fires:

- Instant response – alert organisation, record location, inform of damp-down needs.
- Within 24 hours – identify the extent and causes of each fire.
- Within 1 week – judge effectiveness of fire precaution measures and the short-term effects on key species.
- Medium term (6months – 3 years?) – judge effect on vegetation and any consequent deterioration in the value of the site.

PBC made the observation that information is required on:

- The condition of the site prior to the fire; including heather age structure, species distribution and type of habitats present.

The information requirements of DFRS and DP are different to those of site managers:

- DFRS need a better definition of heathland.
- DP needs centre on the definition of deliberate fires and criminal acts.

In addition to the points outlined above there was a consensus about the core information requirements for fire records:

- Grid ref. and location – it was suggested that an eight figure grid reference of the central point of the fire would be best. Compartment maps of the site would be helpful. Several grid reference points around the edge of the burn would perhaps help to estimate the size of the fire.
- Time and Date.
- Weather information.
- Name of recorder and information.
- Extent of fire (either in m^2 which everyone would just have to learn or in simple, standardised categories – size of bush, car, house, football pitch, etc). Again, the value of compartment maps was mentioned).
- Simple measure of intensity or severity (e.g. 50% scorched earth, 50% leaf-litter remains).

The following points were also mentioned by some organisations (but not all):

- Public/agencies attending the fire.
- Evidence of species casualties.
- Management implications.
- Description of site prior to burn.
- Infrastructure damage.
- Public injuries/near misses.

There was also general consensus on the manner of recording, everyone was clear that any system must be simple and straightforward to operate. More complex ways of recording fire damage were rejected on these grounds.

5.3.3 Presentation of draft model

The draft data model for the proposed monitoring system was presented to the group for comments. There were no major problems with the model and discussion focussed on questions relating to implementation. If DERC are to act as Central repository, they made the case that they could not carry out the assessment of the effects of fires – this is not their role and they felt it could compromise their impartiality. This would have to be done by either:

- The individual conservation organisations who would compare fire records with the results of their own site records and report back data comparing sites in favourable/unfavourable with fire, management and weather records. (This would still need to be collated into an annual summary report).
- An independent body who would collate the information in liaison with DERC and the conservation organisations.

In either case, an annual report would be produced, providing a summary and adding specific appendices for each organisation managing heathlands, detailing fire records for their sites.

The proposed model presented a data model but did not specify the means for transmitting information. The original concept was to employ Internet technology but in the seminar the group decided that the communication of records was considered best done by fax. It was also suggested that records would need double-checking to eliminate double-counting between Fire Service records and other records and to ensure that all possible fires were recorded.

There was some disagreement about recording the effects of fire. HCT and DERC suggested longer term monitoring specifically on the burn site but other groups were doubtful as to whether they would have any staff resources available for this. The possibility of adding to the verified fire record was discussed, the site manager could make recommendations as to what priority be given to future monitoring, based on his/her assessment of the potential damage.

6 DISCUSSION

6.1 Information recording

The recording of information on fires on the Dorset heathlands has evolved according to the requirements of different organisations. To date there has been no strategic direction or control. Because of this it was necessary to carry out a considerable amount of work to complete the first phase of this project. Information is spread amongst many bodies, there is no single point of access and no single point of control. This means that prior to the work conducted for this study there was no clear picture of the number and distribution of fires on heathland in Dorset. Because there has been little or no data integration in the past different information is gathered by different organisations to different standards.

The metadata collected for this study showed that no standard definition of 'heathland' was employed across the recording organisations and that none discriminated between heathland types. This creates problems identifying *heathland* fires and their occurrence within different types of heathland vegetation.

The field recording of fire information was not standardised, resulting in different information being recorded to different standards. Whilst different organisations have different roles and objectives it is important that core data are consistently recorded. Phase 1 of this study showed that core data were not being consistently recorded for all the main relevant criteria.

Different organisations recorded information in different but often overlapping geographical areas. Heath names are not standardised making it impossible to accurately compare information from different sources. Work in Phase 1 showed that different heath names were used by local authorities and NGOs, English Nature who used SSSI names and ITE who used a mixture of SSSI and local names for the Dorset heathland survey. In addition to the variable identification of land parcels, different techniques were used to record the location of fires. In the best cases fire locations were recorded with 100m grid references. Other recorders used site compartments and many used site names. Some data from DFRS recorded the address of the individual reporting the fire incident or access points onto heaths. Whatever the resolution of grid references given the accuracy was often poor. In many cases, for the reasons outlined above, it was not possible to verify the real location of fires, but in some instances locations were clearly inaccurate – all fire locations were plotted in the project GIS in Phase 1 and, for example, some fires were located in the sea. In no cases were the boundaries of fires available in machine-readable formats and information on the areas of burn was scarce. Little information is recorded on the impacts of fire on heathland, particularly in forms that would allow the consideration of long-term trends.

Differences in recording techniques are to be expected across a range of organisations such as those consulted in this study but none of those consulted employed standard quality assurance techniques for recording or processing data. Regular backup of data was not widespread which raises concerns over data security.

The emerging information environment is both complex and fragmentary and has the following implications:

- There is no single/standard point of access to Dorset heathland fire information. This makes it difficult for users to access and share information.
- There is no single/standard point of control for Dorset heathland fire information and the information (all information considered as a resource) is not necessarily secure.

- Heathland vegetation types are not defined or discriminated between. This makes it difficult to identify heathland/non-heathland fires and their occurrence on different types of heathland.
- The location of fire events and their area are not recorded in a systematic or standard form.
- There is little quality assurance across relevant organisations. This study has highlighted obvious deficiencies in the available data but it is not possible to verify accuracy for all variables.
- The sharing of information is additionally hindered by non-comparability issues.
- Little is recorded or known about the long-term impacts of fire on the Dorset heathlands.

These implications need to be addressed by the proposed information system.

Work in Phase 1a on meteorological variables showed significant relationships between weather variables and the number of fires recorded in the earlier Phase 1 work. It was clear that Fire Hazard and Fire Danger ratings produced daily by Forest Enterprise for the New Forest were related relatively strongly to fire risk on the Dorset heathlands. More complex cumulative analyses suggested that if within a 10/11-day period, the number of sunshine hours reaches 100, cumulative relative humidity is <600% and when there has been <5mm of rainfall overall the risk of fire seems great. The aim of this project has been to assess the current and past effects of fire and to recommend a more efficient and comprehensive system for collecting monitoring information. As current information on fires is of very variable quality it would not seem prudent to recommend recording complex meteorological variables to construct a predictive risk system on the basis of our results. For this reason we have not modelled meteorological data in our proposed system. However, it would be prudent for site managers/fire fighters to obtain Fire Hazard and Danger ratings from Forest Enterprise as a proxy for fire risk on Dorset heathlands and this can easily be accommodated in the proposed system if required.

6.2 IT facilities

The basic review of IT facilities was undertaken to assess any possible major constraints for a future monitoring system. The results showed that email and Internet technology was not yet universally adopted amongst the sample organisations. However, the feedback gained from the data holder's seminar unequivocally recommended using facsimile technology for Fire Record transfer and therefore the low adoption rate for electronic data transfer will not constitute a problem. The data model for the information system proposed (in Section 7) is not tied to any particular mode of data transfer and the information system could easily be re-developed using electronic file transfer in the future.

Of the nine organisations consulted all except two stored their data electronically. The use of relational data structures and standard terms for data entry was low and the lack of these methods poses doubts about data integrity. The information system proposed is based upon a centralised data repository where all data management would be conducted by one organisation. This negates the need for all participating organisations to standardise their methods for data management. Only two organisations stored geographic data electronically. There is a need for spatial data management of fire event and heathland data within the proposed information system, but again this objective can be met most easily through the use of a single repository.

6.3 User requirements

User requirements need to be considered in the light of each organisation's objectives. Although DFRS provided c. 85% of the fire event records for the Phase 1 study, recording heathland fires is clearly not their prime objective. However, they are the only organisation with a statutory obligation to record fires and are interested in co-operating with a new fire monitoring system for heathlands.

The objectives for heathlands in Dorset varied between the organisations consulted. It is difficult to disinter whether the differences in objectives stated are real or an artefact of individual's responses on the day. For the purposes of the exercise conducted for this study this is not crucial as the objective setting exercise was introduced as a step towards the critical evaluation of information requirements. What is of value is to consider the common themes referred to in the objective-setting exercise. These included the use of information to direct resources more efficiently, to promote public access and amenity and resoundingly to manage all heathlands sustainably to maintain and enhance biodiversity. The current information situation makes it difficult to assess whether the impact of fire on the Dorset heathlands affects their long-term sustainability. The proposed fire information monitoring system is intended to provide comprehensive and consistent information on fire location and distribution and enable the assessment of fire impact on heathland. The proposed information system is required to be both simple and comprehensive whilst also producing consistent information.

6.4 Information requirements

Information requirements were assessed in the light of organisations' stated objectives and the objectives of this research contract. It became clear through the process of evaluating information requirements that in addition to producing a list of variables to be recorded other core data were needed and that key, new information sources would need to be created. From the consultation process a number of core points arose that should be central to the information recorded and managed in the proposed information system. These are shown in Table 6.1 and are the mandatory requirements for the proposed system. Additionally, other less popular variables were proposed by individual organisations, these are listed in Table 6.2. It is proposed that these be recorded by participants but that they are not mandatory variables. The new information sources required for the operation of the system are described in Table 6.3. The precise detail of the formulation of the new data sources requires further consultation between the participants of the proposed system.

Table 6.1: The common core information requirements for a Dorset heathland fire monitoring system.

Information requirement	Comments
Grid reference	Eight figure gird reference, accuracy problem needs tackling, perhaps through the production of heathland maps with clearly labelled grids
Location	Employs standard heath names (see Table 6.3)
Time	Of fire, as close to start as can be ascertained
Date	Of fire with full century listing
Name of recorder	For verification purposes
Extent of fire	In m^2 or in area categories
Simple measure of severity	Basic assessment of fire intensity

Table 6.2: Additional variables requested by some organisations.

Information requirement	Comments
Public/agencies attending the fire	Optional variable recorded as required
Evidence of species casualties	Optional variable recorded as required
Management implications	Optional variable recorded as required
Description of site prior to burn	Should be available from information in the system
Infrastructure damage	Optional variable recorded as required
Public injuries/near misses	Optional variable recorded as required
Weather	Available from outside the system, can be optionally recorded

Table 6.3: New information sources required for a Dorset heathland fire monitoring system.

Information requirement	Comments
Definition of heathland areas	Requires consensus on definition and mapping for purposes of system participants. Should follow standard classifications such as Phase 1 and/or NVC. Mapping should follow a consistent methodology and scale and should include a minimum level of resolution suitable for all users. Should be stored and managed in a GIS.
Definition of heathland types	As above. Requires core consensus on definition and mapping.
Heathland ownership/management responsibility	Requires co-operation and mapping, for easy and rapid identification/contact of site manager. Should be stored and managed in a GIS.
Standardisation of heathland names	Requires consensus on definition, production of standard list and mapping. Should use most-used names where possible and should be linked to defined heathland areas. Should be stored and managed in a GIS.

The work for this project has identified their strategic need and describes their core requirements in Table 6.3. Although four information requirements are listed it is likely that these would be met through two linked data stores managed in a GIS. One should include heathland data including standard names, standard vegetation classification and mapping extents. The second data store should include cadastral information. These information stores will not only be invaluable for the operation of the proposed monitoring system but will also have wider utility for future conservation management, research and survey, and fire planning.

The feedback on recording information about the impact of fire on heathland gained from users was unequivocal – it must be simple and quick. For these (pragmatic) reasons more complex systems for recording fire impact have been dropped in favour of a simpler matrix (see Appendix 3, the full fire recording proforma). These proposals fall are less complex than the ideas discussed by ITE in Appendix 4. It is clear that further research is required to assess the long-term impact of fire on Dorset's heathland vegetation but also that this should not form part of the currently proposed monitoring system. Instead data provided by the monitoring system in the future should be used in a future review process and could provide base data to any research initiative to further quantify the impact of fire on Dorset heathlands.

6.4.1 Proposed model

The proposed model developed by the project team appeared to meet most users' requirements. The use of facsimile rather than email technology does not affect the proposed data model but only the implementation

and software requirements for the proposed monitoring system. The need for immediate notification led to a refinement of the model with a duplicate but separate track for rapid response (see Section 7).

One of the DETR's objectives for the proposed monitoring system is that it should be able to disseminate collated information. DERC, whilst keen to consider the role of running the proposed central repository, are anxious not to compromise their impartiality by undertaking an interpretive role. This should not present any problems as DERC would still be able to provide information to relevant partners and produce an annual report summarising the records received from each participating organisation, for defined areas of heathland and for Dorset as a whole. Any interpretive analyses as may be required to fulfil reporting obligations should be the responsibility of the relevant commissioning body (i.e. DETR or EN as its statutory advisor) and could use any/all data supplied by the central repository.

The proposed model, with minor modification as described above after feedback from users, forms the basis for the suggested information system, proposals for which are described in the following section.

7 A MODEL FOR THE DEVELOPMENT OF AN INTEGRATED SYSTEM OF DATA EXCHANGE FOR THE ASSESSMENT OF THE IMPACT OF FIRES ON HEATHLAND

7.1 General

A model has been constructed to address the need for a co-ordinated system of data and information exchange. The need for such a system has been identified by DETR and the conclusions of work conducted for this research project. Currently, one of the main limitations to the assessment of the impact of fires on heathland is the dispersed nature of the information required as a basis for such analysis. At present several organisations have statutory, voluntary and commercial interest in the maintenance of the favourable status of heathland and the monitoring of the impact of fires. Each of these organisations and in some cases individuals holds a portion of the 'key' to the question 'how is heathland affected by fires?'.

Closer collaboration and agreement for data sharing is likely to benefit each of the various interest groups and reduce significantly the resources required for comprehensive analysis and monitoring of the heathland resource as a whole.

In order to be able to assess the impact of fires on heathland a number of activities are required that collect, collate and manage the data necessary for analysis. A variety of organisations have a range of interests in the identification of fires, their control, management and prevention in addition to the monitoring and surveillance of their effects on heathland. In proposing a system of co-ordinated information exchange it is necessary to abstract the various roles, sources of information and reporting obligations of all interested parties. A model of how information can be collected and managed is proposed that addresses the requirements of the DETR, as well as the aspirations of many of the local organisations to see improved data collection, in implementing a system that enables long term monitoring of the effects of fires on heathland. Such a system should be extensible and compatible with other initiatives so that data collection and storage is not duplicated across systems and so those roles are clearly delineated.

The proposed system is designed to allow participants to gather standard fire event data. These data are posted to a central repository where fire event records are logged and sent out to site managers for additional information and verification. The verified records are returned to the central repository where they are collated in a database. The central repository manages the fire records and the verification process and stores ecological information on Dorset's heathland and its condition. The central repository provides access to both fire event data and ecological data that together will enable the assessment of fire impact on heathland.

The identification of the various roles within the proposed model has been undertaken independently of existing roles and organisations.

The following 'Roles' are identified:

- A Central Repository
- The fire service
- Site managers
- National data centre

The description, role and remit of each are described in the following sections.

7.2 A Central Repository

7.2.1 Description

At present one of the most significant barriers to any assessment of the effects of fire on heathland habitat is the dispersed nature of relevant data across a number of organisations. These data where they exist are managed in a variety of formats for specific purposes and require bespoke negotiation for access. Many of the organisations that currently collect such data would benefit from additional information and access to collaborative data analyses. It is proposed that a central repository be defined that has the remit of managing data on behalf of the community of organisations.

This repository is likely to be hosted by an organisation with existing responsibilities or interest in the collection and use of data regarding heathland. The repository should act as a location for an information system that is administered by dedicated staff. These staff should be responsible for the data collection, collation and storage and should be able to furnish requests for data and organise provision of access to the data.

The role the repository should be defined to account for the collection, storage and management of data and should necessarily not include the analysis of these data. Such analyses as may be required to fulfil reporting obligations should be the responsibility of the relevant commissioning body (i.e. DETR or EN as its statutory advisor).

7.2.2 Objectives

The proposal for a central repository has the following aims:

- To enable the collection of heathland fire information for the assessment of impact and analysis.
- To increase the use of information for the purposes of maintaining the favourable condition of heathland.
- To reduce significantly the overall cost of data collection, collation, storage and provision of access.
- To increase the value of existing initiatives by collaboration and synergy.
- To reduce the duplication of data collection regarding heathland biodiversity and the incidence of fire.
- To avoid the need for case by case bespoke negotiation for data access.
- To minimise the potential for inconsistencies in data analyses regarding the effects of fire on heathland.

The central repository should have the following objectives:

- **To maintain objective independence**
  The central repository should be seen to be independent to ensure that data are collected without bias and access is granted without prejudice. The role of 'data broker' should be on

behalf of all collaborating organisations (a community that should be wide enough to ensure impartiality of remit).

- **To collect data to an agreed, consistent format**

  The collection of data of relevance to the effect of fires on heathland should employ standards agreed by a representative group of organisations. This standard should be compatible with the full range of information required by the full range of uses to which it may be put. The standard should be clear, public and should not impose onerous overheads to those responsible for data collection.

- **To store data of relevance to fires on heathland**

  The central repository, in addition to storing information related to incidents of fires on heathland, could as a secondary function, store and/or provide access to data of relevance to heathland biodiversity.

- **To administrate regular data collection to an agreed time table**

  Responsibilities regarding data provision are linked to the data provider roles in the model. The central repository should have a responsibility for administration of these channels of data flow to ensure the integrity of the data resource.

- **To store data in a standard and accessible format**

  The data relating to fires on heathland should be stored in a publicly documented format to enable analysis by bodies/individuals outside of the repository.

- **To allow open access to the stored data for analysis**

  The data repository should allow access to the data resources by external bodies for the purposes of analysis.

The implications and implementation of these objectives are outlined in later sub-sections.

7.2.3 Remit

The definition of the processes required to be supported by the central repository is outlined in Figure 7.2 "Top level Data flow and process diagram: 'Central Repository'".

The processes required to manage information of relevance to heathland fire are identified as being:

- Receipt of fire records.
- Notification of the incidence of fire on heathland.
- Forwarding records to site managers.
- Fire Record validation.
- Gathering Heathland ecological information.

For further discussion about these and the various elements identified in the model as outlined in the Data Flow Diagrams (DFDs), see sections 7.7 – 7.11.

7.2.4 Notification of the incidence of fire on heathland

In certain cases the site manger requests notification of the incidence of fire immediately to enable them to respond and possibly assist in the control of the fire. We propose that the fire service undertakes to inform all such site managers in the event of fire by group paging. This process is outside the control of the model described here but is supported by it. Since the central repository will not provide 24hr, seven days a week cover the fire service will be the first in many cases to inform the site manager. However, at the same time the fire service will inform the central repository by faxing a fire incident record. On receipt of this information a

fire record is created and forwarded to the site manager for validation. Therefore the site manager may have been informed prior to the receipt of the fire record but the process converges when the fire record is validated and returned to the repository (as illustrated by the dotted line on the diagram).

7.3 The fire service

7.3.1 Description

At present the fire service undertakes to inform certain parties of the incidence of fire on heathland. They store, in their own information system, information of relevance to fire incidents and provide access to these data on request.

7.3.2 Objectives

The fire service currently informs people with a stated interest in heathland of the incidence of fire. In most cases they are currently the originators of the basic data recorded about fires on heathland. In the model they are defined as the major originator of the minimum fire record and as the first informers of site managers of the incidence of fire.

In addition to their own duties they have the following role in the model:

- Initiate the creation of the Fire Incident Record.

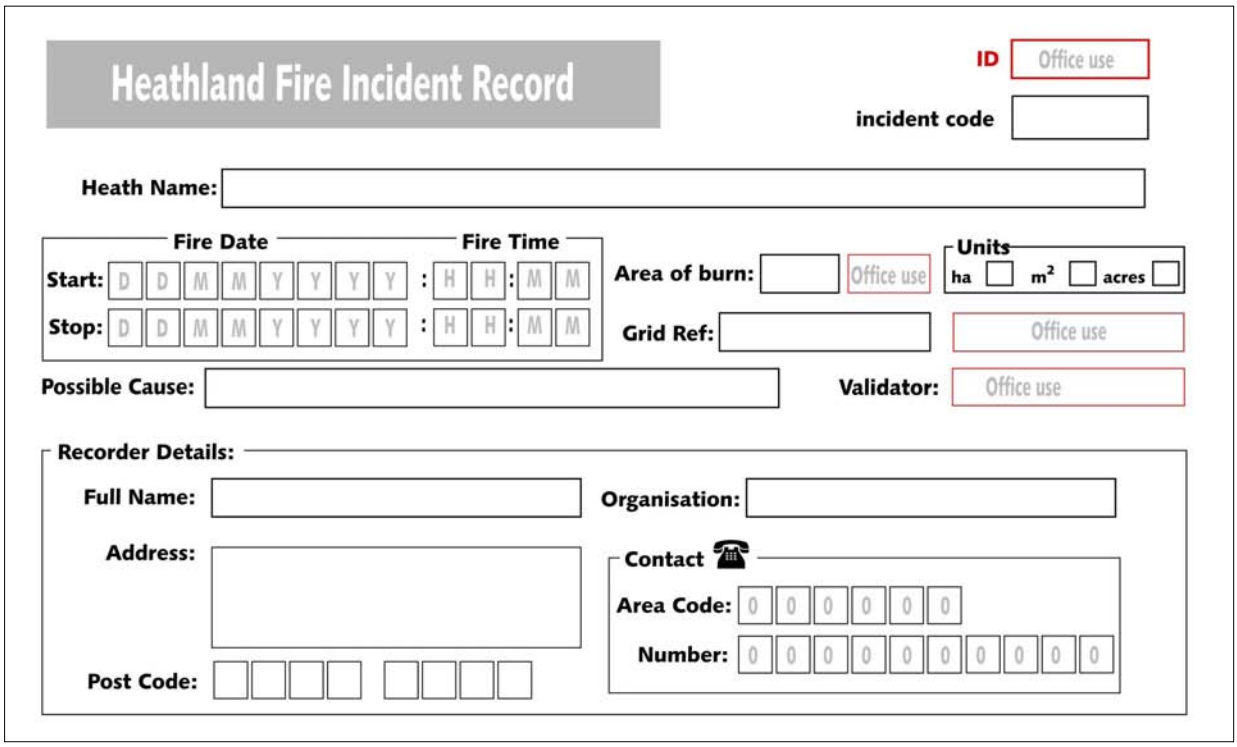
They are the first to be notified in most cases of the incidence of fire. They are able to determine if the fire location is 'heathland' in the broadest sense and as such inform the central repository of the incident. This step is the first to be taken in the creation of the fire record. The central repository should provide the fire service with maps indicating the location of heathland parcels.

7.3.3 Remit

The model outlined in this document does not increase greatly the overheads of the fire service. The processes required to provide information of relevance to heathland fire are identified as being:

- Inform site managers of the incidents of fire.
- This is carried out currently and represents a list of pager numbers that automatically get called with the details of the fire. The list of people informed is not determined by fire location but is a static list of all who may wish to be informed. The individuals decide if the fire is related to their site or not.
- Complete and return a 'Fire Incident Record'.
- A fax template (see Figure 7.1) is completed and sent to the central repository, this can be done electronically from a suitable computer or 'manually'.

Figure 7.1: Fax template for Fire Incident Record.



7.4 Site managers

7.4.1 Description

The definition of a site manager varies from site to site. In essence it is anybody with a formal responsibility for a heathland site. Each heathland site should have one or more people who are contactable in the event of a fire. In some cases this will be a site warden in other cases it may be one of several volunteers who is nominated to be 'on-call' during particular periods.

7.4.2 Objectives

Site managers are external to the model and as such no attempt is made to define their remit. However, in terms of the model a generic 'site manager' is seen as having certain duties with regard to the processes required to maintain the system. As such this generic site manager role can be seen as having objectives. The definition and conformation of these objectives and consequent duties require agreement with the full range of site managers as they exist in the real world.

The objectives of a site manager with regard to the model are:

- **To limit the damage caused by fire**
  This may be immediate where they aim to assist in the control of the fire and the setting of priorities in targeting fire control.
- **To maintain the site in favourable condition and to report condition**
  To manage the site and to survey, monitor and maintain biodiversity of the site.
- **To survey the site**
  To collect physical and ecological data of relevance to the site.

7.4.3 Remit

The model aims not to increase significantly the duties of the site manager with regard to the recording of information relevant to fire incidents. The model aims to streamline the interaction with site managers and to devolve responsibility of the validation of fire records to them. Record validation should not be onerous and should be combined with existing site visits following fire incidents. The information collected should be compatible with information they require for their own records and the submitted information should be readily accessible to them. The collaborating parties should regard the process of record validation in the spirit of collective ownership of the data.

The main duties they have with regard to the model are:

- Record validation.
- Site detail information

7.5 External Data Centres

7.5.1 Description

In order to be able to provide comprehensive information, to facilitate the analysis of the effects of fire on heathland, the repository should have and provide access to national, regional and local data centres that manage information additional to that collected and stored by the repository. The repository should aim to be a node of the National Biodiversity Network (NBN) and as such provide access to resources available through the network. The collection of standard lists of information required to manage the heathland fire data should also be facilitated through the network of partners of the NBN. The 'Site Catalogue' (see Section 7.7) for example, should be collated from sources of geographical, habitat and statutory site designation information. This will ensure that the appropriate authority maintains such standard sources of data and thereby assure their quality.

The definition of the External Data Centre in the model is therefore a 'placeholder' for interaction with the NBN and its resources; the definition of such interaction will progress in parallel with the identification and development of the NBN and its resources themselves.

7.5.2 Objectives

To provide data on request and, where possible, provide access to network resources. The development of the central repository should be informed by developments of the 'Local Record Centre' network of the NBN and should draw on available resources and experiences as appropriate.

The objectives of the national data centres will vary according to their individual character, but are generally:

- To provide access to the best information available of relevance.
- To be an authority for standard terms and invariant data.

7.5.3 Remit

The duties of external data centres are in many respects outside of the influence of this model. However, broadly speaking the generic duties of a national data centre as they relate to the model are:

- To supply the source information for the Site Catalogue.
- To provide access to biodiversity information of relevance to heathland.

7.6 The Model

The model is presented in figures 7.2-7.6 in the form of data flow diagrams (DFDs). These diagrams represent a standard tool of Structured Systems Analysis and Design Methodology (SSADM) and illustrate how information flows across the system boundary and within the system. They depict external sources and recipients of information and the internal stores and processes that hold and change the information.

Note: In the DFDs the numbering of the various elements does not imply sequence.

7.7 Level 0 – The Central Repository

This depicts the activities of the Central Repository and separates these into processes. The processes (the numbered closed boxes on the diagram, see the legend) are each further detailed in the subsequent diagrams.

The following processes are identified:

- Receive Fire Record
- Forward to site manager
- Validate record
- Augment heathland data

Each of these processes obtains information from either an external or an internal source of data and processes these data. The data are then stored internally or passed to an external source. The full details of the processes indicated on the diagram are given in the following sections.

The following external sources are defined:

- Fire Service
- Site Manager
- National Data Centre

These have been detailed in sections 7.3, 7.4 and 7.5 above.

Several internal stores of information are identified:

Fire Records

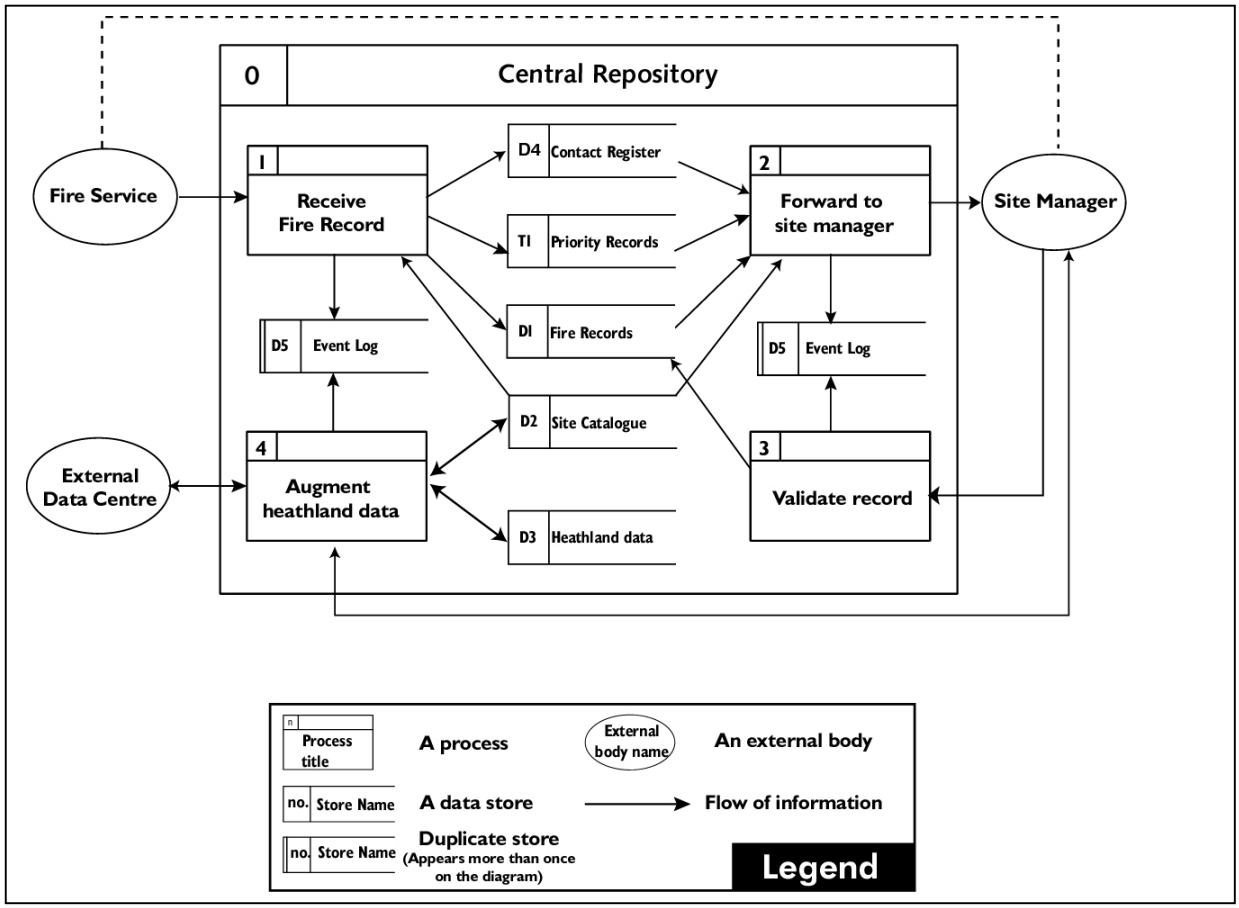
Description:

This is the central store that manages the fire incident information. It is the central store of data regarding fire on heathland and is the 'authority' for such information.

Source:

The primary source for these data is the fire service that provides information about the incidence of fire. This incident record forms the basis of the fire record, which throughout its life obtains information from a number of processes that interact with external and internal sources of information.

Figure 7.2: 'Top level' data flow and process diagram: 'Central Repository'.



Use:

This is the heathland fire data and will be used by all analyses of heathland fires.

ⓘ **Priority Records**

Description:

As indicated on the diagram this represents a temporary store or 'priority marker' of fire records for immediate attention of site managers. For full details of this process see level 1: Receive Fire Record.

Source:

The fire service.

Use:

This store is used to inform site managers immediately of the incidents of fire.

ⓘ **Heathland data**

Description:

This store represents a collection of information regarding biodiversity and heathland. Ideally it would represent access to national data centre resources for fauna, flora and physical data. These data are required for contextual purposes for the evaluation of fire impact, and should be acquired as they become available and according to need.

The store will provide access to lists of species and physical features and provide information about them such as their status, distribution. Current monitoring and survey data should also be accessible.

Source:

National and regional data centres of the NBN.

Use:

The data represented by this store will be used in providing context to analyses of the fire data and general heathland information.

ⓘ **Site Catalogue**

Description:

The site catalogue represents an inventory of the heathland resource. It should be spatially based (ideally on a GIS system) and represent the authority on the identification of heathland parcels and vegetation types. Each parcel should have an official invariant identifier and a proper name (with a list of synonyms). It should be linked to other sources of data (e.g. such as favourable condition information) to provide information about heathland sites.

Source:

SSSI/SNCI registers and habitat maps.

Use:

This is a central data resource providing unequivocal identification and links to the ownership of each parcel of heathland. It will be used in determination of responsibility for each heathland site and providing standard definitive names and physical character of parcels of heathland (dimensions, boundaries, statutory designation information, ownership, etc.).

ⓘ **Contact Register**

Description:

A resource that manages addresses and other contact information. The store will contain as a minimum the contact information for all participating organisations, all site managers and will be linked to the site catalogue.

Source:

Information will be provided by the participants and will be cleared for use by all people whose details are held within the store. Strict guidelines should be defined as to access to this information and security should be implemented to ensure confidentiality and appropriate use. The store will fall under the Data Protection Act and all people with information in the system must be made aware of the use and conditions of use to which the information is put.

Use:

The contacts information is the reference for site manager details and all other interpersonal communication regarding information held in the repository.

ⓘ **Event log**

Description:

The central repository is not the source of any of the data managed by it. As such the generation and augmentation of the data managed by the system is undertaken by external bodies. The interaction with these bodies for these purposes should be logged to ensure correct data management procedures are maintained. It is likely that the logging of events will be an automated element of the 'system' and will reflect events such as when the data where last modified and by whom, when the fire incident record was first received, when it was validated, etc.

Source:

Every time an interaction is made with an external source of information and when internal data are transformed, that event should be logged.

Use:

Such information provides an audit trail within the system. It provides management control of the data life history. Obvious questions that can be answered by such information are:

- What records are currently 'out' for validation?
- How many fire incidents were reported?
- When was the national context data last updated?

7.8 Process 1: Receive Fire Record

The initial creation of a fire record in response to receiving notification of a fire incident (usually but not always from the fire service). Judgement as to whether site is heathland made by the central repository.

1.1 When a fire incident occurs on heathland the fire service send the Central Repository a 'fire incident record' by fax. The original fax is stored in a physical store or archive (M1: Fax store).

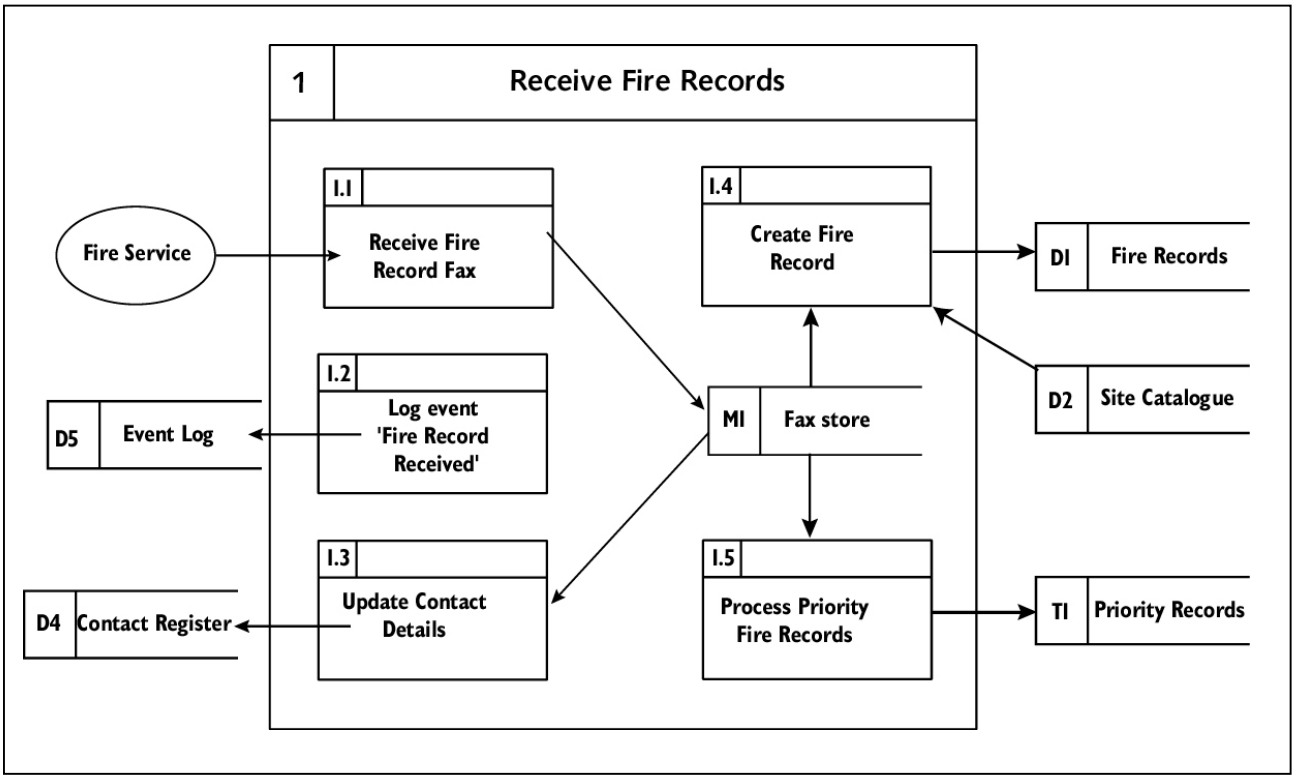
1.2 The 'event' is logged (D5).

1.3 Any contact details are updated/added to the Contact Register (D4) (not all fire records originate from the fire service and as such may contain new contact details).

1.4 The fire incident record is checked against the site catalogue to determine the site identifier from the catalogue and to determine if the fire is on a 'heathland' site. A fire record (D1) is created from the incident record and linked to the site catalogue information (D2).

1.5 If the fire site is one that requires immediate notification of the site manager then the record is marked as a priority for forwarding to the site manager. In most cases the site manager will have been informed of the fire by the fire service directly, through the group paging system.

Figure 7.3: Process 1 – Receive fire record.



7.9 Process 2: Forward to site manager

Once a fire record has been created it requires validation and additional information as a result of a visit to the site after the fire by the site manager. A copy of the full record is sent to the site manager for updating.

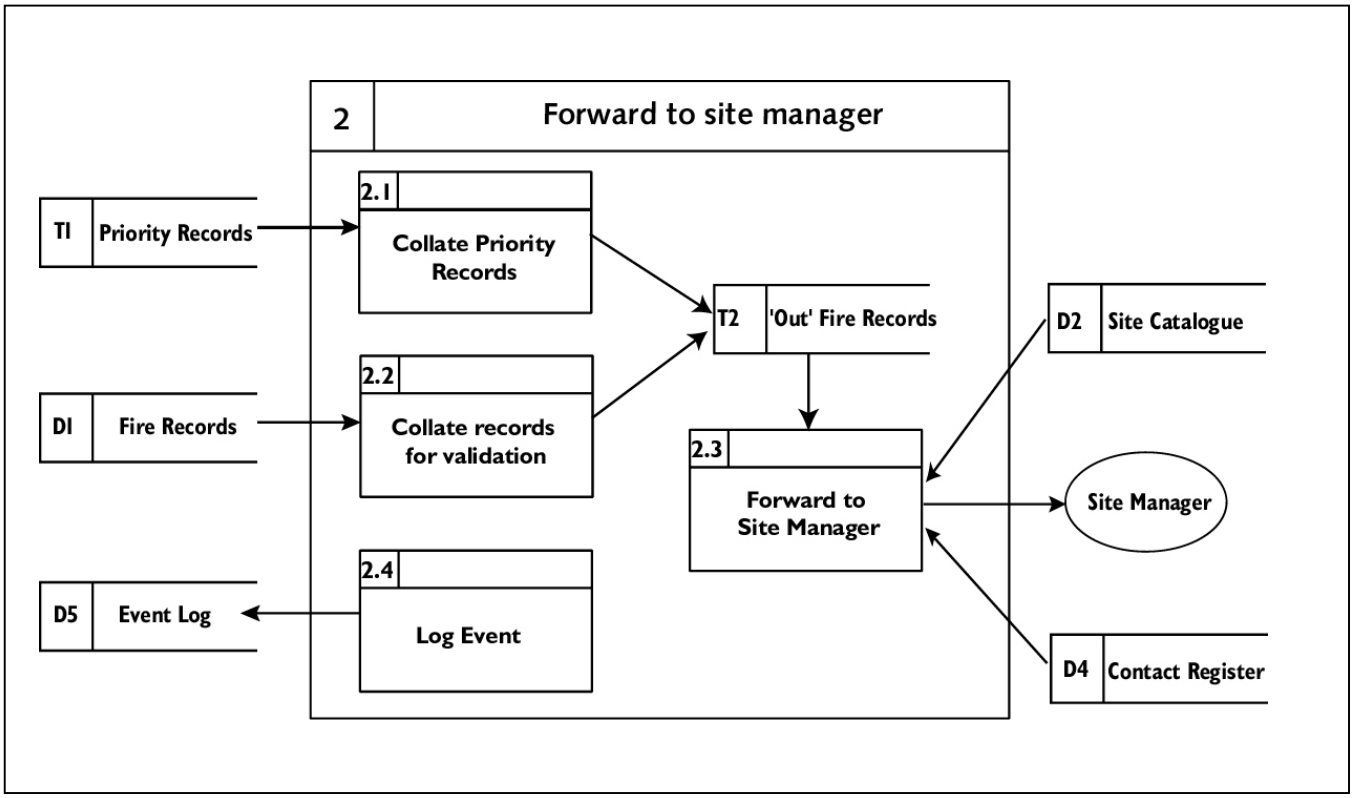
2.1 Priority records (T1) are collated for forwarding to site managers and added to list of records for sending out (T2: temporary store – ''out' fire records').

2.2 Unvalidated Fire records (D1) are collated for forwarding to site managers and added to list of records for sending out (T2: temporary store – ''out' fire records').

2.3 The list of records for forwarding to site managers (T2) is sent out. This process refers to the site catalogue (D2) to determine which site manager and the Contact Register (D4) for their current contact details.

2.4 The action of sending out records is logged as an event (D5). This enables the system to determine which records are currently 'logged' out.

Figure 7.4: Process 2 – Forward to site manager.



7.10 Process 3: Validate record

The site manager on receiving a record undertakes to complete the record with information about the fire and to validate the grid reference, area of burn, etc. (See the Fire Record later in this section). The site manager then returns the copy of the record to the central repository.

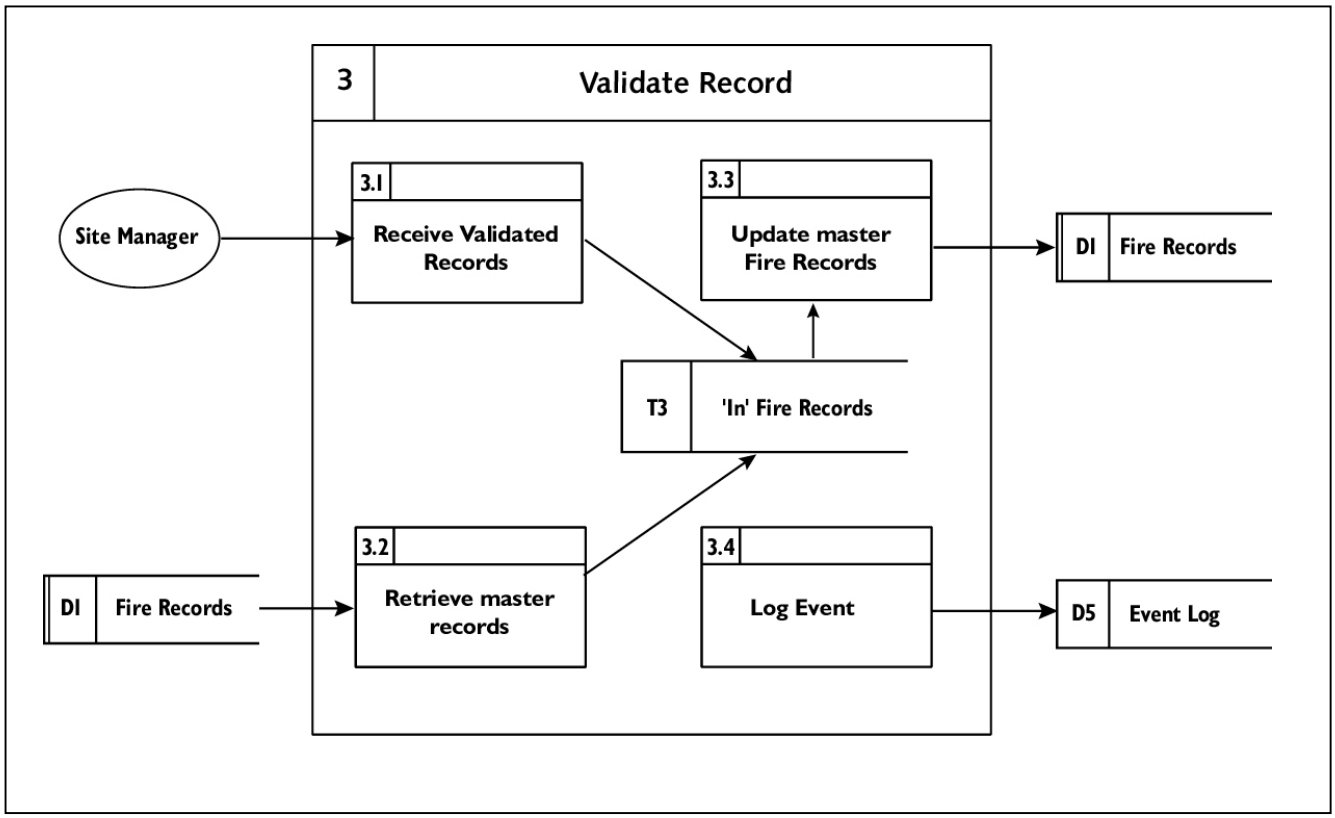
3.1 A Validated record is received from the site manager and placed in a temporary store of 'in' records.

3.2 The master record to which the copy in the store relates is retrieved.

3.3 The new information from the incoming copy of a fire record (T3) is added to the master record (D1).

3.4 The return of the validated record is logged (D5).

Figure 7.5: Process 3 – Validate record.



7.11 Process 4: Augment heathland data

There is an ongoing process of updating the resources of heathland data. This is especially important for critical stores such as the site catalogue (D2). The purpose of this process is to ensure that the best available information required to provide context to the fire records is made available. The exact nature of the storage of such data and which data have access to them provided from a remote location is dependant on agreements between external data centres and the development of the NBN.

Site dimension, favourable condition and other information relating to individual sites should be returned by the site manager at regular intervals (e.g. annually).

4.1 Data deficiencies are identified in the heathland data store (D3) and a request made to the appropriate national data centre

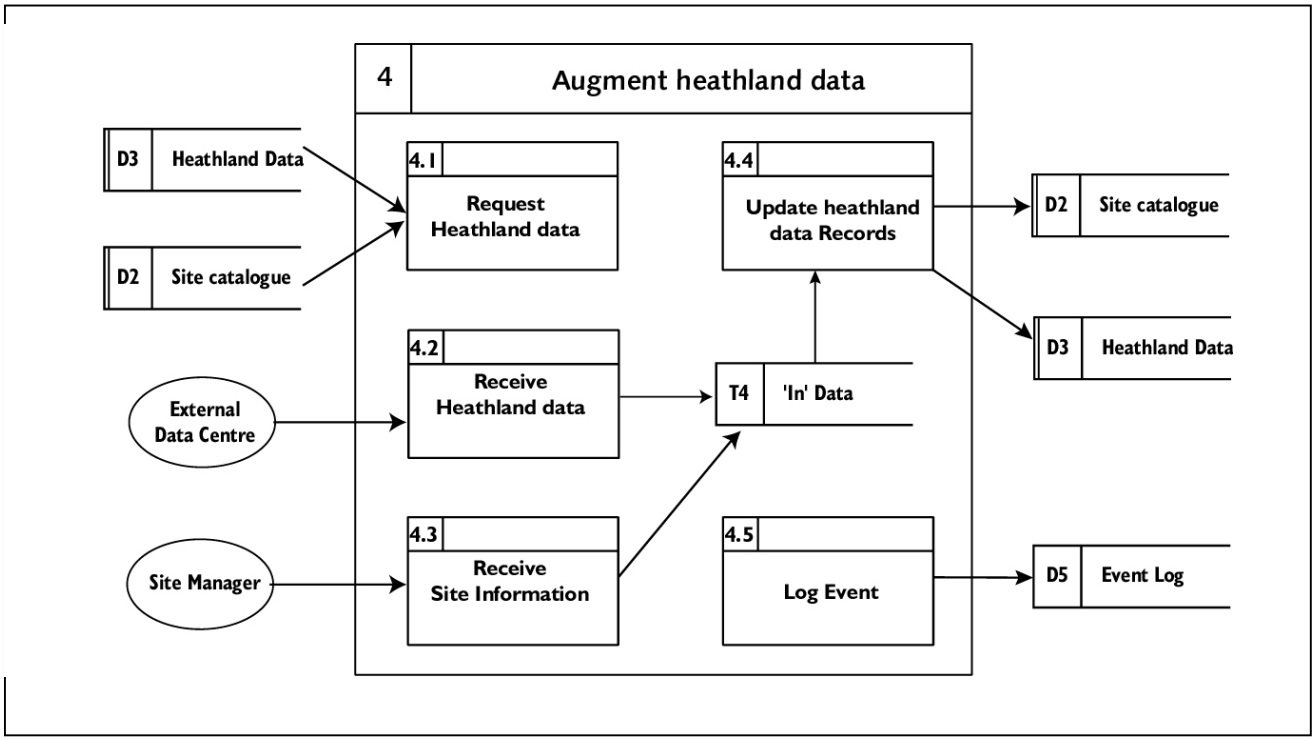
4.2 Data are received from external sources and placed in a temporary store (T4) awaiting processing.

4.3 Data routinely returned by site managers describing the site and physical and biological features.

4.4 The incoming data are 'added' to the appropriate store (D2 & D3).

4.5 The request and receipt of data are logged (D5).

Figure 7.6: Process 4 – Augment heathland data.



7.12 Other Processes

There are a number of other processes that can be identified. They have not been modelled because they are either 'one-off' processes or are outside the scope of the current model (although the model supports them and their existence is implicit in the nature of the model).

7.12.1 Process 5: Start-up process

This will obtain the start-up data for the central repository. Examples of such data are those required for the following stores:

- The Site Catalogue.
- The Contact Register.

This process will also put in place physical arrangements such as the fax template for the fire incident record.

7.12.2 Process 6: Provide access to data

This process is not modelled since it is external to the core processes of the central repository. The nature of provision of access requires agreement and suitable access protocols to be in place to ensure that access is provided in an efficient and acceptable way that does not compromise security of personal and other confidential information.

7.13 Resources required for the creation of a Central Repository

7.13.1 Staff

It is estimated on the basis of fire incidents over the past 8 years that the processes identified in the model would account for 25% of the annual workload of a full time member of staff.

This does not include the following, which require specialist staff time:

- The set up costs for designing and agreeing access protocols.
- Entering the initial data.

7.13.2 Running Costs

Running costs for the system when operational will cover consumable costs (i.e. faxing costs) and accommodation (i.e. electricity, consumables, office space, etc.).

7.13.3 Software

Office software will be required for administrative purposes (letter writing, email, etc).

GIS Software (i.e. one seat of MapInfo®) should be purchased for the management of the Site Catalogue.

Bespoke software should be developed to manage the databases required for the management and storage of the Fire Records, Contact Register, Event Manager, etc. This should be based around a relational database designed to meet NBN data model criteria. The main fire record database should be developed as an 'add-in' to Recorder 2000. This will ensure skill transfer between the two systems and avoid duplication of functionality.

7.13.4 Hardware

A single Pentium® class computer with 128MB RAM, 10Gb hard disk space and Windows 2000.

Access to a Printer, Facsimile machine, backup device and physical file storage (i.e. file cabinets) will be required. Note that costs may be lower if such facilities are provided by the hosting organisation.

Table 7.2: Estimated costs.

Initial Year

Item		Cost
75 days Staff time at SO grade		£5000
Consumables		£1000
Overheads		£1000
Hardware		£2000
Software		
(3rd party – Office/GIS)		£1700
Fire Records		
Site Catalogue		
Contact Register	Recorder2000 application	£12000
Event manager		
Heathland data		
Total		**£22,700.00**

Successive years (estimate, non index-linked)

Item	Cost
75 days Staff time at SO grade	£5000
Consumables	£1000
Overheads	£1000
Total	**£7,000.00**

These costings do not include provision for the development of the two data stores, the Site Catalogue and the Contact Register. It is very difficult to cost these from available information. The very fact that they are needed means that it is difficult to quantify the task.

The Contact Register needs to contain name, address and contact details for all 'Site managers' and their links to heathland sites or parcels. The bulk of the effort involved in creating this resource relates to finding the relevant information, entering the data is likely to require only a few days work. It is likely that information for the Contact Register would be best provided by all relevant organisations as consulted for this study and their contacts. Additionally information may be needed from the land registry. Thus work to create the Contact Register may comprise relatively little effort by a large number of people with one person acting as a co-ordinator and collator.

The Site Catalogue will be a spatial digital data set delineating all areas of heathland in Dorset and providing a controlled site name list. Additionally it will contain subdivisions for different vegetation types, management

units and tenure. In many cases these categories will overlap or be co-incident. Each of these sub-site polygons will require digitising and coding so they can be cross-referenced to the Contact Register. SSSI boundaries are already digitised, other heathland areas would require digitising along with sub-site divisions as outlined above. Because the number and complexity of sites and their sub-divisions are unknown it is not possible to cost this exercise with any accuracy.

8 CONCLUSIONS

To avoid repetition conclusions for Phases 1 and 1a have been presented earlier in this report. Considering the research study as a whole the following summary conclusions can be made:

- **The available information suggests that heathlands in Dorset were subject to over 3000 fires between 1990 and 1998.**
  It is currently unclear exactly what impact these fires are having but it is clear that they are a major management concern.

- **The risk of fire can be related to meteorological variables.**
  Examination of weather conditions can help predict possible fire risk. Additionally, Fire Danger ratings produced by Forest Enterprise can help indicate periods of risk and may e useful to site managers.

- **The current pattern of fire information provision is fragmented and of variable accuracy and quality.**
  In order for a consistent, comprehensive and reliable picture to be built up in the future, information collection and management practises need to change.

- **A model for the development of an integrated system of data exchange for the assessment of the impact of fires on heathland is proposed.**
  The deficiencies in the current situation are clear. Our proposals in Section 7 aim to address all the current problems in a format that imposes minimum overheads on the participants in a new monitoring system. Whilst it is possible to define a logical data model and processes in a report, the actual implementation of proposals requires not only some resource input, but more importantly, the continuing commitment of all relevant participants.

- **Heathland conservation and management bodies in Dorset already have many shared objectives.**
  It was clear from feedback gathered throughout the project that those involved in conserving and managing heathland in Dorset have many common objectives and a shared enthusiasm to tackle information and management issues and this provides a promising basis for the establishment of a heathland fire information monitoring system.

8.1 Recommendations

- **The implementation of a heathland fire monitoring system as detailed in Section 7.**
  The system proposed has been developed according to user requirements, to meet information deficiencies and to minimise effort and cost to partners.

- **Dorset Environmental Records Centre (DERC) is proposed as the candidate organisation to run the proposed Central Repository of information.**
  DERC's business is the collation and management of environmental records. It is widely viewed as being impartial. Staff have the relevant background and training and the addition of the suggested role would be an extension of current activities.

- **Rapid implementation**

  If there is a significant delay from the completion of this contract to the implementation of the proposed system there will be a loss of continuity in fire record information which could only be made up by employing the time-consuming methods used for this project.

  The implementation of the proposed system will have knock-on benefits for other initiatives, for example the proposed Contact Register and Site Catalogue will be invaluable for conservation management and in the development of Fire Plans for specific sites.

- **Research**

  Further knowledge is desirable on the long-term impacts of fire on Dorset's heathlands and the relationship between meteorological variables and fire risk. The detail required means that research requirements are unsuitable for inclusion in a monitoring system. The products of any research should contribute to the review process for the monitoring system.

- **Review**

  If implemented, the monitoring system should be critically reviewed annually and after five years. The first and fifth reviews should be conducted by an impartial body in conjunction with the system's partners.

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APPENDIX 1 - META DATA QUESTIONNAIRE

I. GENERAL

1. Data source title	Name of data set
2. Description	Brief abstract of the nature of data set
3. Date of publication	Date of data 'publication'
4. Commissioning organisation	Name, address and contact
5. Implementing organisation	Name, address and contact
6. Purpose/objectives	Main purpose of data set
7. Requirement for fire event data	Why the organisation needs fire event data
8. Status	Data gathering planned, on-going or complete
9. Start date of data collection	
10. Finish date of data collection	
11. Update frequency	When or how often will data be updated – as fire events occur?

II. SURVEY

12. Geographical coverage	Spatial extent of the data set - whole county, etc.
13. Habitat coverage	Definition for different habitats included. Different types of heath?
14. Is lowland heathland included?	If so, what definition is used?
15. Details of all variables recorded	Full description of how the data are recorded in the field and coded in the data set. Are classifications or groupings employed? Classes used and any assumptions/conventions followed.
16. Variables for location, time, extent, cause, and severity of fire damage	Specific details for variables that are especially important to this study
- **fire location/site**	If fire records refer to a site does this mean the entire site or a portion?
- **National Grid Ref (centroid, point)**	How the locations of points or areas are recorded
- timing	Recording of dates, and start and end times for fires
- **weather conditions**	What weather variables are recorded
- **boundary i.e. extent**	How the boundaries of areas are recorded How and what the units of measurement are.
- **fire maps**	Available or not. What scale?
- **cause or causes**	Type and strength of evidence available
- **fire type/intensity**	Are different types of fire distinguished?
- **nature/severity of ecological damage**	What information on ecological damage is recorded?

III. ACCESS DETAILS

17. Name of data holder(s)	Name and address of organisation holding/supplying data
18. Contact person	Name of contact person
19. Postal address	
20. Email address	
21. Internet address	URL for organisation URL for data
22. Access terms	Terms by which data are made available:
23. Copyright	Data subject to copyright?
24. Constraints on use?	
25. Data format	Give approximate proportions for each and indicate where the same data are held in more than one format: Tabular Report Maps Record Cards.
26. Are data available digitally:	No ☐ Yes ☐ Please answer i-iv
i Platform on which held	PC ☐ MAC ☐ UNIX ☐ - type..... Other ☐
ii Digital file formats available	
iii Indicative size of data set (MB)	
iv Supply media	
27. Accuracy/quality assurance measures used	Standard or special methods employed e.g.: Completeness - omission and/or commission Thematic accuracy - e.g. standard classifications Temporal accuracy - e.g. time recordings Positional accuracy - absolute (NGR) and/or relative (other features) Logical consistency - topology and/or attribute relationships (positioning of GIS layers)
28. Data security procedures	Describe measures for both digital and paper records
29. Supporting documentation:	Please indicate what documentation is available and give title/reference:

User manual ☐ _____

Data definitions ☐ _____

Data lineage/version ☐ _____

Other - please specify ☐ _____

IV. FUTURE OPTIONS

30. Do the data you gather meet your information needs?	
31. If not what other variables/information would you find useful?	
32. How are the data shared within and between organisations?	
33. What are the plans for on-going data collection?	
34. Any other information	

V. AVAILABILITY FOR THIS PROJECT

35. Are these data available for this project?	
36. If so, what is the best way of making these data available?	
37. Will there be conditions attached to data release?	

END - Thank you for your help in this project

APPENDIX 2 – IT EVALUATION QUESTIONNAIRE

EVALUATION OF IT SYSTEMS IN PARTICIPATING ORGANSIATIONS

A Contact	
1. Name of organisation	
2. Contact person	
3. Postal address	
4. Email address	
5. Internet address	
B Hardware	
1. What is your dominant processor architecture e.g. 80486, Pentium	
2. What are the main operating systems your use, tick all used and ring the most common.	Win 3.x ☐ Win 9.x ☐ NT 3.5x ☐ NT 4 ☐ Mac. ☐ Unix ☐ Other……
3. Do you have internet access?	By network connection: By modem dial-up:
1. What web browser software do you use? (Major type, version)	Internet Explorer: Version: Other: Version: Netscape Navigator: Version:
C Data	
1. Do you store your data electronically?	Yes Go to Q2 No: Please describe, then go to end.
2. What software do you mainly use to store your data? E.g. MS Access, Lotus 123. Please describe type and version.	
3. If you use a database do you store your data in single tables or in relational tables?	
4. Do you use standard terms for data entry?	

APPENDIX 3 – Mock-up of verified fire record

Heathland Fire Incident Record

ID: 0098

incident code: AS234

Heath Name: Wortley Burrows

Fire Date	Fire Time
Start: 12 05 1999	12:05
Stop: 12 05 1999	17:30

Area of burn: 89 (Office use: 89) Units: ha ☐ m² ☐ acres ☑

Grid Ref: TL895645 (Office use: TL895645)

Possible Cause: Barbecue

Validator: A. Warden

Recorder Details:

Full Name:

Organisation: DFRS

Address:

Post Code:

Contact ☎

Area Code: 0 0 0 0 0 0

Number: 0 0 0 0 0 0 0 0 0 0

Incident Report

	0	10	25	50	75	90	100	N/A	Dead	injured	Note
Ground layer				✓							
Shrub layer						✓					Extensive gorse damage
Standing trees		✓									Large oak burnt down
infrastructure											
birds					✓				4		Jackdaw nests destroyed
herpetafauna			✓								Small pond damaged
insects											
aquatics											
flora											
Critical Species: Sylvia undata				✓							Nest site destroyed
Critical Species: Dorset heath					✓						Large stand burnt

Minor Severe Extreme

Additional Information

Public/agencies attending the fire

Description of site prior to burn

Management implications

Public injuries/near misses

Weather

Notes / Sketch

Guidelines for completion

The form overleaf is to be used for recording the details of a fire incident on heathland. Fires will normally be reported by the Dorset Fire Service in the first incidence. Each record will then be validated and augmented by a site manager. Certain fields are for administrative uses and should not be completed.

Incident code: The fire incident code as given by the fire service
Heath Name: The name of the heath. The complete list of recognised heath names can be obtained from the Dorset Env. Record Centre. If the official name is not known, please use a name by which the heath is known.
Fire Date: The start date is required. If the start time is known please provide. If the end date and time are known please provide.
Grid Ref: The grid reference of the centre of the fire incident. This should be as accurate as possible (6-8 figure)
Area of burn: The extent of the fire (preferably in m^2) if other units are used please indicate in **Units**
Possible Cause: Please indicate the probable cause
Recorder Details: Please provide your contact details.
Validator: For administrative purposes

Incident Report
The purpose of the incident report is to record the effect of the fire on fauna and flora. Please indicate where relevant the proportion of the natural feature that has been affected by fire. For flora the proportion of the feature destroyed should be recorded. If none of the feature has been affected tick "0". If all of the feature has been affected tick "100". If the feature is not present, tick "N/A". For certain features record the number of individuals killed or injured by the fire (e.g. standing trees, fauna). If the proportion of a faunal community destroyed is known, please indicate as for flora. Record any specific observations in the notes field provided.
Please record any specific / critical species affected.

Additional Information: Please record, where relevant, information in the spaces provided.

Weather: Please note the nature of the prevailing weather. If possible/relevant provide an indication of cloud cover, precipitation, wind speed, temperature and humidity.

Notes / Sketch: This space is provided if you wish to record any additional information or sketch the incident (e.g. record specific damage to stands of vegetation, infratructure, etc.

APPENDIX 4 – ECOLOGICAL ASSESSMENT OF FIRE IMPACTS

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A4.1 Classification of fires

Heathland fires may be broadly classified as follows:

1. Set Fires
   - 1.1 Controlled or prescribed fires
   - 1.2 Malicious fires
2. Fires not set
   - 2.1 Accidental fires
   - 2.2 Wildfires

The characteristics of these fires are summarised below in Table **A41.1** and described in detail below.

Table A41.1: Fire characteristics matrix.

	Fire type			
Characteristic	**Controlled**	**Malicious**	**Accidental**	**Wildfire**
Lit	Deliberately (i.e. for a reason)	Deliberately	Accidentally	Accidentally
Timing	Chosen	Chosen (but not by managers)	Not chosen	Not chosen
Area burnt	Controlled	Variable	Variable	Variable
Intensity	Controlled	Variable	Variable	Variable
Effects	Controlled	Variable	Variable	Variable

A4.1.1 Controlled or Prescribed Fires

Controlled or prescribed fires are lit deliberately at a chosen time, under defined conditions, and with the aim of producing a defined result. These fires are lit in order to manage heathland vegetation for grazing or for conservation. By law, prescribed fires are only permitted during the period between 1st November and 31st March and outside of this period a licence is required from the Ministry of Agriculture, Fisheries and Food. Some researchers have questioned whether or not fire behaviour can be defined precisely enough in management prescriptions to produce the consistent ecological effects called for in conservation management plans (Jonson & Miyanishi, 1995).

Controlled or prescribed fires are a traditional method for the routine management of heathlands and the procedures involved have been well described (Gimingham 1992; Webb 1997). This type of management has been in decline for a long time. In his 1962 paper on the conservation of the Dorset heaths, Moore said 'Probably the most important ecological effect of the decline in rough grazing has been the virtual extinction of controlled burning that used to accompany it'.

In 1960 about 8% of the heathland was burnt annually (Moore 1962). The three surveys (1978, 1987 and 1996) which make up the ITE Dorset Heathland Survey show that fires have decreased over the last twenty years. In the1978, 945ha of the area of the Dorset heathlands was recorded as burnt during the two years before the Survey, In 1978 the annual burning rate was 6% of the total area of heath in Dorset. By 1987 it had declined to 2.4%, and by 1996 to 0.6% (see Webb & Haskins 1980; Webb 1990; Rose et al. 1999 in press). There are no data that enable us to apportion these fires between prescribed burning and other types of fire. It is thought that, at the present time, prescribed fires form a small proportion of the total area burnt annually.

The decline in burning has undoubtedly been one of the factors leading to an increase in the growth of scrub on the Dorset heathlands as a whole. Recently, habitat management schemes have been introduced as a conservation measure to compensate for the decline in traditional management. Free-range grazing (mostly cattle and ponies) has been introduced on a number of nature reserves. This type of grazing, which in the past would have been coupled with controlled burning, may maintain existing open heathland, but will not recover areas invaded by scrub. To return these areas to heathland may require scrub control before grazing is introduced.

During the very dry summers of 1975 and 1976, 775 ha (9.8%) of the Dorset heathlands were burnt. The occurrence of these large fires led to the introduction of stringent protection measures and a reduction in burning. As a consequence, at the present time, these heaths carry extensive areas of mature heather and scrub, which increases at an annual rate of 1-2% (Rose et al., 1999 in press). This vegetation provides a greater quantity of fuel, and when fires occur they are hotter and more intense (Allchin 1997). The increased temperatures attained during these fires may impede the recovery of heathland vegetation and result in the establishment of an increased number of invasive species.

Management by rotational burning is a feature of upland moorlands in northern Britain but is seldom used on lowland heathlands. It is one of a number of options for the management of a heathland and its use depends on the conservation objectives of the site concerned. On many sites its use will be inappropriate while on others only part of the site may be managed in this way. This type of management produces a mosaic of differently aged heather and the varying structure of the vegetation reduces the risk of uncontrolled fires. The choice of rotation can from 15 to 25 years. It should be noted that the capacity of the Calluna plants to regenerate diminishes with age, and the rootstocks are more likely to be killed by the fire in stands older than 20 years.

Burning for conservation management, whether as part of a rotation or not, should generally take place in late February or early March when the vegetation has thoroughly dried out over the winter. This type of fire will arrest succession by removing scrub and other woody vegetation, which may have invaded the open heathland (Gimingham 1992). The regular burning of heathland prevents the establishment of areas of continuous scrub. Once established these areas of scrub may be difficult to return to heathland and when burnt tend to regenerate as scrub (Bullock & Webb 1995).

Fires are also important in depleting the nutrient content of the ecosystem, which promotes a heathland community. Nitrogen and phosphorus are easily lost in the smoke or by leaching of the ash (Allen 1964; Chapman 1967). It is particularly important to maintain a low phosphorus status: this can be achieved by managed burning which removes the standing vegetation and uppermost litter layer.

In most managed fires the aim is to remove all the above ground vegetation but very little of the litter. By leaving the litter, the rootstocks are protected and this enables re-sprouting to occur from the stem bases. To ensure a 'clean burn' in which all of the above ground vegetation is consumed, fires are often burnt into the wind (back burning). Regrowth from the stem bases of Calluna occurs rapidly with this type of fire and there is a good growth of the plants within 2-3 years.

Any form of rotational management, be it cutting or burning, implies that the local extinction of species (i.e. at the patch scale) will occur and that re-colonisation will take place from surrounding areas. A heathland managed on a 25-year cycle will be a mosaic of differently aged stands of Calluna each of which has a characteristic flora and fauna. By planning the burning programme, areas of different ages can be produced side-by-side so that the species from the entire heathland succession are maintained.

At present, 4% of the total area of heathland in Dorset (295 ha in 1996) should be burnt annually to maintain a 25-year cycle. This rotation would result in a number of stands of different ages of which 20% was either bare soil or in the post-burn or pioneer phase, 40% building phase and 40% mature heathland. Data collected during the Dorset heathland Survey show that in each of the three survey years (1978, 1987 and 1996) the

proportion of mature heath was considerably higher than the theoretical ideal. In the 1996 Survey the proportions of the different age classes of heath indicated that the Dorset heaths, as a whole, were following a 60-year burning cycle. This cycle assumes that each area is burnt in strict rotation. However, most of the fires that occur today are not controlled but are malicious, accidental or wildfires. These fires tend to be most frequent on the heaths in the urban fringes: a factor that distorts the calculation. These heaths are burnt on a very short cycle and on the rural heaths the rotation is now well in excess of 60 years (Rose et al., 1999 in press).

A4.1.2 Malicious Fires

Fires of this type vary in intensity, tend to run with the wind and may cover large areas, in some instances burning an entire heathland. These fires can occur at any time of the year but occur mostly during two periods. The first is in the late spring when the vegetation has dried out over the winter and before the new growth appears. The second, which is particularly important in dry years, occurs in the summer (July-September). From a conservation point of view, these fires are usually at the wrong time of year and are likely to have adverse effects on reptiles, nesting birds, insects and other taxa. Where there is a high incidence of these fires, there may be changes in nutrient dynamics and competition between plant species, which lead to vegetation change and the loss of heathland species.

The fire risk increases with vegetation age because old stands contain a much greater fuel load. In malicious fires the amount of vegetation burnt varies. Sometimes these fires burn only through the canopy but where there is a high fuel load and very dry conditions hot fires can result. This will frequently kill the *Calluna* plants and may result in the burning of the litter and upper (organic) layers of the soil. When this occurs, regeneration will often be from seed and is much slower than regrowth from the stem bases. The successful germination and establishment of the *Calluna* plants will depend on the weather conditions in the years following the fire. If a large area of heathland is burnt re-colonisation may be slow, especially for less mobile species. Where an entire heathland is burnt recovery may be both slow and incomplete because there is no near-by heathland to provide colonists.

Malicious fires often occur on the heaths near to housing and result in some heaths being burnt too frequently. If heaths are burnt frequently (less than every 8 years) dwarf shrub vegetation diminishes and is replaced by grasses, ruderal species and scrub.

A4.1.3 Accidental Fires

These fires are not lit deliberately but usually arise through carelessness such as bonfires getting out of control, discarded cigarette ends, vehicles, loss of control during controlled burning, etc. Their characteristics, effects and consequences are similar those of malicious fires.

A4.1.4 Wildfires

These must be considered a possibility but must be very rare with lightening strikes being the main cause. Their characteristics, effects and consequences are similar to those of malicious fires although their occurrence is likely to be restricted to the driest times of the year.

A4.2 Risk of Fire

A number of factors contribute to the risks that a given area of heathland can catch fire. These factors include:

i) Fuel load

The vegetation on the heath constitutes a fuel load. There are two types of fuel, living fuel in which the moisture content is constant, although there may be season variations, and dead fuel in which the moisture

content varies with atmospheric moisture. The size of both types of fuel load will depend upon the age, structure and composition of the vegetation. Many of the species growing on heathland are highly combustible due to the oils contained in their leaves and stems. Heathers (*Calluna vulgaris* and *Erica* spp.) and gorses (*Ulex europaeus, U. minor,* and *U. gallii*) are particularly inflammable. However, at certain times of the year accumulations of dead grass and other herbaceous species add to this fuel load.

The fuel load is affected by the age of the plants. Young plants with a small biomass provide little fuel, but mature, woody plants constitute a much larger fuel load. However, the intensity of a fire resulting from a greater fuel load may be modified by the structure of the vegetation. Very young heathland vegetation is sparse and will not carry a fire. Similarly old, degenerate heather and gorse tends to have an open structure and, in spite of a large fuel load, does not always carry a fire well. Mature vegetation with a closed canopy and a high fuel load tends to produce the most intense fires. Dry heath vegetation burns more easily than wet heath, which contains smaller plants and has a more open structure.

ii) The season of the year

Although evergreen, heathers and gorse are dormant during the winter. At this time the plants contain less sap and are more combustible. Their combustibility increases during dry periods in the winter. Grasses such as Purple moor grass (*Molinia caerulea*), which are deciduous, accumulate large amounts of dry dead material during the winter months. Regrowth in the spring on heathlands is often quite late and it is seldom before May that new growth appears. This results in a long period in the spring, which is often dry, and when the risk of fire is high.

iii) The weather

Weather tends to be linked with season. In the late winter and early spring (late February and March) the weather is often dry and frosty resulting in low humidity. At this time of year the risk of fire is high. However while the above ground vegetation is highly combustible at this time the litter and upper organic layer of the soil are often damp. Fires occurring at this time usually only burn the above ground vegetation and do not affect the litter. This in turn affects the regeneration of the heathland.

In some years very dry periods occur during the summer and again there is a high risk. During these periods the litter and upper soil layers also dry out and fires at this time not only burn the vegetation, but in severe cases, may burn the litter and upper soil layers. This adversely affects regeneration especially as rootstocks may be killed and the seed bank destroyed.

At other times of the year it is usually difficult to burn the vegetation because it is too wet.

iv) Wind strength and direction

Wind strength and direction are important factors determining the course of a fire. With the exception of prescribed fires, all other types of fire tend to run with the wind. The speed with which the fire moves through the vegetation depends on the strength of the wind. Where the wind is strong the fire may move quickly through the canopy of the heather plants and unburnt stems and other material may be left. On other occasions with a strong wind, under dry conditions and a large fuel load the fire may burn intensely with high temperatures being reached. Under these conditions almost all of the vegetation and often the upper litter and soil layers may be burnt. The interplay of wind strength, moisture content of the vegetation and fuel load make it difficult to predict the consequences of a particular fire. There tends to be a seasonal pattern to wind strength and direction (Kirby & Tantram 1999b). South westerly winds, although strong, may often be accompanied by moist conditions. Winds from an easterly quarter, which occur in spring, are often accompanied by dry conditions in the vegetation. Again, there tends to be a diurnal variation in wind strength and direction with off shore winds developing in the afternoons. Both the season and diurnal pattern of winds require further investigation in relation to the occurrence of heathland fires.

v) Human disturbance

Uncontrolled access to open heathland by people often constitutes a significant risk. However, in some cases, the presence of large numbers of people, as at Studland Heath, helps protect the heath with reduced likelihood that fires will be started maliciously and when they do occur they are detected quickly.

A4.3 Severity of fire

The severity of heathland fires depends on a number of inter-related factors that include,

i) Fuel load

Fuel load varies with age (time since last fire) and vegetation type (wet heath will have a much lower fuel load than dry heath or scrub) (see comments above).

ii) Combustibility of vegetation

This varies with season and species composition.

iii) Fire temperature and duration (intensity)

Both depend on the fuel load and weather. Weather conditions both at the time of the fire and in the preceding weeks or months are important.

iv) Wetness of vegetation

If the vegetation is wet it will not burn. When the vegetation is growing it contains a high proportion of sap and will not burn. If the soil moisture content is high, soil temperatures are less likely to rise, but under dry conditions fires may burn the upper litter and humus layers. This helps remove nutrients from the system but also depletes the seed bank.

A4.4 Assessment of fire severity

The severity of a fire is not easy to quantify. One of the principal difficulties is lack of information about most sites before they are burnt. The severity can be expressed in physical terms such as fire duration, temperature and intensity. These factors would need to be measured during the fire and are therefore impractical. Consideration could be given to a simple recording protocol to be used where members of the conservation staff attend a fire. They could report on the starting time and duration of the fire, a simple description of the vegetation burnt, the characteristics of the fire (e.g. a subjective assessment of fire intensity, wind speed and direction), the dampness of vegetation, and the weather in days or weeks before the fire. These details could be completed at the time of the fire or just afterwards. Some of the factors could be recorded using a simple scoring system e.g. a scale of 1-5. Trained conservation staff with knowledge of the habitat and species involved would be needed to make such an assessment.

The initial rapid assessment could be followed by a more detailed survey of the burnt area. Again, this would require trained conservation staff. This assessment would consider the ecological effects of the fire. The aim of this record would be to assess the severity and damage caused by the fire. The record should be made in a way that provides a baseline against which recovery can be judged.

An assessment immediately after a fire could include the following factors. Most are qualitative but some could be recorded on a simple scoring system:

i. Whether all the above ground vegetation has been burnt or whether some remains. To some extent the material remaining will depend on the structure and composition of the vegetation before the fire, which may not be known.

ii. Degree of charring of Calluna stems/ grass tussocks are possible measures (score).

iii. Whether humic soil layers have been burnt or mineral soil exposed (score). This has important consequences for regeneration and nutrient dynamics. Procedures exist for estimating the organic matter present in the soil (see Roze 1989: Forgeard & Frenot 1996).

iv. Degree of damage (charring) to mature trees (score).

v. Size of burnt area (measure/estimate in ha).

vi. Location of burnt area in relation to surrounding heathland (use of GPS techniques).

vii. Size (ha) degree of isolation of heath on which fire occurs – small isolated heaths may lack a source of colonists (use of GPS/GIS).

viii. Known site for critical/notable species – requires list of critical species and as far as possible maps of their distribution, which need to be up to date; this information could form a layer in a GIS for the Dorset heathlands.

ix. Frequency and extent of previous fires. Sites, which are burnt frequently i.e. within eight years of a previous fire, are likely to lose heathland characteristics. Sites burnt very frequently will tend to develop vegetation dominated by grasses, ruderal species or scrub and loose heather and associated species.

Assessments carried out later and related to the time which has elapsed since the fire could include other factors such as:

i. Whether regeneration of dwarf shrubs is from stem bases or from seed. Where regeneration is from seed this may not occur in the first season.

ii. Rate of re-sprouting from stem bases. Here the number of stem bases re-sprouting as a proportion of the total could be estimated.

iii. Density of seedling germination and, in the longer term, rates of establishment (difficult to measure).

iv. Presence and density of ruderal or invasive (and probably undesirable) species.

v. Loss or return of critical species known to be present before the fire.

vi. Any post burn management or restoration.

The presence or absence of critical species requires a much better knowledge of their distribution than we have at present. This is an additional task that will require resources.

A4.5 Nature of disturbance

Disturbance to plant and animal communities is not easy to quantify. Most assessments are usually qualitative and are similar to assessments of fire severity.

Fires on heathland are likely to result in the following effects:

i) Nutrient loss.

This is generally a good thing because it depletes nitrogen and phosphorus held in the ecosystem. However, nutrient loss cannot be measured directly and usually there is no information about the nutrient status of a heath before it is burnt.

ii) Litter loss.

Burning the upper layers of the litter may result in a loss of the seed bank (see below) and in the loss of nutrients. In some instances, the loss of the seed bank may affect the regeneration of the heathland.

iii) Seedbank loss.

Much of the seedbank is in the litter. Calluna seed, which is abundant and long-lived, also occurs in the upper layers of the soil. Even when the litter layer is burnt there is generally sufficient seed in the upper layers of the soil to ensure regeneration. Much less is known about the seedbank of associated species. They may be much less abundant and the little evidence we have suggests they persist for <5 years. Repeated burning at short intervals may deplete the seed bank of heathland species if not of dwarf shrubs.

iv) Heather rootstocks killed.

This is to be avoided but it may occur during hot fires. In these circumstances regeneration is from seed and is very much slower. There are risks that other species may invade the community.

v) Trees killed.

Generally, the destruction of trees and other woody vegetation will be regarded as beneficial to heathland management.

vi) Direct losses of critical species.

Reptiles, birds (nesting sites), invertebrates, higher and lower plants may be affected. Where these species are characteristic of the later stages of the heathland succession they are likely to be absent from the community for a considerable period of time.

vii) Erosion of soils/peat.

This damage is most likely when the litter layer has been burnt. Erosion will hinder regeneration and may affect the direction of the succession after the fire.

viii) Invasive species.

Some species such as Rosebay (*Chamerion angustifolium*), or the moss *Campylopus introflexus* will be temporary. Others species (e.g. birch and scrub) may not be unless there is targeted management. The reduction in competition from heathland species enables these species to become established. It should be borne in mind that heathland will not return immediately after a fire. The pioneer stages of heathland regeneration are often dominated by other species such as Bristle bent (*Agrostis curtisii*) which diminish over a period of up to eight years as the heather plants re-grow. Instant heathland is not possible after a fire. Furthermore, the early stages of heathland succession have their own intrinsic value and a number of species of conservation interest (e.g. *Aculeata*, *Hymenoptera*, ants, spiders) are dependent on this stage and are absent from mature heathland. In some cases, bracken may increase in abundance after a fire. Good quantitative information on this point is lacking. Most observations are anecdotal and there is little information on whether this bracken (*Pteridium aquilinum*) maintains its dominance or declines as the heather and associated species recover.

A4.6 Nature of recovery

Timing of fire may influence the rate of recovery (as in Rose & Webb 1994). Generally speaking, regeneration is best from fires and other types of disturbance, which occur in the spring while the plants are still dormant. Where fires or disturbance occur in the summer and early autumn regeneration is often poorer and slower as the plants have much less time to recover before the onset of winter. Recovery is influenced by the age of the original vegetation (old *Calluna* plants do not re-sprout as vigorously as younger plants).

The success of the regeneration/recovery could be judged by:

i. Re-establishment of original vegetation if known or the establishment of an appropriate type of heathland vegetation.

ii. Presence of key species or loss of critical species known to be present before the fire.

iii. Whether regeneration of dwarf shrubs is from stem bases or from seed –hence the likely time that recovery will take

iv. Rate of resprouting from stem bases.

v. Density of seedling germination and, in the longer term, rates of establishment; however, this is difficult to measure.

vi. The presence of ruderal or invasive species that are judged to be undesirable.

Some areas burnt may not have been prime examples of heathland in the first place. On these areas there may be an opportunity to restore heathland and this should be considered when planning the management of the site after the fire.

A4.7 Suggestions for further work

Fire has been a traditional part of heathland use for many centuries, nevertheless, its use in conservation management needs to be assessed carefully. On some sites, today, fire may not be the most appropriate form of management to achieved desired conservation ends. Furthermore, an excessive number of unplanned fires may be harmful to a site and control of these is an essential part of a conservation plan.

As fire behaviour is so variable, it is difficult to predict the ecological consequences of a particular fire. There is a body of research relating to heathland and moorland management by burning. Most has been directed at the specific aim of producing heather to feed sheep and grouse. We are not in a position to specify in detail how fire may be used in conservation management. We lack rigorous experimental studies that will enable us to plan the use of fires in conservation to achieve specific aims. There is a need to achieve consistent results if fire is to be used as a management tool. In Dorset, most information on fires, particularly malicious, accidental and wildfires, is anecdotal, and there has been almost no quantitative assessment of the effects. The relative contribution of fire compared with other consequences of public pressure (damage to vegetation, eutrophication, elevated temperatures in urban areas, etc) has not been measured.

The study in this report has provided a preliminary summary of the relationships between fire frequency and weather (wind, precipitation) and described its seasonal and diurnal patterns. However, our understanding of how fuel load, vegetation composition and fire intensity affect vegetation and succession is limited. In particular, we have no information on whether or not heaths return to their former or to an acceptable condition following fires. This would require studies of longer duration than hitherto. An analysis of the existing long-term data sets forming the Dorset Heathland survey would provide some insights in to this problem.

The regeneration of a heathland after a fire depends on the availability of propagules, germination, establishment and survival of heathland plant species. Studies of the effects of heathland fires on seed banks and the conditions for germination and establishment of heathland plants are needed.

The invasion of burnt heath by unwanted species (in a conservation sense) is also a poorly developed subject and experimental studies on invasive species (e.g. bracken) and their control is needed.

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