Aerial Survey for Archaeology

Report of a British Academy Working Party 1999. Published 2001

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Abbreviations used in the text

CBA - Council for British Archaeology

CUCAP - Cambridge University Committee for Aerial Photography

EH - English Heritage

MARS - Monuments at Risk Survey

NAPLIB - National Association of Aerial Photographic Libraries

NMR - National Monument Record

RCAHMS - Royal Commission on the Ancient and Historical Monuments of Scotland

RCAHMW - Royal Commission on the Ancient and Historical Monuments of Wales

RCHME - Royal Commission on the Historical Monuments of England

SMR - Sites and Monuments Records

UK - United Kingdom

Foreword

Early in 1999, Section H7 (Archaeology) of the British Academy discussed the current position of Aerial Survey in British archaeology. A number of changes in the organisation of Aerial Survey had been proposed and in part implemented by various agencies, and the Section considered it timely to examine the implications of recent developments. New technologies for Aerial Survey and for access to the Photographic Records had emerged in recent years both in the UK and abroad, and a number of significant advances had been made. The Section proposed that a small Working Party be set up to consider the current position and to make suggestions for future work.

The Working Party included representatives of Aerial Survey practitioners in England, Scotland and Wales, with Dr R H Bewley as Convener. Contacts were made with the Royal Commission on the Historic Monuments of England (merged with English Heritage on 1 April 1999), the Royal Commission on the Ancient and Historical Monuments of Scotland, the Royal Commission on the Ancient and

Historical Monuments of Wales, the Environment and Heritage Service for Northern Ireland, and the Cambridge University Committee for Aerial Photography. Informal discussions were held with the Council for British Archaeology in the light of its proposed review of Aerial Archaeology in the UK.

This Report to the Academy has been complied by Dr R H Bewley for the Working Party and is presented as a document for debate as well as a statement of the current position.

John Coles, FBA
Chairman, Working Party

Introduction

At the request of the British Academy Archaeology Section a working party on Aerial Survey in the UK was set up in May 1999 [note 1]. The aim of the working party was to prepare a report on the current position and potential future of Aerial Survey for archaeology [note 2]. There were three main reasons for the review:

- the merger between the Royal Commission on the Historical Monuments of England (RCHME) and English Heritage (EH),
- the proposed changes to the Cambridge University Committee for Aerial Photography (CUCAP) and
- the possible consequences of devolution in Scotland and Wales.

The working party produced a report which forms the basis of this publication. The reason for giving the report a wider circulation is to stimulate debate and interest in Aerial Survey for archaeology. The British Academy also sponsored a conference on Aerial Archaeology - into the future in May 2001, to assist with raising the profile of the subject.

For the purposes of this report Aerial Survey is seen as a ***process*** involving:

- discovering new sites and landscapes by taking photographs from the air,
- cataloguing, archiving and making these photographs accessible,
- creating maps and records based on aerial photographs and linking these with information derived from other sources,
- analysis and synthesis leading to the publication of these survey results,
- definition of revised objectives.

The recent changes in organisation outlined above and the need to integrate Aerial Survey with other disciplines in archaeology have wider implications and raise the following questions:

- Do the resources devoted to Aerial Survey in the UK meet the needs of archaeological institutions to further the understanding of the historic environment and to assist in its future conservation and protection?
- Does Aerial Survey form part of an integrated strategy for archaeological survey and management in the UK?
- Are there sufficient trained personnel to carry out all these activities, and is there a resource to create a training programme to meet the needs of aerial survey for archaeology?

Figure 1: *Distribution of oblique aerial photographs held in the National Monuments Records for England, Scotland and Wales. (© Crown Copyright)*

This report has been compiled as a position statement for the British Academy and to promote debate to provide solutions for these challenges. Many archaeologists (let alone the general public) do not appreciate that over 50 percent of all archaeological sites recorded in the UK are known from aerial evidence. The distribution of aerial photographs taken for archaeological and historical purposes, and held in the national collections of England, Scotland and Wales is published here for the first time (Figure 1) [note 3].

1. Members of the Working Party: Professor J M Coles (Chair), Professor B W Cunliffe, Dr K Pretty, Mr R Mercer, Mr C R Musson, Dr R H Bewley (Convener).

2. Informal discussions with the Council for British Archaeology (CBA) on future strategies and the CBA's proposed review of Aerial Archaeology also took place.

3. For a distribution of the CUCAP photographs, see Whimster 1983. Many of the CUCAP photographs are also held in the national collections.

Scope of the report

This report covers the UK and provides a rapid overview of the current strategies and resources available for Aerial Survey during the three-year period 1996/7 to 1998/9, including the balance of work between local flyers and those working for national organisations. It is not concerned with the details of methodology but more with approach and intent. Each country and institution is dealt with under a separate heading in as consistent a manner as possible, the currently available resources are set out in Table 1. Reports were received by the working party from English Heritage, RCAHMS, RCAHMW and the Environment and Heritage Service for Northern Ireland. The main points have been summarised below, and the full reports are published here as Appendices 1-3 (with Northern Ireland's included in the main text).

Table 1

YEARS		MAPPING		RECONNAISSANCE			
		Area mapped (sq km)	Resources (Staff FTEs)	Hours flown	Sorties	Targets	Aircraft costs (£K)
England	1996/7	2,225	20	235. 9	63	2,407	40
	1997/8	1,250	18. 5	260	68	2,195	46
	1998/9	2,225	17. 5	296	79	1,952	47
Scotland	1996/7	}	0. 6	120	45	1,765	22
	1997/8		0. 6	101	39	1,111	22

	1998/9	} c. 1,000 }	0. 6	109	47	1,100	22
Wales	1996/7	814	1	62. 5	40	1,324	21
	1997/8	170	1	17	11	650	20
	1998/9	40	1	50	26	1,000	18. 5
N Ireland	1996/7	0	0	7. 5	3	115	1
	1997/8	0	0	7. 5	3	115	2
	1998/9	0	0	3	2	70	0. 5
Total		7,724	60. 8 (or £1. 2 million)	1269. 4	426	13,804	261

England (RCHME/EH)

Aerial Reconnaissance

English Heritage's strategy for aerial reconnaissance aims: 'to identify and record, using aerial photography, the remains, existence and current condition of archaeological and architectural sites throughout England, and thus to increase our understanding of the historic environment. '

This strategy will be implemented through EH staff in Swindon and York and via the network of locally based flyers. The aims for reconnaissance will be achieved through co-ordination of staff based in the national organisation and by providing funds and training for locally based flyers. In the period 1996-98 funds for locally based flyers were almost non-existent but merger between RCHME and EH has provided the opportunity to return to a more appropriate level of funding. A programme for monitoring scheduled ancient monuments from the air has been running since 1997. Figure 2 shows the distribution of RCHME/EH aerial surveys over England 1997-2000.

Figure 2: Distribution of RCHME/EH aerial reconnaissance surveys April 1997-March 2000. This excludes locally based flyers who undertook work in Devon, Essex, Northumberland and the Welsh borders. (© English Heritage)

Mapping, Interpretation and Publication

Since 1992 the approach of the RCHME (and now English Heritage) has been to develop a methodology to map and create records for all archaeological sites visible on aerial photographs at 1:10,000 scale. This project is referred to as the National Mapping Programme (NMP), (Bewley 1998). NMP draws on all the information from existing records and utilises all available photographs (verticals and obliques). The main source of photographs is English Heritage's National Monuments Record in Swindon. Since 1988 over 32,000 sq km or c. 25 per cent of England has been mapped in over 20 separate projects. Currently projects are undertaken in the EH offices in Swindon and York and four external projects, funded and monitored by EH in Cornwall, Essex, Northamptonshire and on the Norfolk and Suffolk coast (Figure 3). An accelerated programme for NMP is being implemented by English

Heritage with the expectation of completion of the initial phase of the programme within twelve to fifteen years (c. 2012).

Figure 3: Progress of EH's National Mapping Programme to 31 March 2000. (© English Heritage)

Each NMP project produces transcriptions of archaeological features in digital form (at a nominal scale of 1:10,000), text records for each site, and an internal report. Where possible a monograph, book, or journal article is also published (cf Bewley 1998, Carter 1995, Crutchley 1997, Fenner & Dyer 1994, Horne & MacLeod 1995, Jones 1998, Kershaw 1997, MacLeod 1995, Small 1999, & Stoertz 1997).

Scotland (RCAHMS)

Aerial Reconnaissance

Aerial photography has been carried out in Scotland by the RCAHMS since 1976 and operates from one centre, Edinburgh. There are also local flyers, partly funded by the RCAHMS. The objectives of the RCAHMS Aerial Photographic Section are as follows:

- to survey, record and document the man-made environment of Scotland through aerial reconnaissance,
- to comprehend the significance of the aerial evidence.

Figure 4 shows the distribution of aerial surveys carried out by RCAHMS from 1997-99. This demonstrates the practical difficulties of achieving national coverage for reasons of distance, terrain, weather and military zones as well as the priorities for reconnaissance over the past twenty years. Catalogues for each year of flying have been produced since 1976 and are published up to 1994 (RCAHMS 1999). A review of their production is in progress and Internet publication is being explored.

Figure 4: Distribution of aerial surveys in Scotland 1997-99. (© Crown Copyright: RCAHMS)

Mapping, Interpretation and Publication

Approximately 1,000 sq km of Scotland has been mapped from aerial photographs. Figure 5 represents the individual cropmark site transcriptions computer rectified at 1:2,500 scale. Areas targeted by RCAHMS for survey include east Perthshire, north-east Fife, west Wigtownshire and eastern Berwickshire. Transcription is also carried out in areas where sites may be affected by development proposals as part of monument protection. The transcription programme is designed to promote the comprehension and analysis of the archaeological information; it forms a layer in the RCAHMS' GIS. Ground-based survey, throughout Scotland, integrating information from vertical and oblique aerial photographs (producing 1:10,000 scale mapping of archaeological material) currently focuses on areas with a potential for afforestation. The information recorded can be accessed via the National Monument Record for Scotland (NMRS) and its GIS. RCAHMS publications have used the results of aerial survey extensively, the most recent example being Eastern Dumfriesshire: an archaeological landscape (RCAHMS 1997).

Figure 5: Distribution of individual sites mapped at 1:2,500 scale in Scotland. (© Crown Copyright: RCAHMS)

Wales (RCAHMW)

Aerial Reconnaissance

Aerial survey has been carried out in Wales since 1986 and Figure 6 shows the distribution of RCAHMW flying from 1996/7 to 1998/9 (along with grant-aided flying by the Welsh Archaeological Trusts for 1999). For 2000/2001 there has been an increase in budget for the RCAHMW central flying but a slight decrease of funding to the Trusts (in contrast to the previous year where the opposite was the case). The RCAHMW flying programme has successfully carried out a programme of monitoring of Scheduled Ancient Monuments from the air since 1992, a process which has now been adopted in England. The RCAHMW Corporate Plan states that Aerial Survey should 'enhance the NMRW by conducting programmes of prospection' and should 'support all other areas of RCAHMW archaeological, architectural and industrial survey'.

Figure 6 (a): Distribution of aerial reconnaissance surveys in Wales 1998/9 and (b) 1999/2000

Figure 6 (b): Distribution of aerial reconnaissance surveys in Wales (a) 1998/9 and (b) 1999/2000.

Mapping, Interpretation and Publication

The RCAHMW Corporate Plan states that Aerial Survey should 'add to the value and use of air photographs by means of enhances interpretation and where appropriate, rectification'. From Table 1 it is clear that resources dedicated to mapping in Wales are limited but much has been achieved, especially in developing a methodology and for applying it to upland landscapes and areas of extensive cropmark evidence (Driver 1995, 1996, 1998 a-c). Revised approaches to funding work by the Welsh Archaeological Trusts (transferring funding from mapping to flying in 1999) and a focus on the Uplands Initiative for targeting air photo mapping prior to field survey, have been instituted following the reinstatement of a full-time post for mapping in 1999. Approximately 552 sq km (or 2. 7 percent) of upland Wales have been mapped, and 1,118 sq km of lowland Wales (5. 4 percent), a total of 8. 1 percent for the whole of Wales. The publication of Wales from the Air (Musson 1994) and Snowdonia from the Air (Crew & Musson 1996) as well as numerous shorter papers and reports detailing results has been an effective method of conveying the significance of the approach to a wide audience.

Figure 7: Air photo mapping: project map to 2000. (© Crown Copyright, RCAHWW)

Northern Ireland

The Environment and Heritage service for Northern Ireland has allocated responsibility for Aerial Survey to one person who reports:

- Aerial survey in Northern Ireland is undertaken on a very small scale,
- Vertical collections of aerial photographs are consulted when necessary,
- Two to three reconnaissance flights are undertaken each year to monitor specific sites and rather than to reconnoitre for new sites; this forms part of the Environment and Heritage Service's overall aim 'to extend and develop records of the built heritage through survey, excavation and research',
- There is no mapping from aerial photographs.

Cambridge University Committee for Aerial Photography (CUCAP)

Since 1945 Cambridge University has had an aerial reconnaissance capability, initiated by the late Professor St Joseph; on his retirement in 1980 David Wilson became the curator of the collection of aerial photographs. With his retirement in 1998, Cambridge University undertook a review of this facility (which not only possesses an important library but also an aircraft fitted for vertical photography). The review concluded that CUCAP should cease flying (by September 2000, now extended) and find a suitable home for the library of aerial photographs. Since then there have been important developments. CUCAP has received a sizable grant of £295,000 from the Research Support Libraries Programme (RSLP) (from the Higher Education Fund for Continuing Education) to computerise its aerial photographic indices. The University recognises the importance of conserving the collection of photographs and of making them available for research, teaching and other purposes. The current flying programme has been extended for a further year but its future is still under review, although there has been a significant increase in requests for new vertical photographic surveys.

Archives of Historic Aerial Photographs

Throughout the twentieth century millions of vertical aerial photographs have been taken (and destroyed). Fortunately national collections in England, Scotland and Wales have been catalogued and made accessible via national agencies (Bewley 1993); these collections include photographs from the RAF, Ordnance Survey and commercial companies. There are, however, at least four collections in Britain which together contain approximately 15 million uncatalogued and mainly inaccessible aerial photographs (Keele University, Imperial War Museum, RAF (JARIC) and the former Directorate of Overseas Survey). Many of the photographs held in these collections (a combination of negatives and prints) are in dire need of conservation and cataloguing. Cataloguing will enable the curators of these photographs to make them available for research and analysis; the photographs cover a variety of European, African and other countries. This backlog needs to be addressed and support given to the National Association of Aerial Photographic Libraries (NAPLIB - an independent organisation concerned about the long-term safety of aerial photographs) who have been instrumental in obtaining information on the scale of the holdings.

Conclusions

The main purpose of this report is to set out the current position of aerial survey in British archaeology and does not attempt to analyse the position or draw definitive recommendations. However, there are a number of trends which can be highlighted for discussion and comment.

The figures in Table 1 highlight the efficiency and cost-effectiveness of the technique in terms of reconnaissance - each target photographed costs less than £20 at an average rate of circa 10 targets perhour.

An average of 125 sq km has been interpreted and mapped per person year, using aerial photographs. This is an impressive achievement when compared with any other form of interpretative survey. Therefore the re-allocation of resources, from within archaeology to this area, would provide a greater return than is currently achieved.

Throughout the last fifty years aerial reconnaissance has been an enormously successful technique for discovering new sites and monitoring change in the landscape. Cropmarks and soilmarks, two of the main sources of new discoveries appear capriciously in response to each season's weather conditions or agricultural regime and then may not be seen again for many years. New sites are discovered every year and, as yet, the law of diminishing returns has not been reached. The need for continued reconnaissance, therefore, cannot be doubted. What requires consideration, however, is the appropriate level of support and the kind of organisation needed to provide the appropriate response for local, regional and national coverage.

The results of reconnaissance have to be coupled with analysis and synthesis of information contained on recent and historic aerial photographs as part of mapping and interpretation projects. In the past twenty years there has been a growing awareness of the need to map, interpret and communicate the information on aerial photographs. The threats to archaeological sites are growing (either from ploughing or urban expansion and development) and thus there is a greater need for more mapping. This aspect of Aerial Survey clearly requires more resources and prioritisation in the future. The distribution maps show that the mapping coverage is not yet comprehensive and in some areas is wholly inadequate.

Aerial reconnaissance (undertaking photography and airborne surveys) has attracted more attention and debate than mapping, interpretation, analysis and synthesis. However, it is the latter which absorbs the greatest resource and provides the major contribution to understanding the historic environment. The interpretative transcriptions produced provide the most cost-effective means of assembling and displaying information derived from aerial photographs and survey. Table 1 clearly shows the disparity of funding between England and other parts of the UK. When compared to the total resource available, with the total amount available for archaeological survey and excavation, the disparity is even more striking. The resources dedicated to Aerial Survey in the whole of Britain each year (c £500,000) are only equivalent to one major archaeological research project involving survey and excavation. Aerial Survey has shown itself to be the most cost-effective technique in the past fifty years for discovering, mapping and recording

the historic environment but its full potential has yet to be realised both within and beyond archaeology. Research into the levels of funding and priorities within British archaeology needs to be initiated.

The provision for training the next generation in Aerial Survey is totally inadequate and a programme for overcoming this deficiency needs to be initiated. The expertise built up over the past twenty years needs to be enhanced so that there is a sustainable future for this highly effective technique of archaeological explanation and interpretation.

There is at present no common strategy for Aerial Survey in the UK. There is nothing which would provide a set of principles to assist those allocating resources for archaeology, and help them in setting priorities. The Academy's conference (Aerial Archaeology - into the future) in May 2001 is an important step in providing a solution.

Acknowledgements

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Appendix 1

Aerial Survey in English Heritage

There are three aspects to Aerial Survey within English Heritage:

1. Aerial Reconnaissance
2. Interpretation, Mapping and Analysis, and publication
3. Cataloguing, Archive and Retrieval

All three fall within the Conservation Group, with the first two in the Projects Division and the third in the National Monuments Record, Swindon.

1. Aerial Reconnaissance

Reconnaissance for archaeology, by pioneering individuals since the 1920s, has a seventy-year history in England but it was not until 1967 that a national organisation (the RCHME) began a national programme of reconnaissance and photography (this was two years after the creation of the library of air photographs, see 3, below). From 1967 to 1989 there was a single centre of operation in London (using Biggin Hill airfield) and in 1989 a second centre was set up in the RCHME's York office (using Sherburn-in-Elmet airfield). In 1990 the London operation was moved to Swindon (using Oxford airfield).

This dual approach allowed for greater flexibility and capacity of operation at a national scale, especially when allied to a network of locally based fliers. The latter have received funds from central government funds since 1975 and form an integral part of the national strategy of reconnaissance. The purpose of aerial reconnaissance for English Heritage is 'To identify and record, using aerial photography, the remains, existence and current condition of archaeological and architectural sites throughout England, and thus increase our understanding of the historic environment'.

Increasingly, the nature of aerial reconnaissance has expanded geographically and by subject. Although the discovery of new sites visible as cropmarks or soilmarks is a high priority, all other forms of sites and buildings are targeted. In particular, monitoring scheduled sites from the air has been an integral part of the programme since 1997. Overall, the programme has declared its aims (in its strategy document) as being to record varying proportions of site types - earthworks (20-15 percent), cropmarks and soilmarks (45-60 percent) architectural targets (20-15 percent), monitoring scheduled ancient monuments (15-10 percent).

The annual budget, excluding salaries, for reconnaissance (hire of aircraft, film and processing costs, grants by the Archaeology Commissions Programme) is approximately £65K.

The priorities for each year are assessed and discussed with all interested parties (internally and externally) but the success in achieving the targets is dependent on the ground conditions and the vagaries of the climate and weather.

2. Interpretation, Mapping and Analysis

One of the major stimuli for embarking on a national programme of reconnaissance (and setting up a national library) was to create maps which contained the interpreted information about archaeological sites. Resources for this were small and trained staff virtually non-existent in the late 1960s and 1970s. During the 1980s it became increasingly apparent that maps containing the information derived from aerial photographs (especially at 1:10,000 scale or the old 6" scale) would be immensely useful for planning and development control work as more and more SMRs were created. The landscape approach adopted for the Danebury area and the subsequent publication of Palmer (1984) were important milestones. Significantly the Monuments Protection Programme also required similar information to determine which sites (and landscapes) were worthy of preservation through scheduling. During the 1980s transcription of cropmarks of the Yorkshire Wolds had begun (Stoertz 1997) and English Heritage commissioned the RCHME to map and record all the upstanding archaeology of Dartmoor (in 1985). A collaborative project (between EH, RCHME and CUCAP) on the classification of

cropmarks visible from aerial photographs led to the publication of The Emerging Past (Whimster 1989). In 1988 the Monuments Protection programme (in EH) commissioned RCHME to undertake a cropmark classification project (Edis et al 1989) which involved pilot mapping projects in Kent, Hertfordshire, the Thames Valley and the Yorkshire Dales (1988-1992) (Fenner & Dyer 1994, Horne & MacLeod 1995). Out of this grew the current National Mapping Programme which has by 2000, mapped over 25 percent of England and created information for the needs of the SMRs, MPP, and the NMR (Bewley 1998).

The National Mapping Programme (NMP) has the equivalent of 13 staff (either in English Heritage offices or grant-aided in local authorities) and has been involved in over 20 projects. It operates within a digital environment producing digital maps and computerised records, all of which are available in the NMR. Copies of the maps are provided to the relevant SMR on a project by project basis. To complete the map of England within an acceptable timescale will require considerable extra resources (in aerial survey terms) but an accelerated programme has now been approved by the Ancient Monuments Advisory Committee.

Serious consideration is now also being given to the next projects in terms of priorities. The coastal areas of England, especially the east coast, have already been agreed as a priority and work has begun on the Suffolk and Norfolk coasts. The results of the MARS project (Darvill & Fulton 1998) also show that areas of intensive ploughing are under the greatest threat. From NMR and SMR information, coupled with the MARS data, areas with a low density of archaeological sites have also been targeted for more survey. Another consideration is the management needs of some of the most extensive and important areas, especially World Heritage Sites; work has been done on Avebury and Stonehenge but Hadrian's Wall is now a priority.

The total budget for the current mapping and analysis programme can be estimated to be c £350,000 per annum.

Publication of the result is either as articles (Bewley 1995, Jones 1998) or books (Stoertz 1997, Bewley 1998).

Each year several one-off projects are undertaken for a variety of purposes - management (eg Cawthorn), development control (Abingdon area) or national synthesis (eg Neolithic Enclosures). These projects are complementary of the NMP in that they either build on the primary 1:10,000 scale mapping or provide the primary level as well as more intensive and detailed information.

3. Cataloguing, Archive and Retrieval

The National Monuments Record (NMR, then part of RCHME) initiated the creation of aerial photographs in 1965. This currently contains over three million prints, slides or negatives. Within English Heritage the NMR provides an Enquiry and Research service as well as the conservation and archive facility for historic and current collections of photographs, maps, drawings and records of the historic environment.

The integral support from the NMR for both the reconnaissance and the mapping programmes is fundamental to the success of each. For reconnaissance, each photograph (whether a print or slide) is catalogued and archived in such a way as to allow easy access. This ensures that the original negative of a photograph is stored

in proper archival conditions but any resulting prints can be on open-access and easily retrieved. The historic collections of photographs (especially the RAF's 1946-48 survey) are similarly accessible.

For NMP and other mapping projects each map is archived in the NMR and copies made for the relevant local authority SMR. The records are computerised and are available through the NMR's national monument database MONARCH. Unpublished reports are also archived and made available in the NMR.

Bob Bewley
February 2000

Appendix 2

Aerial Survey at the Royal Commission on the Ancient and Historical Monuments of Scotland

1. Summary of Activities

Aerial Reconnaissance
The Royal Commission has been carrying out aerial survey since 1976. Its main programmes are prospective archaeological reconnaissance in winter and summer, architectural and industrial archaeological recording in relation to Royal Commission projects, such as Eastern Dumfriesshire or the defences of Scapa Flow, threat-inspired survey, such as Borders woollen mills, and the documentation of monuments and buildings, in areas or in categories that are under-represented in the National Monuments Record for Scotland, across the whole of the country. In the last year for which complete figures are available over 2,000 sites were recorded, divided approximately two-thirds/one-third between archaeology and architectural and industrial subjects. The results of each year's survey are published in an illustrated catalogue.

One member of staff, the aerial survey manager, is responsible for all aerial survey duties, including post-reconnaissance tasks, assisted by a member of the Photographic Section, a member of the Drawing Office and a member of the NMRS Liaison Section (appointed August 1998), all of whom have duties in other areas. In 1999-2000 there is an additional temporary post working on the input of aerial photographic data to the NMRS' ORACLE database. Members of other survey teams, both archaeological and architectural, assist with aerial reconnaissance in their own particular areas and specialisms.

Transcription of Aerial Photographs and GIS Mapping
The Royal Commission began its programme of mapping the results of cropmark survey in 1984, after it had first acquired a set of 1:10,000 maps of Scotland. Manual transcription at 1:10,000 scale has followed new discoveries. Far more rigorous and precise computer rectified transcription has been developed and the digital results incorporated in the Royal Commission's GIS. The Section has provided a service to Historic Scotland, regional archaeologists and other agencies for the protection of sites threatened by development or proposed for scheduling. Mapping has been carried out for the Commission's own publications and for thematic

surveys, as well as to provide a method of handling and depicting complex sites within the NMRS. Extensive areas of Wigtownshire, Berwickshire, Midlothian, Perthshire and Fife have been transcribed. The completion and maintenance of computerised transcription of all cropmark sites is highly desirable and would allow greater comprehension of this form of site, but this would require additional staff resources.

Sponsoring of Aerial Reconnaissance outwith RCAHMS
Since 1976 there has been a policy of encouragement of the application of aerial survey and its products throughout Scotland, with the provision of limited funding for hire of aircraft, as well as advice and training, through the Scottish Archaeological Air Photography Committee, which is open to all those interested in aerial survey and its utilisation in Scotland. The members of the Committee include staff from Historic Scotland, local authorities and universities, as well as informed but non-professional archaeologists. Meetings include regular seminars on aerial survey subjects. The aerial survey manager is the Secretary of the Committee.

2. Aerial Survey: Resources

Staffing
One member of staff within the Archaeology Division, aided by a photographer, a draughtsman and NMRS liaison staff.

The aerial survey manager organises sorties, carries out flight planning, navigation, selection of targets and the preparation of preliminary catalogues. In terms of post-reconnaissance she identifies and categorises sites after the photographs have been printed and prior to their entry into the National Monuments Record of Scotland, handles queries arising from their content and prepares the annual Catalogue of Air Photographs for publication.

Structure of the Flying Programme
The RCAHMS flies from Edinburgh Airport (about half an hour distant from the office in Edinburgh) and when appropriate or necessary lands away at other airfields in Scotland. The RCAHMS negotiates an annual contract with the Edinburgh Air Centre, a company that provides a fully commercial service under Civil Aviation Authority regulations. It is for 120 hours each year at a cost of £19,800 including VAT plus the cost of commercial landings.

Sponsored Flying
The budget for each of the last three years has been £3,000. It is only available for direct flying costs and not for photographic costs, travel or time. This is supplemented, in some cases, by funding from other sources. The allocation was underspent in 1998-9. The lack of regular availability of sufficiently qualified pilots and aircraft in Scotland outside Aberdeen and Edinburgh makes it difficult for regional fliers to carry out reconnaissance, especially in areas such as Shetland where cover is most lacking, and which cannot be reached within RCAHMS' own programme of flying, because of Civil Aviation Authority safety regulations. The aerial survey manager negotiates with the CAA for exemptions to enable aerial survey to take place outside a fully commercial context.

Aerial Photographic Collections
The collection of oblique archaeological, architectural and industrial air

photographs forms an integral part of the National Monuments Record of Scotland and has done since its inception in 1976. The prints, black-and-white and colour are mounted and captioned, and kept on open access within the Library in 1:10,000 map sheet order and NMRS number, along with other archaeological photographs and photographed plans. The aerial photographs are probably the most heavily used part of the archaeological collections. Copies of transcriptions of cropmarks at 1:2,500 are housed with them. Records of all sites may be accessed through RCAHMS' ORACLE database and, outwith the Edinburgh headquarters, through CANMORE on the Internet via the RCAHMS' website.

The collection of vertical air photographs is also held in the NMRS. The information on the location of both oblique and vertical cover is held on the GIS system and can be viewed against a variety of map backgrounds and in relation to other data sets.

The aerial photographs taken in 1996 are now being put into the Library. A computerised preliminary catalogue for each calendar year allows access to material not yet in the Library, and flight traces indicating areas surveyed form a layer in the GIS.

Transcription of Aerial Photographs and GIS Mapping
RCAHMS has developed the AERIAL programme of archaeological aerial photographic digital transcription in cooperation with John Haigh of the University of Bradford and has incorporated the data into the GIS, in which the plans of cropmark sites can be seen in relation to other forms of archaeological information and against a wide variety of informational backgrounds, including digital OS maps. The creation of a layer of rectified photographs of cropmark data would be a desirable addition. Steady progress in the transcription of cropmark information at a scale of 1:2,500 has been made, in conjunction with the needs of RCAHMS and other archaeological agencies in Scotland, but complete cover would require additional funding. Both oblique and vertical cover are employed in the survey of upland areas, but, except in one experimental area, ground survey has been the primary means of recording at 1:10,000 scale. Transcription is usually carried out by the aerial survey manager and the computer rectification and incorporation into the GIS undertaken by the Drawing Office staff. The supporting files form part of the NMRS manuscript collection. Some 1,500 cropmark sites and several thousand square kilometres have been mapped to 1999.

3. Strategy for Aerial Survey

Aerial survey aims to identify and record by appropriate means the archaeology and architecture of Scotland and communicate the results and promote their understanding.

- It seeks to achieve this by:
  conducting programmes of prospective survey throughout Scotland; supporting and enhancing other programmes of the Royal Commission on the Ancient and Historical Monuments of Scotland, whether archaeological, architectural or industrial archaeological, which have been selected for their national significance; contributing to the National Monuments Record of Scotland, seeking especially to improve its coverage of areas or themes where this is needful; recording threatened sites and landscapes, following internal and external requests and responding to national priorities for

recording; promoting high standards of aerial survey and recording; monitoring and evaluating, adopting as appropriate, new technical developments in reconnaissance and post-reconnaissance; supporting aerial reconnaissance by other agencies and individuals throughout Scotland by providing funding, legal assistance, advice and training;
- making available the results of its survey through the National Monuments Record for Scotland, through published catalogues, publications, lectures, seminars and other means of dissemination.

Marilyn Brown
November 1999

Appendix 3

Aerial Survey at the Royal Commission on the Ancient and Historical Monuments of Wales - 2000

1. Summary of Activities

Aerial Reconnaissance
The Royal Commission has been undertaking aerial reconnaissance since 1987. The work includes exploratory photography and monitoring of Scheduled Ancient Monuments (SAMs) for Cadw: Welsh Historic Monuments. Aerial reconnaissance remains a flagship activity for the Royal Commission and has a high profile within the organisation.

One member of staff carries out all aerial photographic duties including post-reconnaissance tasks. Regional air photography was funded through grant-in-aid to the Welsh Archaeological Trusts (WATs) until the year 1995/6, when external funding was switched to the developing programme of regional air photo mapping. The Investigator (Aerial Photography), Chris Musson, retired in May 1997 with Toby Driver assuming responsibility for aerial reconnaissance as Air Survey Officer. Grant-in-aid to the WATs for the year 1999/2000 reverted to the support of regional aerial reconnaissance when the Royal Commission dedicated a staff post to air photo mapping.

The SAM Monitoring Programme
The programme of aerial monitoring of SAMs was pioneered by Cadw from 1984 onwards through funding to the Welsh Archaeological Trusts; responsibility and funding for this work was transferred to the Royal Commission in 1992 and RCAHMW now co-ordinates national and regional aerial reconnaissance. Annual targets for SAM monitoring are currently set at 650 sites per year, with the objective of completing photography of the entire 'photographable' estate every 3-4 years. On average, 20 or more individual SAMs are photographed each hour in flight depending on the mix of SAM and exploratory work.

Air Photo Mapping
The Royal Commission commenced its programme of air photo mapping in 1995. Between 1995/6 and 1997/8, this programme had one member of staff allocated part-time to the task, with three regional air photo mappers based in three of the

four WATs, funded on a part-time (project-led) basis through grant-in-aid. Following the retirement of the Investigator (Aerial Photography) in May 1997, the Air Survey Officer took over active aerial reconnaissance. To answer the reduced output of air photo mapping, the Royal Commission appointed a new member of staff in 1999 as Air Photo Mapping Officer (with an additional remit to develop GIS applications in the Royal Commission), and a second staff post is under active consideration.

2. Aerial Reconnaissance: Resources

Position within RCAHMW: One member of staff, in Survey Branch.

The Air Survey Officer carries out all duties related to aerial reconnaissance. The Air Survey Officer carries out flight planning, photography and navigation in the air, and post-flight documentation including writing the flight report, sending films for processing, ordering and sorting prints, marking-up of colour slides, dispatch of SAM prints to Cadw and final cataloguing. He also assists with general enquiries from the National Monuments Record for Wales (NMRW) and completes a range of other duties.

Structure of the Flying Programme
The Royal Commission flies from three main airfields in Wales as at June 2000: Caernarfon (north coast), Shobdon (Herefordshire/borderlands) and Haverfordwest (south-west Wales). Operations for aerial photography are currently suspended from Swansea (south Wales) and Welshpool (mid-Wales). The shortest travel times to Haverfordwest, Shobdon and Welshpool are all about 1 hour 40 mins. Caernarfon and Swansea are, on average, a 2 hour 30 min drive.

No annual contract is held with a particular operator although prices are checked with airfields at the beginning of each year. In practice, aircraft and pilots must be booked through the usual channels at airfields, a process which can be difficult at peak times or at short notice. That said, the choice of 5 airfields in Wales and the borderlands will usually guarantee at least one flight opportunity on any given day.

Aerial photography in Wales (as in England) continues to benefit from the system of Exemptions from the Air Navigation Order 1995, issued by the CAA to allow flights through non-AOC operators (those operators which do not hold an Air Operators Certificate). Exemptions continue to be issued by the CAA pending a change in European law.

Flying Hours
2000/2001: Funding will allow an 80 hour internal flying programme, including c15 hours of regional aerial photography.

1999/2000: Funding allowed a 52 hour internal flying programme, including 11 hours of regional aerial photography (funding for two regional flying programmes was left unspent by the grantees).

1998/9: Some 50 hours were flown, including 13 hours of regional aerial photography.

These figures compare favourably against flying hours during 1995/6, a particularly busy cropmark season, with 60 hours flown by RCAHMW and further flights undertaken by locally based flyers.

The Royal Commission has been responsible for distributing grant-in-aid to the WATs since 1992. Grant-in-aid paid to Trusts between 1992 and 1998 has varied between £10,000 and £12,000 each year, with a slight increase in 1999 to £12,500. On average, £2,500 of grant-in-aid is used for the printing of SAM monitoring photographs.

3. Cataloguing of Aerial Photos/Access to the Collections

The oblique air photo archive held by the Royal Commission is a constantly expanding resource, frequently used by visitors to the NMRW, RCAHMW staff, and specialist bodies (eg: Countryside Council for Wales, Cadw) with images employed in a range of exhibitions, publications and lectures. Although the archive collection of colour slides can only leave the building for the purposes of publication, printing or official lectures by RCAHMW staff, a duplicate 'lecture set' of colour air photo slides is currently being established for the sole purpose of allowing non-RCAHMW staff in other recognised organisations to borrow slides for lectures.

Until recently, the air photo catalogue only existed as a paper record requiring a manual search to retrieve images. In 1999, under the guidance of Information Management Branch, the complete back-catalogue (excluding 1995) has been entered on a specially designed air photo database. This is now available to be queried on-screen through ArchView GIS, against the 1:50,000 OS Landranger map background and against other datasets. RCAHMW Core Records and copies of Trust records can now be queried on screen. The process of digitising flight traces of all 1:10,000 RAF vertical cover held by RCAHMW, for use in the GIS, is also firmly underway.

4. Air Photo Mapping

Position within RCAHMW: One member of staff in Information Management Branch.

Between 1995 and 1997, air photo mapping developed quickly as a method of rapid survey for Wales. RCAHMW pioneered techniques of digital air photo mapping using CAD for all graphics and a combination of FastMap GIS and Foxpro to create site records on-screen. At the time this process was ahead of some larger survey agencies in terms of the up to date technology employed. Digital map data was bought in for relevant areas, but the delay of a Service Level Agreement (SLA) with the OS for map data for the whole of Wales somewhat restricted the progress of the programme in non-1:10,000 areas (eg: lowland areas), due to the higher cost of larger-scale map data. With the advent of Windows-based GIS and other software advances, the programme of AP mapping was not 'cutting edge' for the period 1997/8 but still proved an extremely effective method of producing digital maps of archaeological sites from air photo sources. With the appointment of an Air Photo Mapping Officer in January 1999, the AP mapping work is working well with the use of ArchView GIS. The programme has been given a further boost with the provision of Ordnance Survey map data for RCAHMW as part of a Service Level Agreement.

At its height, during 1996/7, some 300 sq km of ground was mapped per year with 60 percent of one internal post dedicated to the task. During the most consistent period of grant-aided air photo mapping (1997/8), approximately 247 sq km was mapped in a year.

To date, for the total landmass of Wales (20,640 sq km), 2. 67 percent of upland has been completely mapped from air photographs, while 5. 41 percent of lowland Wales (cropmarks only) has been mapped (Figure 7).

The current direction of the air photo mapping programme has changed following policy review in December 1998. Funding for grant-aided mapping has been re-directed to regional flying. Internal mapping is now being bought more in line with the current thrust of the Uplands Initiative, a programme of grant-aided uplands field survey. It is hoped that within 3 to 4 years, in-house air photo mapping can achieve enough work in upland areas alone to provide a rapid-survey base-map with which to direct Uplands survey on the ground.

5. Aerial Reconnaissance: Remits and Future Directions

The RCAHMW Corporate Plan states that Aerial Survey should: 'enhance the NMRW by conducting programmes of prospection', '. . support all other areas of RCAHMW: archaeological, architectural and industrial survey', '. . to add to the value and use of air photographs by means of enhanced interpretation. . and where appropriate, rectification', and 'allocate funds to WATs for aerial photography to monitor SAMs for Cadw'.

In addition to the need to photograph 650 SAMs for Cadw each year, the remit of the current programme of aerial reconnaissance attempts to respond to all aspects of the Royal Commission's role, in providing information on the 'archaeological, built and maritime heritage of Wales'.

Where possible aerial reconnaissance in Wales has always responded, and continues to respond, to local, regional and national survey priorities; industrial recording has always had a high priority, but this is being supplemented by more work in the intertidal zone; flights have been made over the Blaenavon industrial landscape to allow detailed recording in support of the World Heritage Site bid by Torfaen County Borough Council; noticeable gaps in the collection are addressed whenever survey is carried out over sites or landscapes with poor aerial cover. Current priorities in Wales, be they Deserted Rural Settlements, historic gardens and parklands, or the enhancement of the record of wartime remains following the Defence of Britain survey, continue to be accommodated in the survey programme along with other earthwork and cropmark photography.

The status of RCAHMW's programme of national aerial reconnaissance is high; it is a key component of the Royal Commission's programme of survey and is an area where the Commission can demonstrably provide a nationwide facility, an important consideration given the foundation of the new National Assembly for Wales.

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