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# AIRCRAFT UTILISATION STUDY

JANUARY 1992

# AIRCRAFT UTILISATION STUDY

## INDEX

## ANNEXES

# REFERENCES


Reference 1 R&D Project 328 "Airborne Remote Sensing of Coastal Waters"

Reference 2 R&D Project 311 "A Review of Remote Sensing"

Reference 3 Department of Transport Marine Pollution Control Unit (MPCU) "Controlling pollution at sea"

Reference 4 Committee of Public Accounts. 40th Report. Oil and Chemical Pollution at Sea

Reference 5 MAFF, ADAS, Aerial Photography Unit Services

Reference 6 SD (Scicon) Final Report Police Air Support Study and Annexes

Reference 7 FPA Tender Document: Coastal Aircraft
Offshore Aircraft
Management

Reference 8 Anglian
"Sea Defence Management Aerial Survey Contract"

# AIRCRAFT UTILISATION STUDY

## INTRODUCTION & SUMMARY

### Objective

The Director of Operations identified the need to investigate aviation activity in the NRA with a view to establishing, a single contract. It was considered that this could offer benefits to the NRA in terms of cost effectiveness and standardisation. The following objectives were set for the study:

1) To identify regional NRA activities that are, or have been, supported by aircraft.

2) To investigate and propose NRA activities which could, with actual or potential benefit, be supported by aircraft.

3) To identify tasks that could improve the efficiency/effectiveness of the NRA if carried out by aircraft.

4) To investigate and establish links with other agencies operating aircraft, in similar roles, which could be advantageous to the NRA.

5) To report on the above with indication of costs and make recommendations on feasibility of letting a national contract, by 9th December.

6) Following "5" to produce a specification for the approved aircraft.

7) To let and implement the contract or contracts.

### Project Team

The project team for the study consisted of:
Dave Stanley, Project Manager
David Palmer, Wessex
David Hickie, Severn Trent
Andrew Hunter Blair, Anglian
Tony Champion, Northumbria

In the event Nic Holden was substituted for David Palmer on account of workload and likewise Tony Harris for Andrew Hunter Blair. The project team members had been selected on account of current or previous experience/interest in aviation.

### Timescale

The first meeting was held on the 23rd October. This gave 6 weeks for the completion of the report. Inevitably this meant that the various areas for investigation could not be dealt with to the depth desired. As part of the study a limited flight trial has also been carried out.

## Scope

It is felt that all the major issues have been identified. The key areas of concern in respect of effectiveness and cost have been addressed.

This study represents a comprehensive overview of aviation in the NRA, and the agencies with whom we do, or could liaise with potential benefit.

## Method

The method adopted was to utilise the expertise of the individual project members. The investigative work was allocated accordingly. This method had the advantage that it enabled reports to be compiled quickly. It had the disadvantage of demanding that the individuals step back from their particular areas of interest and to take a broad view. This was not always easy!!

## Aircraft

When reading the various reports the following should be borne in mind:

1) Payload for payload, a single engined helicopter costs 2 to 3 times as much to operate as a single engined fixed wing. The same applies to twin engined helicopters and twin fixed wing.

2) Two engines give you a warmer feeling over water and give added security to any expensive onboard sensors. Only twin engined helicopters are permitted to operate at night.

3) Twin engined aircraft cost roughly twice as much to operate as singles.

4) High winged aircraft give good downward visibility and are therefore good for surveillance or spotting. The survey aircraft used by our contractors have all been low winged.

5) Aircraft can be employed in a number of roles. Multirole operations can compromise efficiency and costs. Helicopters are inefficient and costly, and should only be used where vertical landing, very slow speed or high manoeuvrability are required.

6) An aircraft is only a vehicle. It is not practical to identify an aircraft until the role and equipment, range, endurance and payload requirements are known.

7) The project members sought to establish the preferred systems to meet the needs of users. Inevitably there were different requirements for similar tasks from different regions.

8) There is not a perfect answer!

Layout

The study is divided into sections. Each section covers one of the above objectives. A substantial amount of material was consulted and reviewed. This is referenced where it is not essential to the reports. Information that assists understanding is annexed.

## SUMMARY

1) Role Specification

Different regions are using different specifications for a particular aviation role. Some of these specifications are more comprehensive than others. It is recommended that the NRA produce standard specifications for each of the roles to include considerations such as aircrew qualifications, aircraft types, CAA Regulations, insurance etc. This will ensure proper tenders/quotes that protect both our staff and our interests.

2) Third Party Insurance

There appeared to be a degree of uncertainty as to the amount of Third Party cover to be carried by the contractors. The NRA requires £10 m of Third Party insurance and also that a Hold Harmless clause be inserted into any aviation contract. Details are at Annex C.

3) Life Insurance

A number of personal life insurance policies exclude aviation risks, i.e. death arising when an individual is a constituted member of an aircraft crew. It is further recommended that any additional premiums should be paid by the NRA.

4) Safety

In the event of the NRA letting an aircraft contract, we should review our flight safety (Health & Safety) and weather minimum requirements in order to ensure that they are appropriate to our needs.

5) Enforcement Fisheries

a) Use of aircraft to extend the effectiveness of existing coastal patrol vessels should be considered prior to the purchase of any further vessels.

b) Aircraft would dramatically increase the profile of both river and coastal enforcement.

c) Saving against existing staff seems unlikely.

d) Further limited evaluation should be carried out using aircraft for both rivers and coastal enforcement. Cost approximately £100,000. Note - the use of helicopter and FLIR for night surveillance will require some development to ensure maximum effectiveness and safety.

6) Enforcement-Irrigation

a) Aircraft substantially improve the effectiveness of irrigation enforcement. They provide timely information on where irrigation is taking place. Air to ground communications need improvement.

b) Aircraft are likely to have a significant deterrent and effect if backed by effective enforcement.

7) River Corridor Survey

a) A proper analysis is required to evaluate the need, extent, and preferred image format for river corridor surveys.

b) Regions are obtaining image data on a piecemeal basis in a variety of formats.

c) There is a need to ensure that regions are able to specify their needs, and that they are aware of the technological options available to meet those needs.

d) A standard specification should be drawn up for image format that is compatible with GIS and WAMS.

8) Coastal Baseline Survey

a) The R&D Project (Reference 1) will conclude that the NRAs requirements for coastal monitoring are best met by procuring an (MSS) CASI. On the basis of 4 surveys per year, an aircraft will be required to fly 420 hours per year.

b) An aircraft fitted with a CASI and a survey camera could carry out existing operational surveys and other work which could reach 800 flying hours per year.

9) Flood Defence Surveys

The report identifies the differing requirements in contouring (i.e. $\pm$5-50 cms) between the regions from the same images. This may need to be resolved if a standard sensor system is to be considered.

10) Sensor Systems

A review is required of our data requirements with the objective of identifying a preferred remote sensor system solution..

11) Platform

It is axiomatic that our data requirements give rise to the image/data format which dictates the sensor system. When the sensor system(s) is known then preferred platform (aircraft) can be identified.

12) Fisheries Protection Agency

a) The NRA needs to consider tapping into this source of intelligence in the context of salmon drift netting and possibly offering another dimension to coastal ecological data.

b) The FPA appear willing to assist us in whatever way they can. Their contract experience on fixed wing aircraft could be valuable.

c) Consideration should be given to establishing formal links for reporting coastal pollution information.

13) Marine Pollution Control Unit

The MPCU should be the source of useful maritime pollution information that should assist us in protecting our coastline.

14) NERC/ADAS

NERC and ADAS operate twin engined aircraft as sensor platforms that might be available for contract work. There would be reservations about their ability to meet all of our potential requirements as full time contractors.

15) Police

a) The police aviation units and their contractors are possible sources of enforcement helicopters.

b) A Police Operating Certificate would be advantageous to the NRA.

16) Royal Air Force

a) The RAF is increasingly unlikely to support NRA operations for free, other than in an emergency.

b) RAF pollution reporting procedures are being investigated.

17) Fixed Wing

a) Some 420 flying hours will be necessary to meet the proposed Coastal Survey requirements. Additional hours would be required to cover any Flood Defence survey work undertaken. A significant number of hours will be required in the even of a national approach to River Corridor surveys. Combined, these requirements would certainly exceed current aircraft useage.

There could be a substantial case for the NRA having the exclusive use of a fixed wing aircraft.

b) Wessex have carried out research into acquiring by lease/purchase a fixed wing aircraft for the Coastal Survey (MSS) role. A report by Compass Aviation covers the key considerations at Annex J. This is followed by the aircraft specification produced by Wessex for this role.

c) Both aircraft quoted are low winged. The coastal fisheries enforcement role is best met by a high winged aircraft.

d) Neither the coastal survey or the river corridor survey requirements have been agreed. It is not appropriate therefore to propose an aircraft type until the real need is known.

18) Helicopters

Helicopters are used for sampling in the Severn. It is proposed that we evaluate a helicopter and FLIR in the fisheries enforcement role. Both requirements are for a twin engined aircraft with similar payload. Consideration should be given to combining the requirements into a single contract.

19) Management

Aviation is a tightly regulated specialist activity. It is recommended that, should we require an aircraft, the piloting and management of it be contracted out, utilising the experience of the Police, FPA, MPCU, as appropriate. The FPA indicated a very long lead time for acquiring aircraft.

20) Consultant

As indicated in the introduction to the study, our possible overall aircraft requirements are not straightforward. When our data/sensor requirements have been identified, it is recommended that an aviation consultant advise on the appropriate aircraft type(s) and the method of operation (lease/buy). The consultant could, with advantage, draw up and review our role specifications mentioned in Section 1.

Dave Stanley

DAVE STANLEY

DS/KJN

6th December 1991

## SECTION 1

**OBJECTIVE 1** **To identify regional NRA activities that are, or have been, supported by aircraft.**

### QUESTIONNAIRE

Questionnaires were sent to each of the regions. The purpose was to elicit current and past aviation activity, to establish the number of hours flown, the costs, and also the regional representative responsible for a particular aviation role. The appropriate project member was then expected to contact the regional representative for a particular role, in order to elicit further detailed information. The questionnaires were carefully reviewed. A summary of the declared expenditure on aviation for 1991/92 is below.

Any role where there had been more than £10,000 worth of expenditure, by any one region, was considered. Enforcement, photo survey, river corridor surveys and remote sensing, are covered in detail as part of Section 3.

### SAMPLING

Wessex spent £11,000 on sampling. However this money is spent on the quarterly exercises of sampling the Severn. This need has not been identified elsewhere and was therefore not considered further. However, the helicopter required for this sampling could be incorporated into the possible requirement of an enforcement helicopter, in the event of that option being pursued.

### UNDERSLUNG LOADS

Two regions reported having used helicopters for underslung loads.

#### Sea Defence

Anglian used a helicopter to assist in some sea defence work where the over land option was considered to be difficult and expensive.

Anglian hired a helicopter from Bond Helicopters which had an underslung capability of 1 Tonne and was used to move sand bags in nets. This was considered a very fast and effective way of moving loads. However, given the speed of delivery there are significant logistical considerations to be taken account of at the loading and unloading ends.

#### Liming

Welsh use helicopters for liming operations where they too had access problems which were partly terrain and partly landlord (National Trust). The specification outlining the task is at Annex A. The quotes submitted were in 3 different forms - per hour, per day and for the whole job. A BO 105 aircraft was used with a planned underslung load of 1600 lbs, however this load had to be reduced due to turbulence in the area. Again it was considered to be an effective way of solving access problems.

## QUESTIONNAIRE - DECLARED EXPENDITURE 91/92 IN £1000S TO DATE

| REGION | ENFORCEMENT | UN. SLUNG | PHOTO SURVEY | SALMON | INSPECTION | VIDEO RIVER CORRIDOR | REMOTE SENSING | SAMPLING | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| Anglian | 13 | | 20 | | | | | | 33 |
| North West | 1 | | 17 (Consortium NRA contr.) | | 1 | | 14 | | 32 |
| Northumbria | | | | | | | | | |
| Severn Trent | | | | | | 26 | | | 26 |
| Southern | | | 82 | | | | | | 82 |
| South West | | | 4 | | | | | 8 | 12 |
| Thames | | | 90 | | | | | | 90 |
| Welsh | | 6 | 1 | 3 | 2 | | | 2 | 13 |
| Wessex | | | 3 | | 5 | | 40 | 11 | 59 |
| Yorkshire | | | | | 4 | | | | 4 |
| TOTAL | 14 | 6 | 213 | 3 | 12 | 26 | 40 | 21 | 339 |

October 1991

Services

Both users were aware of the possibilities of using service sources. The opportunity for using the RAF on a training basis (free) would appear to be non existent at the present owing to the excessive hours that were flown in the Gulf. Service aircraft can however be contracted. Wessex, Puma and Chinnok helicopters could be available to carry out this type of operation with maximum underslung loads of 5,000 lbs, 6,000 lbs and 20,000 lbs respectively.

Specification

It was commented that it would be helpful if there were standard specifications available for this role and also a list of suitable contractors. This would ease the burden of the tendering process and reduce the risk of getting it wrong.

PUBLIC RELATIONS

A survey of the regions was carried out on their use of aircraft for PR purposes see Annex B. It is evident that there are varying requirements from nil (Welsh) to the specific hiring of helicopters for taking aerial photographs (Severn Trent and others). Photographs are normally required of specific sites, works (Thames Barrier) and severe flooding incidents.

Photographs are obtained in various ways.

Aircraft are occasionally used for VIP purposes, either to quickly show a region or witness at first hand particular incidents (floods). Hiring is normally done locally.

SUMMARY

The following issues were highlighted:

1) Role Specification

Different regions are using different specifications for a particular aviation role. Some of these specifications are more comprehensive than others. It is recommended that the NRA produce standard specifications for each of the roles to include considerations such as aircrew qualifications, aircraft types, CAA Regulations, insurance etc. This will ensure proper tenders/quotes that protect both our staff and our interests.

2) Third Party Insurance

There appeared to be a degree of uncertainty as to the amount of Third Party cover to be carried by the contractors. The NRA requires £10 m of Third Party insurance and also that a Hold Harmless clause be inserted into any aviation contract. Details are at Annex A.

3) Life Insurance

A number of personal life insurance policies exclude aviation risks, i.e. death arising when an individual is a constituted member of an aircraft crew. This clause, or similar, will embrace any NRA staff who are flying in aircraft on a regular basis, either navigating or operating equipment. It is recommended that staff be required to check their life policies and advise insurance companies where necessary. This action is likely to result in the insurance company requiring an increased premium. It is further recommended that any such premium increases should be paid by to the NRA.

4) Safety

In the event of the NRA letting an aircraft contract, we should review our flight safety (Health & Safety) and weather minimum requirements in order to ensure that they are appropriate to our needs.

## SECTION 2

OBJECTIVE 2 **Investigate proposed NRA activities which could benefit from support by Aircraft**

SURVEY

1) In early November 1991 a questionnaire was circulated to Regions to identify possible requirements and benefits from the use of aircraft in NRA operations and activities.

2) The responses to the questionnaire are outlined in the table, following this section. Listed under each function are the individual requirements and the benefits as perceived by the respondents.

3) A wide range of functional requirements could be fulfilled by the use of aircraft, the majority of which involve using the aircraft as an operating platform, from which aerial images can be taken. The issue of images and sensor systems is addressed in Section 3.

AIRCRAFT UTILISATION STUDY

## ACTIVITIES WHICH COULD BENEFIT FROM SUPPORT BY AIRCRAFT

1. ENVIRONMENTAL QUALITY

| Requirements | Features to be identified | Images Required | Height of Surveys | Benefit to NRA |
|---|---|---|---|---|
| 1. River Corridor Survey | Main river, tributaries, effluents (ST) | Colour prints<br>Video<br>MSS | Medium | Able to quickly identify locations & problems. |
| 2. Monitor thermal discharges | River channels & discharge points (ST)<br>(ST)<br>(WX) | Infra red<br>Video infra red<br>MSS | Low | Control of thermal pollution<br>Identify mixing zones. |
| 3. Sampling of estuaries & tidal waters | N/A (ST) (WX) (SW) | N/A | N/A | Access to difficult areas. |
| 4. Identification of extent of contaminated land | Spoil heaps non-verbal land (SW) (ST)<br>(ST) | Colour prints<br>Video<br>MSS | Medium | Quantification of problem. |
| 5. Determination of mixing zones | Discharges to rivers (ST)<br>(ST) | Colour prints<br>Video<br>MSS | Low/Medium<br>Low/Medium | Improved consent Determinations. |
| 6. Monitor Pollution incidents | Tracking pollution, marine oil spills<br>(SW)<br>(WX) | Colour print<br>Video<br>MSS | Medium/High<br>" | Improved reaction to major incidents. |

Note: 1 Images Required:- Still photograph, (Colour slide, negative, black + white, infra red), Video, Infra Red Video. MSS = Multi spectrum scanner.

2 Heights of Surveys:- Low level - channel only; Medium level - river corridor, High level - wider river corridor.

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## ACTIVITIES WHICH COULD BENEFIT FROM SUPPORT BY AIRCRAFT

1. ENVIRONMENTAL QUALITY (Continued)

| Requirements | Features to be identified | Images Required | Height of Surveys | Benefit to NRA |
|---|---|---|---|---|
| 8. National Coastline base survey | Pollution, Thermal, Position Area, (WX) Land use. | MSS | High | Provision of Base line data survey |
| 9. Trading Estate surveys | Pollution, industrial use. (WX) | Colour print | Low | Improved Survey of locations and problems |
| 10.Fish Farm surveys | Extent of fish farm and discharge (WX) points. | Prints<br>Video<br>MSS | Low<br>High | Improved Survey of locations and problems |

Note: 1 Images Required:- Still photograph, (Colour slide, negative, black + white, infra red), Video, Infra Red Video. MSS = Multi spectrum scanner.

2 Heights of Surveys:- Low level - channel only; Medium level - river corridor, High level - wider river corridor.

FCR/203

## ACTIVITIES WHICH COULD BENEFIT FROM SUPPORT BY AIRCRAFT

2. WATER RESOURCES

| Requirement | Features to be identified | Images Required | Height of Surveys | Benefit to NRA |
|---|---|---|---|---|
| Identify spray irrigators in use | Location of hose reel and abstraction points (ST) (SW) (W) | Video<br>Video<br>Colour Print | High level<br>Low<br>Low | Reduce time spent in identifying farms not utilising equip or illegally abstracting. |
| Land Use | Land use, residential, industrial agriculture and type (T) (ST) | Colour print<br>Video<br>MSS | High level | Gives overview of land use at relatively low cost compared to ground survey. |
| Low flow surveys | Channel-dry damp or flowing (ST). or | Colour Infra Red<br>Video Infra Red<br>MSS | Medium<br>Medium<br>High | Identifies channel flows much quicker than ground survey. |

Note: 1 Images Required:- Still photograph, (Colour slide, negative, black + white, infra red), Video, Infra Red Video. MSS = Multi spectrum scanner.

2 Heights of Surveys:- Low level - channel only; Medium level - river corridor, High level - wider river corridor.

FCR/203

## ACTIVITIES WHICH COULD BENEFIT FROM SUPPORT BY AIRCRAFT

### 3. FLOOD DEFENCE

| Requirement | Features to be identified | Images Required | Height of Surveys | Benefit to NRA |
|---|---|---|---|---|
| 1. Flood Event Assessment | Limit of flooding. (S) (S) (W) | Infra red<br>Colour prints<br>MSS | Medium<br>High<br>High | Identify extent formulate countermeasures & predict warning times. Able to record event in accessible areas |
| | Damage (S) | Colour prints<br>MSS | Low<br>High | Used for cost benefit analysis |
| 2. Coastal Erosion (Annual Beach monitoring) | Beach profile and features (S) | Colour Stereo<br>MSS | Medium<br>High | Coastal management |
| 3. Planning Liaison | Level of contours (A) (T) (ST) (S) | Colour stereo | High | Control of floodplain development. Assess impact of proposed development and run off |
| 4. River Erosion & Silting | Channel profile - cliffs, shoals, islands etc (ST) (ST) | Video<br>Colour prints<br>MSS | Low<br>Medium<br>High | Assess changes in river channels |
| 5. Flood channel survey | Accurate lines of watercourse (T) | Colour stereo | Med/High | Comprehensive cover |

Note: 1 Images Required:- Still photograph, (Colour slide, negative, black + white, infra red), Video, Infra Red Video. MSS = Multi spectrum scanner.

2 Heights of Surveys:- Low level - channel only; Medium level - river corridor, High level - wider river corridor.

## ACTIVITIES WHICH COULD BENEFIT FROM SUPPORT BY AIRCRAFT

### 4. FISHERIES

| Requirement | Features to be identified | Images Required | Height of Surveys | Benefit to NRA |
|---|---|---|---|---|
| 1. Counting Salmon Redds | Salmon Redds (N) (ST) | Video | Low | Saving on manpower costs - presently done on foot. |
| 2. Identification of exploitation of major coarse fisheries | Anglers (ST) | Video<br>MSS | Low<br>High | Will give comprehensive overview quickly. |
| 3. Inland stillwater survey | Condition, location of pools (ST) | Video<br>MSS | Low<br>High | Saving on manpower to do survey on ground. |
| 4. Identification of different features during 12hr tidal cycle in tidal rivers eg R Trent | Banksides and river bed features (ST) | Video<br>Colour prints<br>MSS | Low<br>Low<br>Medium | R & D Project to assess fish population in R Trent |
| 5 Sea trout patrols along beaches | Set nets etc (A) | Colour prints<br>MSS<br>Video | High<br>High<br>Medium | Quicker comprehensive surveys |
| 6.Enforcement Drift nets | Boats, Nets (N) | Visual | Low | Increased control and inforcement of fisheries |
| Coast nets | Nets (N) | Video<br>Colour Print | <br>Low | |
| In-river poaching | Poacher (N) | FLIR | Low | " " " |

Note: 1 Images Required:- Still photograph, (Colour slide, negative, black + white, infra red), Video, Infra Red Video. MSS = Multi spectrum scanner. FLIR = Forward looking infra red.

2 Heights of Surveys:- Low level - channel only; Medium level - river corridor, High level - wider river corridor.

## ACTIVITIES WHICH COULD BENEFIT FROM SUPPORT BY AIRCRAFT

5. CONSERVATION

| Requirement | Features to be identified | Images Required | Height of Surveys | Benefit to NRA |
|---|---|---|---|---|
| 1. Strategic River Corridor Strategic Overview Surveys | Meanders, tree cover, major habitat types | MSS | High | Assess river corridors at much lower cost quickly than ground survey and at lower cost |
| | (ALL) | Colour print | Medium | |
| | (ST) | Video | Medium/low | |
| | (Y) | B + W | Medium/low | |
| 2. River Corridor/Coastal general visual resource information | As above plus structures, tree species, pools, riffles, islands, outfalls etc (ST) | Video | Low/Medium | Provide information at low cost compared with ground survey |
| | | MSS | High | |
| | (SW) (A) | Colour prints | Medium | |
| | (A) | Infra red | Medium | |
| 3. Environmental Impact Survey | Habitat types, channel, profiles etc (ST) | Video | Medium/low | As above |
| | | MSS | High | |
| | (W) (ST) | Colour print | Medium/low | |
| 4. Ecological survey - pre and post maintenance & capital schemes | Aquatic vegetation, flow patterns (T) | Colour prints | Low/Medium | Prioritise area for detailed surveys. Monitor recovery of sites |
| | riverside habitats (ST) | Video | Medium/Low | |
| | | MSS | High | |

Note: 1 Images Required:- Still photograph, (Colour slide, negative, black + white, infra red), Video, Infra Red Video. MSS = Multi spectrum scanner.

2 Heights of Surveys:- Low level - channel only; Medium level - river corridor, High level - wider river corridor.

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## ACTIVITIES WHICH COULD BENEFIT FROM SUPPORT BY AIRCRAFT

6. RECREATION

| Requirement | Features to be identified | Images Required | Height of Surveys | Benefit to NRA |
|---|---|---|---|---|
| 1. Recreational Survey | Boats, people, footpaths, (SW) (T)<br>horses, tents (ST)<br>Recreational activities, etc | Colour print<br><br>Video<br>MSS | Low<br><br>Low/Medium<br>High | Catchment planning database and identify needs for facilities |

Note: 1 Images Required:- Still photograph, (Colour slide, negative, black + white, infra red), Video, Infra Red Video. MSS = Multi spectrum scanner.

2 Heights of Surveys:- Low level - channel only; Medium level - river corridor, High level - wider river corridor.

FCR/203

## ACTIVITIES WHICH COULD BENEFIT FROM SUPPORT BY AIRCRAFT

7. NAVIGATION

| Requirement | Features to be identified | Images Required | Height of Surveys | Benefit to NRA |
|---|---|---|---|---|
| 1. Navigation Survey | Boatcounts, congestions, lock use etc (A). | Colour prints<br>Video<br>MSS | Medium/Low<br>Medium/low<br>High | Better understanding of navigation needs and problems. |

Note: 1 Images Required:- Still photograph, (Colour slide, negative, black + white, infra red), Video, Infra Red Video. MSS = Multi spectrum scanner.

2 Heights of Surveys:- Low level - channel only; Medium level - river corridor, High level - wider river corridor.

FCR/203

## ACTIVITIES WHICH COULD BENEFIT FROM SUPPORT BY AIRCRAFT

8. OTHER

| Requirement | Features to be identified | Images Required | Height of Surveys | Benefit to NRA |
|---|---|---|---|---|
| 1. Transport | NA | NA | NA | Transport to inaccessable areas eg. Liming experiments in Wales |
| 2. Public Relations - Photographs | NRA Sits, Operations, Activities | B + W<br>Colour prints<br>Video<br>(Broadcast quality) | Low/Medium | Provision of high quality PR images of NRA activities in context of river corridor etc. |

Note: 1 Images Required:- Still photograph, (Colour slide, negative, black + white, infra red), Video, Infra Red Video. MSS = Multi spectrum scanner.

2 Heights of Surveys:- Low level - channel only; Medium level - river corridor, High level - wider river corridor.

## SECTION 3

**OBJECTIVE 3** **To identify tasks that could improve the efficiency/effectiveness of the NRA if carried out by aircraft.**

## INTRODUCTION

A number of tasks were identified as worthy of investigating further. Enforcement of both Fisheries and Irrigation were seen as tasks whose effectiveness could be significantly enhanced by the rapid gathering of information from the air. Irrigation monitoring was already being trialled in Anglian. Fisheries river enforcement required flight trials to be set up and run to test the procedure. This was carried out in Northumbria. The report is at Annex D.

River Corridor and Coastal Baseline surveys were already being trialled by regions, using aircraft, with the potential for substantial future cost to the NRA. These were therefore reviewed.

Flood Defence surveys, again using aircraft, were reported as costing a total of £200 k in 1991/92 (Section 1) and therefore suggested that co-ordination might benefit the NRA.

The issue of sensors and platforms is considered in the summary. Each of the above were investigated as follows:

| | | |
|---|---|---|
| Fisheries Enforcement | - | Tony Champion |
| Irrigation Enforcement | - | Tony Harries |
| River Corridor | - | David Hickie |
| Coastal Baseline Survey | - | Nic Holden |
| Flood Defence Surveys | - | Tony Harries |

## FISHERIES ENFORCEMENT

### Scope of Problem

In a recent economic evaluation of salmon fisheries in Great Britain the estimated value of rod fisheries for salmon and sea trout was calculated at £72m and of commercial fisheries between £3m and £5.5m.

The prevention of illegal fishing for salmon and sea trout is one of the major tasks of the Fisheries, Conservation and Recreation function. It is difficult to separate out the exact expenditure on a regional basis with any precision due to variation in reporting methods but the total approaches £3m/year.

This expenditure supports the equivalent of 130 full time enforcement officers who apprehend about 400 people/year for the serious offences of illegal netting and the use of unlawful fishing methods as set out in the Salmon and Freshwater Fisheries Act 1975 and Byelaws and Orders made under that Act.

No Region has identified expenditure on aircraft for fisheries enforcement in the 1991/92 or 1992/93 Corporate Plans.

### Standards of Service and Performance Measurement

While standards of service are being developed and performance measures will follow, historically managers have found it impossible to develop satisfactory measures and have had to rely on experience and judgement when assessing the effectiveness and efficiency of water bailiffing teams.

The problem stems from the fact that illegal fishing does not necessarily generate a "crime report" because, if the poachers are not seen, there is no way of establishing if a crime has been committed. Thus water bailiffs normally rely on intelligence from informers, surveillance on stretches of river that are considered to be at risk and patrolling. In general the number of bailiffs available is small compared with the total length of river which should be covered so in theory there is abundant scope for illegal fishing.

It should be noted that the NRA's duty to maintain, improve and develop fisheries does not specify that we should prevent illegal fishing but clearly if we did not control it to some extent fish stocks would be affected and we would be in dereliction of our duty. There is thus no argument regarding whether or not fisheries should be policed but consideration must be given to the level at which it should be controlled.

Theoretically, it is possible to envisage setting the level at a point at which fish stocks are not significantly affected and, since salmon and sea trout populations are generally robust, most could withstand significant amounts

of illegal fishing. In practice the behaviour of poachers is such that if one gang is consistently successful other gangs form and in a relatively short time an illegal fishing epidemic can start which is difficult to stop. Experience has shown that least effort and, therefore, the least resources are required if the level is set at a point where the epidemic does not start. Moreover not only anglers and netsmen who pay a duty in respect of licences to fish and who obey the various regulations but more particularly fishing owners who have a vested interest have an expectation that the regulations should be enforced. They are frequently vehement in their complaints when they perceive a failure in this respect on the behalf of the NRA. Frequently complaints are received following relatively minor offences.

In order to effect this level of control in Northumbria little time is spent on patrolling river banks and coastal areas but considerable care has been taken to encourage informers and awareness amongst the public for the requirement by the NRA of information of a particular kind. As a result of this policy it is now usually possible to target individual gangs and apprehend them in the act thus leading to a successful prosecution. The attendant publicity discourages recruits to illegal fishing and so assists the enforcement effort.

Such a policy may appear very effective but it takes no account of the poaching gang that is never seen and whose members refrain from boasting about their exploits. Arguably, such gangs may not exist or if they do are not sufficiently damaging to fish stocks to be important, but two facts remain:-

1) our knowledge of fish populations is inadequate to form an opinion of the effect of poaching.

2) our information regarding illegal fishing is only as good as our intelligence system the extent of which is itself not measurable.

Cost Effectiveness

Until standards of service and measures of performance have been defined the cost/effectiveness of particular bailiff forces will not be measurable for two reasons:-

1) the level of illegal fishing depends on the numbers of fish available for capture and how well the terrain lends itself to poaching;

2) a low enforcement cost coupled with a high level of prosecutions does not necessarily demonstrate an efficient force. It might be a feature of a grossly under-resourced region whose bailiffs cannot set foot on the river bank without apprehending an offender. Conversely a region with few prosecutions but incurring substantial

costs may be demonstrating a high level of efficiency through deterrence.

Thus although the salmon producing regions vary very widely in both their resourcing and the number of offenders prosecuted no measure of their effectiveness is available.

## The Potential of Aircraft for Enforcement

In the majority of fishing cases the collection of evidence and the apprehension of offenders follows fairly standard procedures and normally follows on information received from numerous sources.

1. At Sea

Aircraft are perceived to be potentially an additional source of intelligence and salmon producing regions, in response to a questionnaire on potential aircraft usage, identified as their principal interests the overflying of the open sea to check for drift netting and estuaries and the coast for fixed nets.

Clearly in view of the political nature of the problem the policing of the drift net fishery in the N.E. is a priority area and this must extend into the developing sea trout fishery in East Anglia.

Welsh Region reported a requirement for the inspection of approximately 1200km of coastline for drift/fixed nets with North West and Wessex reporting an interest in 220 and 100km respectively. South West also reported a need to cover some 4110 square km of sea equivalent to 700km of coastline for drift nets.

Severn Trent's interest was restricted to the Severn estuary. Clearly individual flights in the Bristol channel could satisfy the requirements of more than one region.

A breakdown of costs is not available for either area but if for instance it is assumed that 10 bailiffs would take 2 hours at £15/hour to check 100 miles of coastline, a total cost of £300 would be incurred. A fixed wing aircraft or helicopter would patrol this in one hour at costs of between £200-£700/hour but the return flight could be over the open sea to inspect for drift nets. Here the cost of patrolling is highly dependent on the type of vessel used. For safety reasons in the North Sea and perhaps the English Channel substantial vessels (44' semi displacement hull, capital cost £500k) are necessary and the annual cost will be as high as £100,000/year. Experience in Northumbria suggests that the current vessel (costing £70k/annum), whilst monitoring a presence in the fishery and controlling poaching in the immediate vicinity does not provide information on what is happening over the horizon. Helicopter or fixed wing flights would give this information and savings could

probably be achieved by alternative methods of apprehension of any offenders (i.e. search on landing or use of inflatables).

2. In River Valleys

Of secondary interest was the patrolling of river systems. Apparently because of scepticism regarding the capability of aircraft in this role Regions did not identify their requirements.

However, the principle of using FLIR from a helicopter at night in the river valleys has been proven except that the operational method requires refinement by the utilisation of a suitable navigation system and possibly the use of night vision goggles by the pilot. Weather limitations must also be defined for safety reasons.

Fixed wing aircraft are almost certainly unsuitable so the cost of a patrol will equate to approximately £700/hour. The speed of a patrol is likely to be less than that over the sea but the cost of bailiffing is also higher because of the problems of surveillance or patrolling over difficult terrain in river valleys.

Potential for Cost Savings

In the case of both coastal and river valley patrols it is clear that the use of aircraft will increase the effectiveness of water bailiffs and dramatically increase the profile of the fisheries enforcement effort. However significant savings are only likely to be achieved immediately in the N.E. where the purchase of a further enforcement vessel was planned.

Savings against existing staff levels seem unlikely in view of the fact that bailiffing teams are based on the number of men required to act safely as an operational force in the face of potential violence and if the team strength is allowed to fall below this level they are ineffective.

However it is clear that there is a gap in our information about the scale and intensity of poaching and the use of aircraft can fill this requirement. If it is then identified that there is a problem aircraft utilisation may provide the most cost effective solution.

Conclusions

The principle of using aircraft for fishery enforcement has been proven by the helicopter trials undertaken in Northumbria (see ANNEX B ) but the need is still questionable and requires quantification. It is therefore recommended that further flights take place in 1992 as follows:-

1) Aircraft: Fixed wing and helicopter

Objective: To check for illegal salmon drift netting and fixed nets.

Areas: East coast from Wash to Holy Island
Bristol Channel
Also in N.W., S.W. and Welsh Regions at direction of Regional FRCN Managers.

Time of year: Summer

No of Flights: 30 (5/Region)

Approx. cost: 30 hours fixed wing at £200/hour = £ 6,000
30 hours helicopter at £700/hour = £21,000

**Note:** Past experience suggests that fixed wing aircraft may be suitable but they must be able to fly below 500 feet and at a speed of around 150 knots. There appears to be some doubt as to whether this is legal in all areas.

2) Aircraft: Helicopter fitted with FLIR (subject to availability)

Objective: To check for salmon fishing by illegal methods at night in river valleys.

Areas: Welsh, North West and Northumbria Regions at direction of local FRCN Manager. Consideration should also be given to flights in Wessex and South West.

Time of year: Autumn

No of flights: 45

Approx. cost: 90 hours at £700/hour = £63,000

**Note:** There will be further costs associated with refining the navigation system on the helicopter, in order to ensure effective operation at night. This will need further investigation.

<u>Navigation</u>

No requirements have been identified for the use of aircraft in relation to the management of Navigation.

## IRRIGATION & ABSTRACTION ENFORCEMENT

1) Introduction

The principle of enforcing legislation where it applies to watercourses and other NRA responsibilities has recently gained a higher profile. Team of Enforcement Officers have been appointed in Anglian Region and they will be assuming their duties to ensure that water abstraction, irrigation, boating, fishing licensing and other related legislation is complied with.

2) Enforcement tasks

These tasks can be broken down into the following groups:

a) Tasks requiring on-going monitoring.
b) Tasks in response to an incident.

On-going tasks can be defined as:

- Monitoring abstraction licenses.
- Monitoring fishing licenses.

- Monitoring boat licenses.
- Monitoring Section 23 of Land Drainage Act 1991 and Section 109 of the Water Resources Act 1991.
- Monitoring Byelaws consents issued under the relevant Land Drainage Acts.
- Monitoring in connection with development planning and control.

Incident related tasks can be defined as:

- Monitoring ban as a result of a drought order.
- Monitoring pollution plumes.
- Illegal eel, salmon or sea trout fishing.

3) Effectiveness of aerial monitoring

The effectiveness of aerial surveillance can be assessed in terms of whether or not all information can be obtained whilst in the air. Many of the on-going tasks will require actual contact with the potential offenders to determine the validity of any licenses they may hold, eg. fishing and boat licensees.

Aerial surveillance can play an effective role in monitoring potential infringements of the above mentioned acts which relate to structures in flood plains or encroaching on watercourses.

Irrigation bans can only be effectively carried out from the air, as large tracts of land would otherwise be hidden from enforcement teams at ground level, eg. behind woods or structures.

Other incidents may require rapid deployment of staff to assess the developing situation, eg. pollution incidents. The source of the pollution may well be obscured within a very short time and the extent of the effected area may be difficult to determine.

In the case of illegal fishing the sudden appearance of a surveillance aircraft will make the hiding of tackle much harder to achieve. The deterrent factor must not be overlooked. The fact that enforcement flights are being flown, can in itself be sufficient incentive to encourage abstractors to comply with licensing requirements.

4) Alternatives

In all cases identified the only alternative is the "man on the ground". In some cases this is the most effective method, eg. checking of licenses. To ensure compliance with irrigation bans this would be a colossal task, an assessment has been made as a one hour flight being equivalent to 3 days ground survey/inspection.

Even allowing for the extra time coverage by ground based staff, they would be unable to view all areas.

5) Costs

To fairly address the subject of costs, a direct comparison must be made between the alternatives. An estimate has been made that 1 hour in the air equates to 3 days of ground activity in terms of area coverage.

- Light aircraft travelling at 100 kts observes 400 sq miles per hour.

- Ground based officer travelling at 20 mph observes 16 sq miles per hour.

Assuming an hourly rate of £20 for the enforcement officer the costs are:

| | | |
|---|---|---|
| Aircraft survey per hour | - £130 | 400 sq miles |
| Ground Officer 3 days | - £480 | |

The ground officer survey would not be as thorough as the aerial survey.

6) Conclusions

The use of aircraft in conjunction with ground based teams would allow rapid spotting of infringements, coupled with the ability to direct enforcement officers to sites, possibly hidden from the ground.

To carry out effective enforcement, it is vital that all areas can be covered, rapidly, fully and with a high profile ensuring the maximum deterrent effect.

Airborne surveillance is the only option which will ensure full coverage.

7) Recommendations

To increase the use of aircraft for enforcement surveillance.

To improve ground to air communications, enabling enforcement teams to be deployed most effectively.

## River Corridor Strategic Overview Surveys

An Overview survey is required to provide a basis for strategic planning and response to conservation issues, undertaken by the Conservation Function.

A feasibility study has been commissioned to identify the methodology for a strategic classification system. Initial studies indicated that a simple classification system could be derived from the survey of several key features such as 'naturalness' of channel and amount of tree cover, 'expected' habitats on specific river type etc; all of which could be derived from aerial images.

Aerial images could provide a cost effective 'snapshot' classification database. Ground survey of 42,000 km would take many man-hours and require much detail to give a general overview of a river corridor.

The image data could also be analysed in greater detail to give day to day interpretation of the potential environmental impacts of operations and regulatory activities.

The aerial data for the River Corridor Overview Surveys could be obtained as a stand alone exercise with current estimates of £400,000 for video coverage or £600,000 for copies of existing colour vertical photographic coverage of all RQO watercourses. As such data is of multi-functional use, it would seem more cost effective for the data to be gathered for multi-functional use. The use of aerial video is explained at AnnexE and the use of stereo photographs (by Southern) is at Annex F

## Multifunctional Overview

Comprehensive aerial image data coverage would improve the effectiveness of all functions, some examples of which are listed below:-

- Provision of visual overview of river corridor.
- Location of channel, assets and other features
- Appraisal of operations and regulatory activities without having to go out to site.
- Land uses identification.
- Appraisal of time required to undertake operation or activity eg site survey.
- Identification of access to site.
- Ability, to identify potential problems prior to going out on site.

Such data also provides a 'Doomsday' record, or 'State of the Environment' in the current terminology of Environmental Auditing. This would be a very useful resource for all functions for future reference.

River Corridor Cont/....

If aerial image data is to be useful for every day usage by Functions, it must be easy to analyse and readily accessible. All three formats (multi spectrum scanning, video and colour stereos) can be easily stored and referenced using Global Positioning Satelites (GPS) to help identify frames/pictures.

The accessibility of the data can be variable. The video allows multiple copies at very low cost and relatively small storage space required for the cassettes. Multi spectrum scanning requires very little storage space on computer disks, but does have limitations for all staff to have easy everyday access. Colour stereo prints require much more storage space than the other two formats and much higher costs entailed in providing additional copies for wide office use.

There is a new system called 'Jasmap' which can store scanned images of colour prints in an Apple Mackintosh computer system. This then can be overlain by OS maps scanned into the system, together with a layer for notes etc. Thames Region is evaluating the system at present.

The three major formats (multi-spectrum scanning, video and colour vertical stereos), together with colour oblique prints for special projects, prosecutions etc, can cover nearly all the aerial image requirements of the NRA.

Public Relations

Comprehensive coverage using video which is of broadcast quality would provide a resource library which can be used for televised PR items.

Retrieval

All image gathering should be compatible with any future GIS and WAMS.

Other Uses

There are many specific uses of aerial data which have been identified in Objection 2 which are not simple to quantify the improved effectiveness of existing functions, eg. identify contaminated land, and recreation surveys. Many new uses will appear once the data starts being used.

The Forward Looking Infra Red (FLIR) and Night sights required for fisheries enforcement are the only other image requirements.

Image Formats

In Section 2 the table identifies the various formats that users consider will meet their requirements.

Many of the requirements could be fulfilled by the use of similar images, but it is recognised that there will always be a need for special or 'one off' image requirements.

Different Regions have different preferences for image format. The range of image requirements is listed below:

- Purely visual.
- Colour print - oblique.
- Video - oblique.
- Video infra red - oblique.
- Colour infra red - oblique.
- Colour stereo pairs.
- Black and White stereo pairs.
- Infra red.
- Multi spectrum scanning.
- Low light intensifiers (Night sights).

Severn Trent Region will have full coverage of all Main River (3700 km) by the end of 1991/92, on low level oblique video format with copies available for easy reference by all functions in each area office. Other regions show a preference for colour prints and/or stereo pairs as the major image source reference material.

Some regions are specifying Black and White, stereo pair photographs. Others specify colour stereo pair photographs. This raises questions on knowledge of the current technology, actual need and cost considerations.

Specialist one off image gathering exercises, eg. colour stereo pairs for flood plain contour mapping can be justified on an individual basis. It is very probable that full image coverage of the Main River savings by all functions able to quickly assess site implications of operations and regulatory activities. Coverage of all RQO watercourses and complete catchments may be justifiable.

These requirements will need to be properly appraised.

The three major feasible options for comprehensive image capture are:-

a) Multispectrum scanning.
b) Oblique video.
c) Colour or Black and White stereo vertical pairs.

The possible requirements for Regional image coverage listed in the table below outlines the cost of video coverage from known costs from the Severn-Trent exercise. Costs for multi spectrum scanning and colour stereo pairs for these requirements have not been costed at present.

| Region | Main River Km (1990) | Video Coverage * £K | RQO Watercourse Km (1990) | Video Coverage * £K |
|---|---|---|---|---|
| Anglian | 5812 | 58,120 | 4453 | 44,530 |
| Northumbria | 1485 | 14,850 | 2785 | 27,850 |
| North West | 5947 | 59,470 | 5900 | 59,000 |
| Severn-Trent | 3573 | Complete | 7055 | 34,820 to Complete |
| Southern | 2748 | 27,480 | 2010 | 20,100 |
| South-West | 1370 | 13,700 | 2788 | 27,880 |
| Thames | 5294 | 52,940 | 3748 | 37,480 |
| Welsh | 5673 | 56,730 | 4802 | 48,020 |
| Wessex | 2312 | 23,120 | 2548 | 25,480 |
| Yorkshire | 1741 | 17,410 | 6034 | 60,340 |
| | 35955 | 359,500 | 42123 | 380,650 |

* Based on average cost of £10/km which includes helicopter hire, camera staff, using Severn-Trent video equipment and provision of six VHS copies.

A Multi-Spectrum scanning (MSS) coastal survey is planned for England and Wales, funded by R & D and lead by Wessex Region.

**Recommendations**

There is a potential need for comprehensive image data coverage of all Main Rivers to provide a multi-functional reference resource, which will benefit all functions in their ability to operate more effectively.

The indications are that Regions are obtaining image data on a piecemeal basis, in a variety of formats; without full liaison with other functions within the region, in many cases, to obtain the optimum coverage of features in the most cost effective way.

A cost benefit analysis is required to evaluate the need whether it extends to all main river RQO watercourses or the whole catchment, and preferred image format for each region.

It is recommended that standard national specifications are drawn up for the provision of aerial images for the various formats, to simplify Regional specification procedures. Formats should be compatible with GIS and WMAS for ease of access.

## COASTAL BASELINE SURVEY

### Requirement

The object of the survey is to monitor the state of the waters around the coast of England and Wales to the 3nm territorial limit.

Why do we want to monitor the coastal zone? It states in the Water Act that the NRA is responsible for monitoring these waters to that limit. What do we do now? We take a few samples in specific estuaries and at a few outfall sites. This in no way constitutes monitoring of the coastal zone.

How can we go about the task? Monitoring this length of coastline in a manner which can be understood by all as a fulfilment of the act is by far the largest task on the NRA list of surveys. There is no way that this job can be carried out by conventional survey techniques. The regional laboratories would be totally out of depth and the cost would be astronomic.

There is only one way open to enable us to undertake the job in hand and luckily for the NRA the costs are minimal compared with conventional techniques.

### MSS

How will we do it? By combining survey results from our survey vessels with results from an airborne Multi Spectral Scanner (MSS). This will allow us to calibrate the coastline water qualities to a spatial resolution of 10m. Better resolution can be obtained in specific areas by flying lower or changing lenses if required.

### Method

Firstly, we will take each of our 'Vigilance' class survey vessels in turn. They will make a passage along their allotted length of coast. The track will be within the 3 nm zone and taking in as many of the known water masses as possible.

At approximately 15 km intervals the vessel will stop. An instrumental profile will be carried out for Salinity, DO and Temperature to a depth of 5 m (to check for stratification and any surface effects). Also a full set of chemical samples will be taken.

Along the track between sample sites all the known electronically measurable parameters will be logged. This involves taking good quality Salinity, Temperature, Depth, Dissolved Oxygen, pH, Turbidity, Transmission and Chlorophyll monitors and mounting them in such a way as they will work at a passage speed of some 8 knots. These monitors are then connected to the Qubit Navigation system.

The navigation system is then used to put up a head up display. This ensures that the vessel goes along a predetermined track. While this task is being performed a background function of logging all the water quality parameters will be carried out. At present this is done every 20 seconds (80 m).

All this data is then fed into a GIS archiving system and used to calibrate the MSS data.

We will take CASI MSS, a survey camera, together with an integrated navigation and logging system, and mount it in a light twin engined aircraft and fly in tracks that ensure that the whole of the coastal zone is covered in one swathe preferably within 24 hours of a survey vessel.

Survey Vessels

The survey vessels presently on the water and on order will give us the capability to monitor most of our coastline. Vigilance has proved itself capable of covering the sea area - Severn Bridge to the River Medway in the Thames Estuary. Sea Vigil, at present working up, will cover the area from the Thames to Flamborough Head (halfway along the Yorkshire coast).

The Northumbrian vessel, which is due for launching in the new year will cover the area from Flamborough Head to the Scottish Border. The last vessel in the present series is due to be delivered to the North West Region in the late spring or early summer and will cover the area on the west coast from the Scottish Border to Holyhead on Anglesey.

This will leave the major part of the Welsh Coast without cover. In the short term it would seem best if both Vigilance and the North West vessel extend their passages as far as Fishguard. There is an obvious shortfall in the NRA's cover in this area which should be addressed.

Frequency

Now, how often should this be done? If we aim to start the first survey in April/May we should have at least three of our vessels fully commissioned. This would be followed by a second survey in July when we should have he last vessel commissioned. The third run would be scheduled for October followed by a mid-winter run in January.

Weather will obviously be a major factor in the speed and ease of each survey. If we own each piece of equipment there will only be minimal cost involved in down time. Should any part be contracted out then costs will escalate considerably.

Benefit

What will we get out of this survey? We will get a full pixel and pixel survey of the coast which will build up year by year into a major national asset. All raw data will be logged from the scanner, thus giving the option of back tracking as further parameters are researched from the spectral pattern.

Plan

1. Order scanner.
2. Set up aircraft.
3. Set up processing and archive systems.
4. Prepare survey vessels.
5. Determine vessel tracks and sample points.
6. Survey Year 1 - Run A: May-June
   Vigilance - Sea Vigil - Northumbria
7. Survey Year 2 - Run B: July-August
   Vigilance - Sea Vigil - Northumbria - North West
8. Survey Year 1 - Run C: All Boats
9. Survey Year 1 - Run B: All Boats

Sampling

How many samples will it take? Assuming we keep a 15 km spacing we can expect to cover the NRA coast with approximately 174 samples per run.

| | |
|---|---|
| Northumbria (to Flamborough) | - 17 |
| Anglian (from Flamborough) | - 32 |
| Wessex Vigilance | - 69 (+19) |
| Welsh | - 44 |
| North West | - 31 (+25) |

If Welsh Region is split at Fishguard as a temporary measure

| | |
|---|---|
| Wessex Vigilance | - 88 |
| North West | - 56 |

this gives an approximate length of coast to cover of some 2,600 km.

What we have to do is build up a data base over the years which will show seasonal variation and gives us true trend analysis over time. Once the main surveys are completed any number of specific areas could be surveyed. This could give tidal variations in a given area.

How Long Will it Take?

From our experience on the South Coast where we aimed to cover approximately 1320 Km on task, we ran out of time at 25 hours and estimated another 7 would have seen the job through. This gives us approximately 41.25 Km on task/hour - a total of 64 hours for 261 Km for the whole coast. Now that was operating close to home. It is estimated that an extra 15.20 hours would be taken up in positioning time when trying to achieve full coast coverage. Also where the 3 nm limit encloses a bay the width of the swath has to be increased by a re-run on a parallel course. This will add some 15-20 hours giving us an estimate of 105 hours per survey. If we now consider the time during the day when sun angle is acceptable; high noon +/- 2 hours, we get a figure of 26 working days per survey, depending on days off/weekend etc - say one month.

The survey will be repeated 4 times per year which will give a minimum on the baseline survey along of some 420 hours in a 12 month period.

Sensors

The question arises as to whether one should go for CASI or ATM, and further whether one should hire or buy. The ATM is a tried and tested system which has been used for land surveys for many years. However, of its twelve channels, less than half are of use in the marine environment; principally those between 430 and 700 nm (visible) and at 12 nm (thermal infra-red). The quality (total suspended particulate matter (SPM) for example). It is limited in its spectral information (detail of colour) and its radiometric resolution (intensity of signal from the sea surface). In addition, it uses relatively old, mechanical technology which is both expensive to build and maintain (a service contract on a system purchased would be essential). The cost of such a system begins at about £0.8-1 million!

The CASI is a new technology which has over the past year proved to be not only reliable but also to provide far more information on water quality, with detail of chlorophyll and SPM (organic and inorganic separated) already available and far more information (effluents, sediment types as well as concentrations, nutrients (indirectly) promised with current research efforts over the next year or so. Furthermore, the system is substantially cheaper to purchase (c £200 k) and maintain, being solid state technology throughout. Its one drawback is that though the idealised marine system, with improved blue end response, thermal channels and wide angle view for improved spatial coverage, is perfectly possible, systems available to date have been built for customers working in the land community with different requirements.

In the quest for the ideal system for marine work the NRA has approached Itres (CASI) and discussed the modifications required. The response was very positive and favourable. With this in mind the option of which sensor should we choose is very firmly - the CASI. Further to that, the unit will be to our specification and therefore not available on the hire market. The recommendation is therefore to purchase. This matter is fully covered by Reference 1.

The Camera

To ensure full utilisation of the MSS data we require survey photographs of the whole area coincident with the survey. At the height and speed we would be travelling a standard 9" formal survey camera such as the Wild (Leica) RC8 or 10 would suffice.

The Aircraft

What we require is a stable, safe efficient survey platform. There are a number of areas which have to be considered when deciding on which option to take. If one starts with our aircraft requirements as itemised in Annex J. It can be clearly seen that they are not standard or straightforward. Also in Annex J is a list of points which lead us to the conclusion that buying an aircraft would probably be the most sensible answer.

If we look at the cost comparison of Buy v Lease v Charter - Annex J - then again for a given aircraft type, buying is the most attractive option. The break even point is in the 2-3 year region and we are talking about a 10 year plus survey programme. The fact that the figures are worked on a PA31 Navajo does not tie us to this option. It is the only type in which all three cost options are readily available. If we look at the second hand market for light twin aircraft there are only a limited number available. They are:

1. Navajo
2. Navajo Chieftain
3. Islander
4. Partenavia
5. Rockwell Commander
6. Dornier Skyservant
7. Shorts Skyvan
8. Twin Otter

The option that we would choose really depends on what is available on the market. As long as it conforms to the general configuration in Annex J. If we do set up an aircraft of this class with the survey systems outlined, it would give the Authority a fully operational survey tool that could be available to undertake further Authority work, other than that which requires a helicopter.

The standard of data collected would be more comprehensive than the existing systems. The positions of all photographs would be electronically archived for easy retrieval and there will be a full MSS data set to back up any purely photographic jobs that are presently undertaken. Potentially the following areas would benefit (also see Section 2 and the following report 'Sensor Systems'):

1. One-off marine studies
2. Coastal fisheries enforcement
3. Any photographic surveys (Flood Defences)
4. Any photographic surveys (Water Quality); fish farm discharges, land contamination mixing zones; pollution incidents; to name but a few
5. Water resources enforcement
6. Conservation - strategic overview surveys, environmental surveys

If we look at the present aircraft usage on Page 8, there is up to £279 k of existing work that could be undertaken. This would probably double the number of hours flown to somewhere in the region of 800 hours/year. Cost savings can be achieved but are difficult to assess at this time. One overriding factor that must be taken into account is that the quality and coverage of the data we will acquire will be unsurpassed.

Conclusions

An aircraft fitted with a MS Scanner, Survey camera and navigation system is recommended to carry out the NRA obligations in monitoring the coastal zone. On the basis of 4 surveys per year, the aircraft would be required for 420 hours on coastal monitoring alone. If required we could have an operational system up and running by early summer. As far as aircraft are concerned the option to buy is likely to be the most favourable. It would have cost saving implications to operational survey work. We would expect to carry out a total of approximately 800 hours per year if al NRA requirements were flown by the same aircraft.

MSS operated nationally would be a great bonus to the NRA, both nationally and internationally.

## FLOOD DEFENCE SURVEYS

### 1) Introduction

This report addresses the requirements for aerial survey within the flood defence function, the technology employed and the need for aircraft support. The information received from regional offices has been collated and is detailed below where specific requirements have been identified.

### 2) Needs & Requirements

The following is a summary of the needs and requirements of the four regions which have identified a need for aerial survey. See the Table over.

| Region | Need | Requirements |
|---|---|---|
| Anglian | To assess erosion of beaches | Accurately map levels to ± 0.5 metres. |
| Severn Trent | Identify floodplain contours for | Overlay analysed stereo data onto OS 1:2500 background. Accuracy to ± 0.25 metres. |
| Southern | Determine beach profiles | Provide analysed stereo data on O.S. 1:5000 background. |
| Thames | Identify floodplains. Contour plotting for modelling purposes. | Provide data for MOSS mathematical mathematical model. Overlay analysed stereo data onto OS 1:3000 background. Accuracy to ± 0.05 metres. |

### 3) Equipment & Use

Specialised equipment in use:

| Region | Equipment |
|---|---|
| Anglian | Stereo pairs camera. |
| Severn Trent | Stereo pairs camera with FMC. |
| Southern | Stereo pairs camera. |
| Thames | Stereo pairs camera with FMC. |

Most other regions used aerial photography in either still or video format for river corridor surveys as well as assessing the extent of flooding. Flood assessment can be carried out in a most cost effective way by aerial survey. A sample tender document that gives a comprehensive specification is covered by Reference 8. Data on at risk areas as well as flooded areas can be rapidly assimilated and where use is made of heat sensitive equipment, the extent of flooding, following the retreat of floodwater, can be readily determined.

TABLE 1.

REGIONAL AIRCRAFT RETURN. USAGE

| REGION | QUESTION | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Survey / Inspection | | | | | | Emergencies | | | | | | Enforcement | | | |
| | Use | Flood Defence | Type | | | Others | Use | Type | | | Assess | Manage Remedial | Use | Consents Sect.28 | License | Plan Develope |
| | 1 | 2 | 3 T | F | B | 4 | 6 | 7 F | P | O | 8 | 9 | 11 | 12 | 13 | 14 |
| Anglian | YES | YES | -- | 1 | 1 | NO | YES | 1 | -- | -- | YES | YES | YES | YES | YES | YES |
| North West | YES | NO | -- | -- | --- | NO | YES | 1 | 1 | -- | YES | YES | YES | NO | YES | YES |
| Severn Trent | YES | YES | -- | -- | 1 | YES | YES | -- | -- | -- | YES | YES | NO | NO | NO | NO |
| Southern | YES | YES | | | 1 | NO | | | | | | | | | | |
| South West | | | | | | | | | | | | | | | | |
| Thames | YES | YES | | | 1 | | | | | | | | | | | |
| Welsh | YES | YES | -- | -- | 1 | | YES | 1 | 1 | -- | YES | YES | NO | NO | NO | NO |
| Wessex | YES | YES | 1 | -- | -- | NO | YES | 1 | -- | -- | NO | YES | NO | NO | NO | NO |
| Yorkshire | | | | | | | | | | | | | | | | |
| Totals | 3 | 3 | | | | 1 | 4 | | | | 3 | 4 | 1 | 1 | 1 | 1 |

Notes. 1. The table shows the three categories data has been requested for i.e. Survey /Inspection. Emergencies and Enforcement
2. Columns show whether a region uses aircraft for this category ( a YES return ) or not.
3. Question 3. T = Tidal. F = Fluvial. B = Both.
4. Question 7. F = Flooding P = Pollution. O = Other.

Analysis of table 1.

Table 1. reveals that of the returns received; 7 use aircraft for Survey / Inspections. 1 for tidal defences alone, the others for tidal and fluvial.
5 regions use aircraft for Emergency work; 4 for flooding incidents. 2 for pollutions and 1 unspecified. 4 assess flooding from the air.
All carry out management / remedial work by air.
Only 2 Regions are using aircraft for Enforcement work; all categories of Enforcement are covered by air .

In all cases the justification for use of aircraft was. cost effectiveness of covering large areas. and speed of making assessment of damage etc.

In the four regions identified, all had heard of MSS, or other similar scanning equipment and all were aware of satellite capabilities. Both systems were considered to be too coarse for their requirements.

As can be seen from the above, similar surveys are being carried out in various regions. However, the requirement for accuracy varies greatly. In the case of Thames, data derived from computer analysis of the stereo photographs is loaded into an industry standard MOSS mathematical model, giving the facility to provide a complete hydraulic model of the surveyed area.

Photographs produced by the survey method described will be available for other uses. Asset surveys can be determined from high quality prints. This may call for an expansion of the area covered at present, eg. Anglian cover the coastline only.

In all cases the subject of new technology was broached and all concerned expressed interest in any advances which would improve the speed of data retrieval and the accuracy of results.

The cases illustrated are examples of on-going mapping projects which will normally be carried out annually or bi-annually.

It has to be stressed that the projects have developed to their present level of complexity over a period of time. The original needs may have been simpler than what is being obtained at present. In fact it is probably fair to say they are now being result-driven rather than need-driven.

4) Alternatives

The alternative to the identified uses above would have to be ground based surveys. An estimate has been made that 1 hours flying equates to 3 days ground survey time with an equivalent penalty in number of staff being used.

5) Costs

As costs for the analysis vary with the depth of research required, no attempt has been made to assess this aspect. Cost comparison will be confined to equipment type, aircraft charges and estimated ground survey. A fuller coverage of survey camera specifications and costs is given at Annex G.

| Equipment | Cost |
|---|---|
| Basic Wild RC8 Stereo Camera | £20,000 |
| Wild RC20 with Forward Motion Compensation | £170,000 |
| Piper Aztec* | £350 per hour approximately |

*Must be modified to accept the equipment which is floor mounted with lens aperture through the bottom of the airframe.

| | |
|---|---|
| Piper Aztec with equipment on hire | £1,000 per hour |

## Conclusions

Aircraft are used by virtually NRA regions in the survey/inspection role, albeit to varying degrees of analysis. The photographs from the various types of survey cameras can be used to determine erosion and accretion on coastal structures and beaches. With analysis having been carried out on the stereo pairs photographs, height data can be provided for mathematical modelling purposes and production of contours on to O.S. map backgrounds. By fitting video equipment to survey aircraft and adjusting flight paths (i.e. not just along coastal margins) other tasks could be carried out at the same time, eg. oblique filming of structures.

To cover the same area by ground survey alone would slow, staff intensive and expensive, surveys are carried out biannually in many cases.

The main conclusion is that the use of aircraft in the role of flood defence survey/inspection is the most cost effective method.

## Recommendations

1) The use of aircraft fitted with stereo survey cameras for flood defence survey/inspection work, is an effective method of producing the images required.

2) There are different data requirements (i.e. $\pm$5-50 cms in height) by the regions. If the NRA is to standardise on a sensor system this may need to be resolved.

3) To investigate fitting video or other equipment to survey aircraft, enabling other photographic needs to be fulfilled.

## SENSOR SYSTEMS

The river corridor report in this section (and other reports) identifies that different image formats produced by different sensor systems apparently are meeting the same or similar requirements, depending upon the region. Even with the same image format (stereo pairs) there are differing height accuracies required (±50 cm Anglian, ±5 cm Thames). Also, the Coastal Baseline Survey (MSS) project proposes fitting CASI and a survey camera into the aircraft to meet differing requirements.

The Table "Sensor System Capability" - over - shows perceived needs against possible airborne system capability, and method of data/image storage available.

The vast majority of our image requirements can be met by MSS and/or Vertical. Survey 8" and/or video. Rather than identifying the images required, the obvious question is, could a single sensor system meet all of the data requirements if the data needs were accurately specified with the acceptable tolerances.

The objectives identified in the appraisal for the R&D project "A review of Remote Sensing Techniques" indicated that this issue was likely to be addressed - Annex H. This report was due in November. The project team anticipated that it would provide information on our operational data requirements, the various sensors and their capabilities available to meet the needs.

The final report (Reference 2) gave scant attention to the NRAs Flood Defence survey requirements (Anglian Region and ADAS not consulted) or the use of video for river corridor surveys (areas of significant regional expenditure).

The conclusion and recommendations are at Annex I.

### Platform

It is axiomatic that our data requirements give rise to the image/data format which dictates the sensor system. When the sensor(s) system is known then preferred platform (aircraft) can be identified.

### Recommendation

It is recommended that we carry out a review of our data needs that can be cost-effectively met by remote sensing systems. Compatibility with GIS and WAMS should be considered. A single system solution should be investigated.

## SYSTEM CAPABILITY

| NEED / SYSTEM | VISUAL | RADAR | MSS | SURVEY 8" | OBLIQUE 2¼ | INFRARED PHOTO | VIDEO | OTHER |
|---|---|---|---|---|---|---|---|---|
| COASTAL - Flood Defence | | | | | | | | |
| Coastal Zone Management Survey | | | | | | | | |
| - beach profile | | ✓ | ✓ | ✓ | | | ✓ | |
| - salting surveys | ✓ | | ✓ | ✓ | ✓ | | ✓ | |
| - asset surveys | ✓ | | ✓ | ✓ | ✓ | | ✓ | |
| Environmental & Conservation | | | | | | | | |
| - habitat | ✓ | | ✓ | ✓ | ✓ | | ✓ | |
| - landuse | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| - pollution monitoring | | | ✓ | | | | | |
| - pollution reporting (visual) | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Fisheries Enforcement | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| RIVER - Flood Defence | | | | | | | | |
| - asset surveys | ✓ | | ✓ | ✓ | ✓ | | ✓ | |
| - consent enforcement\irrigation/licences | ✓ | | | ✓ | ✓ | ✓ | ✓ | |
| - flood assessment/management | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| - planning liaison - development control | ✓ | | ✓ | ✓ | ✓ | | ✓ | |
| Environment & Conservation | | | | | | | | |
| Strategic corridor surveys | ✓ | | ✓ | ✓ | ✓ | | ✓ | |
| Redd counts | ✓ | | | ✓ | ✓ | | ✓ | |
| Environmental impact surveys | ✓ | | ✓ | ✓ | ✓ | | ✓ | |
| Water quality risk assessment | ✓ | | ✓ | ✓ | ✓ | | ✓ | |
| Pollution monitoring/reporting | ✓ | | ✓ | ✓ | ✓ | | ✓ | |
| Fisheries | | | | | | | | |
| Enforcement | ✓ | | | ✓ | ✓ | ✓ | ✓ | |
| Recreation Survey | ✓ | | | ✓ | ✓ | ✓ | ✓ | |
| Database compatible | | | ✓ | ✓ | ✓ GPS | | ✓ GPS | |
| Storage | X | DIGITAL | DIGITAL | PHOTO/SCAN | PHOTO/SCAN | PHOTO/SCAN | CASSETTE/SCAN | |

MSS & Survey 8" could be carried out simultaneously if felt necessary to operate both systems.
Height/field of view to be resolved. Cost/benefit required on systems

## SECTION 3

### SUMMARY

#### Enforcement Fisheries

1) Use of aircraft to extend the effectiveness of existing coastal patrol vessels should be considered prior to the purchase of any further vessels.

2) Aircraft would dramatically increase the profile of both river and coastal enforcement.

3) Saving against existing staff seems unlikely.

4) Further limited evaluation should be carried out using aircraft for both rivers and coastal enforcement. Cost approximately £100,000. Note - the use of helicopter and FLIR for night surveillance will require some development to ensure maximum effectiveness and safety.

#### Enforcement Irrigation

5) Aircraft substantially improve the effectiveness of irrigation enforcement. They provide timely information on where irrigation is taking place. Air to ground communications need improvement.

6) Aircraft are likely to have a significant deterrent and effect if backed by effective enforcement.

#### River Corridor Survey

7) A proper analysis is required to evaluate the need, extent, and preferred image format for river corridor surveys.

8) Regions are obtaining image data on a piecemeal basis in a variety of formats.

9) There is a need to ensure that regions are able to specify their needs and that they are aware of the technological options available to meet those needs.

10) A standard specification should be drawn up for image format that is compatible with GIS and WMAS.

#### Coastal Baseline Survey

11) This report concluded that the NRA's requirements are best met by procuring an (MSS) CASI. The CASI will require a suitable airborne platform.

#### Flood Defence Surveys

12) The report identifies the differing requirements in contouring (i.e. ±5-50 cms) between the regions from the same images. This may need to be resolved if a standard sensor system is to be considered.

#### Sensor Systems

13) A review is required of our data requirements with the objective of identifying a preferred remote sensor system solution.

## SECTION 4

**Objective 4** **To investigate and establish links with other agencies operating aircraft in similar roles which could be advantageous to the NRA.**

Introduction

The agencies listed have been contacted and reported on as shown.

| | | | |
|---|---|---|---|
| MAFF | - | Fisheries Protection Agency | - Dave Stanley |
| Dept of Transport | - | Marine Directorate | - Nic Holden/Dave Stanley |
| NERC | - | | - Nic Holden |
| ADAS | - | | - Dave Stanley |
| Police | - | | - Dave Stanley |
| RAF | - | | - Dave Stanley |

### FISHERIES PROTECTION AGENCY

Introduction

The Fisheries Protection Agency (FPA) is part of MAFF. The FPA is responsible for regulating fishery activities in the U.K. (England, Wales and Northern Ireland). It has an operations centre on Smiths Square, London. The operations centre is manned by 2 fisheries officers and a clerk. The centre is equipped with HF radio, fax and computer data links. Mike Woodhead is responsible for FPA operations. The contact was Angus Radford, one of the two fisheries officers.

Equipment

FPA operates with 2 Dornier 228/200s, 1 Islander Turbo BN2T, 7 Royal Navy Operated Island Class vessels and 4 Tonclass Minesweepers.

There are approximately 100 British Sea Fishery Officers around the coast of the U.K.

MPCU

Co-ordination with the MPCU consists of exchanging flying programmes on a weekly basis. The FPA aircraft report pollution incidents to the coast guards (as should any other aircraft).

Training

The FPA run a 3 week training course for its fishery operation. The training includes the captain and co-pilots of all FPA aircraft. The course covers:

Fishery and EEC legislation
Gathering evidence
Fishing practise
FPA procedures

Aircraft Operation

The FPA contract is for 2,800 hours per year. The Islander normally covers coastal waters out to 30 miles. Dorniers cover the remainder. There are normally 4 FPA vessels at sea using radar and visual ident. The aircraft search sections of sea and relay target information to a supporting vessel that then investigates and boards as necessary. All information gathered by aircraft and vessels is fed into a computer based data system. This includes catch information. It is claimed that 90% of all fishing vessels active in British waters are recorded each week.

Aircraft utilisation is high with the average transit time 10% (Scots 30%).

The aircraft are also subleased to other unspecified agencies.

Effectiveness

The high value of deterrence was emphasised, also that of enforcement. The aircraft are solely responsible for 2-3 prosecutions per year. Total prosecutions by the FPA run at 25-30 per year (this includes aircraft, vessels and BCFOs).

Contract

The aircraft are operated on a 5 year turn key contract, by Flight Refuelling of Hurn using 12 crews. The lengthy lead times for establishing contracts of up to 18 months for aircraft was highlighted along with the importance of marinisation. The FPA has just gone to tender again, Reference 7. There were 70 responses. He was reluctant to discuss costs but indicated it was in the region of £2-3 million per annum. The FPA are very proud of their experience in operating aircraft in the maritime environment. They are in contact with and advising other nations on their experience. They appear to be willing to assist us if requested.

Comment

The FPA are a very well resourced, high profile operation that is establishing a lot of data on fishery activities. It's effectiveness could not be measured by enforcement/prosecutions.

Recommendations

1) The NRA needs to consider tapping into this intelligence in the context of salmon drift netting and possibly offering another dimension to coastal ecological data.

2) The FPA appear willing to assist us in whatever way they can. Their contract experience on fixed wing aircraft could be valuable.

3) Consideration should be given to establishing formal links for reporting coastal pollution information.

## DEPARTMENT OF TRANSPORT MARINE DIRECTORATE

### Resources

The directorate is made up of both the Marine Pollution Control Unit and the Coastguard. Between them they operate ten aircraft.

2 x twin engined Cessna
1 x Islander
7 x Dakotas

The Cessna's are operated as remote sensing aircraft and are fitted with SL Radar, UV and IR Scanners. Their role is to search for oil/chemical pollution from shipping. They fly some 800 hours per year. The Islander is operated by the Coastguard as a spotter plane in the Dover Straits area. The Dakotas are available for spraying oil dispersant.

The remote sensing aircraft work on a monthly basis, covering the offshore area out to 200 nm, the major shipping lanes and some other selected areas.

### MPCU

The role of the MPCU is fully explained in Reference 3. There is an overlap of responsibilities between the MPCU and the NRA that is not resolved. This issue was highlighted when further information was sought from the MPCU as part of this project.

### Reporting

The MPCU are responsible for any oil/chemical spills. Algal blooms are reported to MAFF. The contact given at MAFF Te MPCU could not recall ever receiving a report. In the event of pollution that does not conform to their remit being spotted, this is recorded in the flight log with no further action being taken.

### Effectiveness

The MPCU has been reported on by the Committee of Public Accounts - Reference 4. The MPCU have achieved one prosecution since 1986.

### Liaison

The MPCU should be the source of useful maritime pollution information that should assist us in protecting our coastline.

## NERC AIRCRAFT OPERATIONS

The council have operated an aircraft since 1982.

### Piper PA31 Navajo Chieftain

| | |
|---|---|
| Type: | Piper PA31 350 Chieftain |
| Seating Capacity: | 9 |
| Seating Capacity on task: | 5 |
| Normal Seating Capacity: | 4 |
| Oxygen: | To all seat positions |
| Intercomm: | to 5 seat positions |
| Cabin Size: | Width 4ft 2", Height 4ft 3", Length 12ft 6" |
| Useful Load: | 2050 lbs |
| Aircraft Power: | 28 volts x 60 amps |
| True Airspeed (transit): | 150-170 knots |
| True Airspeed (on task): | 100-170 knots |
| Maximum Authorised Altitude: | 24,000 feet |
| Endurance (Range) | 4 hours (950 n miles) approx, plus reserves |

The aircraft type and configuration would work very well in the multi spectral scanner and photography modes that we intend to set up.

However, the NERC aircraft would not be available to the NRA on an exclusive basis. The currently indicated costs of using their aircraft are not considered to be competitive in the open market.

The NRA has experienced difficulties with NERC over the timescale for processing data.

## ADAS

ADAS operate an aerial survey service based at Cambridge. Their normal operating period is from March to November.

### Equipment

ADAS operate an Aztec twin engined piston aircraft. It is modified to incorporate one vertical port and two other ports for 35 mm and 70 mm cameras. Standard fit includes a WILD RC8 camera for photographic mapping. The aircraft itself is leased but ADAS operate with their own crew and own equipment. The normal crew is a pilot, navigator and equipment operator.

### Operations

Its prime work is that of aerial surveys. Its main customers are MAFF, English Heritage, Nature Conservancy. ADAS have, this year, done a coastal survey for Anglian Region. They have also quoted Anglian Region for a flooding survey service using black and white and IR. ADAS are keen to take on national responsibility for flooding survey services for the NRA.

### Other

Full details on all ADAS aerial services are at Reference 5.

## POLICE

### Introduction

Contact has been established with the Powys Police, Northumbrian Aviation Unit and F7 (Police Aviation) at the Home Office.

Some 17 constabularies operate air support units and the majority use helicopters. Hampshire have a fixed wing aircraft. With the exception of Staffordshire and W. Mercia police who operate jointly, the air support units are autonomous. The Home Office has produced a police air support study (by SD Scicon) Reference 6 which seeks to coordinate the police aviation on a national basis.

### Equipment

The air support units operate a range of single and twin engined helicopters. The majority however are twin Squirrels or B0105s. Only twin engined helicopters are permitted at night. The equipment fitted to the helicopters can include loud speaker systems, night sun and FLIR.

Wiltshire Police carry a paramedic on their B0105 and along with some other helicopters have the capability of carrying stretchers. Wiltshire aircraft is part funded by the NHS.

### Operations

The aircraft are operated in both the ground and air alert mode. However for cost reasons the majority are in the ground alert mode. Helicopters are typically expected to respond to calls and be on the scene within 15 minutes. This requirement poses constraints on the alternative uses of police helicopters.

### CAA

The Police are seeking exemptions for their operations from the CAA in the form of a Police Operations Certificate (POC). Operating with a POC would be advantageous to the NRA in the enforcement role.

### Effectiveness

The 17 police forces that are operating helicopters consider them to be highly effective in the enforcement role.

West Midlands police attribute 60% of their successful prosecutions to the use of their air support unit. The helicopters have demonstrated their usefulness in following stolen vehicles, searching for missing persons, crowd control etc. Some of the police forces use helicopters in a similar role to that anticipated by the NRA in its enforcement activities.

Contractors

The police forces fund, crew and maintain their aircraft in a combination of ways. Some own their aircraft, some lease them on a short or long term basis. The majority of the police forces have pilots under contract. Only one police force has operated with its own pilots. The same force has also the only fatal police aviation accident. All the police forces operate with their own air observers. The cost of operating helicopters in this role varies significantly according to the engine and the fit, and ranges from £300-£800 per hour.

Police Aviation Services is a private company, operating out of Staverton, which leases and/or crews for a number of police forces. Because of their expertise PAS were contracted to carry out the helicopter trials in Northumbria. See Annex D.

Support

There is considerable expertise in police forces in the operation of helicopters in the enforcement role. In the event of the NRA opting for a helicopter to support its operations this expertise should be tapped in on.

In theory, Police Aviation units could be a source (by subleasing) of helicopters for the NRA enforcement role. However, because not all forces operate such units, distance and ground alert considerations are likely to mitigate against helicopters from this source being generally available. However some regions have managed to exploit this option (South West and Southern).

A more likely source is to lease standby aircraft from contractors supporting the police forces.

## ROYAL AIR FORCE

### Emergencies

The Royal Air Force and the Army have in the past supported NRA and water authorities in the execution of its duties, typically in emergencies such as flooding. Established procedures are in place for the requesting of emergency aviation support from the services.

### Support - Training - Contract

The RAF has also been willing to assist in other operations such as underslung loads from helicopters. This has usually been arranged on a training basis and therefore not charged. No "training flights" are currently available owing to the additional hours flown in the Gulf War.

Ministry of Defence advise that any future similar support is likely to be charged for, and should be requested through their contract department.

### Pollution Reporting

As part of this study, the RAF have been requested to advise us of their pollution reporting procedures following sightings from RAF aircraft.

## SUMMARY

1) The MPCU/Coastguard and Fisheries Protection Agency operate aircraft in the surveillance mode in our coastal waters. These agencies should be a source of useful information to the NRA for:

   a) reporting pollution (of all types)

   b) fisheries data

   c) expertise in operating twin engined fixed wing aircraft

2) NERC and ADAS also operate twin engined aircraft as sensor platforms. There would be reservations about using them as full time contractors.

3) The police aviation units and their contractors are possible sources of enforcement helicopters. A Police Operating Certificate would be advantageous to the NRA.

4) The RAF is increasingly unlikely to support NRA operations for free, other than in an emergency RAF pollution reporting procedures are being investigated.

## SECTION 5

**Objective 6** **Following Objective 5, to produce a specification for the approved aircraft.**

### Fixed Wing

Some 420 flying hours will be necessary to meet the proposed Coastal Survey requirements. Additional hours would be required to cover any Flood Defence survey work undertaken. A significant number of hours will be required in the even of a national approach to River Corridor surveys. Combined, these requirements would certainly exceed current aircraft useage.

There is substantial case for the NRA having the exclusive use of a fixed wing aircraft.

Wessex have carried out research into acquiring by lease/purchase and fixed wing aircraft for the Coastal Survey (MSS) role. A report by Compass Aviation covers the key considerations at Annex J. This is followed by the aircraft specification produced by Wessex for this role.

Both aircraft quoted are low winged. The coastal fisheries enforcement role is best met by a high winged aircraft.

Neither the Coastal Survey, nor the River Corridor survey requirements have been agreed. It is not appropriate therefore to propose an aircraft type until the real need is known.

### Helicopters

Helicopters are used for sampling in the Severn. It is proposed that we evaluate a helicopter and FLIR in the fisheries enforcement role. Both requirements are for a twin engined aircraft with similar payload. Consideration should be given to combining the requirements into a single contract.

### Management

Aviation is a tightly regulated specialist activity. It is recommended that, should we require an aircraft, the piloting and management of it be contracted out, utilising the experience of the Police, FPA, MPCU, as appropriate.

### Consultant

As indicated in the introduction to the study, our possible overall aircraft requirements are not straightforward. When our data/sensor requirements have been identified, it is recommended that an aviation consultant advise on the appropriate aircraft type(s) and the method of operation (lease/buy). The consultant could, with advantage, draw up and review our role specifications mentioned in Section 1.

## TRANSPORTATION OF LIME BY HELICOPTER - LLYN GAMALLT

The lime will be required to be moved from the location where it is to be offloaded from the delivery lorries (Grid Ref. SH 7533 4310; Altitude 460m) to two areas at the northern end of Llynau Gamallt (Grid Refs SH 7475 4468 & SH 7497 4457; Altitudes 490m & 480m respectively), a distance of 1.7 Km.

The lime will be in 40Kg double skinned paper bags, delivered on 1 tonne palettes.

We would require the bags to be transported in nets in payloads most appropriate to the specifications of the machine used, but which should be in the region of 0.5 tonne minimum. The nets (of which there should be three or four to maximise flying time) should be provided by the helicopter firm and manpower for loading and unloading nets at either end will be provided by the angling club.

The total quantity of lime will be a minimum of 30 tonnes and a maximum of 48 tonnes. We will require a separate quote for each of these amounts.

The quotes should contain details of maximum payload per trip; the total time taken, including positioning time and costs. Also, contingency costs fo ossible delays due to unforeseen circumstances should be provided (i.e. - approximate costs per extra day).

The lime will be stored and protected at the delivery point, thus the helicopter transport could take place at any reasonable time following delivery in order to allow for favourable weather conditions. we would want the operation to take place as soon as possible - late August/ early September 1991

Contractors employed by the NRA are required to provide evidence that they have adequate insurances in place for Employers and Public Liability, and where applicable for Contractors' damage to works (i.e insurance of works and third parties). See following document

## PUBLIC RELATIONS - REGIONAL USE OF AIRCRAFT

### WELSH

Inherited aerial photos from Welsh Water
No use of aircraft

### WESSEX

Use a company in Weston Super Mare to take photos, mainly for Flood Defence, Catchment Control and water quality surveys (David Palmer)

### YORKSHIRE

Hired photographers who hired helicopters for aerial photos, mainly floods. Had a problem in the past when they wanted a member of staff to go up and take some photos but was not covered by insurance so didn't proceed.

### SOUTH WEST

Spoke to Tim Wood who was very helpful. They use police helicopters (down the road) for aerial videos and photos of floods, free of charge, when helicopters available. One NRA member is allowed up when they go up and they usually get some good material.

### SEVERN TRENT

Hired helicopters for aerial photos - Lea Marston site, River Trent, Home sluices.

Bought copies of photos of flooding taken by outside photographers.

Hired a helicopter for Baroness Trumpington to view floods.

Liming of rivers done from bridges rather than helicopters.

### THAMES

Photos of Thames Barrier.

Photos of severe flooding of Thames and Maidenhead

### NORTH WEST

Used by Pollution Control (Albright & Wilson study on monitoring). Les Hughes in Carlisle (0228 25151)

Use a freelance photographer for aerial shots.

### NORTHUMBRIA

Aerial photos taken pre NRA.

Buy photos from library £25-50 a print plus extra for reproductions, slices etc.

### SOUTHERN

Annual survey since 1973 - sea defence - planes - carried out Spring to Summer on low tide to measure shingle levels and erosion. Stereoscopic shots.
Also used for shots on flooding, sea wall damage assessments.
Occasional photos taken for publicity by independent photographers.

### ANGLIAN

Hired aircraft for VIPS to view part of region. Not usual to use aircraft. Employ aerial photographer when necessary.

ANNEX C

FACSIMILE TRANSMISSION FROM:- **ALEXANDER STENHOUSE UK LTD**
**NORMAN INSURANCE HOUSE**
**KINGS ROAD**
**READING**
**BERKSHIRE**
**RG1 4LW**

FAX TELEPHONE NUMBER: **0734 667458**

IF ANY QUERY OR PROBLEM: **TELEPHONE 0734 261100 or TELEX 849144**

| | | |
|---|---|---|
| Transmission to Facsimile Phone Number | : | 0454 624409 |
| Company Name | : | National Rivers Authority |
| Town/City and Country | : | Bristol |
| For the attention of | : | John Harris |
| From | : | Colin Haworth |
| Time/Date of Origin | : | 28/11/91 1.00 p.m. |
| Number of pages (incl this page) | : | 2 |
| (Additional) Message | : | Hiring of Aircraft |

Dear John,

Our telephone conversation today refers.

I attach confirmation of required clause wording which should be agreed with aircraft operators before signing agreements.

I confirm our specialist aviation brokers normally recommend a minimum Public Liability limit of £50M but for practical purposes we would state an absolute minimum of £10M.

If you need us to discuss matters direct with Anglia Region no doubt you will let us know.

Regards.

Colin Haworth

**Risk:** **AVIATION HULL AND LIABILITY INSURANCE**

**In accordance with your instructions, we confirm having obtained Underwriters' agreement to the following :-**

Arising out of the charter of the assureds aircraft by the National Rivers Authority (NRA). It is noted and agreed to hold harmless and waive rights of subrogation against NRA (Hull) and to include NRA as an addiitional assured (Liability)



C2

REPORT ON

HELICOPTER TRIALS IN NORTHUMBERLAND
11-14 NOVEMBER 1991

The primary needs in fisheries enforcement are the collection of intelligence and the ability to deploy water bailiffs in such a way that they can collect the evidence necessary for a successful prosecution and apprehend offenders.

In designing this trial the prime overall objective was to assess the use of a helicopter as an observation platform for the collection of intelligence. The secondary objective namely testing the direction of ground forces in response to an observed incident was clearly dependent on the success of the first but in order to achieve maximum efficiency of aircraft utilisation the individual trials were structured to test both and accordingly some poaching activity had to be simulated. Programme is at Annex B.

In Northumbria the most difficult area in which intelligence is required is at sea. Here unlicenced drift netting can take place out of sight of land and, due to the use of radio by offenders, out of sight of patrol vessels. Nets can also be set off the beaches which are currently patrolled by water bailiffs on motor bikes or by surveillance using telescopes or night vision devices.

A significant level of poaching also takes place within the river systems but due to the difficult terrain only relatively short lengths of river can be kept under surveillance by the limited number of men available and foot patrolling at night is similarly inefficient.

Since each flight enabled a reassessment of the operational procedures which were found to be critical to success it will be clearer to report against the individual objectives rather than individual flights. Flight report is at Annex A.

Individual Objectives

1) To establish whether at night using FLIR it is possible to determine the type of activity in a river (i.e. rod fishing, net laying etc)

Although problems remain with the efficient scanning of a river system it was clear that in the region of 60% of persons present on a river bank at night could be found without further improvement of the operation of the team or the FLIR system. It is doubtful if a netting operation could be recognised but angling and gaffing operations would be identifiable.

The level of intelligence obtained would be a significant advance on that currently available and further operational improvements can be achieved.

2) To establish whether at night using FLIR it is possible to determine whether drift netting is taking place at sea.

Although a net set by fisheries staff was identified on one of the two flights it was not readily visible and identification of a net using smaller (poacher's) corks would probably not be possible.

However, the identification of boats and the activity of those on board could be achieved and would be sufficient to identify whether they were drift netting.

3) To establish whether, using FLIR, the length of drift nets can be measured.

Not possible but will be possible to a limited but useful degree of accuracy in daylight.

4) To explore whether, by using aircraft to locate fishing, the effectiveness of patrol vessels can be extended.

The coastline between Holy Island and Whitby was overflown during daylight in approximately 2.5 hours.

The general level of fishing was very low and few boats were seen. However, their activity was easily identified and an immediate assessment of whether or not nets were being carried was possible.

In the North of the region a fixed net placed in such a way that it would catch migratory fish was identified in the sea. The intelligence has been checked by water bailiffs and the owner identified. The net is now under surveillance.

In the South a known poacher was identified setting pots; he was also carrying nets in his boat. His activities too are now being watched. (Photo 1)



D2

Also in the South two youths were seen setting a net. The aircraft landed beside them, details were taken and their net seized. A further net was seen from the air but there was no evidence connecting it with the offenders. (Photo 2)

If a bailiffing team had been present in the area they would have been called in to deal with the matter. Communications were shown to be excellent over the sea and the patrol vessel was easy to contact.

The operation of patrol vessels can be enhanced by the use of aircraft but beach launched high speed inflatables will probably prove more effective than larger slower vessels. Careful planning and deployment of shore based bailiffs will be a prerequisite of success.

5) To investigate whether salmon redds can be photographed/counted from aircraft efficiently.

Not possible under the light and river conditions prevailing but may be possible in other areas or using spectral scanning.

6) To apprehend, with the support of bailiff teams, anybody identified poaching on the rivers.

Communications were generally better than those experienced by water bailiffs in the mid to upper reaches of rivers and simulated poaching was pinpointed to within a few yards by the observer in the helicopter.

Clearly a team of bailiffs could be directed to the scene of an incident and further observations or arrests made.

7) To establish the level of fishing activity on a river.

As it was the close season for game fish there was no activity during the trials. However, it was clearly possible to count people on the river bank and identify whether or not they were anglers.

<u>Conclusions</u>

There is no doubt that the use of helicopters will improve the level of intelligence for fisheries enforcement in Northumbria and will lead to an increase in the number of successful prosecutions.

What is not known is whether the level of service that would be thus achieved would be supportable or even necessary.

Paradoxically use of helicopters will probably give the best possible estimate of the level of illegal fishing and so their use as intelligence gathering platforms must be the precursor of any decision to use them in operational enforcement.

TONY CHAMPION

Attached: Photographs - 1. Known poacher with pots and net.
2. Illegal net laying at Skinningrove.
3. Fishery Protection Agency "asset" Royal Navy Island Class off Newcastle.
4. "A Team" - Godfrew Williams, Ian Payne (PAS) John Ball (PAS), Tony Champion, Ivan Swale with net and BO105 after Flight No 6.

Annex A - Flight Report

Annex B - Programme

## HELICOPTER TRIALS - NORTHUMBRIA

## FLIGHT REPORT

### Introduction

The trial took place in the week 11-15 November 1991, using a B0105 helicopter fitted wtih FLIR from Police Aviation Services (PAS) of Staverton. The helicopter was prepositioned at Newcastle airport. PAS supplied a second pilot/FLIR operator free of charge. The Northumbria Police Helicopter Unit kindly made available their crew room facilities.

A possible 9 flights totalling 17½ hours over 5 days was planned for this trial.

Following heavy rain over the weekend the Wear and Tyne were in spate. A violent weather front with storm force winds swept across the area on Tuesday 12th November. There was little or no fishing activity on the coast or rivers. The programme was re-scheduled to take account of the prevailing factors. In the event, the flying was condensed and achieved with 6 flights totalling 9 hours over 4 days.

### Flights

The details of each flight are in the attached reports.

### Crewing

Low level flying at night in river valleys requires an experienced pilot. Ex-military pilots should normally be specified. The minimum for FLIR work at night should be a regular constituted crew of a pilot, FLIR operator and navigator/observer/comms. Additionally, a bailiff was carried on all flights and their knowledge of the river was very useful, particularly their local knowledge of names when communicating to bailiffs, and their understanding of fishing practices when checking on fishing vessels.

PAS crew were professional and helpful throughout the trial.

### CAA Clearance

The landing on the beach to apprehend the illegal netters was technically illegal as the helicopter was operating with a public transport licence. Where possible contracts should be set up so that the helicopter and pilot is categorised by the CAA as private. This permits maximum flexibility in operations.

### Key Points

Further to the flight reports and objectives the following key points should be noted:

FLIR

A FLIR 2000A thermal imager was fitted to the helicopter, manufactured by FLIR System Incorporated (US) and on loan for demonstration from Computing Devises Limited. FLIR consisted of an externally mounted pod capable of being rotated horizontally through 360° and vertically through 180° horizon to horizon. The hardware fitted in the rear of the cockpit included a TV display, video recorder and a handheld controller. Wide angle or close in viewing could be selected along with white or black "hot" and various gain/tuning facilities. FLIR operates in the spectral region 8-12 micrometres with a wide field of view 28° horizontal x 15° vertical, magnification x 1 and zoom field of view of 7° horizontal x 3.25° vertical, magnification x 4.

The size of the heat source determines the maximum detection distance on the screen, i.e. the smaller the source the closer you need to be. For humans 600 was ideal. However, this gave only a limited footprint that made tracking a winding river course at night a very demanding exercise for the crew. Flying at up to 1000' following the mean course of a winding river eases the tracking problem and permits a general search to be carried out to establish levels of activity, albeit at a reduced detection rate. Not every band in the river is covered and some definition is also lost. Even so, a high level of crew co-operation is required between FLIR operator, navigator and pilot. On the last sight flight 4 out of 6 teams of poachers were detected (see the video recording).

This system can be made to work in the enforcement role but it is very capital intensive.

Navigation

Away from built up and lit areas dead accurate night navigation was problematic. GPS would be invaluable in ensuring that reliable grid references were available to the crew and to pass to bailiffs if required.

Nightsights

Nightsights were tried but were limited effectiveness in 'black' areas due to internal cockpit reflections. Optimising cockpit lighting to permit the use of night goggles by either the pilot or navigator might be worth looking at. Attempting to search the length of a river course with nightsights was not practical. Using a pod mounted system might offer a cheaper but probably less effective alternative to FLIR.

Communications

Once a common frequency (462.1) was established - comms generally worked well bearing in mind that the trial was conducted at low level. Over the sea there was no problem communicating with the boat.

**DAVE STANLEY**
**PROJECT MANAGER**

# AIRCRAFT FEASIBILITY STUDY
# PROPOSED HELICOPTER TRIALS. NORTHUMBRIA

## Introduction

The fisheries enforcement team are an effective force in Northumbria. They currently operate on land using vehicles, night sights, and binoculars. A patrol boat is used at sea to counter illegal fishing, drift netting etc. The purpose of the trial is to establish whether, by using a helicopter, the effectiveness of the team can be further enhanced.

## Objectives

The primary objectives are:

1) To establish whether at night using FLIR it is possible to determine the type of activity on a river (i.e. rod fishing, net laying etc)

2) To establish whether at night using FLIR it is possible to determine whether drift netting is taking place at sea.

3. To establish whether, using FLIR, the length of drift nets can be measured.

4. To explore whether, by using aircraft, to locate illegal fishing the effectiveness of patrol vessels can be extended.

5. To investigate whether salmon redds can be photographed/counted from aircraft efficiently.

Secondary Objectives are:

6. To apprehend, with the support of Bailiff teams, anybody identified poaching on the rivers.

7. To establish the level of fishing activity on a river.

## Resources

### Air

A significant part of the flying will be carried out at night and/or over the sea. It is a legal requirement therefore that the helicopter be twin engined. A FLIR will be required and possibly a search light. Also, necessary comms air to ground and seating for at least 3 in addition to the pilot.

It is essential that the pilot be current in night operations at low level.

Northumbria

Northumbria's patrol boat will be required to participate throughout the week.

Drift nets will be necessary for evaluation purposes. Similarly, bailiff teams will be required to simulate poaching activities and to respond in the event of any illegal activity being identified.

Responsibility

Dave Stanley is responsible for managing and coordinating the air resources. Tony Champion is responsible for making available, deploying and managing the necessary Northumbrian resources.

Dates

Option 1 - 11th - 15th November 1991
Option 2 - 4th - 8th November 1991
Option 3 - 25th - 29th November 1991

Option 1 is to be pursued with possible contractors. Option 3 is a fall back in the event of significant aircraft serviceability or unsuitable weather.

## PROPOSED PROGRAMME

| DAY | FLIGHT NO | TIME | OBJECTIVES | ACTIVITY | ESTIMATED FLYING TIME | RESOURCES |
|---|---|---|---|---|---|---|
| Monday | 1 | 0900-1800 | 4<br>Search for drift nets, check comms with boat and bailiffs. | Transit to Newcastle via coast<br>? Day light recee Tyne & Wear Valley | 2½ hours | Boat<br>Bailiff for radio checks |
| | 2 | 1800-2400 | 2 & 3<br>To evaluate FLIR against simulated drift netting. | | 1½ hours | Boat +<br>Drift nets |
| Tuesday | | 1500-1800 | | Face to face briefing | | Bailiffs, boat and air crew |
| | 3 | 2200-0400 | 1 & 6<br>Evaluate FLIR against simulated poaching, search for illegal fishing activity. | Night flight up the Wear<br>?Return down Tyne | 2 hours | Bailiff teams<br>Poaching tackle |
| | 4 | | | Repeat of Flight 3 | 2 hours | |
| Wednesday | 5 | 1500-1800 | 5, 7 (6)<br>To investigate salmon redds and fishing activity | Day flight up River Coquet | 2 hours | Camera<br>Bailiffs |
| | 6 | 1800-0200 | | As Flight 3 if required | 2 hours | as 3 |
| Thursday | 7 | 0900-1200 | 4 To identify and locate illegal fishing in cooperation with boat | Recee South over sea | 2 hours | Boat |
| | 8 | 1400-1800 | 4 | As Flight 7 but North | 2 hours | Boat |
| | or 9 | | 5, 7 (6) | Day flight up Wear | 2 hours | Camera & Bailiffs |
| Friday | 10 | | 4 | Transit South via coast | 2½ hours | Boat? |

Constraints

The helicopter endurance is 2½ hours, speed 120 knots, range subject to wind up to 300 nautical miles.

In the event of heavy rain, programme will be modified if river in spate. Fog and low cloud will preclude river flights, military, air traffic on Otterburn range will be considered on the Coquet flight. On the sea flights, again fog or heavy swell will limit flights.

Flight Down

Dave Stanley will crew and operate the FLIR. Where possible all flights will operate with a 1 member of the Northumbria enforcement team/staff. Where practical, any remaining seats will be made available to other interested staff, at the discretion of the captain.

Northumbria are to supply a night sights and binoculars for use by their member of the crew.

Communications

Cell net telephones vodafone and cell net radio telephones
Motorola P210
Transmit 462.100)to be
Receive 456.600)confirmed

Other Agencies

Where appropriate the following agencies will be advised of the flight trials:

Police
Customs & Excise
Air Traffic Control
Coastguard

Air Fields

Newcastle is the preferred air field for operating the helicopter.

Safety

Lifejackets and a dinghy will be carried for all oversea flights.

HELICOPTER TRIALS - NORTHUMBRIA

FLIGHT REPORTS

| | | | |
|---|---|---|---|
| FLIGHT NO: | 1 | LOCATION: | Newcastle |
| DATE: | 11th November 1991 | HELICOPTER: | BO 105 |
| TIME OFF: | 1600 | LANDING: | 1745 |
| CAPTAIN: | John Ball | TOTAL FLIGHT TIME: | 1.45 |

CREW: Ian Payne, Dave Stanley, John Davidson, Ron Lawson

RESOURCES: FLIR, Mobile Radio (Frequency - 462.1)

WEATHER: Nil Cloud, unlimited visibility.

OBJECTIVE: Recce for cables, Tyne & Wear Valleys.
Communications check - Bailiffs + boat.

ROUTE: Newcastle - W up Tyne - S to Wear Sunderland - sea search for boat.

No significant hazards at 600'. Aircraft communications ineffective - system saturated? Contact with bailiffs and boat primarily through mobile radio. FLIR - far slower ground speed required to achieve effectiveness offered by system when searching river. Bailiffs found and tracked. Boat found at night and identified. Net not spotted - misled by adjacent buoy? Height of helicopter needs sorting in relation to field of view of FLIR.

1) Constituted crew approach to be adopted - Pilot, FLIR operator, Navigator/Communications.

2) Mobile radio needed as back-up.

3) Rerun required against boat and nets.

4) FLIR looks good - need comparison with cheaper night vision systems.

5) Change callsign of helicopter.

| | | | |
|---|---|---|---|
| FLIGHT NO: | 2 | LOCATION: | Newcastle |
| DATE: | 12th November | HELICOPTER: | B0 105 |
| TIME OFF: | 2000 | LANDING: | 2030 |
| CAPTAIN: | John Ball | TOTAL FLIGHT TIME: | 1.30 |
| CREW: | Ian Payne, Dave Stanley, Colin Thrigher | | |
| RESOURCES: | FLIR, Nightsights, Mobile Radio, video (Frequency 462.1) | | |
| WEATHER: | Heavy showers, wind 35 kts, gusting 48 kts | | |
| OBJECTIVE: | Search Wear for 2 teams bailiffs simulating poaching. | | |
| ROUTE: | Newcastle - Sunderland - up Wear to Bedburn - RTB. | | |

Very rough flight. Dead accurate navigation away from towns difficult. Using FLIR to navigate and follow river on occasions. Detailed search of river banks - progress slow and very demanding on FLIR operator/crew - weather adverse factor. First team of "poachers" spotted and accurately passed information to support team. Broke off flight due to fatigue/sickness before reaching second team.

1) Communications worked well.

2) FLIR demonstrated ability to accurately locate poachers.

3) Flight profile following river and 100% search too slow and too demanding - try higher/faster/straighter search of river line accepting overall lower(?) detection rate.

4) Video failed to record.

5) Nightsights not tried - too disorientating in weather conditions.

6) Constituted crew improved performance.

7) Cheap GPS for passing grid reference at night in open countryside would be an asset.

| | | | |
|---|---|---|---|
| FLIGHT NO: | 3 | LOCATION: | Newcastle |
| DATE: | 13th November | HELICOPTER: | B0105 |
| TIME OFF: | 1500 | LANDING: | 1620 |
| CAPTAIN: | Ian Payne | TOTAL FLIGHT TIME: | 1.20 |
| CREW: | John Ball, Dave Stanley, Richard Criswell, Tony Cuthbert. | | |
| RESOURCES: | FLIR, Video, 35 min.<br>FLIR Video - recorded. (Frequency 462.1) | | |
| WEATHER: | Clear | | |
| OBJECTIVE: | Trial FLIR to optimise height and footprint. Check on Redds. | | |
| ROUTE: | Newcastle - Coquet Island - River Coquet - River Alwin and return. | | |

Flew various heights 1500' - 500'. Optimum for detection of humans and maximum footprint was 750-1000 AGL. Bailiffs on ground pointed out Salmon Redds - not possible to detect them from the air. Disturbed gravel had insufficient and discolouration to be spotted at a distance on the River Alwin. Understand it has been achieved elsewhere.

1) FLIR operation improving with experience.

2) Insufficient contrast of gravel to permit detection from the air on the River Alwin.

| | | | |
|---|---|---|---|
| FLIGHT NO: | 4 | LOCATION: | Newcastle |
| DATE: | 13th November | HELICOPTER: | BO105 |
| TIME OFF: | 1745 | LANDING: | 1945 |
| CAPTAIN: | Ian Payne | TOTAL FLIGHT TIME: | 2.00 |
| CREW: | John Ball, Dave Stanley, Kevin | | |
| RESOURCES: | FLIR, Nightsight, FLIR video - recorded (Frequency 462.1) | | |
| WEATHER: | Clear - wind 15kts - inter showers forecast. | | |
| OBJECTIVE: | Net detection, trial FLIR against bailiff teams, search for poaching. | | |
| ROUTE: | Newcastle, , mouth of Tyne, Sunderland up Wear, Bedburn, Frosterley return Sunderland, Newcastle. | | |

Classifying the type of vessel readily achieved. Possible to see buoys and with difficulty the line of net. With more favourable weather FLIR system/team performance improved. 4/6 of the bailiff teams spotted (one missed and one not overflown). No other action detected. Again navigating in a black area, with a windy river and a narrow field of view on the FLIR is not easy but can be made to work. Nightsight of limited use due to internal reflections in cockpit.

1) FLIR can be used for counting and identifying vessel types - net detection very limited.

2) System on this flight appears to offer 60%+ chance of detecting activity on the banks.

3) FLIR excellent for detailed search of limited area - not optimised for general search of wide area - further investigation required as to whether technically possible/alternative approaches.

| | | | |
|---|---|---|---|
| FLIGHT NO: | 5 | LOCATION: | Newcastle |
| DATE: | 14th November | HELICOPTER: | B0105 |
| TIME OFF: | 1320 | LANDING: | 1420 |
| CAPTAIN: | Ian Payne | TOTAL FLIGHT TIME: | 1.00 |
| CREW: | Dave Stanley, Michael Dorkin, Bill Walker, Eddie Yarrow | | |
| RESOURCES: | Video, Camera (Frequency 462.1) | | |
| WEATHER: | Clear | | |
| OBJECTIVE: | Coastal recce - Illegal Fishing. | | |
| ROUTE: | Newcastle - Blythe - Holy Island and return. | | |

Very little fishing activity. Easy to search coast line from helicopter. One suspect net spotted inshore. Nothing else seen.

1) Fast efficient method of determining the extent of illegal netting in-shore.

| | | | |
|---|---|---|---|
| FLIGHT NO: | 6 | LOCATION: | Newcastle |
| DATE: | 15th November | HELICOPTER: | BO105 |
| TIME OFF: | 1435 | LANDING: | 1600 |
| CAPTAIN: | Ian Payne | TOTAL FLIGHT TIME: | 1.25 |
| CREW: | Dave Stanley, Godfrey Williams, Tony Champion, Ivan Swale. | | |
| RESOURCES: | Video, Camera (Frequency 462.1) | | |
| WEATHER: | Clear. | | |
| OBJECTIVE: | Coastal recee - Illegal fishing. | | |
| ROUTE: | Newcastle - Tynemouth - Whitley and return. | | |

Very little fishing activity. No difficulty in locating what vessels there were. NRA boat not considered necessary. However, there should be no problem directing the boat from the air to any areas of fishing activity. Spotted a beach net being set at Skinningrove, landed alongside and caught 2 lads. Ivan Swale (bailiff) handled the incident. Net confiscated.

1) Aircraft offered the ability to rapidly cover wide area and long coastlines quickly enabling the extent of fishing activities to be quickly determined and information to be passed to boat or bailiffs.

2) Flexibility of helicopter over fixed wing clearly demonstrated.

# Use of Aerial Videos

**NRA Severn-Trent**
**October 1991**

## DRAFT GUIDELINES FOR THE USE OF AERIAL VIDEO AS SURVEY AND ASSESSMENT

### 1.0 Introduction and Background

The use of aerial videos can be a very effective method of visually assessing river corridors or wider flood plain areas prior to more detailed survey on the ground. It also provides a permanent record of at one point in time, which can be used as reference material for many purposes.

### 1.1 Severn-Vyrnwy Confluence Project

Aerial videos were first used by the Conservation and Recreation Department of the National Rivers Authority Severn-Trent Region, during the initial environmental assessment of the Severn-Vyrnwy Confluence Flood Alleviation Scheme in the Summer of 1989. There was a need to quickly identify the major potential environmental impacts prior to issuing the brief for Engineering Consultants to undertake the first stage of the Capital scheme feasibility study.

A helicopter was chosen after problems had been experienced using a small fixed wing aircraft to photograph the River Derwent in the centre of Derby. The fixed wing aircraft was found not to be suitable for taking video at a suitably slow speed.

It was originally planned to undertake the initial assessment of areas of possible environmental impact using still photographs taken obliquely along transects across the required area as the primary record, with obliquely shot video as a secondary medium. It soon became apparent whilst flying the area, that taking video shots was far easier than still photographs. After flying the transects, oblique video pictures were taken whilst flying for a short distance up each river system.

The results of the aerial photography immediately showed that the video material was the primary analysis medium to use. Using the pause facility on the video recorder to assess greater detail, it was found that the still photographs were rarely used. The analysis and vegetation mapping exercise was undertaken using the video material with little reference to still photographs. The video following the river channel showed that not only conservation and recreation data could be assessed, but that such views would be of very great use for Flood Defence in maintenance planning and assessment.

### 1.2 Main River Feasibility Study

Following the Severn-Vyrnwy video assessment, a feasibility study was undertaken to assess the potential of aerial videos as a survey method for main rivers.

The River Tame, the River Avon and the Severn Estuary were chosen as the study areas. The River Tame is the main river flowing from the West Midlands conurbation into the River Trent. The Avon, a typical lowland river flows from Stanford Reservoir east of Rugby, through Stratford, to join the Severn at Tewkesbury. The Severn was then followed to the limits of the region along each side of the Estuary.

The first day involved flying along the River Tame in a Jetranger helicopter with a JVC GR1000 SVHS camcorder mounted under the nose of the helicopter, controlled from the front left seat beside the pilot. The only control of the camera was on and off and the downward angle of the camera. A monitor was mounted in the front of the helicopter, at the feet of the left hand seat. The videoing of the Tame was not successful because a stable picture could not be obtained from the camcorder in this position. Whilst on the ground a clear picture was obtainable but once in the air, after a few minutes the picture continually kept disappearing.

A professional type Sony Betacam camera was hired to fit on the hired camera nose mount unit. This was fitted at Coventry Airport, the next day. The equipment was found to provide a good quality picture on the ground and in the air. The River Avon and Severn Estuary were successfully flown. Approximately 250 km was flown at both high (1500 feet) and low (500 feet) levels. The pilot did experience problems in keeping the river on the screen on the tighter meanders. When flying directly into the sun, the reflections on the water distorted the picture quality. On the low level sections, flies caused a problem, impaling themselves on the lens, which then required regular cleaning. This entailed landing in a field beside the river and getting out to quickly clean the camera lens whilst the rotors were running.

The recorder unit was mounted in the aircraft and took 20 minute length Betacam tapes. These tapes were converted to VHS tapes for analysis in the office by a commercial video studio. A good quality definition picture was obtained but the colours were not exactly true to life. The reason for this is not known.

Further test runs on different rivers were tried using the JVC GT1000 SVHS camcorder, hand held in the rear right hand seat behind the pilot, videoing obliquely out of the large rear window opening. These tests proved very successful. The hand held mode allowed the flexibility required in aerial video surveying.

## 1.4 Current Severn-Trent Region Practice

Following the use of SVHS format cameras, problems were encountered in copying more than one generation, in that the picture quality deteriorated rapidly on further copies of copies. The original SVHS picture was quite acceptable but a 2nd generation copy can have slight bleeding of the colours and reduced definition of the picture quality.

The only way to overcome this problem was to vidoe using a format of higher quality. In November 1990 a Umatic video camera and portable recording unit was purchased to provide better quality video master copies. This also gives a library of video tapes of broadcast quality that may be used for television news items etc.

The Umatic camera has been very successfully used in the hand held mode in the rear of Jetranger helicopters.

## 2.0 ANALYSIS OF AERIAL VIDEO SURVEYS

### 2.1 Analysis

Once the aerial video has been recorded, the next stage is to analyse the results in the office. The video must be transferred to VHS format to allow easy viewing on VHS video player/monitor. The use of the still frame facility has been found to be very useful and good definition pictures obtained for analysis.

### 2.2 Features which can be identified

Aerial videos provide a useful survey medium for a wide variety of features. The following features can be easily distinguished and analysed:-

a) Location of river channel

b) Habitat types:-
- grassland
- woodland
- aquatic vegetation

c) Recreation features:-
- footpaths
- fishing pegs
- footbridges
- recreational activities

d) Water features:-
- pools
- riffles
- bank features

e) Structures:-
- bridges
- culverts
- weirs

f) Other features:-
- land use
- Crops in fields
- development in flood plain
- state of aquatic weed cover

These features can then enable decisions to be made at a variety of levels which include:-

a) Identify potential areas for work.

b) Establish priorities for detailed ground survey and investigation.

c) Check on previous work.

### 2.3 Use by NRA Functions

The information gained from the aerial videos can be used by all the functions in their day to day activities, some are listed below:-

All functions
General view of river corridor.

Conservation
Habitats, likely environmental impacts.

Recreation
Identification of recreational activities.

Fisheries
State of watercourse.

Flood Defence
Planning maintenance programme, visual survey of assets.
Overview of capital schemes; extent of flooding.
Catchment Management
State of watercourse, location of sites in relation to regulatory activities.
Record of hydrometric stations.
Illegal abstractions and irrigation.

Environmental Quality
State of watercourse.
Pollution incidents (both potential and actual).

## 2.4 Low Level/high level videos

Video information is required at (i) detailed channel bank to bank level (low level) and (ii) wider flood plain level (high level) for different information requirements. Eg. status of the watercourse can only properly be seen from a low level video picture and landscape character type can only be determined at high level.

## 2.5 Seasonal Variations

The seasonal variations in water levels and tree leaf cover mean that for some activities summer videoing can be preferred but other activities winter/spring videoing is preferable. Eg. identification of tree cover - summer; location of culverts - winter.

## 3.0 CHOICE OF AERIAL VIDEO PLATFORM AND EQUIPMENT

### 3.1 Aerial Video Requirements

The requirements for successful aerial videoing are chiefly -

i) clear space and visibility for using the camera within the aircraft
ii) ability to fly slowly, steadily and stop over meanders or specific locations,
iii) room for all the equipment.

The two main options for aerial videoing are helicopter or fixed wing aircraft. The table below outlines some of the advantages and disadvantages.

| | Helicopter | | Fixed Wing Aircraft | |
|---|---|---|---|---|
| | Jetranger | Robinson | Cessna 172 (high wing) | Twin-engined (low wing) |
| Cost £/hr Approx. | 400 | 150 | 100 | 200 |
| Camera oblique views | Good | Good | Problematic | Limited |
| Slow/stationery manoeuvres | Good | Good | Nil | Nil |
| Space for equipment | No Problem | V Limited | Limited | No Problem |
| Passengers + equipment | 3 | 1 | 2 | 3+ |
| Fuel availability | Limited (Jet A-1) | No problem | No problem | No problem |

### 3.2 Legal Limitations to aerial video flying.

a) Aircraft must be flown by a pilot with a commercial pilot's licence. The pilot is limited to 7 hours flying per day and to a limited number of hours per week.

b) Low flying regulations.

i) A fixed wing aircraft must not fly closer than 500 feet to any person, vessel, vehicle or structure.
ii) A helicopter must not fly below a height that would allow it to land without danger to people and property.
iii) A fixed wing aircraft must not fly over a built up area either below a height that would allow it to land clear of the area and without danger to people and property if an engine fails; or less than 1500 feet above the highest fixed object within 2000 feet if the aircraft; whichever is the higher.

iv) A helicopter may not fly over a built-up area at less than 1500 feet above the highest fixed object within 2000 feet, or below a height that would enable it to land clear of that area if an engine fails. (A twin engined helicopter would be able to fly lower than 1500 feet but over some cities which include controlled airspace associated with an airport, this relaxation does not apply and the helicopter must be also fitted with a transponder transmitting the location and altitude of the helicopter to the Air Traffic Service.

Note that the altitude indicated on the aircraft's altimeter will not always indicate the height above ground level. It may be set to a regional pressure setting, after take-off, so that all the aircraft at a similar height are reading similarly calibrated altitude readings.

### 3.3 Video Format

There are now a very wide range of formats available for amateur and professional usage. Choice is not only dependent on picture quality and cost but also on camera and recorder portability and battery life. An analysis of some of the formats available is shown below:-

| Format | Picture No. of lines | AV Camera cost to buy £ | Broadcast Quality | Quality after 2nd generation editing |
|---|---|---|---|---|
| VHS | 240 | 500 | No | Very bad |
| VHS-C | 240 | 700 | No | Very bad |
| SVHS | 400 | 1800 | Nearly | Not too good |
| SVHS-C | 400 | 1200 | Nearly | |
| Hi8 | 430 | 2000 | Nearly | Good |
| Umatic (lowband) | 260 | 7000 | Nearly | Good |
| Umatic (highband) | 300 | 7000 | Acceptable | Good |
| Umatic (SP) | 300 | 7000 | Acceptable | Good |
| Betacam | 450 | 30000 | Yes | Good |

### 3.4 Use of Video Cameras

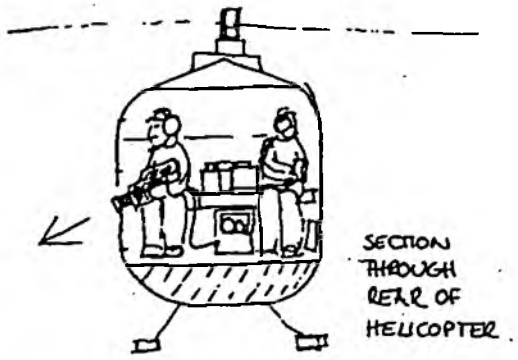
Whatever format of camera is used the main principles of operation are similar.

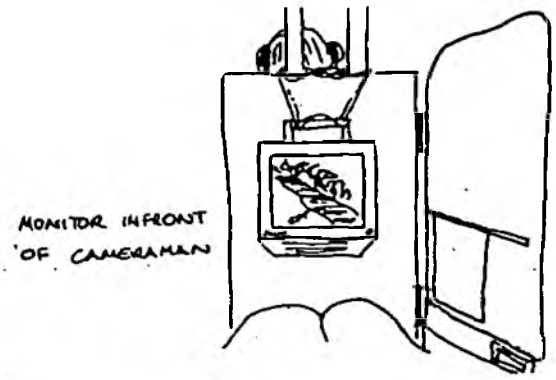
i) Lens
- A wide angle of view should be used as standard.
- Close up zooms will not provide steady pictures and will accentuate unsteady handling of the camera.
- (For special close up work where a zoom lens is required, a gyro stabilised lens may be hired at a rate of approximately £2000 per day).

ii) Focal Length
- Should be set to infinity.
- Automatic focus cameras should be set to manual infinity setting if possible.

iii) Aperture
- Set to automatic or checked regularly.

It has been found that the best method of video photography is to have the camera hand held in the rear of the jetranger helicopter behind the pilot, held on a supporting pad on the right knee, to dampen the vibration from the helicopter. The camera is pointed obliquely out of the rear passenger door window. A Sony 6" portable monitor connected to the camera allows the cameraman to monitor the video picture. This can be mounted on the rear of pilot's seat, facing the cameraman.




3.5 Weather Factors

The key factor is visibility. It has been found that rain is not normally a problem and as long as the rain drops are kept off the lens, visibility tends to be acceptable. In limited visibility/haze it is often possible to successfully video the lower levels eg 500', but not at the higher levels eg 1000'. Although video pictures can be acceptable in poor conditions, still photographs will look very flat, lack depth and are often not worth taking.

The high windspeed past the window will produce a windchill effect and the wearing of gloves is to be recommended. Removing the door in all but the very hottest weather is not recommended.

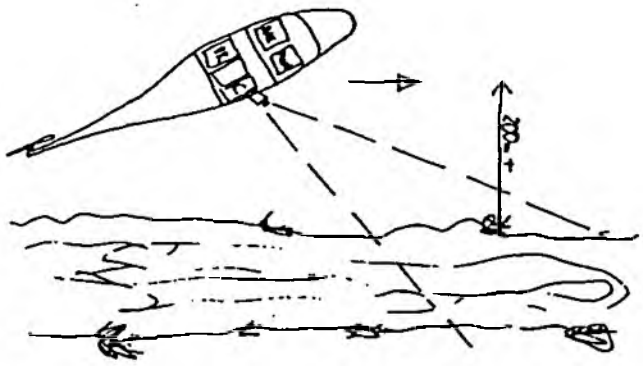
3.6 Effect of the Sun

It is important to remember to never point a video camera directly at the sun as it may damage the camera lens system.

When planning a route it is preferable not to fly into the sun as the reflections on the water and 'sun bursts' in the lens will reduce the picture quality considerably. It is preferable to fly with the sun behind you and not casting shadows across the watercourse, which will be visible in full sunlight.

3.7 Videoing of Watercourses

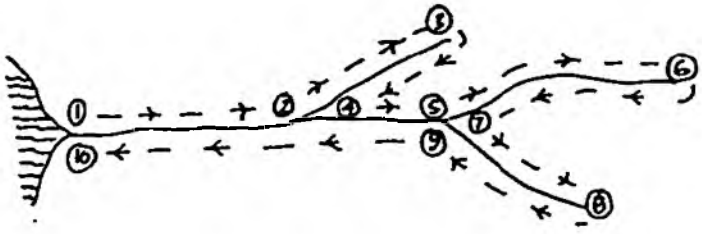
It has been found that the best method to video watercourses is to fly, parallel to the watercourse approximately 500' to the left of the watercourse at approximately 500' height; and 1000' parallel to the watercourse when flying higher at 1000'. If the pilot flies parallel to the watercourse with the helicopter yawed slightly, a good oblique picture may be obtained.



PLAN VIEW OF YAWED HELICOPTER.

To ensure that most effective use of flight time the survey system shown below has been developed.

a) Videoing of Watercourses



b) Videoing of areas.

FLYING ALONG O.S MAP GRIDLINES.

It is important to be able to relate the video picture to a given location and this can be done by using the time code on the camera. Eg 11.30 am - River Cam confluence with River Severn.

3.8 Taking Still Photographs

The taking of still photographs uses a slightly different technique. It is important to stop videoing if you wish to take still photographs of a particular feature and then resume videoing afterwards.

It is important to use speeds of 1/250 of a second or greater to overcome the vibration of the helicopter and to use a 200 or 400 ASA film.

When taking still photographs it is often sensible to have two cameras, one for slides, and one for negatives. At least 10 rolls of 36 exposure film should be taken (per person filming).

## 3.9 Navigation

Pre flight planning

a) Identify area for survey. Obtain 1/50,000 OS maps.
b) Select alternative area if bad weather prevents flying in the first area.
c) Check with other functions as to whether extra information is required for specific projects.
d) Highlight watercourses to be flown on 1/50000 map with a fluorescent marker pen.
e) Brief pilot on heights and technique to be used.
f) Identify with pilot problem areas eg built up areas, bird sanctuaries, military and civil airfields, controlled airspace etc.
g) Check weather forecast (NRA often have better weather reports/radar weather map information than the pilots)

In flight navigation

a) the pilot will be able to navigate to towns and follow major rivers.
b) It is helpful if a NRA member of staff acts as navigator and sits in the seat beside the pilot to:-

i) make strategic decisions on survey operations.
ii) give detailed navigational directions to the pilot.
iii) give directions to cameraman as to which way the watercourse is turning, tight meanders, important features etc.
iv) assist the pilot in looking out for other low flying aircraft.
v) take still photographs as required.

## 3.10 Aerial Video Checklist used for Severn-Trent Operations

- Videocamera/recorder
- Instruction manual
- Video cassettes (7 hrs worth)
- Spare batteries (10 hrs worth + battery charger)
- Video monitor + rope/tape to attach to back of seat
- Spare leads
- Spare video camera - VHS (optional)
- Pad to hold camera on knee

- Still camera (1 for colour negatives, 1 for colour slides)
- Films 10 No +
- Spare batteries
- Lens cleaning cloth
- Wide angle - close up lens

- Gloves
- Waterproof jackets
- Cellphone
- Sunglasses

- O.S Maps 1/50,000
- Regional Map 1/250,000

3.11 Costs of Aerial Videoing

Typical costs for one days videoing of say 350 km, taking approximately five hours in a Jetranger helicopter are shown below:-

| | £ |
|---|---|
| Helicopter - 5 hrs @ £400/hr | 2000 |
| 2x landing fees @ £40 | 80 |
| Video - 5hrs Umatic | 150 |
| VHS | 10 |
| Hire of video equipment 1 day | 200 |
| Change from Umatic to VHS format | 200 |
| | 2640 |

Distance covered in 5 hours is dependent on how much the watercourse meanders etc, which will slow progress and the positioning time for helicopter to reach the specific river reaches and to refuel.

3.12 Average costs for flying and averaging all Main River (3700Km) in the Severn Trent Region has been £10/Km at high and low level (7400Km) during 90/91 and 91/92.

3.13 Future Developments

Global Positioning Satelites (GPS) can be used to provide data on position, time and attitude which can be superimposed on the video picture. This has been trialed using the Umatic camera and Hi 8 camera equipment and shown to provide good results, which could be used in survey and enforcement situations.

ANNEX F

# The Landscape Overview

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**Using airphotography for river corridor analysis with reference to a sample study of the River Stort**

**How airphotos are used**

Airphotos have rarely been used to their maximum capability and much more can be taken from them. They are often acquired in order to prepare contoured maps but beyond this semi mechanical process they may receive little attention. In an alert organisation they will be studied in stereo, but may not be used extensively; in other organisations they will from time to time be held up as single photos with a hand magnifier to make an observation. They are rarely studied in the detail that they deserve, rarely are they annotated on overlays and they do not often form the basis of systematic analysis and mapping theme by theme. They are almost invariably underused. This can be for lack of expertise, of a mirror stereoscope, of sufficient desk space or of calm un allocated time by specialists with many urgent jobs to fulfill.

The airphoto's key characteristic is that with its overlapping adjacent photo it offers a fully three dimensional slightly exaggerated model of the land. They are the basic source material of map preparation, they show enormous detail, which on 1/3,000 scale prints is very fine indeed and from them one can make many valuable deductions and inferences which go beyond the mere disposition of different land uses.

**How they were used in the River Stort study**

**The process can be itemised in four phases as shown below.**

**First stage - the detailed all purpose airphoto interpretation**

1 The airphotos were laid down to display a continuous stretch of land, run by run, and examined as well as possible without the use of a stereoscope. None of the relief is seen and the true identity of much of the land use remains veiled at this stage but the names of the main settlements and roads the direction of north and the general area of interest were identified. At this stage every second photo was overlain with acetate film and a 'map box' was drawn to define the interpretation limits of each photo.

2 They were then examined through a mirror stereoscope run by run in the same way that one

makes a preliminary recconaissance of a new neighbourhood ie moving quickly but occasionally taking a careful look at important places or those whose significance though obscure may be the key to understanding the nature of the place.

3 With a preliminary idea of the shape and content of the landscape the amount and usefulness of the detail in different areas was assessed and a decision was taken about the level of detail to define for each part of the area.

4 An enveloping line was drawn around the river corridor, using criteria discussed later. This was done at low power to obtain the widest perspective. No detail outside this area was interpreted.

5 Within the envelope detail was observed and annotated alternating between high and low power as necessary, with all boundaries drawn out at high power for accuracy. A number of different coloured pens dealt with topography, footpaths, trees and vegetation, river channel detail and general points. This process of examining detail confirmed revised or expanded the preliminary looksee.

Second stage - the generalised land use map

1 A second acetate overlay was added and making use of the fine detail now available and the understanding gained of every feature of the land, generalised boundaries were drawn between parcels of land. Wherever possible real boundaries such as hedges, urban walls, railway or roads were used. Each parcel is capable of separate description and similar parcels though for example separated by a hedge were grouped together.

2 A generalised land use key was drawn up to include and group all the observed land uses, as for example all agricultural uses under say seven headings, recreational uses under the name of the recreation.

3 To this general land use overlay was added information about the tree cover. The trees within any landscape governs what people think of it and has implications for biological richness, and so a 3D inspection was made of the trees, hedges, shrubs and scrub noting particularly the difference between tall trees and tree groups and scrub. This was then marked on the general land uses overlay. Surprisingly perhaps for such a standard item of the landscape, without the 3D image it is impossible to distinguish trees and scrub with

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any certainty, and when foliage is not fully developed (true here of the poplar plantation) even major trees can go unnoticed.

4 At this stage having reduced the detail by subsuming it into this or that land use, there were an easily managed number of lines which could quickly be plotted by eye (sometimes using proportional dividers onto a map. The map scale in this case was conveniently of nearly the same scale as the airphotos, but plotting can easily be done up or down scale. Of course it is important that as many field and other boundaries have already been photogrammetrically plotted on the map by the Ordnance Survey.

Third stage - using information from the first stage to produce a variety of thematic maps or sketches

During the study this stage was demonstrated in part by the insertion on the general land uses map of sites of bank deposition and erosion, and potential pollution checking points. Explained further what is then done is as follows:

1 Identify clearly the theme or topic you wish to map or investigate and recognise what visible land use signs associate with it. Horse keeping for example occupies land, gives rise to a particular grazing pattern, may require a clutter of jumps, involves horseboxes and field shelters and may extend out via bridleways.

2 Scrutinise the overlays for annotations related to the use and define the actual areas that are used. Investigate any further signs or influences. Look for signs of expansion or contraction or stability of the use, a very clear example of marina expansion was informative in the boating sector, while severe overgrazing of a number of connected fields is evident in the horse keeping sector, and speaks of too many horses or a scarcity of horse pasture, or a localised overstocking for a particular locational reason.

Presentation of the information

Though one may wish to plot all the interpreted lines on a map it may better suit the purpose for example to synthesise and quantify information as metres of footpath per hectare or within a particular parcel of walking land; number of fishing stations round a fishing lake (rather than their positions); a verbal description of the topographic roughness of one pasture versus the field adjacent. This may well be information closer to the final form required. The original interpretation is left as

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a repository of quantifiable fact, drawn out and made evident on overlays, which display a comparable relationship with the airphoto of a developed to an exposed but undeveloped film.

If the activity is restricted to a small area one can produce a map or annotated photocopy of that site - it becomes a text figure; alternatively one can plot more widespread occurrences on a map, with whatever factual annotations and (separately) inferences make this thematic map informative and achieve effective communication. For some purposes there is no reason to make an accurate plot when one may trace directly off the photo and project or photocopy larger or smaller to produce an illustration that is accurate enough.

It is most unlikely that every annotation or drawn out line would ever be required in a final map for the result would confuse rather than communicate. The value then of the detailed interpretation of the first stage is that it is all there and can be drawn upon for a wide variety of single purpose maps.

That said it may become important to extend an investigation beyond the first stage detailed analysis, as for example to investigate the pollution potential of a group of urban fringe properties, or to comment in great detail on the whole urban channel and banks.

The question then is whether it is time/cost effective to interpret to stage one detail at the outset. It must depend on the purpose of the enquiry but with the exception of highly detailed interpretation (see the preceding paragraph) it may be only incrementally more time consuming to look at the whole landscape than to focus on two or three themes. That is because the processes 1, 2 and 3 of stage one anyway take time - in domestic terms if you decorate a room you remove the furniture and it then makes sense to paint walls, ceilings, skirtings and the door, though you may not wish to sort the contents of the desk. To look at the landscape which is a wide theme one might need a full stage one interpretation. If however the task is to identify only outfalls along the river or industrial pollution sources this should not be weighed down by unrelated analysis.

**The river corridor idea and how to decide boundaries**

The river corridor was marked with a thin black line and a broad gold stripe on the airphotos. It was marked in as early as possible so as not to expend effort beyond it. The photo scale



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(1:3,000) is less suitable for this purpose than the more generally available 1:10,000 inasmuch as one must take a deliberately broad view of the topography to get the best line.

It is obvious from discussions that the river corridor will have boundaries affecting land use and policy and will in each case have to be agreed with local authorities and those who see their interests being affected.

Few would object to NRA's claim of an interest in the widest area likely to flood, and the NRA is continually refining this bounding line. It is a line well suited to airphoto interpretation and detailed contour mapping.

At the furthest removed from this limited area is the whole basin and this is not claimed as river corridor. Intermediate between these is a handful (each corresponding to an important tributary channel) of amplified corridors in which the river is seen to exert an influence. That influence will include fluvial process, but will encompass land which in terms of run off or potential pollution would have undoubted effect on the river. Such limits will be difficult to define as they depend on edaphic factors of soil, slope and vegetation, further affected by man made structures. Why it could be argued should they be limited to anything less than the whole catchment system.

There is fortunately an intermediate corridor boundary which puts together flood risk areas, and areas of immediate runoff with what the public would accept as an area 'connected to the river'. The connection would be a visual or landscape one ie 'because it feels like you are in the river valley here' or because the land itself displays some river origin quality or valley land characteristic.

This rather long consideration of corridor limits has to be rehearsed before airphoto interpretation can operate to define the boundaries. Even after careful definition with the help of airphotos, the proposed corridor would need to be argued to agreement and it is important for the NRA to know the strength and basis of proposed boundaries and alternatives.

The geography of the River Stort in some places suggests that there is a choice of boundaries, elsewhere only one. Boundaries are defined by a variety of features as elaborated below. As they are drawn onto the photo they represent precise real places on the ground and can be tested in the field. They included:

A form line in the town - In Bishop Stortford the corridor edge is a form line more or less following a contour which would represent one level of flooding. To draw a precise contour requires proper photogrammetric plotting. A form line is guided by a natural break of slope, where there is one, but must extrapolate across the level where there is no feature to follow. Given this inexactitude the line represents a flooding level, and fluvial activity. It has little to do with landscape or visual envelope ('here you feel as if you are in the river valley') because in amongst buildings there is a limited view and the river valley, though only one block away, may have no relevance (except for its flood risk). This river corridor boundary may be relevant to the historic site but may embed many modern factories which stand on made ground in the flood plain and are islanded in times of flood.

A form line in the country - A formline can be drawn more exactly in the open countryside and inexactitude is less important there than in the built environment. There are several places along the Stort where a strong formline marks the edge of actual or historic fluvial activity, and distinguishes dry sloping land from wetland or level river pastures. Despite this temptingly clear fluvial edge the sloping land beyond looks out over the river valley and lies within its corridor as far as the horizon visibility line.

An even stronger formline boundary occurs at Wallbury where woods on a bluff fall steeply to the wet valley edge. This line is definable by reference to vegetation, wetness and form and it would be a good (easy to agree) corridor edge if it were not for the fact that properties within the wood look out over the river valley and can claim to stand within the visual envelope. The question is then: which line rules, and may as much be a political as a landscape question.

A choice between two strong boundaries - Near Bishop Stortford an area of allotments stands downhill from the main road. The river corridor line might be drawn at the road, a typical hard easy to administer edge. This would then include the allotments as greenspace which would without difficulty be assimilated into the valley idea. Alternatively following a formline of sorts the boundary would be drawn below the allotments. Expediency is the principle factor in this decision.

The railway embankment as a corridor boundary - West of the river and south of Bishop Stortford the railway follows the (non alluvial) valley edge and can be taken as the corridor boundary. In places it physically blocks the view out from



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the river as well as access. But in some places it cuts across land of riverine quality and one may then decide whether such an outlier of river land should fall within or be left outside the corridor. Two lines have been drawn in this case. The railway nearly bisects the river valley and corridor to the north of Sawbridgeworth; it clearly can not be taken as a boundary and is merely an element within the corridor standing on an embankment above wet meadows.

The horizon as a corridor boundary - One field of about 20 hectares of cereal crop stands to the east of the river valley. Its slope is broad and convex such that as one moves away upslope from the river, the latter falls below the western horizon and can no longer be seen. The corridor boundary has been drawn to follow this horizon line rather than to include the whole field as far as the next road eastwards. This has wider application in valleys margined by convex slopes. Beyond the horizon line the observer will not feel part of the valley. (In practice designation boundaries avoid cutting across fields as a matter of administrative convenience). A comparable horizon line boundary is found at the edge of a plateau feature or a backsloping terrace.

To summarise: depending on the definition of the river corridor it will be possible to define its boundaries, but a choice may have to made between criteria of different type; in one place the boundary is best defined by one criterion, elsewhere by another. The strongest or most obvious boundary may not be the best one to adopt for a particular corridor concept. Airphotos home in very easily on all the boundaries discussed, including some which one might wrongly believe could only be defined from the ground.

**The generalised land use map**

This is probably the most widely constructed map in landscape and countryside studies. It also features as a standard item in land resource surveys. It is sometimes constructed from airphotos (though often amateurishly used) sometimes from field work, sometimes by reference to the Second Land Uutilisation Survey, sometimes by reference to land use annotation on Ordnance Survey maps. It may have a restricted number of categories in the legend which can make it uninformative. This may be due to real difficulties imposed by scale and time or out of a desire not to attempt a too difficult exercise and be found wanting. If old photos have to be used (for lack of new) there

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is justification for generalisation, but where high quality new airphotos are available the legend can be as specific and detailed as suits the project. This can best be done in a hierachical legend ('order, genus, species') eg. Land - agricultural - grass - grazed pasture - permanent - with specific characteristics x,y,z.

Most reports will stick at the second level which includes also 'urban, industrial' and 'recreation, boating', and to do this they will employ letters and subscripts within a coloured wider class of use.

If one bears in mind the detailed information about land use offered by good photos and a detailed interpretation, the generalised land use may appear to waste an opportunity of incorporating as much information as is available. However if all the available information is incorporated the number of subclasses grows and the map ceases to be a general statement. A balance is required.

What then of the interpreted detail? The detail defined in the airphoto interpretation will not be wasted as a lot of it will be required in other thematic maps, or in site specific sketches. It will also add substance to the written report and help convey a detailed knowledge of the area.

As an example: a number of adjoining permanent pastures east of the railway and half way between Stortford and Sawbridgeworth differ in the number and level of upkeep of their ditches, in their surface roughness and their minor topographic expression. In the land use map they are permanent grass at level three, or agricultural grassland of conservation interest. Because their detailed characteristics (taken from the airphoto) differ they have different conservation value and also offer a different level of landscape experience. This information can be picked up in the conservation value map and the landscape map, and need not be included in the general land uses map.

**Flood control, channel maintenance, towpath, structures and works.**

So far this report has dealt with airphotos, the river corridor and its land uses. 52% of NRA staff throughout the country are employed in flood control; how airphotos perform within this topic is considered next.

When a river floods it is because of a combination of the water which it has to convey downstream, the nature and condition of its



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channel and of its banks and the obstructions that it meets. If it leaves the channel it will flood land depending on whether it lies lower than the flood surge and whether it is prevented from doing so by bunds. How long the flood remains depends on variations in the topography and how the water is able to percolate or drain off the land.

In well documented catchments the rate at which water runs off into river channels need not be explored airphotographically except that in general it is possible to evaluate (from 1:10,000 and larger numerical scales of photo) the nature of the catchment, its local steepness, land use, vegetation cover and urban content and thus to obtain a rough measure of its likely runoff response.

That said, what of channel and banks? In the airphoto study of the River Stort, both banks and the channel could be closely examined for most of the length of 7kms studied, that is they were not concealed by vegetation. With a photoscale of 1:3,000 and 3x magnifiers on the stereoscope there never seemed any need to increase magnification to 8x, though had the image been technically sharper there were occasions when it would have helped.

The Stort is of course a navigation and for long stretches it has a relatively uniform cross section and depth. In many places airphotos show the shape of the channel though in some places the water was too dark to do this. This visibility allowed one to see where deposits of sediment had accumulated; occasionally these were emergent and some were vegetated. At one site near Stortford's pleasure grounds sediment was seen to occupy most of the channel width. The smallest bank of sediment marked was 6 to 9 metres long, equivalent to 2-3mms. In places small scale bank collapse into the channel has been marked; this results in a stepped bank and has some conservation value.

Slight bank erosion, a raw fretted quality was frequently observable at points where the river flows against an obstructing bank.

In a sample of the Dorset Stour, interpreted in a parallel exercise, the sequence of deep pools and riffles (in an agricultural landscape) can be outlined in detail, and the vegetation on emergent bars is very clearly seen at 1:5,000 scale. One can also see the green umbrella of a fisherman next to one of the pools!

The bank - Where as a navigation the Stort has a levee, the width has been noted by a brown

formline. Where very low or high this is annotated in words; certain points where it is both low and narrow are of significance for flooding. At one point, a confluence below the subsidiary river loop used for the 'Gaston Green Mill' marina, there is flood debris in the field, the river appears bankfull and there is no sign of a levee. At another point the levee is narrow and being eroded at a point where the navigation stands high above the natural valley. This was the worst case of potential bank failure. Immediately upstream of Kecksey railway bridge the left hand bank has been repaired with piling

In the section upstream from Kecksey Bridge the natural river is contained by a sinuous high bund, and within this area of natural habitat, there are many signs of flattened reeds and flooding. The strength of this bund has perhaps given some concern and it appears that exploratory holes have been drilled into the bund at intervals of 30m (by memory). What appears to be a bank repair (the width was measured) can be seen at both ends of 'the reach' and there are many tracks of vehicles that were involved. Where access was gained to the site is also visible. A second example of organised bund rebuilding stands immediately upstream of the Naturalists Reserve wetland site, but this may be the means of controlling water to the reserve.

Throughout the length of river, fallen trees were noted. These one expects will be short lived obstructions and relate to gales before the photos were flown. In one or two places there were small amounts of trapped debris. Examination of the trees along the banks would distinguish the tall ones and those growing on the navigational levee which in falling might help create a bank burst. The treescape is considered later.

All visible outfalls were marked but how many were missed it is impossible to say, though perhaps few. Most of the valley is either urban or woodland or pasture, but if drained agricultural land had been present to the river's edge, many more field drain outfalls would have been visible.

Note was made of the many structures though what can be said of them is no more than a description of their obvious structure (number of sluices, under or overspill) rails and and fences, and that as seen by a non engineer. In many places (for example in stilling pools) it was evident that soily bank material had eroded where concrete facing finished but this is

normal and likely to receive regular inspection on the ground.

**Towpath and urban bank** – Within Bishop Stortford the bank was examined in detail; vegetation with trees briars or coarse weeds was annotated. The photos are good enough at this scale to observe dumping and rubbish accumulation but none was seen at the bankside. Natural (soil) banks and protected banks with concrete were easily distinguished, even where the hard facing of concrete extended only for a few feet as around a culvert.

Where there were steps down to the river's edge these steps could be counted, and where the bank had been built with a slope (battered) this could be estimated though the image showed it with exaggerated slope. There was great variation in the width of land left by commercial buildings and their yards or car parks.

The width of the tow path could be estimated (it could also be measured accurately to less than 10cms), and it follows that places where it narrowed unacceptably could be located. The nature of the enclosing building, fence or wall could be described. This would offer scope for a detailed survey of the urban river margin as a recreation/conservation resource.

Services or paths crossing the channel could be distinguished partly from their appearance, partly from their relationships. Their heights were estimated not measured.

It is easy to make an iterative description of a walk along a path from what is seen on the airphoto, putting oneself in the position of a person with the walker's limited and horizontal viewpoint.

**The control of pollution**

16% of NRA staff throughout the country are engaged in pollution control, and this is considered next. The airphoto's contribution has to lie in its ability to see areas, sites and perhaps infer processes that are potentially polluting. But it ought to be expected that polluting industries at all levels can be monitored and controlled by other means within a statutory framework backed up by enforcible proceedures and inspection. For the airphoto interpreter to draw attention to well monitored outfalls on the basis of their appearance is not a very valuable contribution (unless for example in a reconnaissance survey of Eastern Europe). Impossible to detect is any source of polluting

chemicals used within a modern manufacturing 'park' where all sorts of processes may hide under very uninformative buildings.

Given the River Stort as a test, relatively little positive pollution information has been observed. It has little industry, little intensive high input arable farming, and there are few large cattle herds with their attendant slurry. However it does have several disposal sites based on previous gravel extraction. Further to these certain urban fringe type properties were closely investigated to query their possible activities, and in Bishop Stortford a local authority salt storage and vehicle (washing) site was flagged as a potential source with direct outfall to the river. The location of several large middens from horse keeping, some well placed to drain to the river, was also noted.

The old sewage works just south east of Bishop Stortford is closed and tidy, the new one further south lies at the edge of the corridor. A third smaller works with terraced filter beds is contributing filtered naturalised effluent to the river via a small brook.

One of the larger arable fields may be feeding diffuse agrochemical pollution into the ditch at the edge of the flood plain, though how much will depend on the relative importance of downward percolation versus lateral soil water movement - a factor of soil type and slope.

Airphotos seemed to be at an advantage in identifying the site of a backfilled quarry area now occupied by a cereal crop, and on the basis that it might have received potential pollutants during the dumping phase, attention is drawn to it and to areas where leachate might be expected to emerge. For example on the site referred to a number (quantified) of trees standing at the margin are dead and this is seen on the photos. This may be due to pollution, disturbance resulting in water stress or some non associated factor and a site visit is suggested. Within the cereal field a wet seepage area connected to the disposal site might be checked. Beyond that it is a matter of enquiry, but that enquiry can arm itself with airphoto derived information.

The alternative to airphoto 'discovery' of the site is to search out details of the mineral extraction and the disposal site via the local authority. It may seem surprising, but records of past sites can often be sketchy, and one may have to rely on the memory of minerals officers and hope that those who remember are still in post. Hence although a site 'discovered' by



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Visiting Tutor in Airphoto Interpretation:

airphoto may not be a true discovery it is a useful point of departure in conducting an enquiry, particularly as its outline, and something of its layout can be recognised.

An example drawn from the river corridor of the Dorset Stour at Iford Meadows further illustrates the point: here right next to the river is an area now valued naturalised habitat yet with a topography that is out of keeping with the valley and can only be explained by early refuse disposal. This is a Victorian site at the margins of Bournemouth and Christchurch. Lying within the gravel based groundwater corridor it and its contents are part of that system. It has a number of points where runoff would emerge and these can be identified and conveniently tested. Its age and the absence of a tradition of noxious industrial processes in the area suggest that it is a benign heap but it illustrates the principal that old sites, easily identified by airphotos, may be more difficult to locate by an enquiry that begins: 'the relevant authority (at what date?) is asked to identify as precisely as possible (the final site plan?) the extent of all (since what date) disposal sites within the proposed river corridor (where?)

A second site along the Stort is still being actively filled, and to some extent the exposed area is being reworked or deepened to improve disposal conditions. It is routine interpretation to describe the site activity and identify lines of run off and any seepage lines on the flanks.

An interesting case for control occurs at the farm above the lock and level crossing. This farm receives loads of excavated soil chalk and clay (from construction sites) which it stockpiles. At a distance south of the farmhouse it is burning waste timber and also infilling the valley of a brook above a wetland area which is extensive and perhaps important. Though not pollution, it is however likely to modify runoff conditions (and landscape) in a small area.

Concluding this section, overall the incidence of pollution visible on airphotos in the study area was low. The fact that there was little to report is of course useful evidence in itself: there were no visible agricultural slurry ponds or holding tanks, no outdoor silage pits, no intensive pig units, no industrially related outfalls (nor can these easily be inferred unless gross kill off of river vegetation were also seen), no toxic mine heaps, no waste oil handling sites, oil bunkering complexes or suspect industrial storage yards. There may be more to see on other stretches of the river.

## Recreation

Evidence of recreational land use is easy to gather on airphotos, and so is that of outdoor sport. Hence in the River Stort corridor one could write a very convincing 'report of survey' of the kind associated with statutory land use plans. The scale is very important in this and 1:3,000 is as near ideal as could be.

The following sport and recreation was investigated: walking at a variety of levels of exploration, vigour or enquiry - along the towpath, in areas set aside for recreation, across fields, and networking within areas of overgrown and naturalising pasture; use of a hummocky field for grass motor sport; use of the water for narrow boats (quantifiable number moored), cruisers and canoes (quantified numbers therefore use intensity); boat launching and offsite storage; random individual bankside fishing; club fishing; horse keeping and horse riding. If nature reserves and bird watching is recreation (and conservation land management) the Sawbridgeworth marsh reserve was noted. In areas adjacent and north of Bishop Stortford there are pleasure grounds with paddling pool and a children's play area and further north an array of football fields. The large building clearly associated with sport situated within the sports fields was misidentified as a sports hall:it is labelled swimming pool on the map.

Some of the uses are explained further below.

Walking - Valuable planning information which would normally require ground survey and a questionaire is the intensity with which different areas are used and what routes are taken. At this early time of the year (vegetation being low) paths through grass are well seen and at this scale can be marked up on the overlay using different density/size of dotted line. First, second and third order paths can be distinguished. First order ones are broad, surfaced or worn and used by family groups,those with push chairs and those whose object is easy regular exercise rather than exploration. The unmanaged farmland near the town (Stortford) is crossed by footpaths of second order and third order. A feature of the wilder more naturalised parts (wherever the grass is unmanaged) is tiny winding third order footpaths which form networks and often lead to the rivers edge.All these signs make up a clear picture of how people use the area.

Further from the town footpaths are less frequent and go between places rather than providing networks within a limited area. Wear width, presence or absence of vegetation and how



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a path is affected by an obstacle give useful clues as to its importance and level of use. This applies equally to towpaths, casual tracks through fields and bridleways.

Grass track for motor sport - All over the country farmers rent out fields for motor sport and the wear pattern will indicate type and level of use. Land for this has to be irregular or steep. The area noted here may once have been dug over for gravel, and is on the same farm where soil disposal is taking place.

Use of water - The number of boats moored at the mill marina at a time when few are to be found on the river may be significant as a 'home port complement' out of season and after a period of stormy weather. The photos show how and where they are moored. They also show excavation, levelling and building works in progress at the marina facility. Airphotos would need to link into a more regional view for a full understanding of the boating traffic in the area, though that on the River Stort could be evaluated through airphotos flown in this contract.

The presence at the lock and boat building sheds below Bishop Stortford of many canoes and (by memory) two launching jetties suggests that canoeing is done in an organised fashion.

Offsite boats - The owner of Tednambury Farm which overlooks the river across pastures, keeps a boat in his farmyard and appears to launch it just below the bridge leading across meadows to the Marina. The bank there has been ramped down into the water. Below Kecksey's Railway Bridge the hull of a small barge (not a narrow boat) stands next to the river. Close to this the owner of the land has constructed a new set of farm buildings together with a pond fed by groundwater. Change fed by capital investment is under way and the site might be watched for further change.

Solitary fishing at the bank is suggested by the many paths which terminate there. Fishing otherwise seems to be concentrated on the flooded and well wooded gravel pits which occupy an eastern salient of the river at Twyford farm. The small fishing jetties there were counted, and details of the entry track (once used for gravel haulage) and poorly organised pile of rustic construction materials were noted. By memory no fishing club car park was noted.

Horse keeping - There are a large number of grass fields in the river corridor but a strong demand for horse pasture seems restricted to two or three areas. The principal of these is

between Thorley Street and Pig Lane and occupies land (by memory three fields) on both sides of the river. On the left side (east) the fields are damaged by overuse. A small left bank tributary is involved and there is localised damage fed erosion and deposition in a smaller rivulet.

The grass field surface is also damaged by the movement (turning) of vehicles for horse transport. On the right bank horses are stabled and the resultant manure stacked next to the river channel.

Pasture that is horse grazed has a characteristic appearance that can be recognised in the absence of other clues (stable and fodder shed, old baths as troughs etc) at scales at least up to 1;10,000. Horses also throw a distinctive shadow that distinguishes them from cattle, and the fencing arrangements (paddocking, bars and no-panic rounded corners to fields) in high quality horse keeping sites is characteristic.

Nature conservation value - Air photos of this quality should allow accurate conservation mapping of comparative biological richness; important associations can be implied but species or rarity sites are obviously beyond the method.

Easier than landscape, which in part depends on outviews to distant resources and value judgments, habitat richness can be evaluated from point to point with the caveat that each point depends on some externals of the ecosystem with which it connects for example a promising small wetland area may connect with a low grade water supply.

One might approach evaluation of categories of visible feature and map and annotate their boundaries: river bank and channel (degree of training and maintenance, site diversity) woodland (types and stands, dry and wet, planted and semi natural) proceed to wetland and ponds(degree,complexity and wetness), continue with grassland (old established or short term on smoothed or hummocky topography, wet or dry, with or without ditches), continue with scrub and hedge networks (volume, connectedness, presence of trees).

Having established values and land parcel boundaries one could derive a map using these. Alternatively one could overlay a grid network of points assigning a value (1-7) to each and draw up the quality classes from these taking note of natural boundaries when drawing the



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quality contours. This is work of a type and range done in this office and therefore possiblein practice not merely in theory. It follows that field checking will enhance the accuracy of an evaluation, most especially to establish the species content of typical (photo interpreted) areas.

The above is written of the whole corridor, not of the more restricted area of channel, and wider bank. Examples of the more restricted survey (500 metre section by section ground survey along Suffolk rivers done by the county naturalist trust with Anglia NRA) is achieved without airphotos and has both pros and cons; the pros are species identification and on the ground experience of the site, the cons are time consumption, access difficulties, disorientation and limited visibility. The airphoto evaluation is a much more structural excercise, less related to seasonal variation and only sometimes able to recognise species. That said the scale of 1:3,000 is well suited to conservation mapping as the more detail that is visible the better.

Landscape This has been left to the end as it is arguably the most elusive topic and one where preference linked to professional background tends to generate strong views. It has been said by many who have not begun to use airphotos that they cannot substitute for ground work; man lives on the ground and not in the air, land scape is about verticals and horizontals and change as one moves through places. However, how to evaluate and describe landscape on the ground has yet to be solved, there are several views, a number of acceptable ways and a whole lot of cases that slip through the methodological net, and have to be treated on their merits.

An important review by Carys Swanwick of the Landscape Research Group (for whom the present author is an editor), contains the following points from a sample of the more important used methods. Quoted in brief below their relevance to the airphoto method is then examined.

(1) Penning Rowsell at a local level used 22 landscape variables taken from maps and airphotos on a 1km square grid, and identified the problem of defining a landscape tract. He combined this with people's preferences. (2) The Institute for Terrestrial Ecology sampling at national level used 32 classes of land defined by landform and landuse. (3) The Farming and Wildlife Group working at farm level uses visual boundaries and landscape zones of homogeneous quality. (4) Derek Lovejoy used land use, landscape elements and their





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importance to make a value judgement. (5) Land Use Consultants in Mid Wales based their evaluation on landform, landuse,land cover (moorland and rough grazing types - four in all), and amalgamated these observations with visual envelopes. Their observation points were chosen to give a view of the identified unit and for ease of access. Key elements, colours and intrusions were recorded. The evaluation of what is good or less good was made with reference to other established preferences.

Swanwick makes it clear that the problem of selectivity of viewpoints can to some extent be overcome by using many viewpoints and overlapping the various zones, sieving out those most frequently seen. She adds that GIS, TM - Terrain Modelling and SM - Surface Modelling systems are good at this and are really the only way of mapping such zones accurately.

Under 'development of new methods of measuring landscapes', she points out that aerial photography is one of the main sources of information particularly with respect to land cover, land use and vegetation, but she sees it as having difficulty in interpreting more detailed information, for example vegetation type.

Let us consider the significance of these facts and opinions. How do they relate to the present work on the River Stort. First one can put aside the caution that photos at this scale (1:3,000) or indeed colour photos at up 1;10,000 scale are difficult in the interpretation of detail in particular vegetation. It is possible to make good identifications at 1:24,000 as we have done in this office on the Scottish colour photo cover.

It is important to note from the review that, far from being a wholly ground based activity, landscape evaluation relies heavily on airphotography. Landcover change (the essence of the nationwide DOE 'landscape' survey) relies very heavily on it. Note also that selection of viewpoints and definition of landscape tracts is commonly referred to as one of the difficulties in assessing landscape.

Then note the claim that Terrain Modelling and Surface Modelling systems (computerised visualisation) are 'really the only way of mapping such zones accurately'.

What the review fails to recognise is that the 3D modelling of the landscape seen in the airphoto is a very sophisticated system which not only shows every detail of relief (at a less than one metre contour interval) but also

clothes it in the reality of its infinitely detailed land use. It does not suffer from the difficulty of viewpoint selection nor of areas half seen. It has inbuilt land use and it is portrayed in natural colours. No time is consumed obtaining or inputting complex data sets to produce a terrain model for the terrain modelis there to examine, and the information relates to one brief time period with no adjustments for out of date data.

The claim made in this report is that high quality interpretation on good quality colour photography is the fastest, most satisfactory way of mapping landscape in an objective fashion. Larger numerical scales are suitable for larger tracts of land and greater generalisation and vice versa. This does not have acceptance in landscape circles and there are probably few interpreters who would make the claim.

The key to this is that the interpreter should work always in 3D, that he should immerse himself in the surroundings that he observes and that he should already have 'on board' a compendium of landscape images and experience that allow him to transpose the aerial image of any tract (or at any point or along any traverse) into the landscape image and experience at that place as it would be seen from ground. Is this any more demanding in principle than describing a landscape seen from a high viewpoint?

How then is it done? Why was it not demonstrated in the study? On the second point for lack of time to demonstrate all analytical methods in this study of the river corridor.

The method draws on the detailed interpretation done as a basis for all the themes. Further work requires that one identifies whether the landscape in question is that which can be accessed and viewed from roads and paths,or the whole landscape regardless of access. Only airphotos really allow 100% access. One has also to define at the outset the product whether a map and with what level of descriptive key, whether the key should be contained within a frame provided by land use and land cover and based on landscape character, or simply relate to perceived value for example: ugly, dull, quite interesting, interesting, exciting; or combine character with some form of quality grading, or potential to absorb change, or likelihood to change. If a grid of values is used one has to define sample frequency.

Perhaps the drawback to using airphotos is that they are not restricted by access and a



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conscious decision has to be made to limit the number of observation points, or to integrate information for an area or traverse and present it in averaged form. They also pose some difficulty on long outviews. This is not a problem for immediate outviews, that is what can be identified as 'the surroundings.' They function well in locating detractors, pylons, power lines on poles, buildings, intrusive road alignments and out of place land uses.

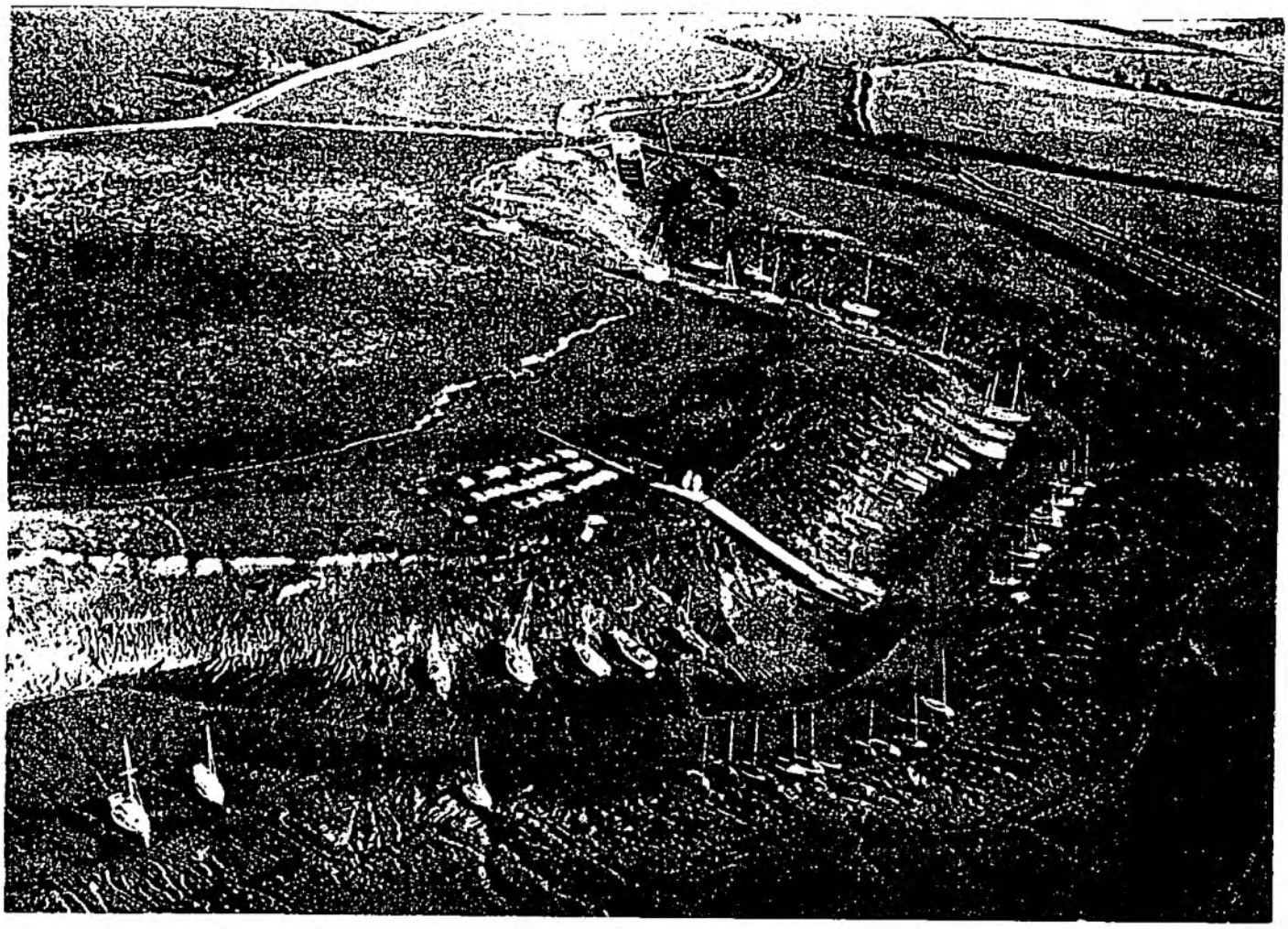
In the Stort valley, landscape could very suitably be described from airphotos as long as the objective of the desciption were clearly stated.

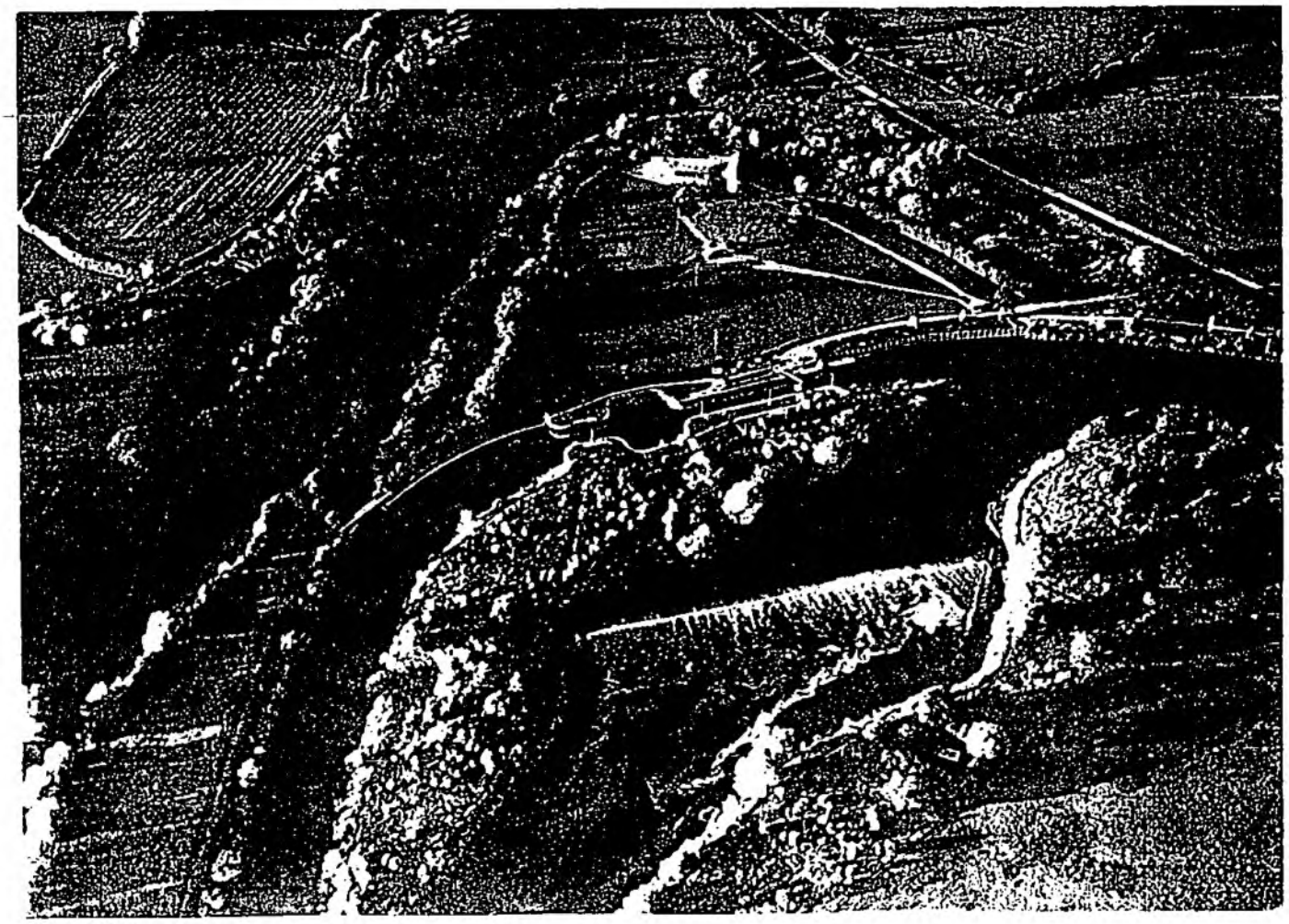
**Concluding remarks** This report claims a lot for airphoto interpretation, particularly at this scale and for this valley corridor. Much of it can be accepted as it has been demonstrated, but there will continue to be resistance to the idea that landscape in particular and to a lesser extent conservation values can be mapped and described with so little traditional ground inspection. There was a time when airphotos were always black and white and in those days field checks were much more important. So are they also at scales above 1:10,000, though less so in colour and the reference level (the compendium of landscape images) of the interpreter is all important.

The report set out to demonstrate that the great amount of detail annotated on the overlays was not a stumbling block but a useful mine of information; that it need not all be entered into a computer as raw data (what a jumble), but in the process of mapping and reporting could be packaged up in a number of ways summarising typical attributes of this or that type of land. Meanwhile it was already stored on overlay as an archive of information. It can at this stage be stated that certain hard fact data sets of operational importance (erosion, outfalls etc) and some generalised maps could be digitised into a GIS without in any way overloading the system.

It has always been the case that the person who does the survey knows more about the result than anyone else and this is certainly the case with airphoto interpretation. It is therefore most effective if the interpreter produces the derivative information, either alone or in close cooperation with others in or outside the Authority.

Airphoto interpretation relies on expensively obtained photo cover but brings very good returns through detailed interpretation. For





Examples of Aerial Video Oblique Views

example it is unlikely that the information collected in five days at the stereoscope could have been collected in less that twenty five in the field. Many such cost comparisons are documented in the field of land resource survey and savings of this order are normal.

Finally it is often the case that airphoto cover is obtained and financially justified with only one product in mind, the contoured map. Where this is the case the airphotos come to the interpreter 'free of cost'.

Bud Young
The Landscape Overview
January 1991

The Landscape Overview

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F11

| | WOODS | PASTURAGE/ANIMALS | ARABLE | MOORLAND | MASSED FLOWE |
|---|---|---|---|---|---|
| MARCH | willows jade green<br>birch purple | grass dull low chroma<br>chain harrowing, rolling produces stripes<br>sheep + lambs | Spring cultivations completed early in month. Winter/Sown crops still show rows<br>barley bluer green than wheat | bracken stalks of smoking controlled fires | daffodils in towns |
| APRIL | larch into green<br>birch leafing<br>ash/oak oak later in wet years | Fertiliser applied – tractors seen in fields<br>Sheep & lambs out. Cattle put out | ploughing harrowing drilling on better soils<br>Numerous tractors begin in any field: | U. European.<br>Gorse in abundant flower<br>bracken still dead | bedding plants in farm flower beds.<br>Blackthorn hedges & scrub |
| MAY | Mayblossom early<br>May blossom late | Early hay crops taken<br>Silaging pastures show yellow (roots) after silage returning to green<br>cow pat rings on cattle pasture | Tramlines very prominent but not on ley grass<br>potatoes ready for harvest<br>signs of irrigation. | Emergence of bracken as bright green cover | buttercups in acid meadows<br>May blossom on scrub and in hedge |
| JUNE | Elderberry flower on sandy site | | oilseed rape in patches flower depending on site<br>Crops yellowing | | Fruit orchards in known sequence<br>Umbellifers in verges<br>lime tree flowers |
| JULY | large chestnut leaves white in B/W | subsurface drain lines show green in dry years | earliest harvesting<br>later cereal harvesting<br>scarifying stubble/ground burning (black) cultivations | U. galii flower<br>flowering of heather changing purple | moorland heather |
| AUGUST | All trees in leaf and getting darker<br>low contrast between species | Any dampness shows yellowing grass – growth has renewal in moist Septembers | Cultivation for winter cereals<br>winter cereals beginning to show | | |
| SEPT | | No distinction between sheep and lambs<br>grass stops growing | early spraying of cereals along tramlines | bracken again brown and dead. | |
| OCT | leaves start to colour in dry drought years | Cattle taken in | | | |
| NOV | strong autumn colours<br>some leaves lost in dry years – ~~horsechestnut~~<br>Ash, plane in towns<br>birch (yellow) oak brown<br>beech red | | | | |



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MAIN AIRPHOTO SUPPLIERS

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Dennis Cox
Cartographical Services Ltd
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Wilts SP5 2EW

Peter Breed and Jon Simms
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Ordnance Survey
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Southampton
SO9 4DH

Iona Myrie
JAS Photographic Ltd
92-94 Church Rd
Mitcham
Surrey CR4 3TD

BKS Surveys Ltd
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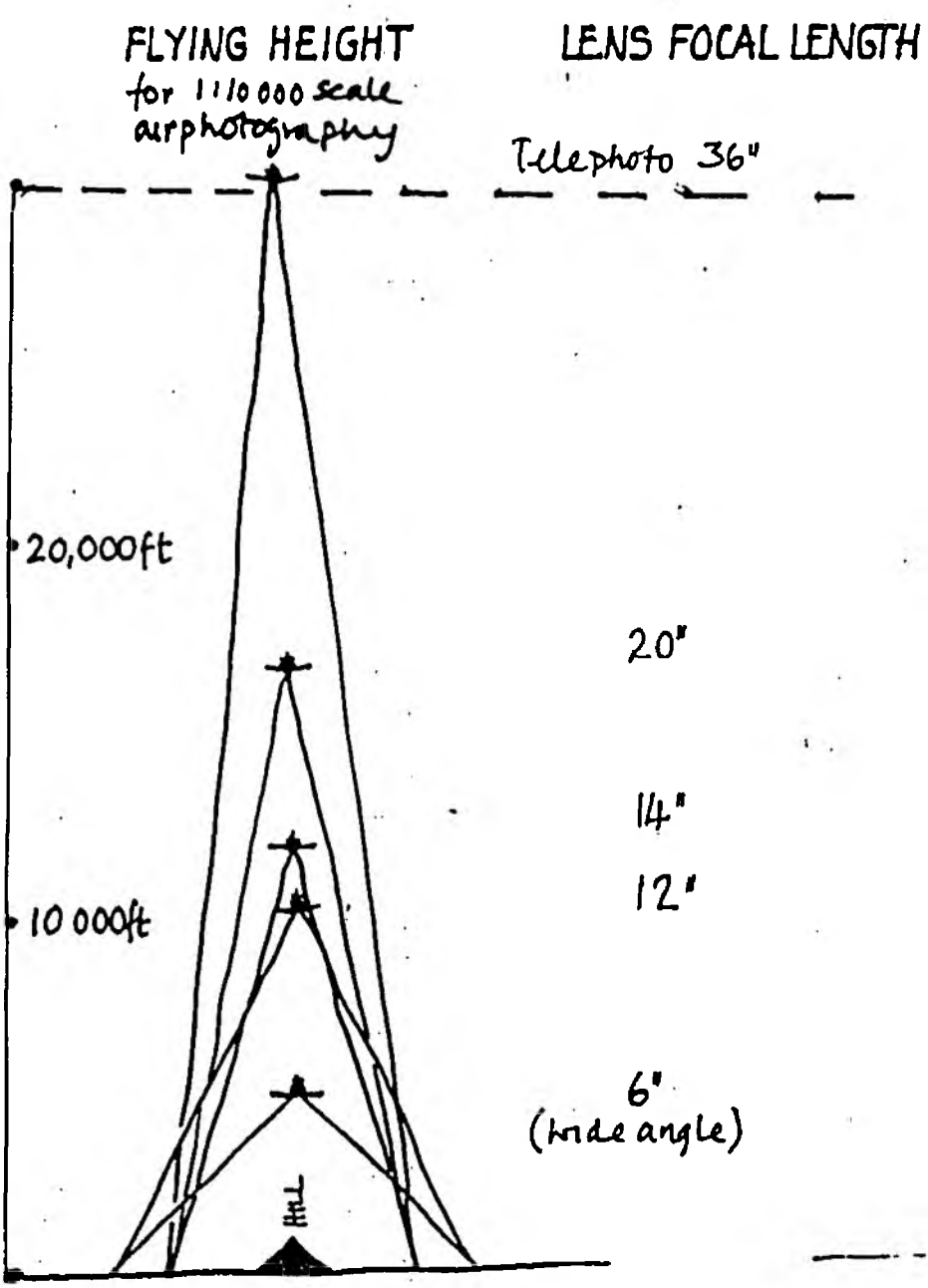
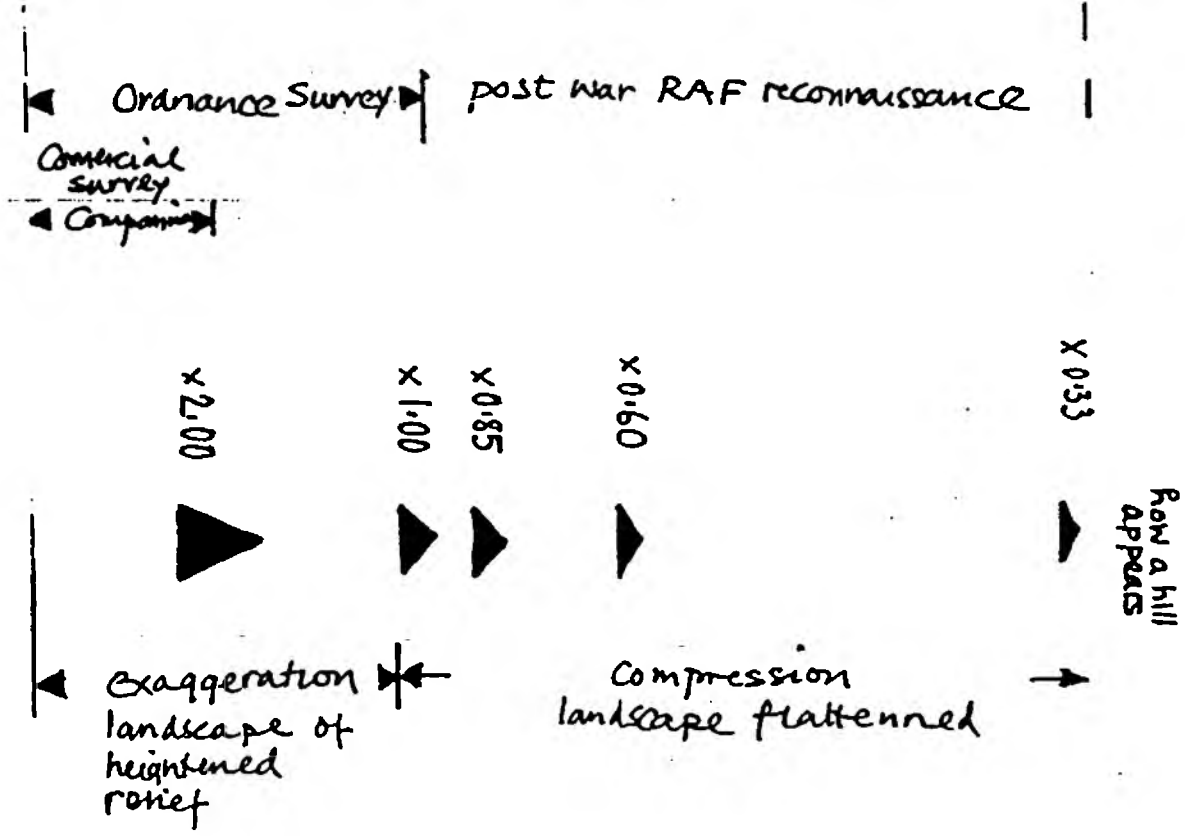
F13




RELATIONSHIP BETWEEN LENS FOCAL LENGTH
FLYING HEIGHT AND SCALE


SOURCE
VERTICAL SCALE RELATIVE TO HORIZONTAL
Ordnance Survey
post war RAF reconnaissance
Commercial survey
Companies
x 2.00
x 1.00
x 0.85
x 0.60
x 0.33
how a hill appears
exaggeration
landscape of heightened relief
compression
landscape flattenned

F15

## Characteristics of Blocks of Rural and U/F Land

1 Extent and Shape

2 Topography and natural drainage

3 Boundaries
- Hedges
- parish hedges
- banks
- walls
- belts

4 soils

5 Rivers, streams seepages ill drained basins marshes wet spots ponds lakes

6 Roads tracks paths temporary accesses

7 Parkland

8 Cover – woods Copses rough – furzy moor

9 Archeological features landscape historical features

10 Other natural habitat (old pastures chalk grass limestone grassland) saltings

11 Shrubs and shoreline land

12 Forestry

13 drainage surface and sub-soil

14 Built structures villages farms yards houses

15 Minerals potential and exploited

16 pylons gas pipe lines wayleave strips

17 Problem land uses

18 Problem boundaries



F 14

SURVEY CAMERAS - SPECIFICATIONS, COSTS.

Dear Nick,
With reference to our telephone conversation of yesterday regarding various camera systems ,please find below some facts and figures relating to the different types.

1. STATE of ART, LEICA RC20 FMC (Forward Motion Compensator)
   The most expensive of all the options due to its extremely high resolving powers and FMC systems.
   Capable of very sharp imagery during low altitude high speed conditions.
   This camera has various LED displays which show on every frame. ie, individual exposure number, forward overlap %, run number, selected parameters, photo exposure data, and has the facility to integrate with any modern navigation system such as GPS, whereby the geographic coords are shown on every frame.
   This camera has many automatic systems such as exposure and is very user friendly. The exact cost will vary depending on required configuration
   but the basic camera system suitable for 2 man crew operation is approx £170.000 .

2. STATE of ART ZEISS TOPO 2000
   This system also does everything the LEICA does but with more automated systems such as forward overlap control, automatic levelling/drift and fully controlled by total keyboard operating procedure.
   (this camera system also has the capability of titling each individual run or frame during flight whilst over each target area. plus the navigational data input facility
   The price of this system will also vary depending on final configuration but the basic system is around £150.000

3. LMK FMC
   In the days of the Berlin wall after which the ZEISS company split into East and West , both companies separately developed their own camera systems, but with very similar facilities, though a considerable price difference with the LMK ,the reliability in the field has left much to be desired, but I now understand that this situation has been improved and users very happy,
   Price for the LMK is.approx.£120.000

4. USED WILD(now Leica)RC10.
   This camera system is probably one of the most common in use
   Though basically electronic in operation, its recording instruments are analogue (mechanical clock,pressure altimeter, an,operator entered data panel with mechanical veeder counter.
   Built for high spec mapping standards but no FMC facility.
   Can be obtained (when available) from between £40.000 - £80.000.depending on spec.

5.USED ZEISS RMK
Similar to above,and available(when on market) from between £40.000 - £60.000 depending on spec.

6.USED WILD RC8
A basic survey camera (as seen on our aircraft when you carried out your earlier flight trails) ,the RC8 is mainly mechanical with basic electronics and all mechanical instrumentation.
These cameras continue to produce excellent results (we still operate 3), and could be modified to produce a limited LED displays (coords etc) which would be exposed onto each frame. Can be purchased from between £8000 - £12000 depending on type of lens (colour corrected lens or not).

SUMMARY.
All survey standard cameras have basic instrumentation that is either a mechanical veeder counter or electronic counter, a pressure altimeter, clock, level indicator and on earlier cameras a small data panel (daily/sortie information pencilled in as required)
The older used cameras are still excellent equipment and (though not done to date) I feel could be fairly easily modified to display some further information, ie basic GPS COORDS.

Should you decide on the modern camera systems, then you have many options and facilities suitable for all varieties of survey tasks.

These camera systems can be set up suitable for remote control (by systems manager), or by a dedicated operator, the configuration does make a considerable difference to final cost , but in your case I would recommend a remote system so to enable you to operate with fewer crew members.

I trust that this information will suffice for now? please do not hesitate to call should you require any further information at all.

Regards.

Dan



G2

ANNEX H

# PROJECT INVESTMENT APPRAISAL

1. R&D Commission : G - General Operations

Topic : G3 - Information Technology

Title : A Review of Remote Sensing Techniques

Proposed No. G03.01.91 Project No.

Classification of R&D : Applied Research with Strategic Aims

2. Project Leader - Gareth Llewellyn
R&D Officer
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Reading
RG1 8DQ

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Fax : 0734 393301

3. Research Contractor

To be decided. Contractor must have an indepth knowledge of the NRA's activities and have a general, but not necessarily a specialist, knowledge of remote sensing.

Possible Contractors : NERC (IOH, IFE & ITE)
WRc (Medmenham) & former NRA staff
Halcrow & Wimpol/Wimpey Environmental

4. Contract Details

Start Date : 01/04/91
End Date : 30/09/91

5. Objectives

Overall Project Objective

To assess the viability of using remotely sensed information in relation to the NRA's operational and planning activities.

Specific Objectives

a) To assess information available from satellite sensors, airbourne sensors and aerial photographs.

b) To synthesise the available information in respect of the Authority's operational and planning duties.

c) To determine those techniques, at their current stage of development, that are likely to be of benefit to the Authority.

d) To demonstrate to the Authority's staff, through the documentation of appropriate images, areas where remotely sensed data may be beneficial.

5. Background

The availability of information from satellites and airbourne platforms has significantly improved since the mid 1970s. Coordinated programmes from NASA, NOAA, ESA and in the UK by NERC and ADAS have ensured an ever improving range of sensors and information are available to civilian scientist/engineers.

The perception of remote sensing as being purely information from satellites is very much a narrow view. Remote sensing also includes the use of airbourne platforms for both wavelength specific sensors and for aerial photographs.

In certain areas of the Authority's operational activities, remote sensing is already utilised. Aerial photographs, both stereo and mono have already been used in Water Quality (bathing beach information, discharge identification), Flood Defence (flood monitoring, surveying) and Conservation (river corridor surveys).

In the past the use of satellite information has been treated with some scepticism within the Authority because of problems with cloud cover, repeatability and spatial resolution. However, studies on effluent plumes have been undertaken for Southern Water Authority in the past and monitoring of sludge dumping has also been carried out off the Forth estuary.

Areas of remotely sensed information that have shown promise as far as the NRA is concered are :-

| | |
|---|---|
| a) Rainfall forecasting | - SMMR/SSMI |
| b) Discharge monitoring | - Spot/Landsat TM |
| c) Algal bloom monitoring | - Airbourne visible sensors |
| d) Sea level/Flood level | - SAR/Altimeters |
| e) Land use classification | - Landsat TM/Spot |
| f) Digital terrain modelling | - Spot/USSR satellites |
| g) Sludge monitoring | - Airbourne sensors |
| h) Vegetation classification | - Airbourne sensors |
| i) Snow water equivalent | - AVHRR |
| j) Flood envelopes | - Landsat/Photographs |
| k) Oil slick monitoring | - Airbourne/Spot/Landsat |
| l) Soil Moisture Deficit | - SMMR/SSMI |

The annual airboune surveys undertaken by NERC and the more specific airbourne photography undertaken by MAFF(ADAS)

will be taken into account. The techniques developed as part of these programmes will undoubtably be of use to the Authority, as will the expertise of NRSC (Farnborough) and the French organisation Eurimage.

The academic establishments particularly active in the field are :-

a) Aberdeen University
b) Bristol University
c) Dundee University
d) Nottingham University
e) Plymouth Polytechnic
f) Reading University
g) Southampton University
h) University College of Wales, Cardiff

NERC institutes such as IFE, ITE and IOH also have expertise in remote sensing applicable to their respective interests. IFE (Windermere), in particular, have used airbourne remote sensing to monitor and predict the growth of blue-green algal blooms.

Context

This review aims to be truely multifunctional and, as such, is applicable to the many of the R&D Topic Areas in all Commissions.

The work will take account of the International Hydrology Programme of UNESCO, a product of which has been "Advances in Remote Sensing for Hydrology and Water Resources Management" by Schultz, G.A. and Barrett, E.C. (1989).

7. Strategy

Methodology

a) Desk study of the NRA's operational and planning data requirements.

b) Literature review of techniques employed in the UK, Europe and North America to obtain data for requirements similar to those of the NRA.

c) Assessment of the relative benefits of each technique in terms of new information obtained, cost effectiveness, and improved spatial coverage in relation to the NRA's activities.

d) Recommend techniques that are of use to the NRA.

e) Selection of appropriate images (from a number of NRA regions) to support the recommended techniques.

f) Documentation of the selected images to illustrate their

benefit to the NRA.

Items b) and c) may run concurrently ensuring that those techniques that are inappropriate are researched to a lesser extent than those that may be of benefit to the NRA.

Monitoring

Project Leader/Topic Leader/Commissioners to review progress of the project and to review draft final report.

The length of the project is reasonably short and as a consequence bimonthly project meetings will be held to ensure the project meets its objectives.

8. Targets and Timescales

Start date : 1st April 1991
End date : 30th September 1991

| | |
|---|---|
| 1. Desk Study of NRA data requirements | 31/05/91 |
| 2. Literature review | 31/07/91 |
| 3. Draft Final Report | 31/08/91 |
| 4. Final Report | 30/09/91 |

9. Outputs

| | |
|---|---|
| Draft Final Report | 20 copies |
| Final Report | 30 copies |
| Image Pack | 3 copies |

10. Costs

Budget for the project will not exceed £30,000 of which upto £5,000 will be allocated to the purchase of appropriate images.

11. Benefits

At present the NRA takes the majority of its information from 'spot' measurements with the spatial aspects coming from interpolation between points. Remotely sensed data will give all Functions a better understanding of the spatial variability of many attributes of the river/coastal environment. In addition, the public relations benefits of satellite images in particular could be as great to the NRA as they currently are to the Water Utilities.

## 12. Assumptions/Risks

There will undoubtably be many techniques which have not been sufficiently developed to be of much benefit to the NRA. It is unlikely, however, that all techniques will fall into this category.

In general terms the weather of the UK will inevitably hinder the use of satellite information for those applications which rely on visible radiation. However, by covering the use of airbourne sensors the problem of weather interference should not detract from the outcome of the project.

It is assumed that the Contractor will have an extensive knowledge of the NRA's operational and planning duties. An understanding of the Authority's data requirements may have been gained through other NRA R&D projects.

## 13. Overall Appraisal

The methodology specified above will ensure that only those techniques that are likely to be be of benefit to the authority will be examined in any great detail. This

This project will provide the NRA with not only an assessment of the best remote sensing techniques currently available but also with images to back up such techniques. This is an important aspect of the project since only images can demonstrate the benefits of this type of data collection.

It is hoped that this project will demonstrate to NRA staff that remoteley sensed data can be complimentary to current methods of data collection.

G. Llewellyn
23/10/90 (version 1.0)

# 6 CONCLUSIONS

The report has shown that both satellite and airborne remote sensing can, at their present state of development, provide information which is useful to the NRA in the discharge of its duties. The potential range of NRA applications which can be met, either in total or in part, by remotely sensed means is very wide indeed. This study has highlighted many of these, and the Authority should investigate further specific areas which are featured by this report. Furthermore, there are areas of great potential which are not as yet fully operational, but show sufficient near-term potential that the NRA should develop their utility.

The following specific conclusions and recommendations are offered:

(1) **Low resolution satellite imagery** such as that acquired by Meteosat, the DMSP-series Scanning Multichannel Microwave Radiometer and NOAA's Advanced Very High Resolution Scanning Radiometer provide operationally useful information on meteorological and hydrological parameters relevant to the needs of the NRA.

(2) **High resolution satellite sensors** such as the Landsat Thematic Mapper and SPOT High Resolution Visible sensor can provide internally consistent information on the catchment scale and above for a wide variety of applications in the NRA.

(3) **Airborne remote sensing** can deliver relevant information at higher spatial resolution, within controlled timescales, under fewer weather constraints, repeatably and with a wide variety of sensors, focussed on specific geographical areas of interest. Independently and in combination with data from satellites and other sources airborne remote sensing is a key technology for the Authority.

(4) **Applications where remote sensing can contribute to the information requirement of the NRA at present include:**

- monitoring inland water quality
- monitoring coastal water quality (including eg outfall location)
- assessment of land cover as an input to hydrological catchment models, fertiliser/pesticide contamination runoff, flood protection and risk assessment, acidification etc
- national synoptic assessment of rainfall rates and snow extent
- assessment of impervious areas in urban catchments

- coastal and riverine engineering and sediment transport modelling
- thermal pollution of rivers and estuaries
- pollution transport studies
- river hydrology through identification of dead zones etc
- identification of landfill sites through heavy element contamination of vegetation cover

(5) **Applications with potential for near term operational use include:**

- improved discrimination of organic contaminants in freshwater and coastal regions through use of high spectral resolution sensors

- all-weather coverage of flood events and storm damage through satellite-borne imaging Synthetic Aperture Radar systems

- improved understanding of soil moisture signatures through active and passive microwave sensor systems, including airborne L-band passive radiometers and satellite SAR

(6) The utility of remotely sensed data to the authority will be greatly influenced by the development of relevant **information processing and modelling capability** in the Authority. Integration of remotely senesd data with other sources of information will be a critical area in the uptake of such data. The use of integrated Geographical Information Sytems to handle remotely sensed and other spatially referenced information for modelling purposes will be vital. The ability of the NRA to make use of remotely sensed data will depend on the information processing environment supported by the Authority.

(7) Where the problem is well understood and the appropriate techniques available, remote sensing can be easily the most **cost-effective** way of acquiring relevant information.

**It is recommended that:**

(1) the Authority should study further those areas highlighted above as being of likely current or very near term interest to the NRA. More detailed analysis of the most promising areas highlighted should be carried out, including pilot studies in specific geographical problem areas known to the Authority.

(2) Those areas which have the potential to provide information of great value to the Authority should be developed.Of particular significance are:

(i) the use of high spectral resolution airborne visible/NIR sensors for improved discrimination of phytoplankton composition in lakes and for identification of organic components of seston in turbid and coloured coastal waters. A better understanding of the optical properites of water based on in situ data is also needed.

(ii) the use of airborne passive microwave imaging instruments for measurement of soil moisture

The information which can potentially be derived from these sensors is of such utility to the Authority that it should positively support research and development in these areas. The Authority should consider how it may achieve the longer term deployment of relevant sensor systems to allow such work to be carried out in the UK.

(3) The extent to which the Authority will be able to make use of remotely sensed data will depend on the information processing environment supported by the Authority. A consistent approach must be taken towards the integration and processing of spatially referenced data, whether available through remote sensing or other means. The authority consider its strategies in data processing and modelling to enable it to make best use of new and/or more extensive information through remote sensing.



I3

ANNEX J

LEASING & PURCHASING AIRCRAFT - A REPORT BY COMPASS AVIATION

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The purpose of this brief is to enumerate the options that are open to the National Rivers Authority in achieving its aim of putting its scanning and camera equipment in the air, with approximate costs, culminating in recommendations.

## 1. Method of Operation

There are two categories under which the aircraft may be operated:

A Public Transport
B Private

A The **Public Transport** category allows the operator/owner to fly for hire and reward, i.e. when carrying out a survey for A. N. Other agency where there is a financial consideration involved.

This is exactly the same category in which all U.K. airlines operate. It is restrictive, particularly in crew duty time. Admin. manning levels are dictated and the operation is therefore expensive to run, not only in personnel, but CAA licencing charges (see Annex 2 B).

B The **Private Category** is very much more relaxed, far simpler to adminstrate and therefore considerably less expensive to operate.

However, this joie de vivre does come at a price. There can be no remuneration from third parties for work done on their behalf. Passengers should only be "substantial" shareholders, directors or employees of the operating company, which may also be the owner.

Having made the points at 'B' above, the subject of Private Category operations is in fact a grey area. The CAA will not lay down a clear definition. If the intending operator can come to an agreement with his Flight Operations Inspector (FOI) that the proposed operation is clearly Private Cat., then the operation may proceed, but the FOI will not go into print to confirm what has been agreed. If they cannot agree, then the CAA may well defer to its Legal Department for a ruling, at which stage it would behove the operator to consult an aviation lawyer. It could well be financially worthwhile if he can remain on the Private Cat.

## 2. The Aircraft

A Purchase
or
B Lease

A Under the purchase option the NRA could operate the aircraft in one of two ways:

i) In-house. This would require the employment of a Chief Pilot supported by, at minimum, an operations clerk with a designated office and its associated running costs.

ii) By a management contract, which would free the NRA from the involvement at i) above. There are various ways of running such a contract e.g.:

a) A fixed price contract based on a projected number of flying hours per year reviewable, say quarterly. Paid monthly in arrears.
b) Based on actual hours flown. Paid monthly in arrears.

There would be additional invoicing at a) and b) above for landing and parking fees, air traffic charges, fuel, crew accommodation etc. as incurred. Most companies would require an advance of these projected monthly outgoings to be kept separately as a 'running expenses account'.

The attraction of the purchase option is that the aircraft is available to the NRA 100% of the time which, with weather "windows" and a growing programme, is likely to become an imperative.

B Lease. The aircraft could be owned privately or by another operator (the management contractor) and run by either of the methods at 2 A i) or ii) above.

The lease agreement would require the NRA to be specific about not only the number of hours but the programme itself, as the owner is likely to require the use of the aircraft when it is not being flown by the NRA.

The additional charges would be the same as at A above. The hourly charge may or may not take into account pilot's fees and fuel, depending upon whether the operation is Private or Public Transport, or the lease is wet or dry. Management companies usually make a 5-7% charge per month on each invoice.

The advantage of the lease option is that the NRA would not have capital tied up in what is, at the moment, a depreciating asset. But the aircraft may not always be available when required. To overcome this major disadvantage, a sole use lease would need to be negotiated.



Jd

## 3. Maintenance

Here again, the options break down into:

A Private Category

B Public Transport Category

A **Private** requires an annual inspection to be carried out on the aircraft, with about a two week down time. Check 1's should be carried out every 100 hours, but may be extended if operational requirements dictate. All manufacturers' AD's (Airworthiness Directives, which are mandatory) must be complied with as they are published. In this category it is up to the operator to ensure that they are done.

The Private maintenance category is flexible and reasonably cheap, certainly by comparison with the Public Transport Category. It is as safe as the Public Transport Category, provided the operator is conscientious about his maintenance, which must be done by a suitably CAA licensed engineer. An operator may not sublet an aircraft maintained under the private category. It best suits an operator with low utilisation. No calendar checks are required

B On the **Public Transport Category**, the maintenance regime is very much more regulated by the CAA, which is all to the good of the fare paying public. The aircraft is required to be maintained by a suitably licensed engineering facility, which may or may not be located at the aircraft's normal operating base.

Check 1's are allowed only a 10% extension on their due hourly or calender date (which can be negotiated with the CAA to be at 100 hour or 90 day intervals, whichever occurs first), after which the aircraft is grounded until the check is carried out and signed off. If a job requires the aircraft to be away past the extension period of a check, either the check must be brought forward, in which case additional expense is incurred because the freqency of maintenance is being increased, or the aircraft must be maintained whilst it is away from base by an organisation approved by the normal maintanance organisation.

In short, safety is paramount, but convenience to a one aircraft operator which will be using the private category for the aircraft's operation is much reduced while costs are considerably greater.

## 4. Insurance

Insurance is fundamentally the owner's responsibility. The operator, if it is not the owner and/or the management company, would obviously need to ensure that the aircraft hull and third party liability insurance cover is satisfactory. Should the aircraft be needed for any unusual activities it would be prudent to be sure whether or not additional cover is needed.

## 5. The Aircraft

It is understood that the NRA may have a requirement to fly a scanner and a survey camera around the coasts of England and Wales in the near future and that its operational profile is likely to be:

| | |
|---|---|
| Altitude: | max 13,000 feet |
| Speed: | 150 - 170 knots |
| Endurance: | 4½ - 5 hours on task |

The aircraft will be required to accommodate:

2 crew
1 operator, with room for a second when required
Scanner and survey equipment.
- approx. equivalent size of 3 PC boxes and VDU.

Because of the maximum altitude the hull need not be pressurised. However, oxygen must be carried on board. The cost of fitting aerials and cameras etc., to the aircraft will be greatly reduced if the hull is un-pressurised. It is most likely, however, that a suitably equipped aircraft will not be found or if it is found, it will not be available. To cut the required panels in the floor of the aircraft may take about 3 weeks to complete. Prior to any work on the aircraft, the CAA must approve the fit, ensuring that safety is not jeopardised (re-routing of control cables under floor etc.). Drawings already approved for such an installation and used in the past will be available and will need to be purchased.

## 6. Conclusions

It is preferable, for ease of operation and reduction of costs, to operate on the Private Category if at all possible. There may be an alternative in the future under the Police Operator's Certificate, (estimated at about 6-12 months before its inception) which is being worked out between the Home Office and the CAA for the growing number of police operated helicopters in the country. The Certificate is designed to meet the Home Office requirements for law enforcement aircraft to operate below current minimum heights in certain situations. In the NRA's case it would probably be more pertinent to low level helicopter operations (water sampling, anti-poaching patrols etc.), but it is quite possible that the fixed wing operation could come under its jurisdiction. However, to operate on a POC would still require the writing of an Operations Manual and all that involves in additional manning levels and cost.

## 7. Recommendations

For the first year of the NRA's operation, a suitable aircraft should be leased. The operation should be on the Private Category, under a management agreement with an experienced and suitably located operator. Under such an agreement, the aircraft would have to be on a Public Transport maintenance schedule.

## 8. Note

It should be noted that this paper does not, in any way, constitute a quote. Compass Aviation would be very happy to discuss the project further with a view to making a quote if required.

Signed by
M H S Bailey for
Compass Aviation

NRA/Compass Aviation
18.11.91

ANNEX 1

Guideline costs for:

## AQUISITION

A **Purchase**

Mid life PA31 Navajo - £60 - £110k

Mid life PA31 Chieftan - £75 - £140k

B **Lease**

i. Annual Contract based on projected hours per annum. Paid monthly in arrears. Wet. Single crew included.

| PROJECTED HRS | PAYMENT PER MONTH |
|---|---|
| 350 | £ 9,917 |
| 400 | £10,833 |
| 500 | £12,708 |
| 600 | £14,250 |
| 700 | £16,042 |
| 800 | £17,667 |
| 900 | £19,500 |
| 1,000 | £21,250 |

- £129,996/4
152,496

B ii. Annual contract based on actual hours flown. Paid monthly in arrears. Wet. Single crew included

£320 per hour



J6

ANNEX 2

Guideline costs on:

## OPERATION

A i) Private Category - Owner/Operator

a) Fixed costs:

| | Per annum |
|---|---|
| CAA Charges | £ 810 |
| Insurance | £ 3,250 |
| Hangarage | £ 5,000 |
| Depreciation | £ 4,000 |
| Financing | £20,000 |
| Crew (Chief Pilot) | £30,000 |
| Vehicle | £ 5,000 |
| Operations Staff | £14,000 |
| Office rental | £ 3,000 |
| Running costs | £ 2,000 |
| | £87,060 |

b) Direct Operating Costs:

Dependent upon hours flown. Include:

Engineering
Petrol, oils, lubricants. For e.g.:

Hrs p.a. 300 - £36,000
400 - £45,000
500 - £55,000
600 - £65,000



J7

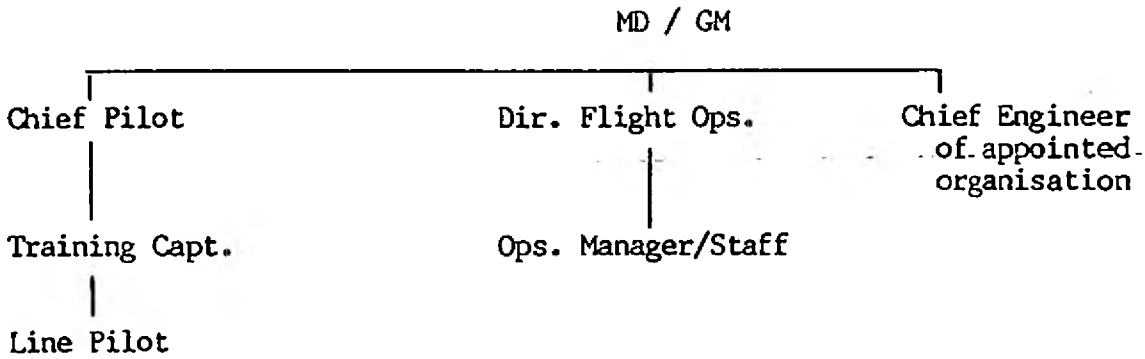
A ii) Private Category Owned Aircraft/Managed Contract

| | |
|---|---|
| Single Crew Charge | £ 45.00/hour whilst flying (max 3 hours) |
| or | £175.00/hour day |
| Travel expenses @ | £ .20/mile |
| Overnight expenses | |
| Admin. charges | £650/month |
| Management charge | £ 6% of monthly invoice |

B i) Public Transport Category Owner/Operator

a) As per A i) above, plus:
£5,000 for initial Air Operator's Certificate (AOC) issue.

b) Company Operations Dept. may be required to be structured thus:




c) For any variation of an AOC, e.g. adding a different type, the CAA will make a charge of £3,570 at today's rate.

B ii) Public Transport Category Owned Aircaft/Managed Contract

As at A ii) above, plus:
Second pilot at £ 145 per day whilst flying
or £ 37 per hour wilst flying (max. 3 hours)
Admin. charges £1,000 per month.

iii) Public Transport Category Leased Aircraft/Managed Contract

As at B ii) above, plus the options at Annex 1 B i) and B ii).

ANNEX 3

A Guideline Costs For:

## MAINTENANCE OF A PA 31 CHIEFTAN

| CHECK | CALENDAR | HOURS | DOWN TIME (days) | APPROX. COST PER CHECK (+ VAT) |
|---|---|---|---|---|
| **PUBLIC TRANSPORT CAT:** | | | | |
| 1 | | 100 (high utilisation) | 1½ - 2 | £1,000 - £1,250 |
| | 90 days (low utilisation) | | 2 - 3 | £1,500 - £1,750 |
| 2 | | 200 | 2 - 3 | £2,000 - £2,500 |
| 3 | Annual | | 10 - 20 | £7,000 - £8,000 |
| **PRIVATE CAT:** | | | | |
| 1 | No calendar checks on Private Cat. other than Annual. | 100 Very advantageous to low utilisation | AS | £1,500 - £1,750 |
| | | | FOR | |
| 2 | | 200 | PUBLIC | £2,000 - £2,500 |
| 3 | Annual | | CAT | £7,000 - £8,000 |

B Approximate cost of specialist installation:

| | |
|---|---|
| i) Purchase of AAN (CAA approved drawing) | £2,000 |
| ii) Modification to airframe | £4,000 |
| iii) Installation of Scanner and Camera | £1,000 |
| | £7,000 |

NRA/Compass Aviation
18.11.91



J9

## AIRCRAFT COSTS

1. Includes: aircraft and modifications, CAA charges, insurance, hangarage, fuel, engineering and pilot.

2. Calculations are at both 400 and 500hrs usage per year. Figures (xxx) are for 500hrs per year.

3. The comparison has been made using figure supplied by Compass Aviation of Bristol and NERC (navajo PA31) aircraft.

| | BUY | LEASE | NERC |
|---|---|---|---|
| Aircraft | 118 | 130(153) | 263(306) |
| CAA | 7 | | |
| Insurance | 3.25 | | |
| Hangar | 5 | 5 | |
| Pilot | 30 | | |
| Fuel | 45(55) | | |
| Management | 11 | 12 | |

Payback Period

| | | | |
|---|---|---|---|
| First year | 220(230) | 147(170) | 263(306) |
| Second year | 321(341) | 294(340) | 526(612) |
| Third year | 422(452) | 441(510) | 789(918) |

x 1000 = £

It all depends on the initial cost of the aircraft and the number of hours flown but it can clearly be seen that the payback period is in the order of 2-3 years.

57/4
27.11.91



J10

# AIRCRAFT REQUIREMENTS

To undertake the coastal baseline survey we need a dedicated twin engined aircraft. It has to be large enough to mount both a((RC8 or RC10)) CASI, a survey camera and a minumum of three crew.

The scanner and survye camera are both a requirement of the baseline survey. Assuming the images and photographs are nationally archived then the data will have a very wide range of uses over many departments - conservation, fisheries, planning, land drainage and sea defence to name but a few.

This will save a lot of money over existing contracts for aerial photography. The images/photographs will in all cases be as good as or better than existing cases. They will also be registered and archived such that they will be a valuable resource to both the NRA and the nation.

It is very clear to see that our organisation has made very little use of this type of data. It would in all cases give a much clearer idea of the problems we are dealing with and in most cases save a lot of money. The actual figures are difficult to calculate but far in excess of any figures we are talking about.

What are the most taxing surveys that other NRA departments are undertaking that are being solved by these means. Beach profiling and flood defences levelling. This involves scaled measurements being taken off survey photographs. There is no problem whatsoever in producing photos to that standard. That assumes normal conditions. If the job requires a motion compensated camera then that can be done but would cost more. The standard of photography we are proposing will satisfy 99% of those within the NRA. One must point out that all this is a by-product of the basic requirement for coastal baseline monitoring.

Once all other NRA survey work has been taken into account then the utilization of the aircraft is going to be very high and this is going to be matched by the spin-offs within the organisation.



J11

## AIRCRAFT CONFIGURATION

| | |
|---|---|
| Pilot | To fly it, must be experienced in survey work (straight level, no roll, pitch or yaw). |
| Navigator | To set up navigation system and direct surveys also run survey camera. |
| Scanner Operator | To run scanner and logging systems. |
| Aircraft | Light Twin (high wing if possible). |
| Navigation | Standard GPS with the option of uprating to differential if required. |
| Logging | Apart from the CASI system position, time, photo reference, altitude and heading all have to be logged and be post processed on the Qubit charting system. |
| Scanner | A CASI scanner with thermal channel. The sytem will be roll corrected, have an incident light channel and built in GPS - all logging to tape. |
| Camera | Wild RC8 or 10 depending on whichever is available at the time. |

74/4



J12

## MSS - AIRCRAFT REQUIREMENTS

1. It has two holes - Scanner, Camera
2. Incident light sensor (small hole in roof)
3. Full logging of height, speed and position of photos
4. Integrated navigation system - GPS
5. Special power supplies to run all electronics
6. Must be as stable as possible
7. Marine radios for contacting survey vessels.
8. Cheap to run.
9. Twin for both technical and safety reasons. (Minimum turbulence around sensor head)
10. Slow working speed 100-150 Kts. Transit as fast as possible.

### Points in favour of Purchase

1. Very few aircraft with this specification, therefore likely to be more expensive to lease
2. Weather delays could make charter expensive and difficult to manage
3. Equipment serviceability problems will arise with switching equipment between aircraft
4. Sole user lease could be expensive
5. The aircraft should be invisible as far as the project is concerned, therefore contract management
6. For PR reasons it will be preferable for the aircraft to carry the NRA logo rather than, say NERC
7. Sorting out power supplies in different planes will be difficult
8. Flight management is improved if we have our own/or dedicated pilot