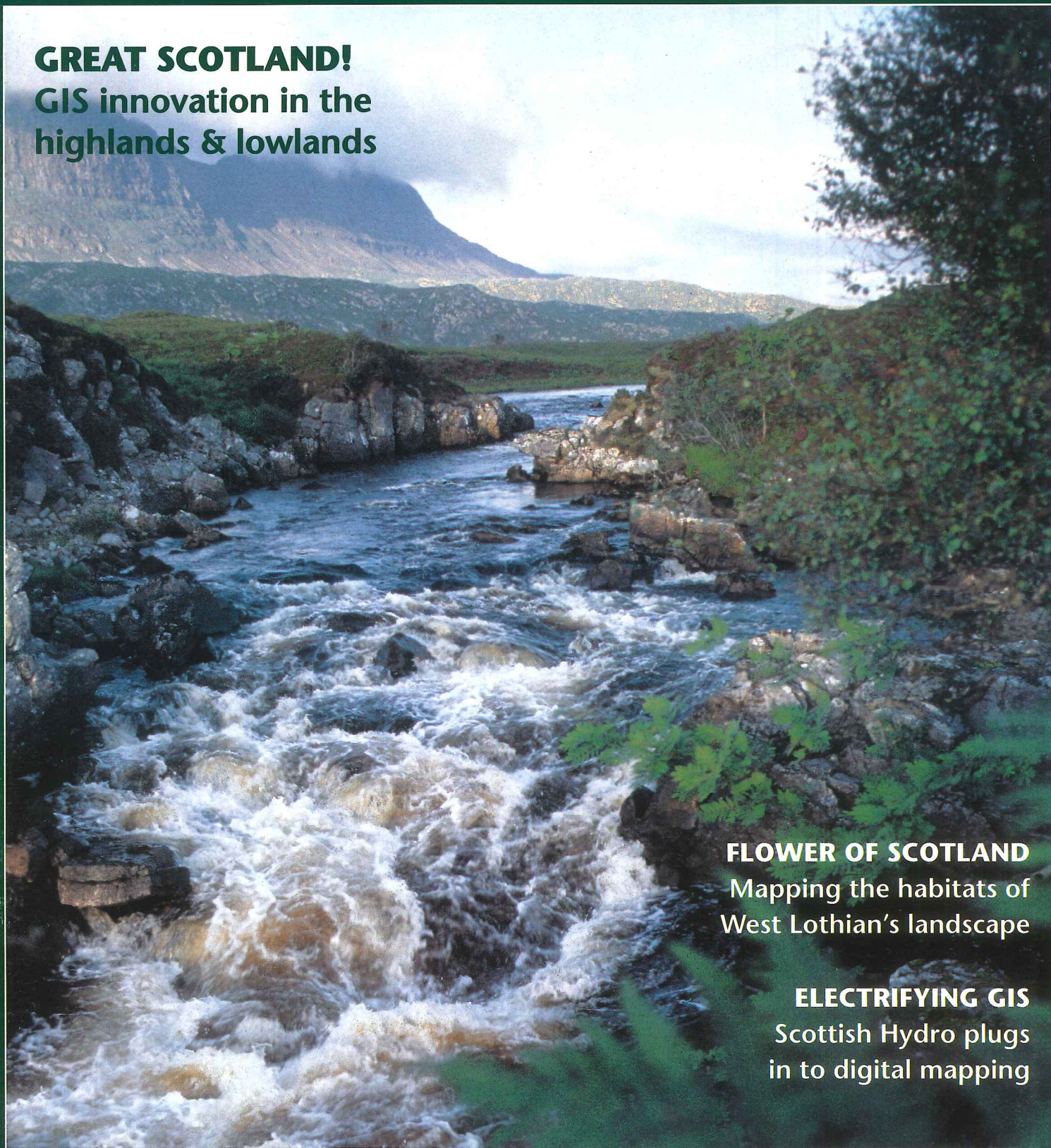


MAPPING AWARENESS

APRIL 1995
VOLUME 9 NUMBER 3

IN THE UNITED KINGDOM AND IRELAND

GREAT SCOTLAND!
GIS innovation in the
highlands & lowlands



FLOWER OF SCOTLAND
Mapping the habitats of
West Lothian's landscape

ELECTRIFYING GIS
Scottish Hydro plugs
in to digital mapping

- GEODEMOGRAPHICS • GIS IN BUSINESS AND GOVERNMENT • GPS • DESKTOP MAPPING •
- ORDNANCE SURVEY • UTILITIES • TELECOMS • TRANSPORT • LOCAL AUTHORITIES •

Preserving a fragile marine environment: integrating technology to study the Ythan Estuary

BY DAVID R. GREEN



Ythan Estuary

Integrating remote sensing and GIS offers a powerful means of improving our understanding of dynamic coastal zone environments. Estuaries in particular have been the focus of a number of studies, especially because of their interest to multiple user groups. Studies conducted on the Ythan Estuary in NE Scotland may well point the way towards more careful management of these important natural resources.

North-East Scotland has traditionally been a focus for studies that range from coastal geomorphology to marine resource management. Its dramatic scenery, combining hard and soft coastlines, numerous fishing villages of architectural and historical interest, wildlife habitats and several major ports, makes it a landscape of considerable environmental importance.

The Ythan Estuary and surrounding agricultural catchment, some 20 kilometres north of Aberdeen, have long been of interest to researchers from Aberdeen University, the Macaulay Land Use Research Institute (MLURI) and the Institute of Terrestrial Ecology (ITE), as well as local historians and archaeologists.

The Ythan was a site of early human habitation, and it later featured as a centre of maritime trade. In 1959, the adjacent Sands of Forvie became a National Nature Reserve; in 1979, this was extended to include the Ythan. Its abundant birdlife makes it a natural focus for species-



distribution studies, and the area holds attraction for many other interest groups, including naturalists, sailboarders, botanists, zoologists and archaeologists.

Nitrate pollution

Recently, the estuary has figured prominently in the news. A significant increase in both the amount and extent of algal weed mats in the lower part of the Ythan has created the possibility that it will be declared a Nitrate-Sensitive Zone by the European Commission. In response, a number of scientific studies have been initiated to determine the possible cause (or causes) of the increase.

The application of remote sensing and GIS



The model aircraft (wingspan approximately eight feet)



A 35mm colour aerial photograph acquired using the model aircraft platform (white dots = grid of ground control points)

is not new to this part of Scotland. Aerial photo-interpretation was first undertaken in the 1970s, and multitemporal satellite remote sensing was subsequently used as a basis for coastal mapping and change-detection studies. Aspects of the coastal terrain, dune systems, beaches, vegetation, agricultural land and estuarine hydrography were all examined. And in 1990, an ARC/INFO-based GIS was used by Lawrie McLean, a University of Edinburgh student, in a study of the Sands of Forvie. As efforts get under way to address the current concern over nitrate pollution, the studies have become more multidisciplinary.

Sands of Forvie



Monitoring change

David Raffaelli, from Aberdeen University's Zoology Department, based at the Culterty Field Station, is undertaking a three-year Scottish Office-funded study into the hydrography and bathymetry of the Ythan. By comparing an analysis of aerial photography spanning the period 1954–1992 with several earlier studies of the area, he is aiming to identify the changes in area of the intertidal mud flat and the course of the main channel that have taken place. The study looks at how changes in the physics of the system contribute to weed growth problems. The results will be published this month.

A closely related study, funded by the Research Council, is estimating the areal extent of the algal weed mats. Using a combination of both ground-based survey and aerial panchromatic/colour photography, the study has identified a major change both in the extent of the weed and in its spatial distribution upstream.

Since there is a continuing requirement to monitor environmental change, the Centre for Remote Sensing and Mapping Science at the University of Aberdeen has developed a means of acquiring low-cost, high-resolution multi-temporal imagery, using a large-scale model aircraft. The combination of a small airborne platform, a global positioning system (GPS) from Trimble Navigation, Digital Image Processing from ERDAS and file-compression technology has demonstrated the potential of 35mm

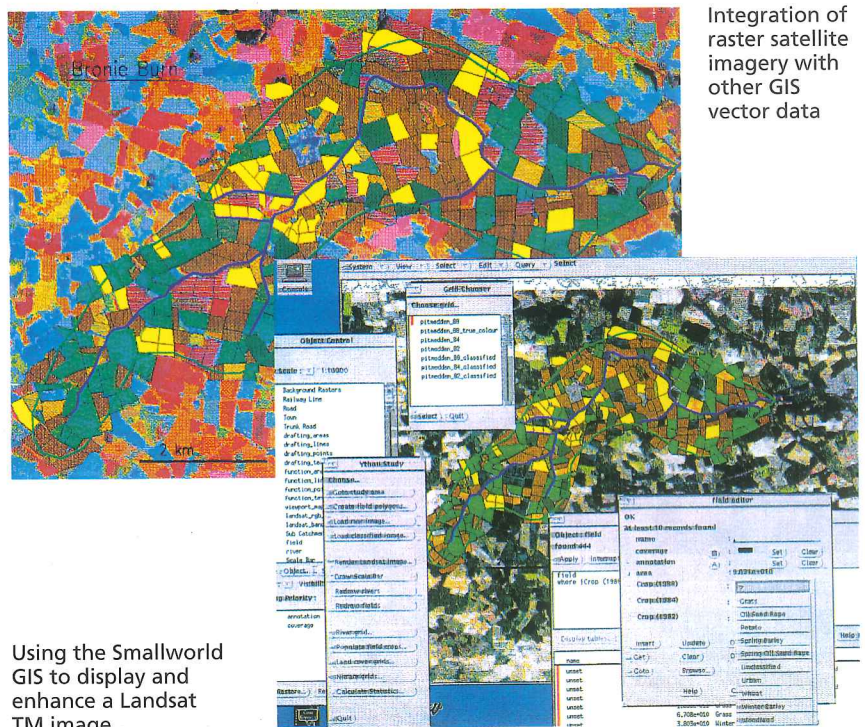
multispectral aerial photography as a data source for GIS analysis (using, for example ESRI's ARC/INFO or Clark University's IDRISI GIS).

Another nitrate project is being funded by the Scottish Office's Agriculture and Fisheries Department. By teaming the expertise of its Socio-Economic Unit with that of the Soils, Plants, and Land Use Divisions of the MLURI, the Department aims to develop a method of integrating process-modelling techniques that relates nitrate losses to soil, water and different land use types. The land use types are being determined from satellite imagery (Landsat Thematic Mapper) with the aid of an ARC/INFO GIS.

Crop mapping

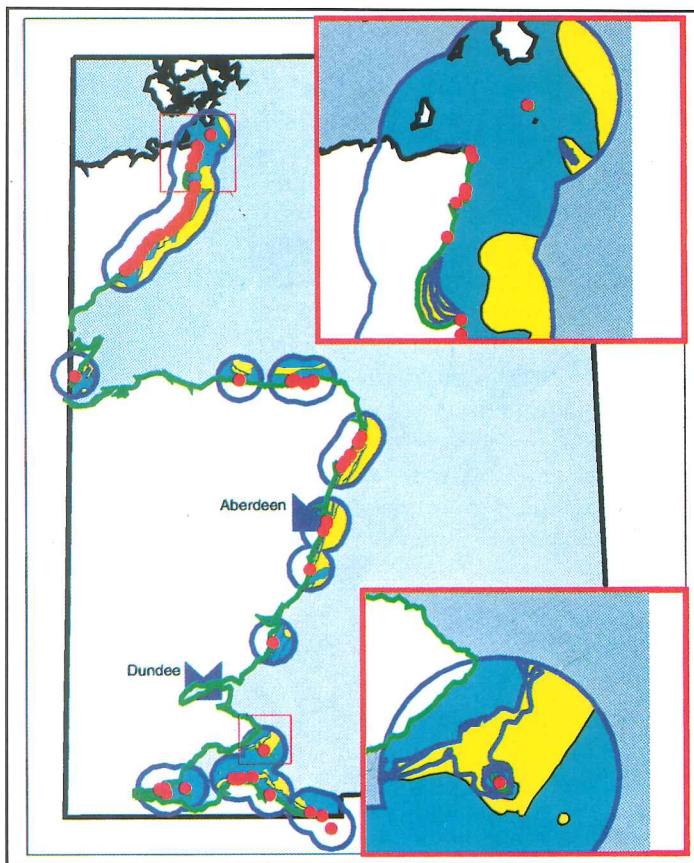
One of the most visually striking changes to the Ythan catchment in recent years has been a marked increase in the production of winter oil seed rape, with its distinctive yellow flowering. Its production has been encouraged by subsidies and by the fact that its cropping regime fits conveniently into the crop cycle of the more traditionally grown cereals.

Digital image processing of multitemporal Landsat TM imagery, using a supervised classification technique, was recently undertaken by Geoffrey Rees to derive crop maps for each of three dates for the Bronie Burn sub-catchment part of the Ythan watershed. Using the ERDAS image-processing suite, classified satellite images were exported to Smallworld GIS to complete the classification process and to add further geographic information, thereby improving the visual appearance of the



Integration of raster satellite imagery with other GIS vector data

Using the Smallworld GIS to display and enhance a Landsat TM image



The locations of shag colonies (red dots) and, within their ten-kilometre feeding ranges (blue outlines), seabed sediments (yellow sand, preferred sand-eel habitat) and 0-60 metre depth bands (blue on yellow). The inserts show details for Moray Firth and Firth of Forth. (Computer cartography at ITE Banchory by P.J. Bacon. Image and caption are from the *Annual Report of the Institute of Terrestrial Ecology 1993-94*)

imagery and the ease with which it can be interpreted. Simple modelling of the relationship between nitrate inputs and agricultural information derived from the Landsat imagery was also undertaken.

Seabird studies

Other local studies of importance have been carried out by the ITE at both Brathens and Monkswood stations. Philip Bacon (ITE, Banchory) has recently been using ARC/INFO to develop models of the relationships between seabirds and the marine environment. By combining information on breeding colonies with bathymetry and seabed sediment data taken from digitised British Geological Survey maps, he has been able to identify key marine areas and assess the impact on bird populations and feeding areas (see above).

A similar national study is currently being


pursued by Mike Yates, a field ecologist based at ITE Monkswood, in collaboration with the British Trust for Ornithology. This project, one of a number funded by the Department of Trade and Industry's Energy Technology Support Unit, focuses on 25 estuaries around the UK, including the Ythan. The aim is to investigate the potential impact of building a tidal barrier in an estuary in terms of tidal range, wave action and sediment redistribution. Different sediment types support different food sources for birds and this, in turn, determines species distribution and abundance.

Yates's study uses an I²S (International Imaging Systems) image system to process satellite and airborne data from the Daedalus Scanner; by relating this to bird-count data, Yates acquires up-to-date information on the estuary. When the information is combined in ARC/INFO with digitised boundaries of the bird-count areas, sediment type can be correlated with bird observations. An interim report on the project—which began in January 1994 and will be completed in March 1996—is to be published late this year.

Although the projects described here are just a sample of many possible applications of GIS, GPS and remote sensing to the study of an estuary environment, the trend towards integrating data of all types offers, perhaps, the most effective means of managing this vital yet fragile resource in the future.

Acknowledgements

The author would like to thank the following for support and information provided in connection with this article: David Raffaelli (Zoology, Aberdeen), Gary Wright (MLURI), Philip Bacon (ITE-Brathens), William Ritchie (Geography, Aberdeen), Mike Yates (ITE-Monkswood), Craig Morton (Vision Systems) and Geoffrey Rees (Smallworld Systems, Australia).

For further information on the model aircraft and Smallworld studies, please contact the author. 



DAVID R. GREEN is with the Centre for Remote Sensing and Mapping Science, Department of Geography, University of Aberdeen, Elphinstone Road, Aberdeen AB9 2UF. Tel: 01224 272324; Fax: 01224 272331; E-mail: d.r.green@aberdeen.ac.uk

Further reading

- Bacon, P., Needle, C., Harris, M.P., and Wanless, S., 1994. 'Modelling Environmental Effects on Seabird Foraging Energetics' *Annual report of the Institute of Terrestrial Ecology 1993-94*. pp. 67-70
- Green, D.R., and Morton, D.C., 1994. 'Acquiring Environmental Remotely Sensed Data from Model Aircraft for Input to Geographic Information Systems' *Proceedings of AGI 94 Conference*. Birmingham, England. pp. 15.3.1-15.3.28
- McLean, L., 1990. *A Geographic Information System for Forvie Nature Reserve: An Application of a GIS Pilot Study*. Unpublished MSc thesis. University of Edinburgh
- Morton, D.C., 1994. *Low-Cost Multi-Band Remote Sensing*. Unpublished MSc thesis. MSc in Environmental Remote Sensing. University of Aberdeen. 152pp + appendices
- Rees, Geoffrey, 1994. *Modelling the Effects of Changing Cropping Regimes on River Pollution*. Unpublished MSc thesis. MSc in Environmental Remote Sensing. University of Aberdeen. 136pp
- Ritchie, W., ed. 1983. *Northeast Scotland Coastal Field Guide and Geographical Essays*. Department of Geography, University of Aberdeen. 140pp+ figures