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This Nessletter is another special. While on holiday this year I met up with Adrian Shine, of the Loch Ness Project.We discussed their forthcoming plans and Adrian promised to let me have details of these,which he has now done. He waited till now because he also wanted to include up to date news about a hydrographic and seismic survey they had planned for the beginning of December '91. As I devoted NIS 104 entirely to the Projected Operation Urquhart, I thought it would be fair to do the same with the intended Programme of The Loch Ness Project. I truely hope that these two ambitious scientific Programmes will not become rivals.

Morphometry

Loch Ness is a glaciated tectonic faultline. Thus it has a steep walled trench like profile of remarkable uniformity and depth. The currently accepted depth contours result from Sir John Murray's Bathymetric Survey of the Scottish Lochs which recorded a maximum depth of 754ft. (230m) by a Kelvin wire sounding machine. This has only been disputed by a water gauge reading of 820ft. (250m) noted during the trials of a mini-sub and by an echo sounder depth of 975ft.(297m) reported from its rowing boat support. The deeper area was alleged to lie a quarter of a mile south of Castle Urquhart.

In 1979 the Loch Ness Project resolved this matter using properly calibrated hydrographic equipment (Kelvin Huges M.S.48 echosounder) in a through search of the reported area. The Bathymetric Survey results were vindicated and no trace of deeper water was found. Ten years of subsequent incidental sonar work have also failed to encounter such depths.

Neverthe less, a few details of hydrographic interest remain, such as a small trench in the northern basin and some of the steep wall topography. These tasks are particularly suited to the recently developed 'swathe' sounders which by projecting a fan of narrow individual beams, greatly reduce the time taken for surveys, while improving their accuracy. in 1987 a survey of Urquhart Bay was made in collaboration with Simrad using their E.M. 100 swathe system.

A complete survey of the deep basins to resolve remaining hydrographic controversies is planned for the near future using the Bentech 'Topas' 3-D Topography and Seismic Profiling Sonar. This employs a parametric source with 45 beams in a 80 degree fan. The work shall be carried out by the surveyors from Marconi U.D.I. using the Star Track Differential G.P.S. system giving an accuracy within 5m.

A 3-D hydrographic chart shall be produced from this survey, the first since the Bathymetric Survey, but the main purpose lies in the system's ability to make a simultaneous seismic profile of the sedimentary structures beneath the loch bed which is to be studied in its own right and in order to determine locations for a multi-disciplinary coring programme.

Sub-Bottom and Seismic Work

The sediment are subject to wide ranging studies concerning the history of the loch. Information is required both on the processes of sedimentation itself and in order to select locations for the Loch Ness Project's Long-Core Programme which is designed to penetrate sediments back to the last ice age and perhaps beyond. The first shallow seismic survey shall be carried out by the Topas swathe system. The data is to be analysed by Dr Julian Dowdeswell of The Scott Polar Research Institute to shed light upon the process of deglaciation.

The suvey will also provide a guide for a complete survey of the composition of the loch bed to be mounted over the next two years in collaboration with Dr Andrew Dugmore and Jane Boyle of the Dept. of Geography, University of Edinburgh. Particle size analysis will reveal

post glacial depositional processes.

The second survey will be carried out using a 'sparker' system by Dr. R.J. Whittington of the Institute of Earth Studies, U.C.W. Aberystwyth. Objectives are:-

1. To map out the total Quaternary sediment thickness.
2. To map out the bedrock surface and investigate the way in which the local geology has influenced glacial erosion along the line of the Great Glen Fault.
3. To establish a seismic stratigraphy for the complete thickness of Quaternary sediments and plot the individual seismic facies relating them to specific glacial/interglacial environments.
4. To define the style and importance of side wall mass transfer of sediment into the central basins of the loch.

Sediments and Coring

The sediments of any lake accumulate wide ranging historical evidence of events both within and around it and indeed beyond the catchment. A multi-disciplinary programme is under way using material supplied by a variety of loch Ness Project coring equipment. The aim is to aquire information over a range of time scales and by as many analytical techniques as possible.

The pysical processes of deposition are being investigated through a complete survey of the deposits in collaboration with Dr Andrew Dugmore of the Dept of Geography, Edinburgh University. Sedimentation rates and particle size analysis will take place together with an investigation of volcanic traces (tephras). The formation of flocks in the sediment is to be investigated by Dr Norman Davis of the Scott Polar Research Institute.

A study of the organic chemistry of sediment can provide insights into the nature of past environments through the identification of source organisms. Lipid work is being conducted by Dr Martin Jones, Newcastle Research Group in Fossil Fuels & Environmental Geochemistry.

Decomposition in sediments is vital to the recycling of nutrients within a lake. These redox zones are being investigated by Dr Andy C. Aplin, also of Newcastle.

With regard to historical information on the most recent of time scales, Loch Ness offers a useful site for the study of biogeochemical behaviour in artifical compounds. These consist of compounds such as PCB's and PAH's having carcinogenic properties and nuclear fision products resulting from bomb fallout and Power statiton accidents. The exceptional depth of the loch results in a long hydraulic residence time, causing a greater than normal tendancy for pollutants to be trapped in sediments. Large quantities of material are required for this work which is being carried out by Dr Hamilton-Taylor of the Environmental Science Division at Lancaster University. A special wide bore (110mm) corer has therefore been developed to supply the material. Work on the mud/water interface has also been proposed by Dr Bill Davison.

In order to trace changes since the Industrial Revolution cores of over 1m are required and these have been distributed to a number of workers. The aim is to discover whether the lake is being polluted by sewage or fertiliser inputs, soil erosion from forestry ploughing or by acid rain. In the latter case, Loch Ness is of particular interest since the Great Glen appears to mark a boundary in a very strong air pollution gradient leading to the acidification of lakes to the south while those to the north are relativley unaffected. Publications on this aspect and upon the matter of recent enrichment are expected soon. This work is being carried out under Prof. Rick Battarbee at the Palaeoecology Research Unit of University College London and includes lead 210 dating and analyses of carbonaceous particles resulting from the burning of fossil fuels.

Diatoms are the main indicators of acidification or enrichment while other aspects in the programme are:-

Pore water nutrient chemistry. (Dr Tony Bailley-Watts and Dr Alan

Kurila, at the Institute of Freshwater Ecology).

Paleomagnetism aaaanad trace metal geochemistry. (Dr John Smith and Peter Jenkins at Nolverhampton Polytechnic).

Pollen and Sediment Laminations. (Dr Paddy O'Sullivan, Plymouth Poly).

The Project is currently extracting 6m cores for distribution to many of the above workers. The objective here, is to follow the longer term paleolimnological history of the lake and its catchment such as deglaciation, climate, hydrology and vegetation. Loch Ness is ideally sited to have recorded marine climatic factors which have influenced Europe and can thus make an important contribution to the paleoclimatic calibration currently being obtained from other lakes in the European Transect. This Programme results particularly from our collaboration with Dr Guy Lister of the Geological Insitute, ETH, Zurich. Other analyses (apart from those already described) include ostracods (Hugh Griffiths, University of Wales, Cardiff), chironomids, cladocera remains (Dr Catherine Duigan, Institute of Earth Studies, University College of Wales), and other palynofacies, (Dr Kate M Parr, Wolverhampton Polytechnic).

Lastly, a special Loch Ness Project objective is based on a suggestion made after the Paleolimnology conference held in October 1989 that it may not be inconceivable that the interglacial sediments may be present. These may lie beneath the glacial clays and may result from lakes beneath the ice preventing scouring. A design has now been produced for a system capable of providing 30m cores and subject to the seismic survey results, the Project shall commence this Programme in 1992.

Physics

Loch Ness has a considerable tradition of physical studies. The first internal seiches to be described were discovered within it in 1904, the first use of the loch as a marine surrogate. This early sucess by the Bathymetric survey was to be built upon by Dr Mortimer in the 1950's and more recently by Dr Thorpe of I.O.S.

These studies have been especially rewarding due to the unique uniformity of the basin together with its orientation N.E./S.W. in line with the prevailing winds. Thermal effects such as internal seiches and waves are thus amplified and simplified.

Loch Ness Project contributions have centred around revealing thermal events through acoustics which allows extensive overviews of thermoclines and other structures. A special study is being made of acoustic scattering layers.

In the process, hundreds of temperature/depth profiles have been accumulated over the past ten years and this activity has continued to be important during the volunteer phases of the Project. A collaborstion has been entered into with Dr D. Bowker of U.C.W. Cardiff with a view to producing mathematical models for the build-up of stratifation and the behaviour of internal waves.

A prime aim of the Project has been to discover the effects of physical water movements and temperature upon the distribution and behaviour of the biomass which is one of the areas where the acoustic overview techniques are so useful. The dynamics of internal physical structures will have concentrating, attenuating and transporting effects upon nutrient supply, plankton and fish biomass.

We wish to observe aspects of change on four basic scales:-

1. Kelvin Helmholz Billows within thermoclines.

This is to be attempted by direct observation (underwater T.V.) of dyed thermocline sheets under shear and the extraction (by Pump) of water and plankton samples at various stages of billow formation.

2.Surges.

These are large scale internal waves generated by powerful internal seiches. Here Pumped samples would still be best but the monitoring of the 30m period waves shall be through acoustics and thermistors.

3.Internal Seiches.

These have a period of approx. 54hrs. and we have already made fixed station observations of the cycle in 1984. These seiches are the main agent of mixing throughout the summer and could well have other effects upon productivity.

The Loch Ness Project is in collaboration with Drs Paul Tett and David Bowers of The School of Ocean Science, University of Wales who propose the mooring of Acoustic Doppler Current Profilers, Thermistor chains and Recording Florimeters within the loch.

Algal production can therefore be related to shear and changes in thermocline depth caused by internal seiches.

Also in this connection, we have had an enthusiastic response from Dr Glen George of I.F.E. to our offer of 'ground truth' work should he be able to conduct an airborne remote sensing exercise simultaneously with the above operation.

4. The Seasonal Cycle.

Changes to illumination and nutrient supply together with the progress of stratification are being monitored by our volunteer programmes and by the regime of physical measurements undertaken as part of the Project collaboration in a multi-disciplinary plankton study.

Plankton

The larger Scottish lochs are still virtually unpolluted and are thus a particularly valuable resource. Nevertheless, biological studies of these oligotrophic lakes are rare. The basic structure of the plankton was revealed during Dr P.Maitland's multi-disiplinary study made in 1977/80. Project work in the 1980's was mainly concerned with short term events such as zooplankton migrations.

More detailed seasonal work was needed together with a more integrated approach. In particular work was required to embrace the recent understanding of the importance of the smaller organisms and microbes in primary production, energy flow and nutrient re-cycling.

Accordingly, a Loch Ness Project initiative was made to the Institute of Freshwater Ecology and the universities in 1989, based around the establoishment of a fixed sampling station.

The result is a three year, N.E.R.C. funded, study of plankton community dynamics by Drs Rodger Jones, Johanna Laybourn-Parry (Institute of Environmental & Biological Sciences, Lancaster University) and Anthony Bailey-Watts (I.F.E.). The qualitative and quantitive characteristics of the entire plankton community are being established. Intensive sampling of physical conditions and water chemistry forms the background to the study of the phytoplankton, bacterioplankton, protozooplankton, rotifers and microcrustacea, during the annual cycle. A flow diagram shall then be constructed tracing carbon transfer through the plankton, in which the major carbon pools and fluxes are identified and quantified and their seasonal variability assessed.

The Loch Ness Project, in the course of operating the sample regime for this survey, are applying acoustics simultaneously, in order to identify internal structures and their relationship to the measured vertical distribution of the various plankton types. During the summer months. The epilimnion is monitored with regard to the effects of external energy inputs such as wind and temperature.

Work on diel migration is also planned to coincide with the above programme and is to be undertaken by Drs Duncan, Seda and Kubecka with regard to both the plankton and the fish. This will provide an important link between two parts of the programme.

One particular area of interest lies in resolving the nature of 'overturns', which we suspect may not be complete. An acoustic scattering layer detected at a depth of over 70m in the early summer may be a vestigal thermocline from the previous season. The layer has been investigated by Optical Plankton Counter and by a 'Marine Snow Camera' during a collaboration with I.O.S. and particle size distribution has been noted to change. The number of larger particles first increases to a peak within the layer and then decreases in the much clearer water beneath.

The orientation, morphometry and wind cycles of loch Ness will ensure a greater than usual turbulance at depth due to internal shear. Bearing in mind that turbulence promotes the formation of 'flocks' which will then, also due to turbulence, remain in suspension for a considerable time; and further, the importance of flocks as anchorages for bacteria, it seems that the layer may be resposnible for both consiuerable productivity and nutrient interchange. It has been noted that the Loch Ness phytoplankton is richer than might be expected from data on the loch basin alone.

Benthos

The littoral benthos of Loch Ness have been examined in detail by Dr Maitland of the I.T.E..However, very little work has been done in the profundal regions of the deeper British lakes.

The macro benthos of the profundal and side wall regions of loch Ness have been examined by the project during the 1980's following similar work in the 300m basin of Loch Morar. The results are now almost ready for publication but more attention is being paid to the smaller organisms, particularly the ostracods (Hugh Griffiths,Cardiff) since their importance has become clear. For example, ostracods are consumed by the smallest individuals of a deepwater population of Artic charr.

Efforts to extend the species list further into the micro-benthos include an examination of nematodes by Dr F. Schiemer of the University of Vienna.

Changes in sub-littoral fauna due to fish farming are to be monitored.

Fish

Loch Ness contains few species of coarse fish such as eels, pike and the recently recorded minnow. The salmonids have therefore enjoyed maximum access to habitat niches since the last ice age. Two species are of particular interest to the Project, the Brown trout and the Artic charr.

During the 1980's a combination of underwater photography, sonar, gill-netting and trawling exercises have defined the basic habitats and the communities within them. Discoveries include a layer of pelagic Artic charr, proably mostly juveniles, exhibiting strong diurnal vertical migrations and a profundal population feeding on benthos at a depth of over 200m.

The use of well seperated netting locations from the 200m profundal to mid-loch pelagic as well as littoral stations are intended to produce material representative of specific habitat niches with a view to population ecology and genetic studies.

Material has now been accumulated from approx. 200 trout and the same number of Charr taken from the various habitats and at different times of year.

Morphological, aging and feeding studies are being conducted by david Martin for both species, though in the case of the Charr the aging is being done by Ron Greer as part of a collaboration we have with D.A.F. Pitlochry.

In Loch Rannoch,benthic and pelagic dwelling Charr have proven genetically distinct. A particular examination is therefore made of Charr caught at different stations and confirmed to be feeding upon the various characteristic communities. Dr Sheila Hartly of Stirling University is currently undertaking multi-disciplinary genetic research upon Scottish Charr populations and the Loch Ness material will thus allow the population to be placed in general context in addition to assesment of possible sub-populations.

In the same way, the Trout genetics are being examined by Dr Andy Ferguson at Queens University, Belfast. In addition to the littoral population, we have noted plankton feeding Trout in the shallow offshore pelagic and 'ferox' feeding upon the deep Charr layer.

Different species living in differing habitat zones and with varied food sources may show differences in their parasitology. This aspect is being examined by Dr Chubb of Liverpool university.

We have recently come across specimens of heavily pigmented eels (yellow) and circumstantial evidence links them to a commercial fish farming installation. We shall establish the cause of this.

With regard the numerical status of the populations themselves we have concentrated upon the pelagic community since this is the most amenable to assesment by acoustic techniques. In addition to basic echosounding the Loch Ness Project have pioneered the use in Britain of a number of more sophisticated techniques designed to measure in situ target strength, thus giving size indications.

There are three basic techniques and we have been fortunate in securing the first U.K. freshwater use, of all of them. Even now the Loch Ness fish are the only population to have been completely surveyed in this manner.

The problem is that the target strength of a small fish within the centre of the beam of an echosounder can be equal or greater than that of a large fish on the perimeter of the beam. The methods resolve the problem in the following ways:-

1.The Craig and Forbe method.

This utilisses a conventional single beam echosounder while a statistical software package analyses target strength and area density. In the summer of 1989 a pelagic day/night survey was made during a collaboration with Dr Torfin Lindem (University of Oslo) using his N.A.D.A.S. package. At the same time trawling took place from the D.A.F.'s research vessel Goldseeker and the results form the main yardstick to the understandins of offshore Charr.

2. The Dual Beam Method (Biosonics).

This uses two beams, one within the other and the ratio of signal strengths recieved gives a correction factor. The stimulus for the use of this equipment came from Dr A.Duncan following her introduction to echosounding at Loch Ness. Through her efforts, two machines are now in Britian, one at Royal Holloway College and the other with the N.R.A.. Both machines have been used in two surveys (spring and autumn 1991) and a N.E.R.C. grant has been applied for, to allow the work to continue.

3. The Split Beam Method (Simrad)

THis equipment uses four beams which sense the position of the target by the phase difference in its echo reception. The EK 500 system has now been used in two surveys, summer 1990 and spring 1991. On the latter occaision a direct comparison was made with the above dual beam method. Further excursion are planned.

LOCH NESS PROJECT HYDROGRAPHIC AND SEISMIC SURVEY

Throughout the week commencing 1st December 1991 a hydrographic and seismic survey is to be made of the deep basins of Loch Ness. This is being done to reveal the depth contours and also to probe the sediments beneath the loch bed.

Quite apart from the public controversey that has made Loch Ness the most famous lake in the world, it remains Britians largest body of freshwater and an under-researched resource.

The loch is unusual in that it lies within a geological fault line which gives it a 'trench like' form of great depth. Indeed there are two basins of over 200m depth.

The contours on todays maps result from Sir John Murray's 'Bathymetrical Survey' at the beginning of the century. His survey was made in April 1903 from a rowing boat with a wire sounding machine. The 1700 soundings they took, established the maximum depth at 754ft (230m). In 1969 however, a controversy occured during the trials of the Vickers 'Pices' submersible. Reports claimed that it descended to 820ft (250m) and that a sonar depth of no less than 975ft (297m) had been obtained.

The new survey is being co-ordinated by David Siviter of Subtechnique for the Loch Ness Project based at the Official Loch Ness Exhibition Centre at Drumnadrochit. The survey will utilizes a powerful new research tool. The TOPAS 3-D Topography and seismic profiling sonar is a new development by Bentech Subsea A/S. It combines 45 beams in a 80 degree fan forming a 'swathe' of coverage enormously reducing the time taken to

conduct surveys.

Navigational data and the production of the survey charts are under the direction of Marconi UDI who will be using their Star-Track Differential GPS system which is accurate to 5m.

In addition to resolving controversies such as the maximum depth of the loch and producing a new chart, the survey also has the ability to penetrate the sediments in order to record the shape of the bedrock within the fault. This, together with the overlying pattern of sedimentation will reveal the process of deglaciation at the end of the last ice-age 10,000 years ago.

Information on the depth and composition of the sediments will be invaluable to a multi-disciplinary coring programme being carried out by the Loch Ness Project in collaboration with a number of scientists including Prof. Rick Battarbee of the Palaeoecology Research Unit, University College London. The sediments provide a time capsule of historical change and the coring programme is revealing information on matters ranging from the relatively short term, such as post industrial revolution acidification and enrichment, to the cycles of climate change relevent to global warming.

Also involved in the coring programme are scientists from Wolverhampton Polytechnic under Dr John Smith and Kate Farr. A PhD on the geochemistry of the Loch Ness sediments is already under way bt Peter Jenkins and another is proposed by Ann Wheeler.

The operation is to take place in collaboration and with logistic support from the Official Loch Ness Exhibition Centre. The survey vessel 'Highland Commander II' has been provided by Caley Cruisers Ltd. of Inverness.

The Official Loch Ness Exhibition Centre. The operational base and public exhibition. Proprietor - Ronald A . Bremner. Press Officer - Betty Gallagher,(04562 218).

The Loch Ness Project, the current reseach organisation. Leader - Adrian Shine, (04562 496). Admin.- Maralyn Shine, (04562 496/218).

Subtechnique, The co-ordinating company for the operation. Director - David Sivyter, (0224 771212).

The Palaeoecology Researh Unit, collaborators in sediment coring. Prof.Rick Battarbee, (071 387 7050).

Bentech Subsea AVS, developers of the TOPAS system. Manger - Ian Young, (0224 580880).

Marconi UDI, surveyors and invertoes of the Star-Track GPS system. Starr-Track Manger - Ian Padgham, (0224 703551).

Caley Crusiers Ltd., Providing vessel for survey. Proprietoer - Jim Hogan, (0463 236328).

THE NAVIGATION SYSTEM

The Marconi UDI 'GPS Navigation System' uses an on board transmitter which sends signals out to be picked up by as many as four satellites of a mutli- satellite network. These signals are then relayed to a cafefully surveyed shore based Master Reference Station which in turn is linked to Goonhilly tracking staion. A signal is then sent out to a satellite which passes it on to be picked up by a satellite dish receiver on board the vessel. I have the specification in front of me and as a layman in such matters it is very complex, with Data Links, Demodulators and 2400 'bits' per second etc. But it would seem that by knowing where the Master Station is, and measuring time taken to and from different satellites, this sophisticated box of tricks can work out where the ship-board transmitter is,with an accuracy within 15 feet. Which is ideal when setting out to produce an accurate chart of the depths of Loch Ness.

THE SURVEY

Along with the above information Adrian sent me the following communique dated 7th December 1991:-

The survey achieved nearly 300 kilometres of hydrographic line survey and seismic profiles covering both deep basins of the loch.

Facts contributing to success were:-
1. the willingness of all collaborating personnel to work at least twelve hours a day.
2. The effectiveness of the Marconi UDI 'GPS Navigation System' which allowed a large proportion of the survey to be carried out in darkness.
3. The calm, if cold, weather.
4. The almost uniform and slight temperature gradient found at this time of year has rendered the calculation of sound velocity, and therefore depth accuracy, more reliable.

The hydrographic survey data is recorded on magnetic tape containing hundreds of thousands of data points and the post-processing will take at least two months to complete (in Norway and Aberdeen) before the definitive new chart can be produced.
However, a couple of points can be made now:-
1. There was no sign of water as deep as that reported during the Trials of the Vickers Pisces submersible in 1969.
2. There are some shallow 'trenches' lying close to the sides of the northern basin resulting in the silt plain rising away from the base of the 'wall'. This is interesting in that deposits might have been expected to smooth the angle between the base of the wall and the silt plain.

Seismic profiles were made and revealed the rocky slopes continuing down beneath the sediments. About 45 metres of total penetrationwas achieved revealing 20 metre of layered sediment beneath which lay a discontinuity, followed by a further 20 metres of sediment. We speculate that this is organic lake sediment overlying glacial clays. This data is also subject to further analysis by a number of scientists and shall provide invaluable information for next years coring programme.

COMMENT

It will be very interesting to hear, and see, the outcome of the survey when all the data is finally processed. When I spoke to Adrian on the telephone he did say that to avoid too many complications they had avoided getting too close to the shores, but that the deep areas had been well covered. Their other programmes sound very interesting and I support the idea of people from different disciplines working at, and on, the loch. I know it is not 'monstr-hunting' as such, but there is so much that is unknown about the loch, that I feel that any studies which may expand our understanding of it can only be to good.

It had been one of the earlier suggestions that the loch floor was covered by a deep layer of silt and sediments, and that the steep sides went way below what seemed to be the bottom. Then when underwater photography was first experimented with, and early sonar was used, that therory seemed to fall somewhat out of fashion. But from Adrian's report of the Project's findings it would seem the earlier suggestion was correct.

Thats it for this Nessletter. While not the usual mix of report and comment, I think it is interesting to know what is planned. I hope you do as well. I have one slight reservation about the two planned scientific programmes, I hope they are going to work in conjunction with one another. We Loch Ness devoties have longed for many years for 'the establisment' to become involved at the loch. Now that they have, more so that they are to do real scientific work rather than just 'monster hunt', it would be tragic if they adopted 'them amd us' stances. Promoting their own programmes and shouting 'Ya boo' at the others.

Please remember your news and views are always needed and are very welcome my is :- R.R.Hepple, 7 Huntshieldford, St Johns Chapel, Bishop Auckland, Co Durham, DL13 1RQ. Subscriptions are U.K.£2.75. North America $9.00

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