The Scottish Association for Marine Science | NEWSLETTER 29

SCOTTISH ASSOCIATION *for* MARINE SCIENCE

SAMS

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NEW SAMS LABORATORY OPENED!

INSHORE CORAL REEF DISCOVERED IN SCOTLAND SEE PAGE 8

March | 05

diary

CoastNET Conference
Coastal Spatial Strategies
15 March 2005
University of Gent, Belgium
Email: lucy@coastnet.org.uk
www.coastnet.org.uk

SAMS Open Evening
4 April 2005, 5.30 – 8.00 pm
SAMS, Oban
www.sams.ac.uk

Official Opening European Centre for Marine Biotechnology
Baroness Susan Greenfield CBE
5 April 2005
SAMS, Oban
Invitation only

Scottish Marine Group
Postgraduate Marine Science Research Topics
6 April 2005, 10 am – 4 pm
The Bute Medical Building
St Andrews University
Contact: j.m.mair@hw.ac.uk

Biological Recording In Scotland
Recording & Monitoring the Marine and Coastal Habitat
9 April 2005
The Bute Medical Building
St Andrews University
www.brisc.org.uk

Launch
Sealice report
11 April 2005
SAMS, Oban
Email: kenny.black@sams.ac.uk

Aquaculture Today 2005
13-14 April 2005
Edinburgh Mariott Hotel
www.aquaculturetoday.co.uk

2nd European Forum of Young Oceanographers
11-13 May 2005
Wimereux, France
Email: uof@oceano.org

GLOBEC Symposium
Climate Variability and Sub-Arctic Marine Ecosystems
16-20 May 2005
Victoria, Canada
www.pml.ac.uk/globec
Email: globec@pml.ac.uk

Palaeoclimate Change: High Lattitudes and Ocean Circulation
2-3 June 2005
Geological Society of London
www.nerc.ac.uk/funding/earthsci/iodpconference.shtml

GLOBEC, IMBER, SCOR, GEOHAB, NERC & CASIX
Advances in Marine Ecosystem Modelling Research
27-29 June 2005
Plymouth Marine Laboratory
www.amemr.info/

6th International Crustacean Congress 2005
18-22 July 2005
University of Glasgow
www.gla.ac.uk/icc6
E-mail: icc6@bio.gla.ac.uk

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Front cover: The new SAMS laboratory was opened on 6 April 2004 by HRH The Princess Royal.

About SAMS

The Scottish Association for Marine Science (SAMS) is a Scottish charity (est. 1884), learned society, and company limited by guarantee committed to improve understanding and stewardship of the marine environment, through research, education, maintenance of facilities and technology transfer. SAMS is a Collaborative Centre of the Natural Environment Research Council, and hosts the National Facility for Scientific Diving, and the Culture Collection of Algae and Protozoa. It is an academic partner in UHI Millennium Institute under whose auspices SAMS delivers the BSc (Hons) Marine Science, and trains ca 25 PhD students.

As the owner and operator of the Dunstaffnage Marine Laboratory - three miles north of Oban - SAMS is an internationally renowned marine research establishment currently employing over 120 staff. Our research activities encompass the entire breadth of marine science. SAMS focuses much of its scientific activities on multidisciplinary research questions from Scottish coastal waters to the Arctic Ocean.

SAMS is funded by an agreement with the Natural Environment Research Council for its Northern Seas Programme, by commissioned research for other public and private organisations, and by donations and subscriptions from its ca 600 members. SAMS operates SAMS Research Services Ltd, which delivers SAMS' commercial activities including the European Centre for Marine Biotechnology and Seas@SAMS, and SAMS Ardtoe, an aquaculture research unit.

SAMS Membership

Ordinary: anyone interested in marine science. Subscription - £12

Student: any person under 18, or registered students at Higher Education Institutes. Subscription - £5

Corporate: organisations interested in supporting marine science. Subscription - £60

Unwaged: anyone without a regular wage. Subscription - £5

For further information and application materials please contact the company secretary Mrs Elaine Walton (Elaine.Walton@sams.ac.uk).

Editor

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www.sams.ac.uk

SAMS Board

Designed by Design Links Edinburgh / Glasgow

Dear SAMS member

Dr Anuschka Miller, EDITOR

I suppose all of us involved with marine science ponder from time to time whether what we do is of any value beyond that most noble human pursuit of gaining knowledge and understanding of our natural world. The importance of an improved understanding of the sea has recently become clear when tsunami disaster struck the coasts surrounding the Indian Ocean without warning. The relevance of marine science research is also reflected in the many advances in exploiting natural marine resources – and the dilemma of not being equally adequate at managing this exploitation sustainably. In the annual Newth lecture 'Is marine management a myth'?, summarised on page 11, Dr Phil Williamson argues for an ecosystem-based approach as our best option for improved management of our much pressured fisheries resources.

It has been over a year since the last SAMS Newsletter was published, and I should like to thank all members for their patience. The delay was due to such positive developments as moving into a grand new building and my joy of becoming a mother for the first time…

But we shall make it up to you this year – the next issue is already in production!

SAMSnews

Professor Graham B. Shimmield, DIRECTOR

What a year it's been! Since I last wrote this column, SAMS has expanded significantly, both our infrastructure, and our activities.

NEW DUNSTAFFNAGE MARINE LABORATORY BUILDING

At the beginning of 2004 all staff moved their offices and laboratories from the old 1960s facility into the new, purpose-built laboratory building at Dunstaffnage. We celebrated this new phase in the long history of SAMS on 6th April 2004 with a grand opening event attended by HRH The Princess Royal alongside around 80 dignitaries from academia, politics, business and the local community. We share some of the highlights of the day with you in the picture diary on page 5 of this Newsletter.

On the day, we dedicated the new SAMS conference room to William Speirs Bruce, Scotland's great pioneering marine polar scientist and leader of the Scottish National Antarctic Expedition. The increasing focus at SAMS on polar research, especially Northern Seas, made this dedication to Bruce, whose achievements have only recently started to receive the recognition they deserve, very appropriate. We were fortunate that in Sir Wally Herbert we had another polar explorer among our guests, who – on the 25th anniversary of his own reaching the North Pole on foot – made the dedication. Bruce's biography is summarised on page 6.

< Pictured left: SAMS Director, Professor Graham Shimmield, and Seafish Chief Executive, John Rutherford, agree the transfer of ownership of the Ardtoe Sustainable Mariculture Research Unit to SAMS thanks to a package of support from Lochaber Enterprise, the Highland Council, Highlands & Islands Enterprise, and Seafish.

SAMS ARDTOE LTD

SAMS has further expanded by taking on a second site. Thanks to support from Lochaber Enterprise, the Highland Council, Highlands & Islands Enterprise, and the Sea Fish Industry Authority, SAMS could acquire the Ardtoe Marine Farming Unit from Seafish in late October 2003. Ardtoe is now managed as a SAMS subsidiary under the name of SAMS Ardtoe Ltd.

For many years Ardtoe researchers including Drs Jim Treasurer and Chris Cutts have been at the forefront of the development of halibut and later cod rearing in the UK. The first farmed haddock in Europe was grown at Ardtoe, and Ardtoe staff pursue projects on fish feed and nutrition. As a world leader in marine species culture with first class facilities, Ardtoe complements much of the work done at SAMS, and the two organisations had been collaborating over many years. At a time when wild fish stocks are under intense pressure, research into rearing finfish in cultivation is of importance both to the environment and to the people of Scotland. At SAMS we are happy that we were in a position to contribute to the continued survival of the excellent facility and research at Ardtoe.

Dr Kenny Black from SAMS is acting director of SAMS Ardtoe, and together with the staff at Ardtoe is developing a world-class facility for fundamental and applied research in fish biology and environmental interactions. Research on the cultivation of marine finfish species continues. The three most recent researchers to join Ardtoe, Drs Ben Wilson, Dave Schoeman and Tim Atack, significantly widen the research portfolio. I would like to use this opportunity to warmly welcome all Ardtoe staff – new and old – to SAMS, and to thank them for their great enthusiasm.

The first two honours graduates, Louise Wilson and Daniel Vincent, receive their BSc (Hons) Marine Science certificates from SAMS President Dr Ian Graham-Bryce during his last official function. © L Robb

FIRST HONOURS GRADUATES

Education is a major component of the SAMS mission, and has played an important role throughout the 121 years of SAMS history. But never before was the Association as active as now in contributing to the education of the next generation of marine scientists.

The development of Scotland's only honours degree course in marine science came to a successful conclusion with the first cohort of honours students graduating at the SAMS Annual General Meeting in November 2004. The external examiners, an invaluable source of advice and support in the quality assurance of the degree programme, were very complimentary about the knowledge and skills of 'our' graduates. The success is a tribute to the commitment and hard work of the course leader, Dr Keith Davidson, and the core lecturing team. But as the vast majority of SAMS staff are actively involved with teaching and supporting the degree programme, the high quality of the course is an achievement all staff can be proud of.

The presence of a significant number of both undergraduate and postgraduate students has significantly rejuvenated the atmosphere and style at SAMS, and keeps us all on our toes…

SEAS@SAMS

For many years Dr Tom Pearson and John Blackstock had operated the environmental consultancy SEAS Ltd from Dunstaffnage Marine Laboratory. When they retired, we welcomed the remaining SEAS staff as new colleagues, and added 'Seas@SAMS' to our growing portfolio of commercial activities. Seas@SAMS, with its significant expertise and good reputation in benthic taxonomy, continues to conduct benthic surveys and coastal environmental impact assessments – from project management, field surveys and advisory roles through to taxonomic analysis, training and reporting. The customer base had previously been restricted to the aquaculture industry and the regulatory sector, but with the added resource and skills base available within SAMS, Seas@SAMS may now additional be in a position to offer its services to the oil and gas industry, the offshore wind energy sector, and port authorities.

FAREWELL AND WELCOME!

Since the last Newsletter two of SAMS' most outstanding scientists, Dr John Gordon, leader of the deep-sea fish group, and Professor John Gage, leader of the deep-sea benthos group, took retirement. Both had been with the organisation as Research Fellows for many years, and much of the long-standing reputation of SAMS has been built on the pioneering work of 'the two Johns'. Any deep-sea biologist will be familiar with their work in pelagic and benthic biology, and it is not possible for me to convey the gratitude of the organisation for their decades of service in a few words here.

Fortunately, both have accepted Honorary Fellowships from SAMS and will continue their work. Being freed from the demands of institutional administration and management makes retirement a rather enticing prospect…

We also warmly welcome Dr Julian Overnell and Dr Tom Pearson as SAMS Honorary Fellows.

NEW SAMS PRESIDENT

The significant developments at SAMS over the last years have been directed by a highly dynamic Council team led for the past four years by Dr Ian Graham-Bryce. In the name of all staff at Dunstaffnage and Ardtoe I would like to express my sincerest gratitude to Ian for the clear leadership with which he steered SAMS through a most turbulent time into a brighter future. At the last AGM, Ian stood down as President to now join the illustrious ranks of SAMS Vice-Presidents.

Our new President is Professor Sir John Arbuthnott, former Principal and Vice-Chancellor of the University of Strathclyde and current Chairman of the Greater Glasgow NHS Board. Sir John's understanding of management in academia and public service will undoubtedly be of great benefit to SAMS when we will further consolidate our relationships with the NERC, SHEFC and the Scottish Executive in our bid to become one of the leading centres for marine science in Europe.

The new SAMS President, Professor Sir John Arbuthnott

Opening of the new SAMS laboratory building

6 APRIL 2004 BY HRH THE PRINCESS ROYAL

Dr Anuschka Miller, SAMS
Images by Colin Griffiths, SAMS

HRH The Princess Royal is welcomed by SAMS Director Professor Graham Shimmield. In the background are the Lord Lieutenant for Argyllshire, Mr Kenneth A MacKinnon, and his wife Clare.

HRH in discussion with SAMS UHI PhD students Jennifer Beaumont and Jose Gonzales Vecino about undertaking postgraduate research at SAMS. Earlier Dr Axel Miller (2nd right) had spoken about the BSc (Hons) Marine Science degree.

The Princess Royal, in conversation with SAMS President Dr Ian Graham-Bryce, leaves SAMS with her protocol party after a 105 minute visit.

The Princess is introduced to some of the SAMS staff and visitors in the foyer – and later again in the café – of the new laboratory.

During a tour of the new laboratory The Princess Royal meets a number of SAMS scientists and students – here the leader of the marine physics group Dr Mark Inall.

The Princess declares the new SAMS laboratory building open.

William S Bruce's biographer, Peter Speak from the Scott Polar Research Institute, delivers a keynote lecture on the life and work of Bruce.

Dr Mark Hart (left) tells the Princess about latest developments in marine molecular biology and biotechnology. Earlier Christine Campbell (centre) of the recently re-united Culture Collection of Algae and Protozoa showed the Princess Europe's largest algal collection.

The Director of SAMS expresses his gratitude to the Princess Royal for her endorsement of the new developments. To the right of the Princess are SAMS President Dr Ian Graham-Bryce, his wife Elisabeth, and SAMS Deputy Director Dr Ken Jones.

On the 25th anniversary of his reaching the North Pole, polar explorer Sir Wally Herbert dedicates the SAMS conference room to Scotland's most eminent polar scientist and explorer, William Speirs Bruce.

Academia's polar hero finally recognised

THE LIFE AND WORK OF WILLIAM SPEIRS BRUCE (1867 - 1921)

Dr Anuschka Miller, SAMS

William Speirs Bruce was an oceanographer, polar scientist, and explorer of prolific activity and success, who conducted 11 Arctic and 2 Antarctic expeditions, chartered much unknown territory, published scores of papers, and sacrificed what little money he had in the pursuit of polar science. Despite that until recently he was denied the iconic status awarded to other polar explorers like Captain Scott, Roald Amundsen, Ernest Shackleton, and Fridtjof Nansen. Now, SAMS has dedicated its new conference room to the memory of this inspirational Scottish polar scientist.

William Speirs Bruce was 'a man who had more that a little of the stuff that heroes are made of, a man who did great things with a quiet will and a gentle heart, who rarely got that public recognition which was the due of his achievements' (John A Thomson, 1924). © The Royal Scottish Geographical Society

BRUCE'S EARLY YEARS

Bruce was born in 1867 in London into a wealthy middle-class family of Scottish descent. After an unremarkable childhood, he acquired his life-long passions for natural history and Scotland as a 20-year-old freshman during biology courses at the Scottish Marine Station in Granton. Studying medicine at the University of Edinburgh, in his spare time he assisted John Murray, editor of the Challenger expedition reports, in analysing biological and geological samples from the first oceanographic expedition. He later also proof-read and compiled scientific reports. As a consequence the young Bruce met many of the leading natural scientists of the time, and gained experience in conducting and reporting research.

Bruce never finished his medical studies. In 1892 he joined a commercial whaling expedition to the Antarctic as naturalist and surgeon. At that time the interior and much of the coastline of continental Antarctica were entirely unknown. While the commercial nature of the expedition meant that he returned with scant data and few biological samples, he still published his first paper, and was hooked on polar exploration: "The taste I have had has made me ravenous."

After a year as meteorologist at the Ben Nevis Observatory, Bruce joined the Jackson-Harmsworth Expedition in 1896 surveying Zemlya Frantsa-Iosifa. The following year the wealthy textile manufacturer, Major Andrew Coats, recruited Bruce as naturalist on a pleasure cruise to Novaya Zemlya. When meeting Prince Albert of Monaco, owner of the finest oceanographic research vessels of its time, the *Princess Alice*, Bruce was invited to join the team of outstanding scientists on a hydrographic survey to Spitsbergen. Returning on the *Princess Alice* to Spitsbergen in 1899 for more detailed hydrographic surveying, Bruce was in charge of salinity and plankton measurements, and – when the ship ran aground near Bruce Point – for the safety of the crew and equipment at an emergency shore camp. This, his 5th polar expedition marks the end of Bruce's time as an apprentice polar scientist.

THE SCOTTISH NATIONAL ANTARCTIC EXPEDITION

On his return Bruce applied to join the British National Antarctic Expedition under Captain Scott onboard *Discovery* (1901-1904), but was ignored by Sir Clements Markham, originator of the expedition and President of the Royal Geographical Society. Bruce thus began to plan leading a separate Scottish National Antarctic Expedition. Antarctic expeditions from Germany and Sweden coincided with the two British voyages, but explored different locations and had complementary objectives.

Financed by the Coats family, the 35-year-old Bruce purchased a Norwegian sealer, had it converted into an ice-strengthened oceanographic ship, and renamed it *Scotia*. He hired 26 experienced crew and six seasoned scientists. They departed from Troon on 2 November 1902. Two books detail the voyage[1, 2], and the names Scotia Sea, Scotia Ridge, and Coats Land commemorate the two-year voyage. Some of the highlights of the expedition were:

- the founding of a meteorological station on Laurie Island, which is today Antarctica's longest permanently occupied base
- the detailed mapping of Laurie Island
- the first oceanographic exploration of the south-eastern Weddell Sea, reaching 74°01'S 22°00'W
- the discovery of Coats Land
- the production of some of the earliest cine film & sound recording of Antarctica

Bruce's team was sufficiently experienced - and perhaps lucky - not to suffer the misfortune of their ship becoming trapped in ice over winter. Careful planning, experience and good leadership will also have limited the death toll to just one man, chief engineer Alan Ramsey, who died from heart problems.

On 21 July 1904, after a 53,000 km round trip, the *Scotia* returned to Millport to a welcome party, and a congratulatory message from the King.

To retain, study, catalogue and display the vast collection and publish the results from the expedition, Bruce founded the Scottish Oceanographic Laboratory in Edinburgh in 1907. Unfortunately, only half the expedition results were ever published as Bruce could not meet all the costs of publishing.

Bruce's plans for a second Antarctic expedition to the Weddell Sea and a trans-antarctic trip remained unfulfilled, as the funding was instead awarded to Shackleton's ill-fated *Endurance* expedition.

SPITSBERGEN

If he could not explore the Antarctic, then the Arctic was his next choice. He undertook six more expeditions to Spitsbergen between 1906 and 1919. He became involved with the coal mining development of the area, claimed mining rights, but handed them over to the Scottish Spitsbergen Syndicate in 1908.

Returning from his last trip to Spitsbergen in 1920, Bruce was exhausted and died on 21 October 1921. His ashes were scattered in the Southern Ocean.

The Bruce biography[3] by Peter Speak is a recommended read for further details.

References

[1] Bruce WS (1992) 'The log of the *Scotia* Expedition, 1902-1904' (Editor P Speak), Edinburgh University Press

[2] Rudmose Brown RN, Pirie JH, and Mossman RC (2002) The voyage of the *Scotia*. Mercat Press Ltd., Edinburgh

[3] Speak P (2003) William Speirs Bruce. NMS Publishing

Otters in South Uist:

IMPACTS OF PROLONGED FISH FARMING ACTIVITY

Jane Twelves, SAMS member

SOUTH UIST

South Uist is an island in the Outer Hebrides archipeligo, off the north west coast of Scotland. It measures roughly 30 miles from north to south and 6 to 8 miles from west to east. Its interesting geomorphology provides a range of contrasting habitats across the island.

The west coast is an almost unbroken stretch of sandy beach, where the calcareous sand is composed of small shell particles. Over centuries this sand has been blown inland by westerly winds and formed the famous machair. A rib of blackland with neutral soil runs down the middle of the island. The east is dominated by acid peat moorlands and hills and is bisected by five fjordic sea lochs. The east coast is rocky and the shore is clothed in brown seaweeds. Inland there are hundreds of freshwater lochs, with pHs ranging from high in the machair lochs to low in the peaty moorland lochs, while brackish lochs occur at the heads of the sea lochs.

OTTERS ON SOUTH UIST

Otters are native to the island, and their distribution and the use they make of the different aquatic habitats are fascinating as a transect from west to east across South Uist reveals.

> Otters occur mostly on the rocky east coast of South Uist. (Map: S Gontarek)

Otters are seldom found on west coast beaches but inland an amazing and complex network of otter runs link the low lying freshwater and brackish lochs and lead to the rocky seashores. There is a pattern to this network as otters take the shortest route between two adjacent lochs.

Most otters occur on the rocky east coast. They live in underground burrows known as holts, and mark their territories - especially the area around their holts - by leaving their faeces or spraints on well-defined sprainting sites.

There is a direct relationship between the standing crop of both intertidal and sub-tidal brown seaweeds and the number of otters. This, of course, is to do with their mostly fishy food, which they hunt for in amongst the seaweed. Otter numbers are thus highest along complex coastlines and sheltered waters.

Most female otters with dependent cubs live on the rocky seashore all year round because of the good supply of food throughout the year. Single adult and sub-adult animals roam in the extensive freshwater habitat during the summer months feeding often exclusively on eels (*Anguilla anguilla*). But when eels hibernate on the bottom of the lochs and are thus difficult to locate, these otters return to the feeding grounds on the rocky coast.

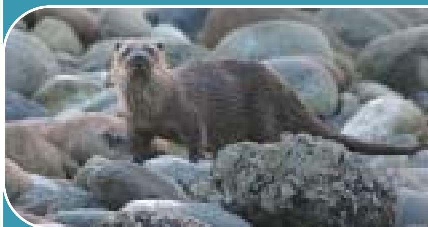
OTTERS AND SALMON FARMS

In 1974 the first salmon farm in the Outer Hebrides was set up in Loch Sheilavaig in South Uist. As the first cages were being constructed, my concern grew that there may be a conflict between this new industry and the otters living in the loch. I thus began to monitor holt usage, but found no indication of diminished use as the salmon farm became established.

I conducted a thorough survey of the area in 1978, when I mapped all signs of otters. Since then I have continued to monitor particular holts, which have continued to be used as the fish farm grew in size.

In 2001 I repeated the in-depth survey and found that, although the current generation of otters does not seem to use the habitat in exactly the same way as their forbears, there were just as many signs of otters in Loch Sheilavaig as there had been 23 years earlier.

> Otters hunt for their prey amongst bown seaweed. © Bill Jackson, ads.jackson@btinternet.com



> Thirty years of salmon farming on South Uist has had little or no effect on otters. © Jim Wood

> Otters are shy and their presence is easiest assessed using tracks and sprainting sites. © R Shucksmith

In the 27 years of salmon farming between 1974 and 2001 an estimated 10,000 tonnes or more of salmon were harvested at this site. Assuming an average food conversion ratio of 1.3:1, approximately 13,000 tonnes of fish food were entered into Loch Sheilavaig.

My surveys suggest that this intensity of fish farming activity over nearly 30 years has had little or no effect on the top predators in the aquatic ecosystem, the otters. ●

A coral reef in Scottish

SAMS SCIENTISTS MAP OUT A *LOPHELIA* REEF IN THE SEA OF THE

Dr J Murray Roberts, SAMS

The most commonly recorded species of reef framework-constructing coral in the NE Atlantic is *Lophelia pertusa*. Records of *Lophelia* in the Sea of the Hebrides go back to Victorian times when Philip Henry Gosse described it from fishermen's reports in his classic 'History of British Sea Anemones and Corals' in 1860. Since then there have been a few reports of *Lophelia* from the Minches – a fine specimen made its way to Glasgow University's Hunterian Museum from a long-line fisherman in the 1900s. More recently dead coral was recovered by dredging east of Mingulay in the late 1960s, and John Wilson, the UK's longest-standing cold-water coral expert, saw colonies of *Lophelia* growing on a seabed ridge during pioneering manned submersible dives using *Pisces* in 1970.

> The *Lough Foyle* docks at the Dunstaffnage pontoon. © JM Roberts

> The most common reef framework-constructing coral is *Lophelia pertusa*. © JM Roberts

> Scientists are carefully sieving coral rubble samples before preserving them. © G Saunders, SNH

The last ten years have seen a large research effort focussed on cold-water corals around the world, and many new reef areas have been discovered. Particularly large and spectacular *Lophelia* reefs have been found on the Norwegian continental shelf, some growing to form chains kilometres in length. Sadly alongside these exciting discoveries, it has become clear that many of the reef areas have been damaged by fishing activities, especially bottom trawling.

Interest at SAMS in the Hebridean *Lophelia* areas began seven years ago with the start of cold-water research at Dunstaffnage. The existing UK records were collated with the British Geological Survey for a report in 1999, and we began to wonder whether live *Lophelia* reefs still occur in the Minch, and how widespread they might be. Our first opportunity to look came in 2001 during a SAMS research cruise aboard RRS *Discovery*. As the ship sheltered in the Minch from autumn gales, a few hours of ship time were used to sample the seabed in the calmer waters east of Mingulay and to record some 3.5kHz echosounder lines. Dead coral rubble, a fragment of live *Lophelia,* and a diverse animal community were recovered, while the echosounder revealed an intriguing pattern: the surface of the seabed looked very complex, supporting perhaps a boulder field or even a reef area.

The following year, in the summer of 2002, we teamed up with Dr Richard Bates of the University of St Andrews and set off for the Mingulay site on the SAMS vessel *Calanus*. However, as we made our way across the Minch, the weather worsened, and there was only time for a quick camera deployment before running for cover in the face of more gale force winds. On the positive side, the video images showed coral rubble on the seafloor. Our case to survey the area was growing.

Given these tantalising glimpses of what might be there, we began the process of developing the MINCH project – Mapping INshore Coral Habitats. The idea behind this project is to map and assess the distribution and status of coral habitats in the Minch. Focussing on the Mingulay site with the most recent records, we also planned to investigate the Stanton Banks, where *Lophelia* had been brought in by fishermen in the 1960s, and two sites described by Phillip Henry Gosse, one to the west of Skye and the last between the islands of Rum and Eigg. Our strategy was to survey each area with a multibeam sonar to produce an accurate bathymetry, which could then be used to identify promising areas to deploy cameras for seabed videography in search of live *Lophelia* reefs.

In the winter of 2002 and spring of 2003 we built a partnership of organisations all contributing to the MINCH project. The partnership grew to include SAMS, the Department of Agriculture and Rural Development in Northern Ireland, the British Geological Survey, TOPAZ Environment and Marine, Scottish Natural Heritage, and the Scottish Executive.

Work began in earnest in April 2003, when the *Lough Foyle* was surveyed and fitted

waters!

HEBRIDES

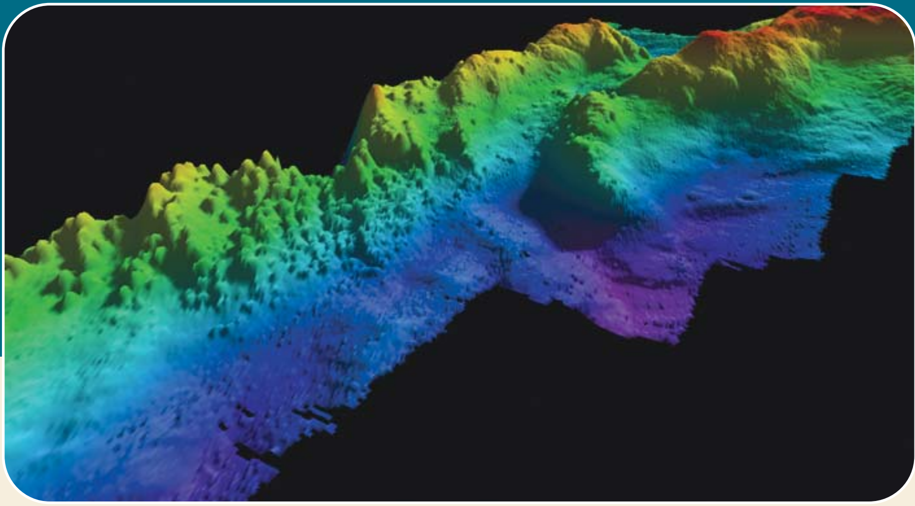
with a special multibeam transducer bracket while she was in dry dock.

In the first week of July 2003, the research vessel *Lough Foyle* tied up to the Dunstaffnage pontoon to set out on the MINCH project. Blessed this time with perfect, calm weather we began to run multibeam survey lines across the Mingulay study site. We had chosen a sonar system from Kongsberg-Simrad, and Chris Harper from Fathoms ran the acoustic surveys overnight while the rest of the team slept. Before breakfast each day everyone gathered to review the night's survey and pick out areas to examine more closely with the seabed video. The first multibeam survey clearly showed the seabed ridge described by John Wilson from the *Pisces* dives. Next to this ridge the seabed formed into a series of hummocks. They looked similar to the surveys the Norwegians had produced of their *Lophelia* reefs. Clearly these hummocks were a top priority for the camera work.

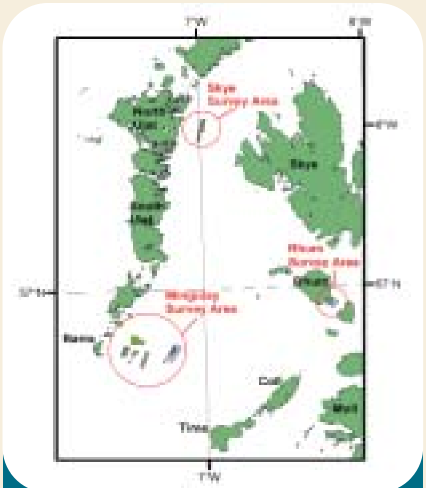
There was a growing sense of excitement on board when the cameras were lowered. As the ship drifted across the survey area, the habitats on the seabed changed from soft burrowed sediments, to areas with fireworks sea anemones and small stones colonised by colourful crinoids. Then larger rocks emerged, some of which supported fan-shaped sponges. A little while later we saw the first patches of coral rubble on the seabed. These became progressively denser until – finally – scattered live coral colonies came into view. This looked like the classic zonation pattern through the dead coral rubble bands that surround Norwegian *Lophelia* reefs. Shortly afterwards the cameras flew across large white coral heads, characteristic of live *Lophelia*. We had found it! There is a live *Lophelia* reef in the Sea of the Hebrides, just as the early reports and fishermen's observations had suggested.

Buoyed up by this discovery the rest of the cruise was spent completing survey work at the other stations, running video surveys and taking seabed samples. Grab samples of the dead coral rubble showed that it supported a wonderfully diverse community of sponges, bryozoans, anemones, bristle worms, crustaceans – the list goes on. These samples were carefully preserved to compare with the growing SAMS collection of animals associated with cold-water coral reefs in the NE Atlantic. The overall tally to date from the European ACES (Atlantic Coral Ecosystem Study) project comes to over 1,300 species. Some of the coral skeleton samples are around 4,000 years old, suggesting that the reef structures started to grow as the ice sheet retreated and water temperatures warmed some 10 - 14,000 years ago.

Apart from their intrinsic value and interest, there are a host of research avenues opening up from the study of cold-water coral reefs. The reefs are long-lived structures, and the chemistry of the coral skeletons and other animals can be used to estimate seawater temperatures back in time – obviously important to build a picture of past climate changes. We know that reefs are hot-spots of biodiversity, but we know little of the ecological relationships between species, nor how species change from area to area. Until very recently there had been no research on how cold-water corals reproduce or disperse in the water currents. The physiology, feeding and growth of cold-water corals remain largely unstudied.



> 3-D view from the multibeam survey of ridge features east of Mingulay. The coral reef is represented by the many small mounds next to this ridge. © MINCH project



> Map of the Sea of the Hebrides with study areas. (Map: S Gontarek)

At SAMS our cold-water coral reef research strategy revolves around monitoring the environmental regime on the reefs by sending down a purpose-built instrument package that lands on the seabed (the SAMS benthic photolander) and using this information to help us design laboratory studies of live coral to investigate coral growth and activity patterns. The Mingulay discovery allows us to further expand this work. Our next step will be to visually survey the reef using a remotely operated vehicle, and plans are afoot to develop a live seafloor observatory to monitor the reef and feed both data and video information from the Mingulay reef to the laboratory and across the Internet.

The foundation for all these studies must be a good understanding of the distribution of coral habitats. The mapping work aboard *Lough Foyle* succeeded in demonstrating the technology available today for broad-scale habitat mapping. Surely in the 21st century it is time to take up where pioneers like Phillip Henry Gosse left off and apply modern habitat mapping techniques to describe Scotland's diverse and valuable marine heritage. We don't know what other surprises might be out there. ●

My PhD Project

A prickly problem: Researching sea urchins and their environment

Adam Hughes, SAMS UHI

You usually get one of two responses when you tell someone that you study sea urchins. Either their attention wanders somewhere into the middle distance, or they come out with some witticism such as 'Urchins eh? That must be a prickly problem', and then go on to ask about the football. But they are not far from the truth: sea urchin research is a tricky subject and one that has a long and fascinating history.

These inscrutable creatures occur from the poles to the tropics, from the deep-sea to the intertidal shallows and rock pools. They often dominate the mobile macro fauna and, when found in large numbers, can profoundly alter their environment. Their infamous cousin, the crown of thorns starfish, is well known for destroying large areas of coral reefs over the past decades. But similarly large aggregations of sea urchins roam the temperate waters, and equally devour all, leaving nothing but barren rock behind them. Whether these 'urchin barrens' are a natural phenomenon, or a result of over-exploitation of the urchins' predators, such as lobsters and otters, is just one of many unanswered questions. For such a long-studied and ubiquitous creature many such questions remain unanswered. For example no one is sure just how long an urchin lives for. A recent study that used changes in isotope ratios following testing of nuclear bombs as a marker, estimated one large urchin species to grow to at least 100 years, and probably much more. This exceeds previous longevity estimates by an order of magnitude.

The idea behind my PhD is to study the impact of sea urchin grazing on invertebrate communities. Two species of sea urchin commonly occur on the west coast of Scotland, the green sea urchin, *Psammechinus miliaris,* and the edible sea urchin, *Echinus esculentus*. Both are omnivorous and feed on a range of invertebrates such as barnacles and mussels, and both can occur in high densities. Despite this, their impact on invertebrate communities is poorly documented.

My investigation combines a number of techniques - some well tried and tested, some new and possibly novel - to improve our understanding of the relationship between sea urchins and their prey species. I have completed a series of field experiments which involved the removal (by hand!) of 5,500 urchins from three intertidal sites. Unfortunately I was unprepared for quite how tenacious and mobile these creatures are, and days after my diligent relocation the urchins had returned to their original homes. In spite of these problems, the study demonstrated that urchin grazing can profoundly alter the intertidal biota of sea lochs. The evolution of this experiment is that I am now using metal cages to exclude the urchins from the experimental areas.

As well as field experiments I am using various analytical techniques to investigate the trophic ecology of urchins. By using fatty acid analysis combined with stable isotope ratio analysis I hope to link temporal and spatial variation in diet with the reproductive and nutritional status of different urchin populations.

A final problem that has been taxing me, as it has taxed a great number of my urchin-studying predecessors, is the question of how to tell one urchin from another. This is relevant if you want to investigate foraging behaviour, migration, growth rates, or longevity. To this end I am investigating the use of RFID tags to identify individual urchins. These tags, similar those used with pets, can be implanted into sea urchins and then read using a scanning machine. This will allow us to return year after year to collect data on movement, growth and mortality of individual sea urchins. Who knows what surprises that will reveal… ●

Adam is a third year UHI PhD student supervised by Dr Maeve Kelly at SAMS and Dr Dave Barnes from the British Antarctic Survey.

> The edible sea urchin, *Echinus esculentus.* © M Lilley

> The green sea urchin, *Psammechinus miliaris.* © A Hughes

THE 14TH ANNUAL NEWTH LECTURE (Dunstaffnage, 4th November 2003)

Is marine management a myth?

Dr Phil Williamson

The anecdote of King Canute's inability to control the waves used to be given in school history books as an example of regal arrogance. The more sophisticated interpretation is that he was well aware of human limitations in marine management, but needed to show such fallibility to sycophantic courtiers. We have come some way since then, in that breakwaters and other coastal structures significantly change local circulation patterns, offshore oil and wind-power developments require environmental impact assessments and well-regulated management, and marine aquaculture necessarily depends on the manipulation of natural processes to provide human benefit.

Yet in many ways we are still at the hunter/gatherer stage with regard to the human use of most marine natural resources. Despite worthy aims of achieving sustainability, it is arguable that marine resources – particularly biological ones – are inherently unmanageable, since they can never be directly controlled. Thus management is essentially a socio-economic activity, involving policies and regulations that are directed at human activities, not the resource itself.

Even with a broader definition of management that includes exploitation-resource interactions, as well as policy and legislation, marine success stories are lacking: management failures seem much more prevalent. That is not only because people misbehave, not doing what others expect they should – perhaps because maritime communities rely strongly on their own cultural mores, and hence are inherently sceptical of externally-imposed constraints – but also because marine ecosystems misbehave, not conforming to human expectations of quasi-stability, nor giving the anticipated responses to changes in exploitation pressures or other perturbations.

Such apparent contrariness of the natural world is demonstrated by the 'stochastic' occurrence of good years and poor years for harvested species, and regime shifts between different ecosystem states. The inexplicability of these events arises from our imperfect understanding of the dynamics of the marine environment. Yet knowledge deficiencies for the oceanic realm are hardly surprising, given its relative inaccessibility to humans, and its greater physical complexity compared with land-based ecosystems. Furthermore, the microscopic size and short life-times of most marine primary producers necessarily result in greater seasonal and year-to-year variability. Somewhat paradoxically, planktonic inhabitants of the 'constant ocean' are therefore more sensitive to environmental changes occurring at the planetary scale.

Worldwide, the total fish catch has been relatively stable since 1985, at around 130 million tonnes per year. However, major changes in species composition have occurred within the global total over that time, with many stocks declining in importance and previously unexploited stocks taking their place. As a result, an increasing proportion of fish stocks are now considered to be overfished (~ 30%) or fished at full capacity (~ 25%), and no undeveloped stocks remain. For European fisheries subject to stock assessments, the overfished and full capacity figures are currently 34% and 46% respectively – leaving only a fifth of stocks with sustainable status, within safe limits.

European fisheries are, of course, highly regulated, with policy decisions underpinned by the work of several hundred marine scientists in the UK and elsewhere – who benefit from well-developed infrastructure and facilities, and around a century of research effort, catch statistics, and environmental data.

So where did it go wrong, and can it be put right? No single sector (scientists, policy-makers or fishers) is uniquely at fault for past mistakes, but future success will require a more conciliatory and cooperative approach between the parties. Success will also require an appreciation that ecosystem effects, arising from large-scale environmental changes, can no longer be considered as noise, averaging out over a few years: Even in the most optimistic scenarios, the future will inevitably be very different from the past.

Recovery of specific fish stocks, such as cod in the North Sea, to their abundance levels of the 1960s and 70s is a laudable management aim: whether it is achievable may depend as much on the strength of the Gulf Stream as on catch restrictions or the decommissioning of fishing vessels.

Some optimism is possible. Most marine species have experienced global change many times before, with around 50 major climatic oscillations in the past million years. For temperate, shallow-water species, sea level changes over this time period have caused a ten-fold change in habitat availability.

With regard to improving marine management practices, the future of the UK fishing industry has been the focus of various reports and commissions. Political momentum exists for their recommendations to be implemented. On the research side joint initiatives are being developed between NERC, government departments, and the fishery laboratories. SAMS scientists already have well-established expertise and interests in ecosystem-based approaches to marine management: there could now be new opportunities to develop partnerships with research users and scientific colleagues, to help achieve sustainable exploitation of marine bioresources. ●

Particular thanks are due to Peter Boyle, Martin Angel, Manuel Barange, Keith Brander and David Sampson for discussions relevant to this lecture.

Dr Phil Williamson is the UEA-based Science Coordinator for three NERC directed programmes (Marine Productivity, Marine & Freshwater Microbial Biodiversity, and UK Surface Ocean – Lower Atmosphere Study).

For information on the NERC Marine Productivity programme, see www.nerc.ac.uk/marprod

For information on the international Global Ocean Ecosystem Dynamics project, see www.globec.org

Diving in the pursuit of science

ADVANTAGES AND LIMITATIONS OF SCUBA DIVING FOR STUDYING SUBTIDAL POPULATIONS

Chris Poonian, King's College London

In recent years SCUBA diving has been widely employed for assessing commercial stocks, for conservation studies, and for detailed ecological research in both temperate and tropical environments. SCUBA allows *in situ* observation of organisms and provides information unobtainable by other survey methods. However, much scientific work employing SCUBA simply utilises standard or convenient procedures, despite evidence of unacceptable levels of imprecision and consequent low reliability and repeatability.

As SCUBA dive time is limited due to financial and logistical considerations, it is particularly important that surveys are conducted with highly efficient techniques. It is, however, impossible to provide strict rules for the design of underwater surveys using SCUBA. Optimal sample unit sizes for a given survey may vary by orders of magnitude, depending on the characteristics of the target organism, environmental variation, habitat variability, and available resources. Despite that it is appropriate to suggest guidelines for certain types of surveys and how different factors may affect estimates obtained. It is likely that most surveys will require pilot studies to optimise sampling technique, which will save time and expense in the long term.

Spatial characteristics of the target organism and survey scale are factors that can seriously affect the results. More effort is for example required to survey rare species at a given level of precision than common species. The size of sampling unit employed must thus encompass the scale of distribution of the organism under consideration. Failure to follow this recommendation leads to results that exhibit a skewed distribution that misrepresent the population, and data that hinder statistical analysis.

Also the mobility of the organism under scrutiny varies, and operates in conjunction with spatial distribution. Mobility in rare organisms may increase the precision of estimates because they are more likely to be noticed by a scientific diver. However, mobility can have a negative effect on precision of estimates for common species as the scientific diver has to identify individuals. This usually results in overestimates when individuals are counted more than once.

Cryptic species pose particular problems. They are usually underestimated because observers easily miss many individuals. The precision for estimates of cryptic species can often be improved when relatively small sampling units are surveyed, as this can help to focus the observer's attention. Divers are more likely to miss cryptic species if too large a sampling unit is surveyed.

The complications of camouflage are exasperated in complex and heterogeneous habitats such as the rocky subtidal, where small sampling units may be less representative. Larger sampling units encompass the variability, and thus create more reliable estimates. Artificial reefs constructed from standardised materials, such as the Loch Linnhe Artificial Reef, are excellent locations for precise ecological investigations because of their structural homogeneity. In such environments, small sampling units provide dependable pseudo-replicates, where even low levels of sampling effort achieve high precision.

PHOTOGRAPHIC SURVEYS

Underwater photography as a population estimation technique can produce data comparable to that from visual diving surveys. Digital technology also requires similar survey and analysis times. But photography has serious limitations in sub-optimal turbidity and light conditions, particularly when one considers the relatively poor definition of photographs currently obtainable from digital cameras. These effects reduce the size of the possible sampling unit, decrease the minimum subject plane-camera distance, and may significantly lower detection incidents of small and cryptic species. Large species on the other hand may not fit in the photo frame, while mobile species may be disturbed by divers and camera apparatus.

The benefits of SCUBA as a means for the study of subtidal organisms clearly need to be weighed against the inherent biases in these techniques to devise reliable methods for a given study. Each study should thus be considered individually to determine the most appropriate sampling unit or method, and indeed whether SCUBA is the most appropriate technique. ●

This study was carried out as part of an MSc in Aquatic Resource Management at King's College, London, and was supervised by Dr Martin Sayer, SAMS. Diving and underwater photography were arranged by Dr Simon Thurston and Hugh Brown from the National Facility for Scientific Diving at SAMS. All fieldwork was funded by a SAMS bursary.