SCOTTISH ASSOCIATION *for* MARINE SCIENCE

ANNUAL REPORT 08-09

About SAMS

The Scottish Association for Marine Science (est. 1884) is a learned society for marine scientists, students and enthusiasts with an international membership of around 500.

It is a Scottish Charity and a Company Limited by Guarantee. SAMS is the owner of a state-of-the art Scottish Marine Institute at Dunstaffnage near Oban with two research vessels, a dive centre, the Culture Collection of Algae and Protozoa, and a large research aquarium. SAMS employs 150 staff that deliver world-class research for sustainable seas. These researchers are active across all marine science disciplines including technology and policy, with significant expertise in multidisciplinary working. The SAMS portfolio includes research on the Arctic, climate change, industrial impacts on oceans, prosperity from marine ecosystems and marine renewable energy. As a collaborative center of the UK Natural Environment Research Council SAMS contributes to the strategic Oceans 2025 research programme.

SAMS is an academic partner of the UHI Millennium Institute, the prospective University of the Highlands and Islands. Under UHI's auspices SAMS delivers a BSc (Hons) Marine Science and a BSc (Hons) Marine Science with Arctic Studies, and trains PhD students. It also delivers continuous professional development training for science teachers and regulators, and provides field station facilities for universities.

Being committed to knowledge exchange and with a considerable track record in winning commercial contracts, SAMS operates a wholly owned subsidiary company (SAMS Research Services Limited) and the European Centre for Marine Biotechnology, an incubation unit hosting three tenant companies.

SAMS is governed by an independent Council, which is supported by a Board and several committees.

Front cover image by Hugh Brown, SAMS, (Ragged Channel, Baffin Island in the Canadian Arctic, during a SAMS-led international expedition studying arctic seaweed biodiversity)

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Director's Introduction

My birthday in February 2008 was a particularly memorable one. I woke up on the sleeper train from Glasgow to London having just accepted the offer to become Director of SAMS following an interview in Oban hours earlier. During the five busy months between then and taking up my new role on 1 September 2008, I was able to visit SAMS, talk to staff and its Council, read piles of reports and publications and successfully bid for a major EU research project that will allow me to remain active as a researcher during my directorship. Meanwhile SAMS was in the competent hands of its Acting Director and my future Deputy Director, Ken Jones.

Of course, I applied for the job in the knowledge that SAMS was an excellent institution with a great future and I had long admired Graham Shimmield's leadership that had resulted in the most modern marine research facility in the UK. I also knew that the clouds of economic recession were building across the world and that we would have to be agile and adaptable to overcome this challenge. But there were also major opportunities; I had seen some of these during my recent experience as a Special Adviser to a House of Commons Select Committee Inquiry on "Investigating the Oceans" and a similar role on the Scrutiny Committee for the UK Marine Bill. Interest in the sea and its economic potential was mounting, Scotland was developing its own Marine Bill and SAMS would be well placed to provide key scientific inputs to help make it work.

I soon discovered that SAMS is a great place to work. The beautiful facilities are only part of the picture. Its staff are highly skilled, good humoured, positive minded and dedicated professionals engaged in an amazing array of research, education and commercial activities. Our visitors often remark that there is a constant buzz of activity in the building. During 2008, amongst many other things, SAMS' staff led a major research cruise to the Arctic (featured in a 15 minute slot on Newsnight), conducted pioneering studies on the effects of mine waste on the deep sea in Papua New Guinea and successfully bid for over £5 million support for new teaching facilities that will make SAMS the best equipped marine teaching laboratory in Scotland. But this is only a small part of the picture as you will soon see when you delve into this report.

SAMS is a collaborative centre of the UK Natural Environment Research Council and continues to enjoy a strong academic partnership with the UHI Millennium Institute, the prospective University of the Highlands and Islands. It is forging closer ties with other institutions in Scotland through membership of two research pools funded by the Scottish Funding Council: SAGES (Scottish Alliance for Geoscience, Environment and Society) and the newly constituted MASTS (Marine Alliance for Science and Technology, Scotland). We value our national and international links, some of which began 124 years ago when we were founded by the father of Oceanography, Sir John Murray.

In 2008-9 there were many new beginnings at SAMS. We began to implement a new governance system that brings more outside talent to guide our science and management. We consolidated our work on marine biofuels, leading to the tacit approval of a new €6 million EU project in this area and we began work in earnest on implementing the NERC Oceans2025 flagship research programme. We were visited by government ministers, leading scientists, entrepreneurs and hundreds of local people. All of this augurs well for the future and we will focus on using our successes as building blocks for work on research, commercialisation and education, not forgetting that, as a learned society we have an important role in outreach to our members and the public in general in Scotland. It is indeed a privilege to lead such a dynamic organisation.

Laurence Mee

OCEANS 2025

Rapid climate-induced changes in Arctic sea-ice and water column structure will have a significant impact on the Arctic marine ecosystem and carbon cycle. The accurate prediction of such changes is a major challenge. During July and August 2008 a multidisciplinary oceanographic research program was undertaken on the *RRV James Clark Ross* in shelf seas to the north of Svalbard in the European Arctic. The objective of the UK-led ICE CHASER (CHAnging Sea-ice and Ecosystem Response) expedition was to improve our understanding of the ecology and biogeochemistry of the region and thereby help refine models of ecosystem response to environmental change. The cruise was funded by the UK Natural Environment Research Council's OCEANS 2025 strategic marine research program and was part of the PAN-AME and PAME International Polar Year research clusters.

Methods

The ICE CHASER expedition sampled open-waters , the marginal ice zone and ice-covered waters, north of Svalbard. Stations were also sampled in Rijpfjorden during ice-free conditions. At each station a range of physical, chemical and biological observations and experiments were conducted in the water column and sediments. The measurements will enable characterisation of the pelagic and benthic ecosystem at each station, and will allow carbon flux through the pelagic and benthic ecosystems to be determined.

Preliminary Results & Discussion

The oceanographic conditions encountered were colder than expected with extensive ice cover. These cold conditions were a local feature produced by northerly winds forcing sea ice south onto the north coast of Svalbard.

The marine ecosystem at the study sites appeared to be characterised by typical Arctic species. Full taxonomic analysis will confirm if this was the case or whether invasive warmer water species were present.

Phytoplankton were observed in the water column with peak abundances recorded at depths characterised by very low light levels (<1% surface solar radiation). The phytoplankton were actively growing, although relatively slowly. Much of the carbon taken in by the phytoplankton was being released back out into the seawater as dissolved compounds. Calcification rates were very low.

High concentrations of recycled nutrients were observed in deeper waters, just below the depths where phytoplankton were growing. It is likely that the phytoplankton were growing best at depths where they were supplied simultaneously with light (albeit at low levels) from above and recycled nutrients from below.

An abundant and active bacterial community was observed in the water column suggesting that considerable amounts of energy, carbon and nutrients were being recycled by the microbial community (rather than being transferred up the food web to larger organisms). This bacterial community was not, however, using the dissolved carbon compounds released by the phytoplankton.

Healthy populations of large herbivorous zooplankton were found in deep waters at our study sites. These Arctic species had stores of high energy lipids accumulated whilst feeding on phytoplankton earlier this summer, and had entered winter "hibernation". This suggests that their food supply must have been active and abundant underneath the sea ice earlier in the year, despite low light levels encountered under the sea ice. It also suggests that a substantial quantity of energy and carbon had been transferred up the food web to larger organisms during spring/early summer.

Incubation experiments revealed that an increase in water temperature may lead to a decrease in phytoplankton growth.

Sea-bed lander experiments revealed that carbon and nutrients were recycled faster at higher sea-bed temperatures.

Ecology Department

ARE BIOGENIC REEF-BUILDING ANIMALS SENSITIVE TO THE IMPACTS OF AGGREGATE DREDGING?

Filter feeding marine animals living on the seafloor rely on the suspension of particles for food, and some species also utilise passing particles for the construction of dwelling tubes. However, the delicate balance between such animals and their environment can easily be disrupted by a variety of human actions. The extraction of aggregates for the construction industry, for example, results in significant disturbance through removal of substrate and the generation of sediment plumes through processing of the aggregate. The latter can lead to local burial of habitats and smothering of animals.

> Extensive reef of *Sabellaria spinulosa* exposed at extreme low tide in the Wash

Filter feeding marine animals living on the seafloor rely on the suspension of particles for food, and some species also utilise passing particles for the construction of dwelling tubes. However, the delicate balance between such animals and their environment can easily be disrupted by a variety of human actions. The extraction of aggregates for the construction industry, for example, results in significant disturbance through removal of substrate and the generation of sediment plumes through processing of the aggregate. The latter can lead to local burial of habitats and smothering of animals.

So how do benthic animals respond to such environmental disturbances? To answer this we have designed and built special aquaria known as paddle VOrtex Resuspension Tanks (pVORTs) to try to recreate typical conditions associated with dredging activities. Using these tanks we have been able to generate current flow and continuous suspension of sediment whilst subjecting animals to various burial durations and depths using different sediment fractions. So far our attentions have focused on the Ross worm Sabellaria spinulosa since this is an important reef-forming polychaete worm, and the mussel (Mytilus edulis), an important commercial species. Results so far suggest that both these species are tolerant of short term burial. Indeed some Sabellaria have been observed to continue growing their tubes whilst buried, probably in a bid for freedom, whilst some of the mussels have been able to just "climb" out of the burial chamber if the sediment is not too deep!

> The paddle VOrtex Resuspension Tanks (pVORTs) in the SAMs aquarium is used to generate current flow and continuous suspension of sediment.

Currently, little is known about how animals respond to increased sedimentation or their natural tolerance to it. Hence this project, which is funded by the Marine Aggregate Levy Sustainability Fund (MALSF), is designed to supplement current understanding and provide further insights into the impact of marine aggregate extraction. When our results are coupled to field data on burial from dredging, it will be possible to determine which species may be most impacted, thus increasing the knowledge base on which to manage dredging operations.

Kim Last, Vicki Hendrick & Andrew Davies

> A *Sabellaria spinulosa* clump consisting of many individuals that have grown their sediment tubes in the pVORTs. Tube growth rates can be up to 10 mm per day.

COMBATING TOXINS IN AQUACULTURE ECOSYSTEMS AND SHELLFISH

Bivalve shellfish of commercial interest feed by filtering seawater using specialised gills. Unfortunately, this can lead to the accumulation of toxins made by certain species of phytoplankton that they consume. A study that monitors the levels of toxin-producing algae in areas where shellfish are grown around Scotland is described in the Microbial & Molecular Biology section of this Annual Report. Here, we deal with the problem of how to rid contaminated shellfish of toxins once they have been taken up by various tissues. SPIES-DETOX (Solid-Phase In-situ Ecosystem Sampler and Detoxification of shellfish) is a project concerned with further developing methods for toxin removal, with a focus on training chefs to use appropriate techniques when preparing bivalve shellfish that might be contaminated. SAMS part in this project, which finishes in the autumn of 2009, involves the removal of toxins in shellfish from naturally and artificially contaminated scallops and mussels.

> Scallops and mussels are fed with toxic algae in a recirculating system in the SAMS aquarium, in preparation for detoxifying experiments using selected bacteria encapsulated by staff from the Central Science Laboratory.

To demonstrate toxin removal, a training course in scallop preparation (shucking) was held at SAMS for a group of trainee chefs. The main aim was to show that a novice could be quickly taught to safely prepare these shellfish using adequate washing to reduce any Amnesic Shellfish Poison (ASP) toxins to a safe level. Work at SAMS had previously shown that careful washing can remove almost all of the ASP toxins. Two teaching methods were tried; one with a trainer giving hands-on instruction and the other using only a demonstration recorded on a DVD. The results indicated that while the personal trainer was more effective, watching the DVD could be sufficient, especially with some revision and/or where used by personnel who had other catering experience. The trainee chefs in the course had almost no previous shellfish and little other catering experience, as they were all at the start of their course.

In tandem with the above training, our research has involved the feeding of the toxic alga *Alexandrium tamarense* to scallops to provide contaminated animals for a washing study to match that conducted in 2007 with naturally contaminated animals obtained from Loch Laxford and Scapa Flow. The results confirmed the earlier trials in which the Paralytic Shellfish Poison toxins were not removed readily from the edible tissues with washing under fresh tap water. When the edible tissues were deliberately soaked in a solution from the digestive gland (hepato-pancreas) to simulate contamination from careless preparation (shucking) it was found that the induced extra contamination was also not removed easily, even with prolonged washing lasting thirty minutes. In addition, the kidneys were found to have high levels of toxin relative to the edible adductor muscle and gonad, so that removal of the kidneys might also be considered a good precaution to take in the preparation of the edible meats.

These results were reported in detail to the Food Standards Agency (Scotland) who co-funded this work and will be available publicly on the FSA website in due course. These and other data will be incorporated into on-going advice via the FSA to industrial shellfish processors to maintain public safety.

Two additional batches of scallops and mussels were made toxic with PSP and then fed selected bacteria capable of metabolising PSP toxins, in order to assess the possibility of decontaminating shellfish found to be above the minimum statutory toxin limit. This detoxification experimental series has yet to be concluded.

Maeve Kelly & Peter Lamont (SAMS) & Elizabeth Turrell (Marine Scotland)

INTEGRATED MULTI-TROPHIC AQUACULTURE

Turning waste into a useful product is the basic premise of integrated multi-trophic aquaculture (IMTA).

By using waste products from fin-fish aquaculture as food and nutrients for other organisms, we can reap the dual benefits of reduced pollution and increased productivity. The principle is simple but the practice is complex: ongoing research at SAMS aims to overcome some of these complexities and bridge the gap between theoretical concept and industrial application. As part of the European Union funded project ENRICH, scientists at SAMS are working to commercialise the concept of IMTA through the introduction of echinoculture (sea urchin farming) alongside existing finfish fish aquaculture.

> *Paracentrotus lividus*

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Sea urchin roe is a luxury foodstuff with a premium price and a global market. This has unfortunately led to wild populations being over exploited and a number of fisheries have been closed around the world. Urchins are therefore a prime candidate group for IMTA. Previous SAMS research has shown that the European sea urchin, *Paracentrotus lividus* (the main commercially exploited European species) thrives when grown alongside Atlantic salmon aquaculture, feeding on the particles that fall out of the salmon cage. The ENRICH project takes these earlier studies to the next stage by addressing some of the bottlenecks that prevent the full adoption of IMTA within the aquaculture industry. Working with business and scientific partners in Scotland, Italy, Croatia and Israel, the project addresses the issues of broodstock supply and development, larval rearing and the technical problems of integrating echinoculture within existing aquaculture infrastructure on a European wide basis.

The work at SAMS focuses on broodstock development and larval rearing in terms of diet quality. We are currently conducting trials to understand the role of maternal nutrition in larval health and development. We are also developing a range of artificial larval diets. Larvae are traditionally fed cultures of phytoplankton, but these cultures are variable in their nutritional content and require specialist growing facilities. By developing artificial diets, it is hoped to eliminate this bottleneck in larval production and to speed up the commercialisation of echinoculture and the adoption of integrated multi-trophic aquaculture.

Adam Hughes

CONTROLLING MARINE INVASIVE SPECIES BY TARGETING VECTORS OF DISPERSAL

The intentional or accidental introduction of invasive ("alien") species is a global problem with major implications for patterns of local biodiversity and ultimately the functioning of ecosystems. Over the last three years, the Marine Aliens team, led by Dr Elizabeth Cook has described the incidence of non-native marine species in coastal areas around the UK. In addition to revealing that the number of new sightings is rapidly increasing, we have described the impact of a subset of abundant and potentially damaging alien species on native flora and fauna. It has also become evident that once invasive species are established in the marine environment, attempting to control them is extremely labour intensive and costly and that the impact on non-target species can be significant. Targeting high risk entry points and eradicating any initial introduction, before its establishment and secondary spread are allowed to occur, are critical in safeguarding our native biodiversity from the impacts of invasive species.

The increase of maritime shipping, recreational boating, aquaculture activity and sales of imported live bait and aquarium specimens have led to an increase in introductions of invasive non-native species (NNS) throughout the world. Ballast water, hull fouling and aquaculture activity have been identified as high risk vectors for the introduction of invasive NNS in aquatic environments. To date, ballast water and intentional aquaculture imports have been the only vectors that have received serious international attention. The transport of invasive NNS on the hulls of commercial shipping, however, is set to become a serious issue with UK legislation to ban TBT in anti-fouling paints taking effect in 2008.

At SAMS, we have also been looking into the incidence of marine NNS in marinas and on recreational vessels. NNS have been found in 90% of the Scottish marinas surveyed, including the first Scottish sightings of the invasive bryozoan, *Tricellaria inopinata*. Over 40% of vessels surveyed were also found to support substantial biofouling on their hulls, including NNS. The research not only suggests that marinas are important refuges for NNS, but that recreational vessels may be important vectors in the secondary spread of invasive species. On-going research is now looking in detail at a range of marinas throughout the UK, to determine the environmental variables which support the greatest range of NNS. This will enable high risk marinas to be identified and a targeted, cost-effective monitoring and control programme to be developed.

Elizabeth Cook & Christine Beveridge

> Non-native species, such as the green alga *Codium fragile*, are common in the UK, both on artificial structures (above) and around our coasts.

MAPPING THE SPAWNING GROUNDS OF NORTH SEA COD

In 2008, the results were published from an international team led by Dr Clive Fox which surveyed the North Sea. Despite recent evidence for sub-stock structuring, North Sea cod are assessed as a single unit. As a consequence, knowledge of sub-stock trends is poor. In particular, there are no recent evaluations of which spawning grounds are active. This work focused on filling this gap with the first ichthyoplankton survey to cover the whole North Sea. In addition to traditional identification methods for larval fish and eggs, this was the first study to make extensive use of DNA-based molecular methods to unambiguously identify early developmental stage cod eggs.

We compared the findings from the plankton survey with estimated egg production inferred from the distribution of mature cod in contemporaneous trawl surveys. Results from both approaches were in general agreement and showed hot spots of egg production around the southern and eastern edges of the Dogger Bank, in the German Bight, the Moray Firth and to the east of the Shetlands. These areas broadly coincided with known spawning locations from the period 1940 to 1970. We were, however, unable to directly detect significant numbers of cod eggs at the historic spawning ground off Flamborough (northeast coast of England). The results demonstrate that most of the major spawning grounds of cod in the North Sea are still active but that some localized populations may have been reduced to the point where it is now difficult to detect the presence of eggs in the plankton.

Clive Fox

> The Gulf 7 plankton sampler is used for mapping the distribution of cod eggs in the North Sea. A variety of sensors are fitted to monitor fishing depth and gather environmental data. Flow meters allow calculation of the volume of seawater filtered by the net, enabling the density of fish eggs and larvae to be determined.

> Cod eggs at developmental stage 3

UNRAVELLING THE COMPLEXITIES OF ROCKY SHORE COMMUNITY PATTERNS

A UK-wide analysis of the patterns evident in rocky shore communities from data collected under the Oceans 2025 programme (along with MarClim and earlier work at SAMS) has shown that, aside from the strong effects of wave exposure, diverse communities of seaweeds occur in places where filter feeders (mussels and barnacles) are rare and *vice versa*. This trend coincides with gradients of phytoplankton concentration: seaweeds are more diverse where phytoplankton concentrations are low, with a much greater biomass of filter-feeding mussels and barnacles when levels of phytoplankton are high.

> Determining the causes of pattern in intertidal communities can be a complex process. This shore on the Isle of Colonsay shows elements that can result from a number of environmental drivers including wave exposure, biological interactions and geographical location.

The latter community is prevalent in enclosed bays and regionally enclosed seas such as the Clyde Sea, and scarce on open coasts and offshore islands. Our index of coastal openness, based on the area of open sea within a fixed distance of a point on the coast, successfully predicts seaweed diversity/filter-feeder biomass and coastal phytoplankton concentrations. These associations suggest that, while seaweeds and filter feeders may compete for space, coastal topography ultimately determines the makeup of coastal ecosystems. On open coasts, greater dispersal of planktonic larvae of filter feeders and nutrients for phytoplankton may result in fewer mussels and barnacles and more seaweeds. Predicting effects of global change on biodiversity can thus be really helped along by understanding the biology of the groups involved.

In addition to these broad-scale patterns, we have been trying to untangle the complexity of causal mechanisms in trophic interactions that structure ecosystems at a more local level. Inverse relationships between the number of grazers or predators and their plant or animal food is usually taken as evidence for 'top-down' control of food webs. Experimental removal of predators or grazers often increases the numbers or biomass of prey species. When these two lines of evidence are combined, the conclusion that the ecosystem is controlled from the top level of the food web seems rock solid. This has long been thought to be the case with the effects of grazing animals on rocky shores and in kelp forests, where abundant grazing limpets and sea urchins are thought to reduce or eliminate seaweeds and kelp. How the ecological mechanisms underlying these effects work, however, remains unknown. Using data from 210 rocky shores around the UK collected over the first two years of Oceans 2025, we have been able to show that models in which grazer sizes depend on plants (bottom-up effect on growth), and grazer numbers depend on their size (size-dependent competition), are much better explanations of the patterns than the established top-down view. The findings suggest that many more grazers persist in the absence of the seaweeds because they switch to microbial food, grow less, and as small individuals compete less with each other. Challenging extensive ecological datasets with alternative causal explanations, using a powerful approach called structural equation modeling, allows us to create models of how ecosystems work. We intend to apply this method to other systems (subtidal, soft sediment habitats) in the remainder of Oceans 2025. We are also testing the new hypothesis in manipulative field experiments designed to show the effects of plants on grazers.

Mike Burrows, Robin Harvey & Linda Robb

DEEP WATER FISHERIES

In April 2008 I was invited to participate in a Census of Marine Life MAR-ECO workshop held at the Institute of Marine Research, Flødevigen Laboratory, Norway. The objective was to analyse similarities and differences in the composition of the demersal fish fauna on continental slopes, seamounts and the mid-Atlantic Ridge. Throughout the year I continued as a consultant, providing input into the Ecopath model for the Esmee Fairbairn Deep-fish project, including participating in a workshop held at Plymouth University (cross reference with Sheila Heymans). I also collaborated with Professor Priede (Oceanlab, Aberdeen University), Dr Bailey (Glasgow University) and Dr Collins (British Antarctic Survey) on studies resulting from the combined database of pre-fishery SAMS/IOS data and post-fishery Aberdeen University data from the Porcupine Seabight, west of Ireland. It was shown that there was an overall decrease in fish abundance at depths from 800 to 2500 m, considerably deeper than the maximum depth of commercial fishing (approx. 1600 m). Changes in abundance were significantly larger in species whose ranges fell at least partly within fished depths and did not appear to be consistent with any natural factors such as changes in fluxes from the surface or the abundance of potential prey. If the observed decreases in abundance are due to fishing, then its effects now extend into the lower bathyal zone, resulting in declines in areas that hitherto have been thought to be unaffected. These studies are continuing to be a fertile source of publications in peer-reviewed journals and elsewhere. I continue to be a joint editor of Oceanography and Marine Biology: An Annual Review.

John DM Gordon
Honorary Research Fellow

OCEANOGRAPHY AND MARINE BIOLOGY: AN ANNUAL REVIEW

This publication has been associated with SAMS/SMBA since its founding by the late Harold Barnes at Millport in 1962 and my current principal activity is as Managing Editor. I am also engaged in preparing two joint-author manuscripts for publication, continue to referee submitted manuscripts for leading journals and I am becoming increasingly involved in assisting authors whose first language is not English to prepare papers for submission.

In 2008 I represented SAMS at the European Marine Biology Symposium in Ponta Delgada, Azores, as an invited Session Chairman.

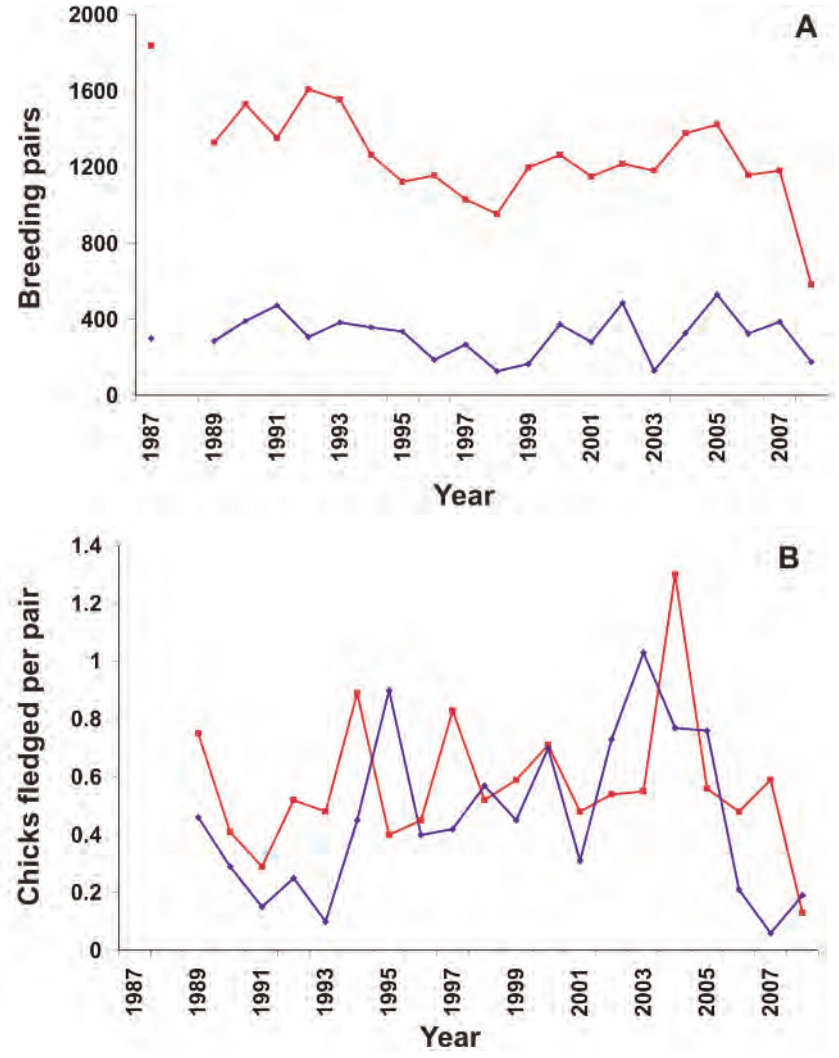
Robin N Gibson
Honorary Research Fellow

SEABIRD RESEARCH IN THE OBAN AREA

In parts of Scotland, particularly in Shetland and Orkney, some seabird species have had poor breeding success in many of the years since the mid-nineteen eighties, apparently because of shortages of small fishes such as sandeels and herring/sprat. Evidence from long term plankton monitoring by the Sir Alister Hardy Foundation for Plankton Research suggests that there has been a northward shift in the distribution of many species, associated with ocean warming, which may have knock-on effects on their predators such as sand eels. However, the west of Scotland has been unaffected until recently.

Since 1990, as part of the Mink-Seabird project, I have been monitoring numbers and breeding success of several seabird species in mainland sea lochs and sounds between Mallaig and West Loch Tarbert, including Loch Fyne.The breeding season of 2008 was the first in which terns experienced serious breeding problems, apparently caused by food shortage. This was particularly noticeable in Common Terns. Over the last twenty or so years, the numbers and distribution of both tern species in the study area have been severely affected by introduced American mink. Now, it seems, terns are experiencing an even more sinister anthropogenic threat. The numbers breeding in the study area in 2008 were the lowest on record. Their productivity (chicks fledged per breeding pair) was unusually low throughout the study area, but conditions appeared most severe between Ballachulish and Loch Feochan. Here, many of the clutches consisted of only one egg instead of the usual three or two, and most chicks died a day or two after hatching. North and south of this section of coast, clutches were normal but productivity was just as poor. Arctic Terns were affected in much the same way.

Terns are elegant and beautiful seabirds with a high conservation value. The Arctic Tern is famous for its remarkable annual migration, the longest of any bird species, almost literally from pole to pole. Northern Britain lies at the southern limit of its Arctic and circumpolar breeding range. In late summer, after breeding, Arctic Terns set off for the Antarctic pack-ice, where they spend the southern summer moulting and feeding on the abundant krill. In March they migrate north again to arrive in Scottish sealochs in May, and eggs are laid in June. The young fly in July and almost immediately set off south with the adults. An Arctic Tern that I ringed as a chick on the Abbot Islands in Loch Etive in July 1982 was found freshly dead at a colony in Loch Melfort in August 2006. It had made the trip to Antarctica and back 24 times – possibly more than even the most long-serving member of the British Antarctic Survey! It would be sad to lose these iconic seabirds from our local waters.



> Records since 1987 show that compared with the 'normal' annual variability in the two tern species, there has been a sharp decline recently in breeding pairs of Common Tern (A) and in productivity in both species (B). Red line: Common Tern, blue line: Arctic Tern.

JCA Craik

Honorary Research Fellow

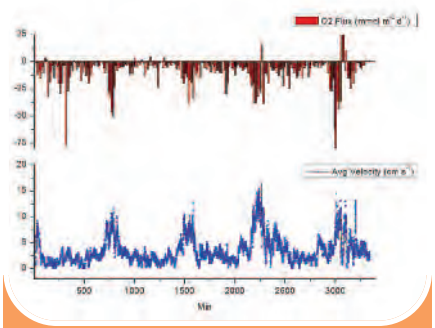
Biogeochemistry and Earth Sciences Department

BENTHIC LANDER DEVELOPMENT

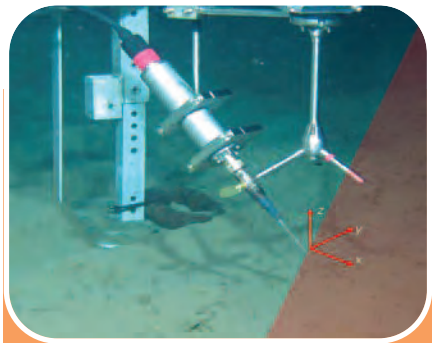
Andrew Hume deploying the Eddy lander in Loch Etive

The lander group has been involved in a number of field campaigns and research activities during the past year, including 2 field campaigns on Greenland, an O2025 cruise on the RRS James Clark Ross to the north of Svalbard and another O2025 cruise to the Celtic Sea. Furthermore, a number of local field campaigns have been undertaken during the year both in Loch Etive and Dunstaffnage Bay. The measurement of oxygen fluxes at and near the seabed continues to be a major objective of the group.

One focus of our research has been the new Eddy correlation lander (SOFI funded), which is a novel technique capable of obtaining benthic oxygen fluxes over large surface areas (~100m^2) by making high frequency measurements of the vertical current velocity and the oxygen concentration at a given point just above the sea-bed. The efforts are closely coordinated with international collaborators: Dr Peter Berg (University of Virginia, US) and Dr Dan McGinnis (Geomar, D). This non-invasive technique has opened up the possibility of *in situ* measurements of benthic oxygen fluxes on substrates (*e.g.* sandy sediments, hard bottoms, sea-grass meadows) that are difficult to sample with conventional techniques such as enclosed chambers. The Eddy lander was successfully deployed in conjunction with the conventional SAMS landers (Chamber and Profiler) in soft bottom sediments densely populated by the brittlestar *Amphiura sp.* in Loch Etive. A significant temporal variability in the benthic oxygen flux was recorded correlating with the horizontal current velocity. The Eddy lander has also been used off Greenland where it was successfully deployed on hard bottom substrates, including a vertical wall, where for the first time, it measured benthic oxygen fluxes on varying types of epifauna under both light and dark conditions. A seasonal study of a shallow and photosynthetically active sediment in Dunstaffnage Bay also commenced in the spring of 2009 simultaneously deploying the three SAMS landers at monthly intervals.



> The benthic O_2 flux (15min bursts) and corresponding horizontal current velocity measured by the Eddy lander.



> The ADV current meter and the O_2 microelectrode on the Eddy lander, recording the O_2 flux just above the sediment in Sagami Bay (Japan).

In addition to studies in coastal waters, we have completed and published results from our work in the deep margin sediments of Sagami Bay, Japan. Three papers focus on benthic oxygen and nitrogen dynamics with special emphasis on microscale heterogeneity and patchiness of these parameters in the sediment and its implications for total carbon and nutrient turnover rates.

Henrik Stahl & Ronnie Glud

THE TOPODEEP PROJECT: IMPACT OF THE GEOMETRY OF SUBMARINE LANDSCAPES ON DEEP-SEA BIOGEOCHEMISTRY

Production of organic carbon by phytoplankton in the surface ocean, followed by transport of some of this organic carbon on sinking particulate matter from the surface ocean into underlying sediments, extracts carbon dioxide from and injects oxygen into the atmosphere. For long geological time scales of thousands up to hundreds of millions of years it is believed that changes in the magnitude of organic-carbon deposition in deep-sea sediments can influence the chemical composition of the atmosphere. Organic-carbon burial in deep-sea sediments must, therefore, be one of the key processes of the 'life-supporting system' on Earth. Consequently, an understanding of the mechanisms controlling the flux of carbon from the oceanic water column into underlying sediments and the burial of carbon in the sediments is of crucial importance.

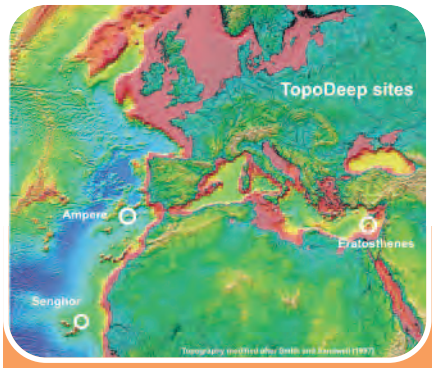
A number of possible controls on these carbon fluxes into deep-sea sediments have been studied. However, to date the impact of submarine landscape geometry has received virtually no attention. This is despite comprehensive and pervasive submarine landscape changes that must have occurred as a result of the rearrangements of continents and oceanic crust during the last hundreds of millions of years. Mid-ocean ridges, but also to some degree abyssal plains, are structured by submarine hills and mountains. Such kilometre-scale seafloor elevations are a major source of environmental variability in the deep sea. In addition to their mere presence, the interaction of the elevations with quasi-steady background (residual) and tidal flow introduces complexity in the environment. This enhanced complexity is expected to influence a range of environmental parameters and processes, including larval dispersal of deep-sea organisms, biodiversity (an important potential indirect control on sediment biogeochemistry), the absolute magnitude of sedimentary carbon burial, and the relative proportions of organic carbon being remineralised in deep-ocean waters and surface sediments versus organic carbon being buried in deeper sediments.

To start shedding light on these grossly understudied aspects of deep-ocean biogeochemistry we initiated the NERC-funded project TopoDeep (Impact of the Geometry of Submarine Landscapes on Deep-Sea Biogeochemistry). This project will elucidate for the first time the link between three fundamental aspects of kilometre-scale flow/topography interactions and organic-carbon dynamics in the deep ocean:

(1) The influence of the presence of a seamount on the transport of organic carbon through the water column and its fate in deep-sea sediments. (2) The impact of geographical latitude: quasi-steady background flow interacts with the seamount, with the shape of the resulting flow field depending on the impact of the Earth's rotation which, in turn, depends on the geographical latitude of the seamount. Are there latitudinal differences in the impact of topographically controlled flow fields on carbon dynamics? (3) The impact of tides: tidal current velocities vary spatially in the deep sea and may have varied temporally over ice age cycles, thereby introducing spatiotemporal variability in the magnitude of tidal impact. How do different tidal forcings influence carbon dynamics at kilometre-scale seafloor elevations?

We will elucidate these three problems by comparing seamounts of similar dimensions which differ in terms of their geographical latitude and tidal forcing: In the Northeast Atlantic the Senghor Seamount at 17°N and the Ampere Seamount at 35°N have similar open-ocean tidal forcing and can be compared in terms of the impact of the geographical latitude; the Ampere Seamount at 35°N and the Eratosthenes Seamount in the Eastern Mediterranean at 33.5°N are at similar geographical latitude and can be compared in terms of tidal forcing, with the tides in the Eastern Mediterranean being much weaker than the tides in the Northeast Atlantic.

The main anticipated achievement of this project is a much advanced understanding of the fundamental controls of seafloor geometry on deep-sea biogeochemistry and biodiversity.



> Locations of the three seamounts to be studied during the TopoDeep project.

Robert Turnewitsch, Andrew Dale, Ronnie Glud, Bhavani Narayanaswamy, Henrik Stahl, Tim Brand, Anni Glud, Peter Lamont, and John Montgomery

Independent Investigations into Deep Sea Mine Tailings in Papua New Guinea

> Sediment cores taken offshore from Lihir Gold Mine

> Open cast pit at Lihir Gold Mine

The world's populations will always need mineral resources and environmental issues associated with their extraction are expected to gain importance throughout the world. The challenge, therefore, is to develop the best mining practices and technologies while minimising the environmental impact of mining operations.

Waste disposal is an important issue that requires consideration and deep sea disposal of mine tailings remains a controversial option.

SAMS is currently investigating the disposal of mine waste in the deep ocean for the Papua New Guinea Government. This project is part of the Mining Sector Support Programme (MSSP) and is funded by the PNG Government via EU 8th EDF funding.

The Mining Sector Support Programme's (MSSP) overall objectives are to sustain the country's economic performance through mineral production and exports and to alleviate poverty, increase employment opportunities and mitigate mine-induced environmental impacts.

The main aim of the project is to investigate the effects of the discharge of mine tailings into the oceans and provide the PNG government with guidelines on the placement of tailings. Within the study we are investigating three sites, Lihir Gold mine located on Lihir Island which is operational, Misima Gold mine located on Misima Island which stopped discharging tailings five years ago, and finally a site at Basamuk which is a proposed tailings discharge site for Ramu Nickel mine.

A review of all data available for both Lihir and Misima mines was completed in August, 2007 and a cruise to the Solomon Sea and Milne Bay, southwestern Pacific was carried out from October to December, 2007. During the 7 week cruise, the first ever photographs of both Lihir and Misima sea beds were obtained along with the first undisturbed sediment cores from both sites. The data obtained during the cruise and from analysed samples has provided information on which the guidelines will be based. These sediment cores have provided the first geochemical and biological data in this region. During September and October 2008 a baseline survey of Basamuk Bay was completed and the samples are being analysed at SAMS laboratories to determine the environmental status of the area before any ore processing begins.

As part of the project and international conference was organised and held by SAMS in Madang, PNG. The conference attendees comprised of scientists, government officials, NGO's , mining operators and landowners who all came together to discuss the issues associated with deep sea mine tailing placement. There was robust discussion of the practice and the initial results from SAMS investigations were presented. In addition the draft guidelines were presented to the audience and an open forum was held to allow discussion and input to the guidelines by all parties.

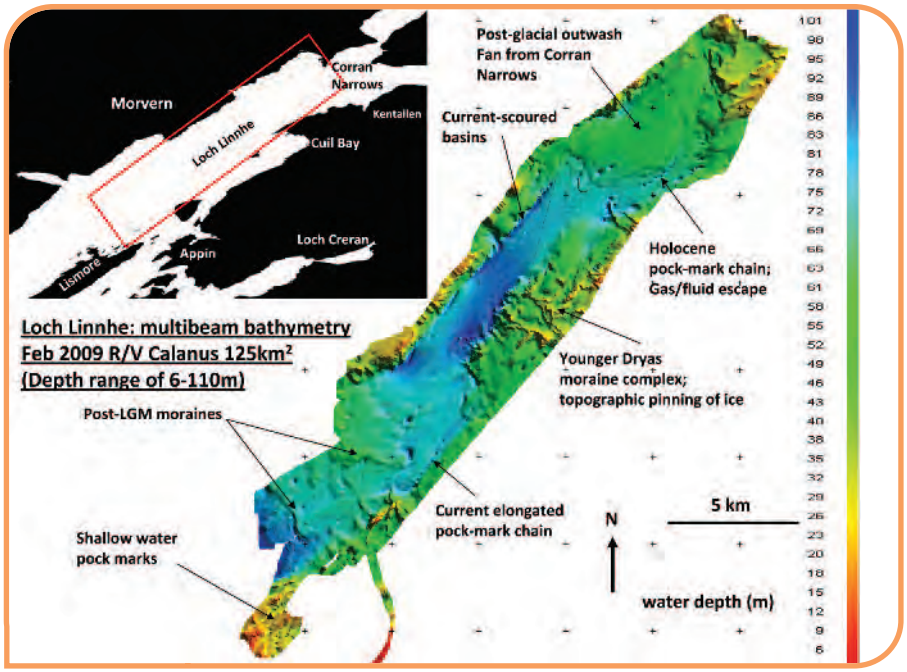
The knowledge SAMS has gained will help inform Papua New Guinea on how to manage mine waste that is produced and protect its marine environment.

Tracy Shimmield

> Location of three sampling sites, Lihir Gold Mine (operational), Misima Mine (closed) and Ramu (pre-operational)

SCOTLAND'S SUBMARINE LANDSCAPE – HUNTING FOR THE LAST BRITISH ICE SHEET

Scotland has been subject to repeated glaciations over the past two million years – the evidence is all around in the wild and rugged landscape; the ice-carved glens and dramatic sea lochs. However, the 'landscape' beneath the sea is now also beginning to reveal further clues as to the limits and dynamics of the British Ice Sheet.



Investigations are underway with project partners the British Geological Survey and the University of St Andrews to re-evaluate the extent and effect of the last northern ice cap to have occurred in the UK. The ice cap existed in Scotland during a cold period termed the Younger Dryas. The cause of this rapid cooling at the end of the last glaciation may have been a temporary slowing of ocean circulation or even perhaps a meteorite impact in North America leading to a decrease in global temperature. Such short, cool climatic events are termed stadials; the Younger Dryas stadial occurred 12,800-11,500 years ago – very recently geologically! During this time a large ice cap was present over much of western Scotland. Modelling studies and onshore fieldwork across western Scotland have established the assumed limits of the ice cap. With the advent of more advanced geophysical techniques, the offshore marine record is now being examined. Studying the marine environment has many advantages to the onshore – the main one being its ability to preserve ancient climates, either in the seabed morphology or by accumulating layers of sediments. This work is being funded by NERC under the auspices of Oceans 2025, themes 3 and 1.

Kate McIntyre, a NERC-funded PhD student at SAMS, is presently examining sediment records, and mapping the offshore limits of the Younger Dryas through the collection and interpretation of multibeam sonar. Multibeam systems use multiple beams of sound directed at the seabed to build an accurate acoustic map of the underlying bathymetry. The SAMS multibeam system is a RESON Seabat 8124, bought with funding from NERC through the Oceans 2025 programme and deployed from the SAMS research vessel RV *Calanus*.

Fjords are glacially eroded features which act as outlet conduits for glaciers draining seaward from the main ice cap, and are hence likely to preserve moraines within their basins which can be identified by multibeam mapping. Loch Linnhe is the southwesterly end of the Great Glen Fault which cuts across Scotland to the Moray Firth on the east coast. During past ice ages, Loch Linnhe was a major outlet for glaciers from the Rannoch Moor area where ice built up in the initial stages of development. Moraines identified by the recent multibeam survey of Loch Linnhe suggest that the Younger Dryas glacier may have advanced significantly further down the loch than the limit previously proposed from onshore field mapping. Further evidence for a more southerly limit is contained in glacially overridden sediments identified in a marine core south of the onshore moraine. The glacier appears to have retreated in several stages, each being marked by a recessional moraine deposited during a standstill or minor readvance of the glacial front, with a period of uninterrupted retreat occurring. This stepped pattern of retreat has also been observed in the Summer Isles region in northwest Scotland, which was the subject of a multibeam survey by the British Geological Survey in 2005, revealing a similar pattern of recessional moraines preserved on the seabed. As well as adding to our knowledge of the glacial history of NW Scotland, the use of multibeam bathymetry here revealed details of glacial and postglacial slope instability in Scottish sea lochs. Data gathered in Little Loch Broom reveal a series of submarine landslides that have occurred between the Younger Dryas stadial and the present. The high-resolution seabed images show slide scars on the flanks of the loch, debris lobes, steep canyons, and pockmarks from shallow gas and fluids escaping from overpressured muds in the glacially overdeepened basins.

At present there is considerable debate over the extent and timing of the short-lived Younger Dryas event. The big question that is vexing glaciologists is whether or not the ice cap grew from nothing after the disintegration of the ice sheet at the end of the last ice age. Numerical models predict that it could have done – but this disagrees with the physical evidence, which shows the glens and sea lochs of western Scotland being filled with glaciers to some extent even during the warm climates. Further surveys are needed to answer this question, both inshore in the fjords and offshore to determine the extent, timing and ultimate disintegration of the last British Ice Sheet.

John Howe & Kate McIntyre

Microbial and Molecular Biology Department

ALGAL DEFENSES AGAINST DISEASE: NOT ALL ALGAE ARE EQUAL

We use the interaction between the filamentous brown alga *Ectocarpus siliculosus* and its fungal pathogen *Eurychasma dicksonii* as a model to study all aspects of algal diseases, ranging from ecological questions down to the molecular mechanisms of infection or resistance against disease. This year has seen significant progress in the development of an extensive array of molecular tools. Our system is now well established, and our efforts towards the molecular characterization of algal defense reactions are beginning to bear fruit.

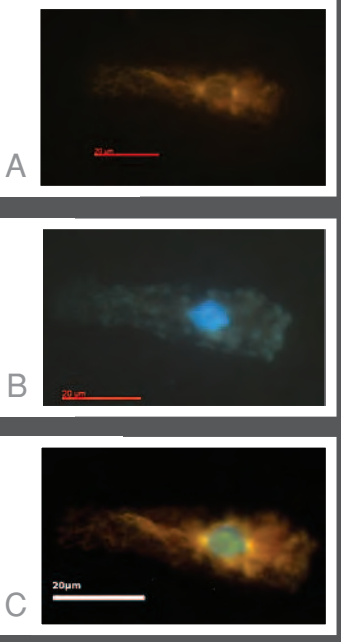
We have developed and now operate routinely a real-time PCR assay for the detection and accurate quantification of *Eurychasma dicksonii* in various brown algae. This has enabled us to confirm the worldwide occurrence of this parasite. Also, we found that different algal strains exhibit different levels of resistance against *Eurychasma*, ranging from high susceptibility to the complete absence of symptoms. This observation provides a strong and original new line of evidence in support of a genetic determinism for disease resistance in brown algae, a result with far-reaching fundamental implications. This result is also critical for underpinning our characterization of algal defense reaction; we can now compare disease-susceptible and resistant algal strains, and correlate their phenotype with minute differences in their protein or metabolite changes. Thus, our model constitutes a powerful and unrivalled basis for the identification of defense effectors in marine algae.

In parallel, we reported a new method for the production of axenic algal cultures from field samples, developed a range of in situ labeling microscopy techniques, as well as 2-dimensional protein electrophoresis. We are now applying this range of techniques to assess Eurychasma abundance and prevalence in the field as part of Oceans2025, and to address the molecular mechanisms of algal defense.

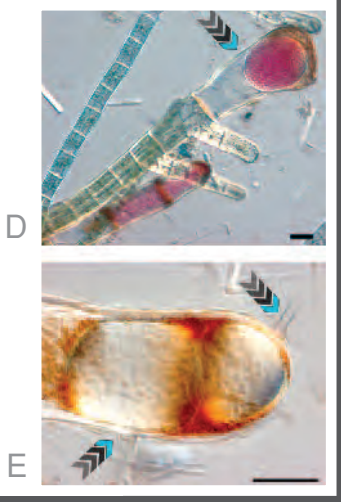
As part of her PhD, Martina Strittmatter carried out 6-week field sampling in the island of Lesvos, Greece, in collaboration with Dr M. Karadaneli, probing the biodiversity of seaweed pathogens. For all of the four different parasites found, Martina's findings constitute the first record of these species (including *Eurychasma dicksonii*, for the Eastern Mediterranean sea, or even the Northern Hemisphere. At least one them constitutes a new species, which is currently being characterized.

Ectocarpus siliculosus is the first, and so far only, fully sequenced seaweed. We have been involved in this international effort since it began in 2004. Last year we hosted the Ectocarpus 2008 meeting in Oban, along with a 2-day genome annotation workshop. The project is now reaching its final stage, but we will continue to mine this information for clues about algal defense reactions. Claire Gachon is also contributing to the genome annotation of *Pythium ultimum*, a devastating crop pathogen related to *Eurychasma dicksonii* in collaboration with Dr R. Buell, Michigan State University, USA.

Claire Gachon, Martina Strittmatter & Frithjof Küpper



Caption: A-C. Immunofluorescence labeling of brown algae. The cytoskeleton is labeled in red (A) with an antibody targeted against b-tubulin. The nucleus was stained in blue with DAPI (B). Combined staining appears as in C. This very generic technique can be further applied to detect and localise any protein in the cell using specific antibodies.



Caption: D. The unknown species illustrated here (arrow) resides in the apical cells of the filamentous brown alga *Sphacelaria sp.*

E. Empty sporangia exhibit typical exit tubes (arrows) through which mature parasitic spores have emerged. Scale bar: 50 µm.

MODELLING THE ARCTIC PELAGIC FOOD WEB

The Arctic seas are expected to experience significant change as global air and sea temperatures increase over the coming decades. Summer conditions are expected to change sharply in the near future in this area, so our focus has been on understanding which particular physical processes play a major role in summertime plankton production. A plankton ecosystem model schematizing the two key food webs operating; herbivorous (diatoms, large zooplankton, sinking detritus) and microbial (flagellates, small zooplankton, dissolved detritus) has been coupled to an ocean-sea ice model (developed at the Proudman Oceanographic Laboratory, Liverpool) to explore how the ocean physics (*e.g.* currents, mixing, sea ice) mediates biological productivity in the Barents Sea in the eastern Arctic. This modelling approach has been reinforced by using a set of uniquely matched in situ measurements (temperature, volume flux transport) and remotely sensed data (sea ice cover and thickness, temperature, chlorophyll and primary production) to assess how well the model predicts *in situ* conditions. In the past, such work has been hampered by a lack of basic data, but initiatives such as the International Polar Year have improved the situation with respect to the spatial and temporal model resolution.

Vincent Le Fouest (SAMS) with Miguel Angel Morales-Maqueda and Clare Postlethwaite (Proudman Oceanographic Lab) Maria Lorena Longhi and Simon Belanger (Canada), and Marcel Babin (France)

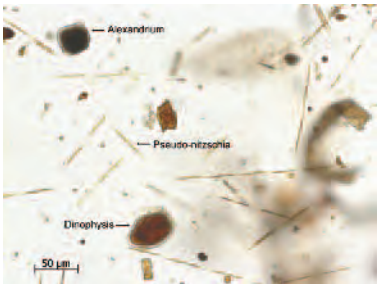
MONITORING FOR TOXIC ALGAE IN SCOTTISH SHELLFISH PRODUCTION AREAS

In order to comply with EC regulation No. 854/2004 and amendments, there is a requirement for EU member states to monitor both the presence and geographic distribution of marine biotoxin-producing phytoplankton in shellfish harvesting areas on a regular basis. The regulation is directly applicable and in Scotland, phytoplankton monitoring has been carried out by SAMS, on behalf of the Food Standards Agency Scotland (FSAS) Food Law Enforcement Branch, since September 2005.

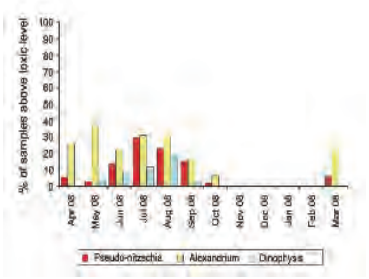
The vast majority of phytoplankton are benign, but under certain conditions, a few species produce toxins, some of which can accumulate in the tissue and organs of filter-feeding shellfish. Although the shellfish themselves may not be visibly affected, the concentration of the toxin could mean that humans or other mammals ingesting these shellfish will suffer subsequent ill health. However, by regulating harvesting on the basis of monitored shellfish biotoxins and phytoplankton abundance, incidences of shellfish poisoning from commercially produced shellfish are very rare in the UK.

Eight genera or species of phytoplankton, currently thought to be of greatest threat to the shellfish industry, are routinely monitored at 36 sites in Scottish coastal waters. Water samples are collected on a weekly basis from these sites over the summer months and returned to SAMS for microscope identification and enumeration of the harmful phytoplankton. The organisms of most concern are the diatom *Pseudo-nitzschia*, and the dinoflagellates *Alexandrium* and *Dinophysis*, which can produce amnesic, paralytic and diarrhetic shellfish poisoning toxins, respectively. This work has shown that the incidence of toxic algae and the species involved vary considerably from area to area and from year to year, indicating the need for continued monitoring. In addition, the 2008-9 data suggest that toxic algae were present in one or more areas at levels that might be harmful to humans for eight months of the year.

Keith Davidson & Sarah Swan



> Potentially toxic species in a July sample obtained from Shetland. The *Pseudo-nitzschia* bloom was at a density of over 2 million cells per litre.



> The frequency of appearance above regulatory threshold concentration of the main potentially harmful organisms in Scottish waters by month. Note that shellfish poisoning due to biotoxins is a potential threat for at least eight months of the year.

HARMFUL ALGAL BLOOMS

> The dinoflagellate *Dinophysis acuminata* is responsible for diuretic shellfish poisoning.

A 'Harmful Algal Bloom' (HAB) is a way of referring to a variety of phenomena involving the actual or potentially harmful effects of marine micro-algae on human health or on the marine ecosystem goods and services used by humans. Examples include the potential poisoning of humans by way of shellfish that accumulate algal toxins, now largely prevented by FSA monitoring of phytoplankton and shellfish, and the occurrence of Red Tides, some of which have killed farmed fish or smothered sea-bed invertebrates. A number of scientific papers published during the last two decades have argued that: (1) there has been a global increase in the number of HABs; and that (2) anthropogenic nutrient enrichment of coastal waters is an important contributing factor. Furthermore, there has been a move to use (3) the occurrence of HABs as evidence of the broader phenomenon of eutrophication, defined by the EC and OSPAR as "the enrichment of water by nutrients causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned".

The evidence for (1), (2) and (3) is equivocal; may be stronger for some types of HABs and coastal waters than for others, and is often assessed with the aid of implicit assumptions about nutrients and micro-algal growth. SAMS has been involved in a study funded by DEFRA to examine the arguments and evidence relating to HABs and nutrient enrichment and to determine if the occurrence of HABs, or of the species causing them, could be used as an indicator of eutrophic conditions. The objectives of the project were to: (i) review a representative selection of the scientific literature on the putative link between the occurrence and magnitude of HABs and the anthropogenic nutrient enrichment of coastal waters; and (ii) investigate the relationship between nutrients and the abundance of species giving rise to HABs by statistical analysis of data sets from coastal waters of the UK and the Republic of Ireland.

It was concluded that it is important to distinguish two potential causal relationships - (i) between nutrient enrichment and HABs, and (ii) between nutrient enrichment and eutrophication, despite their possible overlap. There is no doubt that excessive addition of anthropogenic nutrients results in the undesirable disturbances associated with eutrophication, unless light-limitation prevents increased production of algal biomass or unless strong dispersion removes nutrients or phytoplankton. But HABs are discrete events and as such distinct from a more general increase in biomass and production. HABs occur naturally, so the occurrence of a HAB is not, in itself, an indicator of eutrophication. Furthermore, increases in biomass, and changes in the 'balance of organisms' can occur without an increase in HABs. However, an increase in HABs linked to anthropogenic nutrient enrichment in a specified water body would in our view help to diagnose eutrophication.

Our literature review shows that there is no scientific consensus regarding the stimulation of HABs by anthropogenic nutrients. Attempts to verify arguments about global trends in the occurrence of HABs, or to relate these to nutrient enrichment, are confounded by several factors. These include: spatial and temporal variability in naturally occurring HABs; human mediated transport of HAB species between coastal regions; increases in monitoring effort and the reporting of HABs; and, the influence of natural climate change, such as that due to the North Atlantic Oscillation or the El Niño Southern Oscillation.

We distinguished two main kinds of HABs: those involving large biomasses of micro-algae and hence visible as Red Tides or sea-foaming; and those involving smaller biomasses of toxin producing algae (TPA). For large biomass HABs, the nutrient enrichment - HAB hypothesis was supported by observations in some of the water bodies we reviewed, including the 50 km^2 Tolo Harbour (Hong Kong) and the 21,827 km^2 Seto Inland Sea of Japan. It was not supported by evidence from other water bodies with similar spatial scales. There is evidence from a few sites, such as Puget Sound in North America, for nutrient enrichment having brought about an increase in low biomass HABs of TPA. We conclude that there is no universal explanation for changes in the frequency of HABs; instead, we hypothesize that their occurrence is the result of interactions between changes in specific pressures (including nutrient enrichment), the ecohydrodynamic conditions in particular water bodies, and the biology of particular harmful algal species or life-forms. So far as hydrodynamics are concerned, it is likely that the risk of HABs decreases with increasing strength of vertical mixing and horizontal dispersion. High-latitude waters seem less at risk: it is unclear if this is because they are colder or because their phytoplankton growth season is shorter than is the case for tropical and subtropical waters.

We compiled data sets from coastal waters of the UK and the Republic of Ireland in order to test the hypothesis that HAB species abundance increases with anthropogenic nutrient enrichment. Monitoring data on the abundance of the main harmful algae were grouped into coastal area to match two sets of nutrient variables, the annual river plus direct discharges of nutrients, and the mean winter concentrations, which were used as proxies for nutrient enrichment for each area. The results of the statistical analysis were complex but led us to conclude that the UK and Irish data did not support the nutrient enrichment – HAB hypothesis.

Distinct patterns were evident in the distribution of some HAB species in UK and Irish waters, the most obvious being greater abundance of several HAB species (*Alexandrium spp., Dinophysis spp., Karenia mikimotoi*) in waters to the south west of England, west of Ireland, and west and north of Scotland. We think that the patterns can mostly be explained by the hypothesis that they result from the intersection between the ecophysiology of individual phytoplankters and the ecohydrodynamic conditions in the water bodies in which they live, together with the effects of the Irish and Scottish coastal currents in transporting populations along the coast.

We conclude that the occurrence of HABs and the abundance of HAB species should not be used to diagnose eutrophication in UK waters, unless a link to anthropogenic nutrient enrichment can be demonstrated. Furthermore, evidence of a link in one coastal region should not be taken as evidence of a general linkage in other coastal regions.

Paul Tett (Napier University) & Keith Davidson (SAMS)

BIOFUELS: COULD MARINE ALGAE BE THE SUSTAINABLE ALTERNATIVE?

With the European Parliament's Industry Committee calling for 10% of road transport fuel consumption to come from renewable sources by 2020, pressure is on to find viable biofuel alternatives to petroleum products.

90% of the world's biofuel production is currently bioethanol. Made largely from sugar cane and maize, it is used as a petrol additive. The remaining 10% of biofuel comes from plant oils such as rapeseed, soya and palm and is turned into biodiesel. These "first generation" biofuels or agri-fuels are a long way from meeting the world's need for energy security and reduction in CO_2 emissions. They are seen as environmentally damaging and in addition raise concerns over food security, as it is estimated that 10% of the planet's arable land would be required to meet current world motor fuel energy requirements.

The oceans cover more than 70% of the world's surface and the sea is relatively underutilised for food production as compared with the land and is often more productive on the basis of carbon "fixed" and sunlight energy utilised. It offers the largest area for mass cultivation of biomass; there is less competition for its use and yet it is usually excluded from debates about sources of biomass.

A new UK and Irish joint project, lead by SAMS, plans to investigate the practicalities and underlying methodologies required to utilise algal biomass as a competitive, sustainable biofuel source. The Sustainable Fuels from Marine Biomass or BioMara project aims to demonstrate the feasibility and viability of producing third generation biofuels from marine biomass, using both macroalgal (seaweeds) and microalgal (single celled plants) sources as an alternative to agri-fuels production from terrestrial plants. Its goal is to provide the region with an economically and environmentally sustainable local renewable fuel source, whilst helping to service local public transport infrastructure and build on the region's technology-base. Development of mari-fuels can also help to support traditional ways of life in remoter communities by providing locally produced, relatively cheap, low-impact fuel.

BioMara

This €6 million collaborative research project between Scottish and Irish researchers is coordinated by Dr Michele Stanley from SAMS and is funded through Interreg IV A, Highland and Islands Enterprise, the Crown Estate, the Department of Enterprise, Trade and Investment for Northern Ireland and the Department of Communications, Energy and Natural Resources in the Republic of Ireland. Partners involved with the project come from Fraser of Allander Institute the University of Strathclyde; Questor Centre Queen's University, Belfast; the University of Ulster; the Centre for Renewable Energy at Dundalk Institute of Technology; and the Institute of Technology, Sligo.

Michele Stanley

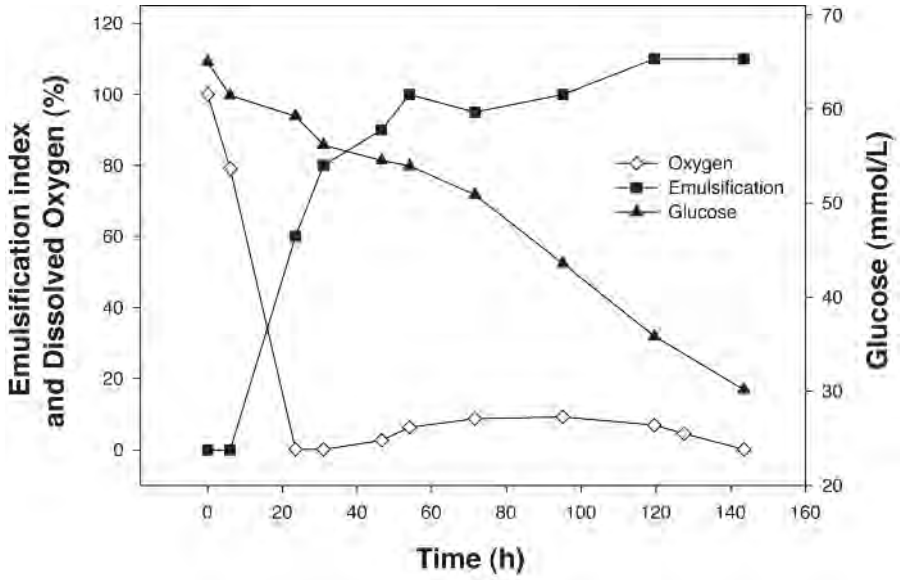
BIO-EMULSIFIERS

An increasingly health-aware populace, concerns about genetically modified foods and food ingredients, and the ever increasing price of petroleum products, are some of the market drivers behind commercial interests in natural surface-active biopolymers produced by microbes. Since 2003, SAMS has been actively involved in identifying new and novel organisms that produce bio-emulsilfiers as potential ingredients in food and healthcare products.

2008 saw the conclusion of a 1 year NERC-funded Follow-on Fund grant to overcome the perennial problem facing all producers of natural products: to be able to produce lots of material, and keep the cost low. Our focus was to optimise the feed and physical parameters that govern when and how much bio-emulsifier our microbes produced, and to scale this up to 5 to 10 litre batch cultures. While production scale-up was successful, increased yields were a modest 3-fold increase for our most promising bio-emulsifier. A number of promising leads were identified that should enable us to improve this further.

This is not the end for bio-emulsifiers and biopolymers at SAMS. Our mission now is to explore new marine environments for more and varied microbes. Armed with our in-house screening and production knowledge, we should be able to develop novel bio-emulsifiers which will be just as good, but cheaper to produce, than our current candidates and thus have a greater chance to make it to market.

David Green & Tony Gutierrez



> Time course of the batch production of a bio-emulsifier. This graph shows the characteristic oxygen depletion coinciding with bio-emulsifier production from the producer strain TG39.

ALGAL SULPHUR AND THE CLIMATE

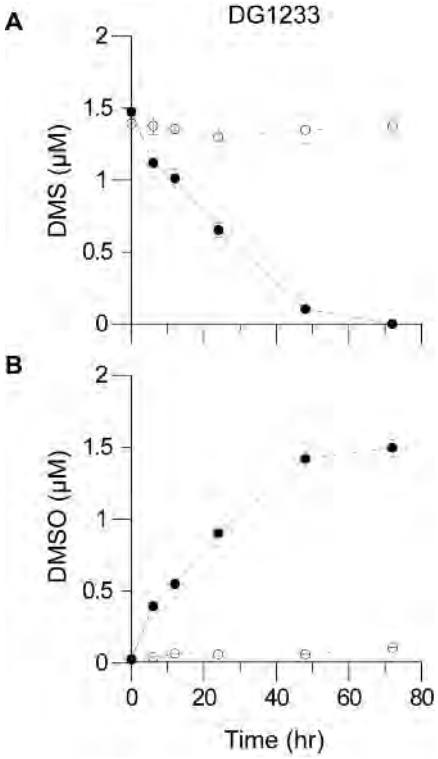
We understand that algae growing in the sea are the beginning of the marine food-web, as plants are on land. Less well known is that they also produce gaseous sulphur molecules such as dimethyl sulphide (DMS) that find their way into the atmosphere where they help form clouds. Climatically, cloud formation over the oceans is important because it helps keep the Earth from over-heating. Therefore, algae are valuable friends to all life on Earth.

How DMS is produced, however, remains poorly understood, and the role of sulphur is not well integrated into global climate models. A team of SAMS biogeochemists and microbiologists received funding from the NERC's SOLAS programme to investigate the relationship between DMS, algae and the bacterial community around them.

The project focused on the idea that algae not only produce the sulphur compounds that bacteria break down to form DMS, but also control bacterial activity through sugars they excrete. We thus reasoned that a tight temporal and even spatial coupling between algal sulphur production and bacterial break down of these compounds was likely. We set about understanding how bacteria metabolise sulphur compounds, and then examined the cycling and turnover of sulphur in a simple model system. This work has reinforced that we do not know why algae produce these sulphur compounds, and this is important if we are to understand how algae will be affected by climate change. Our work also demonstrates that many bacteria produce energy from DMS. This means that less DMS could go to the atmosphere, but this 'loss' process is controlled by the amount of available energy.

Overall, we have made a number of steps toward a greater fundamental understanding of the biological production and losses of DMS in the ocean. We have also generated a set of solid hypotheses that can help account for the variability of DMS in the oceans. This is good news for building the oceanic sulphur cycle into global climate models, because these models need to accurately predict the DMS concentration in the ocean, to know how much will end up in the atmosphere and how this will influence Earth's climate.

Angela Hatton, Mark Hart and David Green



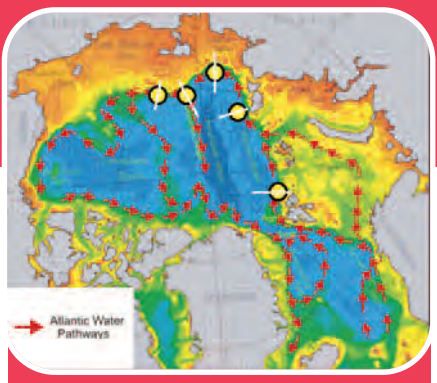
> The effect of glucose ('energy source') on the oxidation of DMS by a marine bacterium–where no energy is available, no DMS oxidation occurs. Time course experiment for (A) DMS loss and (B) DMSO production (the product of DMS oxidation) by the bacterium DG1233. Filled circles (●), glucose added; open circles (O), no glucose added.

Physics, Sea Ice and Technology Department

ARCTIC OCEANOGRAPHY

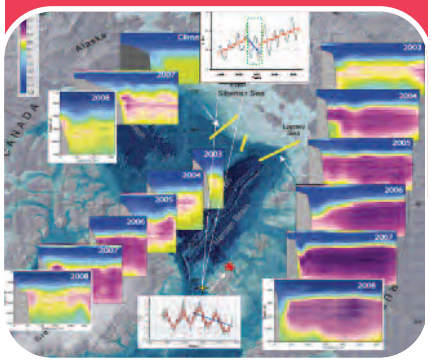
In the past year, established techniques and new developments in technology have been used to sample ocean processes in the Arctic. Vertical mixing and its role in modifying heat flux to the underside of sea ice is an essential parameter. During the past year, we developed and tested the Autonomous Microstructure Profiler (AMP) for deployment beneath sea-ice in the Arctic Ocean. The AMP combines a microstructure sensor package with a buoyancy-driven profiler that is widely-used in the global Argo network of floats. This novel instrument was destined to be deployed beneath Arctic sea-ice north of Greenland in April 2009 to obtain a series of profiles of turbulent mixing and heat flux from the depth of the warm Atlantic water layer to the bottom of the sea-ice. Efforts were ultimately thwarted by adverse ice conditions that forced the early evacuation of the ice camp.

Traditional autonomous mooring technologies and CTD transects were used within the Nansen and Amundsen Basin Observational System (NABOS) program. NABOS has operated since 2002 and is an international collaborative program with an overall goal to improve observations and understanding of the influence of warm Atlantic water (AW) inflows on the Arctic climate. Field studies in 2007 and 2008 were supported by NERC through close partnership between NABOS and the UK ASBO project. NABOS observations in 2008 revealed climatically-important features of AW, which were poorly understood before, including (i) unprecedented warming in the AW layer since 2000 – its routes and development; (ii) seasonal oscillations in the AW layer deep in the Arctic Ocean; (iii) heat and salt exchange between AW and overlying waters. The project will continue through to summer 2009.



> NABOS moorings (yellow circles) and CTD sections (white lines) in the Arctic Ocean.

> Chronology of AW warming in 2000s: water temperature at cross-slope sections and time series at long-term moorings. Mooring-based observations in Fram Strait (yellow star) were carried out by Alfred Wegener Institute in the framework of DAMOCLES and other EU and German national projects.



Inshore, the role of fjords is becoming increasingly more relevant as the links between oceans and glaciers come to prominence. In the last year we have continued collaborations with Norwegian researchers to understand what controls the exchanges between the relatively cold fjords and the warmer shelf waters. A major part of the process is sea ice formation over the fjords in winter, changing the density of the water and altering the circulation at the fjord mouth. We are now starting to apply our understanding of fjordic systems to the great drainage systems of Greenland that feed glacial ice, and ultimately freshwater, into the north Atlantic.

Tim Boyd, Finlo Cottier & Vladimir Ivanov

SAMS ARCTIC MOORINGS REVEAL THE SECRETS OF VERTICAL MIGRATION.

SAMS has been operating two moorings around Svalbard in the high Arctic. One in Kongsfjorden is our main contribution to Oceans 2025 Sustained Observatories theme; the other in Rijpfjorden is operated in collaboration with the University Centre in Svalbard. These moorings are identical in their instrumentation and have been running in tandem for two years. They differ in the environments in which they are placed – Kongsfjorden is ice-free, warmed by the inflowing Atlantic water whilst Rijpfjorden is seasonally ice-covered and representative of Arctic waters. Acoustic data has been used to determine what role sea ice plays in the daily migratory behaviour of zooplankton. This behaviour is acknowledged as an important mechanism in the transport of carbon to the seabed yet the impact of a retreating ice cover on this process is unknown. With funding through the Strategic Ocean Funding Initiative a team comprising researchers at SAMS, St Andrews and British Antarctic Survey has analysed two-years worth of acoustic, hydrographic and associated environmental factors to reveal the seasonal development of migratory behaviour. From this unique assemblage of data it was clear that migratory patterns of zooplankton are rather and are not strongly affected by the shading effect of the sea ice. Subtle differences in behaviour between ice-free and ice-covered waters are linked to the differing food supplies at the surface and predator-prey interactions within the pelagic community. This work to be published in *Limnology and Oceanography*.

Colin Griffiths, Finlo Cottier, Estelle Dumont, Jorgen Berge (UNIS) Stig Falk-Petersen (NPI)

MARINE TECHNOLOGY GROUP

Having recruited two excellent new engineers in January 2008 (Keith Jackson and John Bass) and having returned the Technology Development Group to its normal complement of six, Drs Sillitoe and Wadke left the group in the summer of 2008 to take up new posts at the Universities of Wolverhampton and Manchester respectively. The search for their replacements is under way. The leadership of the group was also advertised in preparation for the partial retirement of the present incumbent, David Meldrum. Keith Jackson has now been appointed as deputy leader and will take over from David Meldrum in 2010.

The group, along with technology teams at NOCS and POL, submitted a successful and high rated proposal for technology development within the context of Oceans2025, the integrated marine science plan being funded by NERC. This Oceans2025 technology theme will underpin much of the work of the group over the next few years, and will see us addressing the overall objective of developing an optimal marine observing network. Specific work packages are focussing on sensor optimisation, smart *in situ* data processing, platforms, networks and communications. The work will complement other Oceans2025 work, both at SAMS (notably with the physics and geochemistry groups) and at other NERC-supported institutes, such as the Sea Mammal Research Unit at St Andrews. We have also been successful in winning substantial funding from NERC to allow the construction of cold-room facilities to further increase SAMS' capabilities in polar instrumentation and research.

The recent decision by NERC to align its science according to seven new strategic research themes, including one that focuses on technology development, will also be of benefit to the group, and we have already been active in submitting proposals and expressions of interests to specific calls originating from within this theme.

Specific highlights from 2008-9 are detailed below.

COMMUNICATIONS TECHNIQUES

The group continues to be active in evaluating new satellite communications technologies, notably the Iridium 9601 modem for the transmission of data from anywhere in the world. The modem is smaller, cheaper and less energy-hungry than previous models, and has opened up the possibility of extensive use of the Iridium system in ocean and ice observation. In this context, SAMS is leading the Data Buoy Cooperation Panel's Iridium Pilot Project, which now has seen more than nearly 100 Iridium-equipped drifters deployed in the global oceans as part of an end-to-end evaluation of Iridium as a reliable communications channel for ocean data. The group is also being sponsored to undertake initial trials of the new two-way Argos communications system launched in October 2006 on board the European METOP-1 satellite. SAMS reputation and visibility in this area continues to benefit from Meldrum's ongoing chairmanship of the Data Buoy Cooperation Panel.

Keith Jackson, David Meldrum & Pushkar Wadke

MICRO-STRUCTURE MEASUREMENTS FROM A PROFILING FLOAT

The group has worked with physical oceanographic staff at SAMS to develop a convenient means to perform microstructure profiling under ice using a microstructure profiler towed up and down a line by a modified Argo float. The use of a line tethered Argo float has been tried before for CTD profiles in open water. However, the requirements of a microstructure profile dictate much more control over descent rate and mechanisms for dealing with the vast amount of data produced in each cast. The issues of deployment on ice have also required much effort in the mechanical design and construction of a suitable head structure and winches. The first opportunity to use the equipment at an ice camp this year was unfortunately thwarted by poor ice conditions but the system is intended to be used for a short term open water deployment soon and then under ice at the next opportunity.

Keith Jackson & Alistair James

ICE PLATFORMS

The group continues to work closely with sea-ice groups at SAMS and elsewhere in the development, construction and testing of novel instrumentation for sea-ice observations. It is now evident that the sea-ice cover of the Arctic Ocean is under threat from increasing heat and fresh water inputs, and SAMS is playing an important role in the international effort to monitor these changes. These efforts have being co-ordinated within the context of the International Polar Year, and the SAMS technology group has been supported both by substantial NERC grants, and by European funding under the RECARO and DAMOCLES programmes.

Recent deployments have centred on a unique instrument developed at SAMS, a high-resolution and easily deployable thermistor chain that will allow new insights into the processes governing the growth and decay of sea ice and its response to heat fluxes from the atmosphere and the sea. The SAMS Ice Mass Balance Array (SIMBA) uses miniature smart temperature sensors, reports data via the Iridium satellite system and has been successfully deployed in both the Arctic and Antarctic during the past year. The concept is generating increasing interest within the polar science community and we have already supplied SIMBAs to the British Antarctic Survey and the Finnish Institute for Meteorological Research.

We have also further developed the SAMS clear-hulled GPS buoy, which uses solar panels, a rechargeable battery and satellite communications, and have made a number of deployments in the Arctic to continue SAMS' study of year-round ice dynamics.

John Bass, Keith Jackson, Alistair James, David Meldrum, Ian Sillitoe & Pushkar Wadke

> A SAMS Ice Mass Balance Array (SIMBA) deployed in the Arctic Ocean to the north of Alaska. The station measures a full set of meteorological parameters, net solar radiation, and the temperature profile through the ice and adjacent air and sea in order to better understand and predict the processes governing the increasingly rapid disappearance of sea ice during the Arctic summer.

> A novel feature of the SIMBA is a chain of more than 100 closely spaced sub-miniature temperature sensors that give a detailed picture of the growth and decay of the sea ice and the flow of heat through the ice.

> SAMS has pioneered the use of small solar-powered buoys for sea-ice research. The buoys use GPS and small Iridium satellite transmitters to report the positions of floes as they move around the Arctic Ocean and out into the North Atlantic through straits on either side of Greenland.

National Facilities

CULTURE COLLECTION OF ALGAE AND PROTOZOA (CCAP)

> Delegates at the Algal Culture Collections 2008 meeting at SAMS.

The CCAP is a NERC funded National Facility, which acts as the UK service collection for the provision of algal, cyanobacterial and protozoan (free-living non-pathogenic) cultures and their associated data to the UK and world-wide scientific communities. The CCAP currently maintains in excess of 3000 strains of algae, cyanobacteria and free-living, non-pathogenic protozoa, with more than 2900 of these being held in the publicly accessible collection. In 2008/9, approximately 100 new strains were added to the collection, with targeted expansion of groups of particular scientific/commercial interest including: toxin producing dinoflagellates and a diverse range of heterotrophic protists. Details of all holdings and accessions are listed on the CCAP website www.ccap.ac.uk.

The collection underpins scientific research, training and commercial activities in the UK and world-wide. In 08/09 a total of 640 orders were serviced with the provision of >1400 cultures to non-SAMS users, in addition to the provision of patent services, extracted DNA, training courses, contract research and algal identifications. The CCAP knowledge-base website www.ccap.ac.uk, launched in 2007, continues to be developed and updated with the addition of still images, video clips (see Glenodinium foliaceum CCAP 1116/3), bibliographic references, biogeographical and chemical information as well as nucleotide sequence accession numbers. There are now 2-way live hyperlinks between nucleotide sequence records in the EBI database and strain records in the CCAP database.

In June 2008 the collection hosted two international meetings: Ectocarpus 2008 and Algal Culture Collections 2008. Ectocarpus 2008, the third in a series of meetings on this important filamentous algal genus, was held in association with a genome annotation work-shop. This alga has recently become the first seaweed for which the entire genome has been fully sequenced and in addition to algal genomics, Ectocarpus 2008 focused on the biochemistry & physiology; developmental biology as well as the biodiversity & evolution of this genus and its relatives. The meeting was attended by over 40 delegates ranging from established academics to post-graduate students and representatives of key research groups in France, Germany and Japan. Abstracts from the meeting are available on-line at http://www.ccap.ac.uk/ectocarpus2008.htm.

Algal Culture Collections 2008 was the third in a series of international algal culture collection meetings hosted at one of the major protistan service collections, after previous meetings at the Culture Collection of Algae at the University of Texas at Austin (UTEX) in 1998 and at the Sammlung für Algenkulturen Göttingen (SAG) in 2002. This meeting coincided with the rapid developments in disciplines and technologies that are increasingly linked to, and impacting on, algal science: a number of algal genomes have been, and others are currently being, sequenced. Furthermore, bioinformatics resources are more than ever being used by the algal community and have become a prime channel of communication of algal-related knowledge to scientists working in other disciplines. In addition, a global energy and food crisis, making front page headlines on a daily basis, has renewed interest in algae as sustainable, renewable resources for food ingredients, fuels and other raw materials. This meeting covered all of these areas with specific reference to the roles of Biological Resource Centres/Culture Collections in the provision and safekeeping of biological resources of defined quality and the digital networking of bioinformatics data. The meeting was attended by over 70 delegates including: academics, students, representatives from the major collections in Asia, Europe and N. America, bioinformaticians and biotechnologists. Abstracts from the meeting are available on-line at http://www.ccap.ac.uk/algalculturecollections2008.htm.

John Day, Frithjof Küpper & Christine Campbell

NATIONAL FACILITY FOR SCIENTIFIC DIVING (NFSD)

DIVING AND SMALL BOATS

The Diving Unit continues to deliver a range of services both in support of underwater science activities and at the national level. The unit hosts the Natural Environment Research Council (NERC) Facility for Scientific Diving and continues to provide emergency hyperbaric treatment for divers with decompression illness under the national registration scheme for Scotland. In addition the unit is accredited by the Health and Safety Executive for the provision of professional diver training and the Royal Yachting Association for small boat training.

NATIONAL FACILITY FOR SCIENTIFIC DIVING (NFSD)

The National Facility for Scientific Diving (NFSD) at SAMS provides divers, equipment, training and scientific/technical support that underpin a wide range of high-class interdisciplinary research in the underwater environment. The primary level of service delivers practical support for diving-related underwater scientific projects through providing additional manpower for groups with limited diving experience, total project management for scientists with no diving experience and/or specialist equipment loans for groups with diving experience but limited resources. On a secondary level, the Facility undertakes to ensure proper adherence to Health and Safety legislation as applied to diving at work activities. This can be through targeted training programmes, communicating advice and guidance for senior management with legal responsibilities for diving at work, undertaking safety audits on behalf of the NERC Health and Safety management structure and facilitating a wider interactive dialogue with others in the higher education field and the Health and Safety Executive. The NFSD is the main service provider and the major supporter of research within the UK that involves scientific diving through its support and maintenance of an extensive underwater research programme, its support for the UK Scientific Diving Supervisory Committee, its interactions with other diving industry bodies, its ongoing diving research and evaluation programme, and its focussed training programme for scientists and technicians involved with working underwater. In addition to diving services per se, the NFSD also provides support and training in associated small boat operations and in emergency diving medicine.

In 2008, the NFSD collaborated with the United States Antarctic Program and the US Navy in a series of diving regulator trials in extreme cold water conditions under ice at the McMurdo research base. The collaboration is contributing to an ongoing assessment as to the regulators that are least likely to fail in seawater of almost -2°C.

DIVING SUPPORT

In 2008, the diving unit supported 674 person dives (361 separate diving operations) in support of numerous science programmes. A total of 34 divers were either employed on diving operations or attended some of the NFSD training courses and workshops. Diving operations included maintaining fish count and sub-sea temperature time-series, conducting photographic and video surveys, collecting animal specimens, conducting diving equipment trials and mapping artificial reef module deployments. The total bottom time was 9856 minutes for 2008 at an average of 25.5 minutes per diving operation.

DUNSTAFFNAGE HYPERBARIC UNIT (DHU)

In 2008, 19 divers suffering from symptoms of suspected decompression sickness were examined at the hyperbaric unit and 15 received treatment. The divers treated received, in total, 134 treatment hours in the chamber. As in previous years, the unit continues to benefit from the medical support it receives from diving medics from the Lorn Medical Centre.

The unit is NHS-registered and continues to be part of the National Registration Scheme for Scotland. DHU staff continue to act as technical advisers for the registration scheme.

DIVING SCIENCE DEGREE MODULE

2008 was the second year of the Diving Science module for the UHI Marine Science degree course. Given in the third year of the course, the module combines a series of lectures and assignments examining the ways in which diving is employed as a scientific research tool with a programme of practical lessons in occupational scientific diving. At the end of the course, the students should have vocational qualifications in professional diving, boat handling and emergency recompression.

RYA SCHOOL

The small boat school continues to provide RYA accredited training programmes. 2008 again saw the provision of a seamanship module for students on the UHI Marine Science degree with all students successfully completing their RYA Powerboat training to Levels 1 and 2. Training was also provided for SAMS staff.

MDJ Sayer, SR Thurston, H Brown & E Azzopardi

Education

SAMS HIGHER EDUCATION

This has been another noteworthy year of higher education activities. In addition to the undergraduate and postgraduate outcomes reported below, the UHI Millennium Institute (UHI) has been granted Taught Degree Awarding Powers (TDAP) by the Privy Council. Internally, SAMS was subjected to a quinquennial Subject Network Review by the UHI. The outcome was very positive, with three commendations: the commitment and enthusiasm of staff; the linkages between teaching and research providing "an exemplary model for UHI" and the quality of undergraduate teaching delivery.

BSc (Hons) Marine Science

The ninth cohort of UHI undergraduates arrived in September. This provided our largest undergraduate intake since delivery began, and is a great credit to the growing reputation of the programme. Maintaining our high success rate with graduates continuing in higher education, Gillian Walker transferred to the University of Manchester, where she enrolled on an MSc in Environmental Protection. Gillian was also our first student to find success on our newly validated H3 Diving Science module. Through the module, she also gained the Health and Safety Executive Part IV certification, qualifying her to undertake commercial or other professional diving operations.

> The BSc (Hons) Marine Science degree is attracting more students each year.

> Gillian Walker: our first student to complete the "Health and Safety Executive Professional SCUBA"

The other highlight of the undergraduate year was the redirection of two H3 students to our recently validated BSc (Hons) Marine Science with Arctic Studies. Thanks to the signing of an ERASMUS Exchange Agreement between SAMS and the University of Tromsø, and scholarship support from the Thomas and Margaret Rodden Trust, Jordan Grigor and Carl Ballantine both opted to spend their third year studying in the Arctic, based at the University Centre in Svalbard (UNIS). They have followed courses in Arctic Marine Biology, Arctic Pollution, Environmental Management and Polar Ecology. As part of the exchange programme with UNIS, several staff have also undertaken duties as guest lecturers.

Postgraduate Research Activities

Over the year there was a further intake of postgraduate students, adding to our vibrant research school community. The main funder for these projects was the Scottish Funding Council's SAGES initiative, linking us with colleagues in St. Andrews, Aberdeen and Glasgow.

One of our most popular students - Romain Pete - also graduated and moved back to France as a post doctoral research assistant. Another - Emily Venables - had a tremendous year. In the summer she participated in a 'Cape Farewell' charity cruise off Greenland, with celebrities including Jarvis Cocker, KT Tunstall, Marcus Brigstocke and Quentin Cooper. NERC and the British Geological Survey were amongst co-sponsors of the voyage, which aimed to bring about a cultural change in attitude to climate change. Emily also won the Norman Heaps Award for the best verbal presentation by a 'young' researcher at the Challenger Conference at Bangor University.

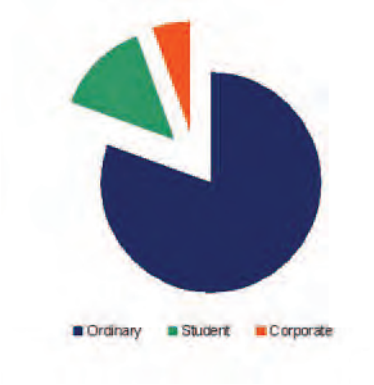
Axel EJ Miller

> SAMS PhD student Emily Venables watches Jarvis Cocker sign an Argo satellite beacon before its deployment during the Cape Farewell charity cruise to Greenland.

SAMS MEMBERSHIP ACTIVITIES

As a learned society SAMS had 441 members from three categories at the end of the reporting period, a loss of 15 compared to the previous year.

Subscription rates have not changed in the last decade and currently stand at £12 for ordinary members, £5 for students and unwaged ordinary members, and at £60 for corporate members.



For their subscriptions, members receive SAMS newsletters, the annual report, may apply for the SAMS research bursary, may access the SAMS reference library, are invited to attend the AGM, the annual Newth lecture and two meetings of the Scottish Marine Group per year.

Scottish Marine Group

The Scottish Marine Group, organised by Susan Chambers from the National Museums of Scotland, met twice in the reporting year:

PhD students from Napier University, Aberdeen University, Heriot-Watt University and SAMS UHI presented their research projects at the SMG postgraduate meeting held on Monday 19 May 2008 at Dunstaffnage. Prizes were awarded to the best presentations: Elisa Capuzzo from Napier University and Gill Andrew from SAMS UHI shared the £100 SAMS prize for the best delivered presentation, while Clare Johnson from SAMS UHI won the £100 SEPA prize for the best visual presentation. ERT (Scotland) Ltd sponsored a prize for the best student poster.

The autumn SMG meeting followed the theme of 'The Status of the Scottish Marine Environment' and was held on 30 October 2008 at the University of Stirling with several invited speakers: Paul Tett (Napier University and SAMS), Marie Russel (Fisheries Research Services Aberdeen), Martyn Cox (Scottish Government), Brian Miller (SEPA) and Abigail Cabrelli (St Andrews University). The meeting attracted an audience of around 45 participants.

Annual General Meeting and 18th Annual Newth Lecture

The 2008 AGM took place on Monday 3 November in the William Speirs Bruce Conference Room at SAMS, and was followed by the SAMS UHI student graduation and the Newth lecture. This year our new director, Professor Laurence Mee, delivered the lecture entitled "*Quo vadis mare nostrum*? Systems science for sustainable seas".

Anuschka Miller

Research bursaries

Three SAMS bursaries were awarded during the past year:

Lorna Teal	University of Aberdeen	Linking macrofaunal activity and sediment function at two sites in Loch Creran	£1,000
Felix Marx	University of Bristol	A complete morphological supermatrix of fossil and extant baleen whales	£1,000
Jaime Davies	University of Plymouth	The ecology of Hatton Bank	£ 710

SAMS OUTREACH

SAMS recognises the importance of science engagement and outreach activities and this year created a dedicated communications department with four staff, one of which was a new post. The department has responsibility for media and stakeholder relations, events, outreach, publications, website and intranet, and branding.

… meeting the public

SAMS has been engaged in two science engagement projects: 'Towards a marine science festival in Argyll', funded by the Scottish Government and Highlands and Islands Enterprise, focussed on developing the local audience base to support a future marine science festival, and to explore event options and partnerships. For this project we visited schools and community groups, delivered public lectures as part of the Oban Environment Week 2008 and attended various events like the Oban Games. The 'Sharing Science' project, also funded by the Scottish Government, provided the public with opportunities to engage with active researchers and to find out about some of the latest advances in science by taking researchers from SAMS and the Universities of Edinburgh and Dundee into two of the Scottish Science Centres. SAMS researchers showcased their research both at Our Dynamic Earth in Edinburgh and at Sensation in Dundee. The project also allowed colleagues from Edinburgh and Dundee to contribute to the SAMS open day.

The SAMS open day in March 2009 saw a record 500 visitors explore our facilities and find out what we do, and why we do it. Students and staff put together displays and interactive activities for all the family resulting in an increase not only of visitor numbers, but also in the length of time visitors stayed.

… in the classroom

SAMS' new outreach officer has been developing numerous workshops for schools on topics including 'marine aliens', 'marine food chains', 'life on the beach', 'seaweeds' and 'ocean acidification' aimed at different age groups. With these we visited nurseries, primary and secondary schools around the area for periods varying from one hour to a full day. Awareness of our availability has grown recently, and we are increasingly invited into schools. We also hosted visits from both primary and secondary schools. We also contributed a workshop to the Argyll and Bute Regional Environment Forum's environment fair in Oban, visited by over 700 school children from the area.

To give school pupils an opportunity to experience the work of a marine scientist, SAMS hosted a number of week-long work experience pupils as well as two Nuffield bursary pupils, who spent 4-5 weeks conducting and writing up a first research project during their summer holidays. These worked on underwater sound and on chemical alarm signals in worms.

To foster links with teachers, and to develop their understanding of the interdisciplinary nature of climate change, SAMS ran a well received weekend course on 'Climate Change and the Oceans' for 16 teachers in May 2008.

… in the news

SAMS continues to engage proactively and reactively with the media by issuing press releases and responding to press inquiries. This year we invited BBC 2 Newsnight's science correspondent, Susan Watts, to join a SAMS led Oceans 2025 Arctic expedition on board the British Antarctic Survey icebreaker *RRS James Clark Ross*. This collaboration resulted in a 3 minute piece on leaving and a 15 minute report on return of the expedition, supported by blogs written by three participating SAMS scientists, Drs Ray Leakey, Eleanor Bell and Henrik Stahl, on the Newsnight website. Professor Laurence Mee and Dr Maeve Kelly also contributed to a news clip on BBC Scotland on the potential of seaweeds to produce biofuel.

Our scientists also contributed to programmes on Radio 4 and Oban FM, and articles about our research appeared in the national and international press as well as regional and local papers.

SAMS supporting 'SciArt'

The Leverhulme Trust awarded a 10 months residency to artist Victoria Clare Bernie, who has been working alongside Drs John Howe and Henrik Stahl on their Oceans 2025 research. She has been producing videos, photographs and drawings for her 'Slow Water' project.

SAMS ran a primary school competition to create artistic representations of plankton, and is now displaying some of the entries in its entrance area.

SAMS further supported an Oban High School pupil studying Advanced Higher Art, who took her artistic inspiration from the marine environment. Her display made of glass, netting, seashore items and a collection of fabrics, was donated to SAMS and is now on display in the visitor area.

Anuschka Miller, Laila Sadler, Helen McNeill, Rory MacKinnon

SAMS FACILITIES

Library

There have been no major changes to our library facilities this year which continue to house a rare collection of historical expedition reports, as well as the latest journals and the undergraduate library. However, in 2010 the undergraduate library will be 'on the move', relocating to the SAMS new Education facility, which will be located in the existing Argyll College grounds.

Olga Kimmins

The SAMS Research Aquarium

The SAMS Aquarium was extensively modernised during the period of this Annual Report to become a state of the art facility in which the environment can be strictly controlled and organisms carefully observed using sophisticated automated systems. The Aquarium is home to many different species. It is one of the few places in the world where live *Lophelia pertusa*, the most widespread reef-forming cold-water corals, are kept and studied. Echinoderms (sea cucumbers and sea urchins) as well as seaweeds and fish can also be cultured here. Even aliens find a home in the SAMS Aquarium – its isolation facility enables study on invasive marine aliens such as the Japanese Skeleton Shrimp *Caprella mutica*. A recirculating system was also set up to investigate interactions between toxic phytoplankton and scallops.

Behavioural ecology studies in the Aquarium include biological rhythms, schooling behaviour of fish, foraging and feeding behaviour, predator-prey interactions and habitat selection of fish and invertebrates.

The Aquarium not only features 13 experimental rooms serviced with pristine seawater at ambient temperature, but can also be provided with seawater at sub-zero temperatures to enable Arctic species research to be carried out. There is also an observation room linked to data and video communications equipment which allows experiments to be controlled without disturbance and to monitor animal behavioural experiments. Automated data recording and computer-assisted behaviour logging have been developed at SAMS and there are also infrared illumination systems for observation at night.

Finally, in case you have ever wondered what a VORT is, you will find them in the Aquarium. A VORT is a vortex re-suspension tank which allows controlled suspension and deposition of particular matter. These are being used to study the effect of aggregate dredging on benthic aquatic organisms, many of which rely on suspended particulate matter to feed or to build reef systems.

Kim Last

ICT & Data Services

The move towards virtualisation of servers continued with the purchase of a second Virtual host in the summer. As well as allowing us to retire a number of older servers, such as the one hosting the SUN finance system, it also gave us the capacity to introduce new services and servers: all without having to purchase additional hardware. Typical examples of new services were the hosting of the new Human Resources Ciphr system and the data collection system for the Sea Glider.

Plans were initiated to move the SAMS network system (authentication & file sharing) from Novell Netware NDS to Microsoft Active Directory: this is expected to be completed in 2010. The Groupwise e-mail system was upgraded from version 6 to version 7 in December 2008.

In February 2009, the SAMS external telecoms and data connections were upgraded as part the UHI Next Generation network project. The principal enhancement was an increase in bandwidth and a direct connection to the THUS network, removing the previous reliance on relay connections at other UHI partner campuses.

Steve Gontarek

Vessels

The year proved busier for the vessels, especially *RV Calanus*, than in the recent past mainly due to three new or increased areas of science: trials and deployments of sea-bed landers (Henrik Stahl), larval fish sampling cruises (Clive Fox) and multi beam/side scan sonar (John Howe). UHI BSc Marine Science undergraduate teaching made use of the vessels, both for the annual field week and for specific teaching modules.

External users included (among others) University of East Anglia, Edinburgh University, Liverpool University, Heriot Watt University, Napier University and Oceanlabs Aberdeen.

Both vessels underwent refits and annual statutory inspections, successful after major mechanical repairs to *RV Calanus* and stability tests requested by the Maritime and Coastguard Agency. A major improvement in operational capability was brought about by the establishment of a fixed mooring in Airds Bay, Loch Etive allowing the ships to remain in the Loch overnight. A new 4m RHIB rescue boat/tender was obtained for *RV Calanus*. The vessels continued to use temporary/relief Masters.

Ivan Ezzi

Appendix

SAMS STAFF 1 April 2008 to 31 MARCH 2009

Director
Prof Laurence Mee

Deputy Director
Dr Ken Jones

Physics, Technology & Sea Ice
Dr Mark Inall (Head)
Mr David Meldrum (Deputy)
Dr Dmitry Aleynik
Mr John Bass
Mr John Beaton
Dr Tim Boyd
Dr Finlo Cottier
Dr Andy Dale
Miss Estelle Dumont
Mr Colin Griffiths
Dr Phil Hwang
Dr Vladimir Ivanov
Dr Keith Jackson
Mr Alistair James
Professor Toby Sherwin
Dr Ian Sillitoe
Dr Pushkar Wadke
Dr Jeremy Wilkinson

Ecology
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Sayer, M.D.J. (2008). NERC Facility for Scientific Diving: Annual Report. In: *NERC Services and Facilities Annual Report* 2007/08. pp. 79-84.

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POSTGRADUATE RESEARCH PROJECTS

(Funding body and supervisors' names in parentheses, SAMS supervisors in blue)

DEGREES AWARDED DURING THE REPORTING YEAR

Boos K, Ph.D, Alfred Wegner Institute (AWI). *Mechanisms of a successful immigration from north-east Asia: settlement dynamics, competitive ability and anti-predatory strategies of Caprella mutica Schurin 1935 in European coastal waters.* (Gutlow L, Franke R and Cook E)

Kristensen M, M.Sc, University of Copenhagen (self funded). *Oxygen and DIC dynamics of sea-ice.* (Glud RN and Rysgaard S)

Larsen M, M.Sc, University of Copenhagen (Self funded). *Amphiura filiformis and benthic nitrogen cycling.*(Glud RN and B Vismann B)

Morris P, Ph.D, University of Southampton (NOC). *Carbon export from iron-induced southern ocean phytoplankton blooms.* (Sanders R, Mills R and Turnewitsch R)

Pete R, Ph.D, The UHI Millennium Institute (UHI). *The influence of organic nutrient perturbation on microbial community dynamics.* (Davidson K, Miller AEJ and Leakey R)

Soedergaard D, M.Sc, University of Copenhagen (self funded). *Autotrophy versus heterotrophy of sea-ice.* (Glud RN and Rysgaard S)

ONGOING RESEARCH

Andrew G, Ph.D, The UHI Millennium Institute (NERC). *Biodiversity and ecosystem function: trophic diversity versus species diversity in intertidal grazers.* (Burrows M, Hawkins S and McGill R)

Batty P, Ph.D, The UHI Millennium Institute (NERC). *The influence of structural and functional aspects of benthic organisms on bioturbation and ecosystem function.* (Nickell L, Solan M, Nickell T and Black KD)

Bayley S-A, Ph.D, The UHI Millennium Institute (Self-funded). *Towards a brighter future for Scottish salmon - new ideas in socio-economic and political dimensions.* (Smith M and Miller AEJ)

Blicher M, Ph.D, University of Copenhagen (Royal Scientic Investigations Greenland). *Arctic macrofauna.* (Glud RN, Sejr M and Rysgaard S)

Burke K, Ph.D, University of Aberdeen (University of Aberdeen). *The fate of organic matter in marine sediments: The role of macrofauna.* (Witte U and Narayanaswamy B)

Davies J, Ph.D, University of Plymouth (JNCC). *Identification of areas of nature conservation importance in deep waters of the UK continental shelf, to contribute towards spatial planning and the development of an ecologically coherent network of MPAs in the North-East Atlantic.* (Howell K, Narayanaswamy B, Stewart H, Jacobs C and Johnstone C)

Douarin M, Ph.D, The UHI Millennium Institute (SAGES). *Secrets from a Deep Reef: Structure, Biogeography and Palaeoclimate Reconstruction from Mingulay Reef Complex Sediment Cores.* (Sinclair D, Long D and Roberts M)

Frost J, Ph.D, Univeristy of Hamburg (Euroceans). *Trophic role of gelatinous and semi-gelatinous organisms in the mesopelagic zone.* (St John M and Fox C)

Gontikaki E, Ph.D, University of Aberdeen (Marie Curie-Ecosummer/University of Aberdeen). *Deep sea benthic community response to simulated sedimentation events in contrasting environments.* (Witte U, Narayanaswamy B and Tselepides T)

Hughes S, Ph.D, The UHI Millennium Institute (FRS). *Inflow of Atlantic Water to the North Sea: Variability and influence on North Sea climate.* (Dale A and Gallego A)

Johnson C, Ph.D, The UHI Millennium Institute (UHI/HIE). *Tracing water masses in the North Atlantic.* (Sherwin T, Shimmield TM and Smyth-Wright D)

Law GT, Ph.D, The UHI Millennium Institute (NERC). *Cycling of trace metals of organically-rich sediments off Pakistan and Scotland.* (Shimmield TM, Cowie G, Shimmield GB and Ganeshram R)

Lonborg C, Ph.D, The UHI Millennium Institute (Marie Curie – Ecosummer). *The importance of dissolved organic matter in two contrasting marine waters.* (Davidson K, Miller AEJ and Alvarez-Salgado A)

MacIntyre K, Ph.D, The UHI Millennium Institute (NERC). *Post-glacial fjordic landscape evolution: the onshore and offshore limits of the Younger Dryas ice-sheet Western Scotland.* (Howe J, Shimmield T, Bradwell T and Stoker M)

Mogg A, Ph.D, The UHI Millennium Institute (NERC). *The role of bacterial associates in the production of dimethylsulphoxide by marine phytoplankton: Significance for the biogeochemical cycle of the climatic feedback gas dimethylsulphide.* (Hatton A, Hart M, Green D and Bavington C)

Moosen H, Ph.D, University of Glasgow (SAGES). *Palaeoclimate reconstructions from Arctic and Nordic shelf seas: development and application of multiple proxies.* (Bendle J, Austin W, Howe J and Cottier F)

Nebot C, Ph.D, The UHI Millennium Institute (UHI). *Human pharmaceuticals in the Scottish marine environment.* (Gibb S, Boyd K and Black KD)

Nordi G, Ph.D, Fiskerrihoejskolen I Torshavn (self funded). *Aquaculture and benthic biogeochemistry.* (Fiskerrihoejskolen and Glud RN)

Porter M, Ph.D, The UHI Millennium Institute (SAGES). *Linking recent variability in Atlantic Ocean circulation and glacier mass balance in Greenland and Norway.* (Sherwin T, Rea B and Mair D)

Riley J, Ph.D, University of Southampton (NERC SOFI). *Shipboard studies of the influence of inorganic seawater chemistry on calcareous microplankton and the biological carbon pump.* (Acterberg E, Sanders R, Tyrrell T, Rees A and Leakey R)

Rodger A, Ph.D, The UHI Millennium Institute (AIE). *Multi-trophic level culture for environmental remediation – active management of aquaculture initiatives for diversification and sustainability.* (Kelly MS, Gillibrand P and Dring M)

Stott K, Ph.D, University of St Andrews (SAGES). *Extending the marine instrumental climate record for European waters using the long-lived marine bivalve: Arctica islandica.* (Austin w, Wilson R and Inall M)

Strittmater M, Ph.D, The UHI Millennium Institute (Marie Curie – Ecosummer). *Molecular biology of the Ectocarpus/Eurychasma host-pathogen interaction.* (Kupper F, van West P and Gachon CMM)

Venables E, Ph.D, The UHI Millennium Institute (NERC CASE). *An investigation of mixing in the Faroe-Shetland Channel.* (M Inall, T Sherwin and W Turrell)

Wilson L, M. Phil, The UHI Millennium Institute (NERC). *Gadoid fish sound production and its role in mate selection, the risk of predation and the impacts of noise pollution.* (Wilson B, and Burrows MT)

RESEARCH GRANTS AND CONTRACT INCOME RECEIVED

Project Leader	Title	Funding body	Duration	Award
K Black	Environmental management reform for sustainable farming, fisheries and aquaculture	EU FP6	01/07 - 12/09	£18k
K Black	Science and Policy Integration for Coastal Systems Assessment (SPICOSA)	EU FP6	02/07 - 01/11	£65k
K Black	Benthic Recovery Processes	SARF	01/07 - 12/10	£113k
K Black & P Batty	The influence of structural and functional aspects of benthic organisms on bioturbation and ecosystem function (PhD Project)	NERC	10/05 - 09/08	£18k
M Burrows	Biodiversity and ecosystem functioning: tests using rockpools as natural mesocosms	NERC	01/06 – 12/08	£65k
M Burrows	Sustainable management of deep-water fisheries and their impact on marine biodiversity	Esmee Fairbairn	01/06 – 12/08	£72k
M Burrows	Oceans2025 Theme 4 WP 4.4 Predators and prey	NERC	04/07 - 03/12	£818k
M Burrows	Oceans2025 Theme 4 WP 4.6 Ecosystem services	NERC	04/07 - 03/12	£254k
M Inall	Ecosystem of the mid-atlantic ridge at the sub polar front and Charlie Gibbs Fracture Zone	NERC	10/06 - 09/10	£191k
F Cottier	Provision of mooring deployment, maintenance and analysis	Norwegian Polar Institute	08/05 - 07/08	£48k
F Cottier	Oceans2025 Theme 10 SO13 Kongsfjord	NERC	04/07 - 03/12	£125k
F Cottier	Oceans2025 Theme 10 SO13 Arctic mooring	NERC	04/07 - 03/12	£106k
F Cottier	UHI BERGE	UHI	08/07 - 07/08	£4k
I Crawford	Human Resources Modernisation	UHI	Ongoing	£25k
J Wilkinson	Validation & Provision of Cryosat Measurements of fluctuations of the earth's land and marine ice fluxes	NERC	02/04 - 02/09	£310k
F Cottier	Convection & cascading on Arctic shelves: a tracer study	NERC	04/07 - 03/09	£69k
J Day	CCAP NF3 CCAP	NERC	04/07 - 03/12	£3,044k
K Davidson	Forecasting initiation of blooms of toxic algae	Interreg IIIB	04/06 - 06/08	£153k
K Davidson	Oceans2025 Theme 3 WP 3.8 Pelagic mixing	NERC	04/07 - 03/12	£566k
C Gachon	Structuring the European Research Area - human resources & mobility	Marie Curie Intra European Fellowships	09/06 - 08/08	£109k

RESEARCH GRANTS AND CONTRACT INCOME RECEIVED

C Fox	Eur-Oceans	EU	04/07 - 03/09	£13k
P Gillibrand	European climate of the last millennium	EU FP6	01/06 – 12/09	£94k
P Gillibrand	The development of modeling techniques to improve predictions at marine cage farms	SARF	07/05 – 06/08	£58k
P Gillibrand	Scallop fishing in the Firth of Lorn Marine SAC: Modelling of indirect environmental impacts	SNH	10/07 - 06/08	£46k
P Gillibrand & S Hughes	Research Degree Part Time ARC/UHI	Fisheries Research Services	04/07 - 03/12	£9k
S Gontarek	Data Management	NERC	06/06 - 11/10	£225k
D Green	Algal-bacterial interactions in determining dimethylsulphide fluxes to the atmosphere	NERC Solas	10/05 – 09/08	£170k
D Green	Characteristics of organic microlayer produced aerosols	NERC	06/06 - 05/08	£16k
A Hatton	Unravelling the ocean methane paradox	NERC	08/07 - 07/10	£454k
A Hatton & A Mogg	The role of bacterial associates in the production of dimethylsulphoxide by marine phytoplankton (PhD Project)	NERC	10/07 - 09/10	£10k
A Hatton	Sequencing the Sea Sulphur cycle	NERC	01/08 - 12/10	£14k
J Howe & K McIntyre	Limits of the Younger Dryas ice sheet in West Scotland (PhD Project)	NERC	10/07 - 09/10	£10k
J Howe	Oceans2025 Theme 3 WP 3.8 Multibeam system	NERC	04/07 - 03/12	£161k
J Howe	Oceans2025 Theme 1 WP 1.5B MOC activity	NERC	04/07 - 03/12	£288k
J Howe	Oceans2025 Theme 3 WP 3.9 Sediment transport	NERC	04/07 - 03/12	£265k
N Hughes	Polar View	University of Cambridge	09/05 - 05/08	£5k
M Inall	Provision of mooring deployment, maintenance and analysis	Norwegian Polar Institute	08/05 - 06/08	£48k
M Inall	Ice Edge	Individual	08/07 -07/08	£10k
M Inall	Oceans2025 Theme 3 WP 3.7 AUV	NERC	04/07 - 03/12	£90k
M Inall	Oceans2025 Theme 10 SO13 Tiree mooring	NERC	04/07 - 03/12	£111k
M Inall	Oceans2025 Theme 3 WP 3.7 Topography	NERC	04/07 - 03/12	£492k
M Inall	Oceans2025 Theme 10 SO1 Tiree mooring	NERC	04/07 - 03/12	£312k

RESEARCH GRANTS AND CONTRACT INCOME RECEIVED

M Kelly	Toxins in aquaculture ecosystems and shellfish	EU Collective Research Projects	07/06 - 06/09	£105k
M Kelly	Reducing the environmental impact of sea cage farming through cultivation of seaweeds	HIE	08/06 - 07/08	£147k
M Kelly	Atlantic Arc Aquaculture Group 2	Interreg IIIB	01/07 -06/08	£160k
M Kelly	Supergen biomass biofuels & energy crops	ESPRC	06/07 - 05/11	£79k
F Kuepper	Pioneering post genomics approaches for studying algal host-pathogen interactions, using the Ectocarpus/Eurychasma model	NERC	05/06 - 05/09	£25k
F Kuepper	Transformations, volatilisation & speciation of organic and inorganic iodine in the marine environment	NERC	10/06 - 09/09	£15k
F Kuepper	Oceans2025 Theme 4 WP 4.5 Microbial media	NERC	04/07 - 03/12	£272k
D Meldrum	Arctic synoptic basin-wide oceanography	NERC	01/07 - 12/09	£220k
D Meldrum	Synoptic Antarctic shelf-slope interactions study	NERC	06/07 - 11/10	£171k
D Meldrum	NERC Technology Forum	NERC	03/08 - 06/08	£15k
D Meldrum	Oceans2025 Theme 8 WP 8.9 Satellite comms	NERC	04/07 - 03/12	£422k
AEJ Miller	Ecosystem approach to sustainable management	EU FP6	01/06 –12/09	£233k
AEJ Miller	Socrates-Erasmus mobility grants	UK Socrates-Erasmus Council	07/06 - 09/08	£3k
AEJ Miller	Ecosummer	EU Marie Curie	01/06 -12/09	£234k
AEJ Miller	Erasmus	Socrates-Erasmus	ongoing	£1k
AEJ Miller & M Strittmatter	Ecosummer (PhD project)	EU Marie Curie	06/07 - 11/09	£94k
AEJ Miller & C Lonborg	Ecosummer (PhD project)	EU Marie Curie	06/06 - 05/08	£75k
AEJ Miller	Addressing Research Capacity	Scottish Funding council, ERDF	03/06 - 06/09	£5,636k
AEJ Miller	Additional Skills Training	NERC	ongoing	£5k
AEJ Miller	FE/HE Articulation	Scottish Funding Council via UHI	ongoing	£28k
AEJ Miller	UHI Learning & teaching infrastructure	UHI	ongoing	£26k
AEJ Miller	Wider access retention premium (WARP)	UHI	ongoing	£2k
B Narayanaswamy & G Shimmield	The Census of Marine Life	Stavros Niarchos Foundation	02/05 - 02/09	£241k

RESEARCH GRANTS AND CONTRACT INCOME RECEIVED

B Narayanaswamy	Deep sea Education & Outreach Group	DESEO	ongoing	£79k
L Nickell & P Batty	Bioturbation and ecosystem functioning (PhD project)	NERC	10/05 - 09/08	£9k
T Potts	Role of certification and ecolabelling in sustainability	ESRC	09/07 - 08/09	£99k
T Proeschold	International incoming short visits 2007/R2	The Royal Society	04/08 - 06/08	£4k
J Roberts	Hotspot ecosystem research on the margins of European seas	EU FP6	04/05 – 03/09	£170k
J Roberts	Biodiversity & vulnerability of European coldwater coral reef ecosystems	EU	01/05 - 05/08	£43k
J Roberts	Trans-Atlantic coral ecosystem studies	EU Marie Curie	05/07 - 04/09	£49k
J Roberts	Deep sea conservation for the UK	Porcupine Marine Natural History Society	07/07 - 06/09	£37k
M Sayer	Grampian technical support	Grampian University Hospitals Trust	ongoing	£108k
M Sayer	National Facility for Scientific Diving	NERC	2001-2014	£2,976k
T Sherwin	Internal tides over oceanic topography & their influence on mixing	NERC	10/06 - 09/09	£15k
T Sherwin	Oceans2025 Theme 10 SO4 Sea glider	NERC	04/07 - 03/12	£120k
T Sherwin	Oceans2025 Theme 10 SO4 ADCP mooring	NERC	04/07 - 03/12	£75k
T Sherwin	Oceans2025 Theme 1 WP 1.5A Mining instrument	NERC	04/07 - 03/12	£127k
T Sherwin	Oceans2025 Theme 10 S04 Extended Ellett Line	NERC	04/07 - 03/12	£805k
T Shimmield	Scottish Alliance for Geoscience, Environment and Society	Scottish Funding Council	10/06 - 09/11	£293k
T Shimmield	Oceans2025 Theme 1 WP 1.6 Mooring	NERC	04/07 - 03/12	£130k
T Shimmield	Oceans2025 Theme 1 WP 1.6 Alpha/Gamma	NERC	04/07 - 03/12	£68k
T Shimmield	Oceans2025 Theme 1 WP 1.6 Climate change	NERC	04/07 - 03/12	£2,417m
T Shimmield	Carbon and radioisotope analysis	NERC	04/07 - 03/12	£447k
T Shimmield	Cruise costs	NERC	04/07 - 03/12	£415k
I Sillitoe	Oceans2025 Theme 8 WP 8.7 Sensor optimisation	NERC	04/07 - 03/12	£258k
I Sillitoe	Oceans2025 WP 8.8 Water column	NERC	04/07 - 03/12	£466k

RESEARCH GRANTS AND CONTRACT INCOME RECEIVED

E Walton	UHI Hardship Fund	UHI	08/07 - 07/08	£500
T Wilding	A Review & Assessment of the effects of marine fish farm discharges on Biodiversity Action Plans	SARF	05/07 - 04/09	£83k
J Wilkinson	Developing Arctic modelling and observing capabilities for long-term environmental studies	EU FP6	12/05 – 11/09	£311k
B Wilson & L Wilson	Gadoid fish sound production and its role in mate selection, the risk of predation and impacts of noise pollution (PhD Project)	NERC	10/05 - 09/08	£29k
B Wilson	MSc Supervision	European Social Fund via North Highland College	08/06 - 07/08	£7k

RESEARCH GRANTS AND CONTRACT INCOME RECEIVED

Research services limited

Project Leader	Title	Funding body	Duration
K Black	Non-native Risk Analysis Panel Sub Contract	DEFRA via Central Science Laboratory	12/06 - 03/09
K Black	Analyses	Glycomar	ongoing
C Cromey	Depomod III software	Commercial sales	ongoing
C Cromey	Modelling benthic effects of large salmon cage farms in Scotland.	SSPO	01/08- 09/08
K Davidson	Provision of an official control monitoring programme for the presence of toxin producing plankton in shellfish production areas in Scotland	Food Standards Agency	09/05 - 08/08
F Kuepper	CCAP culture collection	Commercial sales	Annually
M Sayer	NHS recompression facility	NHS	Annually
M Sayer	Grampian hyperbaric technical services	Grampian University Hospitals Trust	Annually
T Shimmield	Investigation of the environment effects of the placement of metal mine processing tailings into the deep sea	EU & Governement of PNG	02/07 - 11/09

Financial Statements

31 March 2009

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W T S Speirs	(appointed 3 Nov 2008)
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Professor G M Henderson	(appointed 3 Nov 2008)
Professor D Paterson	(appointed 3 Nov 2008)
Professor P H Burkill	(appointed 3 Nov 2008)
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M Gibson	(appointed 3 Nov 2008)

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Registered Office

Dunstaffnage Marine Laboratory
Oban
Argyll PA37 1QA

Charity Number: SC 009206

Council report

The Council, who are also Directors of the Charity for the purposes of the Companies Act, for The Scottish Association for Marine Science (SAMS) presents its report and the group financial statements for the year ended 31 March 2009.

SAMS is a company limited by guarantee governed by its Memorandum and Articles of Association. It is registered as a charity with the Office of the Scottish Charity Regulator. Anyone can become a member of SAMS and there are currently 441 including 24 corporate and 62 students (450 in 2008), each of whom agree to contribute £1 in the event of the charity winding up.

SAMS is not permitted by its Memorandum of Association to become a trade union or to distribute profits to its members.

SAMS is a Collaborative Centre of the Natural Environment Research Council and an Academic Partner of the UHI Millennium Institute (UHIMI).

Principal activity

The principal activity of the group is to promote the study of marine science through research and education.

There have been no changes in principal activity since the last annual report.

Objectives and activities

"To improve understanding and stewardship of the marine environment, through research, education, maintenance of facilities and technology transfer."

The strategies employed to achieve the charities objectives during the year:

- Appointment of a new director
- Implement new governance structure that includes
  - Defining terms of reference for the new committees, appointing suitably qualified Council, Board and Committee members
  - Reviewing SAMS delegated authorities to take account of the changes to governance, directorate and the executive group
- Define a Business development strategy incorporating departmental annual plans
- Develop a new 5 year research strategy that considers the NERC science strategy for 2007-12, Next Generation Science for Planet Earth
- Develop further the good relationships that exist with key stakeholders
- Develop a communications and public relations strategy

Business review

Results

The results for the year are detailed on page 9 of the financial statements. The net incoming resources taken to reserves is £1,334k (2008 - £2,398k).

SAMS appointed a new director, Professor Laurence Mee, who replaces Professor Graham Shimmield.

Terms of reference for the new committees has been defined and the majority of appointments to Council, Board and Committees made. The Memorandum and Articles of Association were revised and approved by the members, incorporating a number of changes including the ability to remunerate a minority of Council members.

Departmental plans were produced for all areas of science and education.

SAMS now has a dedicated Communications team charged with communications and public relations.

Council report

Future Plans

SAMS is committed to sustaining its status as a collaborative centre for NERC and to providing national facilities for NERC.

The UHI project, Addressing Research Capacity in the Highlands and Islands (ARC) continues until July 2009.

SAMS is also continuing to work with the UHI to achieve university status.

SAMS will continue to seek grants and service contracts from new and diverse funds.

SAMS begins each year with a level of income to be generated in order to achieve a targeted level of surplus. The level required to be generated in 2009/10 and beyond is in excess of £1m per annum. The current economic climate will make achieving these levels of new income unrealistic. It is for this reason that SAMS has taken the decision to restructure the business during 2009/10. This restructure will be wide ranging and designed to create a structure that will deliver the strategic objectives of the Group. This will allow SAMS to protect reserves and respond to future opportunities in a dynamic and competitive way.

Risk statement

SAMS Council has an established risk management strategy which comprises:

- an annual review of the risks which the charity may face
- the establishment of systems and procedures to mitigate those risks identified in the plan; and
- the implementation of procedures designed to minimise any potential impact on the charity should any of those risks materialise.

Revisions to the Risk Register are considered by the Council, the Board to Council and relevant Committees. The regular process of consideration and review of the appropriateness of the Register is delegated to the Executive Group which reports back to Council.

Directors

The directors, who served the charitable company as Council Members, during the year are listed on page 1.

Reserves policy

It has previously been the policy of the Association to retain sufficient unrestricted reserves to meet the costs of salaries, insurance and other regular financial commitments to allow for an orderly wind down of the organisation. Following changes in employment legislation these costs included provision for potential redundancy costs for all SAMS employees.

During the year we reviewed our reserves policy as part of the revised governance procedures under the chair of the Shadow Board Michael Gibson. The primary aim of the reserves policy is to ensure that we hold adequate funds to maintain the longer term sustainability of the marine science research undertaken by our scientists and to manage short term volatility in income or liquidity. The policy is designed to ensure that the Association can:

- Continue to meet its ongoing financial commitments within agreed terms of credit
- Deploy the required funds promptly in a planned way to react to new opportunities and strategic decisions undertaken by the Associations' Executive Group

Council report

- Ensure that the Association is not forced into short term decisions that might impact on its longer term vision and strategy because of any short term setback, whether operational or in key sources of income, such as NERC core funding under Oceans 2025

As a result the revised policy aims for the Association to hold, in future, in general unrestricted reserves a minimum of 3 months annualised expenditure in order to provide adequate working capital levels for the continued operation of the Association and completion of existing projects.

As part of the Association's new governance procedures, we will monitor regularly the adequacy of our reserves. On an annual basis we will update our longer term financial plans and forecasts and review the reserves policy.

The accumulated reserves and available funds will be applied towards the objectives of the Association. The Trustees accept that this may involve the use of funds in excess of the income generated in one year while in other years the cycle of the Associations activities does not allow the distribution of all funding received (particularly in respect of capital grants).

The Council

The members of the Council, who act as trustees and directors, are all guarantors of the company, of an amount not exceeding £1, during the period of their appointment as Council members and for a year after resignation. The Council is appointed in accordance with the Memorandum and Articles of Association, which allows trustees to serve a maximum of two consecutive 3-year terms.

The members of the Governing Council during the year are listed on page 1.

Both the Natural Environment Research Council (NERC) and Highlands & Island Enterprise (HIE) have observer status at SAMS Council meetings.

Any member of SAMS can nominate a new trustee to serve on Council. The SAMS Director has the responsibility to outline the duties and responsibilities to potential trustees. A new trustee is nominated and seconded at the AGM.

New trustees attend a briefing meeting with the SAMS Director or Company Secretary and are provided with the relevant guidance notes from Companies House and the Office of the Scottish Charity Regulator.

SAMS Council meet quarterly with an annual retreat. A new governance structure has now been put in place and the Council is served by a Board and five sub-committees; Finance Committee, Audit Committee, Research Committee, Education Committee and Business Development Committee that now incorporates the SRSL Board. The SAMS Council, the Board and its Committees approve the Group's strategy and the implementation of the strategy is delegated to the Executive Group led by the SAMS Director.

Investment policy and performance

The Council has considered the most appropriate policy for investing funds and has found that short to medium term investment of funds should be held in a mixture of current and investment accounts to optimise interest earned.

Council report

Executive Group

Management of the Charity is delegated by the Council to the Director and the SAMS Executive Group. The members of the Executive Group during the reporting period were:

Prof Laurence Mee – Director (appointed 1 September 2008)
Dr Ken Jones - Deputy Director (Acting Director 1 March 2008 – 31 August 2008)
Dr Kenny Black- Head of Ecology
Dr Mark Inall – Head of Physics, Sea Ice and Technology
Dr Ray Leakey – Head of Microbiol and Molecular Biology
Prof Axel Miller – Head of Education
Dr Tracy Shimmield – Head of Biogeochemistry and Earth Sciences
Derek Black - Contracts Accountant
Ian Crawford – Director of Human Resources
David Gunn - Knowledge Transfer & Commercialisation
Fran McCloskey – Financial Accountant
Steve Gontarek – Head of ICT & Data Services
Elaine Walton - Company Secretary
Anuschka Miller – Head of Communications (from 14 November 2008)

Equal opportunities

The company is committed to provide full opportunity for the development of individuals' talents by using criteria based on merit and job performance alone in employment related decisions. It is further committed to ensure it does not discriminate on grounds of gender, marital status, race, colour, ethnic or national origins, age, religious belief, sexual orientation or disability.

Directors' statement as to disclosure of information to auditors

The directors who are members of the Council at the time of approving the directors' report are listed on page 1. Having made enquiries of fellow directors and of the company's auditors, each of the directors confirms that:

- to the best of each director's knowledge and belief, there is no information relevant to the preparation of their report of which the company's auditors are unaware; and
- each director has taken all the steps a director might reasonably be expected to have taken to be aware of relevant audit information and to establish that the company's auditors are aware of that information.

Auditors

A resolution to reappoint Ernst& Young LLP as auditors will be put to the members at the Annual General Meeting

By order of the Council

E B Walton

Company Secretary

Statement of Council's responsibilities in respect of the financial statements

The Members of Council (who are directors for the purposes of company law) are responsible for preparing the Annual Report and the financial statements in accordance with applicable law and United Kingdom Generally Accepted Practice.

Company law, the Charities and Trustees Investment (Scotland) Act 2005 and regulation 8 of the Charities Accounts (Scotland) Regulations 2006, requires the Members of Council to prepare financial statements for each financial year. Under that law the Members of Council have elected to prepare the financial statements in accordance with United Kingdom Generally Accepted Accounting Practice (United Kingdom Auditing Standards and applicable law). These financial statements are required by law to give a true and fair view of the state of affairs of the charitable company and the group and of the surplus or deficit of income over expenditure of the group for that period. In preparing those financial statements, the Members of Council are required to:

- select suitable accounting policies and then apply them consistently;
- make judgements and estimates that are reasonable and prudent; and
- prepare the financial statements on the going concern basis unless it is inappropriate to presume that the group will continue in business.

The Members of Council are responsible for keeping proper accounting records which disclose with reasonable accuracy at any time the financial position of the group and to enable them to ensure that the financial statements comply with the Companies Act 1985, the Charities and Trustees Investment (Scotland) Act 2005 and regulation 8 of the Charities Accounts (Scotland) Regulations 2006. They are also responsible for safeguarding the assets of the group and hence for taking reasonable steps for the prevention and detection of fraud and other irregularities.

Independent auditor's report

to the members of The Scottish Association for Marine Science

This report is issued in respect of an audit carried out under section 235 of the Companies Act 1985 and section 44(1)(c) of the Charities and Trustee Investment (Scotland) Act 2005.

We have audited the group financial statements of The Scottish Association for Marine Science for the year ended 31 March 2009 which comprise the Group Statement of Financial Activities, the Group Balance Sheet, the Balance Sheet, the Group Statement of Cash Flows and related notes 1 to 20. These financial statements have been prepared in accordance with the accounting policies set out therein.

This report is made solely to the members, as a body, in accordance with Section 235 of the Companies Act 1985, and to the charity's Members of Council, as a body, in accordance with section 44(1)(c) of the Charities and Trustee Investment (Scotland) Act 2005 and regulation 10 of the Charities Accounts (Scotland) Regulations 2006. Our audit work has been undertaken so that we might state to the members and the charity's Members of Council those matters we are required to state to them in an auditor's report and for no other purpose. To the fullest extent permitted by law, we do not accept or assume responsibility to anyone other than the charity, its members as a body and its Members of Council as a body, for our audit work, for this report, or for the opinions we have formed.

Respective responsibilities of Members of Council and auditors

The responsibilities of the Members of Council (who are the directors of the charity for the purposes of company law) for preparing the Annual Report and financial statements in accordance with applicable law and United Kingdom Accounting Standards (United Kingdom Generally Accepted Accounting Practice) are set out in the Statement of Council's Responsibilities.

Our responsibility is to audit the financial statements in accordance with relevant legal and regulatory requirements and International Standards on Auditing (UK and Ireland).

We report to you our opinion as to whether the financial statements give a true and fair view and are properly prepared in accordance with the Companies Act 1985, the Charities and Trustee Investment (Scotland) Act 2005 and regulation 8 of the Charities Accounts (Scotland) Regulations 2006. We also report to you if, in our opinion, the information given in the Council's Report is consistent with the financial statements, if the charity has not kept proper accounting records, or if information specified by law regarding Members of Councils' remuneration and transactions with the charity is not disclosed, or if we have not received all the information and explanations we require for our audit.

We read the Council Report and consider the implications for our report if we become aware of any apparent misstatements within it.

Basis of audit opinion

We conducted our audit in accordance with International Standards on Auditing (UK and Ireland) issued by the Auditing Practices Board. An audit includes examination, on a test basis, of evidence relevant to the amounts and disclosures in the financial statements. It also includes an assessment of the significant estimates and judgements made by the Members of Council in the preparation of the financial statements, and of whether the accounting policies are appropriate to the charity's circumstances, consistently applied and adequately disclosed.

We planned and performed our audit so as to obtain all the information and explanations which we considered necessary in order to provide us with sufficient evidence to give reasonable assurance that the financial statements are free from material misstatement, whether caused by fraud or other irregularity or error. In forming our opinion we also evaluated the overall adequacy of the presentation of information in the financial statements.

Independent auditors' report

to the members of The Scottish Association for Marine Science

Opinion

In our opinion the financial statements:

- give a true and fair view in accordance with United Kingdom Generally Accepted Accounting Practice, of the state of the charitable group's affairs as at 31 March 2009; and of its incoming resources and application of resources, including its income and expenditure, for the year then ended;

- have been properly prepared in accordance with the Companies Act 1985, the Charities and Trustee Investment (Scotland) Act 2005 and regulation 8 of the Charities Accounts (Scotland) Regulations 2006; and

- the information given in the Council Report is consistent with the financial statements.

Ernst & Young LLP
Registered Auditor
Inverness

Group statement of financial activities (incorporating the income and expenditure account)

for the year ended 31 March 2009

	Notes	2009 Unrestricted funds Undesignated £000	2009 Unrestricted funds Designated £000	2009 Restricted £000	2009 Total £000	2008 Total £000
Incoming resources						
Incoming resources from generated funds:						
Voluntary income	2	500	-	-	**500**	2,000
Activities for generating funds		193	-	-	**193**	200
Investment income	9	16	-	-	**16**	22
Incoming resources from charitable activities		2,673	325	7,288	**10,286**	9,024
Total incoming resources	***3***	**3,382**	**325**	**7,288**	**10,994**	11,246
Resources expended						
Cost of generating funds	4	21	-	23	**44**	46
Charitable activities	5	2,557	396	6,628	**9,581**	8,757
Governance costs	7	36	-	-	**36**	45
Total resources expended		**2,614**	**396**	**6,651**	**9,661**	8,848
Net incoming resources before transfers		**768**	**(71)**	**637**	**1,334**	2,398
Fund balance brought forward at 1 April 2008		2,236	440	8,768	11,444	9,046
Total Funds carried forward at 31 March 2009		**3,004**	**369**	**9,405**	**12,778**	11,444

Group statement of financial activities (incorporating the income and expenditure account)

for the year ended 31 March 2009

Statement of total recognised gains and losses

There are no recognised gains or losses other than the net incoming resources of £1,334k in the year ended 31 March 2009 and £2,398k in the year ended 31 March 2008.

Company balance sheet

at 31 March 2009

	Notes	**March 2009** £000	March 2008 £000
Fixed assets			
Tangible assets	10	**14,026**	13,358
Investments	11	**53**	86
		14,079	13,444
Current assets			
Cash at bank and in hand		**1,187**	983
Debtors	12	**2,861**	2,751
Total : Current Assets		**4,048**	3,734
Creditors: amounts falling due within one year	13	**(3,299)**	(3,520)
Net current assets (liabilities)		**749**	214
Total assets less current liabilities		**14,828**	13,658
Creditors: amounts falling due after more than one year			
Loans	14	**(2,050)**	(2,214)
Total net assets		**12,778**	11,444
Capital and reserves			
Restricted Funds	15a	**9,405**	8,768
Unresricted funds			
Undesignated		**3,004**	2,236
Designated	15b	**369**	440
Total capital and reserves		**12,778**	11,444

Chair of the Board: Michael Gibson President of Council: Sir John Arbuthnott

Company balance sheet

at 31 March 2009

	Notes	**March 2009** £000	March 2008 £000
Fixed assets			
Tangible assets	10	**13,947**	13,292
Investments	11	**0**	41
		13,947	13,333
Current assets			
Cash at bank and in hand		**960**	921
Debtors	12	**3,013**	2,692
Total : Current Assets		**3,973**	3,613
Creditors: amounts falling due within one year	13	**(3,245)**	(3,329)
Net current assets (liabilities)		**728**	284
Total assets less current liabilities		**14,674**	13,617
Creditors: amounts falling due after more than one year			
Loans	14	**(2,050)**	(2,214)
Total net assets		**12,624**	11,403
Capital and reserves			
Restricted Funds	15a	**9,268**	8,644
Unrestricted funds			
Undesignated	15b	**3,357**	2,759
Total capital and reserves		**12,624**	11,403

Chair of the Board: Michael Gibson

President of Council: Sir John Arbuthnott

Group statement of cash flows

for the year ended 31 March 2009

	Notes	**2009** **£000**	2008 £000
Net cash inflow from operating activities	17(a)	**1,964**	1,834
Returns on investment and servicing of finance	17(a)	**(142)**	(152)
Taxation		**-**	-
Capital expenditure	17(a)	**(1,465)**	(1,270)
Financing		**(153)**	(144)
Increase in cash	17(b)	**204**	268

Reconciliation of net cash flow to movement in net funds

	Notes	**2009** **£000**	2008 £000
Increase in cash		**204**	268
Repayment of long term loans		**153**	144
		357	412
Net debt at 1 April		**(1,385)**	(1,797)
Net debt at 31 March	17(b)	**(1,028)**	(1,385)

Notes to the group financial statements

at 31 March 2009

1. Accounting policies

Accounting convention

The accounts are prepared under the historical cost convention modified to include the revaluation of investments, in accordance with applicable accounting standards and the Statement of Recommended Practice "Accounting by Charities" (SORP 2005) issued in December 2005 with the exception of the accounting treatment of a substantial capital grant received from NERC in March, 2007 (see note 15a on page 26).

Status

The Association is a company limited by Guarantee and not having a share capital. The liability of the members who constitute the Association is limited to £1 per member.

The affairs of the Association are managed by an elected Council of Members, who constitute Directors of the Company for Companies Act purposes. The Association is a registered charity, Scottish Charity Number SC009206, and is not liable to income tax or corporation tax on its income under the Income and Corporation Taxes Act 1988.

Basis of consolidation

The consolidated accounts incorporate the accounts of the company and its subsidiary undertakings for the year ended 31 March 2009. Unless otherwise stated, the acquisition method of accounting has been adopted. Under this method, the results of subsidiary undertakings acquired or disposed of in the year are included in the consolidated profit and loss account from the date of acquisition or up to the date of disposal.

In accordance with section 230(4) of the Companies Act 1985, The Scottish Association for Marine Science is exempt from the requirement to present its own profit and loss account. The result of the financial year dealt with in the financial statements of The Scottish Association for Marine Science is disclosed in note 16 to these accounts.

Fixed assets and depreciation

Individual items of capital equipment are included in the balance sheet only if their cost exceeds £5,000 (including irrecoverable value added tax where appropriate).

Depreciation is provided on all tangible fixed assets at rates calculated to write off the cost or valuation, less estimated residual value, of each asset evenly over its expected useful life, as follows:

Property	-	20 to 50 years
Vessels	-	5 to 30 years
Scientific instruments and equipment	-	2 to 20 years
Computer equipment	-	5 years
Fixtures & Fittings	-	5 to 20 years

Value added tax

As the group is registered partially exempt for VAT purposes, expenditure and fixed assets are shown inclusive of irrecoverable value added tax where applicable.

Leasing

Rentals paid under operating leases are charged to income on a straight line basis over the lease term.

Notes to the group financial statements

at 31 March 2009

Accounting policies (continued)

Pensions

The Association participates in the Universities Superannuation Scheme, a defined benefit scheme which is externally funded and contracted out of the State Second Pension. The assets of the scheme are held in a separate trustee-administered fund. It is not possible to identify each institution's share of the underlying assets and liabilities of the scheme on a consistent and reasonable basis and therefore, as required by FRS 17 "Retirement Benefits", the Association accounts for the scheme as if it were a defined contribution scheme. As a result, the amount charged to the income and expenditure account represents the contributions payable to the scheme in respect of the accounting period.

For staff that are NERC employees, pensions are fully funded and guaranteed by NERC.

Incoming resources

Income represents NERC core grants receivable in the year, other research income receivable from outside bodies and other miscellaneous income. Other funds received of a revenue nature are credited to deferred revenue income and credited to the Income and Expenditure Account as the related research costs are incurred.

Resources expended

Direct charitable expenditure represents the full cost of the research performed. It includes the cost of direct staff, consumable stocks, indirect costs and the apportioned support costs. Support costs have been apportioned to direct charitable expenditure on a percentage basis of total charitable expenditure. Fundraising and publicity expenditure represents the cost of obtaining funds for research, promoting the work of the Association and recruitment of staff. Governance costs represent the necessity of compliance with statutory and constitutional requirements.

Investments

Investments include bank balances for the Sheina Marshall Bequest and the Yonge Fellowship, and equity investments.

Foreign currency transactions

All foreign currency gains and losses are taken to the income and expenditure account as incurred. Monetary assets and liabilities denominated in foreign currencies are translated at the rate of exchange ruling at the balance sheet date.

2. Voluntary Income

During the year SAMS received a grant of £500k (2008: £2,000K) from HIE to be used for the furtherance of activities. The grant was received following an independent report commissioned by HIE into SAMS' existing governance structures and infrastructure.

Notes to the group financial statements

at 31 March 2009

3. Incoming resources from charitable activities

	Unrestricted				
	Unrestricted	Designated	Restricted	**Total**	Total
	2009	2009	2009	**2009**	2008
	£000	£000	£000	**£000**	£000
Education and Knowledge Transfer Grants	259	-	138	**397**	298
Research Income, National Capability and Facilities	1,732	-	7,150	**8,882**	7,102
Recompression	-	325	-	**325**	348
Infrastructure	682	-	-	**682**	1,275
	2,673	325	7,288	**10,286**	9,024

4. Cost of generating funds

	Unrestricted				
	Unrestricted	Designated	Restricted	**Total**	Total
	2009	2009	2009	**2009**	2008
	£000	£000	£000	**£000**	£000
Marketing, publications and newsletters	21	-	23	**44**	46

Notes to the group financial statements

at 31 March 2009

5. Charitable activities

	Unrestricted				
	Unrestricted	Designated	Restricted	**Total**	Total
	2009	2009	2009	**2009**	2008
	£000	£000	£000	**£000**	£000
Staff Costs	1,430	117	3,678	**5,225**	4,793
Other Costs	1,127	279	2,950	**4,356**	3,964
	2,557	396	6,628	**9,581**	8,757

6. Net incoming resources

Net incoming resources are stated after charging:	**2009**	2008
	£000	£000
Auditors' remuneration – audit services	**11**	11
– other services	**17**	6
Depreciation and amortisation	**820**	826
Operating lease charges	**56**	66

7. Remuneration of the members of the Council

The non-executive Council members received £6,875 (2008 - £12,201), in the form of reimbursable expenses, in total from the Association during the year.

The following directors received remuneration:

	2009	2008
	£000	£000
Michael Gibson	**16**	9
Gordon McAllister	**2**	0
Dr R A Scrutton	**1**	0
Charles Stevenson	**1**	0
Professor M Bownes	**1**	0

Notes to the group financial statements

at 31 March 2009

8. Staff costs

	2009	2008
	£000	£000
Wages and salaries	**3,396**	2,997
Social security costs	**267**	234
Other pension costs	**423**	376
	4,086	3,607

The average number of full-time equivalent persons employed by the group during the year was as follows:

	2009	2008
	No.	No.
Scientific	**88**	85
Office management	**33**	28
	121	113

The average number of full-time equivalent persons employed by NERC working for the group during the year was as follows:

	2009	2008
	No.	No.
Wages and salaries	**876**	931
Social security costs	**75**	70
Other pension costs	**188**	185
	1,139	1,186

The average weekly number of NERC employees during the year was as follows:

	2009	2008
	No.	No.
Scientific	**13**	18
Office management	**8**	6
	21	24

Notes to the group financial statements

at 31 March 2009

8. Staff Costs (cont'd.)

Remuneration of higher paid staff earning in excess of £50,000, excluding employer's pension contributions were in the following ranges:

	SAMS 2009 No.	NERC 2009 No.	**Total 2009 No.**	Total 2008 No.
£50,000 - £60,000	4	6	**10**	4
£60,001 - £70,000	1	1	**2**	-
£70,001 - £80,000	-	-	**-**	-
£80,000 - £90,000	-	-	**-**	-
£90,000 - £100,000	-	-	**-**	-
£100,000 - £110,000	-	-	-	1

All employees earning more then £50,000 accrued benefits under a defined benefit scheme during the year.

9. Investment income

	2009 £000	2008 £000
Interest receivable	**16**	22

Notes to the group financial statements

at 31 March 2009

10. Tangible fixed assets

Group	Assets under Construction £000	Property £000	Vessels £000	Fittings and Equipment £000	Total £000
Cost:					
At 1 April 2008	-	13,647	417	5,921	19,985
Reclassification of assets	-	16	103	(103)	16
Additions	71	81	7	1,313	1,472
At 31 March 2009	71	13,744	527	7,131	21,473
Depreciation:					
At 1 April 2008	-	1,816	417	4,394	6,627
Charge for year	-	256	71	493	820
At 31 March 2009	-	2,072	488	4,887	7,447
Net book value:					
At 31 March 2009	**71**	**11,672**	**39**	**2,244**	**14,026**
At 31 March 2008	-	11,831	-	1,527	13,358

Notes to the group financial statements

at 31 March 2009

10. Tangible fixed assets (contd.)

Company	Assets under Construction	Property	Vessels	Fittings and Equipment	Total
	£000	£000	£000	£000	£000
Cost:					
At 1 April 2008	-	13,647	417	5,669	19,733
Reclassification of assets	-	16	103	(103)	16
Additions	71	81	7	1,246	1,405
At 31 March 2009	71	13,744	527	6,812	21,154
Depreciation:					
At 1 April 2008	-	1,816	417	4,208	6,441
Charge for year	-	256	71	440	767
At 31 March 2009	-	2,072	488	4,648	7,208
Net book value:					
At 31 March 2009	**71**	**11,672**	**39**	**2,164**	**13,947**
At 31 March 2008	-	11,831	-	1,461	13,292

Notes to the group financial statements

at 31 March 2009

11. Investments

	Group		Company	
	2009	2008	**2009**	2008
	£000	£000	**£000**	£000
Sheina Marshall Bequest:				
Flat at cost	**-**	26	**-**	26
Bank balances	**-**	14	**-**	14
Debtor	**-**	1	**-**	1
	-	41	**-**	41
Other investments	**53**	45	**-**	-
	53	86	**-**	41

The flat has been reclassified as tangible fixed assets. The bank balance and debtor balance, now received, has been utilised in the maintenance of that asset.

Company

Details of the investments in subsidiary undertakings held by The Scottish Association for Marine Science are as follows:

Subsidiary undertakings	*Holding*	*Proportion of voting Rights and shares held*	*Nature of Business*
SAMS Research Services Limited	Ordinary shares	100%	Marine and research Support services
The European Centre for Marine Biotechnology	Limited by guarantee	Sole member	Non trading

SAMS Research Services Limited gift aid all of its taxable profits to The Scottish Association for Marine Science.

Notes to the group financial statements

at 31 March 2009

11. Investments (cont'd.)

A summary of the trading results is shown below:

	SAMS Research Services Limited 2009 £000
Turnover	**1,696**
Cost of sales and administrative expenses	**(1,555)**
Interest receivable and other operating income	**2**
Interest payable	**(1)**
Net profit before Gift Aid and tax	**142**
Amount gifted to charity	**(103)**
Taxation	**-**
Profit for the year	**39**

The assets and liabilities of the subsidiary at 31 March 2009 were:

Fixed assets	**133**
Current assets	**920**
Creditors: amounts falling due within one year	**(1,004)**
Deferred government grants	**(11)**
Aggregate share capital and reserves	**38**

The results of The European Centre for Marine Biotechnology for the year ended 31 March 2009 are not material to the group. This company ceased trading on 31 March, 2008.

Notes to the group financial statements

at 31 March 2009

12. Debtors

	Group		Company	
	2009	2008	**2009**	2008
	£000	£000	**£000**	£000
Trade debtors	**1,093**	538	**1,026**	193
Other debtors	**0**	2	**0**	2
Prepayments and accrued income	**1,768**	2,211	**1,140**	1,897
Due from group undertakings	**-**	-	**847**	600
	2,861	2,751	**3,013**	2,692

13. Creditors: amounts falling due within one year

	Group		Company	
	2009	2008	**2009**	2008
	£000	£000	**£000**	£000
Current instalment due on bank loan (note 14)	**165**	154	**165**	154
Payments received in advance	**2,579**	2,641	**2,562**	2,604
Taxation and social security	**152**	140	**152**	132
Sundry creditors and accruals	**403**	585	**366**	439
	3,299	3,520	**3,245**	3,329

The bank loans and overdraft facilities are secured by a bond and floating charge over the whole assets of the company and a standard security over Dunstaffnage Marine Laboratory, Oban both in favour of the Bank of Scotland. HIE Argyll and the Islands also hold a standard security over Dunstaffnage Marine Laboratory, Oban.

Notes to the group financial statements

at 31 March 2009

14. Loans

	Group		Company	
	2009	2008	**2009**	2008
	£000	£000	**£000**	£000
Not wholly repayable within five years:				
£2,900,000 bank loan at 1.25% above LIBOR per annum, repayable in monthly instalments of £25,419 commencing 3 March 2004	**2,215**	2,368	**2,215**	2,368
Less: included in creditors: amounts falling due within one year (note 13)	**165**	154	**165**	154
	2,050	2,214	**2,050**	2,214
Amounts repayable:				
In one year or less, or on demand	**165**	154	**165**	154
In more than one year but not more than two years	**176**	164	**176**	164
In more than two years but not more than five years	**603**	564	**603**	564
	944	882	**944**	882
In more than five years	**1,271**	1,486	**1,271**	1,486
	2,215	2,368	**2,215**	2,368

Notes to the group financial statements

at 31 March 2009

15(a) Restricted funds

	01 Apr 2008 £000	Income £000	Expenditure £000	**31 Mar 2009 £000**
Group				
Fixed asset funds	8,684	1,472	(820)	**9,336**
Sheina Marshall Bequest	41		(15)	**26**
Yonge Fellowship	3			**3**
Argos	40			**40**
Research Projects		6,628	(6,628)	**0**
	8,768	8,100	(7,463)	**9,405**

	01 Apr 2008 £000	Income £000	Expenditure £000	**31 Mar 2009 £000**
Company				
Fixed asset funds	8,600	1,405	(767)	**9,239**
Sheina Marshall Bequest	41		(15)	**26**
Yonge Fellowship	3			**3**
Research Projects		6,628	(6,628)	**0**
	8,644	8,033	(7410)	**9,268**

Capital grants are recognised as restricted income in the year in which they are received and the depreciation on all fixed assets funded by capital grants is recognised as an expense against the restricted fund. The only exception to this is a capital grant of £978k received from NERC in March 2007, under Oceans 2025. The individual items of capital equipment for Oceans 2025 are of a specialist nature and to date not all have been delivered by the suppliers to the Associations' scientists. For this reason the Trustees consider it more appropriate to include as income in the 2009 financial statements only the capital grant for those items delivered, commissioned and tested. The amount included in income is £449k. The balance of £529k is included within creditors, payments received in advance in note 13 on page 24.

Notes to the group financial statements

at 31 March 2009

The Sheina Marshall Bequest is an amount left by the late Dr Sheina Marshall OBE, DSC to the Association. The sum bequested was used by the Association to purchase a dwelling property in Oban which is used to accommodate visiting researchers.

The Yonge Fellowship is to commemorate the late Professor Sir Maurice Yonge. Awards will be made from the fund to suitable marine science projects.

15(b) Designated funds

SAMS Council have designated a reserve in respect of the recompression service. This service is delivered by SAMS Research Services Limited, a wholly owned subsidiary of SAMS. The operating surplus is gift-aided to SAMS and held in a designated reserve. The reserve is set up to recognise the uncertainty of recompression income as it is entirely dependent upon divers in the West Coast of Scotland having incidents that require treatment. This reserve is to allow the recompression service to continue trading through low levels of activity. This reserve is also to allow the service to invest in the facility to ensure continued delivery of a high quality facility that meets all necessary legal and regulatory requirements.

16. Income and expenditure account

In accordance with the exemption allowed by section 230 of the Companies Act 1985 the company has not presented its own income and expenditure account or statement of financial activities. The net incoming resources for the financial period attributable to members of the parent company dealt with in the accounts was £1,221k (2008 – £2,429k).

Notes to the group financial statements

at 31 March 2009

17. Notes to the statement of cash flows

(a) Reconciliation of net incoming resources to net cash inflow from operating activities:

	2009	2008
	£000	£000
Net incoming resources	**1,334**	2,398
Net interest paid	**142**	152
Depreciation and amortisation	**820**	826
(Increase)/decrease in debtors	**(110)**	(1,261)
(Decrease)/increase in creditors	**(221)**	(281)
Net cash inflow from operating activities	**1,964**	1,834

Returns on investment and servicing of finance

	2009	2008
	£000	£000
Interest received	**16**	22
Interest paid	**(158)**	(174)
	(142)	(152)

Capital expenditure and financial investment

	2009	2008
	£000	£000
Payments to acquire investments	**(8)**	(5)
Payments to acquire tangible fixed assets	**(1,457)**	(1,265)
	(1,465)	(1,270)

Financing

	2009	2008
	£000	£000
Repayment of long term loans	**(153)**	(144)

Notes to the group financial statements
at 31 March 2009

17. Notes to the statement of cash flows (contd.)

(b) **Analysis of changes in net debt**

	At 1 April 2008 £000	Cash flow £000	**At 31 March 2009 £000**
Cash at bank and in hand	983	204	**1,187**
Debt due within one year	(154)	(11)	**(165)**
Debt due after one year	(2,214)	164	**(2,050)**
	(1,385)	357	**(1,028)**

Notes to the group financial statements

at 31 March 2009

18. Pension commitments to pension fund

The Association participates in the Universities Superannuation Scheme, a defined benefit scheme which is externally funded and contracted out of the State Second Pension. The assets of the scheme are held in a separate trustee-administered fund, Universities Superannuation Scheme Limited. Because of the mutual nature of the scheme, the institution is not able to identify each institution's share of the underlying assets and liabilities of the scheme on a consistent and reasonable basis and therefore, as required by FRS17 "Retirement Benefits" contributions to the scheme are accounted for as if it were a defined contribution scheme. As a result, the cost recognised within the surplus/deficit for the year in the Statement of Financial Activities represents the contributions payable to the scheme for the year.

The latest actuarial valuation of the scheme was at 31 March 2008. The assumptions which have the most significant effect on the result of the valuation are those relating to the rate of return on investments (ie the valuation rate of interest) and the rates of increase in salary and pensions. In relation to the past service liabilities the financial assumptions were derived from market yields prevailing at the valuation date. It was assumed that the valuation rate of interest would be 4.4% per annum, salary increases would be 4.3% per annum (plus an additional allowance for increases in salaries due to age and promotion and a further amount of £1,350m of liabilities to reflect recent experience) and pensions would increase by 3.3% per annum. In relation to the future service liabilities it was assumed that the valuation rate of interest would be 6.1% per annum, including an additional investment return assumption of 1.8% per annum, salary increases would be 4.3% per annum (also plus an allowance for increases in salaries due to age and promotion) and pensions would increase by 3.3% per annum. The valuation was carried out using the projected unit method.

At the valuation date, the market value of the assets of the scheme was £28,843 million and the value of the past service liabilities was £40,619 million leaving a deficit of £11,776 million. The assets therefore were sufficient to cover 71% of the benefits which had accrued to members after allowing for expected future increases in earnings.

The actuary also valued the scheme on a number of other bases as at the valuation date. Using the Pension Protection Fund regulations introduced by the Pensions Act 2004 it was 107% funded; on a buy-out basis (ie assuming the Scheme had discontinued on the valuation date) the assets would have been approximately 79% of the amount necessary to secure all the Universities Superannuation Scheme benefits with an insurance company; under the scheme funding regulations, the assets of the scheme at the valuation date were 103% of the scheme's technical provisions based on projected pensionable salaries and using the FRS17 formula as if Universities Superannuation Scheme was a single employer scheme, the actuary estimated that the funding level would have been approximately 104%.

The company contribution rate required for future service benefits alone at the date of the valuation was 14.3% of pensionable salaries but it was suggested that the company contribution rate will be raised to 16% of pensionable salaries from 1 October 2009.

Surpluses or deficits which arise at future valuations may impact on the company's future contribution commitment. An additional factor which could impact the funding level of the scheme is that with effect from 16 March 2006, Universities Superannuation Scheme positioned itself as a "last man standing" scheme so that in the event of the insolvency of any of the participating employers in the Universities Superannuation Scheme, the amount of any pension funding shortfall (which cannot otherwise be recovered) in respect of that employer will be spread across the remaining participant employers and reflected in the next actuarial valuation of the scheme. The next formal triennial actuarial valuation is due as at 31 March 2011. The contribution rate will be reviewed as part of each valuation.

The total pension cost for the group was £611,000 (2008 - £561,000). The contribution rate payable by the group was 14% of pensionable salaries.

Notes to the group financial statements

at 31 March 2009

19. Capital commitments

	Group		Company	
	2009	2008	**2009**	2008
	£000	£000	**£000**	£000
Capital commitments contracted for	**86**	423	**86**	391

20. Other financial commitments

At 31 March 2009 the group had annual commitments under non-cancellable operating leases as set out below:

	Group		Company	
	2009	2008	**2009**	2008
	£000	£000	**£000**	£000
Operating lease which expire:				
within one year	**14**	2	**14**	2
within two to five years	**40**	54	**40**	54
	54	56	**54**	56

SAMS is an Academic Partner in the UHI Millennium Institute and a Collaborative Research Centre of the Natural Environment Research Council.

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