ANNUAL REPORT 05-06
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Director

Professor G B Shimmield
It is a great pleasure to record the events of 2005-6 for the Association. Having completed all the major capital building work and science audits of the two previous years, this promised to be a year of consolidation and future planning. In this first year of the new SAMS President, Sir John Arbuthnott, SAMS has a major opportunity to play a pivotal role in marine science strategy in Scotland at both an academic and strategic level. Our academic contribution was recognised by a significant award of £5.6 million to SAMS as part of the £11.4 million Addressing Research Capacity (ARC) award to the UHI Millennium Institute. The Scottish Funding Council (SFC), Highlands and Islands Enterprise and European Regional Development Fund are all contributing, allowing SAMS to recruit 14 academic and research fellowship posts, 10 technical staff and to initiate a major refurbishment programme for offices and the procurement of much needed analytical instrumentation. This is an amazing investment in new academic talent in marine science in Scotland, and we have been delighted with the response to the advertisements. Our new staff are drawn from six nationalities, and from countries as far away as Canada and Australia.

At a strategic level, the opportunity for Scottish universities and research institutes to work closely together to develop marine science is now well underway through a process known as “pooling”. Under the chairmanship of Professor Ian Boyd from the Sea Mammal Research Unit at the University of St Andrews, who is also a SAMS Council member, an innovative programme of research coordination and cooperation is being proposed to the SFC. The outcome of the funding bid, likely to exceed £8 million, will be known early next year. In the meantime, SAMS is also a partner in the approved pool for environmental geoscience, known as the Scottish Alliance for Geoscience, Environment and Society (SAGES), coordinated by the University of Edinburgh.

Across the UK, 2006 has seen the emergence of discussion on the proposed Marine Bill, which sets out to tackle the vexed questions of spatial planning, natural resource usage, impact of climate change and data management. The issues of devolution loom large in such discussions, and SAMS is playing a full role in assisting the Scottish Executive Environment and Rural Affairs Department (SEERAD) in assessing how such measures may be implemented to good effect across Scotland. A subtext for these discussions is the potential launch of the first Marine National Park, of which one candidate site is the Firth of Lorne and Sound of Mull, right on our doorstep. SAMS continues to offer impartial and detailed strategic advice to the discussions that are underway in public and government venues.
Although not strictly within the reporting year, I am writing this Introduction at the end of one of the most successful scientific meetings ever hosted by the Association. The 2006 Challenger Society biannual conference for UK and European oceanographers took place over 5 days at the Corran Halls and the Dunstaffnage laboratories. The previous occasion that the Association hosted this meeting on its premises was in 1946, immediately after the war, at Millport! Over 270 delegates enjoyed a fantastic programme of science and social events which has really enhanced the reputation of the Association, its staff, and members. Events such as this make the many trials of everyday activity worthwhile, and again, make me realise how fortunate I am to occupy the position of Director in this dynamic, enthusiastic and successful organisation.

In commending this Annual Report to you, I would like to pay special thanks to the members of SAMS Council who give voluntarily of their time and expertise, to assist in the governing of the complex, challenging, but hugely rewarding organisation that is the Scottish Association for Marine Science.

Graham Shimmield
This 5 year NERC-funded programme, which ends in 2007, has provided new insights into environmental processes acting in northern waters. Some of these have direct relevance to our understanding of water circulation in the N Atlantic – a key factor controlling the climate of western Europe. Others attempt to trace the source and fate of anthropogenic pollutants entering the Arctic, as well as natural processes that lead to the burial and/or recycling of carbon. Closer to home, detailed studies on west coast sea lochs have greatly improved our understanding of how tidal energy propagates within complex lochs with several shallow sills. Comparison of local and regional scale patterns in rocky shore communities has shed light on the role of ‘bottom up’ versus ‘top down’ processes in determining these patterns. Finally, the importance of the exact composition of nitrogen sources entering our seas, in determining the growth of phytoplankton, has been elucidated.

Ellett line hydrographic section

In October 2005 SAMS surveyed the extended Ellett line, from Scotland to Iceland, on one of the last cruises of RRS Charles Darwin. Besides making standard observations, the cruise provided data collection and training opportunities for students from Britain, France, Portugal, the Faroes and Thailand in disciplines ranging from iron biogeochemistry to cetacean monitoring. The cruise demonstrated that Eastern North Atlantic Water continues to predominate in the surface waters of the Rockall Trough, with the most recent observations being the warmest and saltiest to date (relative to the seasonal mean). Amongst the highlights of the cruise were the confirmation of acorn worms in the muds of the Faroes - Shetland Channel, the observation of a large number of sperm whales in the Rockall Trough, and a swath bathymetry survey which revealed the complicated structure of a gully that entraps deep Arctic water flowing south across the Wyville Thomson Ridge.

Faroes - Shetland Channel

A joint experiment with POL and NIOZ in the Faroes - Shetland Channel revealed the existence of deep (600m) tidal bores on the continental slope at the interface between waters of Atlantic and Arctic origin. These findings were reported at the American Geophysical Union meeting in February 2006.
Fjords

Fundamental research into mixing processes in restricted coastal systems (sea lochs, or fjords) has challenged the accepted wisdom that those systems with strong tidal currents at their entrance have limited vertical mixing in the inner reaches away from the entrance sills. A combination of detailed observations and high resolution non-hydrostatic numerical modelling (with the University of Plymouth) revealed the excitation of a significant, propagating internal tide in Loch Etive, a system with very high currents at the entrance. The implications of this result will apply to many other fjordic systems thought to have very weak internal tides.

Three-dimensional numerical modelling of the water circulation in Loch Torridon, in collaboration with FRS, Aberdeen, revealed the influence that sill regions can exert on the circulation and mixing processes throughout fjord systems. The sill introduced complexity (e.g. clockwise and anti-clockwise gyres) into the residual circulation, with implications for exchange of the system. Barotropic tidal energy loss at the sill was accompanied by an internal tide that propagated seaward along the loch basin and the development of lee waves on either side of the sill that propagated upstream when tidal currents slackened. The model also demonstrated the temporal and spatial variability of mixing in the fjord.

M Inall, T Sherwin and P Gillibrand

The salinity-$\delta^{18}$O water relationship in Kongsfjorden, western Spitsbergen, Svalbard

The application of oxygen isotope measurements for differentiating between the two main sources of freshwater - meteoric (atmospheric) and sea-ice meltwater has been thoroughly demonstrated. The latitudinal variation in the value of $\delta^{18}$O for meteoric water, caused by temperature and distance from the evaporation site, makes $\delta^{18}$O an ideal tracer to identify high latitude freshwater sources. Finally, salinity: $\delta^{18}$O mixing lines are particularly valuable in high latitude locations as they can be used to identify freshwater sources within mixed coastal waters. Stations in the inner basin of Kongsfjorden western Svalbard were sampled for oxygen isotope ($\delta^{18}$O) composition of glacial ice and seawater. Temperature, salinity and $\delta^{18}$O profiles were used to describe the seasonal evolution of hydrography and to construct a salinity: $\delta^{18}$O mixing line in an area with inputs of freshwater and marine Atlantic Water. The resulting salinity: $\delta^{18}$O relationship was found to be $\delta^{18}$O = 0.43S − 14.65. The Kongsfjorden data provide a northern latitudinal limit for mixing lines in the Northwestern European coastal system.

S Cox, J Howe, T Shimmield, F Cottier (SAMS) and W Austin (University of St Andrews)

Acoustic seabed mapping and piston coring in western Svalbard and the Fram Strait.

This project examines sediment pathways and the signal of climatic amelioration following the last ice age from high-latitude marine sediments, using sediment
texture and geochemistry. Cruise JR127 surveyed and sampled the Eistla and another unnamed seamount (dubbed ‘Jessica’) in the southern sector of the Molloy Ridge, Fram Strait. These data will reveal insights into the high-latitude depositional setting and sediment pathways on an active oceanic ridge in a gateway setting. Further sampling was also undertaken in Kongsfjorden and Krossfjorden.

J Howe, S Cox and C Wilson

Sediment accumulation and mixing rates along the Svalbard margin

$^{210}$Pb activity profiles can be used to assess the rate of sediment accumulation and the extent and depth of mixing within sediment. Both of these processes are important in understanding the transport of sediment, the biogeochemical cycling of carbon and metals and the redistribution of pollutants within the marine environment. To study these processes within the western Svalbard margin, we have analysed cores which lie on a north-south transect, Yermak Plateau (YP), western Svalbard Margin (KF4), Bear Island Fan (BIF) and Voring Plateau (VP) and in addition we have considered an east-west depth transect, Kongsfjorden (KF1), western Svalbard Margin (KF4) and Fram Strait (KF5).

The results indicate that the sediment accumulation rates are higher at the northern stations and that there is a decrease in sedimentation rate with depth. The sedimentation rate in Kongsfjorden is high and variable. These data have been used to construct chronologies for the cores for the western Svalbard margin.

T Shimmield

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<th>Average liner accumulation rate (mm/y)</th>
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</table>

Table 1: Sediment accumulation rates for cores from western Svalbard.

New seafloor survey image of Rosemary Bank seamount. White areas were not covered by the ship’s track.

Seafloor processes around Rosemary Bank seamount, North Atlantic Ocean

Rosemary Bank is a tear-drop shaped seamount of volcanic origin. The seamount is 70km in diameter and situated in water depths of between 300-2300m, 120km west of the UK mainland. A new seafloor survey from the British Antarctic Survey has been combined with pre-existing commercial oil company data including oceanographic measurements, sub-seafloor seismic reflection profiles and seabed core samples. The spectacular new survey data show features such as...
ancient volcanic cones, slide scars and the terraced slopes of the bank. Deep-ocean currents flowing around the base of the seamount have mounded and sculpted the seafloor around the entire seamount, including generating two fields of giant sediment waves. Current meter mooring and oceanographic measurements indicate that the western flanks of the seamount are strongly influenced by Labrador Sea Water flowing northwest.

J Howe

Predicting the scale of species patterns in coastal communities

A major aim of the Northern Seas Programme has been to identify the chief causal factors structuring biological communities along large-scale environmental gradients. We chose to address this issue by exploiting the ready accessibility of intertidal and shallow water habitats to collect data on patterns of biodiversity over a range of spatial scales, and to relate these data to patterns in remotely sensed environmental variables such as temperature or pelagic productivity. We concluded the collection of rocky shore data in 2005 by expanding our region of interest to eastern and southern Scotland. This large spatial dataset has allowed us to identify several important processes structuring ecosystems. As in coastal upwelling regions elsewhere in the world, highly productive areas in the region are dominated by fast-growing filter feeders such as barnacles, promoted by an enhanced food supply from the plankton. However, where local conditions favour the recruitment of the dominant grazer in the system - the limpet Patella vulgata, high grazing intensity results in communities dominated by grazer-resistant species of algae, especially those forming short turfs and crusts on the rock.

Understanding the effects of ecological processes acting at different spatial scales requires a knowledge of the variation occurring at these scales. Using our spatial dataset we adopted an approach prevalent in analysis of patterns in the open ocean - the concept of ‘scale variance’. Statistical techniques allow us to quantify the differences between regions of differing sizes. Analysis of the scale variance of all the species in our 5-year study indicated that most species showed the greatest variability over large spatial scales (e.g. Littorina littorea). In contrast, those species classed as predators had far greater small scale variability (e.g. Nucella lapillus). This has a very important implication for ecological control of ecosystem structure. In open marine systems it seems that top-down control may be limited to small scale patches of high predator abundance, while bottom-up processes may result in much larger scale patterns of community structure. The next five-year programme will focus on experimental manipulation to test this emerging concept.

M Burrows, L Robb and R Harvey
Bioirrigation in Arctic Latitudes

Biological enhancement of particle and solute movement in response to environmental drivers can have critical implications for the burial and remineralisation of organic carbon in the marine environment. At more northerly latitudes, input of organic carbon is highly seasonally pulsed and it is possible that organisms show rapid behavioural responses in order to exploit this ephemeral resource. During an Arctic cruise in Sept/Oct 2005 on the RRS James Clark Ross, shipboard core incubations with added fluorescent particles were used to examine sediment processing rates and bioirrigation and any changes induced by the addition of algal organic carbon. Measurements of benthic metabolism provided a further indication of changes in organism behaviour and activity rate. Early results indicated that organism responses, including fluxes of nutrients, were complex and did not show linearity. Periodicity was evident in bioirrigation rates which may be of great significance in influencing organic carbon degradation rates.

The objectives of this bioturbation work complement those of the European Union funded project Coastal Ocean Benthic Observatories (COBO) which seeks to integrate innovative technologies to provide in-situ monitoring of coastal sediment habitats, providing information on processes, such as bioturbation and bioirrigation, and their role in regulating ecosystem function.

L Nickell and S Harvey

Quality counts: how planktonic ecosystems respond to nutrient inputs to coastal waters

In coastal marine environments, the supply of nitrogen frequently limits phytoplankton production. Nitrogen may be introduced into surface waters from deeper water as regenerated inorganic nitrogen but may also enter in inorganic or organic form via aquaculture inputs, freshwater run-off from land or sewage discharges. These additional sources, many of which result from human activity, may perturb planktonic ecosystems leading to coastal eutrophication. The importance of inorganic nitrogen for the nutrition and growth of marine phytoplankton is widely recognised; however, the influence of organic nitrogen on the planktonic microbial community and subsequent carbon cycling in shelf seas has received less attention. We therefore investigated the effect of organic nitrogen on a coastal
planktonic microbial community using experimental mesocosms in which both inorganic and organic dissolved nitrogen concentrations were manipulated.

We found that the chemical form in which nitrogen was available to the planktonic microbial community, either inorganic or organic, influenced species composition, succession and the efficiency of carbon incorporation into the community. Important processes governing carbon draw-down were the competition between bacteria and phytoplankton for nitrogen, and the activities of microbial grazers. In particular, phytoplankton growth was rapid when inorganic nitrogen was present, whereas organic nitrogen was used more slowly, resulting in a slower and smaller increase in planktonic carbon biomass. Inorganic nitrogen also stimulated the rapid growth of bacteria which escaped grazing control, while organic nitrogen led to a slower-growing bacterial community controlled by grazers. A rapid succession of microbial grazers was evident but with differences in species and their contribution to biomass depending on the relative availability of the different forms of nitrogen. Overall our research shows that it is the chemical form of nitrogen, as well as the quantity, which influences planktonic microbial community structure. The response of coastal ecosystems to nutrient inputs will therefore differ depending on the quality of nitrogen present.

K Davidson, R Leakey, E Mitchell, M Hart and Axel Miller

Response of phytoplankton biomass to inorganic and organic nitrogen treatments during the 20 day mesocosm experiment. Key: orange – 50:50 inorganic:organic N; green – inorganic N; blue – organic N; red – no addition of N.
PHYSICS, SEA ICE AND TECHNOLOGY
DEPARTMENT

Department members: Dr Mark Inall (Head), Mr David Meldrum (Deputy), Mr Bruce Barr, Dr Chris Cromey, Dr Finlo Cottier, Dr Martin Doble, Dr Phil Gillibrand, Mr Colin Griffiths, Mr Nick Hughes, Mr Alistair James, Dr Duncan Mercer, Dr Oli Peppe, Dr Toby Sherwin, Dr Jeremy Wilkinson, Miss Yingzhao Zhou.
Integrated Studies on Arctic Shelves

Unique data from our mooring in Kongsfjorden, Svalbard, have allowed SAMS scientists to establish the link between exchange of Arctic and Atlantic water masses and the structure of the associated zooplankton populations. In a typical day-night scenario, zooplankton will tend to ascend in synchrony at dusk and descend before dawn to avoid visual predators. However, acoustic measurements show that during periods of midnight sun, zooplankton show unsynchronised behaviour and undertake forays to the surface throughout the day. The Arctic winter of 2005-06 was exceptional in that there was virtually no sea ice formation in the fjords around Spitsbergen. Using data from the mooring, we are working with colleagues at the Norwegian Polar Institute and the University Centre on Svalbard to understand the climatic significance of those unusual conditions.

F Cottier, M Inall, C Griffiths and P Provost

The distribution and abundance of marine mammals in relation to physical oceanographic variables in Scottish waters

Archived observations and model predictions have been assembled into a GIS database for access by colleagues at the Sea Mammal Research Unit (SMRU). Observed data comprise satellite images of sea surface temperature and chlorophyll a (courtesy of Plymouth Marine Laboratory), together with CTD profiles. Model data originating from MetOffice runs of the Proudman Oceanographic Laboratory Coastal Ocean Modelling System (POLCOMS) have been reduced into two-dimensional spatial parameters for inclusion in the database. Marine mammal distribution and abundance data collected by SMRU are being compared against the database using a tool developed by the SAMS GIS team. The tool also contains a predictive element, allowing marine mammal distributions to be forecast from environmental variables.

P Gillibrand, M Inall and S Gontarek

MOEN

Within this EU project, analyses of altimeter and drifter data from the Faroe-Shetland Channel have revealed two patches of high kinetic energy located northeast of the Wyville-Thomson Ridge. The patches are caused by instabilities in the surface slope current that flows north-eastward through the channel. They are trapped by a strong southward flow of Arctic water below 500 m, and may contribute to the mixing of surface water masses originating from different ends of the channel.

T Sherwin

Sea Ice Research

Three important EU programmes came to a successful conclusion this year, namely:

- GreenICE (Greenland Arctic Shelf Ice and Climate Experiment), a six-partner study, co-ordinated by SAMS, of the ice thickness distribution north of Greenland and Ellesmere Island, together with a study of paleo-ice conditions from

Examples of derived parameters from the POLCOMS model dataset. The three figures shown describe the predicted temperature field on the shelf to the west of Scotland on 1st August 2004: Sea surface temperature (SST, °C), surface-bottom temperature difference (°C), and thermocline depth (m). Similar derivations were made for daily predictions of salinity, density and current velocity.
sediment cores;
• SITHOS (Sea Ice Thickness Observing System), the development of a European monitoring system for sea ice thickness and related parameters for climate change detection, environmental protection and support to sea transport and offshore operations;
• IRIS (Ice Ridging Information for Decision Making in Shipping Operations), a study of the mechanics of ridge building and ridge structure, and the relationship between ridging parameters and ice resistance forces on vessels.

On-going funded projects include:

• The NERC funded Cryosat validation programme;
• The EU funded IPY-CARE (International Polar Year - Climate of the Arctic and its Role for Europe) programme, whose role is to prepare a pan-European science and implementation plan for Arctic climate change;
• Commissioned research for the UK Hydrographic Office to update the sea ice and iceberg limit information in its North and South Atlantic summary charts; as well as updates of all sea ice sections for the Admiralty Pilots;
• The start of a new 47-partner EU Integrated Project ‘Developing Arctic Modelling and Observing Capabilities for Long-term Environmental Studies’ (DAMOCLES).

J Wilkinson, N Hughes and M Doble

Autonomous Platforms – landers, Homer and ice tethered platforms

As part of our philosophy of moving away from ship-based observations of the ocean, we have continued development of seabed observatories (landers) and a unique seabed-resident profiling vehicle (Homer). Homer has seen further deployments in Loch Etive and the Irish Sea, and is now capable of 2-way communications with the lab via acoustic and satellite modems. This vehicle is attracting much interest because of its potential to routinely gather water column data without requiring a permanent (and vulnerable) mooring. Within NERC-IPY, we are developing novel Arctic platforms for studying fluxes of heat through sea ice and its relation to thickness changes.

D Meldrum, D Mercer, O Peppe, B Barr, A James and Y Zhou

Communications techniques

The Marine Technology group has for many years pioneered the use of satellite communications for the collection of data from ocean platforms such as drifting buoys. We have continued to be particularly active in developing the Iridium system, largely for polar applications. Iridium is unique in that it is a true global 24/7 mobile phone system, thus permitting online dial-up sessions between the polar experiment and the laboratory for diagnostics and control – and for the downloading of large amounts of data. Currently we have four systems operating high in the Arctic Ocean, reporting a wide range of parameters that will help determine whether the Arctic ice is thinning in response to climate change, and a further platform in the Weddell Sea in the Antarctic. Latest developments have exploited a new generation of miniaturised modems in a laptop-sized GPS drifter for polar use, particularly to support the CryoSat programme.

D Meldrum, D Mercer, O Peppe and Y Zhou

D Meldrum, D Mercer, O Peppe and Y Zhou

Temperature data from the SAMS suite of Arctic platforms, published on the Internet in real time at dalriada.nsm.ac.uk/php.

The latest miniature GPS-Iridium drifter being developed for CryoSat.
This year, much of our fieldwork has again focused on marine processes in the Arctic, but we have continued to work up data from Arabian Sea cruises of past years and also took part in a cruise to Antarctica. In addition to the staff listed under each topic, the Department relied heavily on the commitment of the following SAMS support scientists; T Brand, K Doig, C Haidon, M Harvey, S McKinlay and T Sawyer.

Recent deep-water sedimentation in the Antarctic region

Twelve stations in the northern Weddell Sea, Antarctica, and adjacent waters have been sampled using sub-bottom profiles, seabed camera and short box cores and multicores as part of the ANDEEP (ANtarctic benthic DEEP sea biodiversity: colonization history and recent community patterns) programme. The German icebreaker RV Polarstern spent three months collecting these data during 2005. The cores were studied using x-rays and particle size analysis, and by describing their sediment texture and composition, in order to determine their depositional history and thereby identify and characterise the recent and ancestral (Holocene) sedimentary environments. Two cores from the Weddell Abyssal Plain and Bransfield Strait were examined for excess $^{210}$Pb activity. Six sedimentary provinces were identified: Agulhas Basin, a pelagic province; the eastern Weddell Slope, a hemipelagic and contouritic province with turbiditic input; northern Weddell Abyssal Plain, hemipelagic with evidence of recent and ancestral turbiditic input; Powell Basin, a hemipelagic and contouritic province; Bransfield Strait, hemipelagic with a sedimentation rate of 0.8mm yr$^{-1}$ indicated by the excess $^{210}$Pb profile; and Bellingshausen Sea, a hemipelagic and contouritic province.

J Howe, C Wilson and T Shimmield

Iron and manganese in organic-rich sediments in Oxygen Minimum Zones

Iron (Fe) and manganese (Mn) are ubiquitous components of most marine sediments. Whilst the behaviour and influence of sedimentary Fe and Mn are well constrained in truly oxic and anoxic environments, detailed biogeochemical information in organic rich, transitional suboxic environments, such as those found in Oxygen Minimum Zones (OMZ), is limited. SAMS geochemists, working with a number of international collaborators, recently presented a novel data set at the European Geosciences Union 2006 meeting. Here, sedimentary Fe/Mn biogeochemistry throughout the Pakistan margin OMZ was detailed. Through pore water modeling and sedimentary analysis, the kinetics of reactions involving Fe/Mn within the OMZ were revealed. The study showed that under the suboxic conditions present within the OMZ, Fe/Mn minerals played a significant role in microbial carbon degradation. Fe and Mn were also found to greatly affect the behaviour and distribution of other important trace metals as shown in the figure.

G Law, T Shimmield, G Shimmield (SAMS) and G Cowie (Edinburgh University)

Unravelling the methane paradox

The ‘oceanic methane paradox’ questions how the production of methane, a strictly anaerobic process, can occur within the oxygenated upper ocean. Attempts to resolve the methane paradox, have linked methanogenesis with particulate material, e.g. zooplankton faecal pellets, as microenvironments that facilitate oxygen depletion.

Work at SAMS has identified methanogens within copepod faecal pellets and sedimenting particles using 16S rRNA gene analysis. Furthermore, one cluster of sequences was closely related to methanogens of the Methanosarcinaceae family, that metabolise methylated compounds
including dimethylsulphide, a sulphur gas that affects the Earth’s albedo. Therefore, zooplankton faecal pellets could be instrumental in facilitating both the production of methane and the removal of DMS. We have recently received NERC funding to further investigate the interactions of these biogeochemical cycles and the role that anaerobic microbes play in this process. A combination of laboratory and field-based research is expected to further unravel the ocean methane paradox.

S Wilson, A Hatton, M Hart, Axel Miller and D Green

Anthropogenic inputs of heavy metals to the Kongsfjord area, Svalbard, Arctic

One of the pollutants under examination is mercury (Hg). As a known toxicant it is believed to be present in some regions at levels that pose a threat to both the environment and Arctic populations. Four sediment cores have been analysed for total Hg concentrations in the Kongsfjorden area of Svalbard. The figure shows the results from Brandallaguna, a lagoon situated close to the Ny Ålesund research base. There is an increase in the Hg concentration towards the surface of the core, a trend which has been identified in many other Hg studies throughout the Arctic. The profile is interesting in that it is virtually identical to the lead (Pb) profile, suggesting an anthropogenic influence, possibly from atmospheric transport. The other cores analysed do not display a similar Hg and Pb trend. The sediment from Brandallaguna core is anoxic from the surface and further interpretation of the role of Fe/Mn diagenesis and the degradation of organic matter on the distribution of Hg are being investigated.

L Vare, T Shimmield, K Black and G Shimmield
ECOLOGY DEPARTMENT

Department members:
Dr Kenny Black (Head), Dr Michael Burrows (Deputy), Dr Robert Batty, Mr Dirk Campbell, Dr Elizabeth Cook, Dr Andrew Davies, Dr Symon Dworjanyn, Mr Robin Harvey, Dr David Hughes, Dr Lea-Anne Henry (part time), Dr Maeve S Kelly, Mr Peter Lamont, Ms Hui Liu, Miss Shona Magill, Dr Lois Nickell (part time), Dr Thomas Nickell, Mrs Heather Orr, Mrs Linda Robb, Dr Murray Roberts, Dr Martin Sayer, Dr David Schoeman, Miss Coleen Suckling, Dr Tom Wilding, Dr Kate Willis, Ms Averil Wilson, Dr Ben Wilson.
Biodiversity of cold-water coral reefs

It is well known that tropical coral reefs support many species and that around the world biodiversity is being lost at an alarming rate. Recent work by the cold-water coral research team at SAMS is showing that these deep-water reefs not only support a similar biodiversity to tropical reefs but contain a surprising number of species unknown to science. With fellowship funding from the European Commission’s Marie Curie scheme, Dr Lea-Anne Henry, formerly of the Bedford Institute of Oceanography in Canada, has been examining the animal communities in samples from cold-water coral ecosystems along the European margin. These include the recently discovered giant carbonate mounds from the Porcupine Seabight off SW Ireland, the Darwin Mounds off NW Scotland and the inshore, shallower Mingulay Reef Complex from the Sea of the Hebrides. Hundreds of species have been identified from each area and taxonomic experts have so far confirmed that several are undescribed including an isopod, four hydroids, a pycnogonid, a bryozoan and an aplacophoran mollusc. Several others await confirmation. As well as new species, one hydroid and the aplacophoran require new genera.

In addition to revealing animals previously unknown to science, this work has shown fundamental differences in the communities on carbonate mounds compared to those on the surrounding seafloor. Because the reefs are such rich storehouses of species, they are helping us better understand species distributions and biogeography. Over the last five years it has become clear that many cold-water coral ecosystems, including the Darwin Mounds and some carbonate mounds, have been damaged by bottom trawl fishing. This project is clearly showing how little we understand about the biodiversity of these fragile, long-lived ecosystems and how important it is to document biodiversity and biogeography if we are to develop meaningful networks of protected areas in the future.

M Roberts, A Davies and L-A Henry
Integrated Aquaculture – a glimpse of the future?

Integrated aquaculture, the combination in culture of species feeding from different trophic levels, has been purported to be of benefit to both the species in culture and to the environment. In the project REDWEED, the ability of seaweeds to utilise dissolved nitrogen originating from salmon farms was examined. This three year study is focused on the culture of edible species of seaweed; the red dulse or Palmaria palmata and the brown sugar kelp or Laminaria saccharina around Loch Duart’s salmon farms in north-west Scotland. By growing these additional crops on the salmon farm, the aim is to achieve a harvest of financial value which also represents a loss of nitrogen from the system, ameliorating the impact of salmon farming in that respect.

Both seaweeds were successfully cultured on seeded ropes suspended from long-lines adjacent to the salmon farms. *L. saccharina* in particular benefited from proximity to this nitrogen source, showing enhanced growth rates while growth of *P. palmata* was influenced both by nutrient availability and water motion. The use of stable isotopes revealed that the seaweeds were utilising farm-origin nitrogen and that in some circumstances the nitrogen from the farm could be detected over distances of > 1km.

The data suggest that, were cultivation to be scaled up, a seaweed farm occupying 1ha could remove up to 30% of the dissolved nitrogen resulting from the culture of 500t of farmed salmon. Research continues into ways of scaling up productivity, preventing bleaching of the plants and minimising fouling.

Other projects at SAMS; SPIINES2, MERMAIDS and AAAG (www.sams.ac.uk) are currently investigating the co-culture of salmon, seaweeds, sea urchins, Pacific oysters and scallops. This year also saw the completion of Professor Hui Liu’s stay at SAMS, our first Marie Curie Incoming International Fellow. Hui, from the Yellow Seas Fisheries Research Institute in China collaborated with our researchers in sea urchin and scallop cultivation and on the impact of ASP, the amnesic shellfish poison. SAMS is pleased to announce that we have signed a ‘Sino-Scottish Aquatic Invertebrate Laboratory Agreement’ with YSFRI to help establish further exchanges and collaboration.

*M Kelly, C Sanderson and E Cook*

The European Census of Marine Life (EuroCoML)

EuroCoML is a regional implementation committee for the Census of Marine Life; a 10 year initiative aimed at determining the diversity, distribution and abundance of marine life in the oceans in the past, present and future. Within this framework the aims of EuroCoML are to i) expand partnerships with other relevant European programmes, ii) increase European participation in ongoing CoML projects, iii) improve taxonomy and knowledge of species in European waters and iv) improve information required for resource management in European waters.

EuroCoML has been fully operational for just over a year, with the Project Office being located at SAMS. During this time a number of workshops have been funded bringing together scientists from across Europe to develop potential research programmes which will go some way to achieving the aims of EuroCoML and addressing the questions posed by the global CoML. The workshops so far have looked at “Alien invasive species in European Waters” and “Environmental modulation of Biodiversity and Ecosystem Dynamics,” determining the causes of change in marine coastal biodiversity by identifying key ecological processes operating at different scales. A third workshop on the “European Tracking of Predators in the Atlantic” will take place in September 2006, with a further three proposals currently under discussion. All information on European marine fauna collected by the projects will be deposited with the European Ocean Biogeographic Information System.
Education and Outreach is also of importance to EuroCoML. A Deep-Sea Education and Outreach (DESEO) workshop was funded, allowing the project officers of the four European led deep-sea CoML projects to exchange ideas and to collaborate. The first activity planned for 2007 is a travelling exhibition on the Mid-Atlantic Ridge and an associated book describing different environments which can be encountered in the deep-sea.

The website, www.eurocoml.org, is another area where the science carried out by the different programmes is highlighted.

Graham Shimmield  
(EuroCoML Chairman)

Bhavani Narayanaswamy  
(EuroCoML Project Officer)
Monitoring and predicting harmful algal blooms

There are approximately 3000 known species of marine phytoplankton of which around 100 are thought to have harmful or toxin producing properties. In Scottish waters, harmful algal blooms are of most concern through the potential for humans to consume shellfish that have ingested sufficient phytoplankton such that toxin levels within their flesh have become concentrated to dangerously high levels.

To ensure shellfish safety, there is a requirement for EU member states to monitor the presence and geographic distribution of marine biotoxin-producing phytoplankton in shellfish harvesting areas on a regular basis. In Scotland, phytoplankton monitoring has been carried out by SAMS scientists on behalf of the Food Standards Agency Scotland since September 2005. This monitoring programme acts as an early warning system to ensure that shellfish flesh testing is conducted in the area of concern.

In addition to monitoring toxin producing phytoplankton, we are also conducting a number of research projects to improve understanding of the factors causing their blooms. These projects include studies of *Pseudo-nitzschia* and *Dinophysis* that are responsible for amnesic and diarrhetic shellfish poisoning respectively. We have also just commenced a collaborative EU program with partners in Ireland and France to study the environmental factors that trigger harmful blooms. Such information underpins the development of tools to predict the occurrence of harmful algal blooms.

K Davidson, S Swan, T Wilkinson, D Brennan, C Campbell, S Drain, S McNeil and M Hart

Algal defence: seaweed immune systems have deep evolutionary roots

The brown alga *Laminaria digitata* is a major constituent of kelp forest biomass on North Atlantic rocky shores where it is subject to attack from bacterial pathogens. In collaboration with French and German scientists, we have discovered that, in order to protect itself from such pathogens, the alga employs a cellular chemical defence system which is similar to the innate immunity known from both terrestrial plants and animals. We have also found that the chemical defence reaction of the seaweed can be triggered, as in other plants and animals, by lipopolysaccharides (bacterial cell surface macromolecules). The algal response to infection by bacteria involves an oxidative burst followed by release of free fatty acids and accumulation of oxylipins such as 13-hydroxyoctadecatrienoic acid. This mechanism is similar to the oxidative burst observed in mammalian white blood cells and terrestrial plants. Also the recognition of bacterial attack seems highly conserved between major eukaryotic phyla – these results suggest that the signalling pathways involved in the recognition of lipopolysaccharides may include Toll-like receptors.

F Küpper
SAMS scientists name a new bacterium and sequence its genome

A fundamental aspect of biology is the cataloguing of new organisms. It is therefore a privilege that we have joined the list of biologists to name a new species; in this case, a bacterium that appears to live exclusively with marine microalgae. The organism is now known as Marinobacter algicola [Marinobacter, rod of the sea; algicola, an inhabitant of algae] found associated with a range of Northern Hemisphere marine dinoflagellates and coccolithophores [see Figure]. Interestingly, the M. algicola isolates we have came from algal cultures from different oceanic regions, yet, they are nearly all identical to one another despite their origins being so far apart. This remarkable conservatism suggests that this bacterium is highly specialized to a life with dinoflagellates and coccolithophores. We therefore think it may play an important function in the lifecycle of the algal host.

One approach to identifying what a bacterium can do is to sequence its genetic blueprint – the genome. M. algicola, along with two other bacteria we have isolated from marine dinoflagellates, were chosen by the Gordon and Betty Moore Foundation Marine Microbial Genome Sequencing Initiative for whole genome sequencing by the J Craig Venter Institute in the USA. These data will greatly aid our study to find out what M. algicola is doing for its algal host.

D Green, T Gutierrez and M Hart
CCAP developments

The CCAP is the largest algal culture collection in Europe, covering a wide range of protistan biodiversity. It continues to act as the UK Service Collection for the provision of cultures and their associated data to the UK and worldwide scientific communities. The Collection currently maintains 2800 strains, with 434 new additions in the last year, including 13 type strains. Among the new additions were 276 strains of the increasingly important brown algal model *Ectocarpus*, the entire genome of which is currently being sequenced. The Collection has also increased the diversity and range of protistan and cyanobacterial strains held, and details of new accessions are listed on the CCAP website www.ccap.ac.uk.

Service roles have been expanded over the past 12 months with the servicing of 303 customers, provision of 1024 cultures, accession of 4 patent strains, provision of extracted DNA and the provision of “tailor-made” training for scientists from SEPA and CEFAS. The launch of the new website in 2005 has greatly facilitated interaction with the global user community, and the development of a comprehensive CCAP knowledgebase, including protistan images and bibliographic information, is progressing.

In January 2006 CCAP hosted the final meeting of the EU-funded Alginet – (Microalgae as Cell Factories for Chemical and Biochemical Products) project (http://www.search-labs.com/Alginet/ ), which was attended by 34 delegates from 12 countries. The principal role of CCAP was to develop a single online database allowing access to over 10,000 algal strains located in collections throughout Europe.

CCAP remains a focal point for algal research, both in-house and in worldwide collaborations, covering many fields of protistan biology including taxonomy, biogeography, chemical ecology, geochemistry, cryobiology, biogeochemistry, blue biotechnology, and algal pathology. Furthermore, together with an American partner collection, CCMP (Bigelow Laboratory), CCAP is spearheading international efforts to develop molecular barcoding techniques for protists and protistan culture collections in particular.

The Diving Unit continues to deliver a range of services both in support of SAMS 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 Royal Yachting Association for its provision of small boat training.

The NERC Facility for Scientific Diving is part of the NERC’s portfolio of National Services and Facilities. The facility provides advice, guidance and training for all diving and small boat operations involving NERC staff and for University groups that receive NERC funding. The NFSD funding also supports the activities of the UK Scientific Diving Supervisory Committee (SDSC) which is the body recognised by the Health and Safety Executive (HSE) as representative of the scientific and archaeological sector under the 1997 Diving at Work Regulations (DWR97). In 2005 the NFSD undertook a programme of equipment evaluation in relation to improving the delivery and safety of full-face diving masks with associated hard wire and through water voice communications systems. Training was also given in the use of mixed gases in diving, dive supervision, full-face mask use, underwater digital photography and recompression familiarisation. The NFSD supported a wide range of NERC-supported underwater science projects, including specimen collection, underwater survey, subtidal analytical equipment maintenance, underwater photography and environmental impacts. NFSD staff also contributed to a multinational Diving Under Ice workshop held at Ny Alesund, Spitzbergen, in February 2005.

The NFSD was reviewed by NERC in 2005 and received an overall average rating of 4.38 out of 5.00. NERC funding for the facility is assured until 2009.

**DIVING SUPPORT**

In 2005, the diving unit supported 522 person dives (266 separate diving operations) in support of numerous science programmes. This was the highest total of diving operations supported by the dive unit since 1982. A total of 35 divers were either employed on diving operations or attended some of the NFSD training courses and workshops. These 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 8641 minutes for 2005 at an average of 33.1 minutes per diving operation. Of this total, 83% of the bottom time was accrued in the 10-29 metre depth range, 16% was shallower than 10 metres and 1% was 30 metres and deeper. The unit provided support that underpinned eight peer-reviewed publications in 2005.

**DUNSTAFFNAGE HYPERBARIC UNIT (DHU)**

In 2005, 18 divers suffering from symptoms of suspected decompression sickness were examined at the hyperbaric unit and 14 received treatment. In addition, there was one diving-related fatality. The divers treated received, in total, 96 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 continues to be part of the National Registration Scheme for Scotland. DHU staff continue to act as technical advisers for the registration scheme.

**RYA SCHOOL**

The small boat facility continues to provide RYA accredited training programmes. 2005 again saw the provision of a seamanship module for students on the UHI Marine Science degree and all students successfully completing their RYA Powerboat training to Levels 1 and 2. Training was also provided for staff from the University of Edinburgh.

*M Sayer, S Thurston and H Brown*
This year has provided noteworthy activity on both the undergraduate and postgraduate fronts.

BSc (Hons) Marine Science

The sixth cohort of UHI undergraduates arrived in September. In November, our third graduation ceremony was held in conjunction with the SAMS AGM. To mark the occasion, two sponsored awards were made: the SAMS Council Prize for Academic Excellence was awarded to Saul Reynolds, for obtaining the highest ever mark on the degree for his Honours Dissertation; while the SAMS Prize for Overall Achievement went to Kimberley Blackwell, who received a First Class honours degree.

During the year, SAMS was awarded the first Comann na Mara bursary – sponsored by popular Celtic band Runrig – for undergraduates to undertake field studies at the European Special Area of Conservation, Lochmaddy Bay, North Uist.

Postgraduate Research Activities

In October, a further intake of NERC-funded postgraduate students commenced at SAMS, supporting our vibrant research school community. There have been a number of PhD completions over the year: Rebecca Dean and Pei Sun Loh have since obtained career positions in the UK and Malaysia respectively.

In December, we were delighted to hear that our application for an ERASMUS University Charter had been accepted; enabling both staff and students at SAMS to participate in exchange programmes with Higher Education Institutions across Europe.

Also on the European front, we have been successful in a proposal to form a Marie Curie Training Site for Early Stage Researchers. The ECOSUMMER (Ecosystem Approach to Sustainable Management of the Marine Environment and its Living Resources) site, led by the University of Aberdeen, with partners in Scotland, Greece and Spain, paves the way for collaborative postgraduate projects – including PhD studentships – over a three year period.

Finally, SAMS was invited to join in a Socrates Thematic Network proposal, AQUA-TNET. The network, coordinated by Ghent University, aims to establish a European Higher Education Area in the field of Aquaculture, Fisheries and Aquatic Resource Management. The AQUA-TNET partnership comprises the leading European academic institutions offering aquaculture courses and has representatives from 17 European countries.

Axel Miller
SAMS MEMBERSHIP ACTIVITIES

SAMS is a learned society with a total membership of 451 in four categories. During the reporting year members received SAMS Newsletters 30 (April 2005) and 31 (November 2005) as well as the SAMS Annual Report 2004-05.

AGM and Newth Lecture

The Association’s 91st Annual General Meeting took place on 7 November 2005. The 16th Newth Lecture followed the AGM and SAMS UHI Graduation, and was delivered by Dr Michel Kaiser from the School of Ocean Sciences at the University of Wales, Bangor. Dr Kaiser’s well attended and discussed presentation was on ‘Can’t see the fishermen for the fish: net benefits demand a wider perspective.’ A summary of the lecture was published in SAMS Newsletter 32 and on the SAMS website.

Scottish Marine Group activities

Dr Hamish Mair from Heriot-Watt University convened the Scottish Marine Group for a sixth and final year. The theme for the autumn meeting on 27 October 2005 in Stirling was ‘Scottish Marine Science Overseas’. Dr Mair presented work he and a number of his postgraduate students had been conducting at the Las Perlas Archipelago in Panama. At the end of the meeting Dr Mair stood down as convenor, and was given a warm and sincere thank you for his long-standing and successful efforts on behalf of the Scottish marine science community.

Susan Chambers, curator for marine invertebrates at the National Museums of Scotland, agreed to take over as SMG convenor for 2006.

SAMS Bursaries

SAMS offers up to four bursaries every year of up to £1000 to support worthy research or scholarship activities of its members. During the year, two bursaries were awarded:

Dr Teresa Fernandes (Napier University): Does turbidity affect how fish use mangrove habitats? Award: £810.

Dr Andrew Brierley and Dr Valery Smith (University of St Andrews): Studies on Calanus finmarchicus diapause. Award: SAMS research vessel time.

Anuschka Miller

Speakers at the autumn 2005 SMG meeting. From left: Colin Graham (BGS), Dr Hamish Mair (Heriot Watt), Dr Trevor Telford (Stirling), Dr Finlo Cottier (SAMS), Dr Evanthia Karpouzli (Scottish Executive), Dr Martin Buiv (Gatty).
SAMS OUTREACH ACTIVITIES

SAMS firmly believes in proactive science communication with different sectors of the public, aiming to use the appropriate language, imagery and context to relate to the target group. Although this may be work intensive, we particularly believe in direct two-way communication as one of the most effective means of engagement with the public.

Educational outreach activities target specific groups: schools, the local community, and special interest groups, particularly those interested in marine resource development and protection and/or climate change. We reach out to the general public through engagement with national and international television, radio, newspapers, magazines as well as the internet. The SAMS website (www.sams.ac.uk) is supplemented by a multitude of commercial and project websites based on work carried out or contributed to by SAMS staff.

School activities

A number of SAMS staff visited local primary and secondary schools, and we hosted school groups from Oban High School and Bowmore Primary School (Islay). Annual school days took place on 4 April 2005 and 15 March 2006, where we welcomed each time around 150 pupils from up to nine local primary schools. An interactive programme demonstrated the diversity of our research activities, and aimed to show the children what marine scientists actually do rather than focussing in detail on research content. With this we aimed to enthuse the children about research as an activity in contrast to the textbook science they may encounter in schools.

To reach an even larger audience of school children throughout Argyll and Bute, SAMS is a regular and active participant in the annual Argyll and Bute Regional Environmental Education Forum (ABREEF) Environment Fairs. SAMS is also represented at the ABREEF planning group. A three day ABREEF fair was organised in September 2005 in Campbeltown, which over 700 primary school children attended. Of these we engaged directly with about 200: In groups of up to 15 children, they learnt about marine food webs by playing a dressing up game, about the extent of the oceans by virtue of a ball game with a globe, and about the life of marine larvae through a card game.

SAMS further sponsored the ‘SAMS Cup for Outstanding Achievement in Science’ at the annual prize giving event at Oban High School for the second year. This prize is awarded by the team of science teachers to the best Higher or Advanced Higher pupil in any science discipline.

Open Days – engaging the local community

SAMS annually opens its doors to the local public at an open evening – always held during National Science Week: During the reporting period open evenings were held on 4 April 2005, on the evening prior to the official opening of the European Centre for Marine Biotechnology, and on 15 March 2006. Between 150 and 200 visitors attended the events, at which all departments exhibited some of their research, and at which short overview talks were presented. At these events SAMS staff and students engage visitors in much conversation and discussion, alongside providing as much hands-on experience as a topic allows. A balance of displays ensured interesting visits for both adults and children.

The Argyllshire Gathering took place in Oban on Thursday 25 August 2005, and SAMS, as every year, had a large information and education stand within the Heritage Tent. The display of a selection of live seashore organisms drew crowds of children and parents to our
stand, while we also showcased more advanced research projects to engage those with already developed interests in the marine environment. Besides locals this event draws in tourists with a particular interest in Scottish culture and environments.

When invited to talk to local community groups, we strive to always oblige. This year Dr Anuschka Miller spoke to the Lorn Lunch Club of the Argyll and Bute Conservative and Unionist Association about the scope of activities and research undertaken by SAMS, and on the latest developments within UHI.

Special interest groups

A particularly interesting event was an open meeting on what science can contribute to the debate about marine national parks held on 6 February 2006 in the Corran Halls in Oban. Drs Maeve Kelly, David Hughes, David Schoeman, Michael Burrows and Toby Sherwin gave short overview presentations alongside speakers from the Aberdeen Institute for Coastal Science and Management and from the Community of Arran Seabed Trust. About 90 people attended the meeting that was organised and chaired by Sandy Smith from the British Association for the Advancement of Science.

SAMS exhibited work on the many human uses for macro-algae at the ‘Innovations in Natural Products in the Highlands and Islands’ event on 9 and 10 March 2006 in Inverness.

A variety of staff gave public lectures: Dr Ben Wilson participated in the 2006 IgNobel tour during National Science Week with a talk on the predator-prey relationship between killer whales and herring. Dr Maeve Kelly spoke on ‘seaweed, the ultimate natural resource’ at an evening event on ‘Natural Resources in the Highlands and Islands’ on 9 March 2006 at Inverness College. Dr Anuschka Miller reviewed recent advances in Arctic research at the Orkney Science Festival in Kirkwall on 2 September 2005.

Staff with particular engagement in outreach activities included Debra Brennan, Elaine Mitchell and Sharon McNeill.

Visitors to SAMS

This year saw the completion of Professor Hui Liu’s stay at SAMS, our first Marie Curie Incoming International Fellow. Hui, from the Yellow Seas Fisheries Research Institute in China, collaborated with our researchers in sea urchin and scallop cultivation and on the impact of ASP, the amnesic shellfish poison. As usual, a number of university groups conducted field classes at SAMS using our research vessels and teaching laboratory facilities. These included Edinburgh University (Geosciences), Heriot Watt (Biology - 2 groups), University of Liverpool (Oceanography) and the University of East Anglia (Oceanography). In addition, several groups with non-marine interests took advantage of our teaching facilities and meeting rooms.

Anuschka Miller
DEGREES AWARDED DURING THE REPORTING YEAR

Cousins S, Ph.D, Aberdeen University. An Investigation of the processes involved in Pecten maximus contamination by Amnesic Shellfish Poisons. (Gallagher S, Kelly MS, Eddie B and Taylor A)

Dean R, Ph.D, The UHI Millennium Institute. Biogeochemical cycling in fish farm sediments. (Shimmield TM, Black KD and Gillibrand P)

Hughes A, Ph.D, The UHI Millennium Institute [NERC]. Sea bed biota scrapers and shapers: urchins in control. (Kelly MS and Barnes D)

Loh P-S, Ph.D, The UHI Millennium Institute. Terrigenous organic carbon in Scottish sea loch sediments. (Miller AEJ, Reeves A, and Harvey SM)

Mitra A, Ph.D, The UHI Millennium Institute. The Influence of microzooplankton on marine productivity. (Leakey R and Tett P)

Rose C, Ph.D, Newcastle University. The role of habitat complexity in determining community development on the Loch Linhe Artificial Reef. (Wilding T, Downie M and Bentley M)

Waller RG, Ph.D, University of Southampton. Gametogenesis and larval biology of deep-sea corals. (Tyler PA and Gage JD)

Ware S, Ph.D, University of London. Inshore fisheries ecology. (Atkinson RJA, Sayer MDJ and Bailey N)

Ongoing Research

Adey (née Osborne) EA, Ph.D, The UHI Millennium Institute. Distinguishing wild from farmed salmon. (Black KD and Shimmield TM)


Ashton GV, Ph.D, The UHI Millennium Institute [NERC]. Biological invasions - quantifying the impact of alien species on marine ecosystems, using the introduction of the amphipod Caprella mutica to the west of Scotland as a case study. (Cook EJ, Willis K and Burrows MT)


Beaumont J, Ph.D, The UHI Millennium Institute [NERC]. Quantifying biotic interactions with inshore subtidal structures: comparisons between natural and artificial reefs. (Sayer MDJ, Brown C and Shimmield GB)

Corner R, Ph.D, Stirling University. Reduction of fish farm impacts using smart automatic feeders. (Black KD and Telfer T)

Cox (née MacLachlan) SE, Ph.D, The UHI Millennium Institute. Geochemical signals of environmental change in the Arctic: from freshwater lake to the deep ocean. (Howe J, Shimmield TM, Shimmield GB and Austin W)

Cresswell K, Ph.D, The Open University. Penguin-krill interactions at South Georgia. (Tarling GA, Trathen P and Burrows MT)

Darrock L, Ph.D, The University of East Anglia. Dimethylsulphoxide: origin, fate and cycling. (Liss PS, Malin G and Hatton AD)

Dodds L, Ph.D, The UHI Millennium Institute [NERC]. The physiological ecology of the cold-water coral Lophelia pertusa. (Roberts JM, Taylor A and Gage JD)

Gass S, Ph.D, The UHI Millennium Institute [AFEN]. The environmental sensitivity of cold water corals. (Roberts JM, Gage JD and Tudhope AW)

Johnson C, Ph.D, The UHI Millennium Institute. 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)
MacDonald A, M.Phil, The UHI Millennium Institute. Salmonid survival in an upland river. (Miller AEJ and Chisholm N)

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

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

Pillans J, Ph.D, Newcastle University. DMS photochemistry. (Hatton AD, Uher G and Upstill-Goddard R)

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

Sanderson JC, Ph.D, The UHI Millennium Institute. Reducing the environmental impact of sea-cage farming through cultivation of seaweeds. (Kelly MS and Dring M)

Shucksmith R, Ph.D, The UHI Millennium Institute (NERC). Biological invasions: The role of biodiversity in determining community susceptibility to invasion. (Cook EJ, Burrows MT and Hughes DJ)

Suddick E, Ph.D, The UHI Millennium Institute. Impacts of solar UV radiation on freshwater nitrogen biogeochemistry. (Gibb S, Uher G and Miller AEJ)

Vare LL, Ph.D, The UHI Millennium Institute (NERC). An investigation of temporal trends of pollutant inputs within the Arctic environment: from freshwater lake to deep ocean. (Shimmield TM, Shimmield GB and Black K)

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

Wilson S, Ph.D, The UHI Millennium Institute. Plankton and climate change. (Hatton AD, Miller AH and Law C)

Shelmerdine R, Ph.D, The UHI Millennium Institute (NERC). Large-scale forcing of coastal communities. (Burrows MT and Hughes DJ)

Shields ME, Ph.D, The UHI Millennium Institute. Gradients in benthic community structure and bioturbation along the northern seas continental margins. (Hughes DJ and Gage JD)


Hoppenrath, M, Bolch, CJS, Yoshimatsu, S, Saldarriaga, J, Schweikert, M, Campbell, CN, Toriumi, S, Dodge, J,
Elbrachter, M and Taylor, F, 2005. Nomenclatural note on a Thecadinium species (Dinophyceae, Gonyaulacales), which was described as new independently three times within two months. Journal of Phycology 41: 1284-1286.


Sayer, MDJ, Cook, EJ, Wilson, CM and Barrington, J, 2005. Analysing dive computer profile integrations from incidents of suspected and actual


Book Chapters


Edited works


**PUBLICATIONS**


Non-refereed papers and reports


# Research Grants and Contract Income Received

<table>
<thead>
<tr>
<th>Project Leader</th>
<th>Title</th>
<th>Funding body</th>
<th>Duration</th>
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<td>RS Batty</td>
<td>RNA-DNA Ratio as an estimate of juvenile plaice growth rate</td>
<td>University of Delaware</td>
<td>07/05 - 09/05</td>
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<td>Risk factors in shellfish harvesting areas</td>
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<td>Icelandic Fisheries Laboratories</td>
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<td>Esme Fairbairn</td>
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<td>The role of algal-bacterial interactions in determining dimethylsulphide fluxes to the atmosphere</td>
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<td>Methanogenesis in oxygenated marine environments</td>
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<td>Norwegian Polar Institute</td>
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<td>Factors determining the magnitude of solar stimulated fluorescence peaks in water-leaving radiance spectra from shelf seas</td>
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<td>Larval invertebrate microalgal interactions</td>
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<td>Alternative marine sources of protein and oil for aquaculture feeds</td>
<td>The Crown Estate</td>
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## RESEARCH GRANTS AND CONTRACT INCOME RECEIVED

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<td>To investigate sustainable biological carrying capacities of key European coastal zones</td>
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<td>Reducing the environmental impact of sea-cage fish farming through cultivation of seaweeds</td>
<td>Highland Council and HIE</td>
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<td>Sea urchin production in integrated systems, their nutrition and roe environment</td>
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<td>Algal toxins in shellfish</td>
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<td>Microalgae as cell factories</td>
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<td>The role of bacterial symbiotic metabolites in the development of toxic phytoplankton blooms</td>
<td>California Sea Grant</td>
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<td>Assessment and management of coastal pollution</td>
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<td>Prediction of marine mammal aggregations by reference to oceanographic observations</td>
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<td>Mitigation of the effects of high power sonars on marine mammals</td>
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<td>Ecosystem approach to sustainable management of the marine environment and its living resources</td>
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<td>Commun Na Mara</td>
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<td>Deep sea conservation for the UK</td>
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<td>Biodiversity and vulnerability of European cold-water reef ecosystems</td>
<td>EU Marie Curie Fellowship</td>
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<td>MDJ Sayer</td>
<td>Enhancing marine biodiversity with artificial reefs</td>
<td>Project Aware (UK)</td>
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<td>Meridional overturning exchange with the Nordic seas</td>
<td>EU</td>
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<td>Addressing research capacity</td>
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<td>GB Shimmield</td>
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<td>GB Shimmield &amp; L Nickell</td>
<td>Coastal ocean benthic observatories</td>
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<td>TM Shimmield</td>
<td>El Nino Southern Ocean circulation</td>
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<td>Benthic processes in the Arabian Sea</td>
<td>NERC</td>
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<td>IM Vassie</td>
<td>Arctic-subarctic ocean flux array for European climate</td>
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<td>J Wilkinson</td>
<td>Developing Arctic modelling and observing capabilities for long-term environmental studies</td>
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### SAMS Research services limited

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<td>An environmental impact assessment for the proposed salvage operation on the SS Glenlogan</td>
<td>Pere UK Ltd</td>
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<td>Geotek</td>
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<td>The environmental effects of acoustic and electromagnetic fields produced by tidal generators</td>
<td>Synergie Scotland Ltd</td>
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<td>F Küepper</td>
<td>CCAP culture collection</td>
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*Commercial in confidence*
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<td>DT Meldrum</td>
<td>HOMing Environmental Recorder: A deep water vertical profiling vehicle</td>
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<td>T Wilding</td>
<td>Review of reef effects of offshore windfarm structures and potential for enhancement and mitigation</td>
<td>Plymouth Marine Lab</td>
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</table>
### Director
- **Professor Graham Shimmield**

### Deputy Director
- **Dr Ken Jones**

### Physics, Sea Ice and Technology
- **Dr Mark Inall** (Head)
- **Mr David Meldrum** (Deputy)
- **Mr Bruce Barr**
- **Dr Chris Cromey**
- **Dr Finlo Cottier**
- **Mr David Meldrum** (Deputy)
- **Mr Bruce Barr**
- **Mr Nick Hughes**
- **Mr Alistair James**
- **Dr Duncan Mercer**
- **Mr Oli Peppe**
- **Dr Paul Provost**
- **Dr Tony Sherwin**
- **Dr Jeremy Wilkinson**
- **Miss Yingzhao Zhou**

### Ecology
- **Dr Kenny Black** (Head)
- **Dr Michael Burrows** (Deputy)
- **Mr Robert Batty**
- **Dr Tony Sherwin**
- **Dr Jeremy Wilkinson**
- **Miss Yingzhao Zhou**

### Microbial and Molecular Biology
- **Dr Ray Leakey** (Head)
- **Dr Finlo Cottier** (Deputy)
- **Mrs Debra Brennan**
- **Mrs Christine Campbell** (part time)
- **Dr Keith Davidson**
- **Dr John Day**
- **Miss Giosia Gaj**
- **Dr Tony Gutierrez**
- **Dr David H Green**
- **Dr Mark Hart**
- **Miss Sharon MacNeill**
- **Mrs Elaine Mitchell**
- **Dr Thomas Pröschold**
- **Miss Rachel Saxon (Admin)**
- **Dr Damodar Shenoy**
- **Ms Sarah Swan**
- **Mr Tim Wilkinson**

### Biogeochemistry and Earth Sciences
- **Dr Tracy Shimmield** (Head)
- **Dr John Howe** (Deputy)
- **Mr Eric Breuer**
- **Dr Tim Brand**
- **Miss Katie Doig**
- **Miss Cheryl Haidon**
- **Mr S Martyn Harvey**
- **Dr Angela Hatton**
- **Miss Susan McKinlay**
- **Dr Axel Miller**
- **Miss Terrie Sawyer**

### SAMS Honorary Research Fellows
- **Dr Clive Craik**
- **Dr Robin Gibson**
- **Dr John Gordon**
- **Professor Jack Matthews**

### European Census of Marine Life Office
- **Dr Bhavani Narayanaswamy**

### SAMS SRSL
- **Mrs Janet Duncan**
- **Mrs Joyce Moore** (part time)

### IT & Data Services
- **Miss Susan Drain**
- **Mr Steven Gontarek**
- **Mr Rory MacKinnon**
- **Mr Nigel MacLucas**
- **Mrs Katrina Smalley**

### Activities Manager
- **Dr Anuschka Miller** (part time)

### Company Secretary
- **Mrs Elaine Walton**

### Director’s Secretariat
- **Miss Jane E McLaughlin**
- **Mrs Ali Kloosterhuis-Koelstra**
- **Mrs Allison Dawson** (part time)

### Financial Controller
- **Mrs Patricia Whyte**

### Accounts
- **Mrs Pat Claxton**
- **Miss Sharyn Farmer** (part time)
- **Mrs Inga Hamilton**
- **Mrs Helen Harrison**
- **Mrs Fiona Hart**
- **Mrs Lindy Lamb** (part time)
- **Mrs Lorna Watt**

### Contracts & Knowledge Transfer
- **Mr Lewis Fraser**

### Health & Safety Adviser
- **Mr Ivan Ezzi**
Personnel
Ms Cris Bonomy
Ms Karen Campbell
Mrs Lorna Thomson (part time)

Reception
Mrs Shirley Kersley (part time)
Mrs Irene Partridge (part time)
Ms Margaret Sime (part time)

Assistant Librarian
Mrs Patricia Thomson (part time)

Aquarium Manager
Mr Alex Keay

Estates/Ship’s Husband
Mr Jim Watson

UHI IT
Mr Chris Rydings
Mr Issac Lipkowitz
Miss Nicola Longman
Miss Heather MacDougall
Mr Gary Ryan

NERC National Diving Facility
Dr Martin Sayer
Mr Hugh Brown
Dr Simon Thurston

RV Calanus
Mr Roddy MacNeil (Master)
Mr John MacFarlane
Mr Duncan MacNeill
Mr Norman Smith

RV Seol Mara
Mr Douglas McAlpine
Mr Steven Douglas

Engineering workshop
Mr Andrew Connelly
Mr Mark Robertson (Apprentice Engineer)

Building Maintenance
Mr Duncan MacKinnon

Storeman
Mr Alasdair Black

Electrical Maintenance
Mr Brian Clark
Mr John Hill

Building Maintenance
Mr Duncan MacKinnon

Storeman
Mr Alasdair Black

Electrical Maintenance
Mr Brian Clark
Mr John Hill
We acknowledge support from the following sponsors:

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