



ANNUAL REPORT 2016-2017

INDEPENDENT MARINE SCIENCE FOR SCOTLAND SINCE 1884

OFFICE BEARERS AS
CONFIRMED AT 102ND AGM
OF THE ASSOCIATION

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PROFESSOR
NICHOLAS OWENS
SAMS DIRECTOR

WELCOME

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As always, the year has had its highs and lows. The highs are the outstanding outputs from each of our three 'pillars' of activity: Science, Education & Outreach and Enterprise. The lows are the loss of some dear friends and colleagues.

To focus first on the highs, our scientific outputs, cover the customary wide range of topics. When I am questioned "what does SAMS do", my answer is: "we try to discover how the seas and oceans work, from the level of genes to ecosystems". Whilst that might seem to be a rather flippant answer, it is supported by the list of publications produced this year. SAMS has a world-class capability in marine science across a very broad front; this is a strength, but the funding realities dictate that SAMS has to focus its efforts and an ongoing activity is to continually look at the work we do.

One of the up-and-coming areas for SAMS is our work on seaweed, especially related to helping the development of a new industry. This involves fundamental discovery science, for example on diseases in seaweeds, through to more applied investigations such as testing coppicing techniques to enhance commercial yields. However, science needs to operate within a policy

environment and SAMS led the production of a policy briefing on safeguarding the future of the global seaweed aquaculture industry. This was a major collaborative effort alongside 21 academic and commercial partners, including the United Nations University, and is sure to have a significant future impact for the industry.

Our education activities continue to thrive with more students than ever. However, education is measured in quality, not just numbers and several of our students received prestigious awards for their outstanding achievements. Sam Black received the best UHI undergraduate of the year and the best dissertation in a UK-wide award. Our PhD students did outstandingly well, with Laura Hobbs awarded the best UHI postgraduate student of 2016, Winnie Courtene-Jones won the P1 Marine Foundation UK student award and Kati Michalek was awarded the Lantra Scotland Higher Education Learner of the Year – many congratulations to these students. We are very proud to be able to contribute to their development.

SAMS' enterprise activities, where we use our knowledge and know-how to solve real-world problems continues to thrive, indeed our

trading subsidiary SRSL had the most successful year commercially since it was established. Some examples of the projects undertaken are described later in the report.

As I close it is sad to report the passing of three influential colleagues and friends of SAMS. Ian Graham-Bryce was a dedicated former SAMS President. He presided over a period of intense change which saw the initiation of the UHI Millennium Institute, now the University, and the development of the existing SAMS buildings. Ian Bryden, UHI Vice-Principal for Research was a great advocate for SAMS within the University. It was his initiative that brought us together with our now strong collaborators and colleagues from Texas A & M University, USA. And finally, Graham Shimmield. As well as a personal friend, Graham was an inspirational Director of SAMS and led the significant growth of SAMS, during the late '90s and 2000s, to what it is now. Graham's influence and legacy is very evident but all will be sadly missed.

RESEARCH SUMMIT TO BUILD TRANSATLANTIC CONNECTIONS

An international marine science and technology summit held in Dunstaffnage and Oban in September 2016 has brought together leading academics from across the UK, Europe and the USA to explore new research and business opportunities.

The three-day The Global Marine Sustainability Workshop used facilities at the European Marine Science Park in Dunstaffnage and welcomed representatives from world-renowned institutes specialising in technology and robotics, aquaculture, marine and coastal sustainability and education.

It was organised by SAMS, the University of the Highlands and Islands and the Harte Research Institute at Texas A&M University Corpus Christi (TAMUCC). Highlands and Islands Enterprise (HIE) also supported the summit.

The aim was to build connections across the whole spectrum of marine science, with an initial focus on learning, education and outreach; emerging technologies in aquaculture; and advanced remote sensing capabilities and data science through robotics.

Among the delegates leading the research discussions were: Prof Peter Liss FRS CBE, one of the UK's leading environmental scientists; Dr Marty Rogers, Director of the Alaska Centre for Unmanned Aircraft System Integration; and Dr Sonia Ortega, Head of the National Science Foundation Europe Office.

During the formal dinner on the evening of September 20, the late Prof Ian Bryden of the University of the Highlands and Islands and Dr Luis Cifuentes, TAMUCC's Vice President for Research, signed a memorandum of understanding to

cement the relationship between the institutions.

SAMS Director, Prof Nicholas Owens said during the exchange: "This summit is a tremendous learning opportunity for both academic partners. Not only will we learn what we do differently, we will learn what we have in common; our situation in the North East Atlantic and the Harte Research Institute's setting by the Gulf of Mexico – two areas of great scientific work and joined by the Gulf Stream – make us a great match.

"We also share common ideas and goals for the sustainable development of a 'blue economy' and will explore the potential commercialisation of research and innovation in achieving economic and ecological sustainability in the marine environment."





OUR PEOPLE

SAMS STALWARTS RETIRE

Two of SAMS' longest-serving staff members retired in 2017 with a combined 60 years of service under their belts. Senior marine ecologist Prof Kenny Black and Head of Instrumentation Colin Griffiths have seen huge change in the organisation, from the days of the Scottish Marine Biological Association, to Dunstaffnage Marine Laboratory and finally, as SAMS.

Prof Black worked mainly on modelling the fate and impact of particulate organic matter and medicines lost from marine cage farms and co-developed the world's most advanced tool for this purpose, DEPOMOD, which is mandated in Scotland and widely used across the globe. Mr Griffiths has spent years at sea on research cruises and was crucial to SAMS' efforts in observing the North Atlantic. His most memorable moment was in February 2000 when the ship he was working on was hit by a 95-foot wave, the largest wave ever recorded by scientific instruments in the open ocean.

HOMeward BOUND TO ANTARCTICA

Dr Raeanne Miller embarked on a 20-day voyage to Antarctica aboard Aurora Australis on December 2, 2016 as part of the Homeward Bound initiative. The ambitious programme aims to create a network of 1,000 female scientists in an attempt to address the lack of women in STEM leadership roles and highlight environmental issues affecting our planet. Raeanne was one of an all-female group of 76 women on

the inaugural expedition, which left from Ushuaia in Southern Argentina and was employed as a kick-off event for the project.

TWO NEW PROFESSORS

The University of the Highlands and Islands awarded a professorship to our head of science, Dr Sheila Heymans, for leadership in ecosystem modelling. Her inaugural lecture is scheduled for 16 November 2017 at SAMS.

For his Arctic research and international collaborations the University of Tromsø awarded the title of professor to SAMS physical oceanographer Dr Finlo Cottier.

PROFESSOR HATTON JOINS NOC

Professor Angela Hatton left SAMS in August 2016 to join the National Oceanography Centre as Director of Science and Technology.

Until her move, Prof Hatton was Associate Director of Research at SAMS and has previously held research positions at SAMS and the University of East Anglia.

WOMEN IN SCIENCE AWARD

The University of the Highlands and Islands, of which SAMS is an academic partner, has been recognised for its efforts to promote women in science and technology.

The university achieved the bronze award with the Athena SWAN Charter, a partnership formed to improve the representation of women in

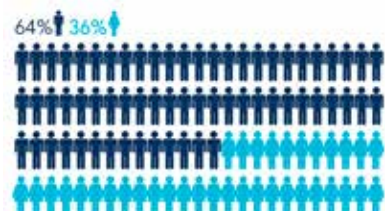
science, technology, engineering and mathematics (STEM). The award is presented to organisations that acknowledge and address obstacles to women making the transition from PhD level into a sustainable academic career in science.

DR SHIMMIELD JOINS BGS

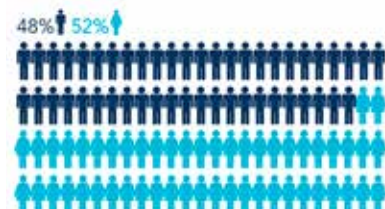
After nearly 20 years with SAMS, Dr Tracy Shimmield left in spring 2017 to join the British Geological Survey (BGS).

Dr Shimmield had previously been head of biogeochemistry and earth sciences at SAMS and would go on to become the first managing director of SAMS Research Services Ltd.

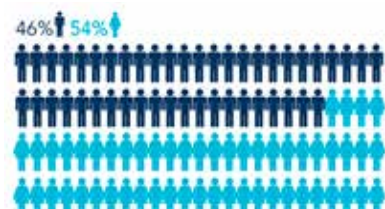
Research, Education and Enterprise: 69 staff



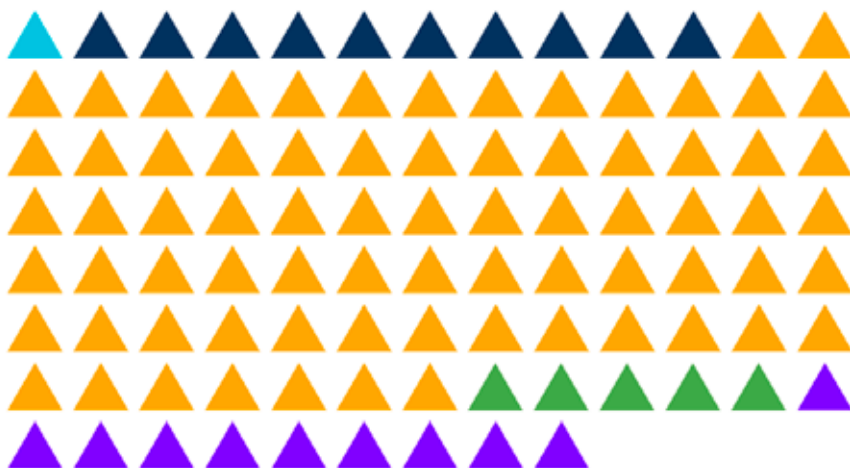
Technical and Experimental: 40 staff



Management, Specialist and Administration: 57 staff



LEARNED SOCIETY



2017 STATE
OF THE SAMS
MEMBERSHIP

TOTAL: 268

▲ Life/Honorary 1% ▲ Corporate 10% ▲ Ordinary 74% ▲ Students 5% ▲ Unwaged 10%

SAMS research bursaries awarded to members during the reporting period

Susan Evans	Support the transport of frozen water and molecular samples to SAMS for analysis	£1,000
Dr Andy McLeod	Quantity significance of UV driven photochemistry	£980
Dr Keith Hiscock	Completing the publication of a book that will include significant information about the natural history of Scottish seabed habitats	£500
Mine Tekman	Microplastic ingestion by Arctic deep-sea epibenthic megafauna	£1,000

BURSARY PROFILE – DR KEITH HISCOCK

Exploring Britain's Hidden World: a Natural History of Seabed Habitats

With such a wide variety of seabed habitats, some unique within Britain, Scotland was bound to loom large in a book about our shallow seas – and it does. It was in 1976 that I first took an interest in subtidal habitats in Scotland whilst working in Shetland. My survey work continued as the then Nature Conservancy Council launched the Marine Nature Conservation Review of Great Britain under my direction when I dived in some of the most iconic locations in Scotland (from the ultimate wave exposure of Rockall, through to

the ultimate tidal currents of the Gulf of Corryvreckan, and into the still waters of sea lochs). All of the time that I was undertaking my research in its various guises, my passions for marine natural history, for photography and for diving accumulated knowledge and images until it became time to pull them together into a celebration of the fabulous and fascinating seabed marine life present around the shores of Britain.

The resulting volume is more than just a coffee table book. It describes the history of exploration from the beginning of the 19th century through to the technology that is used today. It includes coloured line drawings of sediment communities. It describes how the ecosystem

'works' and how we make sense of seabed communities to classify them as biotopes. The book is designed to inform, to give pleasure and perhaps to surprise. Publication of the book is supported through a SAMS bursary. <http://www.wildnaturepress.com/our-titles/exploring-britains-hidden-world/>

OPENING OUR DOORS

During the reporting year SAMS welcomed thousands of visitors. Among the number were 200 delegates, 173 visiting students and 15 work experience students.

PLANKTON OF THE SEA AND OF THE MIND

27th NEWTH LECTURE, 11th November 2016

The parallels between science and art were explored during an afternoon of education and entertainment at the Scottish Association for Marine Science (SAMS) annual Newth Lecture. The lecture, named after the distinguished researcher and former SAMS president Professor David Newth, welcomes a leading UK scientist every year to Dunstaffnage. In November 2016, following the institute's annual meeting, Prof John Spicer of Plymouth University gave the 27th Newth Lecture on 'Plankton of the sea and of the mind. When Hardy met Garstang'. It was delivered to an enthralled audience in SAMS' own William Spiers Bruce Lecture Room, as well as being broadcast live online.

Prof Spicer's fascinating insight into the careers of renowned marine scientists Sir Alister Hardy and Walter Garstang brought up a number of talking points, not least how researchers communicate science.

The message was particularly apt, given that the lecture was delivered in between performances of *The Deep Sea Light* by Nick Turner and Mary Ann Kennedy of Watercolour Music, Ardgour. This surround sound project, which included expertise from SAMS' Prof Ben Wilson, immerses the listener in underwater sounds, encouraging them to think about our marine environment.

Nick's recordings accompanied Mary Ann on vocals and clarsach and Finlay Wells, Oban, on guitar in a mesmeric performance. After hearing Prof Spicer's lecture, Mary Ann said: "Science and art belong together and when John was talking about the importance of

scientists knowing their stuff and using that to be creative, he was also describing musicians."

There was also a presentation and display from textiles company, Crubag, which has been set up by a SAMS marine science degree graduate Jessica Giannotti. Jessica uses the marine environment as inspiration when designing scarves, bow ties, pocket squares and other fashion items.

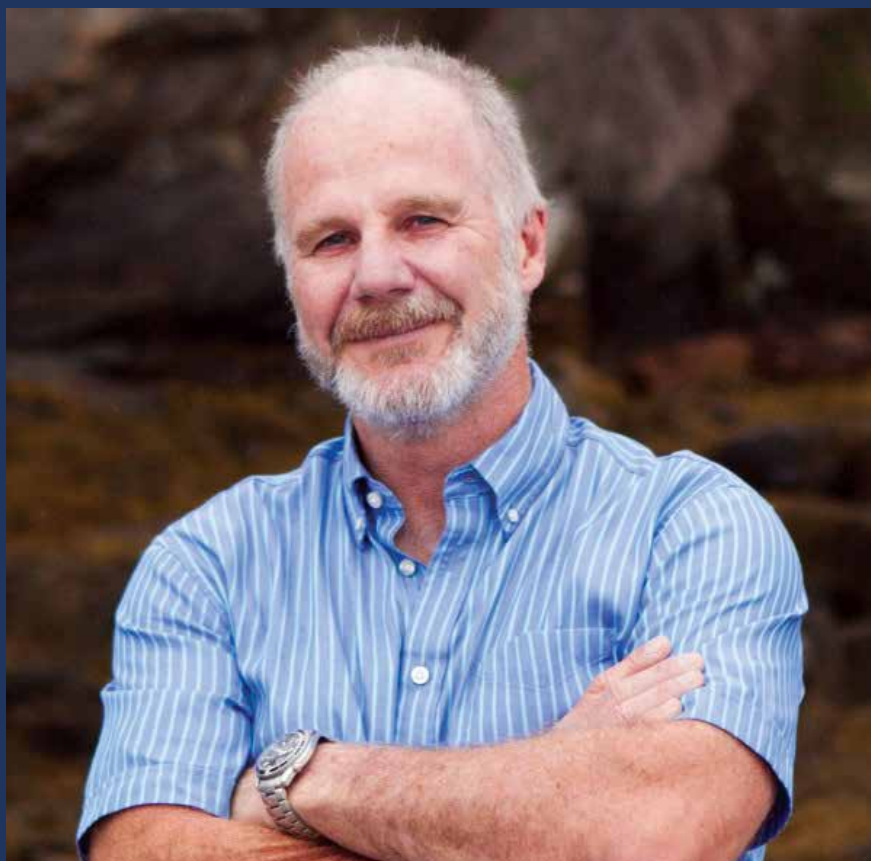
Her recently launched Flora Collection has been a collaboration with SAMS PhD researcher Ruth Paterson and images of harmful algae form the basis of the designs. This year's Newth Lecture will take place on Friday, November 10.



NEWTH LECTURER

Prof John Spicer
teaches marine zoology
at Plymouth University's
School of Biological and
Marine Sciences

OBITUARIES



Prof Graham Shimmield
FRSE (Dec 1, 1958 – Dec 24, 2016)

On Christmas Eve the devastating news reached us that our highly respected former Director, Graham Barry Shimmield, had died from cancer.

A geologist by training, Graham received his PhD in 1985 from the University of Edinburgh. He remained there until 1996, first as Lecturer and then Reader in Chemical Oceanography in the Department of Geology and Geophysics, developing a diverse research portfolio focused on indicators of climate change and human impacts on the marine environment. During this time he

got married to Tracy and had two daughters.

Graham was appointed joint Director of SAMS and NERC's Dunstaffnage Marine Laboratory at the tender age of 37. In the early days he embedded SAMS in the UHI Project to help develop a new university and conjured up his masterplan for SAMS' future - including nascent ideas around a technopole with incubator hub and full-blown science park on our doorstep.

As SAMS Director from 1996 to 2008 Graham transformed the organisation: doubling the number of staff; developing the Marine Science BSc and PhD programmes; negotiating a new

relationship with NERC; building an £8M laboratory; developing the European Centre for Marine Biotechnology as a business incubator; broadening SAMS research to include Arctic science, biotechnology and social science; and setting up SAMS' first commercial subsidiary, SRSL.

When Graham moved to the Bigelow Laboratory for Ocean Sciences in Maine, USA, in 2008 as their new Executive Director he created a similar legacy on the other side of the Atlantic: nearly doubling the size of this institution, developing a philanthropy programme that allowed the building of a \$32M marine research and education campus and the delivery of his final project, a \$6M residence facility that was opened posthumously on 12th May 2017 as the Graham Shimmield Residence Hall.

Graham published more than 70 peer-reviewed papers, was a Fellow of the Royal Society of Edinburgh since 1998 and of the Royal Society of Biology since 1999. He was president of the European Federation of Marine Sciences & Technology Societies; chairman of the European Census of Marine Life; trustee and executive committee member for the Consortium for Ocean Leadership; and chairman of the International Science Advisory Board for the Decommissioning of Man-Made Structures in the North Sea, Oil & Gas.

He is survived by his daughters, Anna and Helen, his parents and his long-term partner and new wife, Jane.



Prof Ian Bryden
(Sept 12, 1958 – Nov 28, 2016)

A graduate of the University of Edinburgh, Ian followed up with a PhD on the dynamics of wave energy devices (1980-84) from the same institution.

After working as a research engineer for British Maritime Technology (1984-86), he returned to academic life and to Scotland at Heriot-Watt University, where he served as a lecturer in offshore engineering (1986-91) and then as a senior engineer at the International Centre for Island Technology on Orkney (1991-96). From Heriot-Watt, Ian moved on to Robert Gordon University in Aberdeen, as head of the School of Mechanical and Offshore Engineering (1996-2001), associate dean of the department of design and technology (2001-02) and, finally, dean of postgraduate studies (2002-05).

He returned to Edinburgh to become professor of renewable energy (2006-13) and then head of the Institute for Energy Systems (2010-13), where he led a number of major research projects, mainly in the field of marine renewable energy, and funded by British research councils and the

European Commission. One of his particular areas of expertise was low- and zero-carbon energy capture, where he devoted his attention not only to the purely technical aspects but to examining how such energy could be incorporated into public policy and harnessed for economic development.

He also brought his 30 years' research experience to his role as director of FloWave TT Ltd, which operates the world-leading All Waters Marine Energy Test Centre in Edinburgh (from 2011). His final position was at the University of the Highlands and Islands, where in 2013 he was appointed both vice-principal (research) and associate principal (specialist colleges), which included SAMS UHI.

He is survived by his partner, Hannah Rosnes, three children and three stepchildren.



Dr Ian Graham-Bryce
CBE FRSE
(Mar 20, 1937 – Oct 10, 2016)

A former president of SAMS from 2000 - 2004, Ian was at the helm during a period of huge change at the marine laboratory.

An exceptional soil scientist, by the age of 35 Ian was directing the department of insecticides and fungicides at Rothamsted Experimental Station in Harpenden, Hertfordshire. He led groundbreaking research, amid concerns about DDT, into the behaviour of chemicals in soil and the reaction of plants to pesticides. When the Agricultural Research Council tried to shut down a project developing the first insecticides to remain stable in sunlight, Ian battled successfully against them.

By 1979 he was directing the world's leading horticultural research station in East Malling in Kent. Enchanted by the light of Romney Marsh, he would paint the birds, sea and skyscape in watercolour.

Although he led a staff of 400 at East Malling, agricultural research was falling out of public favour and he accepted an offer in 1986 to head the environmental affairs division of the Royal Shell Group in the Hague.

He relinquished a hectic schedule, involving 100 flights a year, after being asked in 1994 to apply to be the principal and vice-chancellor of the University of Dundee. There, he swiftly improved the quality of the teaching and swelled the numbers of students by 4,000, the research budget by £45 million and more than doubled the university's financial turnover.

Married to Elisabeth Metcalf for 57 years, they had four children: Fiona, Catherine, Laura and Robert.

OCEAN PROCESSES

RESEARCH HIGHLIGHT

CLOCKWORK COPEPODS

An experiment conducted in Loch Etive has revealed how the microscopic *Calanus finmarchicus* – the main food source for many larger marine species – schedules its day using its own genetic clock.

The 'body clock' of the copepod shapes its metabolic rhythms and movement through the water column. This in turn has an enormous influence on the entire food web in the North Atlantic and Arctic oceans where *Calanus finmarchicus* is a central plankton species.

As part of the study, published in the journal *Current Biology*, SAMS scientists carried out research on Loch Etive, where one of the few known isolated populations of *Calanus finmarchicus* is found. In the world's oceans, countless zooplankton species, like

copepods and krill, rise to the surface at dusk to gorge themselves on single-celled algae that can only thrive where there is sufficient sunlight. The cover of night offers the zooplankton protection from predators like fish, which need light to hunt. When dawn approaches however, they sink back into the dark depths where they can hide from their predators throughout the day – completing a cycle that likely represents the largest daily movement of biomass on the entire planet.

Though this phenomenon was first discovered over a century ago, researchers are still working to decipher which signals these marine organisms use to decide when to rise and when to descend.

Along with colleagues at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI) and the University of Oldenburg

in Germany, the SAMS team showed that *Calanus finmarchicus* possesses an internal genetic clock, also called the circadian clock, which produces a specific 24-hour rhythm that functions even without a day/night cycle. This could be important during the constantly dark polar winter and in the deep sea.

Light is only needed in order to occasionally reset the clock and work previously carried out by SAMS researchers showed zooplankton in the Arctic regulated their movements using moonlight, in the absence of sunlight, during the polar winter.



The warming Arctic region is the part of the globe showing the most obvious signs of climate change. This vast, but largely unexplored ecosystem plays a key role in the climate, biodiversity and oceanography of the northern hemisphere.

A CHANGING OCEAN

In early 2017 SAMS' position as a leading UK institute in Arctic research was exemplified when two out of four projects on NERC's Changing Arctic Ocean funding call came to Dunstaffnage. Arctic PRIZE, led by Dr Finlo Cottier, and DIAPOD, led by Prof David Pond successfully gained funding from the £10m programme, which is being co-ordinated by another SAMS scientist, Dr Kirsty Crocket. A number of UK partners will be involved in the projects.

DIAPOD will examine the effect of a warming Arctic Ocean on

the copepod *Calanus*, a small shrimp-like animal that is a vital source of food for seals, whales and commercially-important fish but is believed to be reducing in number. Arctic PRIZE will involve the University of Tromsø (UiT), the Arctic University of Norway. The project will seek to establish a year-round picture of the Arctic ecosystem, using robotic systems based at SAMS' NERC-funded Scottish Marine Robotics Facility to collect data during the relatively unexplored polar winter.

AN ARCTIC EDUCATION

Dr Finlo Cottier gained his full professorship at the University of Tromsø (UiT), the Arctic University of Norway, during the reporting year. Dr Cottier's collaborative research project with the university, Arctic ABC, was extended into a 'development' stage, bringing in technology. As SAMS' prominence in Arctic

research grew during the reporting year, Dr Cottier spoke at the Gordon Research Conference in Polar Marine Science on the topic of Arctic time series and robotics and at the Arctic Science Summit in Prague. Prof Mark Inall spoke at the Arctic Circle Summit in Reykjavik.

It was also confirmed in late 2016 that SAMS would host the UK Arctic Science Conference 2017, welcoming 125 Arctic researchers and policy influencers to Oban. During the reporting year, the Kongsfjorden and Rijpfjorden observation moorings, as a combination, reached a decade of continuous observations in the Arctic.

CLIMATE PREDICTIONS

In January 2017, SAMS joined the kick-off meeting in Berlin for Blue-Action, an H2020 project aiming to better improve climate



predictions in order to better prepare industry and society for future change. SAMS is involved in the oceanographic measurements that are crucial to climate data and also in the dissemination of the project. Key to this stage is a collaboration with case study organisations covering topics such as oil and gas, tourism, health, fisheries and other maritime activity.

This bridging of scientific data and risk management, or climate services, is at the heart of Blue-Action and will help industry and policy makers design better services in relation to weather extremes and hazardous events.

EYES ON THE OCEAN

SAMS continues to have eyes and ears in the North Atlantic, thanks to a range of observation platforms, supported by international projects: Overturning in the sub-polar North Atlantic (OSNAP).

There is mounting evidence of the importance of the transports of heat and freshwater by the North Atlantic Subpolar Gyre for impacts on European and global climate via temperature, precipitation and

wind strength. To have adequate measurements, an international transoceanic observing system was set up in the subpolar North Atlantic under OSNAP. The main aims of OSNAP are to: (i) provide a continuous record for four years (2014–18) of full-depth, trans-basin mass, heat, and freshwater fluxes; (ii) quantify and understand the response of circulation, and heat and freshwater fluxes to local and remote forcing, within the conceptual framework of the overturning circulation.

The eastern boundary array is operated by SAMS and is composed of tall moorings and repeated glider sections over the Rockall Plateau and Rockall Trough. The SAMS work involves Prof Stuart Cunningham, Prof Mark Inall, Dr Loïc Houpert, Estelle Dumont, Dr Chris O'Donnell, Dr Clare Johnson, John Beaton, Karen Wilson and Dr Stefan Gary.

Between June and July 2016 Prof Cunningham led an OSNAP cruise on RRS Discovery (DY053), from Glasgow to Reykjavik, 26th June–23rd July 2016. Cruise objectives were included refurbishment of the mooring arrays; recovery and redeployment of SAMS gliders on the Hatton Plateau; deployment

of four Argo floats on behalf of the Met Office; and to conduct three glider missions over the Rockall Plateau.

Thanks to the contribution of the different groups involved, the first time series of the sub polar Atlantic Meridional Overturning was presented at the international OSNAP PI meeting in Vienna on April 23 2017.

LARGEST EVER ATLANTIC ASSESSMENT

In the summer of 2016 SAMS was announced as a major partner in the £9m H2020 ATLAS project – A trans-Atlantic assessment and deep-sea ecosystem-based spatial management plan for Europe – and is contributing oceanographic expertise and autonomous underwater vehicles (AUVs). The European Commission's Horizon 2020 funding programme is supporting this largest and most ambitious assessment of deep-sea Atlantic ecosystems ever undertaken.

The North Atlantic is home to a number of ecosystems such as cold water corals and those around mid-ocean ridge vents. ATLAS brings together scientists, industry and government agencies across 12 countries to provide essential new knowledge on these potentially vulnerable biological communities.

SAMS' involvement, through Prof Cunningham, Dr Johnson and Dr Gary, will explore how ecosystems respond to ocean dynamics using both observations and computer models.

SAMS is also working with Heriot-

Watt University (Edinburgh) and GEOMAR (Germany) to analyse ocean models on a range of scales, including super high resolution (100m) sub-models at selected case study sites. ATLAS runs until April 2020 and is funded under the European Union's Horizon 2020 research and innovation under grant agreement No 678760.

A CLIMATE-CHANGE DIET

Ecologist Dr Thomas Brown has devised a method to measure how much of a species' diet is derived from sea ice and in March 2017 published work that demonstrated a change in the feeding habits of the endangered beluga whale. Dr Brown found a substantial change in how one community, based off Baffin Island, was getting energy from food, given the reducing levels of sea ice in the region.

Since 2000 these beluga whales and their prey, which are thought to be mainly Greenland halibut and Arctic cod, are adjusting to changes in the supply of food. Dr Brown showed that, in contrast to before 2000, these fish and whales now appear to have an increasing reliance on energy sourced from open water algae, rather than the Arctic's energy-rich sea ice algae that grows within the Arctic ice during spring. Current trends in Arctic sea ice extent and thickness show decline, with the National Snow and Ice Data Centre reporting record low average monthly sea ice extents in the Arctic in January, February, April, May, June, October, and November in 2016, suggesting increasing influxes of Atlantic-derived waters into the Arctic Ocean as the cause.

AROUND THE OCEAN IN 318 DAYS

It seems strange to think that coastal winds of Central America might significantly impact the ocean floor at 4,000 m deep, some 4,000 km from shore. But a research team that included Prof Mark Inall, Dr Dmitry Aleynik and Dr Andrew Dale has traced a 318-day journey off a full-depth oceanic eddy from the Central American coast to the Clarion Clipperton Zone (CCZ). The team monitored its near-bed velocity signal and modelled the influence of that signal on the advection and dispersion of a near-bed plume.

The Tehuantepecer is a cool, dry northeasterly wind which blows periodically through mountain gaps of eastern Mexico at speeds of up to 200km/h. These winds drive strong coastal upwelling, supporting an abundance of coastal sea life, and rapidly adjust to form an oceanic eddy which then propagates slowly westward. SAMS initial interest in this phenomenon dates back to 2012 when two eddies, one originating from eastern Mexico and the other from further south, merged to form a single 'super-eddy'. Its path led it directly over the mining areas of the CCZ some 300 days later. This work suggests the intriguing possibility that eddies, tracked from space for hundreds of days, might allow predictions to be made of the fate of abyssal sediments disturbed by deep sea mining.

Closer to home, Dr Sam Jones has been working on ODaT (the development of a novel ocean data tool), a project to make better use of oceanographic data generated during science campaigns, as part of a NERC innovation grant awarded in 2016. In collaboration with Marine Scotland, DSTL and BP, Dr Jones has developed a series of 'added value' data layers which build on raw data using

oceanographic knowledge. Another aim of the project is to demonstrate the increase in data density offered by the use of robotic gliders and other autonomous platforms, so code was developed to interpret the outputs of these platforms. The outputs of ODaT were presented via a web-mapping (GIS) server and Dr Jones presented his work at the Challenger Conference in September 2016.

EXPLORING THE DEEPEST OCEAN

During January and February 2017 Prof Ronnie Glud and Dr Robert Turnewitsch were on board the Japanese research vessel *Shinyo-maru* on a cruise to the Mariana Trench.

Prof Glud leads the HADES project, which is using custom-built Landers to explore the deepest part of the ocean. Dr Turnewitsch's role in the project is to look at sediment dynamics and implications for food supply. The cruise allowed the project team to test the new Lander and they were successful in collecting samples and data, which are currently being assessed. The deepest part of the Mariana Trench is around seven kilometres below the surface of the ocean, so only specially-designed equipment can withstand the pressures at that depth.

BLUE ECONOMY



RESEARCH HIGHLIGHT

INFLUENCING POLICY FOR FUTURE SEAWEED INDUSTRY

A rising number of valuable uses being found for seaweed — from food and fertilizer to pharmaceuticals and industrial gels — is driving the rapid growth of an industry that could easily and needlessly drop into some of the same pitfalls previously experienced in both agriculture and fish farming.

Drawing on the expertise of 21 institutions worldwide, SAMS and the United Nations University's Canadian-based Institute for Water, Environment and Health published policy advice in September 2016 for the burgeoning, multi-billion dollar industry to help it avoid expensive mistakes and pursue best practices, backed by relevant case studies involving crops like bananas and shrimp.

The brief, on which Dr Elizabeth Cottier-Cook was lead author, noted that seaweed farms now produce more than 25 million metric tonnes annually. The global value of the crop, US\$6.4 billion (2014), exceeds that of the world's lemons and limes.

Seaweed farming has grown from the late 1950s into an industry offering sustainable employment in developing and emerging economies, notably China (which produces over half of the global total of seaweed — 12.8 million tonnes) and Indonesia (27% of global production — 6.5 million tonnes). Other major producers include the Republic of Korea and the Philippines.

Most of the seaweed produced is used for human consumption with much of the remainder used largely as a nutritious additive to animal feed or as a fertiliser. In the last decade, seaweed cultivation has been rapidly expanding thanks to growing demand for its use in pharmaceuticals, nutraceuticals and antimicrobial products, as well

as biotechnological applications. Seaweed today is used in some toothpastes, skin care products and cosmetics, paints and several industrial products, including adhesives, dyes and gels. Seaweed is also used in landscaping or to combat beach erosion.

However, the policy brief says the industry needs to guard against non-indigenous pests and pathogens, to promote genetic diversity of seaweed stocks and to raise awareness of mistakes in farm management practices (such as placing the cultivation nets too close together, making the crop more vulnerable to disease transfer and natural disasters). Communities that come to depend on a single crop for their livelihood become highly vulnerable to a disease outbreak, as happened in the Philippines between 2011 and 2013 when a bacteria that whitens the branches of a valuable seaweed species caused a devastating loss to the communities involved, estimated at over US\$ 310 million.

Aquaculture has been identified as a main driver of what has been termed the Blue Economy.

Currently, aquaculture supplies over 50 per cent of finfish and shellfish consumed worldwide. This represents a paradigm shift in our exploitation of the sea that for centuries was dominated by capture fisheries.

With the global population growing and the European population expected to rise to 520 million by 2030 (currently 499 million), the demand for aquaculture products is expected to expand. In fact, the demand for aquaculture products will probably be disproportionately large because global fisheries have generally been stagnant or in decline since the mid-1980s and aquaculture will fill the widening gap between demand for marine products and ability of traditional fisheries to satisfy it.

From fish farming through to the development of a seaweed industry, SAMS has a wide range of research interests in the sector.

FUEL FOR THE FUTURE

During the reporting year, a series of macroalgae projects involving SAMS looked at how seaweed can be exploited sustainably in order to provide food and fuel for future generations.

SAMS' own commercial-sized seaweed farm off Port à Bhuiltin has allowed researchers to grow different seaweed species at certain times of year.

The H2020-funded MacroFuels aims to produce advanced biofuels from seaweed or macroalgae; the targeted biofuels are ethanol, butanol, furanics and biogas. The project will achieve a breakthrough in biofuel production from macroalgae through a range of investigations, including increasing bio-ethanol and bio-butanol production



to economically viable concentrations by developing novel fermenting organisms which metabolise all sugars at 90 per cent efficiency.

MACROSEA will target successful and predictable production of high quality biomass thereby making significant steps towards industrial macroalgae cultivation in Norway.

BIOFEED aims to develop novel salmon feed by integrating bioprocessing of non-food biomass and bioprocessing technologies to exploit woody biomass, such as spruce trees and cultivated brown macroalgae (*Saccharina latissima* and *Alaria esculenta*) as sustainable supply of high-quality proteins in feed for Atlantic salmon.

FEEDME investigates the use of seaweed residues after they have been processed for bioenergy for inclusion in animal feeds.

THE SEAGAS project is a three year, InnovateUK-funded project to support the development of an anaerobic digestion process which would utilise farmed seaweed (*Saccharina latissima*), currently an undeveloped, non-food, sustainable resource in the UK. As a farmed resource, seaweed could potentially be used instead of land biomass to produce both bioenergy and a digestate suitable for use as fertiliser. Other advantages include that there is no requirement for either nutrients in the form of fertilisers or for fresh water for irrigation.

IDREEM ENDS

The SAMS-led IDREEM project, which looked at the viability of Integrated Multi-Trophic Aquaculture (IMTA) at various European sites, ended in September 2016.

It was led by SAMS' Dr Adam Hughes, who was awarded an Honorary Fellowship with the Blue Economy Research Institute at the University of the Seychelles during the reporting year.

In the previous four years the EU FP7-funded IDREEM project supported fish-farmers across Europe, in developing different systems to introduce IMTA into their existing farming facilities.

An IMTA system grows shellfish and/or plants and other species in close proximity in order to recycle the nutrients that are lost from the fed culture of finfish.

A proportion of fish feed, and a large proportion of the nutrients in that feed, will not end up in the fish but will be lost to the environment. If the farmer adds a bivalve culture operation near the fish farm, then these filter-feeders might benefit by consuming some of the particles of waste, allowing the shellfish to grow faster or bigger than they might otherwise have done.

Additionally, the farmer might elect to grow some seaweed near the fish farm. These plants can utilise the dissolved nutrients excreted by the fish and the bivalves to enhance their growth. The IDREEM project worked towards the rapid development of Integrated Multi-Trophic Aquaculture (IMTA) production

technology in Europe. This technology is based on the principle of eco-efficiency – turning waste streams into secondary raw materials for further production.

The project concluded that although the concept of IMTA is relatively easy to understand, its definition and application is far from simple. A starting point for an industry definition might be how effective the IMTA system is at removing excess nutrients from the environment, especially nitrogen.

MY SEAWEED LOOKS WEIRD

SAMS researchers Dr Claire Gachon and Dr Yacine Badis produced content for an online course released by SAMS UHI in May 2016, in partnership with The Open University in Scotland. The course makes cutting edge research on seaweed cultivation freely available for the first time to learners, industry and academics alike.

The course is aimed at students with a scientific background and employees within the industry. It aims to build their knowledge and understanding of seaweed parasitology, enhancing employability and skills within the industry and leading to badged recognition for learners.

The content is based on a Natural Environment Research Council-funded project, GlobalSeaweed, which aims to establish a worldwide network of partners tackling emerging issues in seaweed cultivation, such as pests, invasive species and pathogens. For the second year, a

GlobalSeaweed summer school, covering various science and policy aspects of disease management in aquaculture. The programme includes an exciting line-up of invited speakers: Dr Zafar Adeel (Director of the UNU-INWEH, Canada), Dr Clare Scanlan (SEPA), Prof Gwang Hoon Kim (Director of the Kongju Institute of Biotechnology, Korea), Prof Gaoge Wang (Ocean University of China), Dr Suhelen Egan (UNSW, Australia), Dr John Webster (SAIC), Dr Frédéric Mineur (QUB) and Dr Grant Stentiford (CEFAS).

GENIALG IS OUT OF THE BOTTLE

The €11m GENIALG project (€1m for SAMS), led at SAMS by Claire Gachon, was launched during the reporting year.

It broadly aims to scale-up seaweed cultivation in the EU and SAMS' contribution will be similar to the work being carried out via GlobalSeaweed and ALFF. High-throughput phenotyping and marker-assisted breeding will be introduced, with CCAP anticipated to become a reference centre for the ex-situ conservation of kelp germplasm. Production of *S. latissima* will be upscaled, making full use of SAMS' hatchery and seaweed concession, with a strong emphasis on environmental monitoring and establishing biosecurity guidelines.

One aim of GENIALG is to improve research knowledge into disease-resistant algae for use in seaweed cultivation.

A complementary aspect, led by Paul Tett, will address engagement with stakeholders and increase awareness of social acceptability.

BOOSTING OMEGA 3 WITH SEAWEED

Dr Adam Hughes travelled to Goa in March 2017 to attend the kick off meeting for a new Global Aquaculture Challenge, Sustainable New Ingredients to Promote Health (SNIPH). The project aims to assess the potential to improve the omega-3 content of farmed carp and tilapia in India, Kenya and Tanzania using indigenous, non-conventional feed ingredients including freshwater plants, seaweeds and microbes. It is funded by the Newton Fund, Indian Government, BBSRC and DFID, involves partners from SAMS, the Institute of Aquaculture in Stirling as well as India, Kenya, Tanzania and Bangladesh.

Omega-3 fatty acids are essential dietary nutrients with critical roles in brain and eye development. They can reduce risk of cardiovascular disease and have beneficial effects in inflammatory and neurological diseases, and some cancers. However, people in the UK, India and the developing countries, Kenya and Tanzania, all consume well below the daily recommendation of 500 mg. Omega-3s are obtained from fish and seafood, which are increasingly dependent on aquaculture systems to meet human demand. However, feeding diets containing marine fishmeal and fish oil is the only way to achieve acceptable omega-3 levels in many farmed fish. Global demand for sustainable food dictates that alternatives to these finite and limited marine resources must be found.

Globally, carp and tilapia species dominate farmed fish production, and they are able to derive omega-3s themselves from fatty acids found in plants.

The project will identify, produce and test potential new feed ingredients for carp and tilapia diets in India, Kenya and Tanzania.

HARNESSING MARINE MICROBE POWER

Improving the success of large-scale microalgal cultivation is essential if industry is going to achieve cost-effective biofuel production.

Harnessing the natural microbiota that live with microalgae makes a lot of sense because they provide a range of benefits that make algal cultivation more effective and robust to contamination. Knowing which bacteria to add is important. At SAMS, we have identified one such bacterium, *Marinobacter*, as a potentially key species. Current work by Frederik De Boever for his PhD studies (ALFF) is uncovering novel functions and attributes using state-of-the-art phylogenomic analyses. This has revealed a number of unique functions of algal-loving *Marinobacter* that may be advantageous for the growth algae.

There is also interest from a range of industrial sectors for new and functionally novel polymers that have use in sectors as diverse as personal healthcare to medical treatments. Equally, there is a global demand for enzymes to selectively and specifically break polymers to produce a range of new products, such as enzymes to liberate sugars from seaweeds for bioethanol production.

Marine bacteria are experts at both making new polymers, as well as breaking them. Ongoing research by Stuart Simms for his PhD (funded by the IBioIC) is investigating the production and function of a novel gel-forming polymer isolated here at SAMS.

GONE FISHING

Dr Clive Fox began two new fisheries projects in the summer of 2016, looking at *Nephrops* discards and razorclam abundance. Both involve working with fishers on the west coast and Clive took part in meetings in Mallaig and Stornoway during May 2016 as part of the kick-off process.

Dr Fox and Lars Brunner headed to Barra in September 2016 to conduct an electrofishing-based razor clam survey. An initial survey in August that year proved effective and also provided video data. The data analysis and report writing was completed during the autumn and a final report submitted to Marine Scotland at the end of the year.

Working with Dr Amaya Albalat from Stirling University, Dr Fox studied recovery rates of trawled under-sized nephrops. The final sea trials for this research were carried out in late 2016 and work recommenced in early 2017.

POLICY ADVICE

The first set of policy guidelines for the commercial cultivation of seaweed in Scotland have been published by the Scottish Government, thanks largely to the input of SAMS researchers. This development will create opportunities to grow Scotland's seaweed industry by providing clarity over where seaweed may be grown, along with what kinds of developments will be

approved. The Seaweed Cultivation Policy Statement also sets out the framework concerning the environmental impacts of seaweed farms, including the requirements to: consider and mitigate adverse environmental impact; ensure that only native species are cultivated; be sited away from sources of pollution, where growing for human consumption; allow small-medium size farms to be located anywhere in Scotland, subject to agreement and appropriate local conditions. The full Seaweed Cultivation Policy Statement is available on the Scottish Government website <https://beta.gov.scot/publications/seaweed-cultivation-policy-statement-2017/pages/2/>

NewDEPOMOD

A computer particle tracking model used to inform the fish farming industry's regulatory decision-making process on the most suitable aquaculture sites has been getting an upgrade during the reporting year. DEPOMOD predicts the solids accumulation on the seabed arising from a fish farm and associated changes in the benthic faunal community.

The upgraded NewDEPOMOD is the result of a major investment by Scottish Government and has produced a significant research output involving three research cruises, considerable data analysis and the employment of a very wide range of theoretical concepts particularly relating to post-depositional particle behaviour.

The work is encapsulated in a completely redesigned model of more than 90,000 lines of computer code.

AN EYE FROM THE SKY

The Shelleye project, which uses a combination of satellite, modelling and meteorological data to help predict harmful algal blooms (HAB), merged into a follow-up 'Shelleye 2' as the reporting year ended. Dr Phil Anderson, Sharon McNeill and Dr Callum Whyte have undertaken several trips aboard Seol Mara, deploying a spectrophotometer to analyse reflectance from in situ phytoplankton in an attempt to ground truth a new 300-metre remote sensor flying on the sentinel 3 satellite.

SAMS continues to provide a weekly HAB risk assessment Bulletin to shellfish farmers in Shetland, now supplemented with information for finfish farmers on the likelihood of high concentrations of those chain-forming diatoms, which deliver insult to the gills of farmed fish.

Elaine Mitchell, Sarah Swan and Dr Whyte have delivered several harmful algal identification courses to groups from Dawnfresh, Marine Harvest and Scottish Sea farms. These courses focus on sample collection and preparation, enumeration and identification of those species of chain-forming diatoms and small flagellates that have the potential to cause harm or death to farmed salmon and trout.

SEALICE WORK

In October 2016 Dr Tom Adams published research on the marine 'connectivity' between fish farms, in a bid to assess lice dispersal off the west coast of Scotland. The industry operates farm management areas (FMAs) to co-ordinate the management of sea lice control. Part of the

H2020-funded AquaSpace project, the work at SAMS sought to investigate how effective these management areas are likely to be.

The paper examined the probability of a sea louse larvae hatching at one site and reaching any other site. The movement of sea lice larvae between fish farms was predicted using a computer model, capturing essential properties of the sea lice life cycle and variability in tidal and weather conditions over one calendar year. The research found that managing sites together, even within small management units such as FMAs, could lead to a dramatic reduction in transmission of sea lice.

SAMS IN MAURITIUS

In early 2017 SAMS created a new post-doctoral position in Tropical Ecology based in Mauritius, as we hope to assist the emerging Blue Economy in the island nation. Dr Georgina Robinson was the successful candidate and will conduct research in the Western Indian Ocean to develop enterprise and research opportunities in the field of sustainable aquaculture.



CHANGING



RESEARCH HIGHLIGHT

What is it that people value most about nature?

Work by Dr Jasper Kenter, Lead Scientist in Ecological Economics, has developed new theory and methods for understanding values to help resolve conflict between conservation and use of the natural environment, following on from the UK National Ecosystem Assessment.

Managing guest editor Dr Kenter led or co-authored 11 of the 15 papers in a special issue of *Ecosystem Services* (impact factor 4.3), entitled *Shared, plural and cultural values*, available freely from www.sharedvaluesresearch.org.

Shared values are those that bind people together, for example as citizens and as members of communities. Economics traditionally considers the values of individuals, but some of the

values that people hold are not for themselves – they are for others and the communities and society in which they live. These collective, shared values often relate to the landscapes people live in and visit.

The special issue edited by Dr Kenter set out to help decision-makers make more robust conclusions, based on an appreciation of the shared values that people hold together and that are distinct from individual values.

It focused on shared values around managing the natural environment and the ultimate aim of the research team was to 'democratise nature'. However, many of the concepts and applications can be adapted to other policy areas such as health and social care.

Dr Kenter has also been leading training sessions on shared values approaches with policy

makers and applied researchers based on the special issue and the research underpinning it, for example through Ecosystem Services Community Scotland (ESCOM). These new approaches are also now being taught in our undergraduate and postgraduate teaching, such as through the IDCORE 'Renewables and Society' summer schools delivered to research students.

In one case study, Dr Kenter, his UHI colleague Ros Bryce and PhD Researcher Sue Ranger (who is also engagement manager at the Marine Conservation Society) worked together with Sussex Inshore Fisheries Conservation Authority (IFCA). They brought together different stakeholders to form shared values around how to manage a number of newly designate Marine Conservation Zones. The process fed directly into bylaws which were established this year. The process was seen as very successful and was recently replicated by the East Coast IFCA with further interest from other authorities.

COASTS



It can be observed globally, affecting every part of the ocean, but climate change is often most visible on our doorstep, around our coastline and in our local waters.

The complex relationship we have with the ocean, and the constant environmental changes being observed, present challenges in how best to conserve manage and exploit these precious resources.

ROBO-BARNACLES

Tiny electronic devices that sit among coastal creatures are helping researchers study how climate change affects biodiversity across the globe.

The devices, nicknamed 'robo-mussels' and 'robo-barnacles' are designed to fit in with the natural surroundings; the robo-mussels even have the shape, colour and size of real mussels. The devices have built-in sensors that track

temperatures at regular intervals. Using readings collected over a number of years, a team of researchers led by Northeastern University (Boston, MA) scientist Prof Brian Helmuth and including SAMS' Prof Michael Burrows has built a database of nearly 12 years' worth of data. This has enabled scientists to pinpoint areas of unusual warming, and develop strategies that could help cope with climate-related changes in ecosystems.



The database, held at Northeastern University's Marine Science Center in Nahant, Massachusetts, is the largest-ever collection of intertidal temperatures, offering a remarkable way to track the effects of climate change on marine life.

At SAMS, Prof Burrows has been taking hourly measurements of rock temperatures from his 'robo-barnacle' data loggers on the seashore next to the institute. The Oban data shows since 2006, when exposed to the air, summer rock temperatures have regularly exceeded 40°C while dropping below zero in winter. Temperatures fluctuate much less when the tide is in, typically ranging from 6°C in cold winters to 14°C in warm summer months.

RENEWABLES IN THE HIGHLANDS

An ambitious project by the University of the Highlands and Islands promoting marine energy research in the north and west of Scotland came to an end during the reporting year.

The MERIKA (Marine Energy Research Innovation and Knowledge Accelerator) project was funded by a European Union FP7 programme and established a marine energy research and innovation hub in the northern Scotland.

With the by-line "research where the resource is" the project supported staff on the ground, brought in cutting edge environmental monitoring equipment and connected with to seven other scientific institutions from Portugal to Norway to collaborate with the three UHI partners, including SAMS.

The MERIKA team focussed on environmental research facilitating

wave and tidal technologies. As part of the MERIKA project, the University of the Highlands and Islands organised a Marine Renewable Energy Research Day at the European Parliament in Brussels on November 30, 2016 - St Andrew's Day.

The Research Day was hosted by Dr Ian Duncan MEP and concluded with a whisky tasting sponsored by Highlands and Islands Enterprise.

As a capacity-building project, MERIKA's legacy exists in Dr Denise Risch, Dr Jasper Kenter, Dr Simone Martino, Lucy Greenhill and Dr Suzi Billing in post at SAMS and active on a wide range of related nationally and internationally recognised projects.

CAPTURING OUR COAST

By July 2016, the UK-wide citizen science project Capturing Our Coast (CoCoast) had 200 trained volunteers across Scotland. These volunteers had been out surveying the shoreline, from Dumfries and Galloway to the Uists in an effort to provide the most detailed assessment of the UK coastline.

While Newcastle University is the lead partner in the project, SAMS heads up the programme in Scotland.

During the summer of 2016 Scottish co-ordinator Dr Hannah Grist talked to groups on Seil and in Ardfern, and at conferences in Edinburgh, Dundee, Glasgow and Oban.

MICROPLASTICS EMERGING

Around half of marine creatures living at depths of more than 2,000 metres in the North Atlantic could be eating microplastic material. That was the stark

discovery made by SAMS UHI PhD student Winnie Courtene-Jones using data obtained in June 2016 during the annual Extended Ellett Line research cruise on board the RRS Discovery.

Winnie sampled deep-sea starfish and sea snails from the Rockall Trough and found microscopic traces of plastic in 48 per cent of those sampled. The levels of plastic ingestion were comparable to those found in species living in shallower coastal waters.

Microplastics are small pieces of plastic less than 5 millimetres in size and, when ingested by sea creatures, may be passed up the food chain.

Although scientists have previously found traces of microplastics in the deep sea, Winnie's research, documents the first evidence of microplastic ingestion in deep-sea invertebrates.

A range of plastics were identified, though polyester was the most abundant plastic found, mainly in the form of microscopic fibres.

A SUSHI BAR FOR SEALS

Research published in late 2016, involving SAMS scientists Prof Ben Wilson and Dr Steven Benjamins, suggested that Scotland's fastest tidal races act like a sushi bar for seals that are hunting fish (Dynamic habitat corridors for marine predators; intensive use of a coastal channel by harbour seals is modulated by tidal currents).

Harbour seals are known to feed over a wide area of sea, habitually spending several days at a time miles offshore feeding. But the research, led by Dr Gordon Hastie of St Andrews University's Sea Mammal Research Unit, found perhaps the greatest known density of foraging harbour

seals on the planet in the Kyle Rhea channel between Skye and the Scottish mainland.

It is believed the mammals have learnt that the currents in the channel — which had been earmarked for a tidal energy scheme — act like a sushi bar or conveyor belt by shunting mackerel through, providing an easy meal for the seals. The study, part-funded by NERC and DEFRA, suggested that not all tidal sites are treated by predators in the same way with some being particularly special and particularly sensitive to industry development.

COMING ON STREAM

As North Sea oil and gas reserves run low, decommissioning the many hundreds of aging oil and gas platforms, pipelines and associated infrastructure in the North Sea is an enormous industrial, financial, political and environmental challenge.

Launched in spring 2017, the SAMS led and NERC funded STREAM project (Strategic Review of autonomous system capability for long-term decommissioning monitoring) will provide a comprehensive review of the capabilities and cost-effectiveness of applying the latest robotics and autonomous systems for the environmental monitoring needs of decommissioning. Industry partners will steer this strategic review, providing context to the current practice and data expectations of the decommissioning community (from regulators, their advisors and the industry itself).

For example, can robotic submarines be used to check the integrity of the many thousands of kilometres of pipelines criss-crossing the seabed and will this be cheaper, safer and more reliable than sending people out in boats to do the job? By reviewing the current 'state-of-

art' technologies, the project will also identify the key knowledge and technology gaps restricting adoption of autonomous systems by the sector.

For the project SAMS researcher Dr Nienke van Geel will consult a range of stakeholders such as regulators, oil and gas companies, academics, and sensor developers, to better understand the environmental monitoring needs of the decommissioning sector.

This review will highlight the potential capacity of autonomous systems to meet the industry expectations, and will identify key opportunities for innovative sensor and platform technology development.

In addition to talking to those already considering options for decommissioning, the SAMS Scottish Marine Robotics Facility (SMRF) itself houses a significant knowledge-base on how to actually operate autonomous systems platforms and sensors.

LAURENCE MEE CENTRE

The prospect of new industry, income and job prosperity offered to nations by the Blue Growth movement is an attractive option for governments around the world. However, ecological, social, economic and policy aspects of development are complicated and interlinked. Understanding these links continues to be a major focus for the Laurence Mee Centre. For example, the expansion of fish-farming in coastal waters requires development space to be available. This is currently seen as a matter for the planning system, but it is also an issue for the industry, national and local government, and the public who

live in or visit coastal communities. Meanwhile, EU consumption of, and demand, for seafood continues to increase. The 2014 EU trade deficit in seafood was the largest ever at €16.6 billion (€ 20.9 billion imports versus 4.3 billion exports). Aquaculture has potential to reduce this deficit but while it is growing in the rest of the world (including Norway), it is stagnant in the EU-28.

These issues are currently being examined by SAMS researchers as part of the EU's Horizon 2020 Aquaspace project. The project, running from 2015 to 2018, is co-ordinated by SAMS and has partners in 8 other EU countries, plus Norway, Canada, the USA, China and Australia. Fish- and shellfish- farming have been studied at 16 sites around the world and during the reporting year completed a study of fish-farming in Argyll http://www.aquaspace-h2020.eu/?page_id=12050

As part of this study, SAMS held a workshop in January 2016 with industry, regulatory and NGO stakeholders, and followed this up with analysis of public comments on recent planning applications for fish-farming development. Prof Paul Tett, lead scientist on Social-Ecological Systems at SAMS, said: "What this study shows is that there is much dissatisfaction with the current planning process, amongst both those in favour of development and those opposed."

"When you are looking at society's relationship with development in aquaculture and in Blue Growth generally, you must establish what people value most about their environment. How well does the current planning system take this into account?"



Currently fish farm companies looking to establish or expand a site must apply for a Controlled Activity Regulations (CAR) licence once an environmental impact assessment is completed. "When local authorities give planning consent they look for these licences and assess whether the application sits within the planning regulations and existing policies," added Prof Tett. "So, in practice, decisions favour development and a local authority would have to have a very good reason for refusing the application."

"Yet many developers are not happy with the current system because it is expensive and takes a lot of time. Many citizens don't like it because they feel their representations don't get noticed. The question is: is there a better way of doing this?"



LMC researcher Dr Suzi Billing who carried out these studies in Aquaspace, will also investigate these issues as part of the EU Horizon 2020 project Genetic diversity exploitation for innovative macro-algal biorefinery (GENIALG), which began in January 2017.

The new Regional Marine Planning Partnerships in Scotland, which are being formed as a result of the National Marine Plan, seek to improve the planning framework, and LMC researchers Dr Jasper Kenter, Lucy Greenhill and Jake Ainscough will this autumn be organising and facilitating a public dialogue for the Clyde Regional Marine Plan, one of the first to be developed.

In the MERIKA project, which ends in 2017, SAMS and the wider UHI have looked at building the capacity for researching and

teaching social and environmental aspects of Blue Growth, especially that associated with marine renewable energy generation. MERIKA has strengthened collaborations between SAMS and Nord University (Norway), Wageningen Marine Research (formerly IMARES), the National University of Ireland Galway, Wave Energy Centre (Portugal) and Helmholtz Zentrum Geesthacht (Germany).

The LMC team was also successful in funding proposals for shared values approaches under the Valuing Nature Programme (around values for different forms of peatland management) and the Marine Ecosystems Research Programme (looking at ecological, socio-economic and cultural implications of future marine policy for the West Coast of Scotland and the Celtic Sea). As part of this programme, Dr

Simone Martino, research fellow in Resource Economics, has been developing new models for predicting economic prices of salmon. Together with Dr Kenter he is also working on better understanding the value of wildlife for tourism and recreation.



SAMS Research Services Ltd (SRSL) has seen continued success within the Scottish aquaculture industry with several projects for both private and public organisations, ranging from high-level reviews, to the creation and delivery of bespoke on-site phytoplankton monitoring training courses, enabling companies to identify and monitor harmful algal species.

SRSL's Sea Ice Mass Balance (SIMBA) unit has undergone further improvements during the reporting year, including improved software for greater reliability, and a revised internal structure to prevent exposure of the control system during deployment in extreme environments, such as polar regions. Sales of Simba units and components continue strongly, with worldwide customers from Canada to Tasmania.

Furthermore, in early 2017, SRSL underwent assessment by Achilles FPAL, the Oil and Gas Industry supply chain services provider, and successfully achieved Verified Supplier status.

SCOTLAND AND THE UK

SRSL, with Professor Kenny Black and Dr Adam Hughes, produced a high-level review of the evidence of the major trends in aquaculture with the intention of informing policy decisions within the UK Government Office for Science. The report highlights global and national drivers for aquaculture in the UK to develop further, including increasing demand for seafood for export and, domestically, a limit to the expansion of capture fisheries, and the development of technology that will reduce

the environmental impact of aquaculture.

SRSL, alongside Imani Development, was contracted to complete a socio-economic and experiential fisheries data work package for The European Maritime and Fisheries Fund (EMFF). The work package aims to assess the economic, social and cultural footprint of inshore fisheries, especially in remote areas. In 2016, The European Maritime and Fisheries Fund (EMFF) awarded £1.51 million to develop an integrated system for the collection, collation, analysis and interrogation of data from the Scottish inshore fishing fleet, namely The Scottish Inshore Fisheries Integrated Data System Project (SIFIDS). SRSL and Imani's joint work package has contributed key information for the development of this system.

2017 marks the twelfth year of SRSL delivering the analysis of water samples for toxic phytoplankton species for Food Standards Scotland. This programme of laboratory work involves the identification and enumeration of harmful algal species collected from sampling locations around Scottish at shellfish sites to identify whether dangerous levels of toxin producing species are present. Shellfish feeding on the phytoplankton at locations where high levels of toxin-producing species are present can potentially build up dangerous levels of toxins that are harmful to human health within their flesh. The monitoring programme flags up samples where harmful phytoplankton species are recorded above set trigger levels within one week of

samples being taken, allowing targeted testing of shellfish flesh for toxins. SRSL hold ISO17025 accreditation for this service.

INTERNATIONAL

Early in 2017, SRSL provided Dissolved Organic Carbon (DOC) measurements for the EU Antifouling Copper Task Force. The aim of the project was to determine DOC levels in Mediterranean near-shore locations, with the results to be used to aid discussions around copper-based anti-fouling paints. A group of four scientists collected water samples, physical parameters and photographs from a number of marinas in five countries across the Mediterranean from Spain to Greece.

SRSL also continues to advise governments, like that of New Zealand and the Falklands, on environmental topics ranging from the developing a Blue Economy to environmental impacts of oil and gas extraction.



We are SRSL

SAMS Research Services Ltd (SRSL) provides specialist marine consultancy and survey services, underpinned by cutting-edge science. The company mission is to enable clients to understand and mitigate the risks involved in industry interaction with the marine environment. Our consultancy and survey services span the breadth of marine science and are bespoke to the clients' needs, delivering reduced project risk, robust scientific methodologies and data integrity.

SRSL operates a Quality Management System that is ISO9001 certified, and, for the provision of the Toxic Phytoplankton Monitoring program, UKAS 17025 accredited. The Quality Management System has an integrated Project Management System including Standard Operating Procedures (SOPs) which detail how projects are planned and managed at SRSL. The plan is to extend the scope of the certification to include technical aspects of commercial work including field survey operations, analytical services and consultancy. The aim of this is to ensure that during contract and project delivery, SRSL prioritises the customer's requirements and that all projects are managed in a consistent way in order to deliver the best possible service.

DIVING

NERC's National Facility for Scientific Diving (NFSD) is hosted by SAMS and provides divers, equipment, training and scientific/technical support that underpins research in the underwater environment.

Since its establishment as a national facility, NFSD has supported studies investigating topics as diverse as sea-level measurement, water-quality assessment, light measurement, functional ecology, cell biology, animal genomics, paleoclimatology, ocean acidification, biogeochemistry, eco-physiology, habitat mapping and science-based maritime archaeology.

From 2006 to 2017 the NFSD has contributed to over 160 ISI-rated publications with an average impact factor of 3.3 and an H-index of 29.

The emergency recompression facility at SAMS, now named the West Scotland Centre for Diving and Hyperbaric Medicine, treated numerous diving emergencies on behalf of both NHS-Scotland and NHS-England/Wales. The medical and technical expertise at the SAMS facility continues to lead the NHS appraisal mechanism for the whole of the British Hyperbaric Association.

Structure from Motion

The NFSD is using stereophotogrammetry underwater as an advanced

mapping tool that can also provide accurate indices of habitat complexity plus selective volumetric data.

Stereophotogrammetry essentially uses images to make measurements and is commonly used in terrestrial mapping and archaeology but has rarely been used underwater. The technique is more difficult to execute than terrestrial photogrammetry because of the optical properties of water, as well as turbidity and other environmental factors. It is increasingly being used to record coral reefs and other biogenic structures, in addition to shipwrecks.

SCUBA-diving scientists

The potential of scuba divers to provide vital information about the temperature of our oceans has been demonstrated for the first time using 'citizen science'. A study published in July 2016 in Nature's online journal Scientific Reports has shown that temperature profiles from scuba divers' computers can be compiled to provide accurate records across the globe that add to our existing monitoring network in inshore areas. This offers additional data that could help us better understand our marine environment.

The work, led by the Centre for Environment, Fisheries & Aquaculture Science (Cefas) in collaboration with the Scottish Association for Marine Science (SAMS), developed

the diveintosience website that collected more than 7,600 temperature records from sport divers to build up a record of global sea temperature in the first 'citizen science' project of its kind. New boat hits the water
The new diving support boat Glaucus, a six-metre RIB, arrived at NFSD in March 2017.

Putting the new boat straight to work on its first day, the dive team took Glaucus to Ardmucknish Bay, near Benderloch, to replace temperature loggers that are currently providing a time series for water temperature in the area going back 22 years.

Glaucus is fully MCA coded to take four passengers and crew and can be transported by road, allowing the scientific diving team to work from locations that could previously not be supported by our main diving boat Tritonia. Funding for the new boat was from a successful NERC Services and Facilities capital bid.



Research Highlights during 2016 – 17

- Sub-tidal kelp forests represent critically important marine habitats and diving surveys have assessed their structural variability along a latitudinal gradient to predict how they may respond to ocean warming. (MBA Plymouth, Aberystwyth)
- Diving supported accurate multi-scale coring, injection and extraction of samples used to determine the dynamics of pore water in subsurface sediments at the site of a controlled CO₂ release experiment. (SAMS)
- Diving-based collections of long-lived bivalve molluscs have been used in a number of paleoclimatic studies that are reconstructing ocean variability over scales ranging from seasonal to multi-centennial. (Cardiff, Bangor, Exeter, Keele)
- Comparison of established and photogrammetric techniques evaluated their respective accuracy and efficiency for estimating calcification rates and carbonate budgeting of coral reef systems. (Exeter)
- Samples collected using diving supported studies of the genetic diversity, phylogeography and morphology of *Elphidiidae* (Foraminifera) in the Northeast Atlantic. (Edinburgh, St Andrews and others)

WWW.NFSD.ORG.UK



At a glance

Cultures supplied - **1301**
Media supplied - **155**
School kits supplied - **8**
Website visits - **37,072**

CCAP

In addition to its wide ranging services and supporting algal related research and education at SAMS, the Culture Collection of Algae and Protozoa (CCAP) has played a key role in attracting more postgraduate students during the reporting year.

Over the past year, the collection has also supported many of the emerging biotechnology and seaweed disease projects headed by Drs Michele Stanley and Claire Gachon. Nine SAMS-based PhD students have also used the NERC-funded CCAP in their research.

Five of these PhD students were supervised by CCAP Head of Science John Day, on topics including: developing new

approaches of algal production in aquaculture (Cecilia Biancacci and Joe Penhaul-Smith); production of novel metabolites by algae (Keelan Lawlor); bioremediation and heavy metal removal from effluents by algae (Michael Ross); biobanking and cryopreservation (Letícia Tessarolli).

During the year, one of these students (Letícia Tessarolli) successfully defended her PhD, which has been awarded by the University of Sao Paulo, Brazil. In addition, the cohort of Masters by Research in Algal Biotechnology have successfully defended their theses. Again, the projects reflect the biological diversity and biotechnological potential of the holdings of the CCAP and its associated science.

These students and their projects included:

- Douglas Harris - Alkenone production by Haptophytes: Production, variation and analysis of a putative biofuel resource
- Paul Metcalf - Characterization of *Pseudoaltermonas* enzymes for seaweed degradation and saccharification
- Joseph Penhaul-Smith - Upgrading kelp to an omega 3 fatty acid rich feedstock using thraustochytrids
- Jennifer Reed - Assessing the suitability of *Pleurochrysis* and associated strains of *Chrysolita* for simultaneous biofuel production and carbon capture

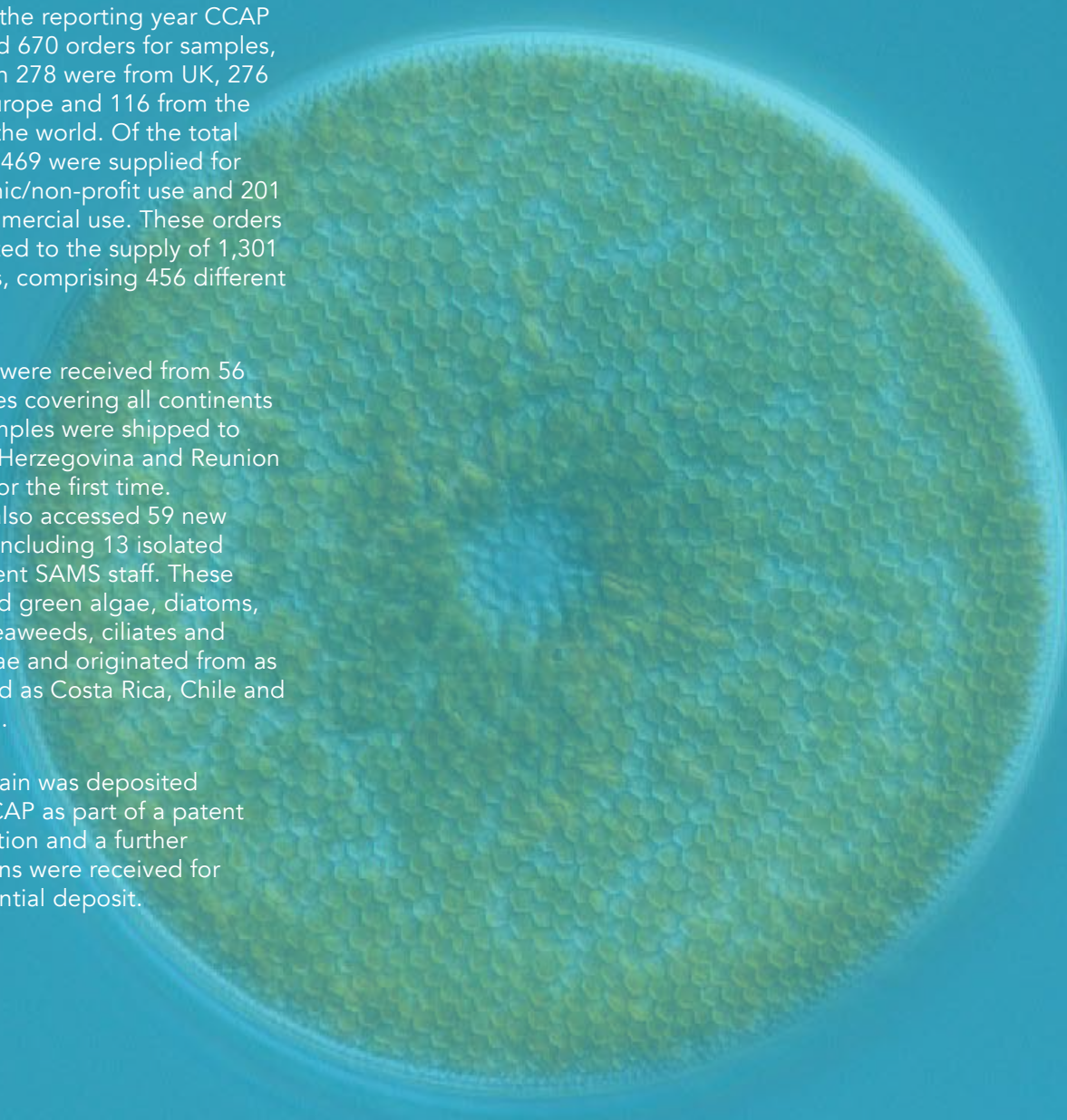
The CCAP continues to provide the platform for our Algal Biotechnology Masters by Research and a further three projects were to commence in the autumn of 2017.

During the reporting year CCAP received 670 orders for samples, of which 278 were from UK, 276 from Europe and 116 from the rest of the world. Of the total orders, 469 were supplied for academic/non-profit use and 201 for commercial use. These orders amounted to the supply of 1,301 cultures, comprising 456 different strains.

Orders were received from 56 countries covering all continents and samples were shipped to Bosnia Herzegovina and Reunion Island for the first time.

CCAP also accessed 59 new strains including 13 isolated by current SAMS staff. These included green algae, diatoms, small seaweeds, ciliates and amoebae and originated from as far afield as Costa Rica, Chile and Canada.

One strain was deposited with CCAP as part of a patent application and a further six strains were received for confidential deposit.



SCOTTISH MARINE ROBOTICS FACILITY



SAMS has been at the forefront of an exponential growth in marine robotics over the past decade and, in the past year, has used autonomous vehicles to great effect from its Scottish Marine Robotics Facility (SMRF), a NERC-funded national capability. Sea-going Gliders have been used to monitor the north Atlantic and track the ocean currents that drive our national and international climate. The Gliders have operated across a number of research projects in 2016/17, most extensively as part of OSNAP and on the Extended Ellett Line. Diving to depths of 1,000 metres and travelling at a snail's pace of 25 centimetres per second, autonomous Gliders are built for endurance and can spend up to seven months at sea. They are capable of measuring fundamental parameters; i.e. temperature, conductivity, density, dissolved oxygen and fluoresce, and can be 'piloted' from anywhere with an internet connection, including a smart phone.

By collecting data throughout the year, including the harsh winter months, we can vastly improve the resolution in which we view physical changes in the ocean and, subsequently, the global climate. By December 2016 the SAMS Glider fleet's combined time at sea amounted to six years and they had travelled 40,000 kilometres on missions as far afield as Greenland.

As well as giving SAMS an extra eye on the north-east Atlantic, our autonomous gliders were deployed in October 2016 to support the Royal Navy's Unmanned Warrior programme. The gliders were part of a fleet of 10 marine robots that completed an ambitious two-week mission off northwest Scotland, despite being

hit by a succession of Atlantic storms with winds gusting up to 60mph and waves up to seven metres high.

The mission comprised the largest simultaneous deployment of marine robots yet attempted in UK waters and the robot fleet collected a variety of marine environmental data.

As well as Seagliders, Scot-MRF specialises in the deployment and operation of: short endurance, autonomous underwater vehicles (AUVs), airborne remote piloted aircraft systems (RPAS) and more commonly used remotely operated vehicles (ROV), which are tethered to a ship and controlled directly by a pilot. SAMS' AUV 'Freya' was on voyage of discovery in May 2016, conducting a survey to gain an insight into Orkney's archaeological past.

Freya is a yellow, three-metre long, underwater robot based at SAMS' Scottish Marine Robotics Facility. Dr John Howe, Karen Wilson and Colin Abernethy worked with Dr Richard Bates (University of St Andrews) and local archaeologist Dr Caroline Wickham-Jones to conduct surveys of Loch Harray and Bay of Firth looking for evidence of submerged landscapes and possible settlements from the last 5,000 years.

This was the first time that such technology had been used to delve into, and attempt to explore, the Neolithic period in Orkney.

RPA's have performed a number of roles for SAMS researchers. Work is underway to assess their suitability as an early warning system for harmful algal blooms and for detecting oil leaks.

Work during the reporting year included aerial surveys using photogrammetry and meteorological profiling on coastal areas and lochs.

To ensure that robotics continues to support and enhance our science, SAMS has partnered with some of the UK's top marine institutes to provide a new Centre For Doctoral Training. The centre, known as NEXUSS (Next Generation Unmanned Systems Science), is joint funded by NERC and EPSRC and aims to develop a generation of future environmental science leaders. SAMS is now seen as centre of excellence for teaching young researchers in environmental robotics. SAMS hosts the annual NERC-funded Advanced Training Short Course in airborne robotics and is the site of choice for the NEXUSS CDT's Grand Challenge using airborne and sub-sea platforms.

Head of Marine Technology Dr Phil Anderson was keynote speaker at INNOVATEROBOTICS, an event run by VisitScotland's Business Events team to showcase what Scotland could offer the global research community in terms of robotics developments.

EDUCATION



SAMS EDUCATION IN NUMBERS 2015/16

At the beginning of the academic year 2016-17 SAMS was involved in educating a total of 175 higher education students, nearly all of which studied full time on one of five programmes:

BSc (Hons) Marine Science (UHI)
- 101 students

MSc Ecosystem Based Management of Marine Systems (St Andrews) - 9 students

Erasmus Mundus Joint Masters Degree in AquaCulture, Environment and Society (UHI)
- 28 students

MRes Algal Biotechnology (UHI)
- 6 students

PhD (UHI or University of Edinburgh) - 31 students

AWARD-WINNING LECTURERS

SAMS UHI scientists won three of the 10 annual awards presented by the university's Highlands and Islands Students' Association in 2016.

Dr Finlo Cottier was named Best Personal Academic Tutor; Dr John Howe was Most Inspiring Lecturer and Dr David Green shared the Best Engagement with Student Voice prize. Prof David Pond was highly commended in the Best Research or Dissertation Supervisor category. Dr Cottier's nomination was based on his 'extraordinary' contribution to his students' work and he was praised for taking a 'genuine interest' in their academic careers and goals.

One of Dr Howe's students said: "John's passion for his subject is unmatched to any other human I've ever met. His work with his field is fascinating and inspirational. He engages with students and draws them into his world and field, making geology easy and exciting to learn. "When I was first told he makes people fall in love with rocks, I thought it was a joke and like so many others, I went into my degree determined to be a biologist or conservationist and now I find myself obsessed with and loving rocks!" In his nomination, Dr Green was praised for going the extra mile to help students reach their potential and Dr Pond was described as a lecturer who 'knows how to teach and inspire students'.

TOP OF THE CLASS

Students from SAMS UHI took the university's top accolades in 2016, as Sam Black and Laura Hobbs respectively won UHI Student of

the Year and UHI Postgraduate Student of the Year titles. Sam, who went on to begin a Masters at the University of Copenhagen, also won the Tripartite Undergraduate Dissertation Prize, an annual UK award from the Challenger Society for Marine Science, the Institute of Marine Engineering, Science and Technology and the Society for Underwater Technology for the best project by a BSc student in marine science, engineering or technology.

The awards came in the same year that Sam raised thousands of pounds for Breast Cancer Now by competing in the gruelling Celtman ultra triathlon.

Laura Hobbs was selected for her award in recognition of her ground-breaking research into zooplankton in the Arctic. During her four-year study, Laura discovered that Arctic zooplankton react to moonlight in the dark polar winter. She observed that zooplankton ascend and descend in response to light levels, perhaps to hide from light-dependent predators. Laura's findings were published in the *Current Biology* journal and have been presented at UK and international conferences. Sam and Laura were presented with their awards at graduation in September 2016. The ceremony was held in Oban's Argyllshire Gathering Halls and keynote speaker was Prof Colin Moffat, Head of Science at Marine Scotland Science.

NATIONAL AWARDS

Two PhD students won national awards during the reporting year. Marine biology researcher Winnie Courtene-Jones, who studies the effects of microplastics on deep-sea ecosystems, was awarded the P1 Marine Foundation UK Student

of the Year title. And aquaculture student Kati Michalek won Lantra Scotland's Higher Education Learner of the Year Award for her work examining how changing climate conditions are affecting bivalve shell production.

INTERNATIONAL INTEREST

The AquaCulture, Environment and Society (ACES) Joint Masters Degree saw an intake of 25 students from 19 different countries arrive at SAMS UHI in September 2016. This second cohort on the fledgling programme would then go on to study in Crete in February 2017 and Nantes in late 2017.

At SAMS UHI the students receive an overview of global aquaculture and learn about aquaculture environmental interactions. They then have the option of modules in Innovation, Technology and Systems, or in Governance, Management and Knowledge Exchange.

In the next semester at Crete they are introduced to fish physiology, endocrinology, behaviour, welfare and innovative new methodologies to test fish and product quality, as well as aquaculture-environmental interactions of Mediterranean marine species.

In Nantes, the focus is on shellfish biology, and physiology and coastal zone management issues related to shellfish aquaculture. During the reporting period, the first Marine Harvest ACES scholar was appointed: Hayley Wolcott received a scholarship from the aquaculture company and will complete her fourth and final semester with Marine Harvest.

Announcing the two scholarships over two years, the company said that Scotland needed to invest in research in order to compete internationally.

PHD SUCCESSES

Four SAMS PhD students: Laura Hobbs, Michael Bedington, Sally Rouse and Sam Jones successfully defended their vivas during the reporting year. Sonji Kurishita completed his Masters by Research in Algal Biotechnology.

A ROBOTIC FUTURE

The increased use of robotics and autonomous vehicles has also given rise to a robotics stream as part of the undergraduate provision offered through SAMS UHI. Graduates will receive a BSc in Marine Science with Oceanography and Robotics. Preparations for the course introduction in autumn 2017 were made throughout the reporting year.

PROFESSORSHIPS

Sheila Heymans was awarded a Professorship from the University of the Highlands and Islands in early 2017 in recognition of her excellent research and international leadership in marine ecology and ecosystem modelling.

Michele Stanley was awarded a Readership from the university in recognition of her excellent research in biotechnology and algology.

Meanwhile, Dr Finlo Cottier was awarded full Professorship at the University of Tromsø in recognition of his excellent research links in the Arctic.

GRADUATION PRIZES

SAMS UHI Student of the Year:
Sam Black

**Johanna Fehling Memorial Prize
for best PhD student publication:**
Dr Greg Moschonas

Prize for best Masters project at SAMS:
Jacob Bentley

**SAMS Council Award
for Academic Excellence:**
Felix Butschek

**SAMS UHI Award
for Overall Achievement:**
Rosalind Barnes

Tim Boyd Prize for Oceanography:
Lucy Hyam

SAMS UHI Postgraduate Student of the Year:
Dr Laura Hobbs



COMMUNICATIONS AND OUTREACH

A DIGITAL DIGEST

News from SAMS has been delivered through more platforms than ever before, helping to amplify our messages, aid student recruitment and highlight the strength of research at Dunstaffnage.

In November 2016 Marc Roseblade joined the team in a temporary position of digital communications and marketing manager and has overseen a significant rise in our presence on social media.

Publishing more regular news items to the SAMS website gives us more original content for use on social media platforms. This helped us spread out news to a wider audience and significantly increase our following on social media during the reporting period.

A new Instagram account was created during the reporting year to encourage engagement with prospective undergraduate students.

IN THE NEWS

SAMS continues to reach global audiences with its news and is appearing more regularly on BBC outlets and national newspapers. In the reporting year, we also appeared on Euronews, Channel 5 and STV News.

Although current media monitoring is not comprehensive, we recorded around 250 direct media mentions of the 'Scottish Association for Marine Science' during the reporting period, including 29 mentions on BBC outlets. This overall figure does not include upwards of 150 media mentions for a single policy brief, the SAMS-led 'Safeguarding the future of the global seaweed aquaculture industry'. This single story was covered in National Geographic, Sunday Times, Nature World News, Huffington Post, Science Daily, BBC World Service and Radio 4's Today programme, among others. Another high-impact story was the launch of the ATLAS project, which had network coverage on the BBC, including BBC Breakfast and BBC Radio 4.

Press releases have been more targeted at suitable news outlets and there has also been a focus on increasing the awareness of SAMS science among policy makers, as well as the general public.

Visitors to the site included BBC Scotland correspondents in science, environment and education, covering stories as diverse as biofouling, European student recruitment and seaweed cultivation.

OUTREACH ACTIVITY

It was another busy year in the Ocean Explorer Centre with a total of 3,911 visits from the general public. We had a German intern, Lara Clemen, with us for some of that time, and she recorded a guided film in German for visitors as well as getting all our children's quiz and molecule hunt leaflets translated into several languages. We also improved our barnacle tank in the Aquarium Annexe which live-feeds into the OEC observatory, with some new animals featured including a sea squirt, cup corals and a resident crab.

For our education programme, we undertook several school visits with workshops including Life as a Polar Scientist, marine plastics, the past, present and future of seaweed, and DNA from strawberries proving very popular. Overall we saw 249 school pupils in the OEC and a further 280 out in the community.

A Festival of the Sea weekend took place at the Rockfield Centre in Oban on the May bank holiday with visiting Michelin-starred chef Graeme Campbell enthralling the crowds with his cookery show, and there was also a seafood market and various science and craft activities. On the Friday there was an outreach day at Oban High School run jointly with the Home Economics Department all about food from the sea. In total, 757 people attended the weekend's events.

In the autumn, our second cohort of ACES students also put on a public event, we welcomed students from SRUC Aberdeen and our H4 Science Communications students hosted an Oban Winter Festival fun day, now a firm favourite on the calendar.

In the new year Helen visited Mull to deliver the Hebridean Whale & Dolphin Trust's first After School Club workshop on seaweed. During the reporting year, the Ocean Explorer Magazine was rekindled and carried features on SAMS science and features on current topics such as women in science, marine robotics and seaweed.

Sam Finch, a photography student from Edinburgh Napier University visited SAMS to photograph researchers at work as part of his marine-themed final year project.

NEW WEBSITE

A new SAMS website was nearing completion as the reporting year ended, marking the culmination of months of work to migrate thousands of webpages from the old site, built in 2007, to a new Terminal 4 system.

The new website aims to be more responsive and user-friendly, and will better showcase the main elements of SAMS as a research institute, a place of learning and as a commercial entity.

SAMS ON FILM

As well as producing video content for general SAMS news stories, our resident filmmaker Andy Crabb was attached to seven research projects in 2016-17, helping to increase their visibility and impact.

A series of short films entitled 'Sam and Dan' followed two of our students, Sam Black and Daniel Mulqueen, who gave an insight into life as a student at SAMS.

These videos were well used on social media as a student recruitment tool.

	2014-15	2016-17	2016-17
www.sams.ac.uk	192,426	181,701	143,454
www.srsl.com	865	447	3236
www.oceanexplorercentre.org	5175	2767	7909
@ScotMarineInst Twitter	1754-2600	2600-3799	3799-5481
Facebook friends	594-889	889-1620	1620-2241
LinkedIn followers	537-922	922-1359	1359-1702

SAMS FINANCIAL SUMMARY

The Association made a deficit of (£171k) in 2016/17 (2015/16 deficit of £632k). This Outturn included a non- recurring exceptional item amounting to a credit of £660k to Income. This was attributable to the settlement of a long running legal dispute with a builder. In addition, the Association benefited from the reduction in its Universities Superannuation Scheme (USS) liability which provided a further credit in year of £250k.

The Group also benefited from the positive contribution of £120k received from the subsidiary company SRSL turning round the previous loss making position and complementing the Science activities carried out across the group.

Positive cash inflows across the Group amounted to £372k.

Recognising the need to remove ongoing deficits in its operation, SAMS has embarked on the delivery of a major Rebalancing and Development Plan aimed at improving the underlying performance of the Group. Central planks of this strategy include:

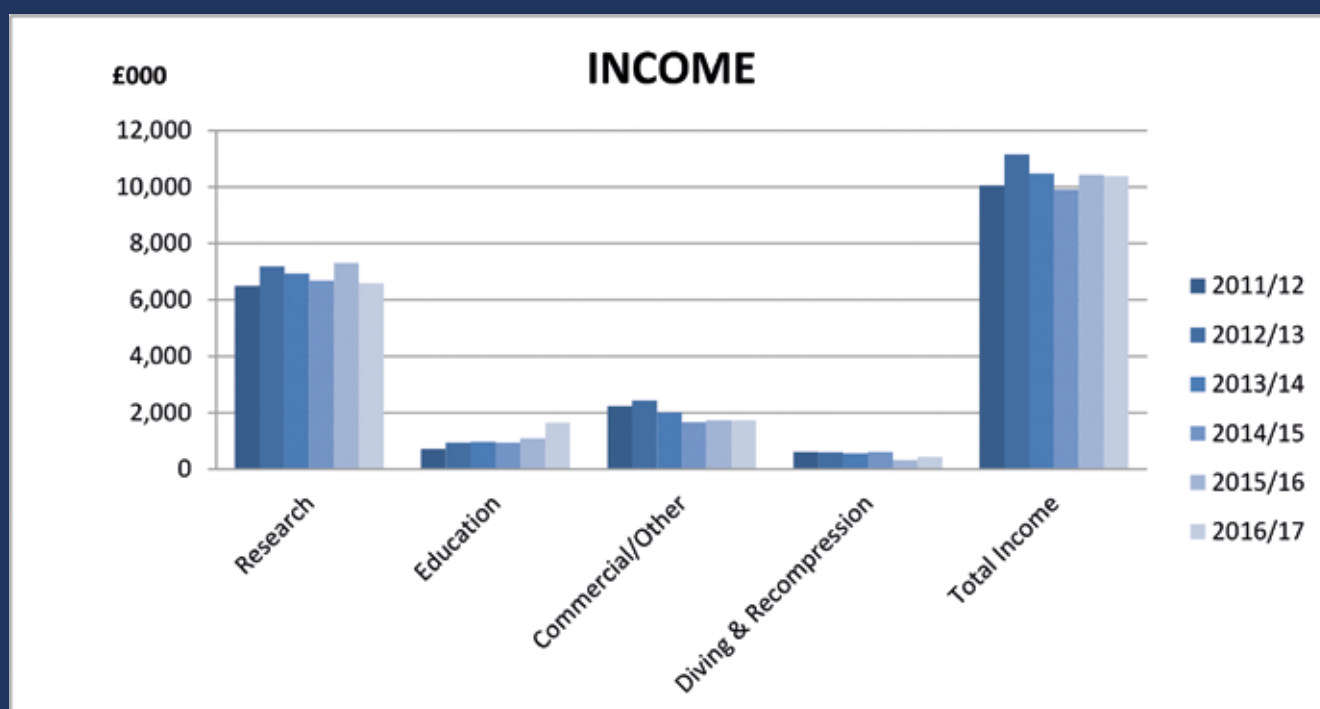
- ◆ Improved planning around the assessment and implementation of Science opportunities,
- ◆ Strategic Cost reviews and close monitoring of the Establishment,
- ◆ Improved Overhead Recovery built into Project Financial Plans.

Strategic Financial Targets have been set by Council to further aid this process with a view to returning SAMS to profitability in 2018/19. In the Current year, 2017/18 the Council has agreed that SAMS delivers a small operating surplus.

The Balance sheet remains strong with modest gearing being eliminated over the next two years. Close monitoring of costs in 2017/18 together with a focus on removing marginal activity will improve liquidity ratios.

Table 1: Summary of SAMS' financial performance in the period 1 April 2016 – 31 March 2017

Financial Summary	2016/17 £000	2015/16 £000	Change %
Operating Income	10,382	10,426	-0.4 %
Operating Expenditure excluding grant funded depreciation	(10,610)	(10,092)	5.1 %
Operating (Deficit)/Surplus before exceptional Item	(228)	334	
Exceptional in year income/exchange rate loss	660	(7)	
Pension Deficit Obligation	250	(25)	
Extraordinary Items	(174)	(118)	
Depreciation funded by grants received in previous years	(679)	(816)	16.8%
(Deficit)/Surplus transferred to reserves	(171)	(632)	-72.9%



Research grants and contracts

This year research contributed 67% of total income and showed a decrease of 3% over the prior year. NERC continued to be our single largest research funder, contributing around 45% of research income.

Education

As an Academic Partner of the University of the Highlands and Islands, we deliver both undergraduate and postgraduate education. As illustrated in the chart above income generated from Education activities has increased to around £1.7m.

Enterprise

SAMS Research Services Ltd (SRSL), our subsidiary enterprise, strives to enhance SAMS international reputation for Science Consultancy and fills the gap in science funding from other sources. Turnover increased from £1.2m to £1.4m as the company generated a surplus in 2016/17 of £120k (2015/16 deficit £216k)

Effective Management of Resources

Staff costs remain the highest proportion of expenditure representing 66% (2015/16 - 67%) of operational income. The Board have set a target of 60% for future years. Total staff costs for the year amount to £6.9m (2015/16 £6.74m). This is a movement of 2% from the prior year. Staff utilisation has been monitored through a newly developed Workload Model. This activity will inform further rebalancing of staff through 2017/18. Insights obtained from detailed analysis of the Workload Model underpinned much of a recent report by Delfinity consultants. In addition, UHI shared procurement activities provides Specialist Procurement Support for 4 days a month. Cash savings estimated at £151k (over 4 years) have been made through collaborative procurement of:

- ◆ Biofuel
- ◆ Multi Facilities Devices
- ◆ External Audit

PUBLICATIONS

1 APRIL 2016 – 31 MARCH 2017

PEER-REVIEWED PUBLICATIONS

- Adams, T.P., Aleynik, D., Black, K.D.**, (2016) Temporal variability in sea lice population connectivity and implications for regional management protocol, *Aquaculture Environment Interactions*, 8: 585–596, doi: [10.3354/aei00203](https://doi.org/10.3354/aei00203)
- Alexander, K. A.**, S. A. Meyjes, and **J. J. Heymans**. 2016. Spatial ecosystem modelling of marine renewable energy installations: Gauging the utility of Ecospace, in: *Ecopath 30 years - Modelling ecosystem dynamics: beyond boundaries with EwE*. *Ecological Modelling* 331:115-128. <http://dx.doi.org/10.1016/j.ecolmodel.2016.01.016>
- Alexander KA**, Freeman S, **Potts T**. 2016. Navigating uncertain waters: European public perceptions of integrated multi-trophic aquaculture (IMTA). *Environmental Science & Policy* 61: 230-237
- Aleynik, D. Davidson, K., Dale A. C., Porter, M.** (2016) A high resolution hydrodynamic model system suitable for novel harmful algal bloom modelling in areas of complex coastline and topography. *Harmful Algae*, 53(3):102–117, 10.1016/j.hal.2015.11.012
- Craig Smeaton, **William E. N. Austin**, Althea L. Davies, Agnès Baltzer, **Richard E. Abell**, and **John A. Howe** Substantial stores of sedimentary carbon held in mid-latitude fjords *Biogeosciences*, 13, 5771-5787, 2016 <https://doi.org/10.5194/bg-13-5771-2016>
- Louizidou, P., **Azzopardi, E., Mogg, A.O.M., Sayer, M.D.J.** and Küpper, F.C. (2016) Exploration of the biodiversity and ecosystem structure of corraligenous communities around Rhodes (Greece). *Proceedings of the 2nd European Conference on Scientific Diving* (Asplund, M.E., Enqvist, D.N.C., Engström, P., Klages, C. and Jensen, M.M., eds.), p.7. Lovén Centre Kristineberg, University of Gothenburg: Sweden.
- Hastie, G.D., Russell, D.J.F., **Benjamins, S.**, Moss, S., **Wilson, B.**, & Thompson, D. 2016. Dynamic habitat corridors for marine predators; intensive use of a coastal channel by harbour seals is modulated by tidal currents. *Behavioral Ecology and Sociobiology* doi:[10.1007/s00265-016-2219-7](https://doi.org/10.1007/s00265-016-2219-7); 14 pp.
- Benjamins, S., Van Geel, N.**, Hastie, G., Elliott, J., & **Wilson, B.** (2016). Harbour porpoise distribution can vary at small spatiotemporal scales. *Deep-Sea Research Part II: Topical Studies in Oceanography*. In press (accepted manuscript); Available online July 9, 2016. DOI : <http://dx.doi.org/10.1016/j.dsr2.2016.07.00>
- Benjamins, S., Dale, A., van Geel, N., & Wilson, B.** 2016. Riding the tide: use of a moving tidal-stream habitat by harbour porpoises. *Marine Ecology Progress Series* 549: 275-288. doi: 10.3354/meps11677
- Helmuth, B., Choi, F., Matzelle, A., Torossian, J.L., Morello, S.L., Mislán, K.A.S., Yamane, L., Strickland, D., Szathmary, P.L., Gilman, S.E., Tockstein, A., Hilbish, T.J., **Burrows, M.T.**, et al, (2016) Long-term, high frequency in situ measurements of intertidal mussel bed temperatures using biomimetic sensors. *Scientific Data*, 3, 160087. <http://www.nature.com/articles/sdata201687>
- Responses of marine organisms to climate change across oceans”, by Elvira S Poloczanska, **Michael T Burrows**, Christopher J Brown, **Jorge Garcia Molinos**, Benjamin S Halpern, Ove Hoegh-Guldberg, Carrie Vanessa Kappel, Pippa Jane Moore, Anthony J. Richardson, David S Schoeman, William J Sydeman, published in *Frontiers in Marine Science*, section Global Change and the Future Ocean.
- Fogarty HE, **Burrows MT**, Pecl GT, Robinson LM, Poloczanska ES. 2017. Are fish outside their usual ranges early indicators of climate-driven range shifts? *Global Change Biology* <http://onlinelibrary.wiley.com/doi/10.1111/gcb.13635/full>
- Hawkins SJ, Bohn K, Sims DW,

- Ribeiro P, Faria J, Presa P, Pita A, Martins GM, Neto AI, **Burrows MT**, Genner MJ. 2016. Fisheries stocks from an ecological perspective: Disentangling ecological connectivity from genetic interchange. *Fisheries Research* 179: 333-341.
- Gillian M. Notman Rona A. R. McGill, Stephen J. Hawkins, **Michael T. Burrows** 2016. Macroalgae contribute to the diet of *Patella vulgata* from contrasting conditions of latitude and wave exposure in the UK <http://www.int-res.com/abstracts/meps/v549/p113-123/>
- Hawkins SJ, Evans AJ Mieszowska N, Adams LC, Bray S, **Burrows MT**, Firth LB, Genner MJ, Leung MKY, Moore PJ, Pack K, Schuster H, Sims DW, Whittington M, Southward EC. 2017. Distinguishing globally-driven changes from regional- and local-scale impacts: The case for long-term and broad-scale studies of recovery from pollution. *Marine Pollution Bulletin*. <http://www.sciencedirect.com/science/article/pii/S0025326X17300978>
- Hutchison, Z.L., Hendrick, V.J., **Burrows, M.T., Wilson, B., Last, K.S.**, 2016 Buried Alive: The Behavioural Response of the Mussels, *Modiolus modiolus* and *Mytilus edulis* to Sudden Burial by Sediment. *PLOS ONE* 11 (3), e0151471.
- Torres, G., L. Giménez, A. Pettersen, M. Bue, **M. Burrows**, and S. Jenkins. 2016. Persistent and context-dependent effects of the larval feeding environment on post-metamorphic performance through the adult stage. *Marine Ecology Progress Series* 545:147–160.
- United Nations University. Policy Brief. Safeguarding the future of the global seaweed aquaculture industry, led by **Liz Cottier-Cook**
- Foster V, Giesler RJ, Wilson AMW, Nall CR, **Cook EJ**. 2016. Identifying the physical features of marine infrastructure associated with the presence of non-native species in the UK. *Marine Biology* 163: 173 DOI: 10.1007/s00227-016- 2941-8
- Geoffroy, M., **Cottier, F. R.**, Berge, J. and **Inall M. E.** 2016. AUV-based acoustic observations of the distribution and patchiness of pelagic scattering layers during midnight sun. – *ICES Journal of Marine Science*, doi:10.1093/icesjms/fsw158.
- Sundfjord, A, Albretsen J, Kasajima Y, Skogseth R, Kohler J, Nuth C, Skardhamar J, **Cottier F**, Nilsen F, Asplin L, Gerland S, Torsvik T. Effects of glacier runoff and wind on surface layer dynamics and Atlantic Water exchange in Kongsfjorden, Svalbard; a model study, *Estuarine, Coastal and Shelf Science* <http://www.sciencedirect.com/science/article/pii/S0272771416304486>
- Vihtakaria M, Ambrose Jr WG, Renaud PE, Locke WL, Carroll ML, Berge J, Clarke LJ, **Cottier F**, Hop H. (2016) A key to the past? Element ratios as environmental proxies in two Arctic bivalves. *Palaeogeography, Palaeoclimatology, Palaeoecology*. Online edition: <http://dx.doi.org/10.1016/j.palaeo.2016.10.020>
- Courtene-Jones, W.** Quinn, B. Murphy, F. **Gary, S. F. Narayanawamy, B. E.** Optimisation of enzymatic digestion and validation of specimen preservation methods for the analysis of ingested microplastics, *Analytical Methods*, 2016, DOI: 10.1039/C6AY02343F <http://pubs.rsc.org/en/content/articlelanding/2016/ay/c6ay02343f#!divAbstract>
- Struve T, van de Flierdt T, Burke A, Robinson LF, Hammond SJ, **Crocket KC**, Bradtmiller LI, Auro ME, Mohamed KJ, White NJ. (in press). Neodymium isotopes and concentrations in aragonitic scleractinian cold-water coral skeletons - Modern calibration and evaluation of palaeo-applications. *Chemical Geology* <http://dx.doi.org/10.1016/j.chemgeo.2017.01.022>.
- Berdalet E, Kudela R, Urban E, Enevoldsen H, Banas NS, Bresnan E, Burford M, **Davidson K**, Gobler CJ, Karlson B, Lim PT, Mackenzie L, Montresor M, Trainer VL, Usup G, Yin K. 2017. GlobalHAB: A new program to promote international research, observations, and modeling of harmful algal blooms in aquatic systems. *Oceanography* 30(1):70–81 <https://doi.org/10.5670/oceanog.2017.111>.
- Day JG** (2016) Cryopreservation - A fundamental underpinning technology for the development of a sustainable blue economy. In: Proceedings of IIR Workshop - Cold applications in Life Sciences, Dresden, Sept 8-9, 2016. pp 32-35. DOI: 10.18462/iir.cals.2016.0035
- Lal S, Pearce M, Achilles-Day UEM, **Day JG**, Morton LHG, Crean StJ, Singhrao SK. 2017. Developing an ecologically relevant heterogeneous biofilm model for dental biocides. *Biofouling* 33:75-87. <http://dx.doi.org/10.1080/08927014.2016.1260710>
- Tessarolli LP, **Day JG**, Vieira AAH. 2017. Establishment of a Cryopreserved biobank for the Coleção de Culturas de Microalgas de Água-Doce (CCMA-UFSCar), São Paulo, Brazil. *Biota Neotropica* 17(2): e20160299 <http://dx.doi.org/10.1590/1676-0611-bn-2016-0299>

- Silkina A, Nelson G, Bayliss C, **Day JG**. 2017. Bioremediation efficacy - comparison of anaerobic digested waste-based medium by a mixed algal consortium before and after cryopreservation. *J. Appl. Phycol.* 29:1331–1341. 10.1007/s10811-017-1066-x
- Day JG**, Tytor S, Egardt J, Applegren M, **Rad-Menéndez C**, Cherpurnova O, Vyverman W, Godhe A. 2017. Challenges for the Maintenance and Cryopreservation of Multiple Isolates of Model Microorganisms: An Example Using the Marine Diatom *Skeletonema marinoi*. *Biopreservation and Biobanking* 15(3):191-202 <http://online.liebertpub.com/doi/full/10.1089/bio.2016.0026>
- Warren A, Patterson DJ, Dunthorn M, Clamp JC, Achilles-Day UEM, Aescht E, Al-Farraj SA, Al-Quraishy S, Al-Rasheid K, Carr M, **Day JG**, et al. 2017. Beyond the “Code”: A Guide to the Description and Documentation of Biodiversity in Ciliated Protists (*Alveolata*, *Ciliophora*). *J Euk Microbiol* 64:539–554. 10.1111/jeu.12391
- Mingxun Wang, Jeremy J Carver, Vanessa V Phelan, Laura M Sanchez, Neha Garg, Yao Peng, Don Duy Nguyen, Jeramie Watrous, Clifford A Kapon, Tal Luzzatto-Knaan, Carla Porto, Amina Bouslimani, Alexey V Melnik, Michael J, Meehan, Wei-Ting Liu, Max Crüseman, Paul D Boudreau, Eduardo Esquenazi, Mario Sandoval-Calderón, Roland D, Kersten, Laura A Pace, Robert A Quinn, **Katherine R Duncan**, et al (2016) Sharing and community curation of mass spectra by
- GNPS. *Nature Biotechnology* (accepted May 10th, in press)
- Widmer C, **Fox CJ**, Brierley A. 2016. Effects of temperature and salinity on four species of north-eastern Atlantic scyphistomae (Cnidaria: Scyphozoa). In press in MEPS.
- Höffle, H., van Damme, **C., Fox, C.**, Lelièvre, S., Loots, C., Nash, R.D.M., Vaz, S., Wright, P.J. & Munk, P. (2017) Linking spawning ground extent to environmental factors - patterns and dispersal during the egg phase of four North Sea fishes. *Canadian Journal of Fisheries and Aquatic Science*, In press doi:10.1139/cjfas-2016-0310
- Albalat, A., McAdam, B. & **Fox, C.J.** (2016) Discard patterns and post-catch survivability of Norway lobster (*Nephrops norvegicus*) in an inshore, live-market, trawl fishery. *Journal of Shellfish Research*: 35, 1053-1065. doi:10.2983/035.035.0428
- Bundy, A., R. Chuenpagdee, J. L. Boldt, M. de Fatima Borges, M. L. Camara, M. Coll, I. Diallo, **C. Fox**, et al. 2016. Strong fisheries management and governance positively impact ecosystem status. *Fish and Fisheries* in press
- Valero M, Guillemin M-L, Destombe C, Jacquemin B, **Gachon CMM, Badis Y**, Buschmann AH, Camus C, Faugeton S. Perspectives on domestication research for sustainable seaweed aquaculture *Perspectives in Phycology* in press. 10.1127/pip/2017/0066
- Gachon CMM**, Strittmatter M, **Badis Y**, Fletcher KI, van West P, Muller D. accepted. Pathogens of brown algae: culture studies of *Anisulpidium ectocarpii* and *A. rosenvingei* reveal that the Anisulpidiales are unflagellated oomycetes. *European Journal for Phycology*. <http://dx.doi.org/10.1080/09670262.2016.1252857>
- Fletcher KI, van West P, **Gachon CMM**. (2016) Nonagonal cadherins: a new protein family found within the Stramenopiles. *Gene*; <https://doi.org/10.1016/j.gene.2016.08.003>
- Bourke MF, Marriott PJ, **Glud RN**, Hasler-Sheetal H, Kamalanathan M, Beardall J, Greening C, Cook PLM. In press. Metabolism in anoxic permeable sediments is dominated by eukaryotic dark fermentation. *Nature Geoscience*. doi:10.1038/ngeo2843
- Graziano, M., Billing, S-L., Kenter, J.O., Greenhill, L.** (2016) A transformational paradigm for marine renewable energy development. *Energy Research & Social Science*. <http://dx.doi.org/10.1016/j.erss.2016.10.008>
- Eckford-Soper LK, Bresnan E, Lacaze J-P, **Green DH & Davidson K** (2016). The competitive dynamics of toxic *Alexandrium fundyense* and non-toxic *Alexandrium tamarense*: The role of temperature. *Harmful Algae* 53: 135-144. doi: 10.1016/j.hal.2015.11.010.
- Murphy EJ, Cavanagh RD, Drinkwater KF, Grant SM, **Heymans JJ**, Hofmann EE, Hunt Jr GL, Johnston NM. 2016. Understanding the structure and functioning of polar pelagic ecosystems to predict the impacts of change. *Proc. R. Soc. B* 20161646 in press. <http://dx.doi.org/10.1098/rspb.2016.1646>
- Heymans JJ**, Tomczak MT. 2015. Regime shifts in the Northern Benguela ecosystem: Challenges for management, *Ecological Modelling*. Doi:10.1016/j.ecolmodel.2015.10.027
- Ofir E, **Heymans JJ**, Shapiro J, Goren M, Spanier E, Gal G. 2017. Predicting the impact of Lake Biomanipulation based on food-

web modelling - Lake Kinneret as a case study. *Ecological Modelling* 348:14-24.

Morato T, Lemey E, Menezes G, Pham CK, Brito J, Soxzynski A, Pitcher TJ, **Heymans JJ**. 2016. Food-web and ecosystem structure of the open-ocean and deep sea environments of the Azores, NE Atlantic. Accepted by *Frontiers in Marine Science*. doi: 10.3389/fmars.2016.00245

Heymans, J. J., M. Coll, J. S. Link, S. Mackinson, J. Steenbeek, C. Walters, and V. Christensen. 2016. Best practice in Ecopath with Ecosim food-web models for ecosystem-based management, in: *Ecopath 30 years – Modelling ecosystem dynamics: beyond boundaries with EwE*. *Ecological Modelling* 331:173-184. <http://dx.doi.org/10.1016/j.ecolmodel.2015.12.007>

Corrales, X., E. Ofir, M. Coll, M. Goren, D. Edelist, **J. J. Heymans**, and G. Gal, 2017: Modeling the role and impact of alien species and fisheries on the Israeli marine continental shelf ecosystem. *Journal of Marine Systems*, <https://doi.org/10.1016/j.jmarsys.2017.02.004>

Reed J, Shannon L, Velez L, Akogu E, Bundy A, Coll M, Fu C, Fulton B, Grüss A, Halouani G, **Heymans JJ**, et al. 2016. Ecosystem indicators – accounting for variability in species' trophic levels. *ICES Journal of Marine Science*. doi:10.1093/icesjms/fsw150.

Acosta LA, Wintle BA, Benedek Z, Chhetri PB, **Heymans SJ**, Onur AC, Painter RL, Razafimpahana A, Shoyama K. 2016: Using scenarios and models to inform decision making in policy design and implementation. In *IPBES, 2016: Methodological assessment of scenarios and models of biodiversity*

and ecosystem services [S. Ferrier, K. N. Ninan, P. Leadley, R. Alkemade, L.A. Acosta, H.R. Akçakaya, L. Brotons, W.W.L. Cheung, V. Christensen, K. A. Harhash, J.

Kabubo-Mariara, C. Lundquist, M. Obersteiner, H. Pereira, G. Peterson, R. Pichs-Madruga, N. Ravindranath, C. Rondinini and B.A. Wintle (eds.)], Secretariat of the Intergovernmental Platform for Biodiversity and Ecosystem Services, Bonn, Germany. http://www.ipbes.net/sites/default/files/downloads/pdf/Chapters_scenarios_3c_FINAL_20160831.pdf

Hicks N, Vik U, Taylor P, Ladoukakis E, Park J, Kolisis F, Jakobsen KS 2016. Using Prokaryotes for Carbon Capture Storage Trends in Biotechnology doi:10.1016/j.tibtech.2016.06.011

Hicks N, Ubbara GR, Silburn B, Smith HEK, Kröger S, Parker ER, Sivyver D, Kitidis V, Hatton A, Mayor DJ, Stahl H. 2017. Oxygen dynamics in shelf seas sediments incorporating seasonal variability. *Biogeochemistry* 0.1007/s10533-017-0326-9

Silburn B, Kroger S, Parker R, Sivyver D, **Hicks N**, Powell C, Johnson M, Greenwood N. 2017. Benthic pH gradients across a range of shelf sea sediment types linked to sediment characteristics and seasonal variability. *Biogeochemistry* 10.1007/s10533-017-0323-z

Grenvald JC, Callesen TA, Daase M, **Hobbs L**, Darnis G. Renaud PE, **Cottier F**, Nielsen TG, Berge J. 2016. Plankton community composition and vertical migration during polar night in Kongsfjorden. *Polar Biology* DOI: 10.1007/s00300-016-2015-x

G. Darnis, **L. Hobbs**, M. Geoffroy, J. C. Grenvald, P. E. Renaud, J.

Berge, **F. Cottier**, S. Kristiansen, M. Daase, J. E. Søreide, A. Wold, N. Morata, T. Gabrielsen From polar night to midnight sun: Diel vertical migration, metabolism and biogeochemical role of zooplankton in a high Arctic fjord (Kongsfjorden, Svalbard) DOI: 10.1002/lno.10519

Somot, S., **Houper, L.**, Sevault, F. et al., *Characterizing, modelling and understanding the climate variability of the deep water formation in the North-Western Mediterranean Sea*, *Climate Dynamics* (2016). doi:[10.1007/s00382-016-3295-0](https://doi.org/10.1007/s00382-016-3295-0)

Bosse, A., Testor, P., **Houper, L.**, et al., *Scales and dynamics of submesoscale coherent vortices formed by deep convection in the northwestern Mediterranean Sea.*, *J. Geophys. Res. Oceans* (2016). Accepted Author Manuscript. doi:[10.1002/2016JC012144](https://doi.org/10.1002/2016JC012144)

F. Touratier, C. Goyet, **L. Houper, X.** Durrieu de Madron, D. Lefèvre, M. Stabholz, V. Guglielmi, Role of deep convection on anthropogenic CO2 sequestration in the Gulf of Lions (northwestern Mediterranean Sea), *Deep Sea Research Part I: Oceanographic Research Papers*, Volume 113, July 2016, Pages 33-48, ISSN 0967-0637, <http://dx.doi.org/10.1016/j.dsr.2016.04.003>.

Durrieu de Madron X, Ramondenc S, Berline L, **Houper L**, Bosse A. et al. 2017. Deep sediment resuspension and thick nepheloid layer generation by open-ocean convection, *J. Geophys. Res. Oceans*, 122 10.1002/2016JC012062.

Houper, L., et al. (2016), Observations of open-ocean deep convection in the northwestern Mediterranean Sea: Seasonal and interannual variability of mixing and deep water masses for the 2007-2013 Period, *J. Geophys.*

- Res. Oceans, 121, 8139–8171, doi:10.1002/2016JC011857.
- Tierney, K. M., G. K. P. Muir, G. T. Cook, G. MacKinnon, J. A. Howe, J. J. Heymans, D. J. Hughes, and S. Xu. 2016. Ecosystem uptake and transfer of Sellafield-derived radiocarbon (^{14}C) part 2: The West of Scotland. *Marine Pollution Bulletin* in press. <http://dx.doi.org/10.1016/j.marpolbul.2016.11.014>
- Muir GKP, Tierney KM, Cook GT, MacKinnon G, Howe JA, Heymans JJ, Hughes DH, Xu S. 2017. Ecosystem uptake and transfer of Sellafield-derived radiocarbon (^{14}C). Part 1. The Irish Sea. *Marine Pollution Bulletin* 114(2):792-804 <http://dx.doi.org/10.1016/j.marpolbul.2016.10.072>
- Hughes AD, Black KD** (2016) Going beyond the search for solutions: understanding trade-offs in European integrated multi-trophic aquaculture development. *Aquacult Environ Interact* 8:191-199
- CARBONI, S., CLEGG, S. H. & **HUGHES, A. D.** 2016. The use of biorefinery by-products and natural detritus as feed sources for oysters (*Crassostrea gigas*) juveniles. *Aquaculture*, 464, 392-398.
- Gallaher, S. G., T. P. Stanton, W. J. Shaw, S. T. Cole, J. M. Toole, J. P. Wilkinson, T. Maksym, and B. Hwang. 2016. Evolution of a Canada Basin ice-ocean boundary layer and mixed layer across a developing thermodynamically forced marginal ice zone, *J. Geophys. Res. Oceans*, 121, doi:10.1002/2016JC011778.
- Zhang, J., H. Stern, **P. Hwang**, A. Schweiger, M. Steele, M. Stark, and H. C. Graber 2016. Modeling the seasonal evolution of the Arctic sea ice floe size distribution, *Elementa: Science of the Anthropocene*, 4: 000126, doi: 10.12952/journal.elementa.000126
- Vlasenko, V., N. Stashchuk, **M. E. Inall, M. Porter, and D. Aleynik** (2016), Focusing of baroclinic tidal energy in a canyon, *J. Geophys. Res. Oc.*, 121(4):2824-2840, [10.1002/2015JC011314](http://dx.doi.org/10.1002/2015JC011314)
- Johnson C**, Sherwin T, **Cunningham S, Dumont E, Houpert L**, Holliday N. 2017. Transports and pathways of overflow water in the Rockall Trough, Deep Sea Research I. <http://dx.doi.org/10.1016/j.dsr.2017.02.004>
- Pacariz, S., H. Hjalmar, A. Jacobsen, **C. Johnson** and F. Rey, 2016, Nutrient-driven poleward expansion of the NorthEast Atlantic mackerel (*Scomber scombrus*) stock: a new hypothesis, *Elementa*, 4, doi:10.12952/journal.elementa.000105.
- Bryce, R., Irvine, K., Church, A., Fish, R., Ranger, S., **Kenter, J.O.** 2016. Subjective well-being indicators for large-scale assessment of cultural ecosystem services. *Ecosystem Services* 21, 258-269. <http://dx.doi.org/10.1016/j.ecoser.2016.07.015>
- Everard, M., Reed, M.S., **Kenter, J.O.**, 2016. The ripple effect: institutionalising pro-environmental values to shift societal norms and behaviours. *Ecosystem Services* 21, 230-240. <http://dx.doi.org/10.1016/j.ecoser.2016.08.001>
- Kenter, J.O.** 2016. Shared, plural and cultural values. *Ecosystem Services* 21, 175-183. <http://dx.doi.org/10.1016/j.ecoser.2016.10.010>
- Purdy DH, Hadley DJ, **Kenter JO**, Kinch J, 2017. Sea Cucumber Moratorium and Livelihood Diversity in Papua New Guinea. *Coastal Management* 12:1–17. <http://dx.doi.org/10.1080/08920753.2017.1278147>
- Kenter, J.O.** 2016. Integrating deliberative choice experiments, systems modelling and participatory mapping to assess shared values of ecosystem services. *Ecosystem Services* 21, 291-307. <http://dx.doi.org/10.1016/j.ecoser.2016.06.010>
- Kenter, J.O.**, Reed, M., Fazey, I. 2016. The Deliberative Value Formation model. *Ecosystem Services* 21, 208-217. <http://dx.doi.org/10.1016/j.ecoser.2016.09.015>
- Kenter, J.O.**, Jobstvogt, N., Watson, V., Irvine, K., Christie, M., Bryce, R. 2016. The impact of information, value-deliberation and group-based decision-making on values for ecosystem services: integrating deliberative monetary valuation and storytelling. *Ecosystem Services* 21, 270-290. <http://dx.doi.org/10.1016/j.ecoser.2016.06.006>
- Kenter, J.O.**, Reed, M. S., Irvine, K.N., O'Brien, E., Bryce, R., Christie, M., Cooper, N., Hockley, N., Fazey, I., Orchard-Webb, J., Ravenscroft, N., Raymond, C.M., **Tett, P.**, Watson, V. 2016. Shared values and deliberative valuation: Future directions. *Ecosystem Services* 21, 358-371. <http://dx.doi.org/10.1016/j.ecoser.2016.10.006>
- Reed MS, Allen K, Attlee A, Dougill AJ, Evans KL, **Kenter JO**, Hoy J, McNab D, Stead SM, Twyman C, Scott AS, Smyth MA, Stringer LC, Whittingham MJ. 2017. A place-based approach to payments for ecosystem services. *Global Environmental Change* 43:92–106. <http://dx.doi.org/10.1016/j.gloenvcha.2016.12.009>
- Ranger, S., **Kenter, J.O.**, Bryce, R., Cumming, G., Dapling, T., Lawes, E., Richardson, P. 2016. Forming

shared values in conservation management: an interpretive-deliberative-democratic approach to including community voices. *Ecosystem Services* 21, 344-357. <http://dx.doi.org/10.1016/j.ecoser.2016.09.016>

Raymond, C., **Kenter, J.O.** 2016. Transcendental values and the valuation and management of ecosystem services. *Ecosystem Services* 21, 241-257. <http://dx.doi.org/10.1016/j.ecoser.2016.07.018>

Orchard-Webb, J., **Kenter, J.O.**, Bryce, R., Church, A. 2016. Deliberative Democratic Monetary Valuation to implement the Ecosystem Approach. *Ecosystem Services* 21, 308-318. <http://dx.doi.org/10.1016/j.ecoser.2016.09.005>

Kerrison PD, Le HN and **Hughes AD** (2016). Hatchery decontamination of *Sargassum muticum* juveniles and adults using a combination of sodium hypochlorite and potassium iodide. *Journal of Applied Phycology* 28(2): 1169-1180. <http://link.springer.com/article/10.1007/s10811-015-0672-8>

Kerrison PD, Stanley MS, Kelly M, MacLeod A, Black KD and Hughes AD (2016). Optimising the settlement and hatchery culture of *Saccharina latissima* (Phaeophyta) by manipulation of growth medium and substrate surface condition. *Journal of Applied Phycology* 28(2): 1181-1191.

Kerrison, PD, Stanley, MS, Black, KD and Hughes AD (2017). Assessing the suitability of twelve polymer substrates for cultivation of the macroalgae *Laminaria digitata* and *Saccharina latissima* (Laminariales). *Algal Research* 22: 127-134.

Kerrison P, Le HN, **Twigg GC**, Smallman DR, MacPhee R, Houston FAB and **Hughes AD**

(2016). Decontamination treatments to eliminate problem biota from macroalgal tank cultures of *Osmundea pinnatifida*, *Palmaria palmata* and *Ulva lactuca*. *J Appl Phycol*. doi:10.1007/s10811-016-0873-9. [http://link.springer.com/article/10.1007/s10811-016-0873-](http://link.springer.com/article/10.1007/s10811-016-0873-9?wt_mc=Internal.Event.1.SEM.ArticleAuthorOnlineFirst)

[9?wt_mc=Internal.Event.1.SEM.ArticleAuthorOnlineFirst](http://link.springer.com/article/10.1007/s10811-016-0873-9?wt_mc=Internal.Event.1.SEM.ArticleAuthorOnlineFirst)

Wood D, Capuzzo, E, Kirby D, Mooney-McAuley K and **Philip Kerrison P** (2017). UK macroalgae aquaculture: What are the key environmental and licensing

considerations? *Marine Policy* 83: 29–39.

K.S. Last, V.J. Hendrick, **C.M. Beveridge**, D.A. Roberts, **T.A. Wilding**. 2016. Lethal and sub-lethal responses of the biogenic reef forming polychaete *Sabellaria alveolata* to aqueous chlorine and temperature. *Marine Environmental Research*. Volume 117, Pages 44–53

Kent, F. E. A., **Last, K. S.**, Harries, D. B., Sanderson, W. G. 2016. *In situ* biodeposition measurements on a *Modiolus modiolus* (horse mussel) reef provide insights into ecosystem services. *Estuarine, Coastal and Shelf Science*. 184 (2017) 151-15

Kent, F.E., Gray, M.J., **Last, K.S.**, Sanderson, W.G., 2016. Horse mussel reef ecosystem services: evidence for a whelk nursery habitat supporting a shellfishery. *International Journal of Biodiversity Science, Ecosystem Services & Management*, 1-9.

Macdonald F, Howe JA, Jones SA, Weeks RJ, Houpert L. 2016. Scottish Marine Robotics Facility: Use of unmanned vehicles for environmental measurement, monitoring and decision making

Fraser. *IFAC PapersOnLine* 49-23: 482-485.

MacLeod AK, Stanley MS, Day JG and Cook EJ (2016) Biofouling community composition across a range of environmental conditions and geographical locations suitable for floating Marine Renewable Energy generation. *Biofouling* 32(3): 261-276.

Michalek, K., A. Ventura, and T. Sanders. "Mytilus hybridisation and impact on aquaculture: A minireview." *Marine Genomics* (2016), Special Issue "Cells to Shells". In Press.

<http://www.sciencedirect.com/science/article/pii/S1874778716300320>

Miller RG, MacLeod AK. 2016. Marine Growth Mapping and Monitoring: Feasibility of Predictive Mapping of Marine Growth. A report by SAMS Research Services Ltd to the Offshore Renewable Energy Catapult. Glasgow, UK. 51 pp.

Narayanaswamy BE, Bett BJ, **Lamont PA**, Rowden AA, Bell EM & Menot LM. (2016). Corers and Grabs – Chapter 10. In: Clark MR, Consalvey M & Rowden AA (Eds), *Biological Sampling in the Deep Sea*. Wiley Blackwell, pp 207 – 227.

Narayanaswamy BE & Foley M (2016) Impacts and effect of ocean warming on deep-sea communities. In: Laffoley, D., & Baxter, J.M. (editors). 2016. *Explaining ocean warming: Causes, scale, effects and consequences*. Full report. Gland, Switzerland: IUCN. pp. 199-212.

https://portals.iucn.org/library/sites/library/files/documents/2016-046_0.pdf

- Narayanaswamy BE**, Rea T, **Serpetti N**, **Lamont PA** (2016). What lies within: Annelid polychaetes found in microhabitats of coral/carbonate material from SW Indian Ocean seamounts. *Deep Sea Research II*. doi:10.1016/j.dsr2.2016.06.018
- Payne, B.L.** & Bro-Jørgensen, J. (2016) Disproportionate Climate-Induced Range Loss Forecast for the Most Threatened African Antelopes. *Current Biology*. 10.1016/j.cub.2016.02.067
- Payne BL**, Bro-Jørgensen J. 2016. A framework for prioritizing conservation translocations to mimic natural ecological processes under climate change: A case study with African antelopes. *Biological Conservation* 201: 230-236.
- Evans C, Brandsma J, **Pond DW**, Venables HJ, Meredith MP, Witte HJ, Stammerjohn S, Wilson WH, Clarke A, Brussaard CPD. 2017. Drivers of interannual variability in virioplankton abundance at the coastal Western Antarctic Peninsula and the potential effects of climate change. *Environmental Microbiology*.10.1111/1462-2920.13627
- Tissue-specific fatty acid profiles of vent-obligate tonguefishes (*Symphurus* spp.) on volcanic arcs in the western Pacific Ocean Stevens, C. J., **Pond, D.**, Fallick, A. E. & Juniper, S. K. 28 Jun 2016 In : *MARINE BIOLOGY*. 164, p. 1-13 13 p.
- Anderson TR, **Pond DW**, Mayor, DJ. 2017 The role of microbes in the nutrition of detritivorous invertebrates: a stoichiometric analysis. *Frontiers in Microbiology*, 7: 2113. 10.3389/fmicb.2016.02113
- Porter, M.**, **Inall, M.**, Palmer, M., Hopkins, J., **Dale, A.**, **Aleynik, D.**, Barth, J., Mahaffey, C. and D. Smeed, (2016). Glider observations of enhanced deep water upwelling at a shelf break canyon: a mechanism for cross-slope carbon and nutrient exchange. *Journal of Geophysical Research: Oceans*, 121, 7575–7588, doi:[10.1002/2016JC012087](https://doi.org/10.1002/2016JC012087).
- Covadonga Orejas, Andrea Gori, **Cecilia Rad-Menéndez**, **Kim S. Last**, Andrew J. Davies, **Christine M. Beveridge**, Daniel Sadd, Konstadinos Kiriakoulakis, Ursula Witte, John Murray Roberts. 2016. The effect of flow speed and food size on the capture efficiency and feeding behaviour of the cold-water coral *Lophelia pertusa*. *JEMBE* 481, 34-40.
- Darling, K.F., Schweizer, M., Knudsen, K.L., Evans, K.M., Bird, C., Roberts, A., Filipsson, H., Kim, J.-H., Gudmundsson, G., Wade, C.M., **Sayer, M.D.J.** and Austin, W.E.N. (2016). The genetic diversity, phylogeography and morphology of Elphidiidae (Foraminifera) in the Northeast Atlantic. *Marine Micropaleontology* 129, 1-23. <https://doi.org/10.1016/j.marmicro.2016.09.001>
- Sayer, M.D.J.**, Azzopardi, E. and Sieber, A. (2016). User settings on dive computers: reliability in aiding conservative diving. *Diving and Hyperbaric Medicine* 46, 98-110.
- Wright, S., Hull, T., Sivyer, D., Pearce, D., Pinnegar, **J.K.**, **Sayer, M.D.J.**, **Mogg, A.O.M.**, **Gontarek, S.**, **Azzopardi, E.** and Hyder, K. (2016) SCUBA divers as oceanographic samplers: the potential of dive computers to augment aquatic temperature monitoring. *Scientific Reports* 6, 30164. ; doi: 10.1038/srep30164 (2016)
- Kupper, F.C., Peters, A.F., Shewring, D.M., **Sayer, M.D.J.**, **Mystikou, A.**, **Brown, H.**, **Azzopardi, E.**, Dargent, O., Strittmatter, **M.**, **Brennan, D.**, Asensi, A.O., van West, P. and Wilce, R.T. (2016). Arctic marine phyto-benthos of northern Baffin Island. *Journal of Phycology* 52, 532–549.
- Sayer, M.D.J.** (ed.) (2016). *Underwater Technology* 33(4), 48pp.
- Heath M, Sabatino A, **Serpetti N**, **McCaig C**, O'Hara Murray R. 2016. Modelling the sensitivity of suspended sediment profiles to tidal current and wave conditions. *Ocean and Coastal Management*. DOI: 10.1016/j.ocecoaman.2016.10.018
- Scott E, **Serpetti N**, Steenbeek J, **Heymans JJ**. A stepwise fitting procedure for automated fitting of Ecopath with Ecosim models. *SoftwareX* 2016; in press.
- Serpetti N**, Taylor ML, **Brennan D**, **Green DH**, Rogers AD, Paterson GLJ & **Narayanaswamy BE** (2017). Ecological adaptations and commensal evolution of the Polynoidae (Polychaeta) in the Southwest Indian Ocean Ridge: a phylogenetic approach. *Deep-Sea Research Part II* 137: 273-281. doi: 10.1016/j.dsr2.2016.06.004.
- Serpetti N**, Witte UF, Heath MR. 2016. Statistical modelling of variability in sediment-water nutrient and oxygen fluxes. *Frontiers in Earth Science* 4:65 doi: 10.3389/feart.2016.00065
- Siemering B**, Bresnan E, Painter, S Daniels C, **Inall M**, **Davidson K**. 2016. Phytoplankton distribution in relation to environmental drivers on the North West European shelf sea *Plos1* (in press.)
- Scherer C, Gowen RJ, **Tett P**. 2016. Assessing the state of the pelagic habitat: a case study of plankton and its environment in the Western Irish Sea. *Frontiers in Marine Science*. <http://dx.doi.org/>

[org/10.3389/fmars.2016.00236](https://doi.org/10.3389/fmars.2016.00236)

Stojanovic, T. A., H. McNae, P. Tett, T. A. Potts, J. Reis, H. D. Smith and I. Dillingham (2016). "The "social" aspect of social-ecological systems: a critique of analytical frameworks and findings from a multi-site study of coastal sustainability." *Ecology & Society* 21(3 (15)).

Turnewitsch, R. Dumont, M., Kiriakoulakis, K., Legg, S., Mohn, C., Peine, F., Wolff, G. (2016) Tidal influence of particulate organic carbon export around a tall seamount. *Progress in Oceanography*, doi:10.1016/j.pocean.2016.10.009.

Wenzhöfer, F., Oguri, K., Middelboe, M., **Turnewitsch, R.,** Toyofuku, T., Kitazato, H., **Glud, R.N.** (2016). Benthic carbon mineralization in hadal trenches: Assessment by in situ O₂ microprofile measurements. *Deep-Sea Research I*, <http://dx.doi.org/10.1016/j.dsr.2016.08.013i>.

Lefering, I., Röttgers, R., **Weeks, R.,** Connor, D., Utschig, C., Heymann, K. & McKee, D. (2016) Improved determination of particulate absorption from combined filter pad and PSICAM measurements. *Optics Express* 24(22): 24805-24823. doi: 10.1364/OE.24.024805.

Whyte, C., Davidson, K., Gilpin, L., **Mitchell, E., Moschonas, G., McNeill, S.,** and **Tett, P.** 2016. Tracking changes to a microplankton community in a North Atlantic sea loch using the microplankton index PI(mp). *ICES Journal of Marine Science*: DOI 10.1093/icesjms/fsw125

Gangloff, M.M., Edgar, G.J. and **Wilson, B.,** (2016) Imperilled species in aquatic ecosystems: emerging threats, management

and future prognoses. *Aquatic Conservation: Marine and Freshwater Ecosystems*.

Wilding TA, Gill AB, Boon A, Sheehan EV, Dauvin JC, Pezy JP, O'Beirn F, Janas U, Rostin L, de Mesel I. 2017. Turning off the DRIP ('Data-rich, information-poor') -rationalising monitoring with a focus on marine renewable energy developments and the benthos. *Renewable & Sustainable Energy Reviews* 74:848 – 859. DOI [10.1016/j.rser.2017.03.013](https://doi.org/10.1016/j.rser.2017.03.013).

BOOK CHAPTERS

Rennie, F., **Billings, S.L.,** (2016) Community land ownership and rural resilience: A case study from the Highlands and Islands of Scotland. In *European rural peripheries revalued; Governance, actors, impacts* Eds: GrabSki-Kieron, U., Mose, I., Reichert-Schick, A., and Steinfuhrer A. Lit Verlag, Berlin ISBN 978-3-643-13050-1 <http://www.lit-verlag.de/isbn/3-643-13050-1>

Thomas DN, **Cottier F,** Brandon MA. Sea ice, ice drift and oceanic circulation. In: *The International Encyclopedia of Geography*. Edited by Richardson D, et al (2017) John Wiley & Sons, Ltd. Published DOI: 10.1002/9781118786352.wbieg0395

Cottier, F., Steele, M. and Nilsen, F. (2017) Sea ice and Arctic Ocean oceanography, in *Sea Ice* (ed D. N. Thomas), John Wiley & Sons, Ltd, Chichester, UK. (doi: 10.1002/9781118778371.ch7) pp195-217

Kerrison, P.D. 2016. Algae as Crops: Seaweed. In Brian Thomas, Brian G Murray and Denis J Murphy (Editors in Chief), *Encyclo-*

edia of Applied Plant Sciences, Vol 3, Waltham, MA: Academic Press, 2017, pp. 148–152.

Slocombe SP, Zhang QY, Ross M, **Stanley MS & Day JG** (2016) Screening and improvement of marine micro-algae for oil production. In: *Micro-Algal Production for Biomass and High-Value Products*, Stephen P. Slocombe & John R. Benemann (eds). CRC, Taylor & Francis group: Boca Raton, FL, pp 61-112.

COMMERCIAL REPORTS

Menzies B, Wood D, Aspray T, **Black KD** (2016) *Finfish Mortalities in Scotland. A report by Enscape Ltd, Herriot- Watt University and SRSL to Zero Waste Scotland (Project 3RP005-502) 78 pages.* <http://www.gov.scot/Resource/0049/00499991.pdf>

Burrows MT, Hughes DJ, Austin WEN, Smeaton C, **Hicks N, Howe JA, Allen C,** Taylor P, **Vare LL.** 2017. Assessment of blue carbon resources in Scotland's inshore MPA network, Scottish Natural Heritage Commissioned Report No. 957. Scottish Association for Marine Science. <http://www.snh.gov.uk/publications-data-and-research/publications/search-the-catalogue/publication-detail/?id=2453>

Cottier F, Inall ME, Miller R, Pond D, Wilson B, Owens N (2017) Written Evidence submitted to the Scottish Affairs Committee; Scotland and the High North Enquiry. pp7

Crahay C, Chepurnova O, **Childs KH, Day JG,** Vyverman W, Wilmotte A (2017) PRESPHOTO: Preservation of microalgae in BCCM

collections. Final Report. Brussels: Belgian Science Policy 2017 – 121 pp. (BRAIN-be - (Belgian Research Action through Interdisciplinary Networks))

J, Hughes A, Greenhill L and MS Stanley (2016) *Blue Biotechnology*. Commonwealth Blue Economy Report Series, No. 5. Commonwealth Secretariat: London. 55pp ISBN (paperback): 978-1-84929-152-1 ISBN (downloadable e-book): 978-1-84859-946-8

Fox C, G Macfadyen and R Cappell (2016), Capture Fisheries. Commonwealth Blue Economy Series, No. 3. Commonwealth Secretariat, London. 62pp ISBN (paperback): 978-1-84929-154-5 ISBN (e-book): 978-1-84859-948-2

Greenhill L, Day JG, Hughes A and Stanley MS (2016) *Marine Renewable Energy*. Commonwealth Blue Economy Series, No. 4. Commonwealth Secretariat, London. 64pp ISBN (paperback): 978-1-84929-155-2 ISBN (e-book): 978-1-84859-949-9

Hughes A, Day JG, Greenhill L and Stanley MS (2016) *Aquaculture*, Commonwealth Blue Economy Series, No. 2. Commonwealth Secretariat, London. 58pp ISBN (paperback): 978-1-84929-149-1 ISBN (e-book): 978-1-84859-943-7

Fazey I, Carmen E, Rao-Williams J, Hodgson A, Fraser J, Cox L, Scott D, Tabor P, Robeson D, Searle BA, Lyon C, **Kenter J**, Murray B. 2017. Community Resilience to Climate Change: Outcomes of the Scottish Borders Climate Resilient Communities Project. Centre for Environmental Change and Human Resilience, University of Dundee.

Fazey I, Carmen E, Rao-Williams J, Fraser J, Cox L, Scott D, Hodgson A, Tabor P, Robeson D, Searle

B, Lyon C, **Kenter J**, Murray B. 2017. Community Resilience to Climate Change. Summary for policy and practice. Centre for Environmental Change and Human Resilience, University of Dundee.

Last, K. S., Beveridge, C. M. & Wilding, T. A. 2016. TROMyt3 A – Chlorine demand trial. A report by SRSL for Cefas, pp.19

Last, K. S., Beveridge, C. M. & Wilding, T. A. 2016. TROMyt3 B - Tolerance of *Mytilus edulis* to suspended sediment. A report by SRSL for Cefas, pp.25

Last, K. S., Beveridge, C. M. & Wilding, T. A. 2016. TROMyt3 C – Bromoform trial. A report by SRSL for Cefas, pp.22

Macleod, A., Benjamins, S., Allen, C. 2016 Habitats Regulations Appraisal: Screening Report for Fair Head Tidal Energy Project. A report by SRSL for Fair Head Tidal Energy Park Ltd., pp. 120.

Macleod, A., Benjamins, S., Allen, C. 2016. Environmental Statement for Fair Head Tidal Energy Project: Marine Mammals and Basking Shark. A report by SRSL for Fair Head Tidal Energy Park Ltd., pp. 74.

MACLEOD, A., COOK, E.J., HUGHES, D. & ALLEN, C. (2016). Investigating the Impacts of Marine Invasive Non- Native Species. A report by **Scottish Association for Marine Science Research Services Ltd** for Natural England & Natural Resources Wales, pp. 59. Natural England Commissioned Reports, Number223. <http://publications.naturalengland.org.uk/publication/5091100843311104>

Holtrop G, **Swan S**, Duff B, **Wilding T, Narayanaswamy B, Davidson K.** 2016. Risk assessment of

the Scottish monitoring programme for the marine biotoxins in shellfish harvested from classified production areas: review of the current sampling scheme to develop an improved programme based on evidence of risk. FSS/2015/021

Ryan, C., Leaper, R., Evans, P.G.H., Dyke, K., Robinson, K.P., Haskins, G.N., Calderan, S., **van Geel, N.**, Harries, O., Froud, K., Brownlow, A. and Jack, A. (2016) Entanglement: an emerging threat to humpback whales in Scottish waters. Document SC/66b/HIM/01 presented to the Scientific Committee of the International Whaling Commission, 20-28 October 2016, Portoroz, Slovenia: 12pp.

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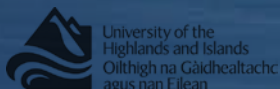
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