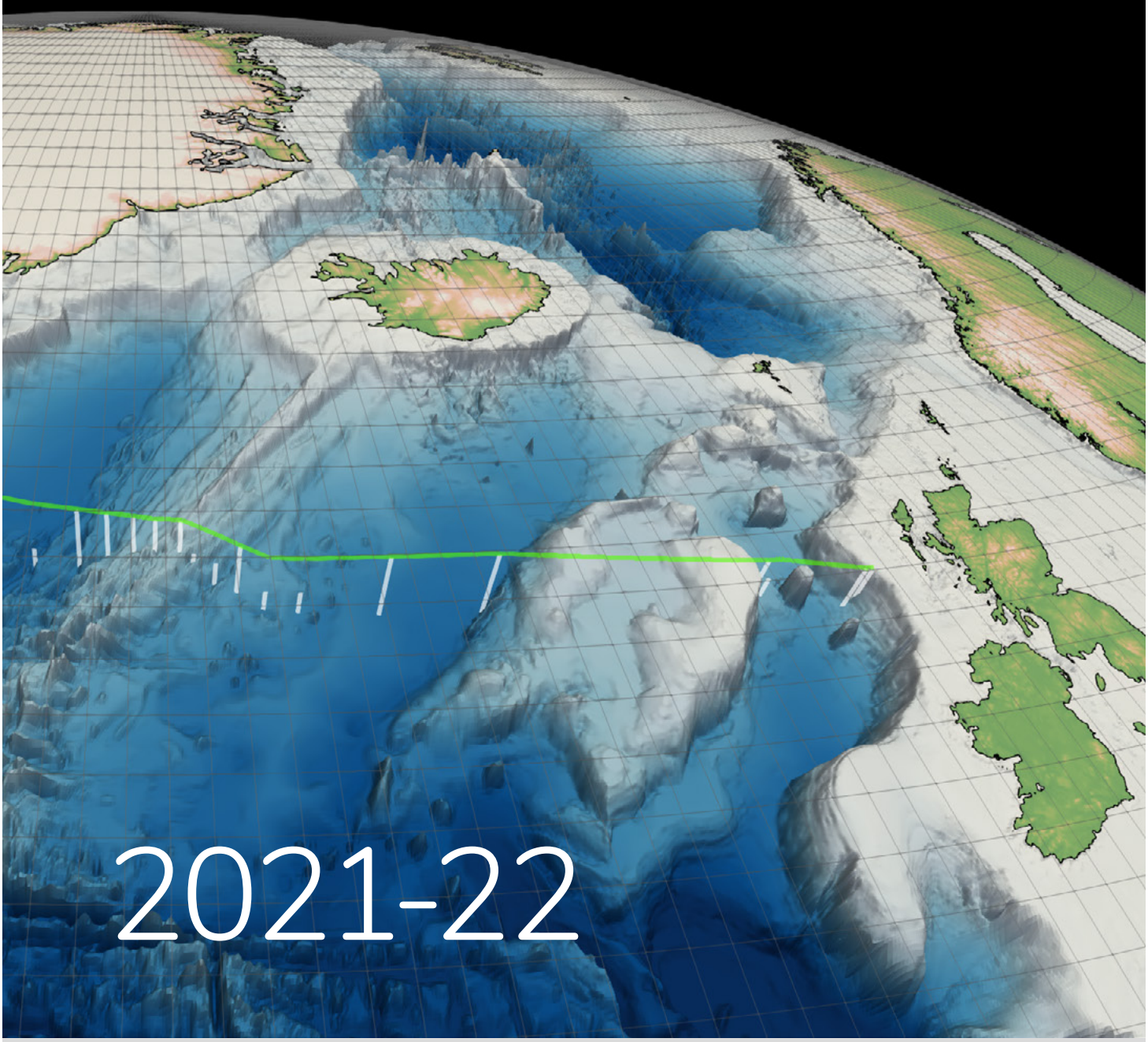
SAMS
Scottish Association for Marine Science

Annual Report

Independent marine science for healthy oceans since 1884



2021-22

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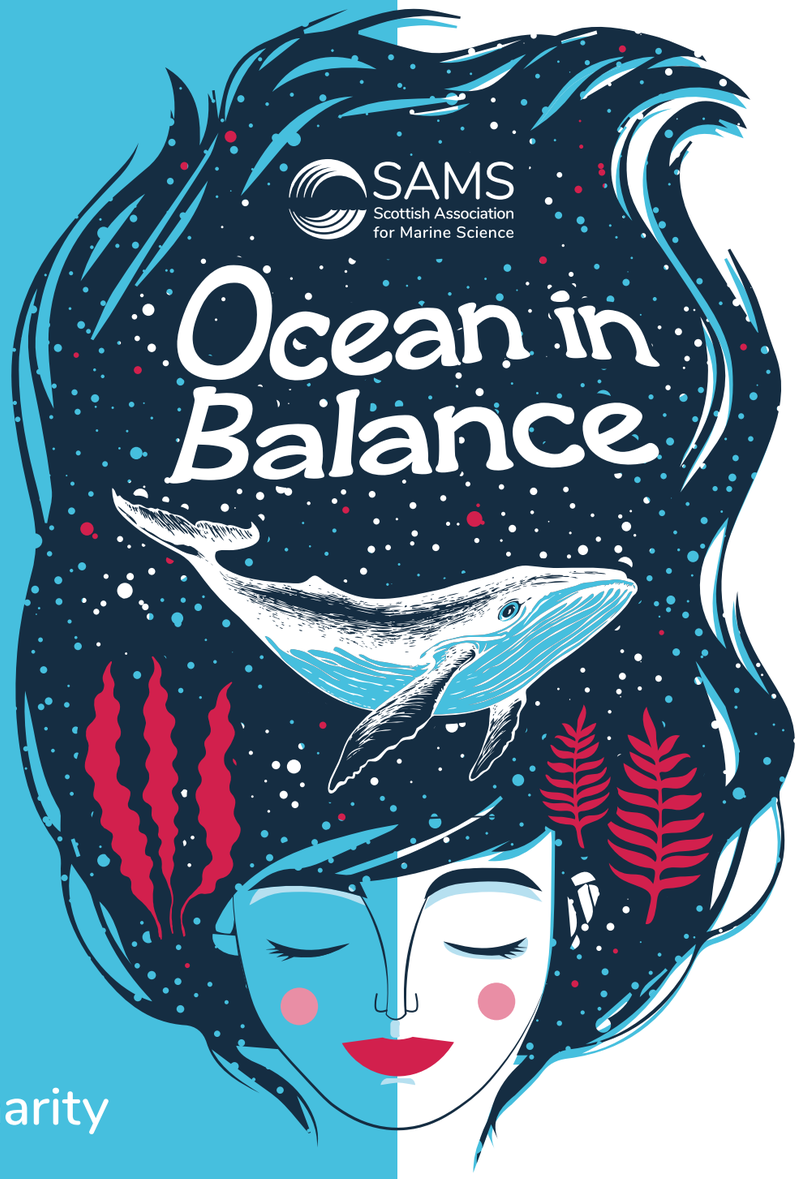

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Cover image: Mooring locations on the OSNAP (Overturning in the Subpolar North Atlantic) observing system. Bathymetry data is GEBCO, **Image credit: Sam Jones**

About SAMS

Our vision is an ocean in balance that is healthy and sustainable. We work towards this by...

- **DISCOVERING** *new knowledge about the oceans through world-class, transformational research*
- **COMMUNICATING** *our new knowledge through inspirational education and public engagement and*
- **APPLYING** *this knowledge through government, business and research partnerships to solve some of the greatest challenges facing our planet*

Our research embraces the great challenge of our time: how to provide sustainable food and energy for a growing human population while safeguarding the health, biodiversity and productivity of the natural environment and researching causes, impacts and solutions to climate change. SAMS focuses on marine related aspects of these challenges, conducting research around the world, across disciplines and at all scales with our partners and stakeholders. To ensure any new knowledge we generate is used we educate, inspire, advise and collaborate with all sectors of society: from school children to world leaders.

Founded by Sir John Murray in 1884 in Edinburgh, SAMS is the United Kingdom's oldest independent and dedicated marine science organisation, engaged in research, education and enterprise.

SAMS is a company limited by guarantee governed by its Memorandum and Articles of Association. It is also a registered Scottish charity. It operates two wholly owned active subsidiary companies: SAMS Enterprise and SAMS Limited.

SAMS is a founding academic partner of the University of the Highlands and Islands, an Associated Institution of the United Nations University, a delivery partner of UKRI Natural Environment Research Council and a partner in both the Marine Alliance for Science and Technology for Scotland (MASTS) and the Scottish Alliance for Geoscience, Environment and Society (SAGES).

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Charity Number: SC009206
Company Number: SC009292

Welcome to the SAMS 2021-22 Annual Report

Finding new solutions to global challenges

The reporting year started with SAMS still very much affected by the Covid pandemic. Although we had a well-developed system in place to manage the various workplace restrictions and had become well accustomed to carrying out virtual meetings, it was a joy as the year progressed to gradually return to something nearing normality. I make no excuses in repeating what I said in last year's report; that is, the response of all our 'SAMS people' to the challenges of the pandemic saw SAMS operating at its best. Everyone was affected in some way, some more than others. But no part of SAMS was unaffected and no part of SAMS failed to respond magnificently.

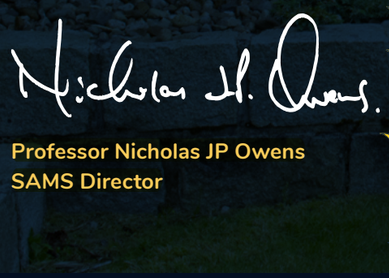
As always, there are more exciting stories to tell about our year than I have space for. I shall highlight three, with many others described elsewhere in this report. First, we embarked on an interesting and important new journey – the establishment of a 'development' programme. Essentially, this is a range of activities to raise funds to enable us to carry out more of our ground-breaking work. There is never enough funding to realise our ambitions to **create a healthier ocean for a strong planet**. However, the development programme will open up new opportunities to realise support from individuals, corporates and trusts outside our traditional funders. Our development programme is a long-term strategic activity which will take several years to come to fruition. It represents a significant step-change in SAMS 140 year-long history, and I look forward to illuminating our successes in future reports.

Secondly, we successfully funded, initiated and opened the SAMS Seaweed Academy. The Academy is a multi-faceted outreach, educational and commercial facing entity to support the nascent seaweed industry in the United Kingdom and further afield. SAMS has had a long history of research on seaweed involving many highly regarded former members of staff, the most prominent perhaps being Harry Powell (1925–2016), founding secretary of the British Phycological Society. These provided the foundations for the current generation of SAMS algal scientists who through their internationally leading work have attracted the interest of the burgeoning numbers of entrepreneurs, conservationists, financial market investors, etc who see seaweed cultivation as an opportunity. Our reputation and the external interest grew to the point where we were receiving enquiries about seaweed many times a day. It was clear there was a need and an opportunity to create a training facility to address the enormous interest, thus the Seaweed Academy was born.

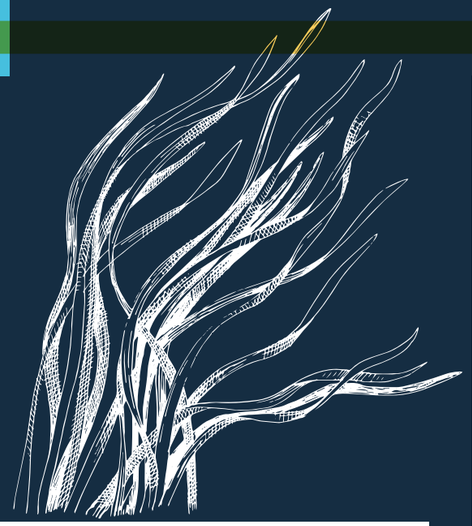
In very short order a great team put together a funding bid to the UK Government Community Renewal Fund which was successful. In a whirlwind period of just a few months the curriculum was developed, the Academy launched, with a glittering opening conference, and the first course delivered. The Academy now attracts a wide range of people from a diversity of backgrounds for tailored training in seaweed and seaweed culture and farming.

This year saw the UN Climate meeting COP26 hosted by the UK in Glasgow. SAMS had a strong presence, demonstrating how important our research is and how driven staff are to make sure their knowledge is heard by those who make decisions for our global future. Physical oceanographer Dr Max Holloway represented Scotland's marine researchers as an observer in the Blue Zone area, where the politicians and diplomats worked. Other staff were involved in the Green Zone for wider society. SAMS staff contributed to Green Zone events discussing ocean climate change (Prof Stuart Cunningham), underrepresented communities (Dr Anuschka Miller), changes in polar systems (Dr Matt Davey) and innovations towards carbon-neutral foods (Prof Michele Stanley). Other SAMS scientists presented at a Scottish Government's marine COP programme event featuring the iAtlantic project (Profs Inall and Cunningham and Drs Sam Jones, Kristin Burmeister and Neil Fraser). Finally, Prof Mark Inall chaired an online event on the future of the Arctic that included a screening of the award-winning documentary 'Into the Dark' by Michael O Snyder, filmed during an expedition of the SAMS-led Arctic PRIZE project.

In closing I would like to reflect on the second Covid year. As can be seen by the rich content of the report, despite all the challenges, SAMS produced an impressive array of outputs across our three business areas of knowledge production, promotion of our knowledge (education and outreach) and use of our knowledge (enterprise). This was only achieved because of the dedication and commitment of all the SAMS staff. However, this endeavour was only made possible through the generous support of our community of supporters who share our passion for the sea. To you, thank you and I hope you enjoy reading our report.



Professor Nicholas JP Owens
SAMS Director



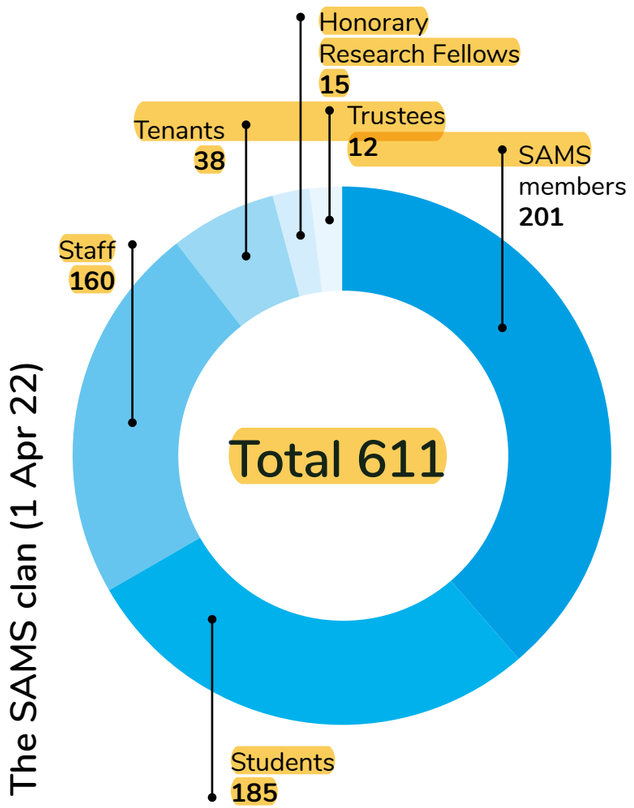
At a Glance

Activities

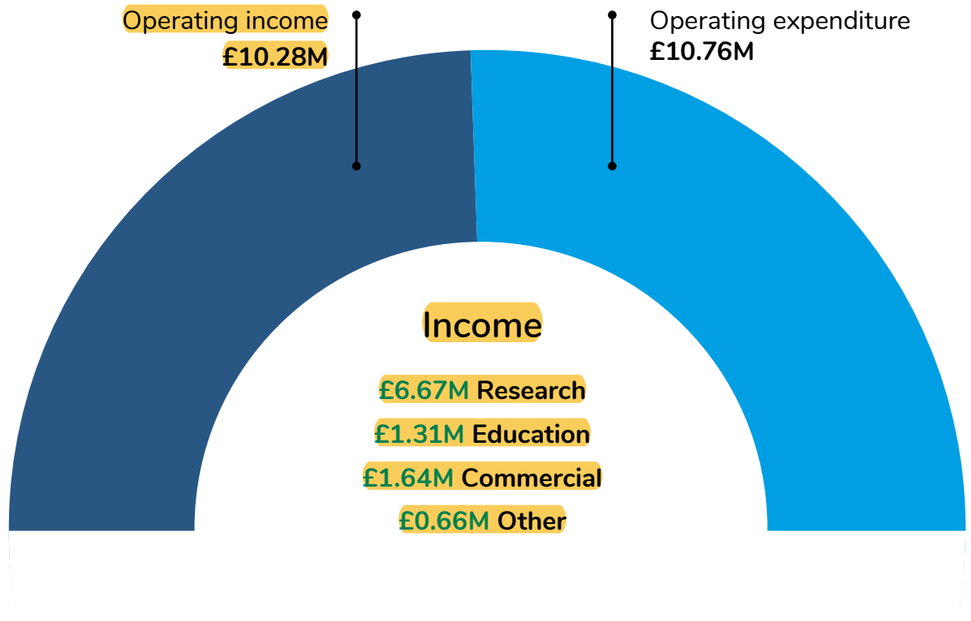
- **22** RESEARCH seminars
- **93** COMMERCIAL contracts
- **124** PEER-REVIEWED publications
- **153** ACTIVE research projects
- **1828** CCAP cultures sold

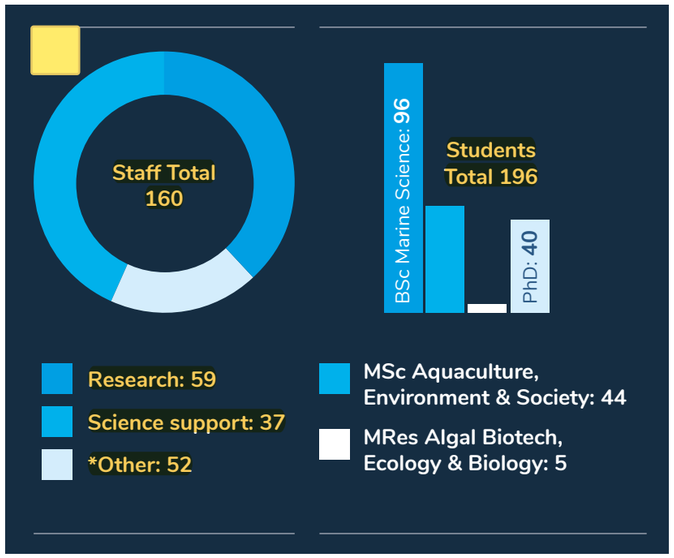
www.sams.ac.uk

232,457 Page views



Finance





7,393 Facebook friends

700 YouTube subscribers

12,112 Twitter followers

148 TikTok subscribers

1,994 Instagram followers

8,628 LinkedIn followers

718 Media mentions

4,167 Ocean Explorer Centre visitors

*Education, Enterprise, Professional Services, Management

Research overview

Our researchers study many aspects of the marine environment to develop a deeper understanding of the ocean system. We have experts in physical oceanography, marine geology, chemical oceanography, marine biology, biotechnology, marine resource management and social science and study the ocean from the air above the sea surface to the deepest ocean trenches all around our planet. This diversity is a characteristic strength of SAMS and has skilled us to work and communicate across disciplines and with different stakeholders.

Our multidisciplinary research team focuses on three complex societal challenges: to increase our understanding of ocean systems; to provide tools and knowledge to manage the health and uses of our dynamically changing coasts; and to support the development of a sustainable blue economy.

We therefore organise our research into three broad research areas rather than traditional disciplinary departments. Projects are usually affiliated with one research area but researchers themselves often contribute to more than one research area.

Three Associate Directors (Profs Keith Davidson, Michele Stanley and Ben Wilson) manage all Principal Investigators and represent the researcher voice on the Executive Group, while two researchers co-lead each Research Area.

Ocean Systems

FIELDS

Arctic science
Physical oceanography
Ecosystem function
Robotics

Dynamic Coasts

FIELDS

Climate change impacts
Marine conservation
Pollution
Fisheries
Social science

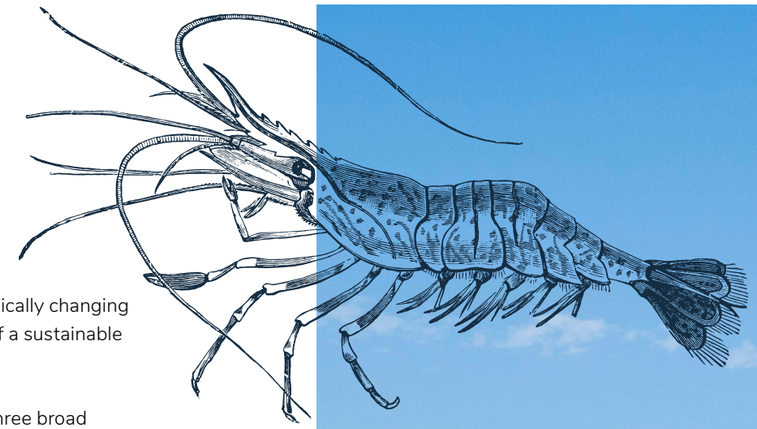
Blue Economy

FIELDS

Aquaculture
Energy generation
Seaweed industry development
Biotechnology

RESEARCH AREA LEADERS 2021/22

Ocean Systems: Prof Finlo Cottier, Dr Clare Johnson
Dynamic Coasts: Dr Helena Reinardy, Dr Will Goodall-Copestake
Blue Economy: Dr Adam Hughes, Dr Lindsay Vare

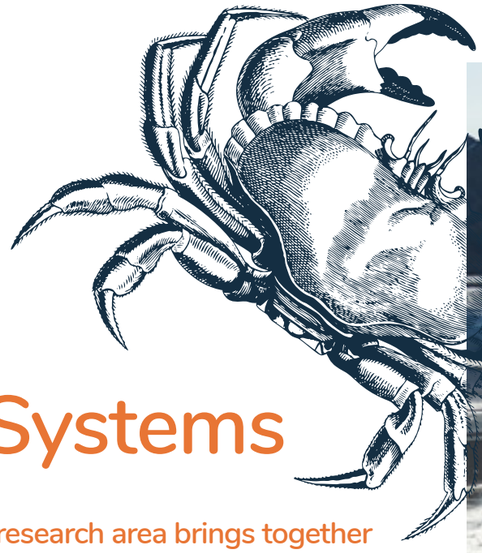


OUR SEAWEED NURSERY

SAMS Enterprise won the Ocean Winds Award for Excellence in Marine Innovation and Growing Blue Economy for the expanded and upgraded SAMS seaweed nursery. The award was made by the Scottish Council for Development and Industry. It recognised the high concentration of world-leading seaweed research and innovation experts at SAMS that drives the conversion of innovative science into practical solutions and commercially available products.

The seaweed nursery produces seeded lines that act as high-quality starter material to commercial seaweed farms. Currently four different species are available.

To safeguard the environment, the nursery produces strains specific to the wider farm area and is developing a biobank of seed cultures.



Ocean Systems

The Ocean Systems research area brings together SAMS scientists who undertake vital research to discover the key processes that comprise the interconnected systems by which our oceans function.

The research activities span spatial scales from the molecular to the planetary across all scientific disciplines. Ocean Systems research feeds into international scientific panels and organisations such as the IPCC and the UN and informs international policy and governance.

Will the Arctic warm or cool?

SAMS oceanographers were invited to speak at COP26 in Glasgow.

Prof Mark Inall chaired an event entitled 'Will the Arctic warm or cool', which examined the future of the Arctic and the possible outcomes for our climate.

Prof Stuart Cunningham spoke at this event and also contributed to a Met Office event in the COP26 Science Pavilion 'Tracking ocean climate change and the impact on our fragile oceans'.

Professors Cunningham and Inall were also part of 'An evening dip into the deep ocean', organised by the iAtlantic project and part of the Scottish Government's marine programme events for COP26.

Plastic pollution

Prof Bhavani Narayanaswamy continued to publish on marine plastics during the reporting period, with one paper in particular looking at plastic debris as the most common and exponentially increasing human pollutant in the world's oceans.

The distribution and impact of plastics in the Pacific and Atlantic Oceans have been the subject of many studies but not so for the Indian Ocean. Prof Narayanaswamy was co-author on a review paper that examined plastic sources and sinks, which are specific for the Indian Ocean, identifying hotspots of possible plastic accumulation.

Historical data gives new climate insight

For the first time, scientists have used ocean measurements taken on research voyages almost 150 years ago to learn more about how human activity has impacted climate.

In April 2021 scientists from SAMS and the National Oceanography Centre (NOC) made the first combined study of water density measurements [illegible] the British HMS Challenger and F[illegible]an SMS Gazelle round-the-world research expeditions in the 1870s to draw parallels with modern-day measurements.

The study was the first global-scale analysis of salinity from these two expeditions and the first observational evidence of changes in the global water cycle since the late 19th century.

With no baseline measurement for salinity pre-1950s, Professor Stuart Cunningham of SAMS and Dr John Gould from NOC converted these density measurements into salinity and were able to show that the planet's water cycle has increased in intensity, just as the global temperature has risen. **www.nature.com/articles/s43247-021-00161-3**

Facing up to glacier melting

SAMS scientists deployed robotic vehicles on a dangerous mission to the face of a glacier in Svalbard as they attempted to expose the hidden link in how rapidly melting Arctic ice is changing our ocean.

The mission to Ny Ålesund, the world's most northerly settlement, was a collaboration between SAMS, UiT The Arctic University of Norway, the Norwegian Polar Institute and the University Centre on Svalbard. The team examined the Kronebreen glacier in Kongsfjorden, measuring the freshwater run-off as it melts, and assessing how it interacts with the saltier sea water coming into the fjord from the North Atlantic.

Humans are unable to sample at the glacier face because of the risk of huge chunks of ice collapsing into the sea below, a process known as GLACI[illegible] calving.

The ocean's effect on climate

SAMS oceanographers studying global currents that dictate much o[illegible]h's climate have developed a method to unlock data from the past 120 years – improving our ability to predict global temperature changes.

The scientists estimated the strength of these currents – known as the Atlantic Meridional Overturning Circulation (AMOC) – going back to the beginning of the 20th century. In doing so, they have reconstructed the longest AMOC time series derived entirely from ocean observations.

Using temperature and salinity data from the past 120 years, they found a close link between the strength of the AMOC and the North Atlantic sea surface temperature, underlining the dominant role of the AMOC in climate.

It's getting hot in here!

A high-impact paper in the journal Science, in which Prof Michael Burrows was an author, showed how extreme warming events in the world's oceans are becoming more widespread and frequent. Eight of the 10 most severe recorded events have taken place in the past decade, the study found. These marine heatwaves have major environmental impacts but also severely alter ecosystem service provision, with widespread socioeconomic impacts.

Heatwave effects, including range shifts and mass mortality of marine species and harmful algal blooms, have knock-on economic consequences that already run into billions of US dollars. As well as reviewing the impacts of these events, the paper discussed the mitigation and adaptation measures that are needed to alleviate the risks and damaging impacts.

For more information visit **www.science.org/doi/full/10.1126/science.abj3593**

Dynamic Coasts

The Dynamic Coasts research area looks at natural and social science underpinning the management of coastal and shelf ecosystems.

It spans pure organismal and ecosystem process in the local and regional coastal zone, and applied research to integrate global, national, and regional policy and management solutions. Specialities with the research area include integration of maritime societal interactions, conservation, biodiversity, organismal biology, ecotoxicology, marine spatial planning, with crossovers into blue economy industries such as aquaculture, fisheries, rural growth, and fundamental marine processes which encompass the coastal zone.

Marine mammal soundscape

During the reporting year, SAMS scientists recovered underwater hydrophones that had been recording the sounds of marine mammals between the Hebrides and the continental shelf for the past year.

Known as passive acoustic monitoring, the microphones detected sounds from a range of marine mammals, including dolphins and fin, minke, humpback and sei whales.

The data collection, funded by the European Marine Fisheries Fund (EMFF) via the Marine Scotland directorate of the Scottish Government, will help to explain when migrating species arrive in Scottish waters, where they are spending their time and how long they stay. This information is crucial to regulators and advisors, such as Marine Scotland, as it will inform placement and mitigation strategies for renewable energy developments and other human activity at sea. It will also allow an assessment of how well populations are recovering since the end of whaling in the 1950s. As sentinel species, cetacean movements can also show how climate change is affecting the ocean ecosystem.

Speeding up fish-farm sampling

The BactMetBar project (Environmental DNA metabarcoding as an alternative to microbenthic assessments in fish-farm compliance assessment) was launched in October 2021 to investigate the use of eDNA in the sampling of sediment below fish farms.

Salmon farming changes the receiving environment in several ways and to ensure regulatory compliance, fish-farmers undertake seabed (benthic) monitoring around their sites. Until recently they did this by taking seven grab-samples along a single transect per production cycle. Under a new regulatory framework, fish-farmers now have to collect and analyse 28 benthic samples across multiple transects, with macrobenthic taxonomic assessments made to generate the 'infaunal quality index' from which the benthic status and compliance is assessed. The four-fold increase in sampling effort is expensive to deliver and is beyond the capacity of current service providers. In addition, macrobenthic faunal analysis is time-consuming (3 – 6 months) and the time-gap between sampling and data interpretation prevents active, near-real-time management of farm sites.

With metabarcoding, organisms can be identified via their unique DNA sequences present in the environment (eDNA) and can be applied to sediment samples, significantly speeding up the process.

'Seal scarer' noise could harm porpoise

SAMS scientists found that the cumulative sound from devices used to deter seals from fish farms on the west coast of Scotland may have had unintended consequences for other species, such as harbour porpoises.

Acoustic Deterrent Devices (ADDs), also known as 'seal scarers', have been widely used in the global aquaculture industry to prevent seals eating farmed fish and damaging netting, potentially leading to escapes. They emit a sound designed to be unpleasant to seals and were introduced by the industry as an alternative to shooting seals near to fish farms.

A study by SAMS and the Centre for Fisheries and Aquaculture Science (CEFAS) modelled the combined noise from ADDs from 120 fish farms covering an area from Cape Wrath to the Clyde.

Using data from 2017 the scientists found that the accumulative level of noise could exceed thresholds in harbour porpoise hearing, which may result in temporary impairment at the lower end of their hearing range. The findings also show that within the study area sound from ADDs could remain above the threshold for temporary hearing impairment up to 28 kilometres from a farm.

besjournals.onlinelibrary.wiley.com/doi/10.1111/1365-2664.13910

Collaborating on seabed health

SAMS held a joint fish farming industry and policy workshop to publicise the results of two Sustainable Aquaculture Innovation Centre (SAIC) projects completed during the reporting year.

The workshop was attended by 43 people, including a representation from Canada. The INCREASE project examined fish farm waste dispersal and deposition around three Orkney fish farms. The NAMAQL project revisited the issue of sediment sulphide measurements and whether these can predict infaunal ecological quality. Sulphide measurements are used as part of fish farm monitoring in Canada and some new data from two sites in Nova Scotia were included through collaboration with Dalhousie University. Combined with new data from the Orkney sites it was confirmed that sulphide quantification can be a useful 'screening' tool.

Seagrass rewilding

The Seawilding project in Ardfern, Argyll is seeking to restore native oysters and seagrass in Loch Craignish, in the hope they can once again become self-sustaining populations.

SAMS scientists are providing research support on the project by conducting baseline assessments of the habitat and monitoring any changes taking place using eDNA methods.

Blue Economy

The Blue Economy research area develops new industry solutions and regulatory tools.

Channelling SAMS expertise in fundamental and applied marine science this research area supports commercial users of the marine environment to gain wealth from the oceans without degrading the very system we all depend on. We have particular expertise in aquaculture, marine biotechnology, marine renewable energy, oil and gas, and industrial impacts.

The Seaweed Academy

During the reporting year, we established The Seaweed Academy, a centre for education, training and research to support the fledgling UK and European seaweed farming industry.

Part of Argyll and Bute Council's submission to the UK Government's Community Renewal Fund, The Seaweed Academy was granted around £400,000 to employ a co-ordinator, Rhianna Rees, and to develop a series of courses and workshops.

Globally, the seaweed farming industry has been growing exponentially and is estimated to be worth around $15billion per annum. However, the vast majority of this activity is in Asia and there is huge growth potential in Europe, with a growing demand for seaweed from gourmet restaurants to livestock feeds.

Already used extensively in food ingredients, agriculture, cosmetics and pharmaceuticals, seaweed farming has a low carbon footprint, using no fresh water and with minimal land-based infrastructure.

Marine growth & North Sea 3D

Kicking off in October 2020, the NorthSea3D project showcases SAMS' 3D imaging capabilities, in an effort to provide high-resolution automated faunal identification on man-made structures, such as oil and gas platforms, to deliver a new monitoring tool for the industry.

Dr Tom Wilding, Dr Joe Marlow and Dr John Halpin will build 3D images using video footage captured by remotely operated vehicles (ROVs) that the industry already uses for maintenance surveys.

The blue carbon potential

SAMS and other UHI partners worked with Highlands and Islands Enterprise (HIE) to explore how carbon sequestration and storage can generate economic growth and community benefits.

The resulting report: *HIE Carbon, Optimising carbon sequestration opportunities in Argyll and Bute*, 2021 was led by SAMS Enterprise.

In November 2021 SAMS also produced a report: *Assessment of Carbon Capture and Storage in Natural Systems within the English North Sea (Including within Marine Protected Areas)*, on behalf of North Sea Wildlife Trust, WWF, Blue Marine Foundation, and RSPB. The report highlighted the importance of the English North Sea region as a substantial carbon store and the significant contribution the marine environment could make to carbon sequestration. The report will inform decisions and identify opportunities to enhance recovery and protection of the seabed and its associated carbon storage and sequestration potential.

Riding the wave of tidal energy potential

At the end of 2021, Emma Whettall became the first of the Scottish-based Bryden Centre students to achieve a PhD and in doing so identified 33 sites along Scotland's west coast - including 15 new locations - where small-scale tidal energy devices could be considered.

Her findings showed that the potential for remote and rural communities across Scotland's west coast to tap into community-owned renewable energy schemes may be greater than previously thought.

Dr Whettall identified sites using a computer model devised by researchers at SAMS. Flow speed and power potential of these candidate sites were then explored in more detail through a low-cost method developed as part of Emma's PhD work, using an SLR camera at a vantage point to capture images of the tidal flow every two seconds.

The Bryden Centre is run by UHI and partners in Ireland and Northern Ireland. Its cross-border PhD programme was launched in 2018 to train the next generation of renewable energy researchers.

GlobalSeaweedSTAR – completion

The five-year GlobalSeaweedSTAR programme, led by SAMS' Professor Elizabeth Cottier-Cook, concluded during the reporting year with the publication of an international policy brief on the global industry.

Bringing together an international expert team of 37 seaweed scientists from across the globe, the policy brief warned that the multi-billion-dollar seaweed farming industry – which has overseen rapid growth in recent years – must balance economic profitability with environment, human and organism health to ensure its long-term survival.

The policy brief was published in conjunction with the United Nations University Institute on Comparative Regional Integration Studies (UNU-CRIS) and includes a series of recommendations to improve the resilience and sustainability of the industry.

The programme was funded by UKRI's Global Challenges Research Fund and involved teams of researchers from 29 countries, primarily in Tanzania, Malaysia and the Philippines.

By working with more than 600 seaweed farmers globally, the programme collated crucial data that has been used to develop seaweed policies at regional, national and international levels.

For more information visit **https://www.globalseaweed.org**

Lumpfish breeding breakthrough

Lumpfish have proven to be successful in reducing sea lice infestation in salmon farm pens, as they eat the parasite, reducing the reliance on chemical treatments.

At present, the lumpfish are sourced from the wild to meet demand, but their use has become so widespread that numbers have rocketed. In 2017, the industry reared 925,000 lumpsuckers for use on salmon farms in Scotland, an increase of around 300 per cent on the previous year, and this number has continued to rise.

SAMS scientists, along with Norwegian collaborators at Akvaplan-niva, have shown there were no abnormalities in lumpfish hatched using cryogenically preserved, or frozen, sperm. The authors say this method will not only reduce the reliance on the wild male broodstock but allow for greater natural selection of preferred traits.

The report was a first publication for Emily Purves, a SAMS UHI graduate supervised by Dr Helena Reinardy, who completed the research in Tromsø as part of her ACES+ Master's Degree.

Assessing the Covid-19 impact

UK seafood businesses were invited to share their experiences on coping with the Covid-19 pandemic, as a team of researchers from SAMS on the Rise-Up project sought to find out how resilient the sector will be to future challenges.

The so-called 'double shock' of Brexit and the COVID-19 pandemic has heavily impacted the sector and has changed the way many seafood businesses operate.

The project findings will generate policy recommendations and advice for government.

2021 Prizes

Johanna Fehling Memorial Prize

LOLA PARADINAS

-

ACES dissertation

ARIEL ANTINERO

-

SAMS Board Award for Academic Excellence

MARGRET MENKE

-

SAMS Award for Overall Achievement

IAIN WALSINGHAM

-

Tim Boyd Prize for polar science

PAMELA SCHULZ MIDENCE

Education

Higher Education at SAMS

As a partner of the University of the Highlands and Islands (UHI), SAMS delivers undergraduate, taught postgraduate and research degrees in marine science. We also co-supervise research students from other universities. Students thrive in an immersive research atmosphere and in turn stimulate our research teams. As interns or, after graduation, as employees, our students also support SAMS' commercial activities and the companies at the co-located European Marine Science Park.

Marine Science BSc

Course leader: Dr John Howe, Deputy: Dr Arlene Ditchfield

Teaching

In this second year of the pandemic, we adopted a hybrid form of teaching in the autumn 2021 semester, where we taught synchronously face-to-face and online. The educational experience was not popular with either teaching staff or students, and we thus moved back to a primarily face-to-face mode of teaching in the spring 2022 semester.

An assessment review was launched, exploring both load and type of assessments.

Student numbers

A total of 96 students were registered across the four years of the programme. Despite a proactive marketing campaign including a new student blog and TikTok channel as well as a trial homestay system, we experienced a second year of falling recruitment. Only 17 students joined our first year, which meant we had 23 fewer students across the programme than the previous year. We attribute this to the combined effect of Brexit, Covid, accommodation shortages and the developing cost of living crisis. Encouragingly, we saw a growing number of UK students from outside Scotland.

Results

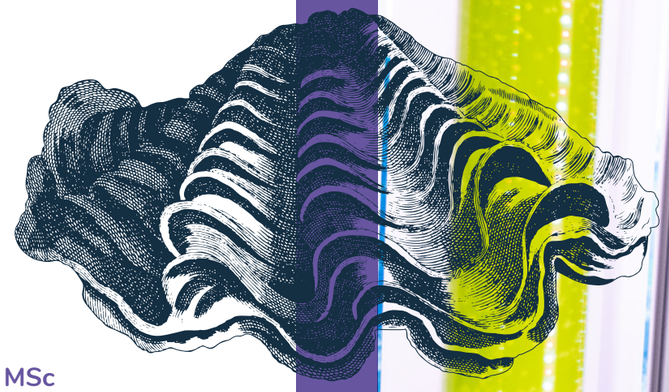
Despite the pandemic, and maybe in recognition for the gargantuan effort made by the teaching team to support student learning online, the BSc once again achieved 100% overall student satisfaction in the National Student Survey.

It is a great testament to the students and staff that student attainment remained high despite the pandemic. We warmly congratulate the 22 students who graduated successfully from our undergraduate programme. In this cohort 10 achieved first class and eight upper second class classifications. An amazing result!

Student exchanges

SAMS hosted two incoming students, one from Alicante and one from Zurich. At the same time three SAMS students completed a semester at UNIS and two at Van Hall Larenstein University of Applied Sciences in the Netherlands.

Education... continued



Taught Masters

AquaCulture, Environment & Society MSc (ACES)

Programme leader: Prof Elizabeth Cottier-Cook

This is a two-year elite programme, with students studying their first semester at SAMS, the second at the University of Crete in Greece and the third at the University of Nantes in France before their research dissertation semester which students can choose to conduct at a variety of academic or industrial partners. The Erasmus Mundus scholarship funding for the programme has been renewed for another five years.

44 students have been studying on this ~~elite~~ programme during the reporting period across two cohorts.

From September to November 2021 the ACES teaching at SAMS had to be delivered online due to the large number of students unable to secure a UK visa due to the pandemic. The international ethos of the programme meant students participated from different time zones, adding an extra complexity to timetabling and with a need to record all sessions. From the end of November onwards lecturers blended face-to-face with online teaching but the fieldcourse was cancelled due to Covid regulations.

Industrial Biotechnology MSc

Professor Michele Stanley continues to lead a 'Blue Biotechnology' module for Strathclyde University registered students studying industrial biotechnology. In March 2022 eight students travelled to SAMS for face-to-face learning, but the delivery was sadly impacted by several Covid cases among both staff and students. Thanks to many staff that rallied round, the programme could nevertheless be completed successfully.

Offshore Renewable Energy doctorate training

The Edinburgh University led, EPSRC funded Industrial Doctorate in Offshore Renewable Energy programme continues to receive two summer schools from SAMS introducing the budding engineers to environmental and social science they will need to consider when designing devices for the marine environment. Due to the pandemic, the summer schools had to be delivered in a hybrid format, combining online learning with field-based elements. Nonetheless the feedback from students and exam board were extremely positive.

"After completing the ACES masters I was hired to work for a feed company and now visit salmon farms all over Scotland. I conduct fish quality checks, feed trials, and provide fish diet advice to farm managers. ACES was a life changing experience, allowing me to see and experience different countries and cultures while making many friends and gain a first-class aquaculture qualification. The subjects covering Atlantic salmon and feed were crucial in obtaining my current role. I would not have the opportunities I have now without this incredible masters."

James Hedges, ACES+ alumnus 2021

NEW Algal Biotechnology MSc approved

Programme leader: Dr Matt Davey

A new taught masters in algal biotechnology was develop[illegible]d approved by UHI. It will be a traditio[illegible] face-to-face programme. Late adve[illegible]ment resulted in few competent applications and the programme start has thus been postponed to 2023.

SAMS hosted first Scottish Model Arctic Council

Undergraduate students from around Scotland and wider UK came to Oban to play their part in the first-ever Scotland Model Arctic Council (ScotMAC), a three-day simulation of the Arctic Council, the top international forum for co-operation, environmental protection, and sustainable develop[illegible] in the Arctic. Hosted by SAMS 11 – 13 March 2022, SCOTMAC was an educational initiative of Polar Aspect, the Scottish-Arctic Network (ScAN) of universities and Trent University in Canada.

Participating students took up roles as diplomats from the eight member states and six Indigenous Peoples' organisations that sit around the Arctic Council table (see below) and had to negotiate an 'Oban declaration' that articulated a consensus on challenges such as Arctic shipping and indigenous knowledge. The deliberations took place against the backdrop of the invasion into Ukraine by Russia and the resulting pausing of all official meetings of the actual Arctic Council.

ScotMAC was primarily funded by the Scottish Government's Arctic Connections Fund, which provides financial support to Scottish organisations to work with Arctic counterparts. The programme had been designed and was delivered by Dr Anthony Speca from Polar Aspect with the support from Marie-Anne Coninsx, formerly European Union Ambassador to the Arctic.

Postgraduate research

Head of SAMS Graduate School: Profe~~ssor~~ Bhavani Narayanaswamy

45 postgraduate research students were at SAMS during the reporting period. Of these five were MRes students on the Algal Biotechnology, Biology and Ecology programme with the remaining 40 pursuing doctoral research. Their research contributes to the research content of this report.

Lower case research (highlighted text)

SAMS Enterprise 2021-22

At the beginning of FY 2021/22 SAMS Research Services Ltd (SRSL) completed its rebranding to SAMS Enterprise. The change of operating name reflects the evolution and growth of the business over 19 years.

After its inception in 2002, SRSL offered primarily research services but SAMS Enterprise now provides a broader range of services, expertise and products. While we still deliver a significant volume of contract research for clients, our consultants also deliver insightful policy guidance reports to NGOs, industry bodies and local and national government departments and agencies on a global basis. This is in addition to developing new technologies and services for research and industry.

We achieve this in a symbiotic relationship with our world class research colleagues at SAMS. Working to ISO 9001 and ISO17025, the Enterprise team acts as an effective interface between commercial and public stakeholders and SAMS' research excellence, which covers all aspects of the blue economy and oceanographic knowledge.

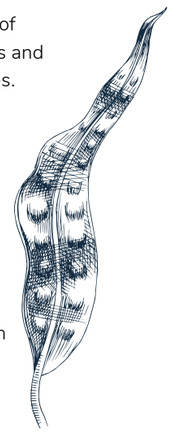
In 2021-22 SAMS Enterprise achieved a turnover of £1.61 million, up from £1.32 million in 2020/21. For FY2021/22 Enterprise delivered a Net Profit of £379k (2020/21 - £133k). There was a contribution of £401K to SAMS Research staff time (which includes 30% overhead of £93k). In addition, Enterprise staff delivered £144k of staff time to support SAMS' science and education. The Enterprise team generated a further £722k of income for SAMS Research which, due to the requirements of the funding bodies, is invoiced via SAMS rather than Enterprise.

The overall value in financial contribution from Enterprise to SAMS for FY 2021/22 is therefore £1.65m.

The business model evolved through the year to maintain sustainable development and growth of the team and business areas while supporting the core consultancy deliverables. The viability of product and research areas was revised to deliver focus on areas of optimum opportunity and growth. As a result Marine Growth (3D Photogrammetry and Artificial Intelligence) has reverted to Research while development of SIMBA (Snow Ice Mass Balance Apparatus) as an avalanche and flood forecasting tool has accelerated with support from HIE/Co-Innovate funding.

During the year the Enterprise team progressed the concept of The Seaweed Academy, the UK's first dedicated seaweed industry training and development facility. The £400,000 project, initially funded by the UK Government's Community Renewal Fund, now delivers commercial training courses, consultancy and industry development activity. This will support further development of the seaweed nursery business and new consultancy opportunities.

In the continuing challenging economic climate of gradual Covid-19 recovery this was a significant achievement by the Enterprise team, working in partnership with Research colleagues, to deliver quality consultancy, contract research and services to very tight deadlines, while retaining profitability.



Fundraising

While SAMS' science moves from strength to strength, the disappearance of core income from public sources, shortfall in the full economic cost of competitively won research projects, heightened competition in a diminishing funding market, and escalating costs is all adding pressure to SAMS' long-term financial viability.

Taking a positive and pro-active response to these challenges, SAMS began a brand-new, exciting journey into philanthropic fundraising. We aim to make fundraising a fundamental support function which will strengthen SAMS' existing three business pillars of research, education and enterprise and will focus on raising funds from trusts, foundations, individual philanthropists and corporates, as well as through community-driven donations.

We are committed to a mission and donor-centric approach, with relationships being at the very heart of our fundraising activities; connecting with our supporters and encouraging motivated individuals and companies to become part of the SAMS family and to invest in our priorities.

The values guiding our fundraising approach dovetail with SAMS' organisational values. As fundraising starts to become more embedded within SAMS, and as the team starts to grow, these will remain the foundations of everything we do.

Excellence = Integrity

We will do the right thing, ensuring our fundraising is legal, responsible, high quality and done with the absolute best intentions - always

Relevance = Inclusivity

We will create pathways for everyone to be able to make a difference to the future of our oceans

Commitment = Passion

We will be led by our mission, and our belief in it will inspire others to care

Responsiveness = Dynamic

We will respond to trends and opportunities, managing risk in a way that allows us to explore new income streams without judgement or fear

Respect = Joyful

The journey of our donors, our staff and our stakeholders will be inspiring, safe and rewarding

Independence = Transparency

We will be open and honest in how we fundraise and how we use donations, supporting our credibility and organisational profile

Fundraising Guide

To find out more and download our SAMS fundraising guide.

www.sams.ac.uk/support-sams/fundraise-for-us

Corporate Support Guide

To find out more and download our corporate partnerships guide.

www.sams.ac.uk/support-sams/corporate-giving

Fundraising Legacy Guide

To find out more download our fundraising legacy guide.

www.sams.ac.uk/support-sams/leave-a-legacy-to-sams

The past year has seen the development of policies and procedures that will ensure that our approach to the solicitation, consideration and acceptance of philanthropic gifts is ethical, compliant, and wholly appropriate to our organisational mission, values and beneficiaries. These were written in accordance with the Fundraising Regulator's Code of Fundraising Practice, the standards expected by The Scottish Charity Regulator (OSCR) and the Scottish Fundraising Adjudication Panel.

We have established a Development Committee comprising senior staff, trustees, and external advisors, to provide strategic direction and support, and acting as the conduit to ensure the main trustee board understand fully the fundraising activities of the charity. No complaints have been received regarding our fundraising activities and we have not worked with commercial participators this year.

SAMS is looking forward to broadening its supporter base, and making sure everyone feels they have a role to play in creating a healthier ocean, for a stronger planet.

Check out our new fundraising webpages: www.sams.ac.uk/support-sams/

Membership

AGM and events

The 107th AGM took place online on 3rd December 2021.

In June 2021 we held the Newth lecture. The first ever virtual membership event, it attracted a record 143 attendees including from Dubai, Australia, India and Puerto Rico. The lecture explored the role of Scotland in the UN Decade of Ocean Science for Sustainable Development and was chaired by SAMS trustee Susan Watts. It featured contributions from and a panel discussion with Prof Dr Martin Visbeck (GEOMAR), Dr Hannah Grist (SAMS), Prof David Paterson (MASTS), Susan Davies (Scottish Seabird Centre) and SNP President Michael Russell. ~~It can be viewed on the SAMS YouTube channel.~~

We also developed a new membership event to encourage collaborations between science and the arts.

The Wild Sci-Art Seminar will be an annual event, named after Challenger Expedition artist John James Wild.

The first seminar focused on algae in art and was co-organised with CCAP. Another virtual event, it attracted 350 subscribers, most of them new audiences. It is available to watch online.

Hosted by Prof Juliet Brodie from the Natural History Museum, it featured presentations from keynote speaker and BioArtist Anna Dumitriu, with further contributions from fashion entrepreneur Jessica Gianotti, design engineer Samuel Iliffe, Alice Sharp from the art and environmental organisation Invisible Dust, and writer Miek Zwangborn.

Clan SAMS

This tartan was created by the Scottish Association for Marine Science (SAMS) in collaboration with Crùbag, a Scottish textile design studio and materials innovation lab focused on the ocean, and House of Edgar. ~~Both SAMS and Crùbag are based on Scotland's west coast in Oban.~~

SAMS Honorary Fellows

Dr Robert Batty
Prof Kenneth Black
Dr Ruth Brennan
Dr Susannah Calderan
Christine Campbell MBE
Dr Clive Craik
Prof Angela Hatton
Dr Ken Jones
Dr Ray Leakey
Prof Jane Lewis
Dr Andy McLeod
Prof David Meldrum
Dr Pedro Murua Andrade
Dr Natalia Serpetti

Current members

4
Honorary & Life

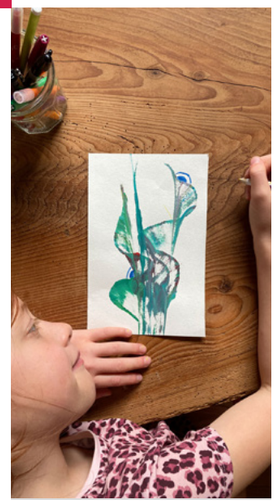
9
Corporate

28
Student/unwaged

160
Ordinary

SAMS Ocean Explorer Tartan

It celebrates the beauty of the seas and the important historical and ongoing discoveries made by marine scientists in Scotland. Dive in deeper at www.sams.ac.uk



Public Engagement

Engagement with our various audiences was impacted by the Covid-19 pandemic lockdown, with most staff working from home, and visits, meetings and events hosted online. Virtual engagement quickly became the new normal in 2020-22 and we developed new digital projects and platforms.

NEW: Ocean Explorer Learning

Developing an ocean literate society is much hampered by the fact that the sea has never yet featured in the school curriculum and many teachers have limited marine knowledge to impart to the next generation. To address this, we are developing an online resource hub for educators about the marine environment. ‘Ocean Explorer Learning’ will provide lesson plans and activities for educators from nursery to senior phase across all disciplines, covering the sciences as well as the arts, social studies, health and wellbeing, and languages. There will be special sections for home educators and after-school-clubs.

New: TikTok

Social media is a powerful communications tool and SAMS has been engaging with its various audiences on Twitter, LinkedIn, Facebook, Instagram, YouTube and Vimeo. To reach young people better, we launched a TikTok channel to distribute ocean literacy messages and help us recruit future students. Most TikTok content was made by undergraduate student ambassadors.

Schools workshops

SAMS’ Ocean Explorer Centre experienced a post-Covid boom in visitor numbers since re-opening on July 5th, 2021. The centre, usually attracting c 5,000 visitors over 12 months, had 1,872 visitors in the first six weeks, and a total of c 4,200 visitors over 9 months. The centre was updated with a new display about underwater sounds and information about local Marine Protected Areas and species.

Towards the end of the reporting period we welcomed schools back to the OEC with a seaweed day for 180 children from six local primary schools as part of the Seaweed Academy launch.

We delivered day-long workshops about marine conservation and local marine life to more than 350 primary pupils in mid-Argyll and the islands. Intern Mia Leng also provided a month-long MarPAMM marine education outreach programme to four cohorts of 10 young ambassadors on the ‘Our Isles and Oceans’ sailing programme.

Royal visitors at the Oban Games

HRH The Princess Royal and Vice Admiral Sir Timothy Laurence visited the SAMS display stand during their visit to the Argyllshire Gathering Oban Games in August 2021, discussing our MarPAMM project activities as well as SAMS’ educational offer. As Chancellor of UHI, the princess demonstrated a particular interest in the student experience. The stall also attracted our new MSP Jenni Minto and the new Bishop of Argyll and the Isles, the Right Reverend Dr Keith Riglin.

Finance

2021/22 Financial performance

The SAMS group report a deficit of £1.924m in the reporting year. Excluding an increase in our Universities Superannuation Scheme liability of £1.446m, the overall deficit from operations was £0.478m. The overall income was £10.283m against an expenditure of £10.761m. For details, please consult the statutory accounts on the SAMS website..

Plans for the future - our 2020-25 corporate strategy

RESEARCH EXCELLENCE:
supporting and training staff; balancing skills with emerging fields; attracting personal fellowship holders

PROVIDING SOLUTIONS:
SAMS Enterprise provides solutions for businesses in six target sectors

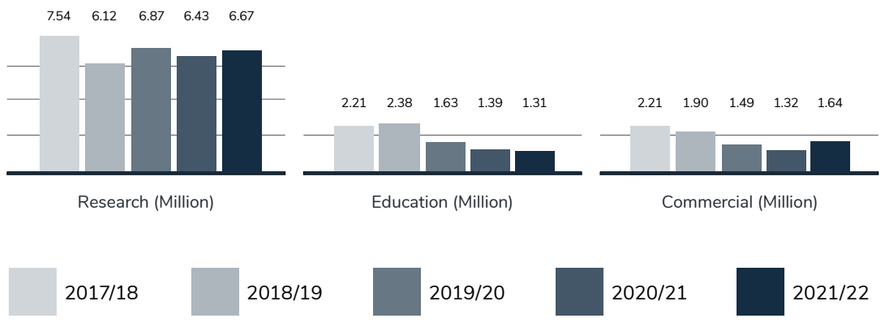
EDUCATION FOR A BETTER FUTURE:
developing new Masters level programmes through UHI that support economic regeneration

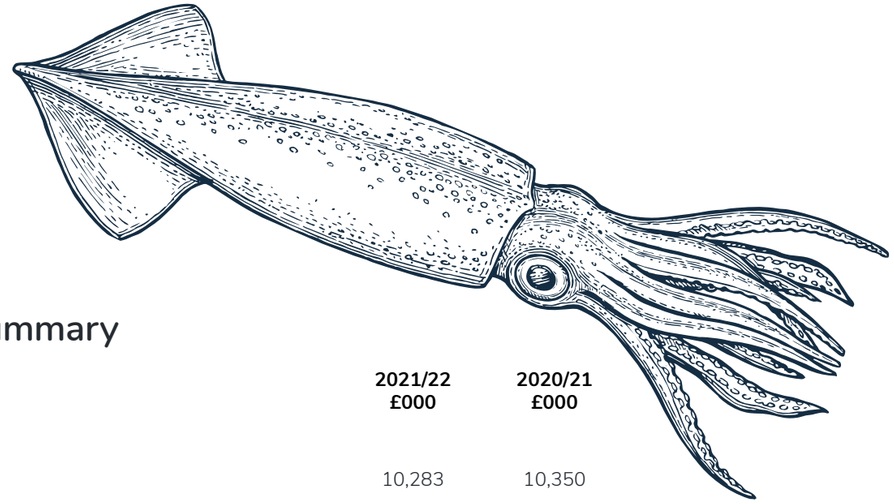
IMPACT AND INFLUENCE:
increasing science communication and public engagement activities

EFFICIENT OPERATIONS:
continue working with HIE and Argyll and Bute Council to pursue major infrastructure investments especially around aquaculture and aerial robotics.

DEVELOPMENT & FUNDRAISING FUNCTION:
substantially increasing income generation from charitable sources

Income over five years





Financial Summary

	2021/22 £000	2020/21 £000
Operating Income	10,283	10,350
Operating Expenditure excluding grant funded depreciation	(10,761)	(10,310)
Operating Surplus/(Deficit) before exceptional item	**(478)**	**40**
Pension Surplus / (Deficit) Obligation	(1,446)	219
Reconciliation of funds: Total funds brought forward	13,171	12,912
Total funds carried forward	**11,247**	**13,171**

Research

Research grants and contracts brought in a total of £6.673m over the reported 12-month period, a 3.7% increase against the previous year. 47% of research income (£3.151m) came from UKRI. SAMS continued to experience a substantial decrease in EU income, bringing in only £708k. Following Brexit, UK institutions can be included as Associate Partners in Horizon funded projects. The Research Excellence Grant, awarded to fill the gap from funders who do not pay the Full Economic Cost of delivering the research project, contributed £1.015m. Other funds, including government, agency and innovation centre income, experienced a significant upturn to £1.798m.

Education

As in the previous year, education contributed 13% of SAMS income from undergraduate (£620k), taught and research Masters £89k (ACES = £69k), doctorate (£531k) programmes and field station along with other education activity (£70K).

Enterprise

SAMS Enterprise achieved a turnover of £1,639m, an increase of £0.318m on the previous year. SAMS Enterprise delivered a net profit of £375k. SAMS Ltd, our other subsidiary contributed an additional £227k to SAMS income mostly from the sale of CCAP cultures and rental receipts.

Our People

Professorship for inspiring lecturer

Marine geologist John Howe has been recognised for his research and teaching with a professorship from UHI. A specialist in seabed mapping, robotics and past climates, Professor Howe has also been instrumental in the development of the Marine Science BSc programme that he continues to lead. His enthusiastic lecturing style has won him several awards of 'most inspiring UHI lecturer'.

Farewell, Dr Tom Pearson (1938-2022)

Dr Tom Pearson joined the Association in Millport and followed the organisation to Oban in the early 1970s. He researched organic pollution and degradation of the marine environment when this was a novel topic. Eventually he and John Blackstock set up their own environmental monitoring company, SEAS Ltd, that was based at Dunstaffnage: an early example of a spin-out company. The 1978 OMBAR publication 'Macrobenthic succession in relation to organic enrichment and pollution of the marine environment' written with Rutger Rosenberg remains a classic paper in benthic ecology. To this day, much of the regulation of 'disposal at sea' remains rooted in Tom's work: a scientific legacy of great societal importance.

Women in Scottish Aquaculture awards

The WiSA lifetime achievement award in 2021 was awarded to retired SAMS researcher Dr Maeve Kelly who spent 27 years studying commercially relevant invertebrates and laid the foundation for SAMS' sizable seaweed farming research and development portfolio.

WiSA's Innovation Research Champion award went to Dr Georgina Robinson, a Future Leaders Fellow at SAMS. Dr Robinson was recognised for her work in developing a system to recycle fish farm waste. Waste from farms is fed to deposit feeders like sea cucumbers and worms that are themselves farmed as high-protein food sources for people and livestock. They may even generate electricity...

On the hot list – again

For two year's running, Prof Michael Burrows has been identified as a world-leading climate scientist. He ranked 180th on the 'Hot List' of the world's 1,000 most influential climate scientists compiled by the Reuters news agency. With 8,355 citations of his 154 publications, Prof Burrows was also included last year on the Web of Science's Highly Cited Researchers list.

~~Challenger Woodward Fellowship (pic of Robyn) Marine biogeochemist Dr Robyn Tuerena was awarded a Challenger-Woodward Fellowship for her work on nutrient biogeochemistry, which focuses mostly on how changes in the Arctic marine environment affect productivity.~~

Retiring after long service

March 2022 saw two colleagues retire after a joint 55 years of service to SAMS.

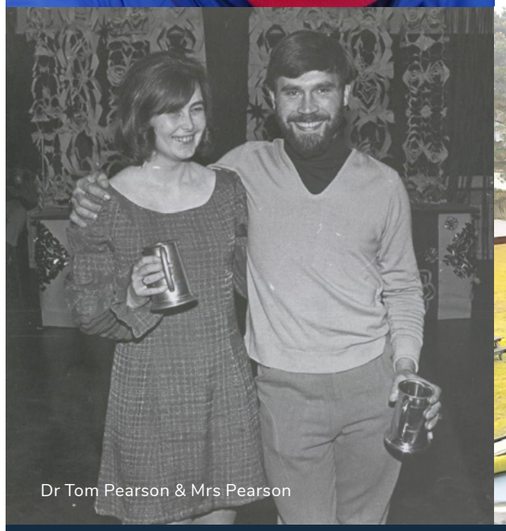
Tim Brand joined SAMS in 1999 as a support scientist in water column chemistry with particular expertise in nutrient analysis. Tim was a leading member of the technical team, in charge of a range of instruments as well as the analytical laboratory and SAMS-wide chemical safety. Tim was also a committed teacher, providing practical skills training for students from year 1 to PostDoc level. An extremely knowledgeable scientist, Tim will be a big loss to SAMS.

Benthic ecologist and lecturer Dr David Hughes joined the organisation in 1990 and worked on a wide range of research topics with special interest in deep sea ecosystems. Dave's career is characterised by diversity as he managed to incorporate into one job not just research but also scientific diving, safety advisor, welfare officer, first aider, consultancy, library committee member, union member, module leader and research supervisor. With David's retirement SAMS is losing a rare polymath.

At his farewell do, Dave reminisced: "When I first arrived, Margaret Thatcher was in No. 10, New Kids on the Block were top of the charts, and we still had weekly meetings of the "Computer Users' Group", a select band of people who knew how to operate those mysterious machines." That's how long 32 years is!

Challenger Woodward Fellowship

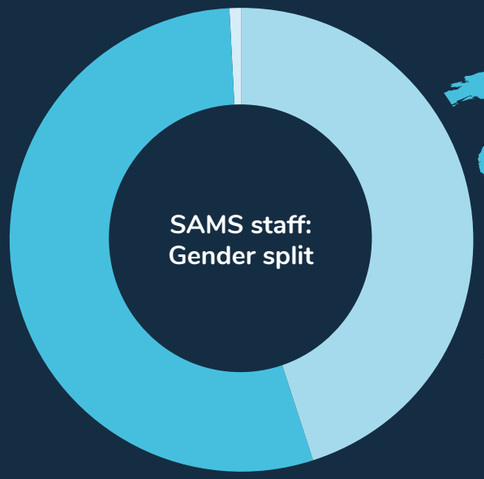
Marine biogeochemist Dr Robyn Tuerena (left) was awarded a Challenger-Woodward Fellowship for her work on nutrient biogeochemistry, which focuses mostly on how changes in the Arctic marine environment affect productivity.



Dr Tom Pearson & Mrs Pearson

Leaving presentation for Tim Brand

SAMS diversity

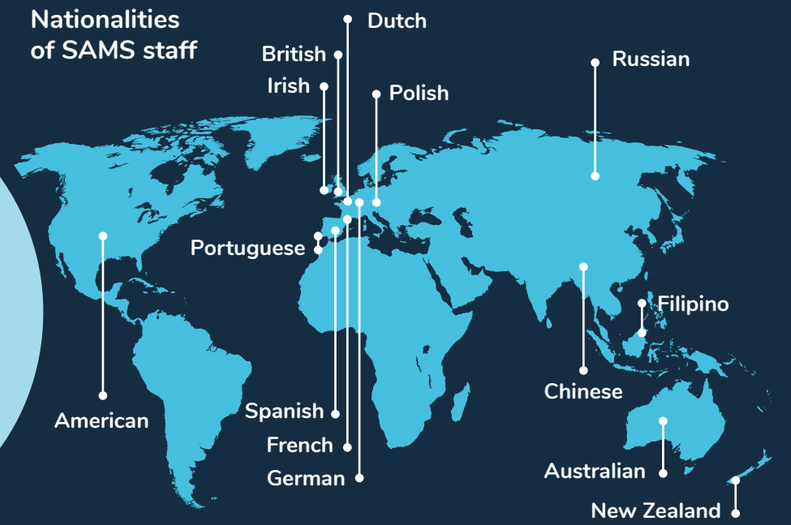


54% Female

45% Male

1% Other

Nationalities of SAMS staff



SAMS is championing equality issues through the Athena Swan process, especially working to enhance female represeentation at higher grades. While more than half the staff are female, and we have four female professors including an associate director, we focus now on improving the 'pipeline' of young talent. Our board is gender balanced with a female chair.


Image by Alasdair O'Dell SAMS

Peer-reviewed journal articles & reviews

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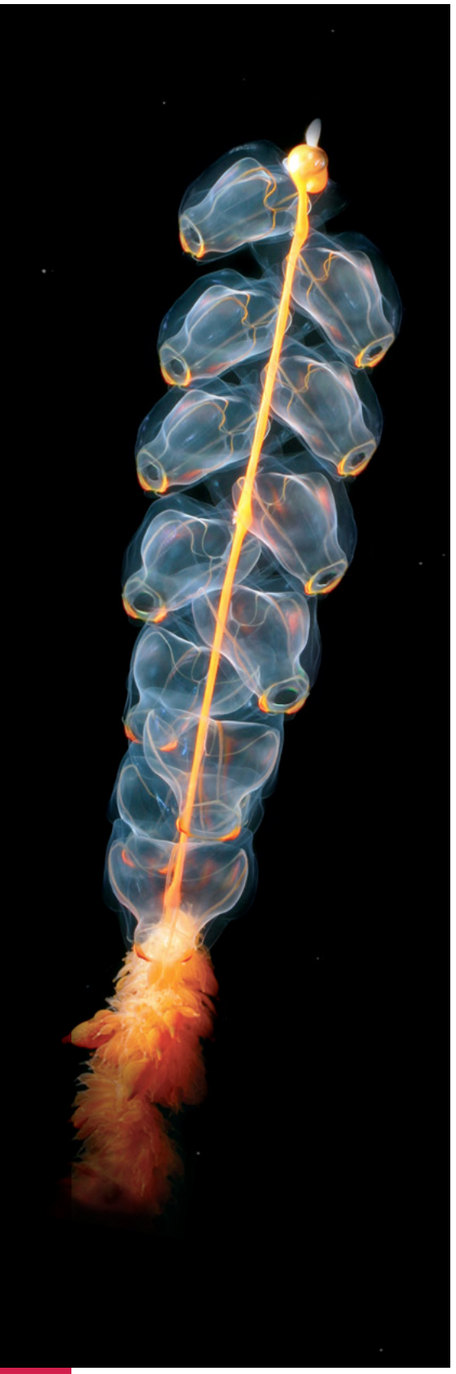

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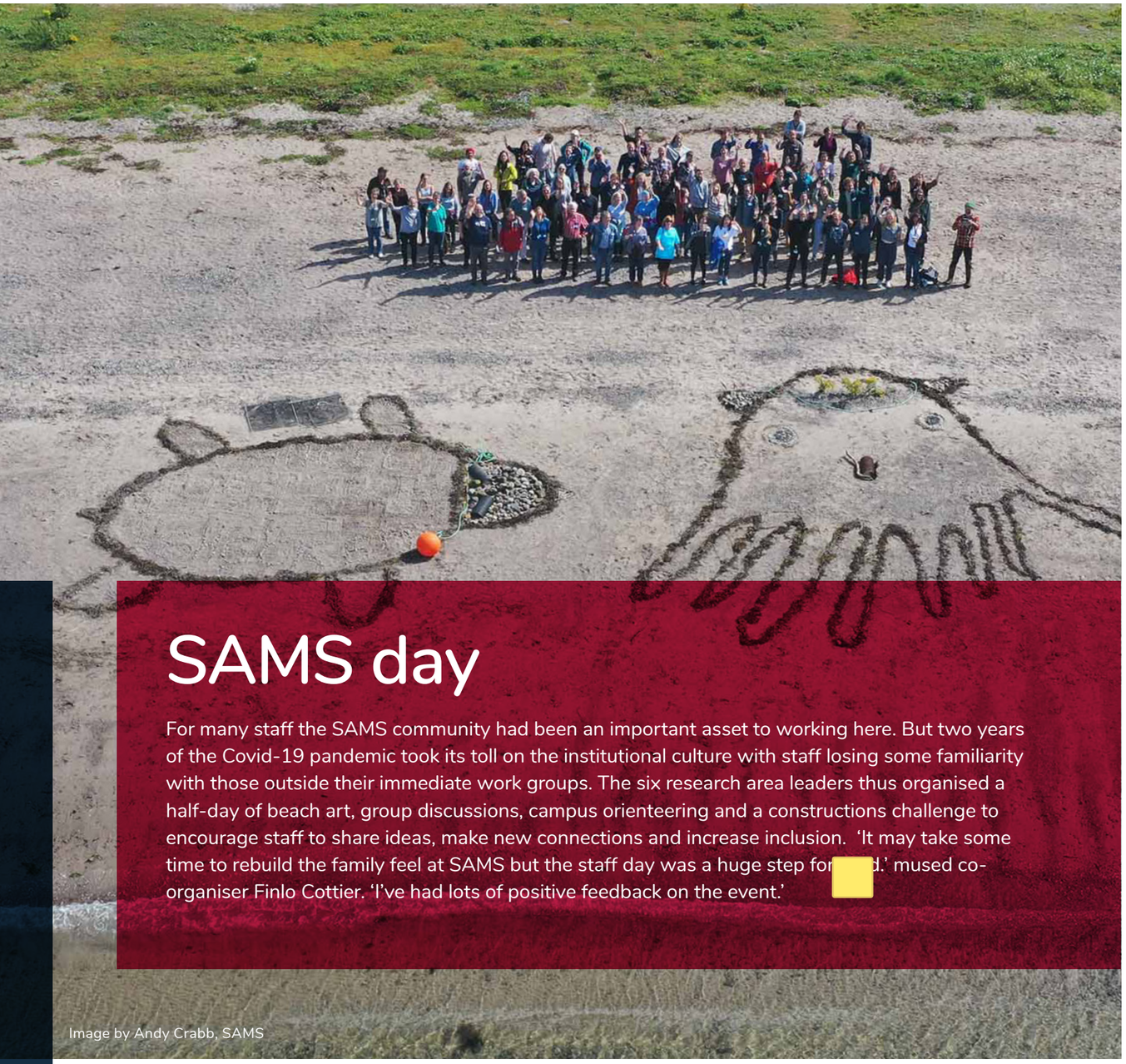

SAMS day

For many staff the SAMS community had been an important asset to working here. But two years of the Covid-19 pandemic took its toll on the institutional culture with staff losing some familiarity with those outside their immediate work groups. The six research area leaders thus organised a half-day of beach art, group discussions, campus orienteering and a constructions challenge to encourage staff to share ideas, make new connections and increase inclusion. 'It may take some time to rebuild the family feel at SAMS but the staff day was a huge step for[illegible]d.' mused co-organiser Finlo Cottier. 'I've had lots of positive feedback on the event.'

Image by Andy Crabb, SAMS

SAMS Staff

1st April 2020 to 31st March 2021

Professor Nicholas JP Owens
Director

Professor Keith Davidson
Associate Director Education

Professor Ben Wilson
Associate Director Research

Mike Spain
Head of Enterprise

Professor Axel EJ Miller
Deputy Director

Professor Michele Stanley
Associate Director Innovation

Susan Johnson
Head of HR

Donald Smith/ Patricia McGill/Graham Little
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Mackinnon, Lorna
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Billing, Dr Suzi
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