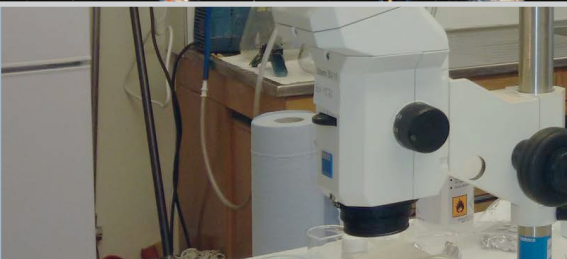
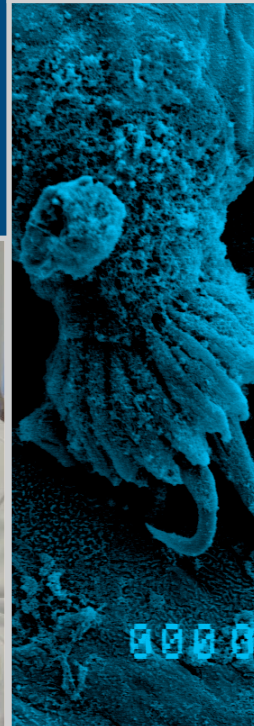
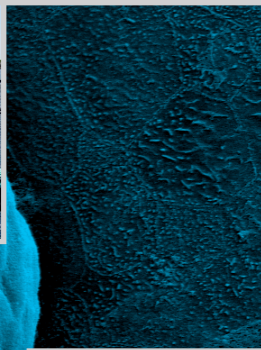




Marine Science and Innovation Strategy

January 2024



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Scotland's benefits from its seas

Scotland's seas cover an area about 462,263 km². This is SIX times greater than the Scottish mainland and islands added together – 80,240 km²



[Source: Facts and figures about Scotland's sea area](#)

Offshore wind generated 3,492 GWh of electricity, 11% of all renewable energy generation in Scotland



[Source: Scotland's Marine Economic Statistics 2020](#)

Scottish aquaculture generates an estimated £362 million in Gross Value Added for Scotland



[Source: Scotland's Marine Economic Statistics 2020](#)

Pre-covid, marine tourism in Scotland generated £598 million in GVA and employed 31,100 people



[Source: Scotland's Marine Economic Statistics 2019](#)

Scottish residents are willing to pay up to £132 million per year for management policies that result in a large increase in wildlife and habitats



[Source: Research report on marine values in Scotland](#)

Scotland has more than 125,000 km of rivers and streams



[Source: Facts and figures about Scotland's sea area](#)

Foreword : Chief Science Adviser for Scotland

As Chief Scientific Adviser for Scotland, I am delighted to write the foreword for the Science and Innovation Strategy presented by the Marine Directorate. I have always been aware of how important “Marine” is for Scotland as an Island Nation: in size and scale with a particularly extensive coastline, its regional food production from seas and freshwater, its increasing potential of renewable sources of energy, and its importance to local communities in both rural and urban locations. These examples and more are encompassed in the Scottish Government’s publication – the Blue Economy Vision for Scotland.

The role of science and innovation in delivering the Blue Economy Vision is, however, becoming more compelling and even more important if we, as an island nation, are to achieve the outcomes we desire from that vision. The dual crises of climate change and biodiversity loss mean that the marine environment must be considered in every aspect of human activity in the marine space if we are to preserve natural resources and to minimise adverse impacts of future developments.

Science has some of the answers to these issues, and expertise is required and available from multiple disciplines, many within Scottish organisations. Research and development in engineering, marine biology, geophysics, oceanography, energy technologies and social sciences, to name but a few, is vital as the data, and evidence this provides, feeds into innovative solutions, be they new technologies, useful products, or importantly, process improvements.

Marine Directorate is the home for a considerable number of scientists working to deliver research outputs, data and modelling, and feeding into monitoring, surveillance and regulation. These scientists and engineers have a key role in supporting multiple strategies of importance to Scotland including the National Strategy for Economic Transformation, the National Innovation Strategy and, of course, the Blue Economy Vision for Scotland.

The future of science however is BIG and this often requires large teams taking interdisciplinary approaches. The Marine Directorate is a principal player alongside multiple universities and colleges, research institutes, and commercial companies



Julie Fitzpatrick OBE
Chief Scientific Adviser
for Scotland

and industry partners. These consortia will be required to attract the investment required to support science from Scottish, UK, and international commercial funding sources, and equally importantly to provide the knowledge that can then be implemented in relevant locations and systems.

Scotland is internationally competitive in marine science and this Science and Innovation Strategy sets out six “strategic outcomes” which the Marine Directorate, along with its partners, intend to deliver. The document also outlines “**strategic enablers**” which include people, data, digital, and infrastructure, all of which are essential components of any successful plan.

I consider the future for marine science to be bright and this strategy sets out the pathway to how that will happen, with the expertise of Marine Directorate’s many scientists, data specialists, analysts and engineers at its core.

Julie Fitzpatrick OBE

Chief Scientific Adviser for Scotland



1. Ministerial Introduction

I am pleased to introduce the Scottish Government's Marine Science and Innovation Strategy. This strategy is driven by the ambitions set out in our Blue Economy Vision. It has been developed to deliver on our commitment to protect the beautiful and diverse waters of Scotland on which our coastal communities depend, and which are integral to our national identity and maritime heritage. The Vision sets out our ambition for Scotland's Blue Economy to 2045. It promotes an approach that is consistent with Scotland's National Performance Framework and our international obligations. This is captured in the six outcomes that we want to achieve.

This strategy positions Scottish Government so that it can utilise the best evidence and data available for making informed management decisions to deliver these Blue Economy outcomes. It instils a commitment to innovate and use the best available technology, artificial intelligence, modelling and analysis to deliver for Scotland's marine environment, communities and economy.

In the Scottish Government's Marine Directorate, our strongest asset is our world class and dedicated people whose expertise and commitment will meet the challenges ahead. This new strategy sets out how we will focus on what government science can and should be doing. We cannot meet all the challenges, nor deliver alone, which means our aim will be to do this with a 'whole of Scotland' approach. We will closely collaborate with a wide range of world-leading, marine science partners including marine users, academia and private sector stakeholders. We all have a vital role to play in making the most of our marine assets to provide the optimum return for the people of Scotland, now and into the future.

Scotland has a key role to play in stewarding the marine environment and to do that we will commit to developing our capacity as a key contributor and member of the global marine science community. This strategy will help us to develop and access the evidence required to make the most of the opportunities Scotland's marine and freshwater environments provide, and innovatively respond to climate change and nature loss.

The threats to our ecosystems are severe, requiring a response from us that's unprecedented. The opportunities are also unparalleled with regard to sustainable marine economy sectors such as aquaculture, fishing and the renewable energy industry. Fulfilling our aspirations will require us to pioneer new ways of working across all our marine sectors.



Mairi Gougeon
**Cabinet Secretary for Rural Affairs,
Land Reform and Islands**

Such collaboration is essential if Scotland is to maintain its position as an international leader in the marine environment. This new strategy allows the Scottish Government to make decisions using the best available evidence to deliver our Blue Economy Vision. It will help us shape Scotland's marine future for the benefit of all.

Mairi Gougeon

Cabinet Secretary for Rural Affairs, Land Reform and Islands

2. Who we are



2. Who we are

Scottish Government's Marine Directorate leads on marine and elements of freshwater management in Scotland. The Marine Directorate integrates core functions involving research, compliance, monitoring and policy to manage Scotland's seas and rivers.

The Marine Directorate has over one hundred years' experience delivering high quality science and advice on Scotland's rivers and seas. Its science has been responsive to the changing demands of how we engage with Scotland's seas and rivers, including our role in addressing the climate crisis and nature crisis at a time where all governments are facing very challenging budgets.

The Programme for Government focuses on policy and legislative commitments that will make the biggest difference in the current economic situation. It is in this context that the Science and Innovation Strategy is framed to support the Scottish Government in responding to Scotland's needs now and in the future when we are in the midst of rapid environmental change.

This Science and Innovation Strategy flows from the Scottish Government's Blue Economy Vision and is aligned with our aquaculture vision, wild salmon strategy, biodiversity strategy and our new innovation strategy and the Government's ten-year economic strategy. As always, the direction of these strategies and visions are aimed at improving Scotland's National Performance Framework, which in turn allows us to meet the UN's Sustainable Development Goals (SDGs).

Scottish Government's Marine science and innovation strategy will maximise the opportunities that Scotland's assets afford us. We will do that by working closely in collaboration with other scientific partners and institutions in addition to policy colleagues and social scientists and communities across Scotland, and internationally. We will build on our rich maritime history of trusted expert scientific knowledge while seeking to venture into pioneering new approaches

The culture we will create for our science, evidence, data and digital work is one that is:

Curious
Collaborative
Competent Inclusive Diverse

These were the thoughts captured during one of our workshops with science and policy colleagues in the design of the new strategy

where appropriate to maximise the opportunities arising, for example, from the development of artificial intelligence, machine learning and new technology. We will also ensure that the knowledge and learning gleaned from those opportunities is transferred through courageous story-telling and communication to inspire our communities.

i Vision

We will be innovative in using science, evidence and data to develop, strengthen and evaluate our policies and promote opportunity in delivering the Blue Economy vision.

ii Mission

Our mission is to provide the scientific evidence and data for policies, regulatory and statutory duties that contribute to the delivery of long-term benefits to nature and the people of Scotland. We will provide science leadership across Scotland by entering into dynamic partnerships with collaborators from across Scotland, and internationally. By effectively and efficiently delivering this mission our aspiration is that our science, impactful research and data ensures that the marine and freshwater environment is healthy and vibrant and in balance with thriving business and communities.

iii Values

Our Scottish Government values represent who we are, who we aspire to be, and what we believe in. They build on the foundations of our Civil Service Code and National Performance Framework aspirations. They guide how we act, the decisions we take and how we work together, across all parts of government, to improve the lives of the people of Scotland.

Our values are:

- » we act with integrity;
- » we are inclusive;
- » we are collaborative;
- » we are innovative and
- » we are kind



3. What we do

i. Strategic Outcomes



3. What we do

i. Strategic Outcomes

The outcomes in the Marine Science and Innovation Strategy reflect Scottish Government's vision for the Blue Economy, itself building on the UN SDGs, the National Performance Framework for Scotland and other relevant Scottish Government strategic priorities. The strategic outcomes set out what we want to achieve, where we must lead, where and who to work closely with and how we will successfully deliver our mission. These outcomes will ensure that our science, evidence and data strengthens real world impacts we have.

These outcomes align with the priorities of other key national and international organisations, which are equally focused on delivering high quality research and innovation for the benefit and enrichment of our lives, our economy and our marine environment. The latter two of which are not mutually exclusive outcomes, our evidence and data should be working for both to be realised in order that we can meet and manage our current needs as an island Nation but also into the future, when for example if sea levels rise as estimated the role our seas play in food and energy security will become increasingly important. To make the most of the opportunities while managing the challenges we will engage in horizon scanning to determine what's needed for Scotland, for example in e(environmental)DNA or seaweed biotechnology.

The outcomes recognise the context in which we operate, namely towards delivering our long-term ambition for Scotland's blue economy, and the important contribution we can make to national and global efforts – alongside our partners and stakeholders. We can do much more together when our approach is one of strategic collaboration and clarity around the role government should play in direct delivery, commissioning and convening. Our contribution to that collaborative approach includes our long term data collection and analysis, our research vessels and our aquarium. Marshalling that collective evidence allows us to be at the vanguard of resilient marine policy development and adaptive management.



The Scottish Coastal Observatory (SCOBs) Story

The Marine Directorate started the Scottish Coastal Observatory in 1997. This programme fulfils statutory environmental marine monitoring obligations under the Marine Scotland Act, the UK Marine Strategy and the Oslo/Paris Commission (OSPAR) Quality Status Assessments.

Citizen science

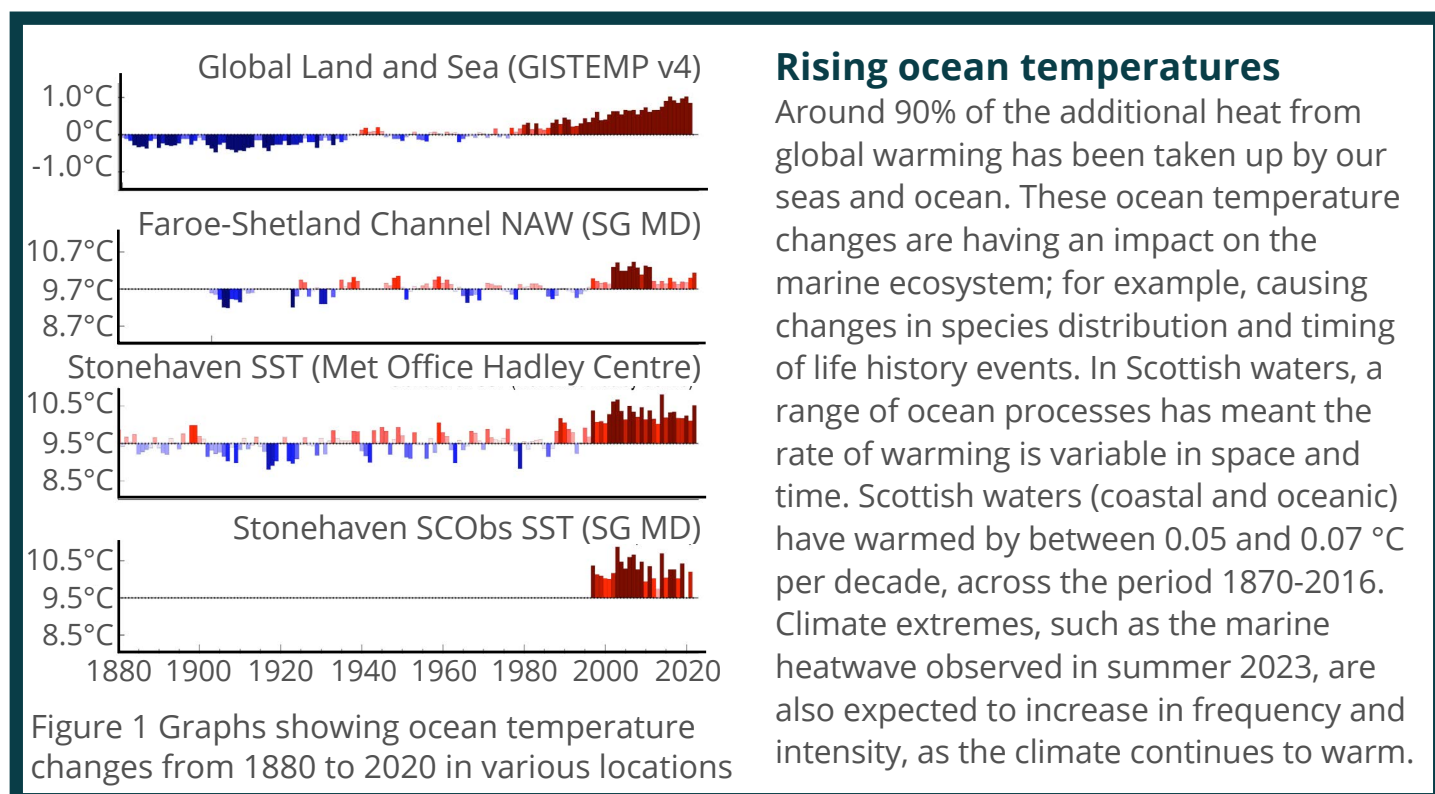
Key to the success of this programme has been the input from the voluntary samplers who have been collecting samples and maintaining sampling kit monitoring began.

SCOBs data have provided the first sustained description of Scotland's coastal environment. Observed changes since 1997 include a decline in the saltness of seawater and levels of silicate, a nutrient essential for the growth of diatoms (an ecologically important type of microscopic marine plant) at some sites. Changes in the diversity of the plankton community (microscopic plants and animals) have also been recorded. SCOBs data collection is ongoing with new information gathered weekly to understand the impacts of climate change and biodiversity loss on Scotland's coastal environment.

The Marine strategic outcomes for science and innovation are presented below. As already outlined, their direction is set by a focus on the delivery of Scotland's Blue Economy (outcome one), and how the Marine Directorate will enact the science and innovation capacity to do that (outcomes two to six). The outcomes have been developed in collaboration with internal and external stakeholders demonstrating our commitment to working in partnership, and ensuring that the strategy encompasses the breadth and depth of work we produce, as well as the full extent of what we can achieve together as a nation.

Our six outcomes

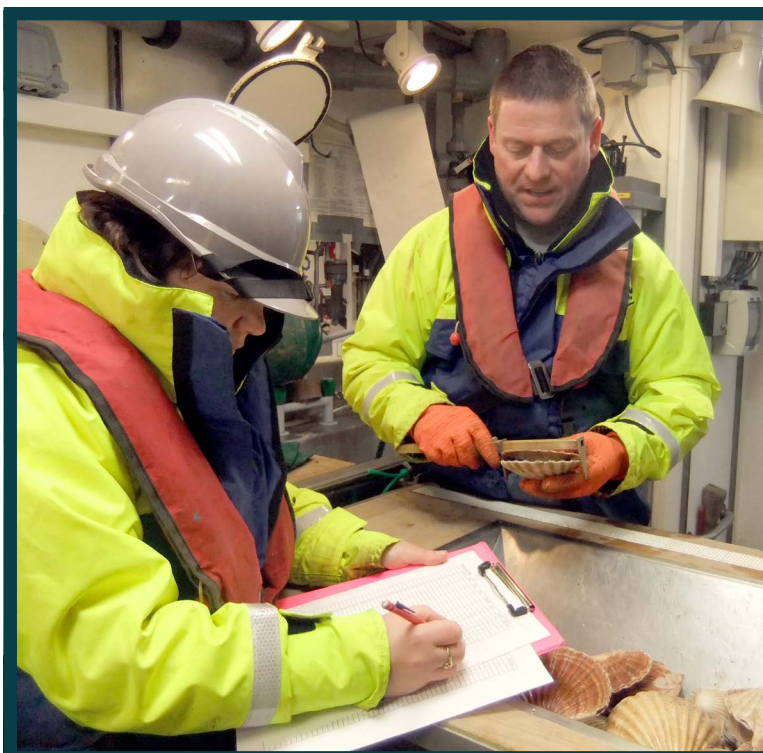
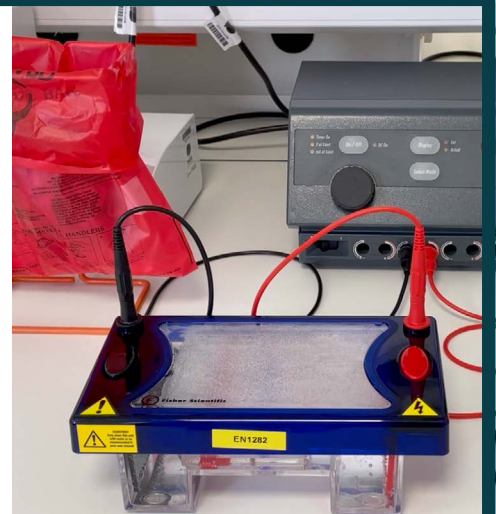
- i. The Marine Directorate, with the rest of Scottish Government, delivers our Blue Economy vision. Our long-term ambition demonstrates the value we place on our marine environment and natural capital and its significance to the health of our planet. Scotland's shared stewardship of our marine environment supports ecosystem health, improved livelihoods, economic prosperity, social inclusion and wellbeing.
- ii. Scottish Government's marine and freshwater management, policies and plans are informed by science, evidence and advice that's continuously improving and innovating and based on quality data and analysis and supported by strong collaboration across the science (natural and social) community.
- iii. With our partners we aspire to co-create a Scotland-wide delivery approach to marine research that develop communities of practice, which harness our collective expertise in marine research across Scotland. These communities of practice would work together to deliver the scale of our collective aspirations as an Island Nation and attract world class talent to deliver the science, technology and innovation Scotland needs in the marine and freshwater environments to deliver the Blue Economy. Thereby ensuring we are returning the best value for Scotland and cementing the Nation as one of the centres for marine research globally.



- iv. The Marine Directorate will complement its existing work through collaboration nationally and internationally in a manner that fosters bold, innovative solutions, and technologies to deliver the scientific solutions – such as Scotland’s existing work on Blue Carbon - to the challenges we face as a nation, and as a planet.
- v. The Marine Directorate will develop its ability to anticipate, respond innovatively and adapt efficiently to opportunities and emerging challenges, such as the twin threats of climate change and biodiversity loss.
- vi. Our assets, in particular our aquarium and national reference laboratory, provide national value to Scotland across industry, the scientific community and in delivering a public service; informing contingency planning for disease outbreaks, collecting valuable data and enabling innovation, research and development.

Novel tools for biodiversity monitoring

Marine Directorate had been using alternative, non-invasive approaches to monitor marine biodiversity. By analysing signatures of environmental DNA (eDNA), shed into environment by living organisms, presence of different species can be predicted simultaneously and without directly collecting or observing them. Monitoring based on detection of eDNA has been successfully applied when investigating presence and distribution of both protected as well as invasive non-native species in Scottish coastal waters.



ii. Strategic Enablers:
people; data, digital;
and infrastructure



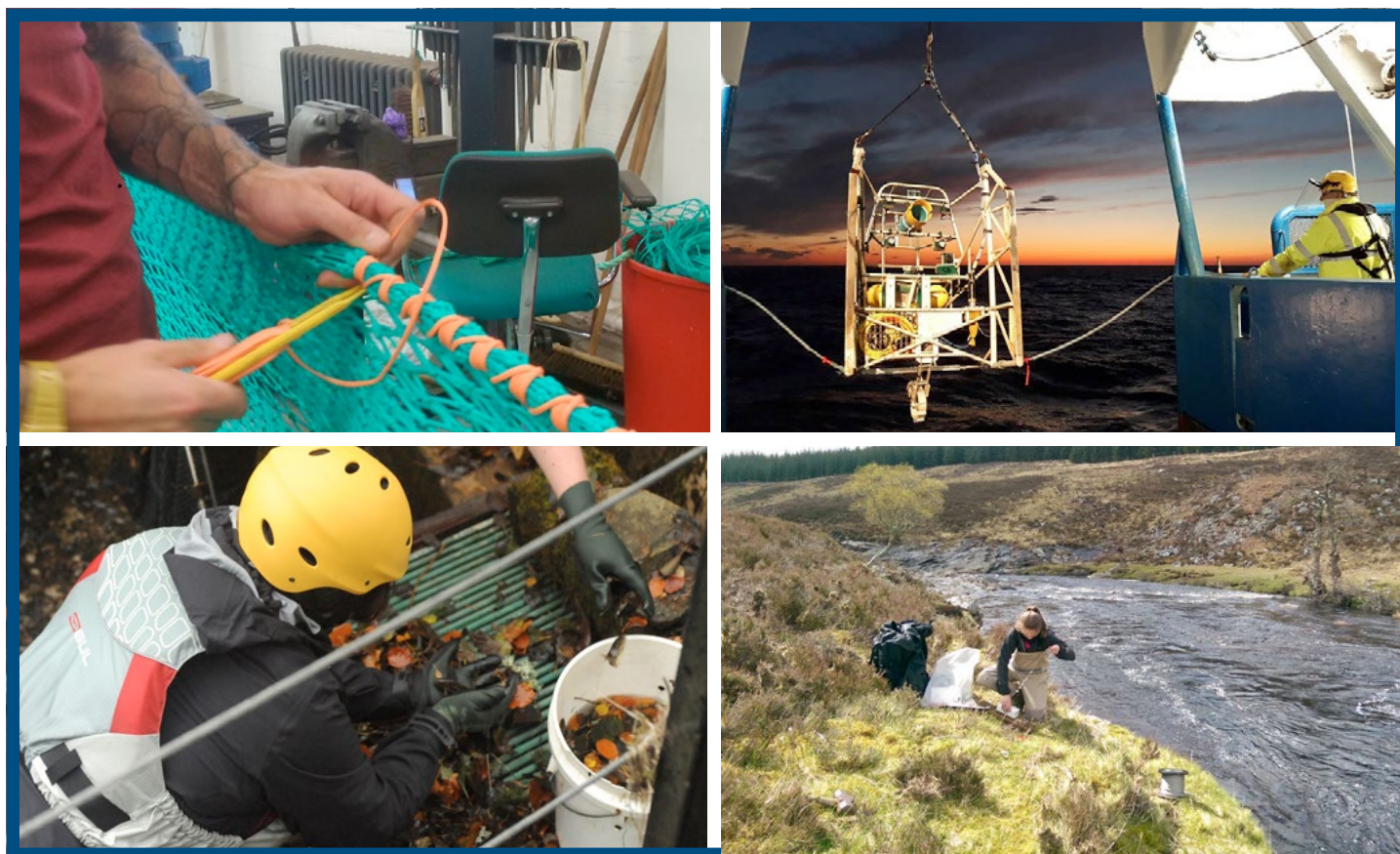
ii. Strategic Enablers: people; data, digital; and infrastructure

To deliver on the new science and innovation strategy we need to ensure our strategic enablers to the strategy are adequately resourced and positioned. We will also foster a culture which is high impact and high performing as a consequence of our intentional choice to be courageously curious, where colleagues are empowered and creativity flourishes and our approach to communication breaks down barriers and silo's so that we enhance our collaboration - internally and externally.

People

The first of our enablers is People and we will create an excellent place to work that fosters - as a priority - diversity, inclusivity, and the development of talent in order to recruit, develop and retain a highly skilled, curious and creative workforce. Going forwards we will need a mixture of generalist science and engineering skills in addition to deep specialist knowledge for particular areas. We will ensure, through the further and consistent development of science, analytical and engineering as professions within government, that all our colleagues are developed to fulfil their potential and have a built-in ability to be agile through having discrete, time bound, integrated multi-disciplinary delivery teams across Marine.

This will include working closely with the new Chief Scientific Adviser, Marine and Scottish Government's Head of Profession for Science in addition to the Marine Directorate's own professional leads to ensure we have clear progression routes and development opportunities to create a high performing working environment where colleagues can flourish and reach their potential while creating clear impact for Scotland.



We will also continue to ensure that we create the environment where our colleagues adopt the best practice approach to science and government policy by following accepted government advice and norms on the independence and integrity of science. By putting innovation as a key element of this strategy we will also intentionally incorporate continuous improvement into all we do. We will foster partnerships and a collaborative approach across the whole of Scotland as part of our 'DNA' to intentionally create the greatest value for Scotland as a return on the investment into science, evidence and data in Marine Directorate.

Data and Digital

The second strategic enabler is around our Data and Digital. We need to deliver the Marine Directorate Science and Innovation Strategy in a manner that incorporates Scottish Government's digital commitments and aspirations captured in *A changing nation: how Scotland will thrive in a digital world and in Scotland's Artificial Intelligence Strategy*.

For the Marine Directorate this means, in line with principles of transparency and sharing our assets for the benefit of Scotland, we will commit to open access, high-quality data and information services, which meet the needs of Scottish Government, our partners and stakeholders around our strategic focus on the blue economy. By doing so it will enhance data capability for modelling and new technology purposes, which will, for example, in some cases be delivered through 'Cloud Based Infrastructure'.

To effectively manage and share the data collected, the Marine Directorate follows the FAIR principles (findable, accessible, interoperable and reusable), to optimise reuse of data where possible and permissible. These principles offer a well-structured approach for improving our stewardship and data governance, ensuring we continue publishing open data to support and underpin scientific analyses in a transparent and trusted way.

Innovation and the development of new technologies, such as Artificial Intelligence, offers opportunities for monitoring, modelling, and understanding of our marine and freshwater environments (e.g., through use of WeeHoloCam, drones and submersibles). To make best use of these opportunities, Marine Directorate will invest in and develop digital methods for handling large volumes of data, increasingly captured in real time or near real time.

With growing amounts of data arriving at a faster pace, Marine Directorate will also develop capabilities, infrastructure, and tools to model our oceans and make use of Artificial Intelligence and large language models for efficient analysis, reporting and overview.



New technologies are continually appearing on the horizon, such as non-destructive monitoring by use of environmental DNA (eDNA) shed in water by organisms inhabiting marine and freshwater environments. Such technologies offer significant opportunities for new insights but can be unfamiliar or experimental. To manage that challenge while maximising new opportunities for all we will foster a culture that's founded on curiosity and an openness that seeks to add to Scotland's evidence base. By making data, evidence and analysis available as far as possible, we will not only increase trust in our evidence but we will also create new sources of value for others to build on.

Infrastructure

The next strategic enabler is our infrastructure. With the loss of one of our main buildings and laboratories on our site in Aberdeen we will ensure the replacement laboratories are commensurate with the ambition set out in this strategy whilst engaging with the public sector reform underway in Scotland. Early strategic conversations are underway as we strive to have world class facilities allowing Scotland to retain its position as a world leading marine centre of excellence.

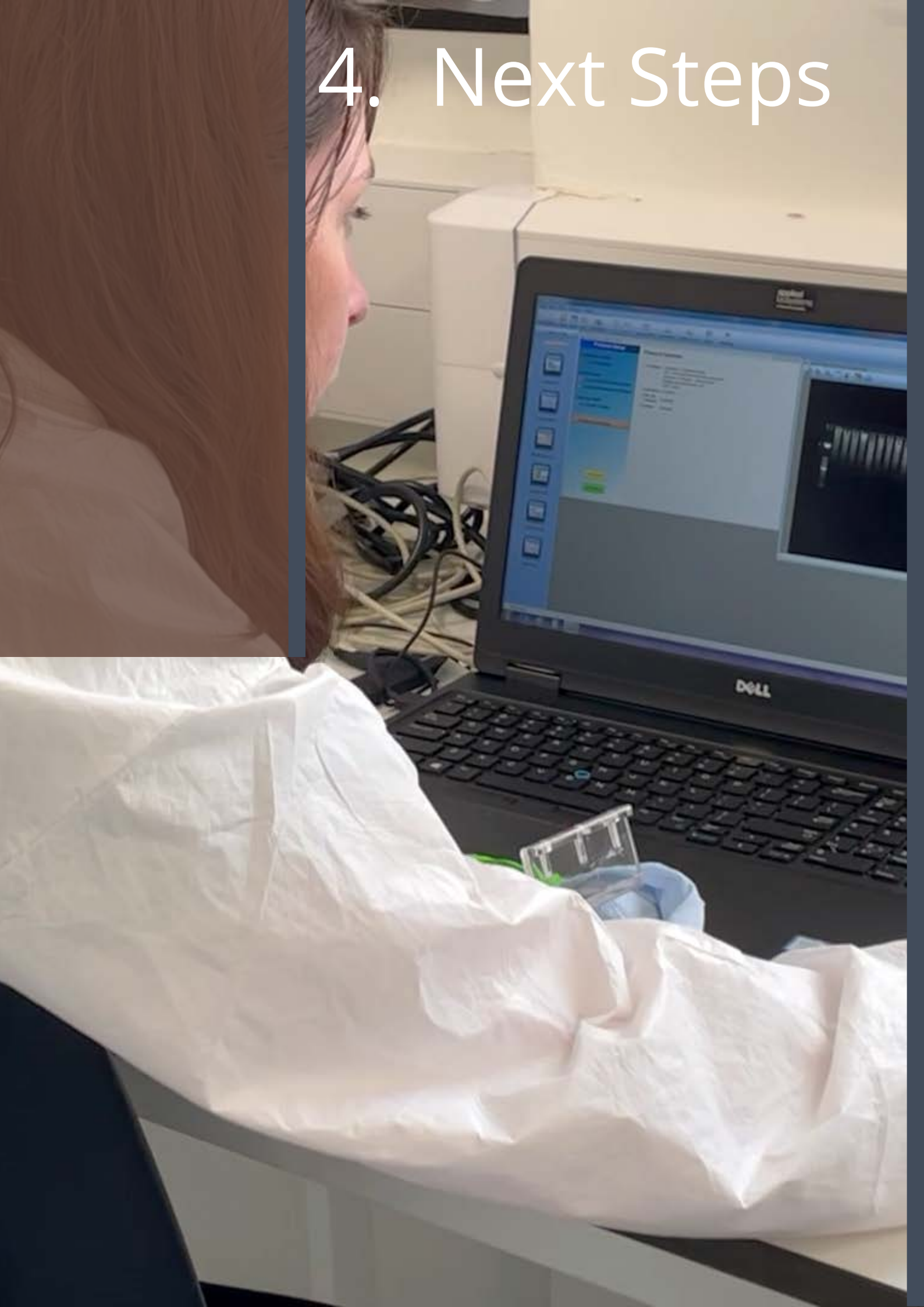
The Marine Directorate currently has two research vessels. We are committed to collaborating with partners across Scotland to ensure we are working together to meet our needs as an Island Nation with seagoing research vessels. This will mean ensuring we are fit for purpose in delivering the new strategy and the blue economy vision while ensuring our carbon footprint is minimised by exploiting new developments such as artificial intelligence, robotics and autonomous vehicles. Our data capture, storage, sharing and management capability will need to match the work our vessels deliver.

We are committed to ensuring that there is equality of opportunity for colleagues whether on land or at sea onboard our vessels, particularly in leadership roles. To support this, we developed a new Scientist-in-Charge (SiC) pathway for increasing diversity, inclusion and equality in these roles. The SiC pathway focuses on a transparent and consistent approach to encourage and equip science colleagues (including those returning to work) and early career science colleagues in fulfilling the SiC on board our vessels when at sea.

Our vessels will also be critical to better understanding our Marine Natural Capital and deliver the requisite monitoring and evaluation at sea, for example once the next iteration of the National Marine Plan is complete.



4. Next Steps



4. Next Steps

In order to deliver the new science and innovation strategy we will need to be highly collaborative, highly communicative and use all of Scotland's resources, talent and assets that are available to us. This will entail being cognisant of where Scottish Government (SG) priorities, and the science and innovation strategy itself, sits in SG and within the national and international context. One of the first steps is mapping the marine and freshwater science and innovation capability and capacity Scotland has across the nation and we would seek to work on that with our partners as part of our next steps.

Our commitment is to proactively engage with stakeholders and partners to ensure effective and efficient data collection, management and access over the short, medium and long term. One element of that will include how we transfer the knowledge gleaned through delivery of the strategy via storytelling to the community at large to benefit from. We will also communicate our research priorities through an Areas of Research Interest (ARI) scoping exercise.

Building on the work that went into the design of this strategy from a very large number external colleagues, stakeholders and partners alongside our policy, operational and science colleagues we will now create an operational plan to deliver this strategy. An element of that operational plan will include the need for - real and virtual - horizon scanning to equip us with the skill sets (for example those such as needed for just transition and community participation), knowledge and data we will need to respond to living with ever faster environmental change against the backdrop of balancing the needs of our natural capital with those of a thriving, healthy economy.



5. A word of thanks

A significant number of people helped to build this new strategy and for that reason we wanted to acknowledge all of our colleagues in the Marine Directorate and across Scottish Government for their contribution, effort, time and ideas.

Similar thanks need to go to all of our colleagues working in communities, within academia, business and the charity sector who gave of their time so generously and shared their ideas, concerns and hopes for the marine and freshwater environments that went into helping us design the new strategy.

It is greatly appreciated and we look forward to working together in delivering the new strategy for Scotland.





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