Annual Report Year One

MAY 2023

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Photo: Matt Jarvis Media

FOREWORD

by **Stephen Catlin**

> **We bring to the partnership our experience of, and concern for, the physical consequences of climate change together with a deep appreciation of the necessity for robust, timely data to make informed decisions**

Photo: Matt Jarvis Media

The world is acutely aware of the growing impact of climate change and the risks associated with it. However, there is little understanding around how the ocean impacts climate change and in particular the carbon sequestering capacity of the continental shelf seabed. We are hoping to change that.

We recognise the need for urgent action and intend to be part of the solution, but at the same time appreciate the complexity of the challenges and the need for collaboration. We are thrilled to have partnered with Blue Marine Foundation and the University of Exeter to establish the Convex Seascape Survey. The Convex Seascape Survey is a pioneering collaboration of world leading marine scientists that aims, over its five year term, to build a greater understanding of the properties and capabilities of the ocean and its continental shelves in the earth's carbon cycle. The data collected will be publicly accessible, giving the scientific community (and beyond) the much needed data to truly understand the potential of the seabed and its role in carbon sequestration.

As a (re)insurer we bring to the partnership our experience of, and concern for, the physical consequences of climate change together with a deep appreciation of the necessity for robust, timely data to make informed decisions. We do not believe in quick fixes, it is only by filling the gaps in our understanding that sustainable solutions will be found.

On a personal note, my long record of supporting climate related research projects speaks to my belief in the need to tackle climate change, and to take a considered and properly informed approach to doing so. During my tenure as CEO of Catlin Group, we were instrumental in the establishment of two highly successful, high-profile science programmes – the Catlin Arctic Survey, and the Catlin Seaview Survey – which supplied incontrovertible evidence that climate change was already the cause of major disruption, years before this became accepted. Looking back, I am very proud of the impact the surveys have had and their contribution to our understanding of climate change.

Looking forward, I am excited for what we can achieve and hope that in four years' time, I can say that we have helped shine a light on one of the most critical, unsolved scientific questions of our time how the ocean impacts climate change.

Stephen Catlin, Executive Chairman
Convex Group Limited

PROJECT OVERVIEW

One of the critical, unsolved scientific questions of our time is how the ocean impacts climate change. The seascape is the ultimate sink for carbon emissions and, in a time of climate emergency, could be an immense ally in efforts to slow runaway planetary warming.

Blue Marine Foundation, the University of Exeter and Convex Insurance Group Limited have partnered on an ambitious, five-year global research programme: The Convex Seascape Survey.

The programme gathers a pioneering collaboration of world leading experts working to quantify and understand blue carbon stored in the coastal ocean floor. It will deliver new, reliable, open-source data which will educate, inspire and enable informed decisions on ocean use, to harness the power of the sea in the fight against climate change.

SEA AROUND US
FISHERIES, ECOSYSTEMS & BIODIVERSITY

UBC THE UNIVERSITY OF BRITISH COLUMBIA

OCEANX

Universiteit Utrecht

Encounter Edu

PRIFYSGOL BANGOR UNIVERSITY

University of Sheffield

convex SEASCAPE SURVEY

BLUE MARINE FOUNDATION

University of Exeter

UNIVERSITY OF Southampton

PML Plymouth Marine Laboratory

JICAS JERSEY INTERNATIONAL CENTRE OF ADVANCED STUDIES

King Abdullah University of Science and Technology

Q-quatics

THE UNIVERSITY OF WESTERN AUSTRALIA

BlueAbacus

NORTH ATLANTIC OCEAN

NORTH PACIFIC OCEAN

SOUTH ATLANTIC OCEAN

INDIAN OCEAN

SOUTHERN OCEAN

KEY SCIENTIFIC QUESTIONS

OBJECTIVES
WHAT WE WANT TO FIND OUT

Seascape carbon – where is it, how and when did it get there and where did it come from?

We will identify the origins of carbon on the world's continental shelves and explore how it has accumulated and altered over time, discover where the biggest stores are found, molecularly fingerprint where they came from, and put the size of these carbon stores into context in the global carbon cycle.

Human influences on seascape carbon

We will map the spread of multiple different human activities disturbing the seabed over two and a half centuries to the present day. By overlaying disturbance maps with our maps of the distribution of carbon in the seascape, and experimental measures of the consequences of bottom disturbance in the field and laboratory, we will identify historic and contemporary patterns of human influence on blue carbon and determine its vulnerability to loss and re-release to the ocean and atmosphere. We will thereby make quantitative links between human pressures on the seascape and their impact on carbon dioxide emissions and identify potential management options to slow climate change.

The role of life and biodiversity on seascape carbon stores

We will study and monitor the effects on wildlife and habitats of protection from seabed-disturbing human influences at multiple representative locations worldwide. We will measure how long it takes for carbon capture and burial to recover following protection and quantify the complementary benefits of protected areas to wildlife and people, in terms of ecosystem services, economic benefit and increased human wellbeing.

OUTCOMES
WHAT WE ARE GOING TO ACHIEVE

We will gather, and make publicly accessible, high-quality data on seascape blue carbon.

We will bring understanding and transparency to the capacity of the ocean as a carbon sink – which will support the vital value of a protected seascape and create a lasting legacy.

We will educate young people, the general public, governments and decision-makers in the UN climate change process and engage them in the immense value of a vibrant, living ocean.

We will develop a communication and education programme to raise global awareness and press coverage around this extraordinary story.

While this survey is all about the gathering of data, success could result in the proper integration of the ocean into political efforts to slow and stabilise climate change.

HOW IS THIS WORK UNIQUE?

We are aware of certain other nascent investigative work in this area such as biogeochemists looking at sediment carbon and an initiative looking to generate carbon credits in a fishing project in Africa. However, crucially our leading scientific department at the University of Exeter is very close to most scientists working in this field, and many of them are deeply integrated into our project. We are certain that the interdisciplinary depth, global scale and scope of The *Convex Seascape Survey* is unique and will lead the world on this crucial problem.

WORK PROGRAMMES

WORK PROGRAMME ONE:
THE WHERE, WHEN, HOW AND WHAT OF BLUE CARBON IN THE SEASCAPE

Understanding seabed carbon deposition and accumulation through history and into the future.

Task 1.1: Data mining and synthesis.

Task 1.2: Oceanographic modelling to predict carbon accumulation.

Task 1.3: Field research.

Task 1.4: Tracing the origins of blue carbon inputs to the seabed carbon sink.

Task 1.5: Placing sediment carbon into context of global carbon.

WORK PROGRAMME TWO:
HUMAN INFLUENCES ON SEA-SCAPE CARBON

The recent period of human global influence and domination of the planet has come to be known as the Anthropocene. In programme two we will explore the Anthropocene Seabed, documenting how human influence has grown in the ocean and shaped the seascape.

Task 2.1: Historical development and spread of human influences on the seabed.

Task 2.2: Contemporary intensity and distribution of bottom disturbance by human activities.

Task 2.3: Where are the world's remaining areas of pristine/intact seabed habitat?

Tasks 2.4 – 2.6: The importance of sediment carbon and the impact of seabed disturbance.

Task 2.4: Viewing the impact of seascape disturbance from space.

Task 2.5: Measuring the impact of trawling on sediment and animals from within the water.

Task 2.6: Quantifying the global impact of seascape disturbance on sedimentary and atmospheric carbon.

WORK PROGRAMME THREE:
LIFE AND BIODIVERSITY EFFECTS ON BLUE CARBON CAPTURE AND BURIAL, AND BENEFITS OF PROTECTION

Understanding how seascape protection recovers wildlife, rebuilds habitats, restores their blue carbon values and delivers wider economic and wellbeing benefits to human society.

Task 3.1: Monitoring and measuring uptake of carbon by seabed habitats and recovery of carbon stocks after protection.

Task 3.2: Laboratory mesocosm experiments.

Task 3.3: Evaluating the co-benefits of seabed protection from human impacts on wildlife and ecosystem services.

Task 3.4: Economic values of protection.

Task 3.5: Measuring, monitoring and minimising the project's carbon and environmental footprint.

WORK PROGRAMME FOUR:
COMMUNICATIONS AND OUT-REACH

Communicating and helping the general public visualise this project is key to its success. Work programme four will showcase scientific findings and project progress through media and live education outreach sessions.

Task 4.1: Development of communications plan and assets.

Task 4.2: Development and creation of digital platform.

Task 4.3: Deliver outreach.

Task 4.4: Secure exclusive programme media partners.

Task 4.5: Conduct press campaigns with announcements.

Task 4.6: Promote conclusive results to create a legacy.

UN SUSTAINABLE DEVELOPMENT GOALS (SDGS):

The project contributes to a broad range of the UN SDGs. Of these, we make the most substantive contribution towards realising the following seven:

1 NO POVERTY

2 ZERO HUNGER

3 GOOD HEALTH AND WELL-BEING

4 QUALITY EDUCATION

Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

5 GENDER EQUALITY

6 CLEAN WATER AND SANITATION

7 AFFORDABLE AND CLEAN ENERGY

Goal 5. Achieve gender equality and empower all women and girls

8 DECENT WORK AND ECONOMIC GROWTH

Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Goal 9.5 Enhance scientific research and 9.c Significantly increase access to information and communications technology

10 REDUCED INEQUALITIES

11 SUSTAINABLE CITIES AND COMMUNITIES

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

Goal 13. Take urgent action to combat climate change and its impacts

14 LIFE BELOW WATER

Goal 14. Life Below Water

15 LIFE ON LAND

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

17 PARTNERSHIPS FOR THE GOALS

Goal 17.6 Enhance NorthSouth, SouthSouth and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing

TIMELINE OF PROGRESS
SINCE INCEPTION

November
2021

Project announced at COP26, Glasgow

Bloomberg press announcement

May
2022

Project Team onboard
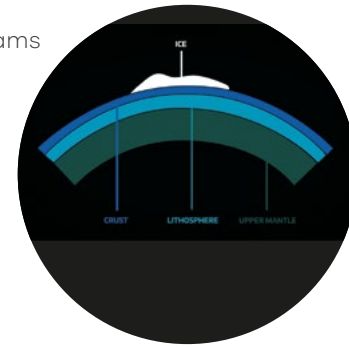

October
2022

Education and digital partners onboarded

January
2023

Seascape Survey portal launch on EncounterEdu platform

Ocean & Climate teaching resources, lesson plans and interactive diagrams released

March
2023

British Science Week, 'Seabed Safari' live lesson with bioturbation team
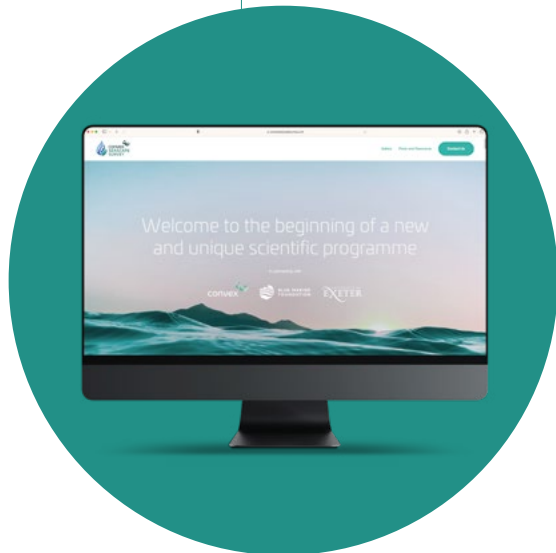
2022

2023

April
2022

official project start

July
2022

Website phase 1 launch

November
2022

Strategy Day, Cornwall

Project presented at COP27, SharmElSheik

February
2023

First Advisory Board meeting, Convex HQ

Science Strategy Day, Exeter

Project presented at World Ocean Summit, Lisbon

EXECUTIVE SUMMARY

Early in 2023, Convex Seascape Survey scientists from Exeter and Southampton, set up the biggest experiment of its kind to look at the role of seafloor creatures in helping to draw down carbon from the atmosphere and lock it away forever.

The seabed is the largest interface between water and earth on the planet, with thousands of organisms in each square metre of sediment. Previously only 26 species that lived on the seafloor had been characterised in this way. Convex Seascape Survey has added 20 species to that in one experiment.

Now in progress, the Great British Bioturbation-athon involves seven scientists and one boat. Dormitories next to the lab at Millport in the Firth of Clyde mean the scientists can run analyses through the night. Working round the clock, despite gales, placing each of the species – worms, molluscs, starfish and so on in separate tanks with fluorescing particles to show how they burrow and move carbon around. The study involves 146 sediment grabs and mud sieving to find the creatures that enable the ocean to perform its function in cooling the climate. Just exactly how these animals do it and how much they capture are the big questions the survey will be trying to answer for all the world's continental shelves.

After the first year we are making good progress in the science of carbon capture and storage by marine ecosystems.

- We have been developing high performance supercomputer models to help predict areas where the largest seafloor carbon deposits have built up over the last several hundred years. These help to inform areas of sampling interest, now identified as: the Patagonian shelf, Argentina; the Sunda Shelf, Indonesia; the Indus shelf, Pakistan; the Congo fan, Democratic Republic of Congo and the Celtic Deep, UK.

- Scientists from the Convex consortium have also developed a pioneering seabed disturbance experiment to track the fate of carbon stirred up by bottom trawling activities. This will be deployed in UK waters in June 2023.

- The project has been preparing to deploy a global citizen science campaign, working with industry and ocean enthusiasts to find and verify places in the world where the seabed is as close to biologically undisturbed as possible, so that we can look at carbon stock recovery rates when we leave the sea alone.

- We are developing a first of its kind map of human disturbance activities of the seabed over the past 250 years. To help us do this, we have accessed the multimillion pound database from Prof Daniel Pauly's 'Sea Around Us Project', which will allow us to compare fisheries catch data around the world since 1950. We have scoured the archives to understand the way things would have looked in the past and what the implications for carbon storage were then, versus how things stand now.

- Oyster beds are a key carbon sink, but almost everywhere they are in decline. A Paper 'The world was our oyster: Records reveal the vast historical extent of European oyster reef ecosystems.' Has been submitted for publication in the Journal of Ocean Sustainability.

- We are making waves with our live lessons and content. For the first time we have brought the ocean into carbon cycle materials for UK schools. Incredible to think it had not been included until now, given the vital importance of its role. If we do our job as planned, our media and educational outreach have the potential to provide a glimmer of hope for people of all ages that nature-based solutions could have a part to play in fighting climate change at a time of high climate anxiety.

A major ambition for the project is outreach, enabling this world of blue carbon to capture the public imagination. We know we are in an exciting space. This is seen in the invitations we are receiving to speak at

> "Now in progress, the Great British Bioturbation-athon involves seven scientists and one boat"

global events and to join important business, policy and research forums on blue carbon. We know this from the warm receptions we have received this past year, when presenting the project on the world stage at events such as COP27, Egypt and the World Ocean Summit, Lisbon. In the delivery of this project we find that we are inventing new vocabulary both literal and scientific – to explain what we are doing.

Bringing the seabed and the creatures which live in it, burrow into it or swim above it to capture hearts and minds is no small challenge but it is one that we relish. We firmly believe that the time is right to bring the latest developments in creative and immersive technology to meet this challenge. We believe the ocean has for too long lagged behind the terrestrial environment within the classroom and hope to reach five million school children by the end of the project.

The report that follows shows our progress across the major programme pillars in our first year of project delivery and describes our main objectives moving forward. We hope you enjoy reading about our quest to quantify seascape carbon in this pioneering five-year project.

Updates on our progress can be found on social media **#convexseascapesurvey**

PAID PERFORMANCE

2 X AD CAMPAIGNS WITH A TOTAL OF

91K
REACH

OUTREACH

World Ocean Summit & Expo 2023

1500+ attendees,

the **Project logo** was showcased on the banner of every presentation, panel sessions and on marketing materials throughout the event and reached 13 million viewers online.

COP27 | 35000 delegates, **150,000 dedicated online viewers**

EDUCATION

4 X LIVE
LESSONS

17,558
STUDENTS IN

282
SCHOOLS
ACROSS **21 countries** INCLUDING ROMANIA, NEW ZEALAND, AND BERMUDA

TEACHING RESOURCE DOWNLOADS OVER 300

SEABED SAFARI WAS THE MOST POPULAR LIVE LESSON, WHICH REACHED

12,387
STUDENTS

MULTIMEDIA, ACTIVITIES, AND TEACHING RESOURCES

4000
VIEWS

THE BESPOKE CARBON CYCLE INTERACTIVE DIAGRAMS RECEIVED OVER

1795
VIEWS

Sidmouth Primary @sidmouthschool

Year 1 took part in a Live Seabed safari lesson today in preparation for #BritishScienceWeek2023. We really enjoyed watching and learning about the sea creatures #Year1science @encounteredu @ExeterMarine @ConvexSeascape

TESTIMONIALS FROM TEACHERS:

Resources

"Fabulous! Thank you for this, I'm writing yet another PowerPoint for KS3 and this has saved me lots of time thank you!"

Reviews of live lessons

"The children loved the live lesson and were so pleased that their questions were answered. It certainly created awe and wonder."

"Great knowledge shared with the children. Encouraged children to think about the environment and ask some questions. Live images really supported this."
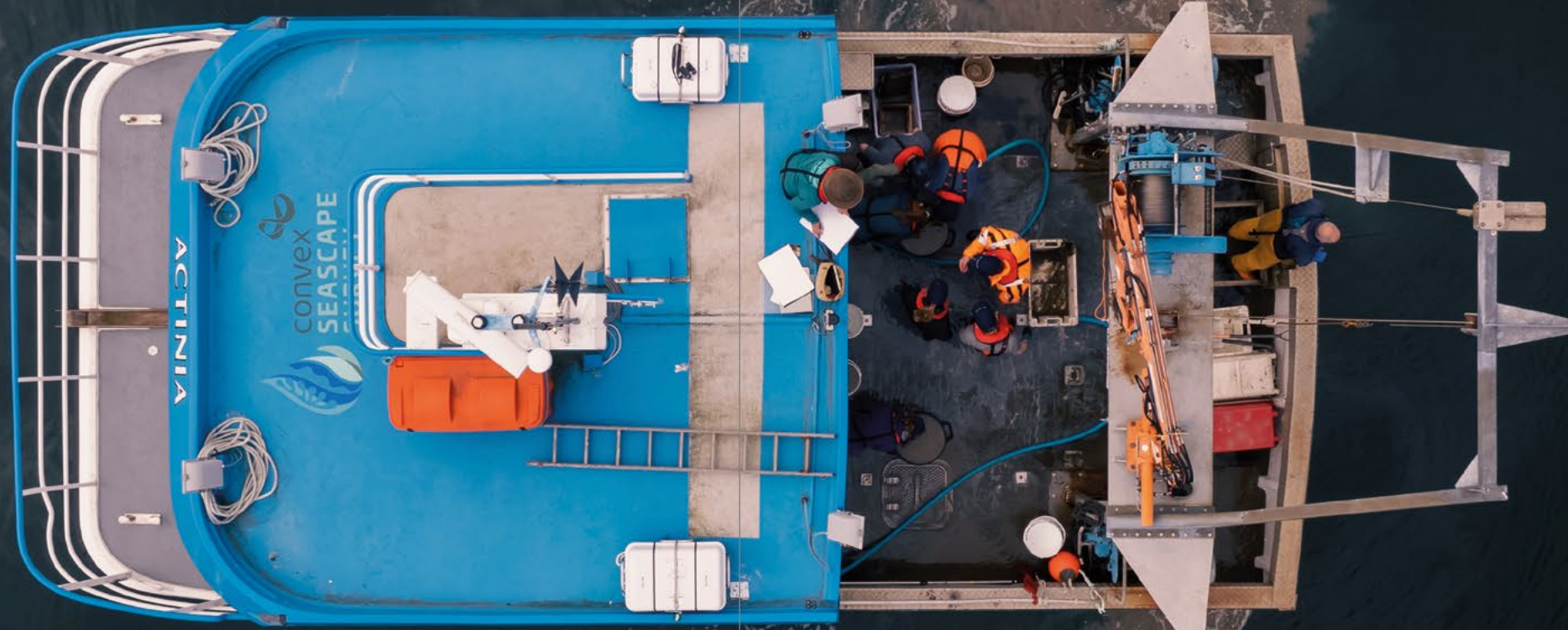
GRANT MANAGEMENT AND UNIVERSITY MANAGEMENT

Blue Marine Foundation is the grant recipient, with overall responsibility for ensuring the effective and timely delivery of the five-year programme and with ultimate responsibility for managing the budget. Blue Marine is well aligned with Convex Insurance, as an agile, effective and extremely well-regarded conservation organisation that is enviably globally networked. We have a great track record of delivering multi-partner projects of scale and especially of delivering public private partnerships. This is Blue's largest project to date, and it is our role to ensure real-world significance of the project and best reach of the data that we gather.

The University of Exeter, a member of the Russell Group of universities has responsibility for overseeing the science and research function of the project. The Research Management Group, under the guidance of Professor Callum Roberts oversees the delivery of world-leading results and all coordination with the partners of the scientific consortium (P4.)

ADVISORY BOARD REMIT AND MEMBERSHIP

Dr Trisha Atwood, Associate Professor at Utah State University and National Academies of Sciences Gulf Research Early Career Fellow with expertise in quantifying marine sediment carbon

Professor Bill Austin, St Andrews University, Scotland, current chair of the Scottish Carbon Forum and lead of the UN's Global Ocean Decade Programme on Blue Carbon (GOBC)

Steve Crooks, Partner, Silvestrum Associates, experienced wetland scientist in the response of coastal wetland systems to human impacts and climate change and the translation of this into effective policy

Professor Michael Depledge (Chair) – expert in oceans and human health and government advisor on chemical pollution

Professor Hilary Kennedy – Biochemist and person responsible for getting coastal ecosystems recognised for their importance for storing carbon and mitigating climate change

Dr Ruth Parker Centre for Environment, Fisheries and Aquaculture Science. Shelf sea biogeochemist and UK policy expert

Loreley Picourt Secretary General of the United Nations Ocean & Climate Platform. A strong advocate for multilateral cooperation, she works for a better integration of the ocean-climate-biodiversity nexus in decision making at the national and international levels

ROLES AND RESPONSIBILITY

Responsibility	Blue Marine Foundation	University of Exeter	Convex Group Ltd	Consortium partners
FINANCE	Grant recipients: overall financial responsibility; overviewing research spend, delivering outreach package	Regrant from BMF for research elements; management of research partner budgets and equipment	Project supporters and overviewers. Ensuring BMF is managing budget	Specific research task agreements
PROJECT	Overall responsibility for delivering the programme on time and on budget, managing Exeter	Overall Responsibility for delivery of scientific aims and objectives of the project, managing delivery partners, data collection, sample management	Overview project	Specific research tasks delivery
PROJECT	Reporting to Steering Committee; Managing Project Advisory Board	Reporting to BMF; Managing Research Management Group and consortium	Project overview; Chairing Steering Committee	Managing specific research staff in delivery of tasks
PROJECT	Ensuring project is represented on world stage e.g., COP, United Nations OceanClimate Platform	Ensuring results are represented on world stage; representing project to global research community	Identifying opportunities for project on world stage and B2B groups	Presenting specific research task results
DATA	Overall responsibility for data management and reach	Ensuring collection and quality of the data. Peer to peer dissemination	Identifying opportunities to share data	Collection, quality and dissemination of specific data relating to tasks
PROJECT	Horizon scanning research and policy opportunities	Horizon scanning research and policy opportunities	Horizon scanning business best practise opportunities	Connecting Project to existing networks
NETWORKS	Project overview forums e.g., United Nations (OcanClimate, GOBC, UK Blue Carbon Forum, Verra Ocean Forum, DEFRA Carbon Monitoring Project	Research networks and opportunities for collaboration such as Sea Around Us Project, University of Western Australia	Commercial and business networks such as marine underwriters	Specific research networks
OUTREACH	Overall responsibility for outreach with an ambition of 5m school children and billions of opportunities to see. Managing digital and education delivery partners. All press and media production	Delivering education and press content. Peer to peer outreach and scientific publication	B2B and industry sector outreach. Additional opportunities such as Pacific Ocean Row	Additional outreach opportunities

| Responsibility	Blue Marine Foundation	University of Exeter	Convex Group Ltd	Consortium partners
TECHNOLOGY	Tech partner scoping such as Moonshot, Google X, Tidal X	Consideration of application of new tech opportunities	Identification of tech opportunities for project team to scope	
PARTNERS	Scoping and relationship management of general project and commercial partners e.g., United Nations groups, Fugro, OceanX	Scoping and delivery of research and data collection specific partnerships e.g., Sea Around Us Project, OceanXplorer, Quest	Connecting project to existing networks and previous Catlin Research Projects and Convex affiliations e.g., Biological Institute of Ocean Science, Bermudan School Network, SeaView	Management of delivery specific project partners e.g.,research vessels, labs etc
CAPACITY BUILDING	Collaboration and best practise in blue carbon science, facilitating knowledge sharing and delivering workshop events	Representing project at research forums, peer to peer knowledge transfer Identifying Blue Carbon expertise in developing world, due diligence and delivery with local institution partners e.g., Nelson Mandela University, SA, CADICConicet, Argentina Training the next generation of blue carbon scientists in the UK and beyond	Blue carbon knowledge, blue economy expertise amongst networks	Inputting expertise into Project planning and delivery thereby increasing seascape carbon expertise globally
EQUIPMENT	Identifying legacy opportunities	Procurement, storage and deployment of general project equipment e.g., carbon analyser, bioturbation tanks etc. Ensuring equipment use after the project	Identifying legacy opportunities	Design, procurement and deployment of specific project equipment e.g. trawl monitoring rig
SAMPLE COLLECTION	Identifying opportunities for collaboration and financial savings e.g. Fugro, OceanX	All sample handling, storage and logistics permits etc		Task specific sample management

WORK PACKAGE ONE:

The where, when, how and what of blue carbon burial in the seascape

Workstream Objective: To identify the origins of carbon on the world's continental shelves and explore how it has accumulated and altered over time, discover where the biggest stores are found, molecularly fingerprint where they came from, and put the size of these carbon stores into context in the global carbon cycle.
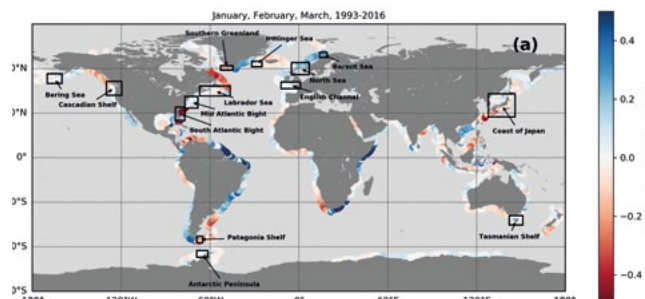
Workstream Lead:
University of Exeter

Workstream timeline:
July 2022 – June 2027

Workstream budget:
$ 851, 883
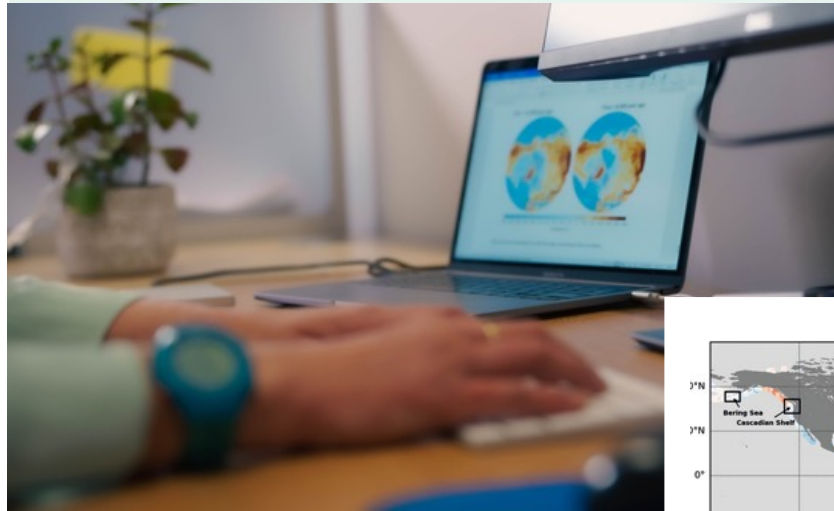
Above: Dr Sarah Bradley reviewing previous models from data archives on glacial isostatic adjustment. **Photo:** Matt Jarvis Media
Right: Across shelf carbon flow model, by Dr Dan Ford

Key achievements over the year

- **First order versions of Global Ice Sheet Reconstruction and Relative Sea Level models created by researchers at the University of Sheffield and Plymouth Marine Laboratory. These supercomputer models help predict areas where the largest seafloor carbon deposits have built up over the last several hundred years.**

- **Using High Performance Computers, researchers are producing predictions of paleontography across the major continental shelves over the last glacial cycle .**

- **Areas of sampling interest identified globally to include: the Patagonian shelf, Argentina; the Sunda Shelf, Indonesia; the Indus shelf, Pakistan; the Congo fan, Democratic Republic of Congo and the Celtic Deep, UK.**

- **The team at the University of Exeter working to estimate the balance between carbon uptake and release by the ocean in particular shelf sea regions have produced the first model global assessment predictions of across-continental shelf surface flows using a satellite observation based reanalysis.**

- **A manuscript on 'across shelf carbon flows' has been produced for review and submission for publication.**

- **Key areas of interest for producing the first baseline assessment carbon budgets for regional shelf seas, taken from existing data sources, have been identified as the European Shelf, Patagonian shelf, Tasmanian shelf and the mid/south Atlantic Bight. This completes Task 1.5.1**

Key challenges

Challenge	Mitigation
Identification of high risk of sampling and local partner collaborations in three key areas of interest	Opportunistic sampling on existing research and commercial vessels deployed in the regions.
Focus on 'ships of opportunity' reduces the project's ability to provide capacity building in regions where collaborators have not been found	Focus on capacity building on sample cruises for example onboard Research Vessel *OceanXplorer*, by deploying a Project multicore sampler and providing training for carbon analysis onboard. In this way, carbon samples can be taken and processed to test our carbon deposit models, in regions which lack the necessary infrastructure for sample collection, storage and processing and increase carbon expertise onboard the vessel, which can be shared locally, as the vessel travels.
Recruitment of high calibre project staff has been challenging	Job recruitment has taken several rounds to find the right candidate. Staff are in position now and PDRA Daniel Ford is being shared across WP1 and WP3 tasks under Dr Jamie Shutler's guidance.

LOOKING AHEAD TO YEAR TWO

1.1 The team working on the topographic and hydrodynamic modelling of shelf seas will have a complete picture of the first area of interest- the Northern European continental shelf shortly and begin analysing cores and taking part in fieldwork campaigns in the area.

1.2 A paper describing the process that the team will follow and including some model output as a proof of concept will be submitted for publication. This first output will allow the team to run a sample of the data visualisation tools that will be used for the complete set of model data later in the project.

1.3 The team will continue to work on collaboration sampling opportunities in Indonesia, Congo Basin and Indus shelf.

1.3 The team will continue to work on collaboration agreements with suitable local partners in areas of interest such as CADIC CONICET, Argentina, for work on the Patagonian Shelf.

1.3 Baseline assessments on the four areas of carbon accumulation interest will begin with the team working to identify appropriate repository data and whether further fieldwork conducted by project collaborators such as in Argentina could provide any missing information.

1.3 The carbon analyser will be installed and ready to run first analyses by July 2023.

1.5 A manuscript describing the global across-shelf surface flows and the relation of these to shelf sea carbon accumulation rates, using multiple existing data (satellite, model reanalysis and previously published papers), will be ready for peer review and submission in June 2023.

WORK PACKAGE TWO:

Historical development and spread of human influences on the seabed

Workstream Objective: To assess the impact of multiple different human activities on the seabed and ocean over time and investigate and identify positive practices.

We will map the spread of multiple different human activities disturbing the seabed over two and a half centuries to the present day. By overlaying disturbance maps with our maps of the distribution of carbon in the seascape, and experimental measures of the consequences of bottom disturbance in the field and laboratory, we will identify historic and contemporary patterns of human influence on blue carbon and determine its vulnerability to loss and rerelease to the ocean and atmosphere. We will thereby make quantitative links between human pressures on the seascape and their impact on carbon dioxide emissions and identify potential management options to slow climate change.

Workstream Lead:
University of Exeter

Workstream timeline:
April 2022 – June 2027

Workstream budget:
$ 1,550,048

Key achievements for the year

- A paper looking at historical loss of European oyster reef ecosystems has been submitted for publication.

- A pioneering seabed disturbance experiment is in design for deployment off Plymouth Sound in June 2023.

- A formal partnership with the University of British Columbia's *Sea Around Us* Project will give Project researchers access to a multimillion dollar database containing a wealth of fishing and fisheries data across the timescales of interest and a shared postdoctoral researcher to interpret the data.

- A citizen science experiment to identify pristine areas of the seabed and industry contacts who may have access to footage of these has been developed.

Key challenges

Challenge	Mitigation
Delays have been caused by difficulties recruiting staff to this work programme, especially the historical ecologist role for Task 2.1	Job recruitment has taken three rounds to find the right candidate. The new candidate will start in June 2023. In the meantime, the team at the University of Exeter, led by Dr Ruth Thurstan has been undertaking this task.
Designing an experiment that captures the complexity of biogeochemical processes occurring in both the sediment and the water column has been challenging, we are entering a new element of science here	The entire research consortium has risen to this challenge, with advice coming from institutions and experts all over the world. Sampling design has been continually refined in response to these discussions and feedback and a broad consensus has been reached. A final version of the sampling protocol will be presented to the group in April.

LOOKING AHEAD TO YEAR TWO

2.1 Further baseline manuscripts will be developed on patterns of human impact in the areas of interest. The European oyster reef ecosystems paper is due for publication by June 2023.

2.3 The pristine seabed search citizen science campaign and industry collaboration will be a major focus for summer 2023, with the results broadcast on Project social media.

2.4 Carbon budget work will continue and begin to feed in to Earth systems models to investigate the carbon budget across all continental shelves. The postdoctoral research fellow on this is currently being recruited.

2.5 The trawl experiment will be carried out off the coast of Plymouth in June 2023, with subsequent data and analysis of sediment carbon disturbance.

2.6 Mapping and analysis of satellite data to understand patterns and intensity of human disturbance of the seafloor to begin, postdoctoral researcher to work on this currently being recruited.

Left: Left shows an undisturbed seabed habitat in Scotland. Right shows the same area two days after a dredge fishing vessel fished in the area. **Photo:** Bally Philp. **Right:** This image shows a seabed that has been previously disturbed by human influence. **Photo:** Howard Wood | COAST

WORK PACKAGE THREE:

Life and biodiversity effects on blue carbon capture and burial and benefits of ocean protection

Workstream Objective: To measure how long it takes for carbon uptake to recover when protected and quantify the complementary benefits to wildlife and people.

We will study and monitor the effects on wildlife and habitats of protection from seabed-disturbing human influences at multiple representative locations worldwide. We will measure how long it takes for carbon capture and burial to recover following protection and quantify the complementary benefits of protected areas to wildlife and people, in terms of ecosystem services, economic benefit and increased human wellbeing.

Workstream Lead:
University of Exeter

Workstream timeline:
April 2022 – June 2027
(Q1Q20)

Workstream budget:
$ 1,317,200

Dr Adam Porter showing Elyssa Quinton around the University of Exeter mesocosm laboratories in preparation for the Great British Bioturbation-athon. **Photo**: Matt Jarvis Media

Key achievements for the year

- The largest of its kind experiment – to determine the importance of the role of seafloor creatures in the carbon cycle *"The Great British Bioturbation-athon"* has been designed and deployed in Millport, Scotland.

- Artist in Residence Naomi Hart to cover the experiment in Millport and at the British Science Festival in September and to exhibit the work at the British Science Festival.

- A blueprint 'project lifecycle carbon model' has been designed by the team at the University of

Exeter to understand projected carbon spend and identify areas where reduction in carbon spend will have the biggest impact. This will be used to inform project, and wider university decisions, going forward.

- A manuscript examining the general issues around the carbon use in research projects and best practise has been completed by Dr Jamie Shutler and is in internal review.

Key challenges

Challenge	Mitigation
Delays have been caused by difficulties recruiting staff to this workstream	The research team at the University od Exeter has had to progress tasks without additional support. However, all posts have been recruited now, with new staff due to start by summer 2023.
We have not been able to identify suitable collaborators in some regions of interest for this workstream	We are working to substitute access via ships of opportunity with exciting partnerships in negotiation with high-profile organisations such as OceanXplorer and Schmidt Ocean Research.

LOOKING AHEAD TO YEAR TWO

3.1 Field sampling design and the use of high-tech equipment for field monitoring will be developed and applied to study sites around the world identified from the citizen science campaign.

3.2 A literature review of the question, *what evidence is there for biological burial of carbon by marine benthic invertebrate fauna and what are the implications for long-term sequestration?* will be submitted for review and publication shortly.

3.2 Following analysis, the team will have results on the bioturbation characteristics (the way that organisms disturb the sediment and aid the sequestration of carbon) from the Millport mesocosm experiment on 20 individual species. From this it is hoped that common characteristics will be identified to extrapolate estimates for approximately 100 globally occurring species.

3.3 Exciting research from project partners at KAUST will begin analysing legacy cores from the Southern Ocean, using the latest technology looking at historical levels of great whales, their carbon sequestration capabilities, and the carbon storage potential of rebuilding these great whale stocks.
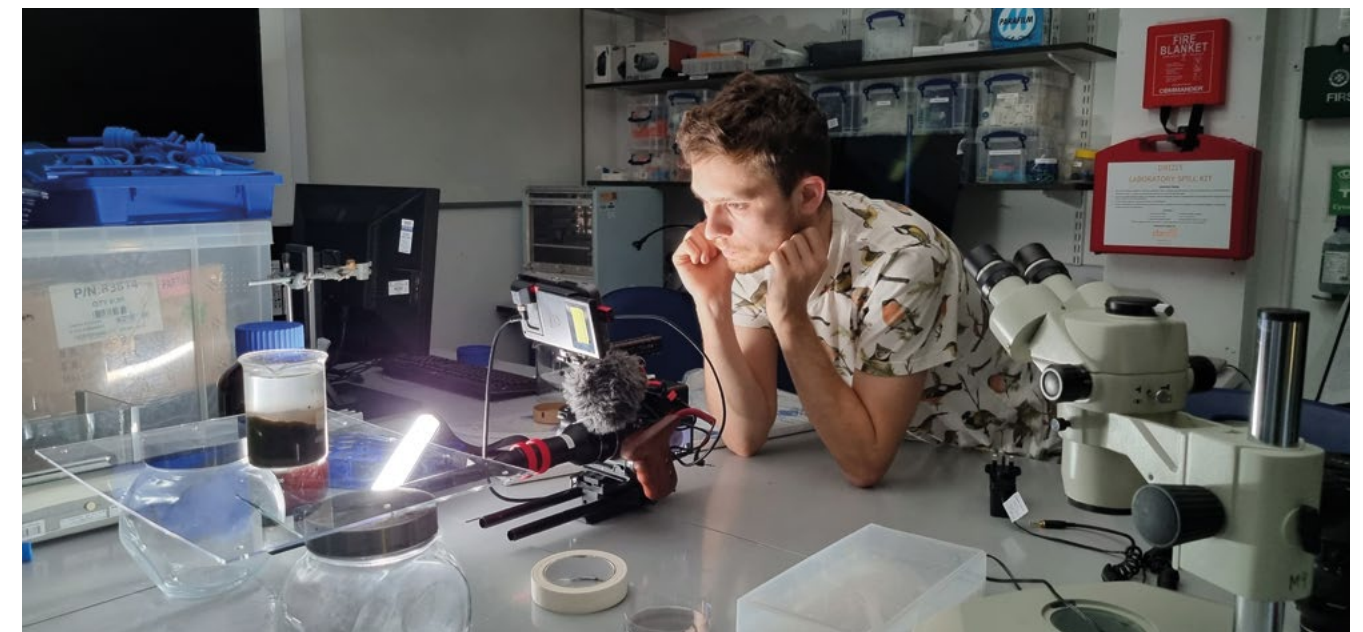
Matt Jarvis, the Project videographer capturing macro photography of benthic invertebrates. **Photo**: Dr Adam Porter

WORK PACKAGE FOUR:

Communication and Education

Workstream Objective: Working closely with Convex's PR resources and Blue Marine's own media connections, we will ensure global press and outreach opportunities are maximised around this exciting and inspiring Convex project.

**Workstream Lead:**
Blue Marine Foundation

Workstream timeline:
April 2022 – June 2027
Q1Q20

Workstream budget:
$ 2,250,000

A baleen whale can absorb as much as 33 tonnes of carbon dioxide in its lifetime.
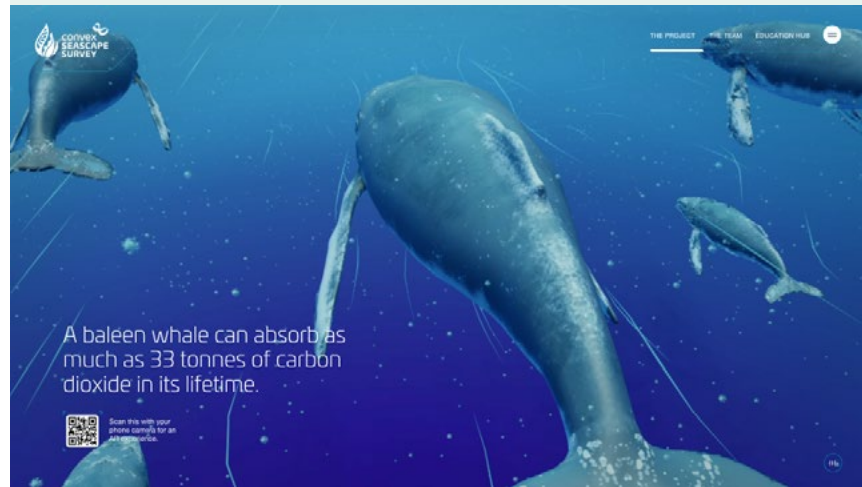
Key achievements for the year

- The ocean carbon cycle has appeared in curriculum-linked materials for the first time, to Key Stages 1-4 within the first year of Convex Seascape Survey Education series "Ocean & Climate".

- Live lessons launched on key environmental days, such as International Women and Girls in Science Day, British Science Week and Earth Day.

- Phase 1 of the digital platform (new website) taking users on a journey of the ocean carbon cycle has been designed and is now in development for launch in early July 2023.

- Promotion of real world science and climate challenges as part of a suite of live lessons, watched by over 175 thousand students and school children in the first year of project delivery.

- Women and Girls in Science showcase as part of International Women's Day and International Women and Girls in Science Day. Assets produced: 1 x educational live lesson interviewing two scientists from the project, a social media campaign

(including reels and stories) and a film for our YouTube channel.

- YouTube channel launches with films including: "Science Deep Dive", "Educational Series", Science Away Day film and "Meet the Scientist".

- Social media channels launched [April 2022], now with over 100K hits.

- Physical participation at key world events with a live audience of 36,000 and online audience of more than 12m (incl. COP27 and World Ocean Summit & Expo Lisbon).

- Engagement with two press partners, Al Jazeera and Sky TV. Al Jazeera broadcasting on the Project 26 May 2023 (Al Jazeera digital reach 1.2bn and TV reach 430m.)

- Two episodes of the Convex Podcast Series have been recorded with the University of Exeter's Professor Callum Roberts and Blue Marine Founder George Duffield.

Introducing the Convex Seascape Survey.
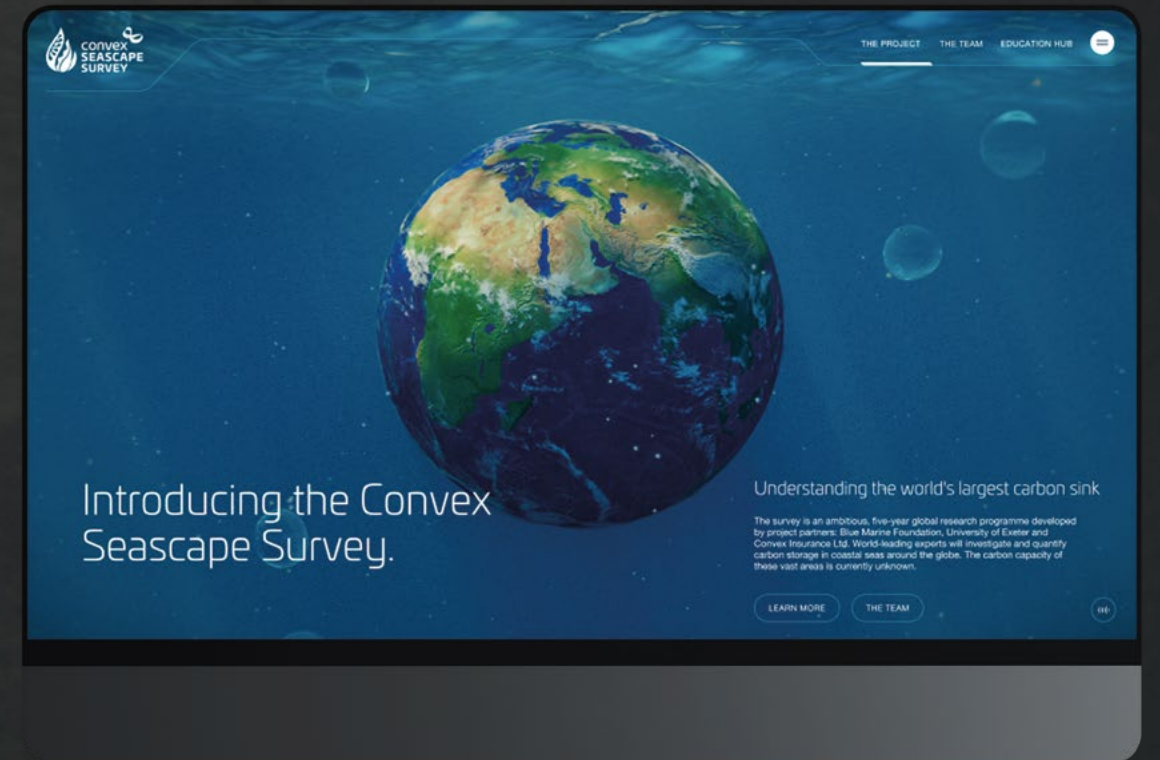
Above: The new Project website is in development with Unseen Studios, and this image captures a recent development grab.

CONVEX SEASCAPE MEDIA FEEDS

FACEBOOK
145000
IMPRESSIONS
2400
ENGAGEMENT
2700
FOLLOWERS

INSTAGRAM
19000
IMPRESSIONS
202
FOLLOWERS

TWITTER
23000
IMPRESSIONS
477
ENGAGEMENT
134
FOLLOWERS

LINKEDIN
21000
IMPRESSIONS
113
ENGAGEMENT
268
FOLLOWERS

YOUTUBE
527
IMPRESSIONS
11
FOLLOWERS

WEBSITE
3600
VIEWS
1938
NEW USERS

SOCIALS
40,000
IMPRESSIONS
1600
ENGAGEMENT

SOCIALS
73207**
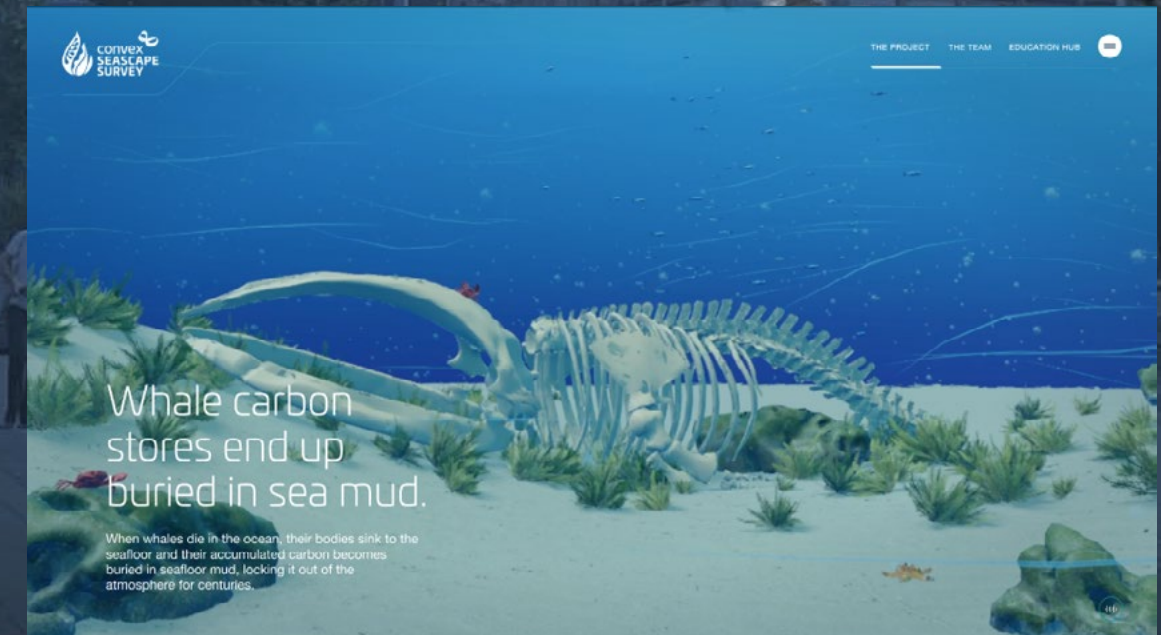IMPRESSIONS
1419
ENGAGEMENT

Key challenges

Challenge	Mitigation
Newsworthiness in early stages of the project	Linking press releases to key calendar dates like 'Women in Ocean Science.' Creating lighter media pieces of interest – Great British Bioturbation-athon
Range of expertise required to deliver the workstream is incredibly broad	We plan to increase capacity to the Project Team by bringing more involvement from the wider Blue Marine Communication and Education Team to help deliver the Project. We are building suite of experienced freelancers to deliver certain aspects of the Project, such as film, podcasts and social media.
Seascape and sediment carbon is a challenge to make glamorous or photogenic and to reach public hearts and minds, with the added practical consideration that stirring sediment up for study, can make image capture incredibly difficult	We are bringing the latest visualisation techniques such as mixed reality and CGI to bring the Project to public consciousness. We are exploring with artists and potential public engagement partners, new ways to bring the Project to public attention.

LOOKING AHEAD TO YEAR TWO

4.1 Continuing strategic development of the Project social media campaign to reach more viewers for Year 2, with campaigns created around international events such as: AR whale experience #WalkWithWhales in partnership with the wider Blue Marine Foundation communication team around World Ocean Day in June.

4.1 Whilst we wait for results that may be newsworthy, we will develop new novel ways of bringing the project to the widest audience possible, with public engagement partnerships in development with high-profile partners in the art and the science communication worlds. For World Ocean Day 2023 we are planning a live AR experience in London, showcasing Humpback Whales with the story of how they are important for the cycling of carbon from the ocean surface to the seafloor.

4.2 The new Project digital platform will launch in July 2023, featuring the latest techniques in computer generated imagery and augmented reality. Phase 1 of the new website will focus on the context to the Project and take viewers on the story of seascape and sediment carbon. Development will start immediately for the next two phases of the platform, which will focus on the Project locations and methodologies (launch 2024) and finally on the data collection and results (launch 2025.)

4.3 We will continue to work towards our goal of reaching five million school students over the

course of the project and of providing the highest quality and most engaging educational materials around the themes of blue carbon, the Project and pioneering scientific research. We look forward to broadcasting the live lessons with partners and from locations around the world in year 2, with lesson themes planned such as 'How do we know about climate change?' (April 2023), 'The Whale Pump and Carbon Cycling' (June 2023). Planned themes for year 2 of the programme will surround the expedition locations, and science being conducted.

4.4 We will continue to showcase the project to world-leading broadcast and press partners, with a view to securing further partnerships following the Al Jazeera broadcast, plus communication and PR from the Great Bioturbation-athon (including Instagram Live.)

4.5 Continued presentation of the Project on the world stage, with PR in the planning for COP28 in the UAE December 2023 and the team being invited to join the planning committee for the 2024 Economist World Ocean Summit.

4.5 We are being approached to set up a series of 'seascape carbon' best practice workshops with others working in the field and will look to arrange seminars on the topic for 2024/25.

"The new Project digital platform will be launch in July 2023, featuring the latest techniques in computer generated imagery and augmented reality"

Whale carbon stores end up buried in sea mud.

When whales die in the ocean, their bodies sink to the seafloor and their accumulated carbon becomes buried in seafloor mud, locking it out of the atmosphere for centuries.

Project Financial Summary

EXPENDITURE SUMMARY	
Inception to Date: Funded Contribution	$3,834,784
Inception to Date: Planned Expenditure	$1,318,297
Inception to Date: Actual Expenditure	$1,349,579
Projected Spend to next payment date	$1,013,075
Projected Spend to next payment date + 3M Buffer	$2,204,912
% Actual Spend of Funded Contribution	35%
% Actual + Projected Spend of Funded Contribution	62%
% Actual + Projected Spend of Funded Contribution + 3M Buffer	93%
Next payment date	6/1/2023
Next payment amount	$1,455,020

EXCHANGE RATE	
Calculations to USD based on budgeted rate of 1.4 USD to 1 GBP	
Actual average exchange rate achieved	1.23903
FX Gains/(Losses) held for future allocation (Y3)	£355,856

Work Package	Inception to Date Actual Expenditure	Inception to Date Planned Expenditure	Current Quarter Actual Expenditure	Current Quarter Planned Expenditure	% Spend to Date vs Planned Expenditure	Projected Spend to next payment date	Commentary Notes
WP1	84,036	74,448	70,823	61,235	113%	74,357	
WP2	57,834	53,949	52,241	48,356	107%	113,608	
WP3	82,538	96,335	51,042	64,840	86%	75,292	
WP4	331,362	364,538	155,085	65,450	91%	279,236	
CrossProg.	84,709	700	84,709	700	12101%	192,550	Carbon analyser system procured ahead of schedule
Uni Mgmt	440,802	443,121	172,046	174,367	99%	190,516	
Grant Mgmt	268,297	285,207	80,142	78,652	94%	87,514	
TOTAL	1,349,579	1,318,297	666,089	493,599	102%	1,013,075	

WEST WITTERING
Olly Williams

~Mud.

Cloying, lead us
Skirt stunted, salty
Oaks, onto strand

Of sand. The dunes leading
Into light. Fragile razor
Grasses swaying,

The wind warm.
Air clean. Here we stripped and
Ran- tide in.

Over rippled ridges,
Ropes of lush seaweed
And tiny shells

Avoiding pebbles, splashing
Waist deep, rubbing mud.
Exfoliating, unaware

That in our happy hands
We held sea's secret;
A sacred sludge that captures,

Transforms the dead,
Cleanses air, oxygenates,
Regenerates. Most misunderstood.

Mud~
Last chance, to preserve
All life on earth.

2023/24 OBJECTIVES

Support further presentation of the project on the global stage

Communicate the context and objectives of Convex Seascape Survey to Convex partnership communities

Increase education and communication reach

Finalising of overseas partners and pristine sites for sampling

Start of field and expedition sampling

Design of modular carbon sampling package that will be deployed to two overseas partners, building capacity in scientific institutions in the developing world

First project papers published

Ongoing development of a map of the human disturbance activities of the seabed over the past 250 years

PROGRESS TIMELINE

2023

2024

May 2023

Seabed disturbance experiment near Plymouth Sound, UK

10 May Project Launch Event, Fishmongers Hall

July 2023

25 July New Project website goes live

November 2023

14 Nov SteerCo Meeting, Convex, London

30 Nov 12 Dec 2023 COP28, UAE

February 2024

OceanX cruise to Indonesia with Project coring equipment onboard

April 2023

28 April 8 May Great British Bioturbation-athon, Millport Field Studies Centre, Scotland

28-29 April Al Jazeera filming on board sampling, Millport

June 2023

8 June World Ocean Day Project art and education showcase

13 June SteerCo Meeting, Convex, London

19 June Project Advisory Board Meeting, London

29 June Convex Town Hall Meeting, Project showcase

September 2023

7 Sep Project presented in keynote for British Science Festival, Exeter

10 Sep Mud & Mixology event for British Science Festival, Exeter

14 Sep SteerCo Meeting, Convex, London

December 2023

Project Advisory Board Meeting, London

March 2024

11-13 March 2024 11th World Ocean Summit, Lisbon

APPENDIX

WORK PACKAGE 1

Task	Leads	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Task 1.1: Data mining and synthesis-mapping of seabed topography, carbon accommodation space and prior sampling effort	● James Scourse ● Sophie Ward ● Sarah Bradley	In progress				
Task 1.2: Oceanographic modelling to predict carbon accumulation-hydrographic model development and application	● James Scourse ● Sophie Ward	In progress				
Task 1.2: Oceanographic modelling to predict carbon accumulation-verification and refinement of hydrographic models of carbon burial based on field sample analyses	● James Scourse ● Sophie Ward			Not yet started		
Task 1.2: Oceanographic modelling to predict carbon accumulation-projection of changes in carbon burial under future sea level rise	● James Scourse ● Sophie Ward				Not yet started	
Task 1.3: Fieldwork – Identification of field sample sites and international project partners	● James Scourse ● Sophie Ward ● Sarah Bradley ● Zoe Roseby	In progress				
Task 1.3: Fieldwork – Collection of fresh core samples to verify insights from models and data mining, and resampling of previously collected cores kept in collections worldwide	● James Scourse ● Sophie Ward ● Sarah Bradley ● Zoe Roseby		Not yet started			
Task 1.4: Tracing the origins of blue carbon inputs to the seabed carbon sink. Analyses of samples for content and origin of buried carbon and testing	● Dan Charman ● Rod Wilson ● Tom Roland ● Jack Middelburg ● Carlos Duarte		Not yet started			
Task 1.5: Placing sediment carbon into context of global carbon – data mining to identify three shelf seas to develop and apply an existing carbon budget model to	● Jamie Shutler		Complete			
Task 1.5: Placing sediment carbon into context of global carbon-development of carbon budget models for the three identified shelf seas	● Jamie Shutler		Not yet started			

● University of Sheffield
● University of Utrecht
● University of Exeter
● KAUST (King Abdullah University of Science and Technology
● Bangor University

Complete   In progress   Not yet started

Milestone/ Goal	Activities completed towards milestone	Milestone changes
Task 1.1: Data mining and synthesis- mapping of seabed topography, carbon accommodation space and prior sampling effort	• Researchers at the universities of Exeter, Bangor and Sheffield have made good progress in the task of mapping seabed topography to understand carbon accommodation space and predict carbon accumulation. • Models produced by High Performance Computers are producing predictions of paleontography across the major continental shelves over the last glacial cycle. • Project Post Doctoral Researcher (PDRA), Dr Zoe Roseby onboarded to the data mining, modelling and fieldwork tasks 1.1-1.3.	
Task 1.2: Oceanographic modelling to predict carbon accumulation. Hydrographic model development and application	• Information from task 1.1 is being fed into hydrodynamic models to understand ocean currents and how they have changed over the course of thousands of years, which in turn allows prediction of where carbon is likely to have accumulated. • Ultimately the models will fit together with paleotopographic and hydrodynamic models (tasks 1.1), helping to build a picture of potential key areas of carbon accumulation from the past, and indications of historical conditions during accumulation. Tasks 1.3 and 1.5 (across continental shelf surface flow simulations using existing satellite data) focus on carbon disturbance and the role of current environmental factors in deposition, and ultimately, the conditions needed for keeping it there. Together these models are combined to inform where fieldwork will take place to further test and refine model accuracy and any data gaps that need to be filled with the collection of new samples.	
Task 1.3: Fieldwork Identification of field sample sites and international project partners	• Early sites of sampling interest have been identified as: the Celtic Deep (Western Irish Sea mud bank, the Sunda shelf in South East Asia, Patagonian shelf, the Congo fan, the South African shelf (shared sampling with Task 3.1) and the Indus delta. • A local partnership to increase carbon expertise is in development with Centro Austral de Investigaciones Científicas (CADICCONICET), Argentina.	
Task 1.3: Fieldwork – Collection of fresh core samples to verify insights from models and data mining, and resampling of previously collected cores kept in collections worldwide	• The due diligence process has identified local collaboration in certain areas of interest such as the Indus delta, the Sunda shelf and the Congo Basin as unlikely to be suitable for this project. • 'Ships of opportunity' proposal change to access sampling in these regions and to gain additional new samples more generally via research cruises that are already happening in these areas. CSS would place a researcher onboard and pay for sample logistics, rather than commission a full cruise. • A place has been secured for PDRA Zoe Roseby onboard a cruise to the Irish Sea, allowing us to sample the mud belt via the University College Dublin *Quest* project. • Proposals to the Natural Environment Research Council general cruises of interest, and Schmidt Ocean Research Vessel *Falkor* underway.	Transfer budget to access sampling in certain space- identified regions via ships of opportunity rather than via formal partnerships with local institutions. Whilst local organisations are often willing to collaborate, they can lack the infrastructure to support the project in the timeline or with the degree of accuracy needed. International commercial and research ships already working in these areas have permits.
		to sample in international waters already granted, and often have capability to analyse samples onboard. This circumvents the need to send samples through certain political regions and reduces risk of compromising sample and analysis quality.
Task 1.4: Tracing the origins of blue carbon inputs to the seabed carbon sink Analyses of samples for content and origin of buried carbon and testing		A state of the art Carbon Analyser has been procured for Penryn campus. This will improve project scientists' access to timely and high specification sample analytical capabilities. Installation completion for July 2023.
Task 1.5: Placing sediment carbon into context of global carbon. Data mining to identify three shelf seas to develop and apply an existing carbon budget model to	• The University of Exeter team working to estimate the balance between carbon uptake and release by the ocean in particular shelf sea regions have produced the first global assessment predictions of across continental shelf surface flows using a satellite observation based reanalysis. These results will provide evidence for the strength and variation of shelf carbon export processes. This information will feed into the regional shelf sea carbon budgets that we will use to identify the importance of shelf sea sediment carbon storage across the globe. • Project Post Doctoral Researcher, Dr Dan Ford onboarded for task 1.5. • Manuscript produced on 'across shelf carbon flows' for internal review and submission for publication in July 2023. • The team have also identified four shelf sea regions of most interest for this baseline assessment: the European Shelf, Patagonian shelf, Tasmanian shelf and the mid/south Atlantic Bight. They will produce detailed carbon budgets for these four areas. They are now working to identify appropriate repository data that can be used for these baseline assessments and whether further fieldwork conducted by project colleagues e.g. identified local collaborators in Argentina could help to fill data gaps.	

WORK PACKAGE 2

Task	Leads	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Task 2.1: Historical development and spread of human influences on the seabed. Scan of archives and other data sources for evidence of the spread of human influence on continental shelves	● Ruth Thurstan ● Callum Roberts ● Julie Hawkins	In progress	In progress	In progress	In progress	
Task 2.1: Historical development and spread of human influences on the seabed-collation of eyewitness evidence of the unimpacted state of the seabed	● Ruth Thurstan ● Callum Roberts ● Julie Hawkins		Not yet started	Not yet started		
Task 2.1: Historical development and spread of human influences on the seabed-evidence synthesis and mapping	● Ruth Thurstan ● Callum Roberts ● Julie Hawkins				Not yet started	
Task 2.2: Contemporary intensity and distribution of bottom disturbance by human activities-mapping and analyses of satellite data to determine patterns and intensity of fishing gear use and other forms of disturbance	● Kristian Metcalfe		Not yet started	Not yet started	Not yet started	
Task 2.2: Contemporary intensity and distribution of bottom disturbance by human activities-analyses and mapping of overlap in hotspots of vulnerable buried carbon (from Tasks 1.3) and human disturbance of the seabed	● Kristian Metcalfe				Not yet started	Not yet started
Task 2.3: Where are the world's remaining areas of pristine/intact seabed habitat? Design and application of a citizen science programme (Comms/ Outreach)	● Ruth Thurstan ● Callum Roberts ● Julie Hawkins ○ Annabel Kemp ● Blue Marine	In progress	In progress			
Task 2.3: Where are the world's remaining areas of pristine/intact seabed habitat? Identification and verification of seabed habitats in potentially unimpacted sites with Blue Marine Outreach	● Ruth Thurstan ● Callum Roberts ● Julie Hawkins ○ Annabel Kemp ● Blue Marine		Not yet started	Not yet started		
Task 2.4: Viewing the impact of seascape disturbance from space – collation, analysis and mapping of satellite data on sediment disturbing human activities	● Jamie Shutler ○ Dan Ford	In progress	In progress			

Task	Leads	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Task 2.5: Measuring the impact of trawling on sediment and animals from within the water – deployment of a field experiment off Plymouth, UK, to determine the effects of trawling on sediment fauna and biogeochemistry	● Jamie Shutler ● Tim Smyth ● Pennie Lindeque ● Vas Kitidis ● James Fishwick		Not yet started			
Task 2.5: Measuring the impact of trawling on sediment and animals from within the water. Design of a simplified modular sampling programme to deploy internationally to measure effects of seabed disturbance on buried carbon	● Jamie Shutler ● Tim Smyth ● Pennie Lindeque ● Vas Kitidis ● James Fishwick		Not yet started	Not yet started		
Task 2.5: Measuring the impact of trawling on sediment and animals from within the water – identification of international research sites and partners	● Jamie Shutler ● Tim Smyth ● Pennie Lindeque ● Vas Kitidis ● James Fishwick		Not yet started			
Task 2.5: Measuring the impact of trawling on sediment and animals from within the water – deployment and analyses of international field experiments	● Jamie Shutler ● Tim Smyth ● Pennie Lindeque ● Vas Kitidis ● James Fishwick			Not yet started		
Task 2.6: Quantifying the global impact of seascape disturbance on sedimentary and atmospheric carbon. Earth systems models developed to investigate carbon budget for continental shelves and explore role in climate change mitigation.	● Tim Lenton ● Paul Halloran ● Robert Marsh ● Jack Middelburg		Not yet started	Not yet started	Not yet started	Not yet started

● University of Southampton/ National Oceanography Centre
● University of Utrecht
● University of Exeter
● Plymouth Marine Laboratory

Complete In progress Not yet started

Milestone/ Goal	Activities completed towards milestone	Milestone changes
Task 2.1: Historical development and spread of human influences on the seabed. Scan of archives and other data sources for evidence of the spread of human influence on continental shelves	• The literature review and archive investigation needed to understand the historical patterns of human influence on the continental shelves is well underway by the team at the University of Exeter. • The first manuscript describing patterns of human impact in the areas of interest, *'The world was our oyster: Records reveal the vast historical extent of European oyster reef ecosystems'* has been submitted for peer review to the *Journal Ocean Sustainability*. Oyster reefs are a reliable indicator of the spread of bottom disturbing fishing pressure in the past because they were valuable, intensively exploited, and people quickly took note of their loss. • A formal partnership with the University of British Columbia, Quantitative Aquatics and the Sea Around Us Project has been signed, giving researchers access to a multimillion dollar database containing a wealth of fishing and fisheries data across the timescales of interest.	Recruitment challenges have delayed the start of a PDRA, due to start January 2023. This post has now been filled after three rounds of recruitment and will start 1 June 2023. The established team at University of Exeter have begun the investigations in the meantime under the guidance of Dr Ruth Thurstan.
Task 2.3: Where are the world's remaining areas of pristine/intact seabed habitat? Design and application of a citizen science programme	• Work has begun on the citizen science element of the project, which will gather data from both public and industry to identify the last remaining areas of undisturbed seabed worldwide. • Potential industry contacts with access to the seabed and footage data from Remotely Operated Underwater Vehicle, have been extensively researched and a list compiled. • This list is now ready for review with partners Blue Marine and Convex. The campaign to reach these organisations, along with members of the public with information about the seafloor, for example the diving community, is in development with Blue Marine media team and will go live in June 2023.	
Task 2.5: Measuring the impact of trawling on sediment and animals from within the water – deployment of a field experiment off Plymouth, UK, to determine the effects of trawling on sediment fauna and biogeochemistry	• The team at Plymouth Marine Laboratory have collaborated closely with academics across the project to design a trawl experiment that will provide the data needed to understand the processes taking place during seabed disturbing activity, such as trawling and dredging on the continental shelf, specifically the impact of activity on sediment and animals. Water and sediment samples will be collected for analysis and this information will be used to frame the earth systems modelling for task 2.6. • The experiment is in final stages of refinement and was presented to the team on 26th April 2023. • A £3.5m bid has been submitted to the Natural Environment Research Council (Highlight Topic) for additional funding to develop and reproduce this experiment. The process of formulating the bid allowed the research consortium to refine and deepen their thinking on both experimental design and application of data produced.	The experiment was originally planned for April 2023 but will most likely occur in June 2023. This was to ensure refinement of the experiment to best reflect all the sampling interests across the consortium and could still be subject to weather changes once a date is set. The date change will not affect work programme delivery provided the experiment takes place during summer 2023.
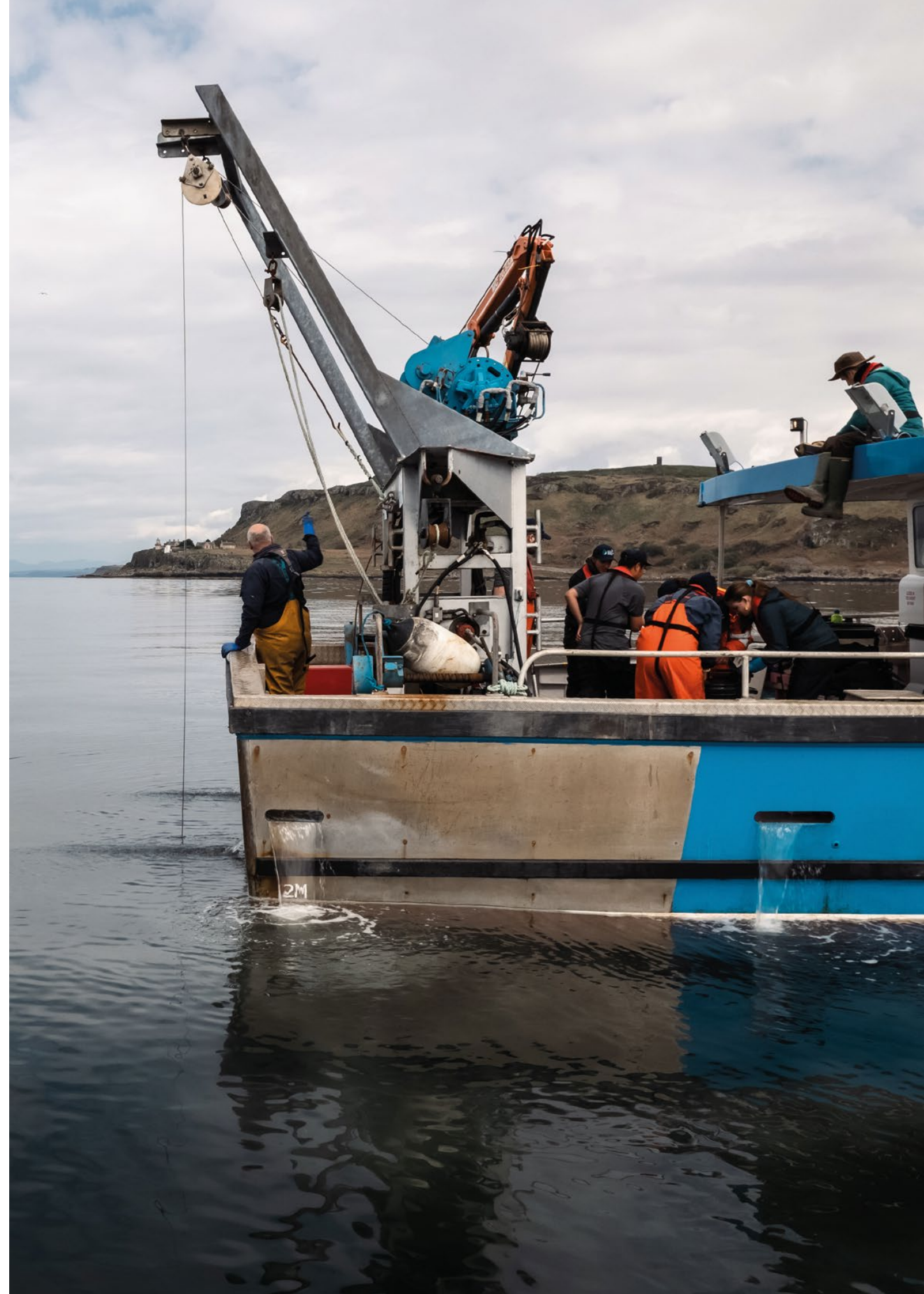
WORK PACKAGE 3

Task	Leads	Milestone				
		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Task 3.1: Monitoring and measuring uptake of carbon by seabed habitats and recovery of carbon stocks after protection. Identification of protected and control sites for field study, and of international research partners for collaboration (sites shared with Task 3.3)	● Callum Roberts ● Ceri Lewis ● Julie Hawkins ● Carlos Duarte				Not yet started	Not yet started
Task 3.1: Monitoring and measuring uptake of carbon by seabed habitats and recovery of carbon stocks after protection. Design of modular sampling programme to evaluate the effects of protection on biota (sampling design shared with Task 3.3)	● Callum Roberts ● Ceri Lewis ● Julie Hawkins ● Carlos Duarte				Not yet started	Not yet started
Task 3.1: Monitoring and measuring uptake of carbon by seabed habitats and recovery of carbon stocks after protection. Field research (sites shared with Task 3.3)	● Callum Roberts ● Ceri Lewis ● Julie Hawkins ● Carlos Duarte			Not yet started	Not yet started	Not yet started
Task 3.2: Laboratory mesocosm experiments. Laboratory mesocosm measurements of the effects of seabed biota on carbon capture and burial	● Ceri Lewis ● Martin Solan ● Jasmin Godbold ● Technician	In progress	In progress	In progress	In progress	
Task 3.2: Laboratory mesocosm experiments. Laboratory mesocosm measurements of the effects of global change processes on seabed carbon capture and burial	● Ceri Lewis ● Martin Solan ● Jasmin Godbold ● Technician			Not yet started	Not yet started	
Task 3.3: Evaluating the co-benefits of seabed protection from human impacts on wildlife and ecosystem services	● Ceri Lewis ● Julie Hawkins ● Carlos Duarte			Not yet started	Not yet started	Not yet started
Task 3.4: Economic values of protection – economic cost benefit analyses of change in ecosystem services under protected vs unprotected vs partially protected management regimes	● Callum Roberts				Not yet started	
Task 3.5: Measuring, monitoring and minimising the project's carbon and environmental footprint	● Jamie Shutler	In progress	In progress	In progress	In progress	In progress

Legend (Leads):
- ● University of Sheffield
- ● University of Southampton/National Oceanography Centre
- ● University of Utrecht
- ● University of Exeter
- ● KAUST (King Abdullah University of Science and Technology
- ● Bangor University
- ● Plymouth Marine Laboratory
- ● Blue Marine Foundation

Status: Complete · In progress · Not yet started

Dr Martin Solan preparing air lines and filtration systems for the bioturbation experiments in Millport, Scotland.
Photo: Matt Jarvis Media

Milestone/ Goal	Activities completed towards milestone
Task 3.1: Identification of protected and control sites for field study, and of international research partners for collaboration (sites shared with Task 3.3)	An initial review of Marine Protected Areas has been undertaken to identify sites for field study, and of international research partners for collaboration. The South African continental shelf has been identified as a site of interest and potential collaborators have been approached. Work is underway to formalise this collaboration and arrange the overseas package including recruitment of a shared PhD student. The team are working on agreements with partners in Western Australia and Jersey to allow data sharing and joint working to understand the benefits of protection from seabed disturbing human influences.
Task 3.1: Design of modular sampling programme to evaluate the effects of protection on biota (sampling design shared with Task 3.3)	Researchers have begun to design Baited Remote Underwater Video System field observations which will be carried out with our overseas partners or from Ships of Opportunity. This will produce data on both seabed and open water biota. Experienced field researcher Dr Ben Harris will join the team in May 2023. His recent expertise monitoring pristine sites in New Zealand will be used to inform field sampling design and the use of high- tech equipment for field monitoring.
Task 3.2: Laboratory mesocosm experiments - Laboratory mesocosm measurements of the effects of seabed biota on carbon capture and burial **Task 3.2:** Laboratory mesocosm experiments - Laboratory mesocosm measurements of the effects of global change processes on seabed carbon capture and burial	Researchers at the universities of Exeter and Southampton have designed and planned the first large scale mesocosm experiment of the project - The Great British Bioturbation-athon. This will provide experimental evidence to understand the contribution of seabed invertebrate fauna to the movement and burial of carbon in shallow muddy ecosystems. The data are central to our understanding of the role biodiversity plays in seascape carbon storage. The team are working with Naomi Hart, artist, on improving science communications around the often overlooked seabed community's important role and they have been selected by the British Science Festival to host an event at the 2023 festival in Exeter in September. In early May 2023 the team completed 2 days of ship sampling, 146 sediment grabs and ten days of lab experiments for the Great British Bioturbation-athon. In this time they recorded and characterised the sediment disturbance function for 20 new species of benthic invertebrates, effectively doubling the number of previously characterised species worldwide.

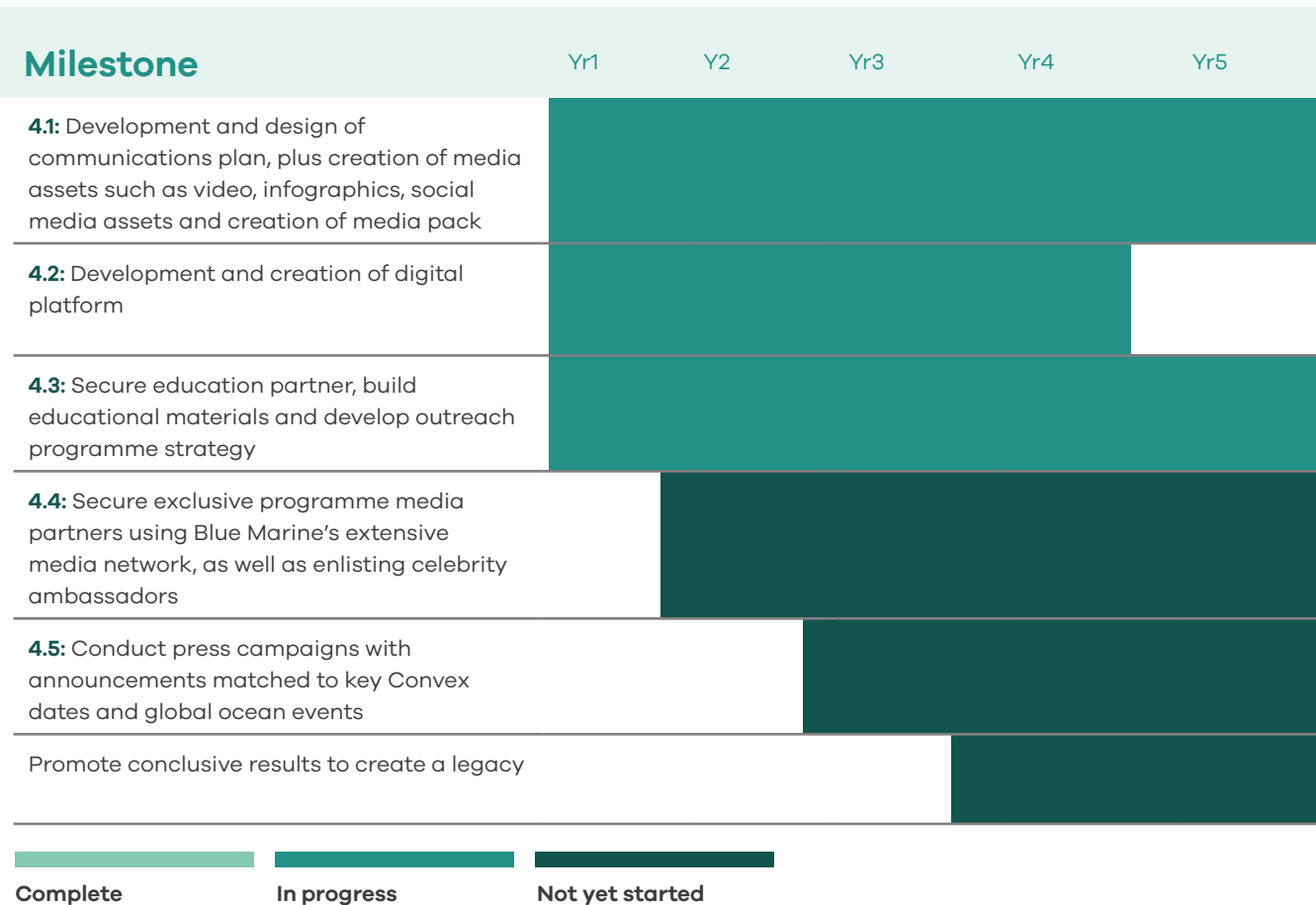| Milestone/ Goal	Activities completed towards milestone
Task 3.3: Evaluating the co-benefits of seabed protection from human impacts on wildlife and ecosystem services	Researchers at KAUST have been designing a research activity on understanding the fate of suspended carbon as well as resolving, by combining pigment, carbon, eDNA and QPCR analyses, the impact of whaling on Southern Ocean productivity and carbon sequestration as a basis to calculate the carbon benefits of rebuilding great whale stocks.
Task 3.5: Measuring, monitoring and minimising the project's carbon and environmental footprint	The Project Team have also begun the task of quantifying and reducing the carbon spend of project activity by producing a lifecycle model to understand projected carbon spend and identify areas where reduction in carbon spend will have the biggest impact. This will inform our decisions about research activity design, especially around field work. At the end of the project, we will be able to assess and compare actual carbon spend. A manuscript examining the general issues around the carbon use in research projects has been completed by Dr Jamie Shutler and is in internal review.

Caption: Dr Adam Porter in the field collecting species which will be used in the bioturbation experiments. **Photo:** Matt Jarvis Media

WORK PACKAGE 4

PROGRESS TOWARDS MILESTONES

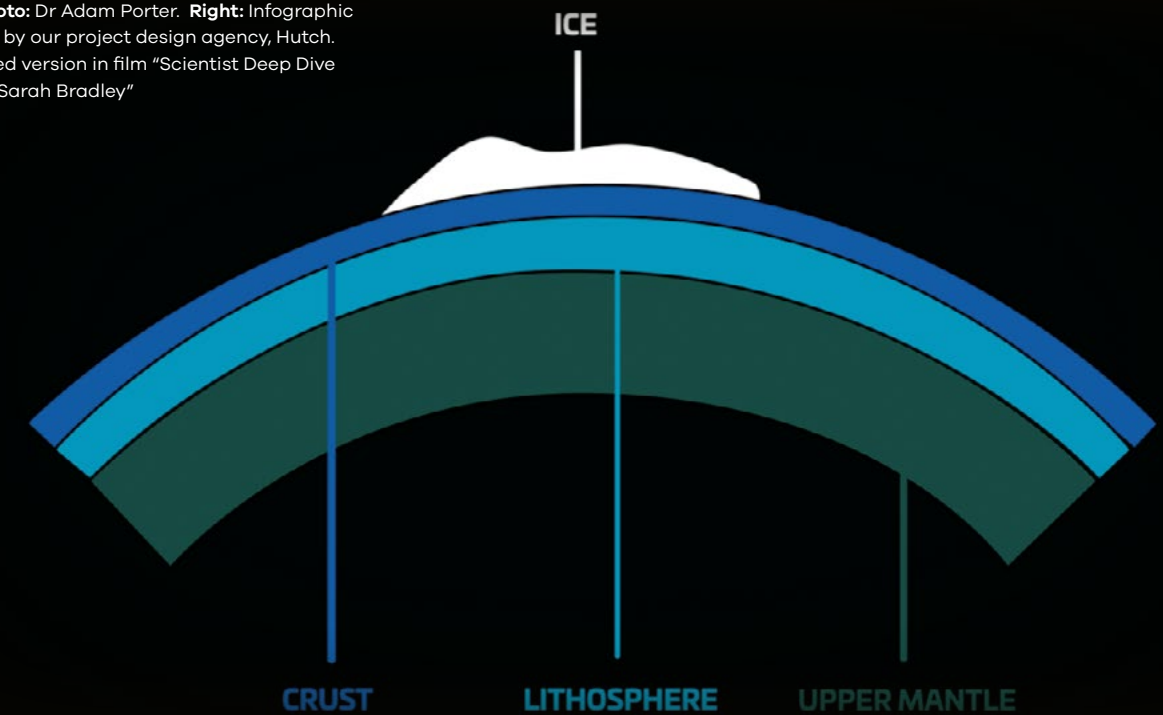| Milestone	Lead 1	Lead 2	Lead 3	Collaborator 1	2
4.1: Development and design of Project Communication Plan, plus creation of media assets such as video, infographics, social media assets and creation of media pack	Jo Coumbe	Elyssa Quinton	Gabriella Gilkes	Alessandra Polo	
4.2: Development and creation of digital platform	Jo Coumbe	Elyssa Quinton	Gabriella Gilkes	Unseen Studio Team	
4.3: Secure education partner, build educational materials and develop outreach programme strategy	Jo Coumbe	Elyssa Quinton	Gabriella Gilkes	Jamie Buchanon	Sophia Lourenco
4.4: Secure exclusive programme media partners using Blue Marine's extensive media network, as well as enlisting celebrity ambassadors	Jo Coumbe	Charles Clover	Elyssa Quinton		
4.5: Conduct press campaigns with announcements matched to key Convex dates and global ocean events	Jo Coumbe	Elyssa Quinton	Gabriella Gilkes	Gabriella Gilkes	
4.6: Promote conclusive results to create a legacy	Jo Coumbe	Elyssa Quinton	Gabriella Gilkes		

Milestone	Yr1	Y2	Yr3	Yr4	Yr5
4.1: Development and design of communications plan, plus creation of media assets such as video, infographics, social media assets and creation of media pack					
4.2: Development and creation of digital platform					
4.3: Secure education partner, build educational materials and develop outreach programme strategy					
4.4: Secure exclusive programme media partners using Blue Marine's extensive media network, as well as enlisting celebrity ambassadors					
4.5: Conduct press campaigns with announcements matched to key Convex dates and global ocean events					
Promote conclusive results to create a legacy					

Complete   In progress   Not yet started

Milestone/ Goal	Activities completed towards milestone	Milestone changes
4.1 Design and development of communications plan	• Nov 2021 Project announced in Bloomberg during COP26 How Much Carbon Can the Oceans Absorb? – (Bloomberg potential reach 36.39m.) • June 2022 Announcement during UN Ocean Conference in Lisbon that a dialogue has been entered with St. Andrews university to include the Project as part of the UN Ocean Decade Blue Carbon Programme. This places the importance of the Programme within the context of global research, lends authenticity and elevates the potential platform for the results. • October 2022 communications plan and social media strategy implemented. • 3 x press releases linked to International Womens' Day, International Women and Girls in Science and on Great British Bioturbation-athon written and distributed. • Marketing materials developed and produced: field kit, vinyl stickers and field equipment magnets. • Resident artist, Naomi Hart, has been recruited onto the team to document the Bioturbation-athon from an artistic perspective.	
4.1 Creation of media assets (incl. social media)	• Dedicated Project social media accounts launched across all major platforms Meta, LinkedIn, YouTube. • A suite of media assets has been produced: 16 reels to be distributed on Project social media, 4 short films which are showcased on Project YouTube channel, a bank of photographs, and infographics produced by Hutch.	
4.2 Creation of digital platform	• Convex Seascape Survey website 1 launched on 8th June 2022. • A suite of digital agency partners interviewed in June 2022 with Unseen Studios, Bristol, selected and onboarded in Nov 2022. • A new look Project website version is in design development, due for launch on 25th July 2023, featuring latest techniques in computer animation and mixed reality features, to bring the story of ocean carbon and the work of the Project to life. • Further phasing of the digital narrative will be released showcasing methodology and results in Y2 and Y4. • A CGI animation of seascape carbon is in production for COP28 in the UAE.	

Milestone/ Goal	Activities completed towards milestone	Milestone changes

4.3: Secure education partner, build educational materials and develop outreach programme strategy	• A suite of potential education partners were interviewed in summer 2022, with EncounterEdu selected and onboarded in November 2022.
	
	• The first year lesson plan including live lesson structures and an overview brief were planned, including goal, structure, and asset list for the first five (a year) of live lessons – to introduce the concept of the ocean carbon cycle and relevance to tackling climate change.
	
	• Ocean & Climate Live 2023 lesson plan:
	
	  1) Women on the frontiers of climate science (broadcasted Fri 10th Feb) **| 1845 students**
	
	  2) Seabed Safari (broadcasted Tue 14th March) **| 12387 students**
	
	  3) How do we know about climate change? (broadcast Tue 18th April) **| 3326 students**
	
	  4) How to teach the carbon cycle (broadcast Wed 17th May)
	
	  5) The whale pump & ocean impacts (broadcast Thu 8th June)
	
	• World Ocean Day 2023 will have a Project Education specific live lesson, and the outreach and communications strategy for Blue Marine will be focused on using the Project whale VR experience, communicating the importance of whales in the ocean carbon cycle.	

4.4: Secure exclusive programme media partners using Blue Marine's extensive media network, as well as enlisting celebrity ambassadors	• Al Jazeera (19M subscribers) have been engaged on the project and will be broadcasting a news report on the Great British Bioturbation-athon in the week of May 10th 2023. • SkyTV have shown interest. • The project has also been presented (as part of a wider suite of Blue Marine activities), to major broadcast players such as Blue Planet III and Netflix documentary series.	• Interest from Silverback Productions to partner on Plymouth trawling experiments. • Interest from Blue Planet III producers • *Ocean X* and Project media team collaboration
4.5: Conduct press campaigns with announcements matched to key Convex dates and global ocean events	• Press campaign around the Great British Bioturbation-athon. Dates of release to be confirmed.	

Above: The media team, Elyssa Quinton and Matt Jarvis, getting creative and interviewing Dr Ceri Lewis for International Women and Girls in Science Day. **Photo:** Dr Adam Porter. **Right:** Infographic created by our project design agency, Hutch. Animated version in film "Scientist Deep Dive with Dr Sarah Bradley"

ICE

CRUST   LITHOSPHERE   UPPER MANTLE