convex SEASCAPE SURVEY

Annual Report Year Two

APRIL 2023 – MARCH 2024

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FOREWORD

by **Stephen Catlin**

As we reflect on the second year of the Convex Seascape Survey, we stand at an intersection of knowledge, progress, and challenge. Our journey has taken us deeper into the enigmatic world beneath the ocean's surface, revealing invaluable insights about the role of the seascape in carbon storage and how this could help mitigate climate change.

The work of the project this year has been expansive and multi-faceted, developing pioneering technologies, and fostering global partnerships. The collective effort of a team of over a hundred experts, across more than 20 institutions in nine countries has been instrumental in the progression of this ambitious, five-year global research endeavour.

This year, we have significantly advanced our understanding of the ocean's function as a carbon sink, improving our knowledge of how the ocean and the atmosphere interact in transferring carbon dioxide. The scientists, led by University of Exeter, have undertaken a series of field trips to examine the role of animal life above and within the seabed and the carbon they lock away. The expeditions also looked at protected seabeds to discover whether removal of human seabed disturbance influences its ability to store carbon.

Developing the use of technology is an essential tool in the project; we have built global science base lines using tech and data to model and map ocean based carbon storage through time.

"This year, we have significantly advanced our understanding of the ocean's function as a carbon sink, improving our knowledge of how the ocean and the atmosphere interact in transferring carbon dioxide."

Such progress, however, has not been without challenges. As we delve deeper into the study of blue carbon, the complexity of the issues we face intensifies. Nonetheless, the need for robust, comprehensive science remains paramount.

As we look to the future, our mission is not solely centred on scientific discovery. We aim to educate and inspire, fostering greater understanding and appreciation of the ocean's immense value. The pursuit of verifiable data accessible to all, coupled with innovative ways to educate and communicate is opening doors to audiences never before reached by ocean science.

The Convex Seascape Survey is more than just a research programme; it is a testament to the power of collaboration, innovation, and perseverance in the face of global challenges. I am deeply proud of what we have achieved so far and am excited about the discoveries that lie ahead.

Our journey continues, and I invite you to join us as we delve deeper into unlocking the secrets of the seascape and its role in the fight against climate change. Together, we can make informed decisions on ocean use and contribute significantly to the world's understanding of ocean based carbon.

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 a vital 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 them sea in the fight against climate change.

SEA AROUND US
FISHERIES, ECOSYSTEMS & BIODIVERSITY

THE UNIVERSITY OF BRITISH COLUMBIA

OCEANX

NORTH ATLANTIC OCEAN

Universiteit Utrecht

COAST

Encounter Edu

University of Sheffield

PRIFYSGOL BANGOR UNIVERSITY

convex SEASCAPE SURVEY

BLUE MARINE FOUNDATION

University of Exeter

UNIVERSITY OF Southampton

CMS GeoScience

PML Plymouth Marine Laboratory

JICAS
JERSEY INTERNATIONAL CENTRE OF ADVANCED STUDIES

Q-quatics

NORTH PACIFIC OCEAN

جامعة الملك عبدالله للعلوم والتقنية
King Abdullah University of Science and Technology

OCEANX

SOUTH ATLANTIC OCEAN

INDIAN OCEAN

NELSON MANDELA UNIVERSITY

THE UNIVERSITY OF WESTERN AUSTRALIA

BlueAbacus

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.

The historical impact and spread of human influences on the seabed.

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 and benefits of protection.

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 SEASCAPE 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, EDUCATION AND OUTREACH

Communicating and helping the 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:

TIMELINE OF PROGRESS SINCE INCEPTION

July 2022

Website and social media platforms launch

October 2022

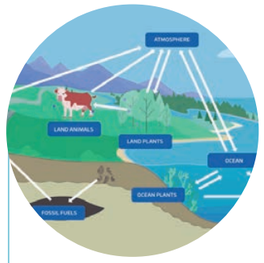
Education and digital partners onboard

November 2022

Project presented at COP27, SharmElSheik

April 2022

official project start and project team onboard



January 2023

Release of education materials and resources

February 2023

First Advisory Group meeting

Science Strategy Days

Project presented at World Ocean Summit, Lisbon

Live lesson: 'Women on the frontiers of climate science'

Live Lesson: 'Seabed Safari'

April 2023

Live lesson: 'Women on the frontiers of climate science'

Live Lesson: 'How do we know about climate change'

Live Lesson: 'How to teach the carbon cycle'

May 2023

Fieldwork in Millport, Scotland | Aljazeera press coverage on bioturbation-athon

June 2023

Dive press articles promoting citizen science, Live Lesson: 'Whales, carbon & climate'

#WalkWithWhales augmented reality filter

Advisory Group meeting.

July 2023

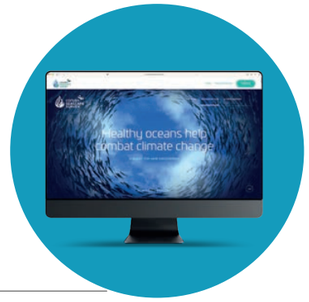
Naomi Hart's Sea Mud Magic Art Trail in Exeter

September 2023

Fieldwork on the Isle of Arran

Presentation and event British Science Festival

October 2023

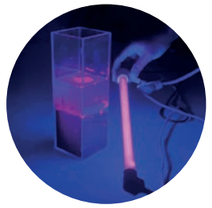


Digital Experience launched

Project-linked art workshops lead by Naomi Hart

November 2023

Chris Levine showcase two-day tour Southampton Uni to Exeter Penryn



December 2023

Project presented at COP28, United Arab Emirates | Live Lesson: 'COP28 Review & Q&A'

January 2024

Arran expedition film released

Press article in ECO magazine

Launch of Seabed piece by Naomi Hart

February 2024

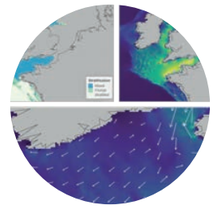
Project Away Days in Windsor

March 2024

Project presented at World Ocean Summit, Lisbon

Live Lesson 'Time to heal the sea'

Live Lesson: 'Time to rewild the ocean'



April 2024

Interactive data tool PALTIDE published

Project poster exhibited at UN Ocean Decade conference

Press article in The Sunday Times

Project presented at Out of the Blue event

EXECUTIVE SUMMARY

As the second year of the Convex Seascape Survey draws to a close, the many threads of our multidisciplinary research are beginning to weave together with gathering momentum. Our academics bring expertise from many fields, enabling the project to cross boundaries between disciplines - an important approach to science given the interconnected nature of the seascape.

Scientific Milestones

- Launching cutting-edge data app PALTIDE, our modellers brought to life the history of the northwest European continental shelf sea, from the Last Glacial Maximum (21,000 years ago) to the present day. Users can pinpoint a moment or location in ocean history, visualising and interrogating datasets on relative sea level and tidal patterns, to help resolve many complex earth system questions.
- We successfully estimated the air-sea CO2 flux for four major continental shelves, greatly improving understanding of how the ocean and atmosphere interact. Our analyses showed each to be highly distinctive, with the Patagonian shelf revealed to be the strongest, increasingly acting as a carbon sink.
- We conceptualised a novel rig system for experiments collecting empirical data on carbon dynamics at the sediment-water interface during a trawling event. Furthermore, Convex Seascape Survey is now a collaborating partner on new NERC funded project C-FLOOR, which will further expand on this line of research.
- A field expedition was completed on the Isle of Arran, off the Scottish west coast, where we investigated the crucial question of whether a healthy seascape stores more carbon than a degraded one. Working with the Community of Arran Seabed Trust (COAST) the team sampled across a gradient of seafloor habitats, from sites frequently disturbed by mobile fishing gear, to areas un-impacted thanks to protection.
- We're gaining unique insights as the data from the Great-British Bioturbation-athon is analysed to quantify the role of seafloor creatures in transporting carbon and nutrients from the water column into the sediments. We characterised bioturbation rates for 19 additional species, adding to the previous global total of 26. Several research papers are in preparation and will soon be submitted for peer review.

> "Our academics bring expertise from many fields, enabling the project to cross boundaries between disciplines - an important approach to science given the interconnected nature of the seascape."

With all these investigations, we are incrementally adding to the evidence base, demonstrating how we can maximize the ocean's ability to lock away carbon dioxide. The information gathered will underpin current thinking on nature-based climate mitigation and could inform future policy in this arena. Another fundamental ambition for the survey is to ensure the knowledge generated is publicised and makes an impact on the world-stage, ultimately available to guide decision makers in sustainable ocean management. Project visibility reached new heights this year through our strategic use of innovative communications techniques.

Outreach Achievements

- Our digital asset #WalkWithWhales reached millions of people after its release on World Ocean Day in June 2023 and later in the year, we launched a unique website experience which introduces the project and takes viewers on an immersive journey exploring seascape carbon.
- Expanding our art-science collaborations, we worked on new projects with multimedia artist extraordinaire Naomi Hart and world-renowned light artist Chris Levine, bringing our discoveries to new audiences.
- We produced two beautiful short films on key pieces of fieldwork which spotlight the incredible people working behind the scenes on the survey and collected a bank of photography for use on our website and in press.
- Press interest in the survey has accelerated, with more than 25 press articles published in print and online, including top tier media outlets such as The Sunday Times and Forbes.
- We continue to build awareness and cross platform social media growth stood at 77% over the last 12 months, taking the projects channels to over 5,500 followers.
- New learning resources were added to our bespoke education programme and total student reach is nearing 400,000, with a high volume of downloads across all materials.

The report that follows shows our progress across the major programme pillars in the second 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.

IMPACT

SOCIAL MEDIA

2,338,791
IMPRESSIONS

847,412
REACH

77%
FOLLOWER INCREASE

4.9m
PEOPLE REACHED WITH THE AUGMENTED REALITY FILTER #WALKWITHWHALES

PRESS

9 ARTICLES WITH A TOTAL REACH OF

42,495

STAND OUT RESOURCES:

CARBON CYCLE QUIZ - **4,703 VIEWS**

CARBON CYCLE INTERACTIVE (INTERMEDIATE) - **7,522 VIEWS**

OUTREACH

Presentations, Panels Sessions & Posters

129,000+ Attendees

Out of the Blue, UK | Brilliant Minds 2023, Denmark | Convex Town Hall, UK | Urbanization, Water & Food Security Conference, Tuscany | British Science Festival, UK | The Times Earth Summit, UK | COP28, United Arab Emirates | NERC BIO-Carbon 2024, UK | The Role of Seabed Mapping in Ocean Science, UK | World Ocean Summit & Expo 2024, Lisbon | Marine Studies Group Shackleton Conference, UK | Shelf Sea Oceanography Workshop, UK | Ocean Salinity Workshop at the European Space Agency, The Netherlands | ICESFOA Working Group on Fishing Technology and Fish Behaviour, Canada | UN Ocean Decade Conference, Spain | EGU Geoscience Conference, Austria

EDUCATION

TOTAL POTENTIAL REACH

381,010

Education materials utilised by 768 teachers from 541 schools in 34 countries

(Andorra, Australia, Bermuda, Canada, Costa Rica, Ecuador, Georgia, Greece, Guernsey, India, Ireland, Isle of Man, Italy, Jersey, Kenya, Lithuania, Macedonia, Malaysia, Malawi, Maldives, Mexico, New Zealand, Nigeria, Norway, Philippines, Poland, Portugal, Qatar, Romania, Spain, Thailand, UAE, UK, and USA)

3 X LIVE LESSONS
VIEWED BY
15,000
STUDENTS

TESTIMONIALS

The Ocean & Climate resource provides an excellent starting point for ocean literacy education. Its strengths in scientific accuracy, engaging content, age-appropriate materials, and practical applications make it a valuable tool for educators across the junior, middle and high school grade bands.

Jae Williams, Canadian Ocean Literacy Coalition

I really love the way lessons are set up and live lessons, we need more!!

Ceri Cowley, home educator

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

Blue Marine manages an Advisory Group to provide strategic guidance over the lifetime of the Convex Seascape Survey. This includes members; authenticating the science, sharing their knowledge and networks, as well as providing advice to identify any gaps, shifts, new research, technologies or collaborations, that the research and project teams may need to consider. They will also be informing an up-coming mid-term review to be completed by Blue Marine in the coming year.

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 supporter and oversight. 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.	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

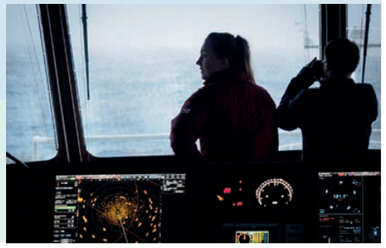
WORK PACKAGE ONE:

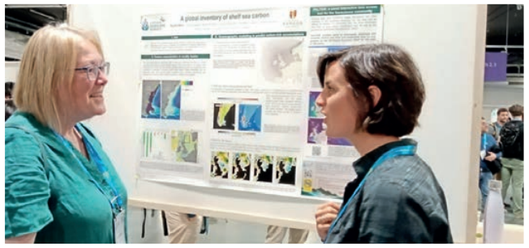
The where, when, how and what of blue carbon burial in the seascape

Workstream Objective: 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 and put their size into context within the global carbon cycle.

Workstream Lead:
University of Exeter

Workstream timeline:
July 2022 – June 2027





Left: Sub-sampling sediment cores. **Photo:** Danny Copeland
Top Right: Dr Zoe Roseby on a coring expedition. **Right:** Dr Sophie Ward presenting a research poster

Key achievements over the year

- Paleoceanographic modelling to predict carbon-rich sediment accumulation is underway, following completion of the global icesheet reconstructions. Of particular interest, we are developing a case study of the Fladen Ground area of the northwest European continental shelf region.
- Our first seabed core sampling was carried out in the Irish Sea as part of University College Dublin's Quest cruise in the Irish Mud Bank and Celtic Deep, helping us verify and refine our computer models of mud accumulation. We have also conducted a data mining exercise to identify existing core sample coverage.
- Completion of air-sea CO2 flux models, represents significant progress towards placing continental shelf carbon within the global carbon budget. These tell us how much carbon is transferred between the ocean and atmosphere interface. Data papers have been published and further data analysis is planned.
- Innovative data tool PALTIDE was published online, enabling users to visualise, interrogate and download datasets on relative sea-level and other tidal parameters for any point on the northwest European continental shelf, at any point in time from the Last Glacial Maximum (21,000 years ago) to the present day.
- Partnership agreement signed with OceanX and research proposal drawn up by researchers from WP1.3 and WP1.4 for sampling in the Pahang coastal waters, Malaysia.

Key challenges

Challenge	Mitigation
Barriers to accessing areas of interest with ships of opportunity due to some country's restrictions on external collaborators.	After a sampling campaign with OceanX in Indonesia stalled, we pivoted to another opportunity for core collection in Malaysia.

Above: Research technician Torsa Sengupta and PhD student Riyad Hossain Bhuiyan extruding a sediment core. **Photo:** Danny Copeland

LOOKING AHEAD TO YEAR THREE

WP1.3 If proposals are approved, OceanX will collect samples from Malaysia's Pahang coastal waters in October 2025, for researchers studying sediment and carbon accumulation rates.

WP1.4 If proposals are approved, OceanX will collect samples in Malaysia's Pahang coastal waters in October 2025 for researchers investigating ecological and human activity gradients and sources of blue carbon in the context of land use changes.

WP1.4 Researchers will visit Jersey to assess the origins of carbon from a series of sediment cores, using environmental DNA. These same methods will be carried out on sediment cores collected from Turkey and the Fladen Ground in the North Sea.

WP1.5 The Patagonian Shelf budget will be completed, providing proof of concept for further carbon budget models for other shelf seas.

WORK PACKAGE TWO:

The historical impact and spread of human influences on the seabed

Workstream Objective: We will uncover historic and contemporary patterns of human influence on shelf sea carbon and determine its vulnerability to re-release into the atmosphere as a consequence of disturbance by bottom-towed fishing.

Workstream Lead:
University of Exeter

Workstream timeline:
April 2022 – June 2027

Below: Fishing boat in the waters around the Isle of Arran, Scotland. **Photo:** Matt Jarvis.

Key achievements for the year

- The differences in design and use of bottom contacting mobile fishing gears have been investigated through a structured literature review, returning 2410 sources of relevant material.
- Access gained to seventy years of data on global historical trawl fishing through collaboration with Sea Around Us, which will be used in spatial models to understand overlap with significant carbon deposits.
- Contemporary distribution and intensity of seafloor disturbance is being mapped using vessel-tracking data derived from automatic identification system (AIS) systems.
- 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 of Ocean Sustainability.
- Rig conceptualised and manufactured for trawl experiment collecting empirical data on carbon through collection of water and sediment samples in Plymouth.
- Extension of the Plymouth experiment with new NERC C-Floor grant which will provide additional evidence on the effects of seafloor disturbance from the fishing industry on seabed carbon stores. Convex Seascape Survey is a collaborating partner, and all parties are waiting for this funding to be officially awarded by NERC so a start-date can be set.

Key challenges

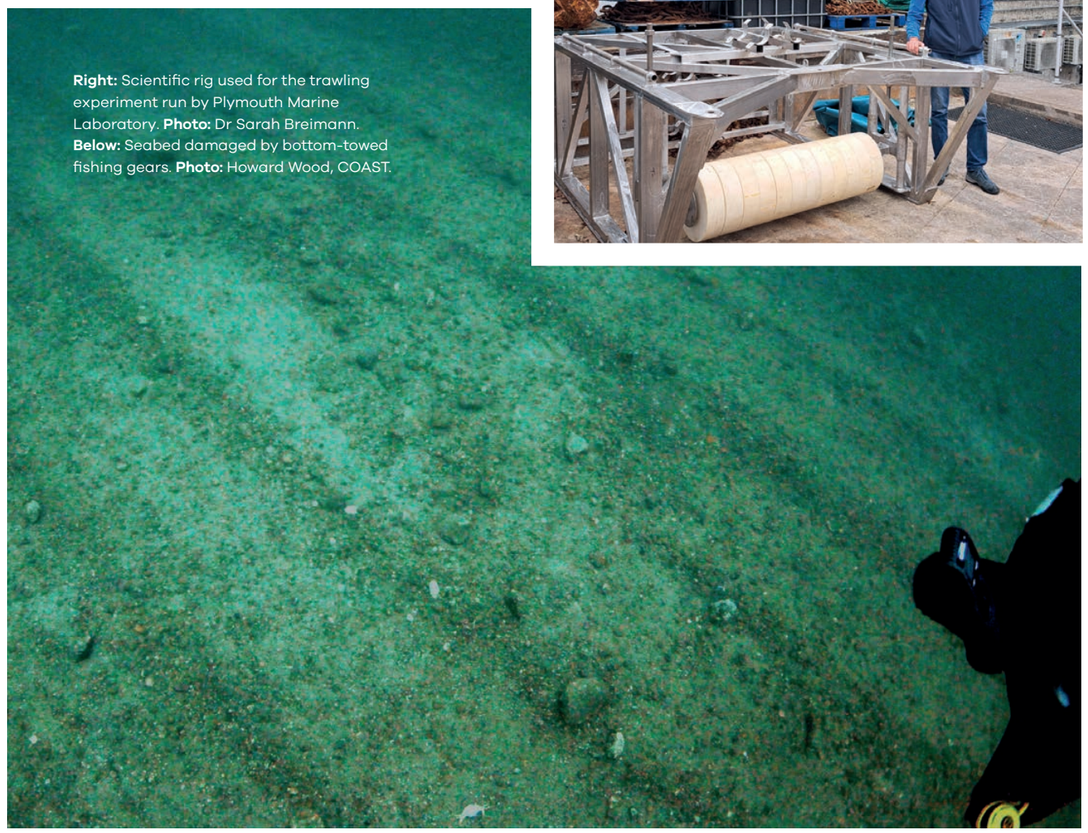
Challenge	Mitigation
Delays to fabrication of sampling equipment for trawling experiment in Plymouth Sound were followed by further logistical constraints and unsuitable weather conditions.	Fieldwork postponed until spring 2024, but with little knock-on effect to other workstreams.

LOOKING AHEAD TO YEAR THREE

2.4 Sunda shelf satellite mapping of seabed disturbance and integration of additional remote sensing techniques into experimental design to test methods.

2.5 There will be further deployment of the rig which collects data on the impacts of trawling on the seabed throughout the summer of 2024. Additionally, this activity will be built upon as part of the NERC funded project (C-FLOOR).

2.6 Work continues to quantify the exchange of atmospheric CO_2 resulting from seabed disturbance to include the effect of key biogeochemical processes in the water column and in the sediments.



Right: Scientific rig used for the trawling experiment run by Plymouth Marine Laboratory. **Photo:** Dr Sarah Breimann. **Below:** Seabed damaged by bottom-towed fishing gears. **Photo:** Howard Wood, COAST.

WORK PACKAGE THREE:

The role of life and biodiversity on seascape carbon stores and benefits of ocean protection

Workstream Objective: Workstream Objective: We will measure how marine life influences carbon burial and storage, how long it takes for carbon uptake to recover when the seabed is protected and quantify the complementary benefits to wildlife and people.

Workstream Lead:
University of Exeter

Workstream timeline:
April 2022 – June 2027

Right: Dr Ceri Lewis during bioturbation experiments in Millport, Scotland

Key achievements for the year

- **Following field and lab experiments in Millport, Scotland and the survey has contributed significantly to global knowledge on sediment mixing by benthic invertebrates, characterising the bioturbation rate of 19 species and adding to the previous total of 26.**
- **Additional bioturbation experiments have been completed at University of Southampton and three papers describing the results of this work are currently in preparation.**
- **Sampling campaign piloted in South Arran, Scotland looking at the effects of protection on seabed carbon has produced preliminary results.**
- **Our partners at KAUST in Saudi Arabia have begun unravelling the role of great whales in ocean productivity and carbon sequestration by analysing cores collected off the Western Antarctic peninsula.**

Key challenges

Challenge	Mitigation
Vibrocore equipment for seabed coring in South Arran, had mechanical faults.	Other data collection completed as planned and Vibrocore returned to the supplier. Experiences from this pilot study will inform future fieldwork campaign plans.
Obtaining permissions and permits for lots of different sampling techniques and collection of biological samples.	Working with local partners to access laboratories in country for sample processing and analysis e.g. New Zealand and Turkey.

LOOKING AHEAD TO YEAR THREE

3.1 Plans are in place to carry out gradients of disturbance sampling throughout the waters of Jersey next month and then further afield in New Zealand later in 2024, across the Hauraki Gulf Cable Protection Area. Collaborators in South Africa will also commence fieldwork later this year and further possible locations are being explored including Turkey, Australia, Denmark

3.3 The team at KAUST will collect further cores during a Southern Ocean cruise scheduled for January 2025 to continue to reconstruct historical changes in carbon storage and explore links with the abundance of great whales. They will couple eDNA with stable isotopes to fingerprint blue carbon sources, alongside coupling eDNA with sediment accumulation chronologies to reveal past biodiversity.

3.5 We will continue to collect data on carbon spend throughout the project activity including for conferences, meeting travel, fieldwork and boat time.

Left: Dr Ben Harris and Mara Fischer manually coring the seabed. **Photo:** Danny Copeland.

WORK PACKAGE FOUR:

Communications, education and outreach

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 project.

Workstream Lead:
Blue Marine Foundation

Workstream timeline:
April 2022 – June 2027

Key achievements for the year

- **Digital asset #WalkWithWhales featured for World Ocean Day, reaching 4.9 million people online and appearing on billboards in major UK cities. Furthermore, a first of its kind digital experience was launched which takes viewers on an immersive journey exploring seascape carbon and fulfilling Phase 1 of the project website.**
- **Presence at conferences with significant audiences and key stakeholders, raised the profile of the survey through a range of events, media showcases and presentations e.g. COP28 in Dubai and World Ocean Summit in Lisbon. At the latter, we hosted a hot ticket dinner, in association with Ocean14. The guestlist included well known oceanographer Syvia Earle, The Commonwealth Office and various high-profile philanthropists.**
- **The Citizen science campaign reached a total of 1.25 million people through a targeted social media campaign and several articles published in the dive press.**
- **Artist in residence, Naomi Hart, led a series of project-linked workshops with refugees local to Exeter and created 'SeaBed' – a bedspread about the bed of the sea. This piece was made from salvaged fabric and this worm-made-of-rags depicts the ragworm, Hediste diversicolor, a common UK species. It is now publicly exhibited at Fish Factory.**
- **Beautiful short film "The first ever study on Arran's seafloor carbon" was hugely well received and quickly became the most watched video on our YouTube channel, alongside other favourites including "Do seafloor creatures affect climate change".**
- **Awareness of the Convex Seascape Survey continues to grow. Cross platform social media growth stood at 77% since the last report taking the projects channels to over 5,500 followers, LinkedIn and Instagram are the platforms where we saw the most growth. The project reached over 890k people across our platforms, with impressions in excess of 2.4 million for year 2.**
- **Press momentum has been building, with more than 25 press articles published this year in print and online, with a total of 166.89 million unique monthly visitors.**
- **Our education partner, EncounterEdu, delivered a thrilling day of activities for more than 60 children at the Convex offices.**
- **We produced three Live Lessons throughout the year, which attracted a large audience totalling more than 15,000 students. The first focused on a review and Q&A about COP28 and climate change policy, while the second two aligned with British Science Week and discussed the concept of marine rewilding.**
- **The education programme expanded on teacher resources this year, with creation of a further 20 lessons' worth of materials and the total downloads for these now tops 119,640.**

CONVEX SEASCAPE MEDIA FEEDS

FACEBOOK	INSTAGRAM	X	LINKEDIN	WEBSITE
2,056,600 IMPRESSIONS	141,352 IMPRESSIONS	76,280 IMPRESSIONS	59,181 IMPRESSIONS	24,000 VIEWS
706,060 REACH	135,955 REACH	3,145 VIDEO VIEWS	8,865 VIDEO VIEWS	14,000 UNIQUE VIEWS
2,225 VIDEO VIEWS[1]	3,028 VIDEO VIEWS[1]	572 ENGAGEMENTS	1,354 ENGAGEMENTS	
864 ENGAGEMENTS[1]	3,028 ENGAGEMENTS[1]	386 FOLLOWERS[2]	1,209 FOLLOWERS[2]	
2,724 FOLLOWERS[2]	1,196 FOLLOWERS[2]	141% FOLLOWER INCREASE	334% FOLLOWER INCREASE	
1.2% FOLLOWER INCREASE	NO DATA[3] FOLLOWER INCREASE			

1) incomplete data, only from 2024, 2) at end of March, 3) no data from April 2023

Key challenges

Challenge	Mitigation
Original budget did not include funds for attendance or sponsorship at global events such as COP or World Ocean Summit, nor did it allow for art-science collaborations.	The budget is being re-profiled to accommodate these new and emerging opportunities for outreach.
Lack of high-quality images of continental shelf seabeds and seafloor creatures for our press and social teams to utilise.	Further commissioning of photography/film during project fieldwork and purchase of targeted assets from talented photographers such as Henley Spiers.

LOOKING AHEAD TO YEAR THREE

4.1 World-renowned light artist, Chris Levine, creating an artwork called '7.83 Hertz' which uses cutting-edge laser technology to plunge audiences into the benthic zone. After a tour of the project's science, Chris has been inspired by the interfaces between different states such as atmosphere-ocean and seafloor-water column and will shine a light on the need to let the ocean rest. He said "When immersed in 7.83 Hertz, you will feel and hear the continuous work of the ocean, but it encourages you to slow down and celebrate its ability to protect us now and in generations to come." The piece will speak to the human subconscious and instil the importance of a healthy functioning ocean

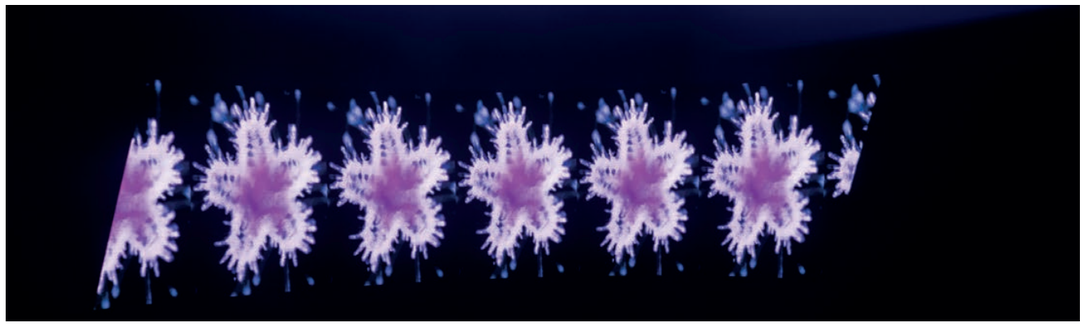
.

4.1 A media team are set to visit the researcher's conducting fieldwork in Jersey, to capture the first underwater media for the project, as well as footage of the molecular work being done. Furthermore, we will capitalise on journalist interest seeded at the media dinner, inviting them to visit Jersey to report on the survey's investigations there.

4.2 The second phase of the project digital platform is being developed and will be launched in summer 2024. The website will include pages with details of each work package, as well as hosting project media and news, as well as an Open Source Portal which will be a shop-front repository for all data and research papers published.

4.3 We will continue to work towards our goal of reaching five million school students over the course of the project. To do this we will be developing a new marketing campaign to promote the package of resources we have created on blue carbon themes to teachers, parents and students. We look forward to broadcasting Live Lessons in year three, bringing in overseas project partners and study locations.

4.4 Building on the achievements in press to date, we will continue to work with our PR agency to ensure all opportunities are seized and the survey continues to be covered by top tier media outlets. With the first published results expected in year three, we will ensure these are disseminated widely.



If you dream...

of future discoveries and

inventions, let me tell you

that the fertile field

of discovery lies for the

most part on those borderlands

where one science meets another...

Sir D'Arcy Wentworth Thompson,
CB FRS FRSE, 1903

2024/25 OBJECTIVES

Support further presentation of the project on the global stage

Integrate and improve links between the project and the broader blue carbon community

Enhanced collaboration and cross-pollination between work packages

Continued relationship building with overseas partners

Further fieldwork and data analysis across workstreams

First wave of project papers published in top journals

PROGRESS TIMELINE

2023

April 2024

Out of the Blue, The Conduit, UK

UN Ocean Decade Conference, Barcelona

EGU GeoScience Conference, Vienna

May 2024

Trawling disturbance experiment, Plymouth Sound, UK

Project team presentation to Convex GEC, Bermuda

Evening outreach event at BUEI, Bermuda

Second phase bioturbation experiments, Millport, UK

June 2024

Fieldwork campaign and media capture, St Helier, Jersey

Chris Levine launch of '7.83 Hertz' for World Ocean Day, Mayfair, UK

Naomi Hart x CSS craft workshop, Penryn, UK

UN Consultative Process of Oceans and Law of the Sea, New York

Oceans Past X Conference, UK

July 2024

Team Science Discussion Days, Exeter, UK

Rare Earth BBC Radio 4 Interview, The Seabed: Our of sight out of mind?

August 2024

Steerco Meeting, Convex, UK

Journalist visit to WP3 fieldwork, St Helier, Jersey

New project website to launch

September 2024

Project Advisory Group Meeting, UK

October 2024

Coring fieldwork aboard OceanX in the Pahang coastal waters, Malaysia

Coring fieldwork on the Quest cruise, Irish Sea Mud Bank, Celtic Deep

Fishmongers Hall project presentation London, UK

Knowledge Exchange Awards, Exeter, UK

November 2024

COP29, Azerbaijan

Fieldwork in the Hauraki Gulf Cable Protection Area, New Zealand

2025

Early-mid 2025 Fieldwork Campaigns

KAUST coring expedition to the Antarctic

Gokova Marine Reserve, Turkey

Uthukela Banks Marine Protected Area, South Africa

March 2025

World Ocean Summit & Expo, Lisbon

APPENDIX

WORK PACKAGE 1

Task	Leads	Milestone				
		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					
Task 1.2: Oceanographic modelling to predict carbon accumulation - Hydrographic model development and application	James Scourse Sophie Ward					
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					
Task 1.2: Oceanographic modelling to predict carbon accumulation - projection of changes in carbon burial under future sea level rise	James Scourse Sophie Ward					
Task 1.3: Fieldwork - Identification of field sample sites and international project partners	James Scourse Sophie Ward Sarah Bradley Zoe Roseby					
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					
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					
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					
Task 1.5: Placing sediment carbon into context of global carbon - development of carbon budget models for the three identified shelf-seas	Jamie Shutler					

- University of Sheffield
- University of Utrecht
- University of Exeter
- KAUST (King Abdullah University of Science and Technology
- Bangor University
- University of Southampton/NOC
- Plymouth Marine Laboratory

On track | **Slow or delayed** | **Not yet started** | **Completed**

Milestone/ Goal	Activities completed	Milestone changes
Task 1.1: Data mining and synthesis-mapping of seabed topography, carbon accommodation space and prior sampling effort	Completed by Sarah Bradey on schedule in September 2023.	
Task 1.2: Oceanographic modelling to predict carbon accumulation. Hydrographic model development and application	Tidal model of the northwest European shelf seas used to predict fine- carbon rich sediment accumulation. Associated geological data has been analysed and a manuscript is in progress. A case study of the Fladen Ground area of the northwest European shelf is being developed, using legacy cores and existing data, combined with hydrodynamic modelling to better understand influences on carbon accumulation and burial. Dr Sophie Ward has developed a (palaeo)tide model for the northwest European shelf sea and will extend these methods to other shelf seas and continue data-model comparisons.	
Task 1.3: Fieldwork • Identification of field sample sites and international project partners • Collection of fresh core samples to verify insights from models and data mining, and resampling of previously collected cores kept in collections worldwide	Academics from WP1 and WP3 have been planning how to bring fieldwork campaigns together to maximise use of data collected. On 19/20th March post docs and PhD students held 2 days of workshops to discuss the different inputs and uncertainties they will each need to consider in answering task specific questions. This resulted in a refined approach to fieldwork planning and progress toward finalising the upcoming campaign in Jersey. The team have been working with Coastal Marine Services (CMS geosciences), Falmouth, on finalising a sampling plan and forming a collaboration agreement to enable CMS to collect the necessary deep core samples in Jersey. The team have been developing the age-depth models that will be used for assessment of carbon accumulation rates.	
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	Post doc, Dr Rebecca Parker and PhD student, Riyad Bhuiyan, joined the team this quarter and have begun to develop and refine the necessary molecular (eDNA) and geochemistry methodologies for this task. Academics have also provided information on sample preparation and storage to inform the fieldwork planning in Jersey, Turkey, New Zealand, Indonesia, and NW Australia. Our partners at KAUST in Saudi Arabia have been analysing cores collected off the Western Antarctic peninsula with the aim of unravelling the role of great whales in ocean productivity and carbon sequestration. Professor Rod Wilson presented data on fish gut carbonate production (30 min slot), discussing this and the wider issues covered by the project at the NERC BIO-Carbon 2024 - Annual Science Meeting - 27-29th February (National Oceanography Centre, Southampton).	
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	To continue to develop the carbon budget models, Dr Jenny Watts has collated data on the riverine carbon inputs to the Patagonian shelf. Jenny has also calculated dissolved inorganic carbon (DIC) accumulation for the northwest European Shelf and Patagonian Shelf. Surface carbon budgets using satellite data have been further refined for the Patagonian shelf and northwest European shelf through collaboration with the EU project OceanICU. Innovative methodology developed for looking at carbon fluxes across different states through the water column and across the continental shelf systems.	

WORK PACKAGE TWO

Task	Leads	Milestone				
		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					
Task 2.1: Historical development and spread of human influences on the seabed - collation of eye-witness evidence of the unimpacted state of the seabed	● Ruth Thurstan ● Callum Roberts ● Julie Hawkins					
Task 2.1: Historical development and spread of human influences on the seabed - evidence synthesis and mapping	● Ruth Thurstan ● Callum Roberts ● Julie Hawkins					
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					
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 1.1-1.3) and human disturbance of the seabed	● Kristian Metcalfe					
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 ○ Blue Marine					
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					
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					

Task	Leads	Milestone				
		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 ● Sarah Breimann ● Vas Kitidis ● Karen Tait ● Tim Smyth					
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 ● Sarah Breimann ● Vas Kitidis ● Karen Tait ● Tim Smyth					
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 ● Sarah Breimann ● Vas Kitidis ● Karen Tait ● Tim Smyth					
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 ● Sarah Breimann ● Vas Kitidis ● Karen Tait ● Tim Smyth					
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					

● University of Sheffield
● University of Utrecht
● University of Exeter
● KAUST (King Abdullah University of Science and Technology
● Bangor University
● University of Southampton/NOC
● Plymouth Marine Laboratory
○ Blue Marine

On track **Slow or delayed** **Not yet started** **Completed**

Milestone/ Goal	Activities completed	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 • collation of eyewitness evidence of the unimpacted state of the seabed • seabed-evidence synthesis and mapping	Academics have been working to understand how best to include information on historical fishing intensity in models of fishing pressure. Dr Ciaran McLaverty continues to apply spatial models to estimate fishing effort from catch data extracted from the University of British Columbia Sea Around Us database. A total of five MSc student projects are being undertaken in support of this work package.	
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 • analyses and mapping of overlap in hotspots of vulnerable buried carbon (from Tasks 1.3) and human disturbance of the seabed	Academics working to increase understanding of relationship between vessel size and gear footprint. They are now working on setting up the modelling framework using data from Global Fishing Watch to produce some preliminary outputs based on currently collected data. These analyses will then be re-run later to incorporate new data generated through this work package.	
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) • identification and verification of seabed habitats in potentially unimpacted sites	Despite the gradual pace of submissions, there has been significant progress in pinpointing future areas to study. Annabel Kemp has produced a comprehensive document outlining potential sampling areas for further investigation.	Despite various interest and many more enquiries, we received just six useful submissions to the citizen science portal. This may reflect the paucity of undisturbed soft sediment habitats and the difficulty of reaching people within offshore industries who may have better knowledge of suitable areas. However, the survey has been very widely publicised, with well over 1.25m impressions and an above average click through rate of 12%. This well serves our second purpose of outreach and communication about the Convex Seascape Survey.

Milestone/ Goal	Activities completed	Milestone changes
Task 2.4: Viewing the impact of seascape disturbance from space • collation, analysis and mapping of satellite data on sediment disturbing human activities	The annual science meeting discussions and presentations in Windsor (Feb 2024) identified the Sunda shelf as a possible focus for this work (as the remote sensing methods could be feasible in this region, whilst there would be benefit in this approach as there is a dearth of data on fishing frequency within this region, as fishing here focuses on small craft with no AIS systems i.e. satellite position communication). Within her PhD Dr Jenny Watts developed an airborne drone methodology capable of mapping surface sediment plumes and this could be useful during the planned Plymouth Marine Lab (PML) trawling experiments – discussions with the PML team have been initiated.	
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 • design of a simplified modular sampling programme to deploy internationally to measure effects of seabed disturbance on buried carbon • identification of international research sites and partners • deployment and analyses of international field experiments	On 20th March, the team at Plymouth Marine Laboratory ran a successful test deployment of the rig that will be used to collect data needed for this experiment. Deployment and recovery of the (large) piece of equipment confirmed that this experiment will rely on calm conditions and fair weather, therefore the team will be led by conditions when planning the timing of the sampling campaign due to take place this spring/ summer. The team will further develop this activity, informed by the experiment, as part of the additional NERC funded project (C-FLOOR). All parties are waiting for this funding to be awarded by NERC so a start-date can be set.	
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.	Dr Beatriz Arellano Nava has been working to quantify the exchange of atmospheric CO2 resulting from seabed disturbance to include the effect of key biogeochemical processes in the water column and in the sediments.	

WORK PACKAGE THREE

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					
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					
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					
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					
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					
Task 3.3: Evaluating the co-benefits of seabed protection from human impacts on wildlife and ecosystem services - evaluating the co-benefits of seabed protection from human impacts on wildlife and ecosystem services	● Ceri Lewis ● Julie Hawkins ● Carlos Duarte					
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					
Task 3.5: Measuring, monitoring and minimising the project's carbon and environmental footprint	● Jamie Shutler					

● University of Sheffield
● University of Utrecht
● University of Exeter
● KAUST (King Abdullah University of Science and Technology
● Bangor University
● University of Southampton/NOC
● Plymouth Marine Laboratory
● Blue Marine

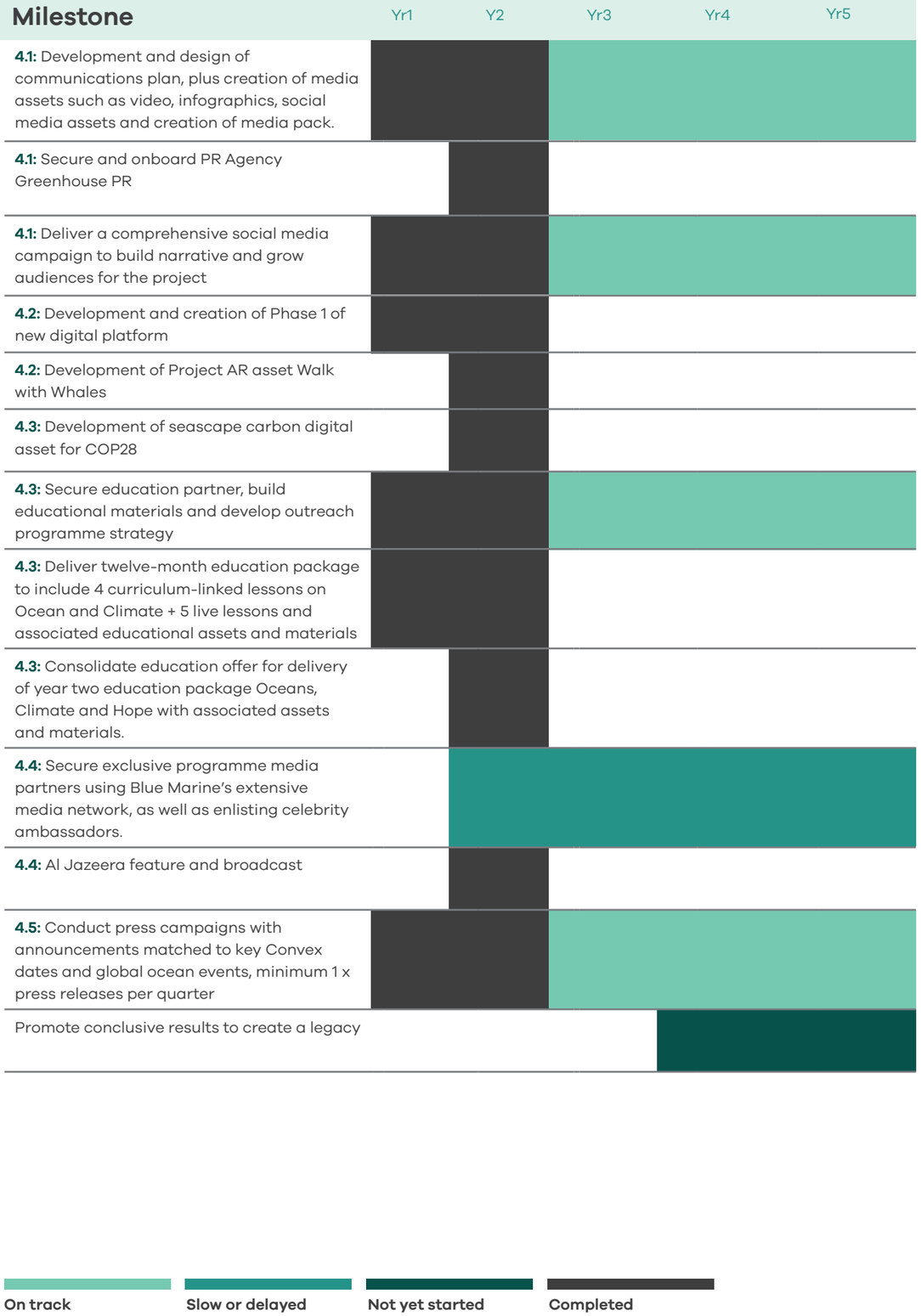
On track | **Slow or delayed** | **Not yet started** | **Completed**

Milestone/ Goal	Activities completed
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) Design of modular sampling programme to evaluate the effects of protection on biota (sampling design shared with Task 3.3)	Academics designing and refining overseas fieldwork campaigns in Jersey, New Zealand, Turkey, and Australia while investigating further possibilities in Denmark, Indonesia, and Canada. Collaborators in South Africa have begun initial exploratory work to inform fieldwork due to take place locally in 2025, they are also recruiting for a post doc to join the team at Nelson Mandela University. PhD student Sabrine Sykes has joined the team. Dr Ben Harris and Dr Adam Porter attended in person the NERC BIO-Carbon Meeting at the National Oceanography Centre in Southampton during February 2024. Organised by UK government agencies to help the standardisation of carbon methodologies across projects (brokered via CCSAG advisory group meetings.)
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	Academics have been working on manuscripts, setting out their findings ready for review, they have also been carrying out follow-up experiments to investigate invertebrate interactions with particulate organic carbon, while planning a follow-up mesocosm experiment due to take place in Millport in April 2024. Currently, they have 3 papers in the pipeline.
Task 3.3: Evaluating the co-benefits of seabed protection from human impacts on wildlife and ecosystem services	
Task 3.5: Measuring, monitoring and minimising the project's carbon and environmental footprint	The project team continue to collect information needed to monitor the project's carbon and environmental footprint.

WORK PACKAGE FOUR

PROGRESS TOWARDS MILESTONES

Milestone	Lead 1	Lead 2	Lead 3	Collaborator 1	Collaborator 2
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.	Jo Coumbe	Emma Nichol	Gabriella Gilkes	Alessandra Polo	
4.2: Development and creation of digital platform	Jo Coumbe	Gabriella Gilkes	Gail Fordham	Unseen Studio Team	
4.3: Secure education partner, build educational materials and develop outreach programme strategy	Gabriella Gilkes	Gail Fordham	Anna Hughes	Jamie Buchanon	
4.4: Secure exclusive programme media partners using Blue Marine's extensive media network, as well as enlisting celebrity ambassadors.	Jo Coumbe	Charles Clover	Gabriella Gilkes	Gail Fordham	
4.5: Conduct press campaigns with announcements matched to key Convex dates and global ocean events	Jo Coumbe	Charles Clover	Gabriella Gilkes	Gail Fordham	
4.6: Promote conclusive results to create a legacy	Jo Coumbe	Gabriella Gilkes	Gail Fordham		



Milestone/ Goal	Activities completed	Milestone changes
4.1: Design and development of communications plan	The Prophets PR team are now properly integrated and delivering on press and socials for the project, working alongside the Blue Marine media team on an iterative on-going story matrix. A brand narrative and social plan has been developed, as well as documents for media FAQs and a Social Media Posting Guide for academics. profiling information for key scientists and programme stakeholders has been collected.	Original budget did not include funds for attendance or sponsorship at global events such as COP or World Ocean Summit, nor did it allow for art-science collaborations. The budget is being re-profiled to accommodate these new and emerging opportunities for outreach.
4.1: Creation of media assets (incl. social media)	Digital asset #WalkWithWhales featured for World Ocean Day, reaching 4.9 million people online and appearing on billboards in major UK cities. Beautiful short film "The first ever study on Arran's seafloor carbon" was hugely well received and quickly became the most watched video on our YouTube. World-renowned light artist, Chris Levine, is creating an artwork '7.83 Hertz' which plunges audiences into the benthic zone and it's role in the carbon cycle. Artist in residence, Naomi Hart, led a series of project-linked workshops with refugees local to Exeter and created 'SeaBed' – a bedspread about the bed of the sea.	
4.2: Creation of digital platform	A first of its kind digital experience was launched which takes viewers on an immersive journey exploring seascape carbon and fulfilling Phase 1 of the project website. It was nominated for the Annual Webby Awards and we came in a very impressive 2nd place in the Sustainability and Environment category.	
4.3: Secure education partner, build educational materials and develop outreach programme strategy	Worked with EncounterEdu, on a suite of new resources centred around blue carbon themes. Three Live Lessons produced throughout the year, which attracted a large audience totalling more than 15,000 students. The first focused on a review and Q&A about COP28 and climate change policy, while the second two aligned with British Science Week and discussed the concept of marine rewilding.	
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	Coverage in press has increased, with x25 articles published in print and online. A successful media dinner was organised in London, seeding interest from top tier journalists. Lisa Bachelor, The Guardian's Seascape Editor, was hosted at World Ocean Summit in Lisbon in March.	

convex SEASCAPE SURVEY

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BLUE MARINE FOUNDATION

convex