

Sir Alister Hardy Foundation for Ocean Science

The Continuous Plankton Recorder Survey



2017/18
Annual Report



LR & V- Eimskip: Lagarfoss



M- Sea Cargo: SC Express



DJ & DI Smyril Line: Narrona



IN P&O: Norbay



ST Bring: Norbjorn

IB, SA & SB MacAndrews: Encounter Vega Reederie: Vega Philipp



NI, MD & MC Eimskip: Skogafoss



EA & EB D- & DA ACL: Atlantic Sea



MB Container Line: Oleander



Z's Eimskip: Reykjavoss & Selfoss



PR Brittany Ferries: Armorique



C- DFDS: Petunia Seaways



HE DFDS: Hafnia Seaways



B's MMD/ Geest Line: Benguela Stream



LG DFDS: Primula Seaways



R- DFDS: Anglia Seaways



A- SERCO Northlink Ferries: Hildasay



Our Network of Ships, Tow Routes and Instrumentation

The CPR Survey would not be physically or economically possible without the generous support of ships, owners, charterers, managers, port operatives and agents. We are extremely grateful to all those involved, helping in our operational activities - we could not do it without your continuing support.

----- Routes seeking funding

Routes deploying Planktag Instrument: A-, C-, IN, LG, LR, M-, PR, R-, V-

Routes deploying Minilog Instrument: A-, BA, C-, IB, LG, R-

Routes deploying RBR Instrument: AT, LR, V-, VJ

See page 6-7 for instrument details

Pacific

AT

VJ

VJ AAL Shipping: AAL Melbourne

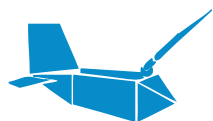


AT Matson Shipping: Matson Kodiak



About Us

The Continuous Plankton Recorder (CPR) Survey has been running since 1931 collecting plankton (coupled with ocean physical, chemical and biological observations) with the resulting data providing information on the biogeography and ecology of the planktonic community. The results of the Survey are used by marine biologists, scientific institutes, governmental bodies and in environmental change studies across the world.



We collect: Plankton, fish larvae, bacteria and viruses.

Physical, chemical and biological observations of water masses.



We analyse: Our data > 250,000 sample records. > 175,000,000 biological records.

We share: Our data: Available to external researchers and collaborators, private companies and policy-makers.

Our findings: We publish ~40 peer-reviewed papers a year.

Our knowledge: Through training, consultation and our expertise services.



We record: > 800 phyto and zooplankton taxonomic entries.

Phytoplankton Colour Index (PCI).

Ocean conductivity, temperature, depth and chlorophyll-a fluorescence.

Supporting Us

We are a non-profit organisation, further support is needed to help us continue our work. Donating helps to ensure the protection of our oceans by backing marine science. We can act together to safeguard a critical resource, contribute to maintaining healthy and sustainable oceans and encourage corporate social responsibility.

If you have an affinity to the ocean and plankton science, giving back by supporting the world's longest running most geographically extensive marine ecological survey, no matter how much, will make a difference.

The Sir Alister Hardy Foundation for Ocean Science (SAHFOS) has been home of the CPR Survey since 1990. In April 2018 it was incorporated into The Marine Biological Association, where the CPR Survey will continue to operate. Herewith is a report of the activities of SAHFOS during 2017 and up to March 2018.

On the cover: A Continuous Plankton Recorder

Editor: Gemma Brice.

Design and Layout: Gemma Brice.

Proof-reading team: Marion Smith, Martina Brunetta and Julian Morley.

Maps: Robert Camp

Printer: Kingfisher, Totnes

Paper: Printed on recycled paper

©2017-2018

ISBN 978-0-9566301-4-8

Charity number 1001233

Sir Alister Hardy Foundation
for Ocean Science

The Laboratory, Citadel Hill,
Plymouth, PL1 2PB, England

Tel: +44 (0) 1752 426492

E-mail: cprsurvey@mba.ac.uk

www.cprsurvey.org

www.mba.ac.uk/cprsurvey.ac.uk

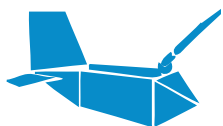


Follow us @cprsurvey

Contents

Our tow routes and ships

2. The Continuous Plankton Recorder
4. Why do we study plankton?
5. Why support?
6. Director's welcome
8. Staff
12. Operations
26. Analysis
34. Data and IT
36. Research highlights
50. Knowledge exchange
59. Publications
63. Financial summary
64. GACS



The Continuous Plankton Recorder

A platform for integrated ocean observing

In addition to the traditional biological sampling undertaken by the CPR the towed body can be equipped with a range of sensing capabilities to extend its utility for integrated observing

Seawater enters via the aperture. Plankton is captured on a filter silk band then covered by a further silk band. The continuously moving band is wound through the CPR on rollers turned by gears, which are powered by a propeller allowing for long distances to be towed

Cost Effective, Proven and Reliable. Since 1931

Vemco Minilog :
Temperature sensor

Star Oddi CTD :
Conductivity, Temperature and Pressure (Depth)

SAHFOS CPR Internal :
Phytoplankton, Zooplankton, Planktonic Bacteria and Viruses



Planktag : Conductivity, Temperature, Chlorophyll-*a*, Fluorescence and ambient Light.
Data telemetry enables observations to be streamed back to within minutes of the CPR surfacing

WaMS : Water and Molecular Sampler

UFE Multispectral Fluorometers
: Rapid optical detection of phytoplankton forms, Pressure (Depth) and Temperature

RBR CTD : Conductivity, Temperature, Pressure (Depth) and Fluorescence

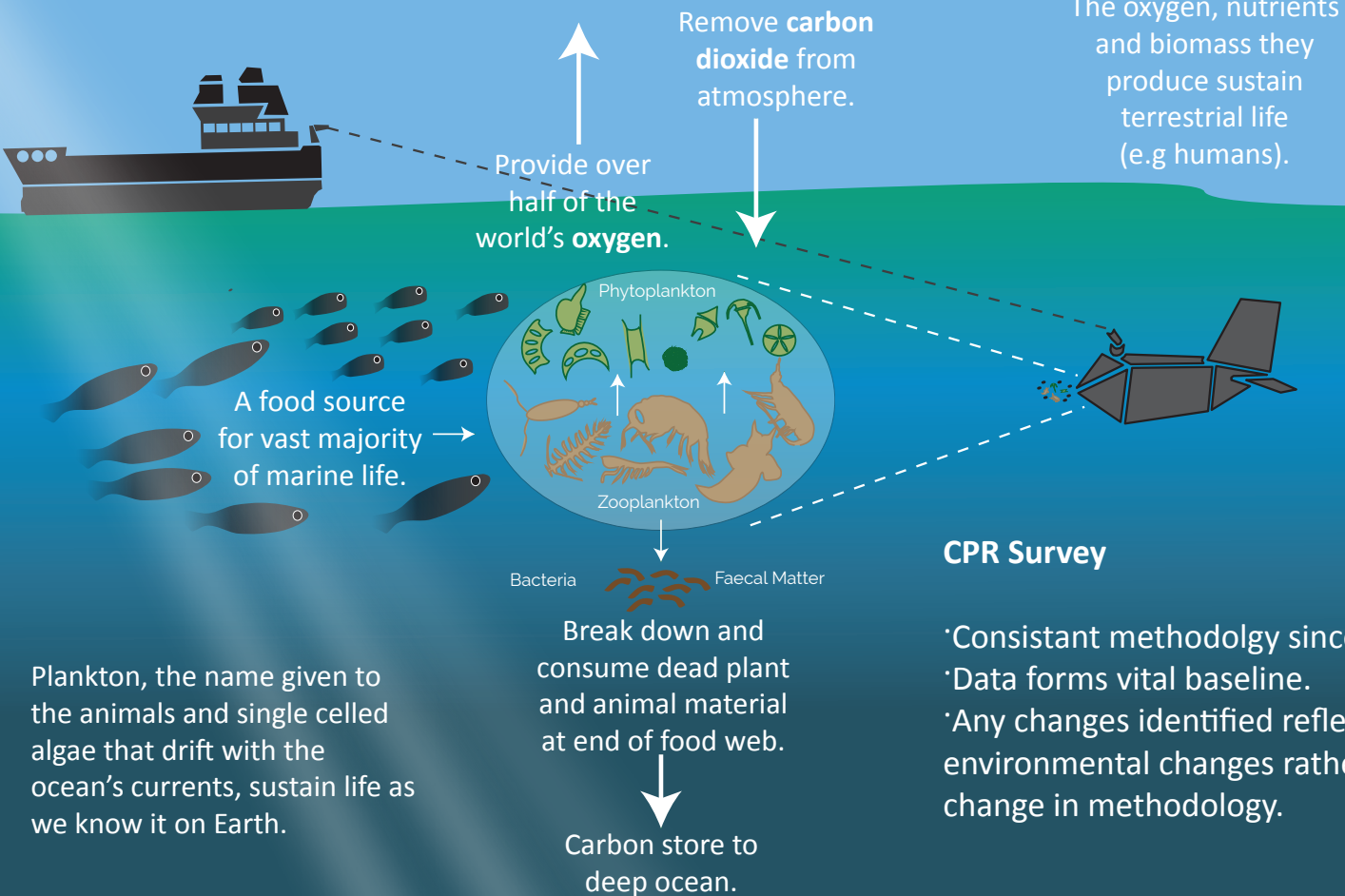
Key Statistics

Length x width x height :
100 x 36 x 42 cm
Weight : 85kg
Tow depth : 5 - 10 metres
Tow speed : 8 - 25 knots
Aperture size : 1.27 cm²

Collects: Phyto- and Zooplankton, Planktonic Bacteria and Viruses.

Instruments record:
Conductivity, Temperature, Depth, Chlorophyll-*a*, Fluorescence, ambient Light, and three-axis accelerations.

Why do we study plankton?



Plankton, the name given to the animals and single celled algae that drift with the ocean's currents, sustain life as we know it on Earth.

CPR Survey

- Consistent methodology since 1958.
- Data forms vital baseline.
- Any changes identified reflect real environmental changes rather than change in methodology.

Why should you support The CPR Survey?

Donating is helping to ensure the protection of our oceans by supporting plankton science. We can act together to safeguard a critical resource, contribute to maintaining healthy and sustainable oceans and encourage corporate social responsibility.

If you have an affinity to the ocean and plankton science, giving back, by supporting the world's longest running most geographically extensive marine ecological survey, will make a difference. Giving is a reflection of inner values and can be deeply fulfilling.

As a non-profit organisation we always fully appreciate support that helps us to continue our work.

Supporting us also gives back and it can:

- Highlight your ethics and, as a business, promote trustworthiness.
- Demonstrate social and environmental awareness and commitment to protecting our oceans.
- Promote the importance of green issues to staff, as well as improve employee relations.
- Tax benefits can also be met from donating, in the form of tax rebates. It can be a good way to save up taxable income too.
- Can help define your business corporate identity, show ethics and trustworthiness, define you as different from the competition and act as an important recruitment tool.
- Demonstrating social and environmental awareness and

commitment to protecting our oceans can boost business reputation and become an essential part of a Corporate Social Responsibility programme.

- Promote positive media coverage, better public relations and raise brand awareness. An easy way to highlight to your customers (as well as potential new ones) that the company is dedicated to charitable causes.

Anything that you can give will make a difference, and there are a number of ways to show support:

- Research grants
- Fellowships
- Specific donations
- Equipment donations
- Easyfundraising (an online cashback service) www.easyfundraising.org.uk/causes/marinebiologicalassociation

We already have a strong history of working partnerships through our network of volunteer ships and we want to expand upon these mutually beneficial partnerships, inspiring others to work with us.

Interested in supporting The CPR Survey?
Contact Nicola Rickard
nicric@mba.ac.uk

Director's Welcome



In many ways a sad introduction to write knowing it will be the last Annual Report for SAHFOS, but do not despair, I am optimistic about our future and have some very exciting new beginnings to report.

By any standards, 2017 was a tumultuous year for SAHFOS. Back in December 2016 I noted in The Plankton Post (our internal circular) that we had two very tough financial years ahead of us: “if we do not adapt we will not survive”.

There was always the hope that the funding gurus would see sense and prevent what seemed like an inevitable restructuring process to me. We had to suspend some unfunded routes (see page 14) and lose almost one third of our staff. As a tight knit family, it was a shock to everyone, and we all had friends and colleagues that lost their jobs. February 2017 was a low point for SAHFOS (and by no means the lowest in SAHFOS’ long history) but, as with all troughs, there is only one way out and that is upwards. Despite a *mense horribilis* (horrible month!), throughout I was always focused on the more significant goal of a sustainable and productive future for SAHFOS. I have been incredibly proud of the resilience, spirit and camaraderie our remaining staff have demonstrated as we

all came to terms with the restructuring process. Such a positive attitude started to pay dividends very quickly as we strategically lobbied funders on the critical importance of the suspended routes. It will take a while to get our full complement of routes back, and that rebuilding process will be relatively straightforward since we have not cut our “golden thread” volunteer networks. We need to be creative and persuasive as we explain the importance of long term, large scale monitoring to continue measuring the pulse of the ocean.

Of course there are many examples of the impact our research has on climate change, the blue economy and on ocean health which just so happen to be the themes of our new science strategy “Pathway to a Century”, a 15-year roadmap to guide The CPR Survey to a century of observations (1931 – 2031). Despite dealing with a massively challenging year, our 2017 report contains many impactful, and I hope interesting, success stories. I will share some of my favourites here, but I would encourage you to read the report and find your own favourites.



Our first tow of the entire NorthWest Passage has allowed us to provide baseline data in the Canadian Arctic, critical in allowing evaluation of future changes in this frontier marine environment. Did you notice plankton received some critical acclaim on Blue Planet II? SAHFOS researchers provided some of the vital statistics used in Sir David Attenborough’s narrative! On a similar theme, the same programme highlighted the plight of ocean plastics, which has suddenly become highly political and topical, our analysts and researchers have been providing information to government on microplastics since 2004, and macroplastics going back 60 years (data from gummed up CPRs!) For those versed in social media our #yearofplankton was a big success highlighting the amazing morphological diversity and beauty of our plankton. Look out for our new Twitter feature: #60yearsofdata since 2018 is a milestone year for the CPR Survey, marking 60 years of continuous monitoring in the North Atlantic!

Scientifically it has been another productive year; I am constantly amazed at the quality and quantity of high impact research publications that come from our scientists and CPR Survey collaborators. We have highlighted some of the best examples in this report. Noteworthy is the PNAS paper featuring research by Pierre Hélaouët looking at controls on marine food webs, weighing up climate oscillations and fishing pressure, essentially illustrating the critical importance of decades of monitoring data.

Finally, I want to say thank you to all our Staff, Trustees, Science Advisory Board, collaborators and volunteers who have always done an outstanding job at supporting SAHFOS. I hope you will remain with us through our next chapter...

Willie Wilson

A Strong Future Together

In April 2018 SAHFOS was incorporated into the Marine Biological Association (MBA) and Willie Wilson was appointed as Director of the new MBA. Although SAHFOS will exist as a dormant company, our branding will change to The CPR Survey, which is actually how it was known for 60 years between 1931 to the formation of SAHFOS in 1991. We will continue to celebrate our association with Sir Alister Hardy with plans to establish a Hardy Research Fellow, a new Hardy Boardroom at the MBA and an annual Hardy Lecture series. The MBA was established in 1884 and counts seven Nobel Prize winners among those who have worked here. In 2013 the MBA was awarded a Royal Charter in recognition of its long and eminent history and its status within the field of marine biology. We believe The CPR Survey will strengthen the MBA as a leader in global marine biology.



SAHFOS Staff in 2017



Prof William H Wilson

Director

Mrs Gill Tanner

Director of Business Administration

Dr Sonia Batten

Director North Pacific CPR Survey

Kate Brailsford

Administrator (until December)

Gemma Brice

Plankton Analyst & Publishing Officer

Derek Broughton

Software Developer

Martina Brunetta

Silk Preparer & Plankton Analyst

Clare Buckland

Plankton Analyst (until February)

Robert Camp

Plankton Analyst & Instrumentation Technician

Dr Claudia Castellani

Research Fellow (until March)

Dr Dave Conway

Contract Analyst

Dr Chiara Consolaro

Plankton Analyst (from November)

Prof Martin Edwards

Chief Scientist

Dr Astrid Fischer

Plankton Analyst, Technical Secretary to NMBAQC & Laboratory Assistant (until August)

Dr George Graham

Instrumentation Scientist & Data Team Manager

Lance Gregory

Operations & Workshop Manager

Nick Halliday

Contract Analyst

Chris Harris

Marine Engineering Technician (until June)

Dr Pierre Hélaouët

Data Scientist

Linda Horsfield

Administrator (until February)

Usha Jha

Plankton Analyst & Silk Preparer

Mr David Johns

Laboratory & QA Manager

Tanya Jonas

Contract Analyst

Dr Priscilla Licandro

Research Fellow (until March)

Clare Marshall

Plankton Analyst (from November)

Doug Moore

Plankton Analyst (Canada)

Julian Morley

Marine Engineering Technician

Jean Nyman

Finance Officer

Dr Clare Ostle

Research Fellow & NMBAQC Technical Secretary

Prof Chris Reid

Senior Research Fellow

Nicola Rickard

Fundraising, Publicity & Web Content Manager

Dr Katrin Schmidt

Plankton Analyst (until February)

Jennifer Skinner

Plankton Analyst & Outreach Officer

Marion Smith

PA to Director & HR Manager

Dr Rowena Stern-Kluckner

Research Fellow

Darren Stevens

IT Manager (until February)

Claire Taylor

Plankton Analyst, Assistant Laboratory Manager & Silk Preparer

Dr Antony Walne

Instrumentation Technician (until March)

David Wilson

Ships Liaison Officer

Marianne Wootton

Senior Plankton Analyst

Claire Wotton

Contract Analyst

Board of Trustees



Science Advisory Board



Governance

SAHFOS is a company limited by guarantee with charitable status. Company Registration number 2563736 and Charity Registration number 1001233.

SAHFOS is governed by a [Board of Trustees](#), who are also Directors under company law. In addition to the main Board there are also two sub committees:

[Science Advisory Board](#)

[Finance and Resources Committee](#)

The Director, Willie Wilson, has delegated responsibility from our Board of Trustees for the day-to-day running of the organisation.

Members of the Board of Trustees are elected at the AGM by the membership. The Board of Trustees appoints the Director who is accountable to the Board of Trustees.

Photo top. Board of Trustees in April 2017. From left to right: Prof Geoff Boxshall, Gill Tanner, Prof Peter Liss, Richard Coombs, Rob Hubble, Prof Willie Wilson, Dr Samantha Lavender, Prof Paul Hart, Prof Ann Bucklin, Prof Patrick Holligan, Prof David Southwood, Prof Judith Petts, Claire Taylor.

Photo bottom. Science Advisory Board in April 2017. From left to right: Prof Kevin Gaston, Dr Tarquin Dorrington, Prof Patrick Holligan, Prof Willie Wilson, Prof Peter Liss, Dr Stephanie Henson, Dr Peter Wiebe, Prof Geoff Boxshall

Board of Trustees

Prof Peter Liss, CBE, FRS (Chair)

Prof Geoff Boxshall FRS

Prof Ann Bucklin

Mr Richard Coombs

Prof Paul Hart

Prof Patrick Holligan (Vice Chair)

Mr Rob Hubble FCA

Dr Samantha Lavender

Prof Judith Petts CBE

Prof David Southwood

Science Advisory Board

Prof Patrick Holligan (Chair)

Dr Tarquin Dorrington

Prof Geoff Boxshall FRS

Prof Martin Edwards

Prof Kevin Gaston (from April)

Dr Kjell Gundersen

Dr Erica Head

Prof Mike Heath

Dr Stephanie Henson

Dr Tiziana Luisetti

Dr Julie Robidart

Dr Caron Montgomery

Dr Peter Wiebe

Dr Phil Williamson

Prof Willie Wilson

Our Fellows

Distinguished Honorary Fellows

Dr Bob Dickson CBE

Prof Robin Pingree

Honorary Fellows

Prof Franciscus Colijn

Dr Paul Dowland

Dr Arnold Taylor

Dr Luigi Vezzulli

Emeritus Life Fellow

Dr Graham Hosie





Operations

119,954
nautical miles
towed in 2017

92.72%
success rate

6,767,228
nautical miles
towed in total

53
CPR bodies in
our fleet

Services we offer

The day-to-day running of the CPR Survey.

Training: CPR Technical and Volunteer Ships', Liaison courses.

Supply of equipment and spares: New CPRs, Filter mesh, CPR spares.

Maritime expertise: Advice on towing at sea and working with the entire shipping industry - working with sister surveys to suggest the best possible tow arrangement - setting up new CPR routes.

Ongoing technical support to other CPR surveys.

Ships of Opportunity (SoOP): We have used our expertise to assist others in securing the use of volunteer merchant ships.

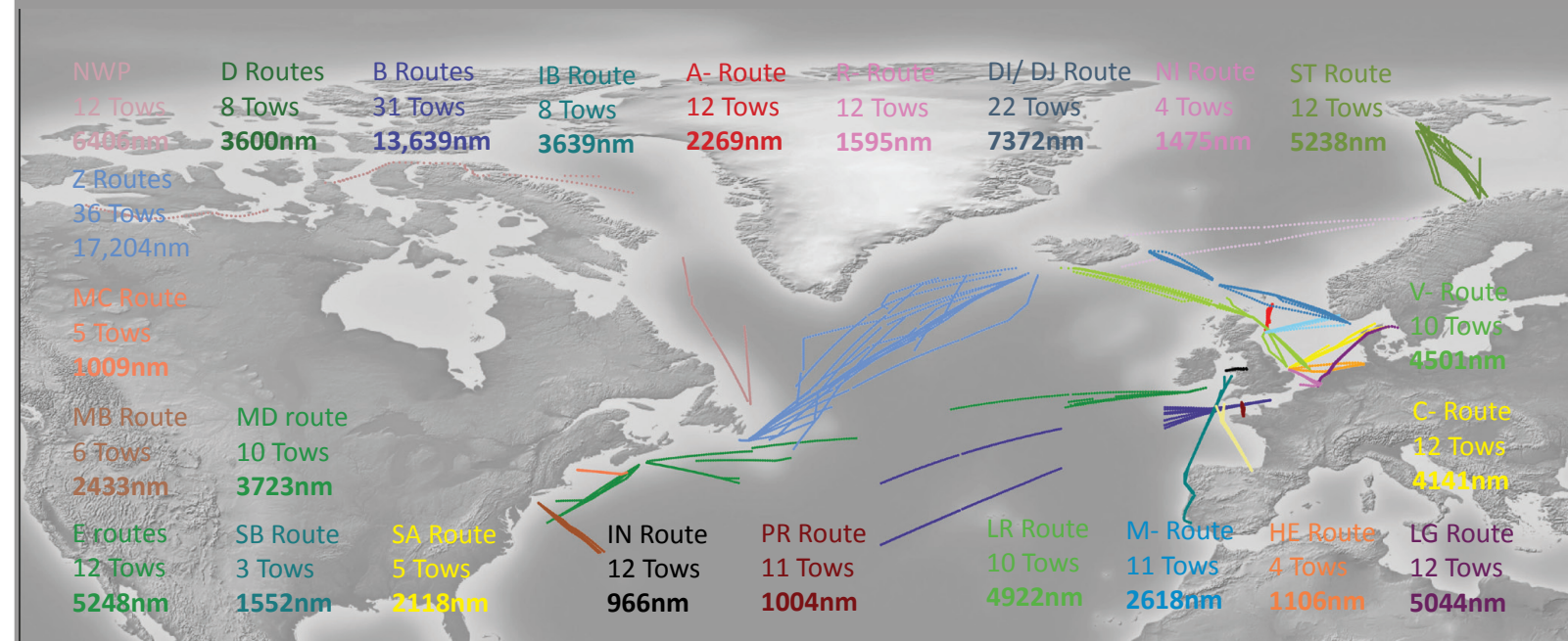
We can act as lead collaborators for projects utilising SoOPs.

We can provide a test bed for marine instrumentation packages utilising the CPR payload area.

Expertise in customs and shipping regulations specific to the CPR, formalin, marine samples and marine instruments containing lithium and other batteries.

Overleaf. Top: Total tows per route in the North Atlantic. Bottom: Total tows per route in the Pacific.

Interested in our services? Contact Lance Gregory
lgreg@mba.ac.uk

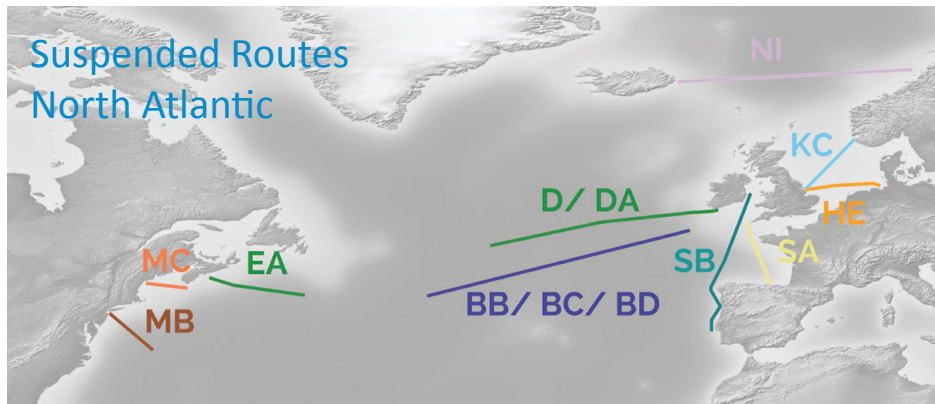


Route suspensions

We always pride ourselves that we achieve consistent calendar monthly tows on our designated routes. However, in 2017 the harsh economic reality caused us to review the routes we were towing against our capability.

Part of the rationale regarding which routes to suspend involved looking at our key and

longstanding volunteer network (our golden threads). As such, we have managed to keep much of this network in place so as and when funding materialises we will be in a good place to reinstate our routes. [LG](#)



Interested in helping fund a route? Contact cprsurvey@mba.ac.uk

Date of last tow	Route / Ship
December 2016	KC - <i>Norrland</i>
February 2017	NI - <i>Skogafoss</i> (Replaced with the DJ route)
March 2017	SB - <i>Vega Phillip</i>
April 2017	HE - <i>Hafnia Seaways</i>
April 2017	SF - <i>Pharos SG</i>
May 2017	MC - <i>Skogafoss</i>
May 2017	D - <i>Atlantic Cartier / Atlantic Sea</i>
May 2017	SA - <i>Encounter</i>
May 2017	BB - <i>Benguela Stream</i>
May 2017	BC - <i>Benguela Stream</i>
May 2017	BD - <i>Benguela Stream</i>
June 2017	MB - <i>Oleander</i>
June 2017	EA - <i>Atlantic Sea</i>

Restructure changes

In the Operations Team, we said goodbye to Chris Harris (Marine Technician) and Linda Horsfield (Operations Administrative Assistant).

We rearranged our team and we have held several in house training sessions. This is so the unique skills required to successfully run a Ship of Opportunity (SoOP) global monitoring programme have been spread where practical across the whole team.

We also welcomed Claire Taylor and Usha Jha to the Operations Team. After successfully completing their

training they are now busy preparing filtering mesh not only for the SAHFOS survey but also for our sister surveys across the globe.

June 2107 saw the retirement of Mr Chris Harris, Marine Technician (right). Chris worked for The Survey for 8 years. He particularly enjoyed instructing on our IMarEST recognised CPR technician courses. Chris enjoyed the social side of these courses and he has subsequently visited some of the participants in their home countries. [LG](#)



Claire Taylor and Usha Jha preparing silks for their new role in the Operations Team.





Our partnership with the shipping community

With the CPR Survey and Database growing in scientific importance with every mile towed, it is crucial to stop and reflect on the fact that we are very much a collaborative organisation and that The Survey is very much a shipping industry and SAHFOS joint endeavour.

We were very pleased to be given the opportunity to highlight the work and support we receive from our “Navy of Volunteers” at the MAST (Marine Alliance for Science and Technology) event held in Glasgow (see also page 54).

At the very core of our Survey, are the volunteer ships. Without co-operation of the Captains and crews we could not maintain the wide ocean scale coverage that we do.

We wish to thank whole heartedly the Owners, Operators, Charterers, Captains and Crew of all the vessels that tow and support our global Survey and extend a warm invitation to visit us any time at our laboratory in Plymouth.

This was the 7th Annual MAST science meeting and it was well attended, particularly by senior civil servants and scientists.

We currently have over 110 volunteers from every section of the industry supporting our Survey.

These volunteers assist us with the day-to-day running and logistics of the Survey both from the shore side and on-board the towing ships. [LG](#)

Ship Changes

There have been several changes to ship’s port schedules and fleet rotations in 2017 resulting in some long serving ships being moved away from a regular liner service to a tramp service. To maintain our regular survey routes we welcomed the following new ships:

Route	Ship change from	Ship change to
M	<i>Norrand</i>	<i>SC Express</i>
IB/ SB	<i>Vega Philip</i>	<i>Encounter</i>
IB/ SB	<i>Encounter</i>	<i>Kristin Schepers</i>
Z’S	<i>Reykjafoss</i>	<i>Selfoss</i>
B’S	<i>Benguela Stream</i>	<i>Royal Klipper</i>
VJ	<i>AAL Melbourne</i>	<i>APL Qingdao</i>



New route - MD

Traditionally we covered the Nova Scotia area by our EA and EA tows. However, due to the ever-changing nature of the shipping industry, our tow ship on this route missed her Halifax port call on several occasions. This then caused her to take a more southerly course on her route back to the UK, away from our scientific area of interest.

To cover the shelf area we instigated a new route, the MD, using a different shipping

company, Eimskip and ship *Skogafoss* that tracks closer to the Nova Scotian coast. The first MD route was towed in March 2017.

Our route suspensions meant the EA route ceased in June 2017. Added to this the ACL *Atlantic Sea* ship (that towed the EA and EB routes) was unfortunately in dry dock for an unscheduled visit for the months of July to October. For this period, the MD route covered the area. [LG](#)



Port and Ship Visits

We operate a regular planned programme of port and ship visits to meet with the volunteers who do so much behind the scenes. It is particularly pleasing to be invited on board the ships where we get to meet and thank the Captains and crews of the towing ships. [LG](#)



Pacific Operations

The AT route from Washington State to Alaska was sampled throughout the year with no problems. Grateful thanks to Matson, Gary and Mark at Kinnetic Laboratories for the consistently smooth turnarounds of gear in Anchorage. The VJ route between British Columbia and Asia continued to be variable in position; in late summer we heard that the AAL *Melbourne* was being taken off the route entirely. Thanks to AAL Shipping for transferring the equipment in Asia so that it could make its way back home to us in a timely fashion, and for all their help with this transit.

We are grateful to APL shipping and look forward to working with APL *Qingdao* in 2018. [SB](#)



The APL *Qingdao* which will be towing on our VJ route from 2018.

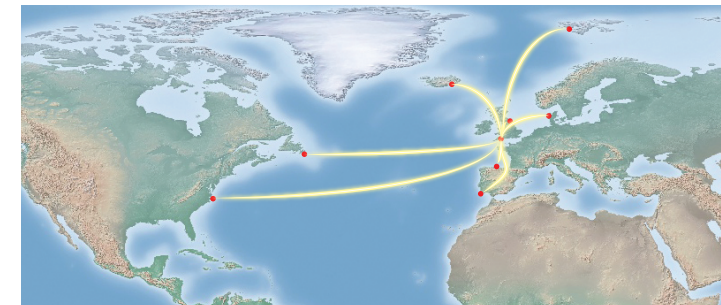
Thanks from Matson Kodiak



The MV *Matson Kodiak's* Master, Captain William Fransen, sent a thank you to highlight how the small honorarium we pay the "crew fund" helps with crew welfare aboard ship. *Matson Kodiak* carry out six months of tows each year between Tacoma Washington and Anchorage Alaska. They have towed this route every year since 2004.

"Due to the contributions that SAHFOS makes to our Ship's Fund our officer's and crew have been able to enjoy a few quality of life items. Your donations were the impetus for a large-scale fund raising effort that resulted in TV service in each stateroom. While SAHFOS's contribution is only a minor one, we had accumulated a significant amount of your funds to where we started to think big....the CPR funds really jump started that whole project. Please pass along to your colleagues how much we appreciate and enjoy the benefits derived from the tow payments!" [DW](#)

International Logistics



Operating an international marine survey requires us to comply with the various and complex transport dangerous goods codes that apply to some of the SAHFOS generated elements, equipment or chemical solutions within the CPR or in which our marine specimens or samples are shipped in.

Our compliance to these international codes along with providing assurance to our volunteers, sister surveys and partners is maintained through the services of:

- Retaining a Dangerous Goods Safety Adviser
- Training of operations staff
- Undertaking an annual external dangerous goods compliance audit
- Publishing a comprehensive dangerous goods policy document
- Providing detailed process flows to ensure that all persons follow the specific and required procedure.

This is performed to ensure that any possible interruptions or delays to our Survey operations are removed or minimised. [LG](#)

Development of the Ocean Indicator

In 2017 the Operations Team developed the Ocean Indicator (left), which is an improved Hardy Plankton Indicator. This was trialed at sea from the MBA *Sepia* using different tow configurations. The Ocean Indicator type 2017 is based on the Small Plankton Indicator first tested in 1922 (described in, The Hardy Plankton Indicator and Sampler, RS Glover, *Bulletins of Marine Ecology*, Vol IV, 1953.)

The Ocean Indicator is designed to sample the top layer of the water column (1 – 3 m) over short tow legs. Several modifications to the original design have been incorporated:

- The indicator has six available tow points (number 1 the most forward and number 6 aft).
- Detachable, profiled weights have been added to the dive plane. This is so the depth of tow and the flight attitude can be changed to match specific projects.
- An additional small payload area has been added to the underside for an electronic instrumentation package.

A variety of sampling discs can be fitted to the rear of the indicator. These could include discs of differing mesh sizes or specialist molecular filters.

Due to its size the Ocean Indicator fills an important niche able to be simply and easily deployed especially off smaller boats. In 2017 it was used successfully by scientists from Plymouth University on EXXpedition Voyage. This was an all-female crew sail around the waters of the UK sampling for microplastics in the sea.



Handover of the 2017 Ocean Indicator to Plymouth University

Over 200 nautical miles were sailed with almost 100 scientific samples for further analysis. Unfortunately, as expected, microplastic particles were found in all areas tested throughout the journey. More will be learnt from the laboratory results, but from general observations on board while collecting samples, it is clear there is considerable plastic pollution in UK waters. This appears to be particularly apparent in areas of higher population. The expedition was filmed by Sky TV and mentioned on local radio. [LG](#)

A reflective viewpoint by a long established supporter and volunteer of the Survey

On a recent visit to Immingham Ships Liason Officer Dave Wilson had the pleasure to see first-hand how Eimskip help the CPR Survey. Here he met John Kearton, Agency Clerk, Eimskip UK to talk about the long-standing partnership between SAHFOS and shipping companies to aid marine science.

I cannot believe it is 20 years since I first got to know about SAHFOS. It is a pleasure to know about the research SAHFOS has conducted since the 1930s and that they are still successfully going to this day. I recognise that it has taken many years of hard work and research to get to the point where the world is now waking up and recognising what is happening in the

oceans, from the lumps of waste and plastic in the central ocean to the microplastics finally reaching the news. Ocean debris will always be claimed by storms but from the work SAHFOS does and microscopic information collected, we will see changes in the near future to protect the ecosystem that we do not actually see but so heavily rely on.

Eimskip as a shipping organisation has been assisting SAHFOS well before my time here and it is great to be involved in this ongoing process. The feedback we receive through the annual reports reminds us of how our small part is hopefully going to make a difference.

Eimskip Agency Clerk John Kearton receiving a crystal CPR from Ships Liason Officer Dave Wilson



Image Credit Eimskip

New technology aboard CPRs

There is an increasing need to monitor the marine environment at reduced costs using autonomous methods. The CPR Survey aims to optimise and enhance its established CPR Survey network, it currently provides a huge network (covering 20,000 km per month) that can be utilised as a platform by other technologies.

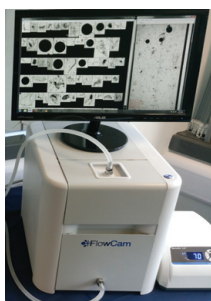


The Water and Microplankton Sampler (WaMS) enables the Survey to monitor the full size range of plankton (and pathogenic species) in the oceans from the larger plankton (which the CPR already samples) to the nano and pico plankton size ranges. It is also aimed at monitoring the smaller Harmful Algal Bloom (HAB) species. The micro-sampler is seen as adding huge value in contributing to the EU Marine Strategy Framework Directive and also complimenting the molecular analysis already undertaken at SAHFOS.

Near-real-time sensors for variables such as chlorophyll from CTD sensors are being developed on the CPR transects across some coastal to open ocean waters (including the Minilog and RBR). Conductivity is used to derive (a measure of) ocean salinity, and, combined with temperature and fluorescence parameters, will provide us with in-situ information into the dominant environmental forcing on plankton distributions.

The Planktag, a real-time sensing unit, has been developed for conductivity, temperature, depth and chlorophyll-a fluorescence. These instruments collect measurements at 1Hz on submergence and then transmit their data wirelessly on emergence at the end of a

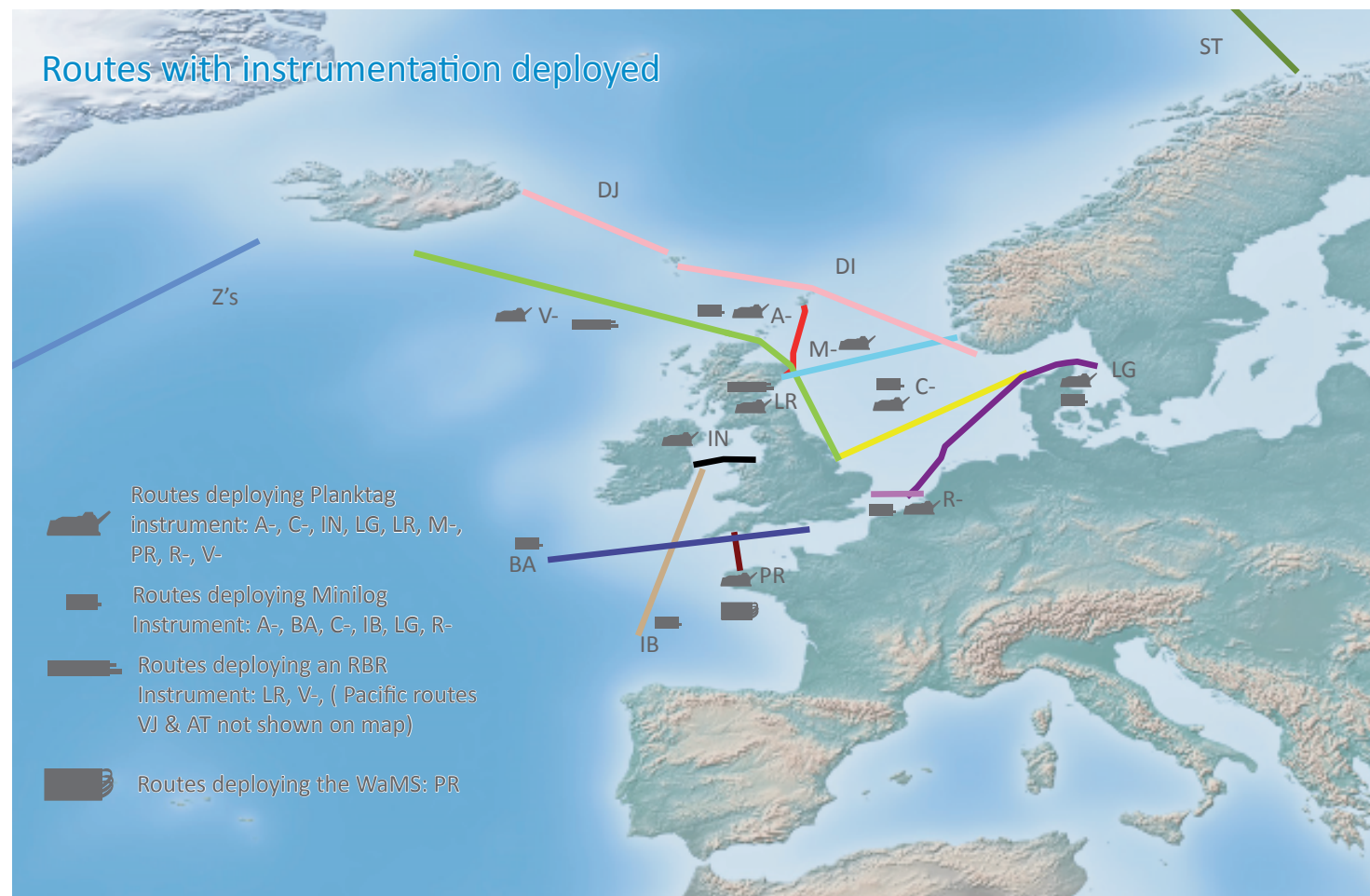
tow, providing near real-time data delivery and enables us to gain insights about the physical environment and proxies related to the phytoplankton population well in advance of the CPR samples returning to the Laboratory.



The FlowCam® Macro allows rapid cell identification. Methods will continue to be explored using flow cytometry to sort cells on size and pigment for further classification, and quantify cells by size and pigment which can be isolated for later molecular analysis. New automatic visual identification methods will also be continued to be developed to speed up components of the traditional taxonomic analysis and compliment the existing plankton time-series.

There is considerable scope for the further development of the CPR instrumentation programme to provide synoptic physical/biogeochemical measurements with the plankton for use in global climate change and ecological models and satellite calibration as well as to help interpret causes of plankton and fisheries variability. Variability in ocean chemistry – nutrients, pH, CO₂ concentration and other dissolved gas measurements – provide crucial constraints to plankton growth rates and survival as well as insight into the impact of global climate change on the ocean. Observations of temperature and salinity can be combined to estimate ocean pH whilst waiting for maturity in the new generation of *in-situ* pH sensors in order to take direct measurements from the CPR platform. [GG & ME](#)

Routes with instrumentation deployed

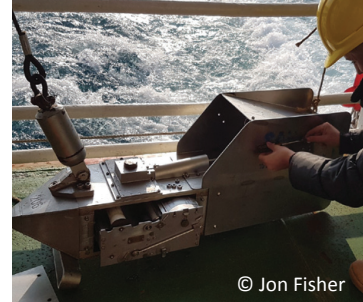




© Wayne Broomfield



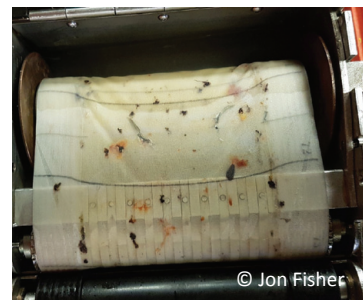
© Brynn Devin



© Jon Fisher



© Jon Fisher



© Jon Fisher

NorthWest Passage Tows

In July, we trained Dr Jon Fisher from Memorial University, Newfoundland as a CPR Technician. Jon was attempting to tow a CPR from the RSS *Shackleton* through the entire length of the NorthWest Passage during the summer of 2017. The goal of these deployments was to sample plankton assemblages and environmental conditions spanning Canada's NorthWest Passage and Atlantic Arctic Gateway. SAHFOS, as well as running the training programme, supplied the equipment and acted as the CPR logistic liaison between the University of Newfoundland and the RSS *Shackleton* for the project.

Jon said: "I was impressed by the breadth and depth of the course offerings and delighted that this successful collaboration resulted in the collection of over 2800 nautical miles of CPR data.

This project was a great success and we hope it will lead to many other CPR ventures in the Arctic.

The data will be instrumental in characterising spatial variation in Canadian Arctic plankton assemblages in a frontier marine environment and provide baseline data against which future changes can be evaluated". [LG & JF](#)

Tow routes through the NorthWest Passage

The data will be instrumental in characterising spatial variation in Canadian Arctic plankton assemblages in a frontier marine environment and provide baseline data against which future changes can be evaluated.



Images

Overleaf. All photos taken on expedition. Top left. The research vessel RSS *Shackleton* in the midnight sun. Middle. A polar bear seen from the ship. Top right. Exchanging internals on the CPR. Centre. Recovery of the CPR after a successful tow. Right. Collected plankton on the silk.

This page. Above. Map of tow routes taken through the NorthWest Passage. Left Dr Jon Fisher (2nd from right) receiving his certificate from Director Willie Wilson and the Operations Team: Julian Morley, Chris Harris and Lance Gregory.

Interested in our training courses?
Contact Lance Gregory
lgreg@mba.ac.uk

Analysis

In 2017, the total number of CPR samples collected for analysis from the North Atlantic and Pacific was over 4100 (Fig. 1.) This reduction from previous years is due to the restructure that took place in early 2017, that led to the cessation of a number of CPR routes from a lack of funding. However, in addition to the routine CPR samples that the team undertook, we also analysed net-caught zooplankton samples from Ireland and Israel, phytoplankton samples from an estuary and additional CPR samples from the tows in the NorthWest Passage (Page 24).

The restructure led to a loss of capacity within the team, reducing the number of analysts to 9 UK staff and 2 overseas, with additional capacity provided by 2 contractors. In August Dr Astrid Fischer, an experienced and respected analyst left for new challenges. This led to a direct replacement and an additional new analyst to cover contractual obligations so we welcomed Dr Chiara Consolaro and Clare Marshall to the team. Despite the challenges posed by these changes, the Analysis Team continued to work professionally and with dedication, and look forward to a successful future.

As mentioned in previous reports, the Gulf of Maine sister-survey samples were collected and stored in the UK, but the decision was made to cease sampling due to the lack of funds. Work is underway to re-visit these samples, as the problems reported in the Northern Right whale population in the region are likely linked to the plankton community in the Gulf of Maine.

CPR analysts continue to develop their skills in taxonomy - regular in-house training is provided, a Phytoplankton Workshop was run in 2017 (page 32), and analysts not only helped with this, but benefited from attendance at lectures and practicals. Senior Analyst Marianne Wootton took part in the IPI phytoplankton component of NMBAQC, and the team are planning the next zooplankton NMBAQC inter-lab exercise. [DJ](#)

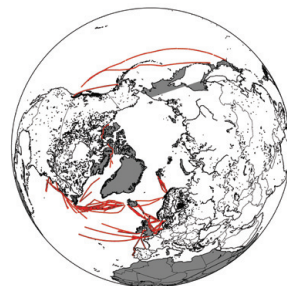


Figure 1.
2017 routes
towed
totalling 4100
samples.

Services We Offer

Considered an International Centre of Excellence for planktonic taxa identification, with experience in plankton analysis from around the world our experienced staff are able to offer a range of services including:

- Phytoplankton identification of net caught, bottle and CPR samples.
- Zooplankton identification (including fish larvae) of net caught, bottle and CPR samples.
- Identification of plankton, including viruses and bacteria, using molecular techniques.
- Rapid quantification and identification of zooplankton samples using FlowCam® Macro.
- Microplastic identification: using light microscopy.
- Laboratory facilities: use of a range of equipment including microscopes and formaldehyde fume cupboards.
- Help with research and student projects.
- Quality control of outside agency analysis.
- Routine monitoring of plankton.
- Environmental impact assessment for plankton.
- Organisation of workshops in plankton taxonomy and other related subjects.
- Bespoke training in plankton identification: tuition one-to-one or small groups.
- Access to the world's largest catalogued plankton archive.
- Lectures for higher education, wildlife groups, expert panels etc.
- Media engagement: radio and television interviews, images and consultancy.

Whether using traditional light microscopy or molecular techniques, we are able to work with formalin, ethanol and lugols preserved specimens. Dr Rowena Stern, a Research Fellow at SAHFOS, is a leading expert in retrieving DNA from notoriously difficult formalin-preserved samples.

Our Analysts have expertise in the identification of plankton from around the world; from polar to tropical waters. Our skills are routinely assessed by participating in external programs such as the North East Atlantic Marine Biological Analytical Quality Control Scheme and the International Phytoplankton Intercomparison exercise.

Interested in our services? Please contact cprsurvey@mba.ac.uk



Taxonomy

During recent decades there has been a steady decline in the number of scientists studying taxonomy and systematics. Although there are a variety of reasons for this 'taxonomy crisis', should we be concerned? Does the world need taxonomists? Taxonomists study, describe and name organisms according to an internally agreed set of rules. Without this classification of the life around us, we would not be able to be certain about the identity of an organism and how it might relate to other organisms. In short, without taxonomy we would not be able to look at biodiversity, a key tool used in ecology and environmental management. With an estimated 90% of the world's species yet to be described, the answer is a resounding yes, we do still need taxonomists!

At SAHFOS we actively promote taxonomy: we regularly organise and host identification workshops (see pages 31 - 33), offer tuition for student projects related to plankton and provide assistance to other scientists requiring plankton identification.

This year we hosted two students and a research assistant from the University of Plymouth. Undergraduate student, Alba Oliver, visited the lab and received training in Plymouth zooplankton identification in relation to her honours project.

Dani Bridger, PhD student, is looking at the effects of an offshore mussel farm in Lyme Bay on the surrounding ecosystem, including plankton. Dani comes to SAHFOS once a year to analyse her plankton samples and is looking to see how the plankton community within the farm compares to outside the farm.

Chloe Game, a research assistant working on a project looking at the atoll environment of the British Indian Ocean Territory (Chagos Archipelago), also received zooplankton identification training on samples collected from the region. Excitingly, preliminary results indicate the presence of a new, i.e. yet to be described, species of copepod in the samples. The results from the plankton sampling together with other parameters such as water property and coral habitat are included in a paper submitted for review. [MW](#)

Sample Archive: a new home

We are proud that, where possible, all CPR samples collected by the Survey are kept for future use; this is undoubtedly a unique and valuable resource. However, given that the CPR Survey is the longest running, most geographically expansive survey of its kind in the world, inevitably this means that a huge number of samples have been amassed over the years: approximately half a million in fact!

Due to an impending demolition of the existing sample storage unit a new home needed to be found. The logistics of sourcing an appropriate home combined with installing suitable air filtration, with the added pressure of a relatively short deadline, would be no mean feat. So how do you rehome an irreplaceable sample archive, estimated to be worth millions! With a team of dedicated, hard-working and positive minded staff of course; which SAHFOS has in bundles.

The entire archive was moved and the new site kitted out by the end of April 2017, with the archive fully operational by mid-July. This was a huge team effort and everyone pitched-in, either moving, cleaning or re-shelving the 3000 boxes.

We are delighted with our new sample archive home. It has easy access, is secure, clean, organised and most of all safe to work in. An added bonus is that we now have some extra space for even more samples. We now have space to house approximately another 10 years' worth of samples at the current rate of collection.

The sample archive has proven to be an invaluable resource, allowing researchers to travel back in time to look at samples, many of which have been collected decades ago. Retrospective analysis have previously taken place on topics such as fisheries, cholera, microplastics, and our in-house developed molecular techniques genetic analysis of phyto- zoo- and bacterioplankton samples preserved in formalin.

Our sample archive is available to collaborating researchers. We actively encourage and promote the use of it in order to accelerate scientific progress. [MW](#)



Interested in developing a project using our sample archive?

Please contact Marianne Wootton mawo@mba.ac.uk



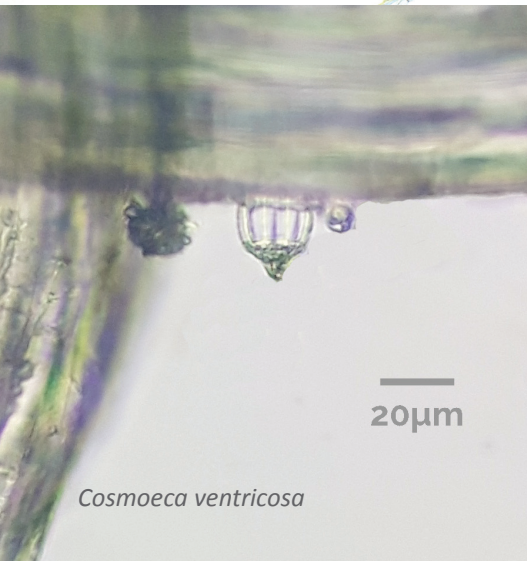
Boreotortanus discaudatus

Interesting and unusual biodiversity records

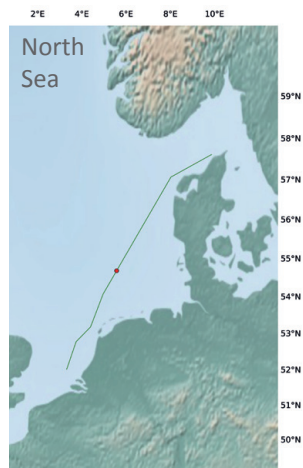
2017 saw the first record of the copepod *Tortanus (Boreotortanus) discaudatus* (left) found in North Sea CPR samples (right). This specimen, from July, was found a long way from home: *T. discaudatus* is typically found in coastal waters off North America. Interestingly, in 2014 researchers from the Scottish Environment Protection Agency also found this copepod in the Firth of Forth. It is therefore conceivable that this non-native species is persisting in the region. With members of the tortanid family known to produce dormant resting eggs, it is possible that *T. tortanus* eggs may have drifted across the Atlantic on ocean currents, or could have hitched a ride to the UK via ship ballast water - as yet the cause is unknown.

The first record of a choanoflagellate found in the CPR Survey! After consultation with world famous choanoflagellate expert Helge Thomsen, this specimen is likely to be *Cosmoeca ventricosa* (left). Despite worldwide in distribution, *C. ventricosa* is thought to only occur in Antarctica during autumn-winter months, in congruence, this CPR specimen was found on a July sample (right).

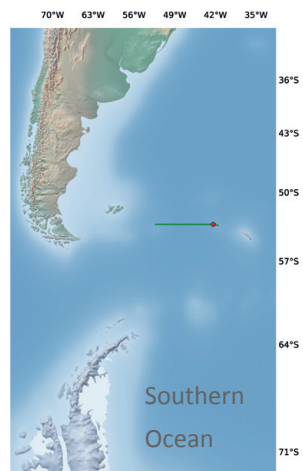
Choanoflagellates have captured the attention of evolutionary biologists for over a hundred years: metazoans (i.e. multicellular organisms, such as you and me) originated from a single-celled ancestor, and choanoflagellates appear to be it. [MW](#)



Cosmoeca ventricosa



Sample Positions



International Quality Control

There is little point in collecting marine data unless you can attest to the quality of the resulting dataset. This is especially true when data are used directly to answer marine policy needs, such as the Water Framework Directive and the Marine Strategy Framework Directive. The NE Atlantic Marine Biological Analytical Quality Control Scheme was set up on behalf of UK competent monitoring authorities, with its principle aim being to develop and promote best practice in relation to sampling and analysis procedures, through a range of training exercises, workshops and literature guides. The scheme comprises of 7 components, with 5 being well established (Fish, Invertebrates, Macroalgae, Particle Size Analysis and Phytoplankton). A further 2 components are also included; zooplankton (led by SAHFOS) and epibiota which, is in development by Joint Nature Conservation Committee.

David Johns continues to Chair the scheme, with Astrid Fischer Technical Secretary until August 2017. She did a fantastic job in a position that has a very steep learning curve, covering as it does so many areas of marine monitoring!

Zooplankton Accreditation Ring Test

The First International NMBAQC Zooplankton Control Test had 19 people from 12 organisations in 5 countries participating. In March, SAHFOS led the results workshop examining the zooplankton ID and enumeration tests, of which SAHFOS analysts scored 100%. The workshop concluded with a decapod training session focusing on invasive species, led by Antonina dos Santos (Instituto Português do Mar e da Atmosfera, Portugal).

Right. Participants from the The First International NMBAQC Zooplankton Control Test

SAHFOS 2017/8 Annual Report



The NMBAQC committee meet annually. In early 2018 they were hosted by Matt Green, Natural Resources Wales, in Cardiff

Astrid has been ably succeeded by Clare Ostle, who took on the role in September 2017. The scheme continues to grow, with new suggestions for components often governed by new policy requirements. [DJ](#)

For more details see www.nmbaqcs.org



4th International Marine Phytoplankton Workshop



Workshop Participants July 2017

July commenced with the 4th International Marine Phytoplankton Identification Workshop. Since its inception in 2009, this two-week workshop proved ever popular, welcoming participants from around the world including Cyprus, Iceland, Ireland, Madeira, Portugal, Saudia Arabia, Seychelles, South Africa, UK and the USA.

We managed to secure world-renowned speakers, some of whom have been with us throughout the workshop's history. Eileen Bresnan (Marine Scotland) kicked off the meeting, talking us through Phytoplankton Taxonomy in Policy. After introductory lectures from Abdul Chrachi (MBA) concerning Microscopy Techniques and Rowena Stern (SAHFOS) regarding

Algal Classification, Diana Sarno (Stazione Zoologica Anton Dohrn, Naples) began her deliverance of all things diatom. Alex Kraberg (Alfred-Wegener Institute) followed the next day, imparting her wealth of knowledge on dinoflagellates to the group whilst Michael Cunliffe (MBA) presented techniques of flow cytometry.

Saturday was a little different – we organised a Plankton Art Day with local artist Debby Mason passing on some great skills. Ananya Ashok won the prize for her great artwork of *Planktoniella sol*. We also offered National Marine Aquarium passes as part of the delegate goodie bag to enjoy one of the local attractions.



Left. Artist Debby Mason demonstrating the ink press. Right. Ananya Ashok and her plankton drawings.



Week two started with Willie Wilson guiding the delegates through Isolation, Culture Techniques and Cryogenic Procedures, with Claire Widdicombe (Plymouth Marine Laboratory) then covering Enumeration, Settling and Slide Preparation. We welcomed the return of Ian Probert (Station Biologique de Roscoff) to disseminate his wealth of knowledge of Haptophytes and Flagellates followed by Wiebe Kooistra (SZN) who introduced the participants to Genetics. The day ended on a trip to Plymouth University to tour their Electron Microscopy Unit, where we offered a competition giving the winner the opportunity to have their own sample photographed. A celebratory meal was held at Citadel Hill where each participant was awarded with a certificate, plus gifts presented to winners of mini-competitions we ran throughout the course. The Royal Marines next door even piped us in!

The last day began with Robert Camp and George Graham demonstrating the FlowCam® Macro, Gerald Boalch (MBA) then took the helm to discuss *Prasinophyceae* and other interesting species, whilst Astrid Fischer (SAHFOS) gave an insight into the International Phytoplankton Intercomparison (IPI) ring

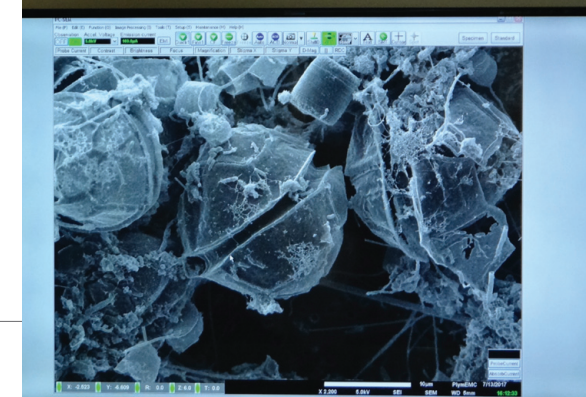
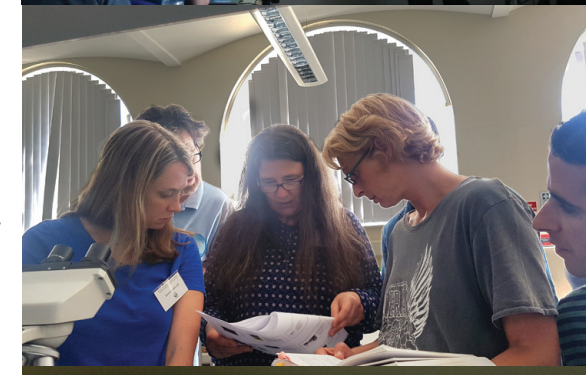
test. The workshop ended with tours of both SAHFOS and the MBA, including a tour of the Seawater Hall and the Library.

We received very positive feedback from the course, the delegates enjoyed their time at SAHFOS and were all very complimentary and appreciated the amount of effort put in.

We are very grateful to EuroMarine for supporting this valuable workshop and must convey our thanks to Zeiss and Plymouth University for providing us with a good range of microscopes. Our thanks must also go to Ian Probert and others at the Roscoff Culture Collection, Alex Kraberg and to Carmelo Tomas (University of North Carolina) for providing us with a plethora of cultures.

Final thanks must go to all the speakers, without their support and passion this event would not be able to go ahead. Further workshops we will advertise on our website. [CT](#)

Images. Top. Wiebe Kooistra's genetic presentation. Middle. Alex Kraberg offering advice in practical session. Bottom. SEM from Plymouth University Electron Microscopy unit.



Data and IT

The IT and Data Teams have been making good progress on a range of infrastructure projects (like streamlining server management and migrating database systems) that pave the way for exciting developments in the way that SAHFOS data can be accessed and visualised. New interactive visualisations of SAHFOS data are being explored (Figure 2) with a view to developing an

interactive data portal. Console - the system for CPR data input and QA/QC - is also being overhauled with the first part of the process, the Tow Log Entry (Figure 3), currently being trialled by users as a web app. Additional developments include work on a SAHFOS Data Service Strategy and scoping of development requirements for the GACS database. [GG](#)



Figure 2. Interactive visualisations available on our website.

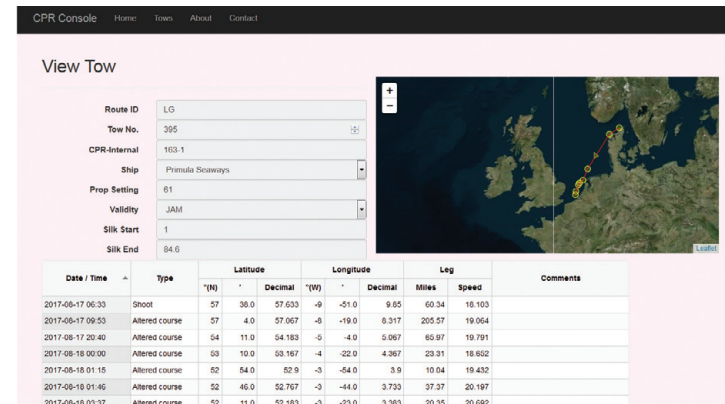


Figure 3. Tow Log Entry currently being trialled as a web app with users.

Website

2017 has seen our online visitors spend longer on our website: 51,864 page views with an average duration of 2mins 20 - the highest in 5 years.

The best performing news story was the publication of the Marine Plankton taxonomic book, more than 27% of news page views were on this story. This page was reached via a link from our social media channels.

The top three most visited pages across the SAHFOS website were our homepage, our staff page and The Continuous Plankton Recorder page. [NR](#)

Want to use our data?

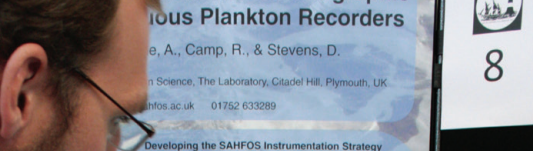
Data lie at the heart of SAHFOS, they are a valuable resource to us and the wider scientific community. Our plankton observations, ancillary datasets and associated metadata are freely available to collaborating researchers conducting research into global change and environmental science. We actively encourage and promote use of CPR data in order to accelerate scientific progress. We offer aggregated datasets which

are consistent over the time of the Survey, and provide a wealth of information without the overload of 'raw' data. Likewise, data can be requested from Standard Areas as monthly means, again making the data-sets more user-friendly. Our staff have many years' experience using the data, and regularly offer advice and suggestions to external scientists, which builds collaborations and is a benefit to all. [DJ](#)



Data Requests in 2017/18 (105)

Our requests ranged from small targets/ areas such as looking at how plankton might affect shellfish growth, effects on fish (fish larvae, salmon and basking shark), seabirds, human health, and large scale indicator development for UK and EU policy work.



Research Highlights



We are involved in a wide variety of research activities, ranging from blue-sky research and new technologies, to policy-driven work. As such, research is carried out not only by the Research Group at SAHFOS, but also in the wider scientific community all over the world, by researchers, students and in major research projects.

Research Themes

CPR Survey science includes both operational and innovative, blue-sky research. Our strategy 'Pathway to a Century,' a 15-year roadmap to guide CPR Survey to a century of observations (1931 – 2031), includes three themes:

Environmental Change



Climate change is one of the greatest societal challenges of the 21st Century. The continued collection and interpretation of CPR Data provides detailed insights into how the ocean is responding to this threat. Analysis of our data allows prediction of future ecosystem function changes. This is critical for understanding oceanic ecology.

Ecosystem Health



As a major reservoir of natural capital, the ocean provides global economic benefits valued at \$2.5 Trillion/ year. Most of that value depends on healthy ecosystems. The CPR platform is capable of performing unique health checks at large ecological scales helping to identify anthropogenic threats such as microplastics, HABS, pathogens and invasive species.

Blue Economy



Blue Economy is best defined as taking inspiration from the ocean to derive economic benefit for a sustainable society. Biodiversity and sustainable resources are the foundations of a vibrant blue economy. Understanding the building blocks through analysis of CPR Data is key to providing insights for ecosystem services and management strategies.

Services we offer

Collaborations

We actively encourage and promote collaborating with fellow researchers in order to accelerate scientific progress. We have expertise in:

- Biogeography
- Macroecology
- Climate change ecology
- Invasive species
- Marine biodiversity
- Geostatistics
- Time-series analysis
- Numerical data analysis and modelling
- Optical methodologies
- Monitoring plankton
- Biogeochemical monitoring
- Molecular ecology and eDNA techniques

Data

Data lies at the heart of SAHFOS, it is a valuable resource to us and the wider scientific community. Our plankton observations, ancillary datasets and associated metadata are freely available to collaborating researchers conducting research into global change and environmental science.

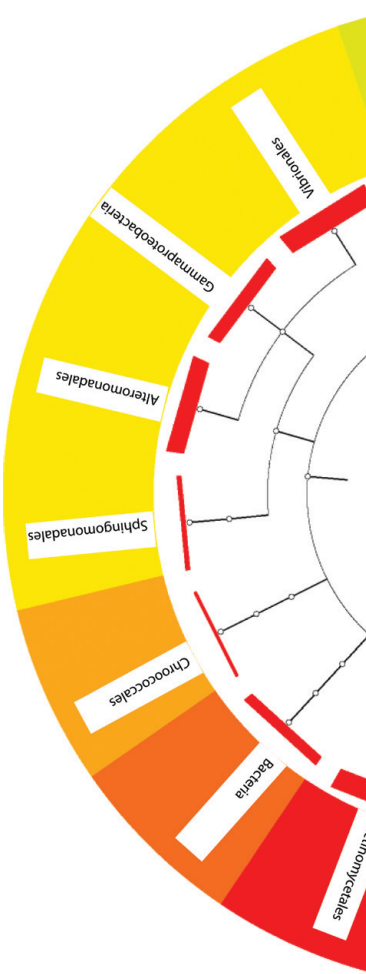
Consultancy

In addition to offering CPR data, the team at SAHFOS can provide expert knowledge, independent and impartial advice or provide evidence for a wide range of marine scientific projects.

Staff have already provided advice and reports to Non-Governmental Organisations, governmental bodies, Competent Monitoring Authorities and private companies, at both national and international levels, on a variety of plankton-themed areas of work.

Policy

The CPR Survey has co-evolved with policy drivers and, through SAHFOS' development of policy-relevant applied indicators, the CPR has played an integral part in providing relevant, targeted advice to UK, European and international decision-makers. The uniqueness of the CPR dataset means SAHFOS holds a distinctive position in the marine scientific policy community. The Survey's issue-driven focus and applied indicator approach have played key roles in ensuring the continuation of this monitoring programme during tenuous economic climates; therefore maintaining the applied aspect of CPR research is crucial.





Plankton's response to climate change

Most of us have a preferred environment where we live. If that environment changes we have two options. We can stay where we are and adapt to those changes, in which case we display 'niche plasticity,' or we can be 'niche conservative' where we move and try to track our preferred environment.

We looked at c. 150,000 CPR samples from the North Atlantic over a 60 year period. We show large differences across 35 plankton taxa. Dinoflagellates and copepods tended to be more niche conservative and track climates changes compared to diatoms which had more niche plasticity

The consequences of this are a change in the structure of the plankton ecosystem. We cannot assume that the ecosystem will remain the same and move as the climate changes and there will be consequences for biogeochemical cycling, higher trophic levels and biodiversity. [AW](#)

Chivers, W. J., A. W. Walne and G. C. Hays (2017). "Mismatch between marine plankton range movements and the velocity of climate change." [Nature Communications](#)

Microplastics in the CPR



SAHFOS have been recording the presence of microplastics in the CPR since 2004, and have been routinely counting and categorising them since 2016. Microplastics have been found all across the North Atlantic and adjacent seas, with higher concentrations in the South North Sea and the Norwegian Sea. Blue strands are the most commonly counted microplastic within the CPR Survey. [CO](#)

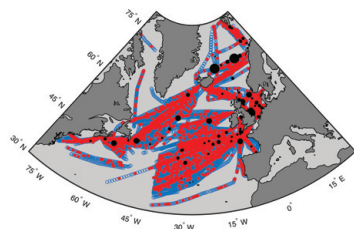


Figure 4. Map of CPR samples since 2004, where red circles = microplastics present within sample, blue open circles = microplastics absent, and black circles = microplastic counted (since 2016).

Influence of Man-Made Structures in the ecosystem: is there a planktonic signal?



To achieve our goal, it was of prime importance to be able to identify the different signals for each planktonic group, to quantify how much they contribute to the main signal, to finally be able to assess whether or not MMS have an impact on the plankton community.

Like an orchestra composed of many instruments we needed to identify the different signals for each planktonic group

The results suggest, however, that when there is a change in the plankton dynamics, either long-term or seasonally, most of the time this is correlated by a change in sea surface temperature and/or wind patterns. Results indicate that, if oil and gas platforms have an impact on plankton, this impact is marginal at the selected spatio-temporal scales (local to regional, month to decade). Even in areas 'colonised' by a huge amount of structures, the plankton dynamic can most of the time be explained by environmental drivers. Furthermore, when biological patterns cannot be explained by SST or the wind, we failed to detect any clear link with either the presence or the quantity of MMS. [PH](#)

INSITE – Influence of Man-Made Structures (MMS) In The Ecosystem is a major industry-sponsored project with the aim of providing independent scientific evidence to better understand the influence of man-made structures on the ecosystem of the North Sea.

SAHFOS focused on trying to identify whether the MMS have had an impact on the plankton community at large scales in space (local to regional) and in time (month to decade).

Plankton respond to their environment in a very complex way, over different space and time scales. The changes in their abundance over time, or the signal of these changed, is composed of a quantity of entangled sub-signals. We can think of this in a similar way as a song (the long term signal) is composed by many instruments, each having its own rhythm, tone and intensity.

The full report can be found: www.insitenorthsea.org/the-insite-science-day-2017/downloads



✚ From microscope to management

Taxonomy as a science is in decline – however, taxonomic information provides a crucial understanding of the most basic component of biodiversity. There is an increasing focus towards sustainable management of the marine environment using an ecosystem approach, and towards conserving biodiversity, key species, and habitats. To do this effectively, sensitive indicators need to be developed to support marine policy, inform conservation efforts for higher trophic organisms, and protect human health. These indicators require detailed taxonomic data. The role of plankton taxonomic data is critical in biodiversity management and conservation. [DJ](#)

McQuatters-Gollop, A., **D. G. Johns**, E. Bresnan, **J. Skinner**, I. Rombouts, **R. Stern**, A. *Aubert, M. Johansen, J. *Bedford and A. Knights (2017). "From microscope to management: The critical value of plankton taxonomy to marine policy and biodiversity conservation." Marine Policy



Understanding algae systems

Whilst plant responses to their environment are known through biotechnology, little is known about marine algae counterparts, that collectively contribute to 50% of Earth's primary productivity. A Sloan-Foundation funded SAHFOS-MBA partnership has managed to identify a common haptophyte as a potential model species that can be used to look at how algae respond to changes in the marine environment. [RS](#)



An isochrysis, a common haptophyte. Credit Planktonnet

✚ A surveillance role for plankton

The Marine Strategy Framework Directive (MSFD) uses an indicator-based approach for ecosystem assessment; to determine whether, or not, these ecosystem components are at 'Good Environmental Status' relative to prevailing oceanographic conditions. As plankton form the base of the marine food web, and are connected through multiple trophic levels to benthos, fish, seals, cetaceans, sea birds and humans, variations in their abundance and species composition can act as indicators of change in current conditions and can be used to understand long term changes in these higher trophic levels. They can also perform a strategic role in assessing these state indicators by influencing target setting and management measures. In addition to their primary role of assessing the state of pelagic habitats against direct anthropogenic pressures, plankton community indicators can therefore also fulfil an important 'surveillance' role. [JB](#)

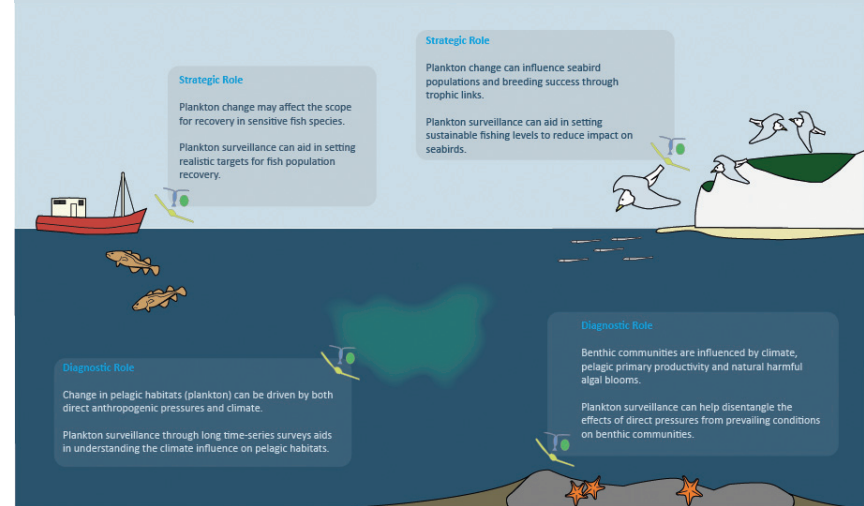


Figure 5. Infographic by Jacob Bedford demonstrating the role of plankton within the MSFD

*Bedford, J., **D. G. Johns**, S. Greenstreet and A. McQuatters-Gollop 2018. "Plankton as prevailing conditions: a surveillance role for plankton indicators within the Marine Strategy Framework Directive." Marine Policy.

Food webs in the Arctic

SAHFOS has been funded to use the CPR Sample Archives to look at plankton food webs in the Arctic as part of NERC's changing arctic ocean research theme. PhD student Elliott Price will be working to understand how climate change is affecting Arctic foodwebs. He will be linking the diet and environmental factors of key arctic zooplankton with top predators in the Arctic using isotope tracing and genetic methods to identify stomach contents of zooplankton from CPR samples and on fresh samples from our ship of opportunity on the Svalbard to Tromso (ST) route. [RS](#)

What controls marine food webs?

The question of whether food webs are resource- (bottom-up) or predation- (top-down) controlled is one of the most fundamental research questions in ecology. Marine ecosystems, originally thought to be mainly steered by bottom-up control, have recently been shown to exhibit periods of top-down control due to the extraction of large predators through fishing or climate oscillations.

Combining more than four decades of monitoring data in a statistical model demonstrates that both bottom-up and top-down effects are regulating processes in the North Sea ecosystem (Fig. 6). The simulations indicate that bottom-up processes, forced by temperature, dominate change in the abundance of planktonic groups, whereas top-down impacts of fishing have dominated change in the biomass of commercially exploited fish. Some species are directly affected by both fishing and temperature (such as cod and sandeel). Interestingly, long indirect pathways occur that exemplify the complexity of the interaction web. For instance, sandeel, herring, sprat and haddock are influenced by indirect temperature effects through a cascade of interactions in the plankton, whereas whiting, zooplankton groups and diatoms are indirectly influenced by fishing mortality. [PH](#)

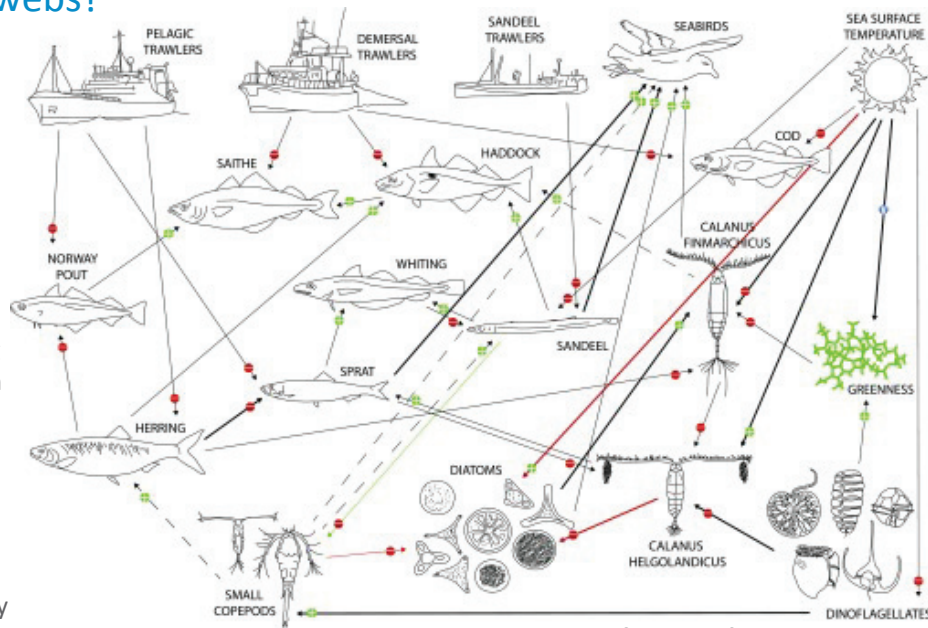
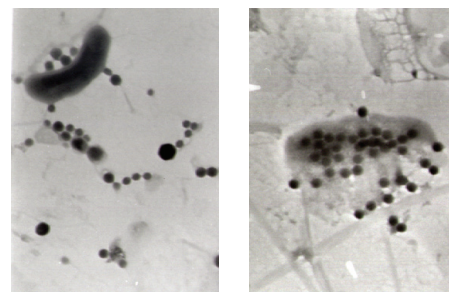


Figure 6. Representation of the significant interactions modelled between functional groups and drivers

The food web is controlled both by bottom up and top-down forces

Lynam, C.P., Llope, M., Möllmann, C., Hélaouët, P., Bayliss-Brown, G.A., Stenseth, N.C., 2017. Interaction between top-down and bottom-up control in marine food webs. [Proceedings of the National Academy of Science.](#)

Antarctic virus shunt impacted by climate change



Viruses from Antarctic samples

An eight year time-series in the Western Antarctic Peninsula (WAP), with an approximately weekly sampling frequency, was used to elucidate changes in virioplankton abundance and their drivers in this climatically-sensitive region. Virioplankton abundances at the coastal WAP show a pronounced seasonal cycle with interannual variability in the timing and magnitude of the summer maxima. Bacterioplankton abundance is the most influential driving factor of the virioplankton, and exhibit closely coupled dynamics. Sea ice cover and duration predetermine levels of phytoplankton stock and thus, influence

virioplankton by dictating the substrates available to the bacterioplankton. However, variations in the composition of the phytoplankton community, and particularly the prominence of Diatoms inferred from silicate drawdown, drive inter-annual differences in the magnitude of the virioplankton bloom; likely again mediated through changes in the bacterioplankton. Findings suggest that future warming within the WAP will cause changes in sea ice that will influence viruses and their microbial hosts through increases in the phytoplankton bloom and shifts in the dominant phytoplankton species. Thus the flow of matter and energy through the viral shunt may be decreased with consequences for the Antarctic food web and element cycling. [WW](#)

Evans C, Wilson W.H. *et. al.* (2017) Drivers of interannual variability in virioplankton abundance at the coastal Western Antarctic Peninsula and the potential effects of climate change. [Environmental Microbiology.](#)

Invasive species



The International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM) convention has recently become legal to control the transfer of potentially invasive species to new marine environments that may harm marine habitats. SAHFOS is partnering with Applied Genomics and the University of Plymouth in using novel genetic detection systems to identify non-native or invasive species and develop a risk categorisation. [RS](#)

Has ocean warming expanded the niche for harmful algal blooms?

Applying a mathematical model to the period 1982–2016, it has been proposed that ocean warming has expanded the niche for harmful algal blooms (HABs) of the species *Dinophysis acuminata* and *Alexandrium fundyense*. These species can generate shellfish toxicity and pose risks to human health. The model predicts an increase in the growth rate and in the duration of the bloom season for these species, with a ‘hot spot’ being the North Eastern Atlantic and North Sea waters surrounding the United Kingdom. Results suggest that other factors, such as prey availability, predation or ecological interactions, are currently limiting any temperature-driven increase in *Dinophysis* in the region. It will be necessary to incorporate these factors within models to fully evaluate climate-driven HAB risk. [DJ](#)

Dees, P., E. Bresnan, A. C. Dale, M. Edwards, D. G. Johns, B. Mouat, C. Whyte and K. Davidson (2017). Harmful algal blooms in the Eastern North Atlantic Ocean. [Proceedings of the National Academy of Sciences](#)

Climate change effect from days to decades



Long-term changes in climate are affecting the abundance, distribution and phenology of species across all trophic levels. Short-term climate variability is also having a profound impact on species and trophic interactions. Crucially, species will experience long- and short-term variation simultaneously, and both are predicted to change, yet studies tend to focus on only one of these temporal scales. Using a novel approach to look at both scales, and how these impact upon a marine top predator (the European Shag). A thirty-year time series of diet data for the bird, along with sea surface temperature and zooplankton data, showed daily effects on the seabirds (from higher wind speeds), to longer term changes caused by variations in key plankton species. [DJ](#)

Left. A European Shag
©Andreas Trepte, www.photo-natur.net

Howells, R. J., D. G. Johns *et. al.* 2018. From days to decades: short- and long-term variation in environmental conditions affect offspring diet composition of a marine top predator. [Marine Ecology Progress Series](#)

Pink Salmon cause a trophic cascade in plankton populations



A 15-year time series of summer observations of plankton populations sampled by CPRs reveals opposing biennial patterns in abundances of large phytoplankton and copepods in waters around the Aleutian Islands, Alaska. This is likely caused by the predation pressure on copepods from highly abundant eastern Kamchatka Pink Salmon, which has a distinct two-year life cycle, that results in a trophic cascade effect by reducing copepod grazing pressure on large diatoms in high-abundance, odd years.

Large copepod abundances are negatively correlated with Pink Salmon - odd years with high Pink Salmon runs have the lowest copepod abundances. Diatoms, which make up a significant proportion of copepod diets, are positively correlated with Pink Salmon - odd years with high Pink Salmon have the highest diatom abundances.

Trophic cascades are not commonly observed in nature but our evidence is compelling. Our work supports the expanded inclusion of annual indicators, trophic effects, and their interactions within the larger context of marine resource management. [SB](#)

Batten, S., G. T. Ruggione, and I. Ortiz. 2018. Pink salmon induce a trophic cascade in plankton populations in the southern Bering Sea and around the Aleutian Islands. [Fish Oceanography](#)

Will ocean warming effect sustainable fishers management?

Including the temperature tolerances (relative to a fish species thermal range) into the development of ecosystems models can help assess the combined impacts of fishing and rising temperatures. By simulating a range of scenarios it allows for the exploration of different management approaches in a warming ecosystem to identify those strategies that best meet a range of objectives. This is an important step to the implementation of an ecosystem approach to sustainable fisheries management in a warming ecosystem and could improve our short-term management of declining stocks such as cod, whiting and herring. [PH](#)

Serpetti, N., Baudron, A.R., Burrows, M.T., Payne, B.L., Hélaouët, P., Fernandes, P.G., Heymans, J.J., 2017. Impact of ocean warming on sustainable fisheries management of the Ecosystem Approach to Fisheries. [Scientific Reports](#)

Rapid Assessment of Zooplankton Abundance

We are exploring the latest in autonomous technology for rapid zooplankton counting (abundance estimation) and discrimination (identification and speciation) in order to assess the feasibility of rapid monitoring and reporting of zooplankton observations. This investigation, which complements our manual taxonomic analysis using conventional microscopy, is part of the SAHFOS contribution to the EU H2020 project AtlantOS (www.atlantos-h2020.eu).

We are using a FlowCam® Macro, which is designed to automatically detect individual particles in an aqueous sample, take high resolution digital images of the particles and derive more than 30 different types of measurements from the digital image (Fig. 7). Designed for the range 50 microns and 5 mm it

ideally fits the size-range of the mesozooplankton. Parameters include count, size and volume and advanced, morphological measurements such as circle fit, perimeter and roughness.

The system is capable of imaging and characterising thousands of particles per second in real-time

The system is capable of imaging and characterising thousands of particles per second in real-time and of differentiating particle types in a heterogeneous sample. Using the particle properties we can screen out unwanted particles such as bubbles and fibres (Fig. 8) using a series of processing steps to achieve images datasets containing only zooplankton of interest.

Utilising image libraries containing similar particles types, generated with input from our expert taxonomic analysts, the FlowCam® Macro then uses simple classification algorithms to

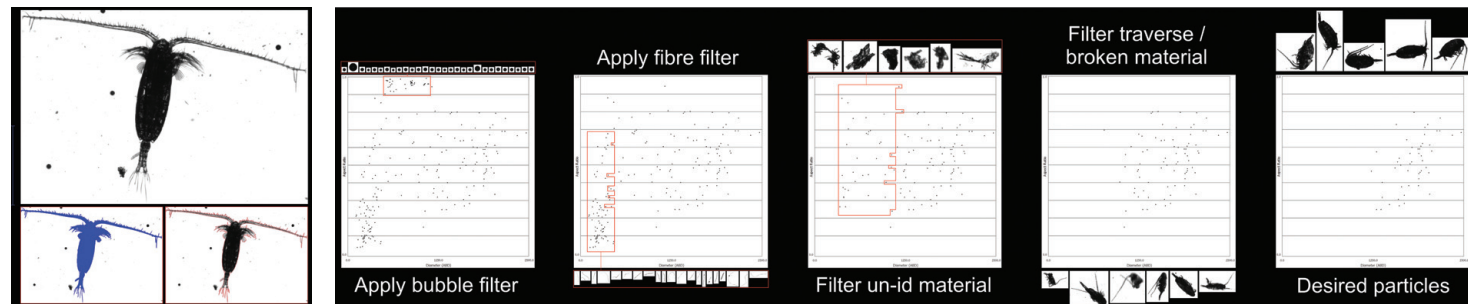
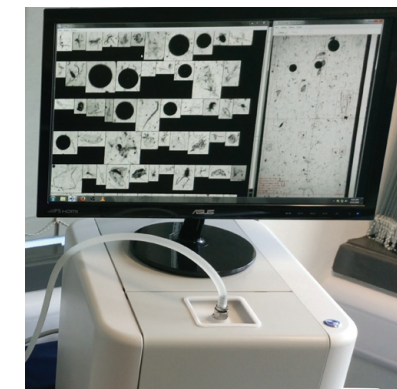


Figure 7 (left). A FlowCam Macro image of a copepod, edges can be automatically traced to estimated perimeter. Figure 8 (right). Typical processing steps (left to right) applied to a CPR sample of particles with different identifiable features (bubbles vs fibres). Clustering is used for removal of extraneous particles.

automatically identify and group the particles as they are imaged. FlowCam® Macro is intended to complement, not replace, traditional CPR analysis. Our Analysis Team currently identifies ~1000 taxonomic entities, many to species level, which is not currently possible by machine. For example, subtle morphological differences between important indicator species such as *Calanus helgolandicus* and *Calanus finmarchicus* are unlikely to be visible on imaged particles. On occasion when these features are visible, they do not produce a difference in particle statistics that allows for these species to be separated. However classification into a range of higher taxonomic groups is feasible and will provide directly comparable categories of particle for inter comparison with the traditional CPR analysis method.

The FlowCam® Macro has proven to consistently produce high quality images of the main components of the mesozooplankton including euphausiids, decapods, copepods and hyperiids. The information obtained from samples run on the FlowCam® Macro could compliment and contribute to the marine observation work carried out by SAHFOS and the collection of bulk zooplankton data needed to support the AtlantOS project in answering challenging questions about the impact of climate change on marine ecosystems. Ongoing tests and research at SAHFOS will further investigate the potential of the FlowCam® Macro to obtain fast and reliable estimates of zooplankton biomass and other plankton metrics. [GG](#)



Left. The AtlantOS Plankton Report.

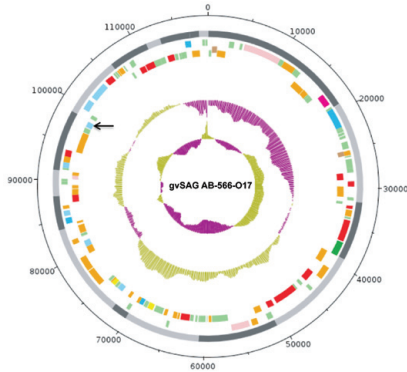
Right. The FlowCam® Macro®.



SAHFOS 2017/8 Annual Report

Edwards, M., D. Broughton, R. Camp, G. Graham, P. Helaouët and R. Stern (2017). AtlantOS Plankton Report: Based on observations from the Continuous Plankton Recorder Survey. [SAHFOS Technical Report](#)

Hidden world of giant viruses discovered



From a teaspoon of seawater, we discovered a hidden world of giant viruses. Using a newly developed technique called single virus genomics, we picked out individual viruses from seawater collected from the Gulf of Maine (off the East Coast of the US) and analysed their genomes. The discovery was unique since no cultivation of the viruses was required, this was the first time such giant viruses had been isolated from the 'wild'. The research also revealed that every giant virus analysed by the team was different and new to science. Strikingly, some of the genomes also revealed new infection mechanisms or enzymes not previously observed in viruses. A whole new world of viruses has been revealed! [WW](#)

Figure 9. Giant virus single amplified genome, arrow highlights the discovery of a metacaspase gene never seen in viruses before

Wilson W.H., Gilg I.C. *et al.* 2017. Genomic exploration of individual giant ocean viruses. [The ISME Journal](#)

Arguments for long-term ecological monitoring

Ecological models require the use of real-life data to train and confirm findings. Using the CPR dataset it has been demonstrated that long-term observations reveal both the prevalence of nonlinear processes in species abundances and an improvement in out-of-sample predictability as the number of observations increase.

The Survey's dataset is a premiere example of how continuous long-term projects help to create new perspectives in ecology. By providing robust, longterm datasets, it captures variability in species abundance that occurs on temporal scales ranging from interannual cycles to multidecadal shifts. Furthermore, the global collaboration with surveys around the world gives plankton counts in nearly every major ocean basin on earth. In addition to

providing a long-term description of population dynamics, these spatially broad environmental monitoring programs can provide regional insights into global problems. Beyond the common sense value of collecting these data, our analyses provide a quantitative justification for continued support of these programs. These data are critical for predictability and understanding, and are particularly important given increasing threats to global ecosystems, such as human exploitation pressures and climate change. [DJ](#)

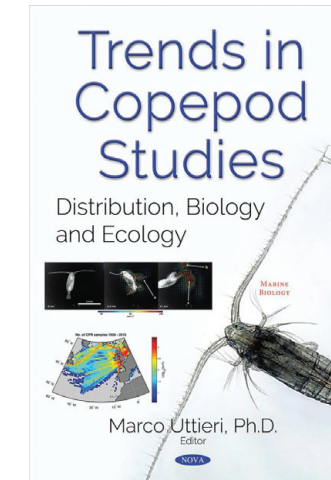
Giron-Nava, D. G. Johns *et al.* (2017). Quantitative argument for long-term ecological monitoring. [Marine Ecology Progress Series](#)

Blue Planet II



If you were one of the millions of viewers who tuned into this extraordinary series you would have noticed plankton featured throughout. David Johns was a scientific consultant and provided some of the vital statistics used in Sir David Attenborough's narrative and in the book to accompany the series.

Trends in Copepod Studies



The front cover of the book displays a map of CPR samples collected in the North Atlantic between 1958 and 2015.

SAHFOS contributed one chapter to this comprehensive book on copepods. Using CPR data we summarised the main findings on pelagic copepods, showed the importance of long-term surveys, highlighted key policy issues that the Survey has contributed to over time and discussed the strengths and limitations of CPR observations.

MCCIP Report



With the foreword by Sir David Attenborough these report cards summarise 10 years experience of science to policy reporting.

SAHFOS scientists contributed to three chapters: Ocean Acidification, Non-native species and Human Health.

Knowledge Exchange

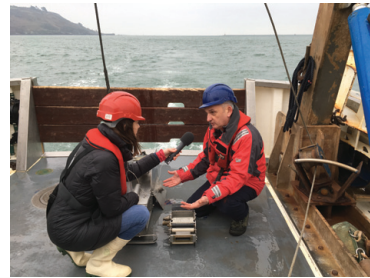


Media

We want to share the world-class science emanating from SAHFOS and are happy to handle enquiries from across all media platforms. Our scientists are also available for media interviews on recent marine biological findings or areas of our expertise that are in the news. This expertise covers a wide range of fields and specialities including: climate change, biodiversity, plankton taxonomy, jellyfish, harmful algae, fisheries and marine policy. With scientists from across a wealth of countries, we can attend to enquiries from non-English speaking communities. [NR](#)

BBC World Service

Reporters from the BBC's World Service visited SAHFOS in February to find out more about the CPR Survey for the popular radio programme, The Food Chain.



BBC
WORLD
SERVICE



The Food Chain

Heart FM

This national radio station interviewed us about the CPR resulting in several 'Drive time' sound bites.



Discovery Channel

The Canadian Discovery TV crew filming for the 'Daily Planet Show' programme presenting the CPR story from a tow in the North Sea to samples under our microscope.



New online shop

Towards the end of 2017, we launched a brand new online shop, selling various plankton and CPR themed clothing and accessories. The shop is provided in partnership with Teemill, a UK based company who champion organic, sustainable and ethical clothing, without compromising on style.

Every item is designed in-house by SAHFOS staff and produced by Teemill using certified organic materials, printed in a wind powered factory, and shipped in plastic-free packaging.

With every item sold SAHFOS receives a small donation, so this shop provides a great way to show your love for the ocean and support SAHFOS at the same time!

Since opening in November, the shop has enjoyed a high volume of traffic and sales from around the world, with many people sharing photographs of their purchases on social media.

Visit the shop today <https://themba.teemill.co.uk/>



Check out our shop
themba.teemill.co.uk



Outreach activities

Communicating SAHFOS science and engaging with a variety of audiences is at the heart of our organisation. Activities such as training workshops, delivering presentations at scientific conferences and introducing school children to the wonders of the marine environment are all part of the rich calendar of events we carry out each year. **JS**



British Science Week

This 2-day event welcomed over 130 secondary and primary school students to discover marine science in action and learn about the many ways we depend on life in the sea.



Cornwall College

We had a great day hosting 20 third-year undergraduate students from Cornwall College, introducing them to the CPR Survey and helping them develop their zooplankton identification skills.



SAHFOS welcomes new local MP

Labour MP Luke Pollard enjoyed a trip to Citadel Hill to discover more about SAHFOS and the MBA. Pictured with Interim Director Dr Matt Frost (left) and Willie Wilson.



Commemorative Symposium for the 33rd International Prize for Biology in Japan

Funded by the University of Tsukuba, Willie Wilson was invited to deliver a presentation at the prestigious 'Marine biology opens a frontier for the future' Symposium and was also lucky enough to meet the Emperor and Empress of Japan.



Plankton Art Masterclass

In partnership with local artist Debbie Mason, we hosted a Plankton Art Masterclass which proved very popular and led to the production of some excellent prints.



Plymouth Medical Society

Outreach Officer Jennifer Skinner was invited to give an after dinner talk about the CPR Survey to this group as part of their programme of evening lectures.



EU Maritime Conference

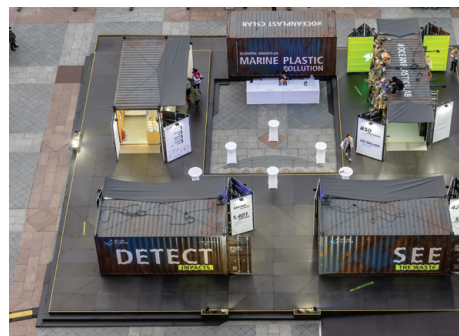
Senior Plankton Analyst Marianne Wootton and Director Willie Wilson headed to Poole in May for the EU Maritime Festival and attended the 2 day conference on 'The Future of our Seas'.



MASTS Annual Science Meeting

SAHFOS hosted a special session at the Marine Alliance for Science and Technology for Scotland (MASTS) ASM on maximising monitoring potential of volunteer observing systems.

The session began with invited speaker Claire Durkin, Head of Global Science, Innovation and Knowledge Economy for the Department of Business, Engineering and Industrial Strategy (BEIS). Followed by Operations Manager Lance Gregory who highlighted the work and support we get from our 'Navy of Volunteers'.



Ocean Plastics Lab

Launched this year, the Ocean Plastics Lab is a travelling exhibition, showcasing the contribution of science to understand and combat the problem of plastics in the ocean. SAHFOS contributed CPR silks and information on the spread and abundance of plastic as recorded by the CPR Survey. So far, the Lab has welcomed over 10,000 visitors during stops in Turin and Paris, and will be heading to Brussels, Washington and Ottawa in 2018.



World Symposium on Climate Change Communication

Outreach Officer, Jennifer Skinner, delivered a presentation at this symposium entitled "Addressing the challenges and opportunities associated with communicating climate change research on the microscopic scale".



ICES Annual Science Conference 2017

The SAHFOS trade stand was on display at the ICES ASC in Fort Lauderdale, Florida, in September offering delegates the chance to find out more about the CPR Survey and collaborative opportunities. SAHFOS research was also represented during one of the evening poster sessions with a presentation of Pierre Hélaouët's work as part of the INSITE project.



Showcasing SAHFOS at the NMA's Christmas lecture

The SAHFOS trade stand was the perfect accompaniment to Plymouth University's Prof John Spicer's sold out Christmas lecture at the National Marine Aquarium, entitled 'A Marine Biologist in Antarctica'.



PlyMSEF Medal Lecture

SAHFOS Director Willie Wilson presented this year's PlyMSEF medal to Prof Doug Wallace from Dalhousie University, Nova Scotia, for his talk entitled 'Vital signs: Monitoring the ocean's deep breathing in the Labrador Sea'.

Social media

 @CPRSurvey
3,500 followers

 @CPRSurvey
1,000 likes

 www
52,864 page views

Our social media accounts continue to grow with more users 'following' us and an increased level of interaction. Twitter is the more popular platform for our users; we gained on average 60 new followers each month.

Follow us on social media

@cprsurvey



Invisible Worlds

As a textile artist working from my Studio Gallery in St Agnes on the Cornish coast, revealing often hidden marine treasures has become central to my artwork.

Through research I came to SAHFOS where I dived into the world of phytoplankton. The chance to spend time in their laboratory looking at plankton from all over the world is mindblowing to a nature lover and an awe-inspiring gift to an artist.

Simply looking down a microscope is amazing to a novice. As Alice fell down the rabbit hole, I fell through the silk hole! Despite discovering how difficult it is to draw whilst looking down a microscope, I wanted to stay all night looking at the detailed, beautiful and purposeful structure of these tiny organisms. I found inspiration in everything I saw. From looking through different planes and layers of plankton down the microscope to their colour or absence of colour. I loved the buzz and complexity of naming (and hints at stories behind names). I was struck by the

contrast of minute individual organisms against blooms visible from space colouring vast swathes of sea.

The rolls of silk themselves are beautiful to me, vintage feel fabrics, their blue markings and nautical mile numbers, and their ability to capture so much vital information about our planet. All this inspiration now influences the materials, approaches and techniques I choose back in the Studio. In some pieces I simply re-live the shapes and patterns I saw as I 'draw with my needle and threads' into felt I have just made. In others, artistic license exaggerates features and something more abstract is created.

Layering fabrics is a frequent feature in my artwork. Adding sheer fabrics alters shades and textures underneath and is perfect for the 'planes', layers and directions of plankton under the microscopes. I layer translucent and bronze fabric, including collection silks, over and under muted embroidery threads, not just expected ocean blues and greens.

'Invisible Worlds' is an ongoing project, building up a body of work which will be on view in my St Agnes Gallery and elsewhere. It is an open Studio so people can see my processes too.

As Alice fell down the rabbit hole, I fell through the silk hole into the magical world of plankton

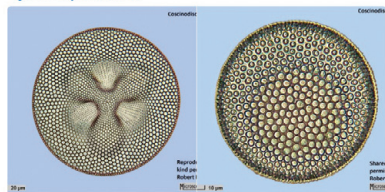
Top Tweets of 2017

June's tweet

Earned 9,366 impressions

276 engagements

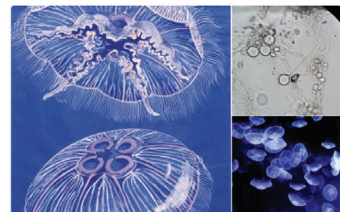
The glass-like cell walls of algae like these *Coscinodiscus* turn the cell into a mini greenhouse, capturing 100% of sunlight #yearofplankton



November's tweet

Earned 6,285 impressions

Did you know a collective noun for jellyfish is a smack?! Most feed on #plankton, although larger jellies also eat crustaceans, fish & even other jellyfish. @SAHFOS we regularly record the stinging cells (nematocysts) from jellyfish on our CPR silks! #yearofplankton #BluePlanet2



July's tweet

Earned 6,485 impressions

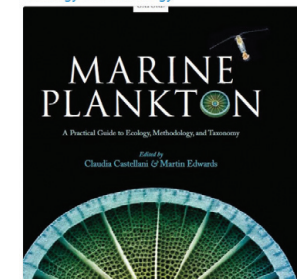
A big @SAHFOS welcome to 15 delegates of 10 different countries here for 4th International Marine Phytoplankton Taxonomy Workshop #phyto2017



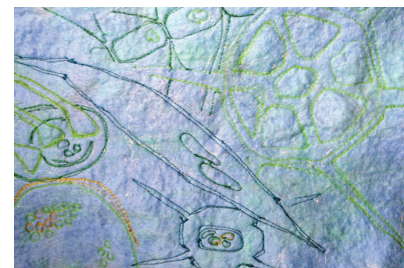
February's tweet

Earned 5,736 impressions

OUT NOW! 'Marine plankton', a practical guide by @SAHFOS. More info here: buff.ly/2kQyJn1 #plankton #taxonomy #ecology #methodology



Look out for our 2018 posts where we will be celebrating #60yearsofdata



Future of Our Seas

Selected by NERC, SAHFOS was chosen as part of a new 'Future of Our Seas' consortium, to build capacity in public engagement with environmental research across the UK.

As one of the six successful bids, the Future of Our Seas project combines scientists, facilitators, creatives and skilled media communicators, to develop researcher's capacity and skills to engage people in a nation-wide conversation on our marine environment.

In March, the first of two three-day researcher training events took place in

Plymouth at Citadel Hill Laboratories. During this workshop, participants developed their communication skills and began to develop ideas on how to design an engaging activity to promote their research at a large public event in May. The training workshop will be repeated in Oban, Scotland, in June with a similar large-scale public event in August.

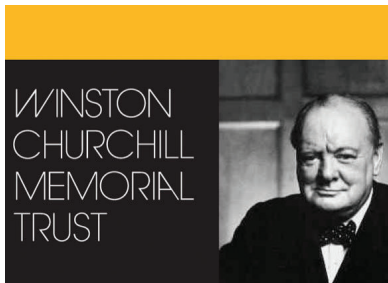
The consortium brings together eight other major UK-leading marine research, engagement, advocacy and environmental arts organisations. Together they will consolidate their learning, expertise



Participants of the Future of Our Seas Researcher training event in March

and training into a blueprint for how to build consortia, build capacity, and how to create innovative activities in public engagement. [JS](#)

Winston Churchill Memorial Trust Fellowship



The Winston Churchill Memorial Trust Fellowship funds UK citizens travel overseas and the opportunity to develop a skillset that could translate back in the UK.

Initial development of the SAHFOS philanthropic and fundraising efforts showed the US approach to private funding came up time and again as best practice. From 1,200 applicants Fundraising Manager Nicola Rickard was selected to travel to the US to develop a skillset for the creation of a Fundraising Strategy for SAHFOS.

From Aquariums to Marine Science Institutes, State Governor's to philanthropic Hollywood actors; everyone approached was very willing to share their thoughts and practices. This has provided a true insight into the logistics and priorities necessary to run a successful philanthropy office. These contacts have still been maintained and there may be opportunity in future to develop them further. [NR](#)

Publications

SAHFOS staff in bold.

*Associate Researchers/
Students

Peer-Review : 35

Batten, S., Ruggerone, G.T. and Ortiz, I., 2018. Pink salmon induce a trophic cascade in plankton populations in the southern Bering Sea and around the Aleutian Islands. *Fish Oceanography*.

*Bedford, J., **D. G. Johns**, S. Greenstreet and *A. McQuatters-Gollop (2018). "Plankton as prevailing conditions: a surveillance role for plankton indicators within the Marine Strategy Framework Directive." *Marine Policy* **89**: 109-115.

*Beaugrand, G., and R.R. Kirby. "How Do Marine Pelagic Species Respond to Climate Change? Theories and Observations." *Annual Review of Marine Science* **10**, **1** (2018): 169-97.

Bonitz, F. G. W., C. Andersson, T. Trofimova and H. Hátún (2018). "Links between phytoplankton dynamics and shell growth of *Arctica islandica* on the Faroe Shelf." *Journal of Marine Systems* **179**: 72-87.

Brown, T., D. D. Kelly, S. Vercauteren, **W. H. Wilson** and A. Werner (2017). "How Biobanks Are Assessing and Measuring Their Financial Sustainability." *Biopreservation and Biobanking* **15**(1): 65-71.

Capuzzo, E., C. P. Lynam, J. Barry, D. Stephens, R. M. Forster, N. Greenwood, *A. McQuatters-Gollop, T. Silva, S. M. van Leeuwen and G. H. Engelhard (2017). "A decline in primary production in the North Sea over 25 years, associated with reductions in zooplankton abundance and fish stock recruitment." *Global Change Biology*: 1-13.

Chivers, W. J., **A. W. Walne** and G. C. Hays (2017). "Mismatch between marine plankton range movements and the velocity of climate change." *Nature Communications* **8**(14434).

Clare, D. S., M. Spencer, L. A. Robinson and C. L. Frid (2017). "Explaining ecological shifts: the roles of temperature and primary production in the long-term dynamics of benthic faunal composition." *Oikos* **126**(8): 1123-1133.

Dees, P., E. Bresnan, A. C. Dale, **M. Edwards**, **D. G. Johns**, B. Mouat, C. Whyte and K. Davidson (2017). "Harmful

algal blooms in the Eastern North Atlantic Ocean." *Proceedings of the National Academy of Sciences* **114**(46): E9763-E9764.

Dencker, T. S., L. Pecuchet, E. Beukhof, K. Richardson, M. R. Payne and M. Lindegren (2017). "Temporal and spatial differences between taxonomic and trait biodiversity in a large marine ecosystem: Causes and consequences." *PLoS ONE* **12**(12): e0189731.

dos Santos Schmidt, T. C., A. Slotte, J. Kennedy, S. Sundby, A. Johannessen, G. J. Óskarsson, Y. Kurita, N. C. Stenseth and O. S. Kjesbu (2017). "Oogenesis and reproductive investment of Atlantic herring are functions of not only present but long-ago environmental influences as well." *Proceedings of the National Academy of Sciences* **114**(10): 2634-2639.

Evans, C., J. Brandsma, D. W. Pond, H. J. Venables, M. P. Meredith, H. J. Witte, S. Stammerjohn, **W. H. Wilson**, A. Clarke and C. P. Brussaard (2017). "Drivers of interannual variability in virioplankton abundance at the coastal Western Antarctic Peninsula and the potential effects of climate change." *Environmental Microbiology* **19**(2): 740-755.

Everett, J. D., M. E. Baird, P. Buchanan, C. Bulman, C. Davies, R. Downie, C. Griffiths, R. Heneghan, R. J. Kloser, L. Laiolo, A. Lara-Lopez, H. Lozano-Montes, R. J. Matear, F. McEnulty, B. Robson, W. Rochester, J. Skerratt, J. A. Smith, J. Strzelecki, I. M. Suthers, K. M. Swadling, P. van Ruth and A. J. Richardson (2017). "Modelling What We Sample and Sampling What We Model: Challenges for Zooplankton Model Assessment." Frontiers in Marine Science **4**(77).

Fu, C., N. Olsen, N. Taylor, A. Grüss, S. **Batten**, H. Liu, P. Verley, Y.-J. Shin and handling editor J. Link (2017). "Spatial and temporal dynamics of predator-prey species interactions off western Canada." ICES Journal of Marine Science **74**(8): 2107-2119.

Giering, S. L. C., R. Sanders, A. P. Martin, S. A. Henson, J. S. Riley, C. M. Marsay and **D. G. Johns** (2017). "Particle flux in the oceans: Challenging the steady state assumption." Global Biogeochemical Cycles **31**(1): 159-171.

Giron-Nava, A., C. C. James, A. F. Johnson, D. Dannecker, B. Kolody, A. Lee, M. Nagarkar, G. M. Pao, H. Ye and **D. G. Johns** (2017). "Quantitative argument for

long-term ecological monitoring." Marine Ecology Progress Series **572**: 269-274.

Holm, M. W., T. Kjørboe, P. Brun, **P. Licandro**, R. Almeda and B. W. Hansen (2017). "Resting eggs in free living marine and estuarine copepods." Journal of Plankton Research: 1-14.

Hoppenrath, M., N. Yubuki, **R. Stern** and B. S. Leander (2017). "Ultrastructure and molecular phylogenetic position of a new marine sand-dwelling dinoflagellate from British Columbia, Canada: *Pseudadenoides polypirenooides* sp. nov. (Dinophyceae)." European Journal of Phycology **52**(2): 208-224.

Howells, R. J., S. J. Burthe, J. A. Green, M. P. Harris, M. A. Newell, A. Butler, **D. G. Johns**, E. J. Carnell, S. Wanless and F. Daunt (2017). "From days to decades: short- and long-term variation in environmental conditions affect offspring diet composition of a marine top predator." Marine Ecology Progress Series **583**: 227-242.

Krovnin A.S., Melnikov S.P., Kivva K.K., Artemenkov D.V., Moury G.P. (2017). Influence of variability of oceanological conditions on redfish in the North Atlantic pelagial. Trudy VNIRO. **169**: 51-63

Lawrence, S. A., S. A. Floge, J. E. Davy, S. K. Davy and **W. H. Wilson** (2017). "Exploratory analysis of Symbiodinium transcriptomes reveals potential latent infection by large dsDNA viruses." Environmental Microbiology.

Lindgren, M., M. Van Deurs, B. R. MacKenzie, L. Worsoe Clausen, A. Christensen and A. Rindorf (2017). "Productivity and recovery of forage fish under climate change and fishing: North Sea sandeel as a case study." Fisheries Oceanography

Lynam, C. P., M. Llope, C. Möllmann, **P. Hélaouët**, G. A. Bayliss-Brown and N. C. Stenseth (2017). "Interaction between top-down and bottom-up control in marine food webs." Proceedings of the National Academy of Sciences **114**(8): 1952-1957.

Mahadik, G. A., **C. Castellani** and M. G. *Mazzocchi (2017). "Effect of diatom morphology on the small-scale behaviour of the copepod *Temora stylifera* (Dana, 1849)." Journal of Experimental Marine Biology and Ecology **493**(Supplement C): 41-48.

Manno, C., N. Bednaršek, G. A. Tarling, V. L. Peck, S. Comeau, D. Adhikari, D. C. E. Bakker, E. Bauerfeind, A. J. Bergan, M.

I. Berning, E. Buitenhuis, A. K. Burrige, M. Chierici, S. Flöter, A. Fransson, J. Gardner, E. L. Howes, N. Keul, K. Kimoto, P. Kohnert, G. L. Lawson, S. Lischka, A. Maas, L. Mekkes, R. L. Oakes, C. Pebody, K. T. C. A. Peijnenburg, M. Seifert, **J. Skinner**, P. S. Thibodeau, D. Wall-Palmer and P. Ziveri (2017). "Shelled pteropods in peril: Assessing vulnerability in a high CO2 ocean." Earth-Science Reviews **169**: 132-145.

*McQuatters-Gollop, A., **D. G. Johns**, E. Bresnan, **J. Skinner**, I. Rombouts, **R. Stern**, A. *Aubert, M. Johansen, J. *Bedford and A. Knights (2017). "From microscope to management: The critical value of plankton taxonomy to marine policy and biodiversity conservation." Marine Policy **83**: 1-10.

Meyer-Gutbrod, E. L. and C. H. Greene (2017). "Uncertain recovery of the North Atlantic right whale in a changing ocean." Global Change Biology: 1-10.

Middleton, J. E., J. Martínez Martínez, **W. H. Wilson** and N. R. Record (2017). "Functional dynamics of *Emiliana huxleyi* virus-host interactions across multiple spatial scales." Limnology and Oceanography **62**(3): 922-933.

Reuman, D. C., L. Zhao, L. W. Sheppard, **P. C. Reid** and J. E. Cohen (2017). "Synchrony affects Taylor's law in theory and data." Proceedings of the National Academy of Sciences: 201703593.

Serpenti, N., A. R. Baudron, M. T. Burrows, B. L. Payne, **P. Helaouët**, P. G. Fernandes and J. J. Heymans (2017). "Impact of ocean warming on sustainable fisheries management informs the Ecosystem Approach to Fisheries." Scientific Reports **7**(1): 13438.

Sheppard, L. W., **P. C. Reid** and D. C. Reuman (2017). "Rapid surrogate testing of wavelet coherences." EPJ Nonlinear Biomedical Physics **5**: 1.

Vezzulli, L., **W. H. Wilson**, and C. Pruzzo. Investigating the Macroecology of Emerging Vibrio Pathogens in the ocean using the Continuous Plankton Recorder technology. CIESM Workshop Monograph. **49**. 158pp

Weynberg, K., M. Allen and **W. H. Wilson** (2017). "Marine Prasinoviruses and Their Tiny Plankton Hosts: A Review." Viruses **9**(3): 43.

Wilson, W. H., I. C. Gilg, M. Moniruzzaman, E. K. Field, S. Koren, G. R. LeCleir, J. M. Martínez, N. J. Poulton, B. K. Swan

and R. Stepanauskas (2017). "Genomic exploration of individual giant ocean viruses." The ISME Journal **11**: 1736-1745.

Submitted/ Accepted/ In Press: 7

Batten, S. D., D. E. *Raitsos, S. Danielson, R. Hopcroft, K. Coyle and *A. McQuatters-Gollop (Accepted). "Interannual variability in lower trophic levels on the Alaskan Shelf." Deep Sea Research Part II: Topical Studies in Oceanography.

Burns, F., M. A. Eaton, D. B. Hayhow, C. L. Outhwaite, N. Al Fulajj, T. A. August, K. L. Boughey, T. Brereton, A. Brown, D. J. Bullock, T. Gent, K. A. Haysom, N. J. B. Isaac, **D. G. Johns**, M. C. R., F. Mathews, D. G. Noble, G. D. Powney, D. W. Sims, S. M. Smart, K. J. Walker, J. R. Webb, T. J. Webb and R. D. Gregory (Submitted). "An assessment of the state of nature in the United Kingdom: a review of findings, methods and impact." Ecological Indicators.

Fowler, A., A.-M. Jørgensen, J. Svendsen, P. Macreadie, D. Jones, A. Boon, D. Booth, R. Brabant, E. Callahan, J. Claisse, T. Dahlgren, Q. Dokken, **D. G. Johns**, R. Leewis, H. Lindeboom, R. May, A. Murk, G. Ottersen,

D. Schroeder, S. Shastri, J. Teilmann, V. Todd, G. Van Hoey, J. Vanaverbeke and J. Coolen (Submitted). "Environmental benefits of leaving offshore infrastructure in the Ocean." Frontiers in Ecology and Environment.

Hartman, S., M. Humphreys, C. Kivimäe, M. Woodward, V. Kitidis, T. McGrath, D. Hydes, N. Greenwood, **C. Ostle**, D. Pearce, D. Sivy, B. Stewart, P. Walsham, E. McGovern, C. Harris, A. Griffiths, A. Smilenova, J. Clarke, C. Davis and P. Nightingale (Submitted). "Seasonality and spatial heterogeneity of the surface water carbonate system on the NW European shelf." Progress in Oceanography.

James, C. C., A. Giron-Nava, A. F. Johnson, D. Dannecker, B. Kolody, A. Lee, M. Nagarkar, H. Ye, **D. G. Johns**, **M. Edwards** and G. Sugihara (Submitted). "Mutual influence webs unravel the mysteries of ecosystem structuring." *Science*.

Sheehan, E. V., P. Hosegood, C. Game, M. J. Attrill, D. Tickler, **M. Wootton**, **D. G. Johns** and J. J. Meeuwig (Submitted). "The effect of deep oceanic flushing on water properties and ecosystem functioning within atolls in the British Indian Ocean Territory." Limnology and Oceanography.

Stamieszkin, K., N. C. Millette, J. Y. Luo, E. M. Follett, N. R. Record and D. G. Johns (Submitted). "Conditions for mixotrophy in the North Atlantic Ocean." Proceedings of the National Academy of Sciences.

Technical Reports/ Books : 7

Bresnan, E., C. B. Austin, C. J. A. Campos, K. Davidson, **M. Edwards**, A. Hall, D. Lees, A. Mckinney, S. Milligang and J. Silkeh (2017). Human Health. MCCIP Science Review 2017.

Castellani, C. and **M. Edwards** (2017). Marine Plankton: A Practical Guide to Ecology, Methodology, and Taxonomy. Oxford University Press.

Costello, M. J., Z. Basher, L. McLeod, I. Assad, S. Claus, F. Hernandez, J. Mees, L. Vandepitte, M. Yasuhara, H. Gislason, **M. Edwards**, W. Appeltans, H. Enevoldsen, G. Edgar, P. Miloslavich, S. D. Monte and I. S. Pinto (2016). Chapter 7. Methods for the observation of marine biodiversity. In: The GEO Handbook on Biodiversity Observation Networks. Springer International Publishing AG.

Cottier-Cook, E. J., C. Beveridge, J. D. D. Bishop, J. Brodie, P. F. Clark, G. Epstein, S. R. Jenkins, **D. G. Johns**, J. Loxton, A. MacLeod, C. Maggs, D. Minchin, F. Mineur, J. Sewell and C. A. and Wood (2017). Non-native species. MCCIP Science Review 2017: 47-61.

Edwards, M., D. Broughton, R. Camp, G. Graham, P. Hélaouët and **R. Stern** (2017). AtlantOS plankton report: Based on observations from the Continuous Plankton Recorder Survey. SAHFOS Technical Report. 12: 1-15.

Williamson, P., C. Turley and **C. Ostle** (2017). Ocean acidification. MCCIP Science Review 2017: 47-61.

Wootton, M., A. C. Fischer, C. Ostle, J. Skinner, D. P. Stevens and **D. G. Johns** (In Press). Using the Continuous Plankton Recorder to Study the Distribution and Ecology of Marine Pelagic Copepods. New York Nova Science Publishers, Inc.

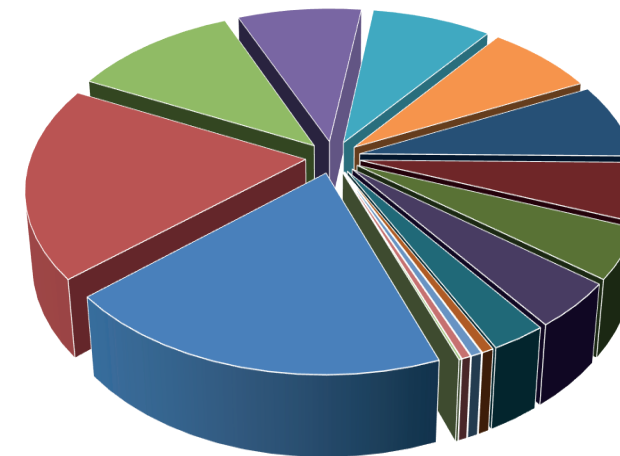
Financial Summary

The principal sources of funding for 2017/18 are broadly derived from grants and contract income from Primary Funding Organisations, and Research & Academic Organisations.

Primary Funding Organisations provide support funding to enable the general operation of the CPR Survey.

In 2017/18 these were: Natural Environment Research Council (NERC) UK, Department of Environment, Food and Rural Affairs (Defra) UK and National Science Foundation (NSF)/ Woods Hole Oceanographic Institution (WHOI) U.S.

Research & Academic Organisations commission SAHFOS, to undertake specific research or tow specific routes. SAHFOS may also collaborate with other research groups, at times under the umbrella of International Organisations.



In 2017/18 these were:

Prince William Sound Science Centre, North Pacific Research Board, Dept. of Fisheries & Oceans Canada, European Union, European Environment Agency, Institute of Marine Research Norway, Oil & Gas UK, Bermuda Institute of Ocean Science, and others.

Total incoming resources for 2017/18 together with other income from charitable activities, are reported at £2,300,000.

The CPR Survey is dependent on securing funding from external sources through contracts and grants to enable it to continue its work. Different sources of funding continue to be investigated in order to diversify the funding stream. **JN**

- Department for Environment Food & Rural Affairs (Defra) - UK
- Natural Environment Research Council (NERC) - UK
- NERC Other - UK
- National Science Foundation/Woods Hole Oceanographic Institution - USA
- Pacific Research
- European Union Projects
- Institute of Marine Science - Norway
- Other
- Ministry of Fisheries & Oceans - Canada
- INSITE Programme
- BEIS -Dept of Business, Energy and Industrial Strategy
- Marine Ecosystems Research Programme (MERP) - UK
- NEXEN Energy (Oil & Gas)
- Bermuda Institute of Ocean Science
- DTU Aqua - Denmark

Global Alliance of CPR Surveys

The Global Alliance of Continuous Plankton Recorder Surveys, known as GACS, brings together CPR surveys around the globe to foster collaboration within the CPR community and to act as an interface between it and other global observing programmes.

GACS partners continued their surveys in 2017 adding a valuable additional year of samples and data.

For MedCPR the effects of seasonality are now evident, demonstrating that even with just three years of data new insights can be gained.

The Brazil Southern-Ocean CPR Survey now has a PhD student examining spatial changes in the zooplankton communities of Drakes Passage and nearby Straits.

Some surveys have had logistical challenges with ships but have nonetheless maintained sampling (AusCPR and the North Pacific CPR Survey). There are often fluctuations in funding security resulting, this year, in some cut backs in the North Atlantic survey and a suspension of sample analysis in the NW Pacific survey.

The Southern Ocean Survey is working on a 25 year report to SCAR that will bring together all of the data collected by the partners during this time, a remarkable achievement.

The annual GACS meeting, hosted by SAHFOS, occurred in December 2017 in Plymouth. Energetic discussions on developments in sensors, microplastics measurements and data analysis arose.



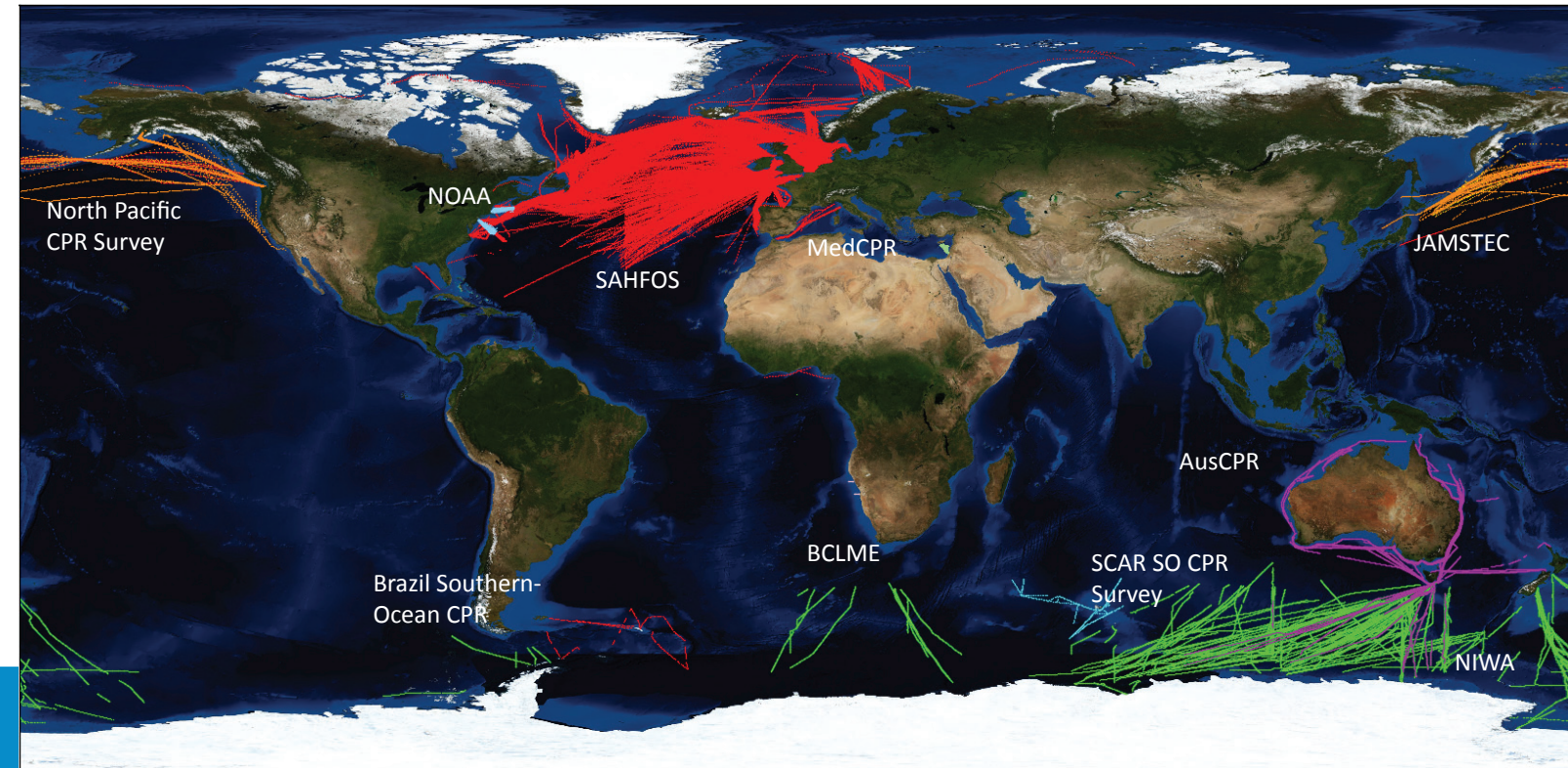
December 2017 meeting of GACS members who travelled to Plymouth from Japan, Australia, Canada, South Africa and Cyprus

Ending with enthusiastic consensus on next steps, and the database and new data products are expected to be ready in 2018.

There is ever increasing awareness of the needs of globally consistent biological time series, evident in initiatives such as the GOOS Biology and Ecosystems Panel, Biodiversity Information Partnership and the upcoming OceanObs 19 conference, and GACS is well placed to contribute with many of its members active in these initiatives. **SB**

To find out more about the
Global Alliance of CPR Surveys
please visit our website
www.globalcpr.org

Global CPR Tows: Sample Positions



Established in 1931, the Continuous Plankton Recorder (CPR) Survey is the longest running, most geographically extensive marine ecological survey in the world. The Survey is a globally recognised leader on the impacts of environmental change on the health of our oceans. It provides the scientific and policy communities with a basin-wide and long-term measure of the ecological health of marine plankton.

The CPR Survey Team is based in Plymouth, England, and consists of scientists, technicians and administrators, who all play an integral part in the running of the Survey.

Follow us
@cprsurvey



CPR Survey
The Laboratory, Citadel Hill
Plymouth, PL1 2PB, UK
Tel: +44(0)1752 426492

cprsurvey@mba.ac.uk
www.cprsurvey.org
www.mba.ac.uk/cprsurvey.ac.uk